LIVING TINY

A discrete choice experiment on the preferences of young one- and two-person households towards sustainable Tiny Houses

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Living Tiny

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Preface

This report is written as the final product of my master Construction Management and Engineering at Eindhoven University of Technology. Over the past six months I have studied information about Tiny Houses and I have conducted a study into the housing preferences of starters regarding Tiny Houses. This research was established based on two problems or developments that occupied me and my environment.

Firstly, as an almost graduated student, I have a lot to do with recent graduates who (have to) leave their (student)houses and are looking for a new house. However, immediately the problems starters have concerning the search for a house arise: high rents, no permanent working contract or too little registration time. Most of them mentioned that they just wanted an affordable house in the city, surface and other factors were not that important. With the prospect that I too will have to leave my home when I graduate, it seemed interesting to investigate the possibilities for starters at the housing market.

The second factor that strongly determined my graduation research is sustainability, a very relevant topic at the moment. I am well aware that it is necessary to reflect on the consequences that choices may have on the environment, for example. However, I also see that not everyone around me is aware of it, while we can achieve more together than alone. What I noticed was that in my immediate environment, full of students, changes are taking place, stronger than in the environment of my parents, for example. People have started to eat less meat, or choose more consciously for the products they buy, because they are more sustainably produced. With this in mind, it seemed interesting to discover which factors influence the choice behavior of (young) people and how sustainability affects this choices.

A topic that can combine sustainability and starters on the housing market is 'Tiny Houses'. This concept appeals to me right away, because of the efficient use of space, sustainability and the awareness of the choices you make came together in one concept. In addition, a Tiny House offers possibilities to build and design your own house according to your own wishes and saves space for other houses. During the research I have only become more enthusiastic about the possibilities of Tiny Houses, so it is not impossible that I will ever live in a Tiny House myself.

Of course, this study would not have succeeded without any help. First of all, I would like to thank my supervisors at the university, Mr. Borgers, Ms. Dane and Mr. de Vries, for their input, support and knowledge. Despite the problems with the mail system, I could always count on help. Thank you very much! I would also like to thank my parents, family and friends for their interest and gifts regarding Tiny Houses and for being test subjects for, for example, the questionnaire. Special thanks to Mike for listening to the enthusiastic and unenthusiastic stories about the project and hearing about and repairing my (computer)problems. Thanks, without your help, I could not have had done it this way!

With this report I completed a great student life in Eindhoven. I have been enjoying it for the past years and therefore I would like to thank my fellow students in my study and student association.

Finally, I hope that this report offers new opportunities and also interests others. Not necessarily to live in a Tiny House, but above all to consciously reflect on the influence that your choices may have on, for example, the environment.

Sascha Peters

Summary

The expected growth of the population and urbanization are expected to cause major problems, especially in the cities. The expectation is that Dutch cities will grow strongly in the coming years and within the cities the number of single-person households will mainly increase (CBS, 2016). These single-person households consist mainly of widowed older people and new starters on the housing market. The growing population will raise problems with regard to locations for housing, but also for a growing environmental impact through, among other things, more consumption and transport (United Nations, 2018). In addition, the living area per inhabitant is increasing strongly, which will reinforce the problems surrounding sustainability and space for homes (CBS, 2018d).

Tiny Houses could be a solution for (part of) the housing and sustainability problems. Tiny Houses are dwellings with a maximum surface that may or may not be on wheels and may or may not be self-sufficient. Residents often opt for this type of housing from financial or environmental considerations (Mutter, 2013). Because of their small size, they occupy a limited space and are more sustainable than larger houses. These small dwellings will be of particular interest to young starters on the housing market in small households. The independently living respondents of this age group, Generation Y, often live with one or a maximum of two people and earn too much for the social sector, but too little for the private sector. However, Generation Y likes to live in the city, in an attractive, easily accessible location, to be flexible with regard to their employment situation, for example. Often the costs for such housing are very high (Dalhuisen-Timmermans, 2013).

This research therefore contributes to the knowledge and insights regarding Tiny Houses and aims to answer the following question: *What are the preferences of one- and two-person starter households (Generation Y) with regard to living in a sustainable Tiny House in the Netherlands?* This question is answered by means of a literature review and a discrete choice experiment.

In the area of living preferences, the most important attributes are costs, surface, sustainability and location of the house. In addition, Generation Y would have few problems with sharing facilities (Dalhuisen-Timmermans, 2013) and the type of home, i.e. the placement of Tiny Houses relative to each other, has an important influence on the sustainability of the home. The preferences for each of these attributes therefore have been tested in the choice experiment.

For the choice experiment, several Tiny Houses were designed on the basis of six attributes, each with three levels. These Tiny Houses were presented to the respondents in choice sets. Each of the respondents was asked in a questionnaire to choose nine times between two Tiny Houses or to opt for the 'none of both' option. This is to simulate the real market situation as well as possible. These questionnaires were distributed on social media, the TU/e campus and at the Eindhoven railway station. In addition to the choice sets, there are also asked a number of personal questions about the personal characteristics and living situation of the respondents. The data obtained from this questionnaire were analyzed with discrete choice models. On this basis, insights were gained into the preferences of all respondents and of different clusters of respondents.

With more than 300 responses in the age between 18 and 30, there appeared to be great interest in the topic Tiny Houses from the target group. The results also show that the majority of the respondents prefer a Tiny House instead of the option 'none'. The results show that the general preference of the respondents goes to a detached or terraced Tiny House of at least 23.5 m^2 with garden or balcony in the city center. In addition, it appears that the respondents prefer not to share facilities, but they do want a sustainable energy generating PVT system. The respondents can be

further classified, based on their preferences with regard to Tiny Houses. The first cluster consists of 25 percent of the respondents, contains relatively many respondents aged 23 or younger and is very interested in relatively small and sustainable Tiny Houses. This cluster has therefore received the label 'Tiny House lovers'. The second and largest cluster consists of 58 percent of the respondents. Since both the characteristics and the preferences of this cluster are very similar to the entire dataset (preferences for relatively large and urban Tiny Houses), this cluster is labeled as 'Tiny House moderates'. The third and smallest cluster is the counterpart of the first cluster with relatively many respondents aged between 24 and 30 and with a limited interest in Tiny Houses. These respondents, with the label 'Tiny House critics', prefer relatively large Tiny Houses in a non-urban environment.

From the research it can be concluded that Tiny Houses can be a solution to solve some of the problems surrounding urbanization and sustainability. Given the interest in Tiny Houses, part of the target group is willing to live on a smaller surface. For an effective policy the focus should mainly be on very young starters from the 'Tiny House lovers' cluster. In addition to their preferences for small and sustainable Tiny Houses, they have no specific preference for a type of Tiny House. The other two clusters, on the other hand, prefer a detached or terraced Tiny House, instead of the most sustainable and space-saving flat of Tiny Houses. As a result, the preferences of these respondents must be traded of against the advantages in terms of sustainability and urbanization. It can be taken into account that free-standing and terraced Tiny Houses offer more possibilities for solar panels.

The results from this research can be used by organizations such as housing corporations, municipalities and Tiny House developers. They offer tools to respond to the housing preferences of Generation Y, young starters in the housing market. By responding appropriately to these residential preferences, smaller homes can become more interesting, resulting in more and more sustainable houses on the same surface. This is interesting for both housing corporations and municipalities, since it combines living preferences with sustainability requirements. Finally, Tiny House developers can use the insights into preferences regarding Tiny Houses to develop appropriate Tiny Houses to attract new customers.

Samenvatting

De verwachte groei van de bevolking en verstedelijking zullen naar verwachting zorgen voor grote problemen, vooral in de steden. De verwachting is dat de Nederlandse steden de komende jaren sterk zullen groeien en binnen de steden zal voornamelijk het aantal éénpersoonshuishoudens stijgen (CBS, 2016). Deze eenpersoonshuishoudens bestaan voornamelijk uit ouderen die hun partner verloren hebben en nieuwe starters op de woningmarkt. De groeiende bevolking zal zorgen voor problemen met betrekking tot locaties voor huisvesting, maar ook voor een groeiende milieubelasting door onder andere meer consumptie en transport (United Nations, 2018). Ook het woonoppervlakte per inwoner zal sterk stijgen, wat de problemen rondom duurzaamheid en ruimte voor woningen zal versterken (CBS, 2018d).

Tiny Houses zouden een oplossing kunnen zijn voor (een deel van) de woning- en duurzaamheidsproblemen. Tiny Houses zijn woningen met een maximaal oppervlak die al dan niet op wielen staan en al dan niet zelfvoorzienend zijn. Vaak kiezen bewoners voor deze vorm van wonen uit financiële of milieubewuste overwegingen (Mutter, 2013). Door hun kleine oppervlakte nemen ze een beperkte ruimte in en zijn ze duurzamer dan grotere woningen. Deze kleine woningen zullen vooral interessant zijn voor jonge starters op de woningmarkt in kleine huishoudens. De zelfstandig wonenden uit deze leeftijdsgroep, Generatie Y, wonen vaak met één of maximaal twee personen en verdienen te veel voor de sociale sector, maar te weinig voor de particuliere sector. Echter woont Generatie Y graag in de stad, op een aantrekkelijke, goed bereikbare locatie, om flexibel te zijn voor bijvoorbeeld werk. Vaak zijn de kosten voor dergelijke woningen zeer hoog (Dalhuisen-Timmermans, 2013).

Dit onderzoek draagt daarom bij aan de kennis en inzichten met betrekking tot Tiny Houses en heeft als doel om de volgende vraag te beantwoorden: *Wat zijn de voorkeuren van één- en tweepersoons starters huishoudens (Generatie Y) met betrekking tot het bewonen van een duurzaam Tiny House in Nederland?* Deze vraag is beantwoord aan de hand van een literatuuronderzoek en een keuze-experiment.

Op het gebied van woonvoorkeuren blijken de meest belangrijke attributen kosten, afmetingen, duurzaamheid en locatie van de woning te zijn. Daarnaast zou Generatie Y weinig problemen hebben met het delen van voorzieningen (Dalhuisen-Timmermans, 2013) en heeft het type woning, (de plaatsing ten opzichte van elkaar) een belangrijke invloed op de duurzaamheid van de woning. De voorkeuren voor elk van deze attributen zijn dan ook getest in een keuze-experiment.

Voor het keuze-experiment zijn verschillende Tiny Houses ontworpen op basis van zes attributen, elk met drie levels. Deze Tiny Houses zijn in keuzesets voorgelegd aan de respondenten. Elk van de respondenten is in een vragenlijst gevraagd om negen keer een keuze te maken uit twee Tiny Houses of te kiezen voor de optie 'geen van beiden'. Dit om de reële marktsituatie zo goed mogelijk na te bootsten. Deze vragenlijsten zijn verspreid op sociale media, de TU/e campus en op het treinstation van Eindhoven. Naast de keuzesets zijn er ook nog enkele persoonsgebonden vragen over persoonlijke kenmerken en woonsituatie gesteld aan de respondenten. De verkregen data uit deze vragenlijst zijn geanalyseerd met discrete keuze modellen. Op basis hiervan zijn inzichten verkregen in de voorkeuren van alle respondenten en van verschillende clusters van respondenten.

Met ruim 300 respondenten met een leeftijd tussen 18 en 30 jaar bleek er grote interesse te zijn in het onderwerp Tiny Houses vanuit de doelgroep. Ook blijkt dat het grootste gedeelte van de respondenten de voorkeur geeft aan een Tiny House in plaats van aan de optie 'geen van beiden'. De resultaten tonen aan dat de algemene voorkeur van de respondenten uitgaat naar een vrijstaand of rijtjes Tiny House van ten minste 23.5 m^2 met tuin of balkon in het stadscentrum. Daarnaast blijken de respondenten liever geen faciliteiten te delen, maar hebben ze wel graag een duurzaam energieopwekkend PVT systeem. Een verdere verdeling van de respondenten, in drie clusters, kan worden gemaakt op basis van hun voorkeuren met betrekking tot Tiny Houses. Het eerste cluster bestaat dan uit 25 procent van de respondenten, bevat relatief veel respondenten van 23 jaar of jonger en is zeer geïnteresseerd in relatief kleine en duurzame Tiny Houses. Dit cluster heeft dan ook het label 'Tiny House lovers' gekregen. Het tweede en grootste cluster bestaat uit 58 procent van de respondenten. Aangezien zowel de kenmerken als de voorkeuren van dit cluster sterk overeen komen met de gehele dataset (voorkeur voor relatief grote en stedelijke Tiny Houses) is dit cluster gelabeld als 'Tiny House gematigden'. Het derde en kleinste cluster is de tegenhanger van het eerste cluster met relatief veel respondenten tussen de 24 en 30 jaar en met een beperkte interesse in Tiny Houses. Deze respondenten, met het label 'Tiny House critici', geven de voorkeur aan relatief grote Tiny Houses in een niet stedelijke omgeving.

Uit het onderzoek kan worden geconcludeerd dat Tiny Houses een oplossing kunnen zijn om een deel van de problemen rondom verstedelijking en duurzaamheid op te lossen. Gezien de interesse in Tiny Houses is een deel van de doelgroep bereid om op een kleiner oppervlakte te gaan wonen. Voor een effectief beleid zal de focus voornamelijk moeten liggen op zeer jonge starters uit het 'Tiny House lovers' cluster. Naast hun voorkeuren voor kleine en duurzame Tiny Houses, hebben zij geen specifieke voorkeur voor een type Tiny House. De andere twee clusters geven namelijk de voorkeur aan een vrijstaand of rijtjes Tiny House, in plaats van de meest duurzame en ruimtebesparende flat van Tiny Houses. Hierdoor zullen de voorkeuren van deze respondenten dan ook afgewogen moeten worden tegen de voordelen op gebied van duurzaamheid en verstedelijking. Hierbij kan wel worden meegenomen dat vrijstaande en rijtjes Tiny Houses meer mogelijkheden bieden voor zonnepanelen.

De resultaten uit dit onderzoek kunnen worden gebruikt door instanties zoals woningcorporaties, gemeenten en Tiny House ontwikkelaars. Ze bieden handvatten om in te spelen op de woonvoorkeuren van Generatie Y, jonge starters op de woningmarkt. Door op de juiste manier in te spelen op deze woonvoorkeuren, kunnen kleinere woningen interessanter worden, wat zorgt voor meer en duurzamere woningen op hetzelfde oppervlakte. Dit is zowel voor woningcorporaties als voor gemeenten interessant, aangezien het de woonvoorkeuren combineert met duurzaamheidseisen. Tot slot kunnen Tiny House ontwikkelaars de inzichten in de voorkeuren met betrekking tot Tiny Houses gebruiken om passende Tiny Houses te ontwikkelen om zo nieuwe klanten te lokken.

Abstract

Several studies show strong population growth and urbanization. This causes problems with regard to locations for housing, but also for a growing environmental impact through, among other things, more consumption and transport. By reducing the living surface, the problems regarding urbanization and sustainability can be met partly. A possible solution is therefore small living, living in a Tiny House. Research shows that mainly young starters, Generation Y, are an interesting target group for Tiny Houses, since they often live in small households and suffer serious disadvantages from the high costs of large dwellings. This research investigates the sustainability of Tiny Houses through a literature review. In addition, a discrete choice experiment is carried out concerning the preferences of Generation Y with regard to Tiny Houses. The results give insight in preferences for the following attributes: surface, outdoor space, shared facilities, type of house, sustainable system and location. Research data was collected from 300 respondents, mostly aged between 18 and 30 years. The data has been analyzed with discrete choice models. The results show, among other things, that the respondents are interested in sustainable Tiny Houses, especially the younger respondents within the target group. These respondents have preferences for relatively small and sustainable Tiny Houses, without specific preference for a specific type of Tiny House. The older respondents, on the other hand, prefer a detached or terraced Tiny House, instead of the most sustainable and space-saving flat of Tiny Houses. As a result, the preferences of these respondents must be traded of against the advantages in terms of sustainability and urbanization. By responding in the right way to the residential preferences of (a part of) the target group, smaller houses can become more interesting, resulting in more and more sustainable houses on the same surface.

Keywords: *Tiny Houses, urbanization, sustainability, housing preferences, choice experiment*

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Glossary

Choice experiment

A method with which preferences can be tested by giving respondents the choice between different hypothetical scenarios (Louviere, Flynn, & Carson, 2010)(Louviere et al., 2010). This gives the possibility to test a (relatively) new product.

Housing preferences

The preferences for different residential factors, attributes, that influence the choice for buying or renting a property. These attributes can relate to location, neighborhood and dwelling (Jhun Kam, Sheng Hui Lim, Al-Odaibi, & Shwan Lim, 2018).

Small living

The conscious choice to live in a smaller home. The house must be permanently inhabited and therefore not serve as a second (holiday) house (Mutter, 2013).

Sustainability

The impact on the depletion of natural resources, which can disturb the ecological balance. For a building, a part of the sustainability can be determined on the basis of the energy consumption of the property and the way the energy source is obtained. Energy consumption can be divided into electricity consumption and space heating (and cooling) (Schamhart, 2006).

Tiny House

A house where it is important that no more space is taken than is considered necessary for the resident(s) (Van der Heijden, 2016). This is therefore a house with a relatively small maximum surface area, often about 30 m^2 maximum. In addition, there are (partially) self-sufficient Tiny Houses or Tiny Houses on wheels, but this is not necessary.

Urbanization

The process whereby more people travel to the city, making an area more urban. This is accompanied by a higher demand for, for example, facilities and goods in a specific area.

CHAPTER 1
INTRODUCTION

First Tiny House in the Netherlands
Owner: Marjolein Jonker, 2016
(Jonker, 2017)

1. Introduction

This chapter describes the problem definition and context of the research. The problem is briefly explained in section 1.1, after which the goal and the research questions are described in section 1.2. Furthermore, the importance and limitations of the research are described in sections 1.3 and 1.4. Finally, section 1.5 contains a reading guide as a handle for the following chapters.

1.1 Population and housing trends

At the moment, the world's population is over 7.5 billion and the expectations are that this number will increase significantly, up to nearly 10 billion by 2050 (United Nations, 2018). This population growth is accompanied by urbanization. At present, about 55 percent of the world's population lives in urban areas and by 2050 that is expected to be 68 percent (United Nations, 2018). The increase in population and urbanization entails some challenges and problems, for example in the areas of transport, housing, employment and energy needs, but also with regard to other facilities such as food, health care and education (Mutter, 2013). In order to ensure sustainable development of the cities, a successful management of the urban growth is necessary, at which it is important to build on a sustainable way that meets the long-term demands (United Nations, 2018). To this end, it is important to know the wishes of the (future) residents.

The growing demand for facilities and goods also creates a higher environmental impact. Statistics indicate that mobility, food, housing and demolition provide 80 percent of the environmental impact during their life cycle (Mutter, 2013). The houses in particular have a major impact on this, due to the growing surface per dwelling (Mutter, 2013). A larger surface area involves the use of more sources, both in construction and in usage (Wilson & Boehland, 2005). Cited from Wilson and Boehland (2005): *"Ahluwalia, the director of research at NAHB estimates that a new 5,000-square-foot house will consume three times as much as the 2,082-square-foot house NAHB has modeled, even though its square footage is only 2.4 times as large"*.

The extra energy that is used for this causes more and more exhaust gases ending up in the atmosphere, which causes pollution. Many studies indicate that a large part of the total energy is used in the construction and residential sector. According to Initiafy (2017), approximately 40% of the total energy is used in the construction sector and it is expected that this will increase by 1.8% in 2030. From this 20% (Belaïd & Garcia, 2016) to 27% (Thøgersen, 2017) is used for space heating, water heating and electric applications. Fortunately, more and more people are becoming aware of the importance of living a more sustainable life. A conscious choice is made to buy products that are better for the environment (Lachman & Brett, 2010), buildings are better (after) isolated (Aarts, Bakker, Schellen, & Hak, 2005) and solar energy and other forms of alternative energy are increasingly being used (Sampaio & González, 2017).

A similar problem occurs in the Netherlands, since the Dutch population is expected to grow from 17 to 18 million people in 2030 (CBS, 2016). Around 75 percent of this growth will take place in and around the cities (CBS, 2016). Besides that, The average surface of a house in the Netherlands has risen from 108 m2 for a house built between 1945 and 1955 to 126 m2 for a house built between 2005 and 2015 (CBS, 2018d). However, the size of a household has shrunk from an average of 3.56 people per household in 1960 to 2.22 people per household in 2010 (CBS, 2017). This decrease in the number of people per household has to do with the growing number of single-person households (CBS, 2016). It is expected that, by 2030, 70 percent of the households in the cities will be single-person households (CBS, 2016). These single-person households will mainly consist of older people, who are left-alone after the death of their partners, and of students or graduates, who will live on their own (CBS, 2016).

In contrast with the growth of the living area, another trend is coming up, namely the trend of small living. Small living is a trend based on the principles of "minimizing, de-cluttering, and downsizing" (Ford & Gomez-Lanier, 2017). According to the followers, living on a smaller surface gives more freedom (Anson, 2014) and possibilities to enjoy life to its fullest (Van der Heijden, 2016) and to gain new experiences. Due to the smaller surface Tiny House owners are used to spend more time outdoors (Pflaumer, 2015). Research by Dopper and Geuting (2017) indicates that small living is seen mainly as a solution for starters and to a lesser extent for students.

Concluding from the above, it is expected that by 2030 a significant proportion of the households will be single-person households of students and graduates, starters in the housing market (CBS, 2016). In addition, research indicates that small living is expected to best fit starters, and possibly students (Dopper & Geuting, 2017). This group is also described as 'Generation Y', the people born between 1980 and 1997 (Jhun Kam et al., 2018).

Generation Y thinks it is more important to gain experiences (Dalhuisen-Timmermans, 2013) and to spend time outdoors (Jhun Kam et al., 2018) than to have (large) possessions. They prefer to be flexible in their location for example for working (Jhun Kam et al., 2018). This group wants to live affordable in a nice location, preferably in a city (Dalhuisen-Timmermans, 2013). However, they often earn too much for social rent, but too little for the private sector, which makes finding a home almost impossible (Dalhuisen-Timmermans, 2013). These (too) high prices are reinforced by the growing house surface and a high house demand.

Conclusion

In conclusion, the growing population and urbanization are creating a growing environmental impact. Only with good management of the urban growth, by responding to the housing requirements of the future residents, this can be limited. However, not only the population growth causes environmental problems, but also the trend in which the houses are getting bigger, while the number of people in a household is getting smaller and smaller, contributes to this. These larger homes are less sustainable than smaller homes. With a view on the growing number of single households and overall population and thus the rising number of houses, the environmental impact is expected to grow in the future.

A counter trend that increasingly comes to mind is small living. Because of their smaller area, these homes are more affordable, more sustainable and they take up less space. Because of the small size, residents will be stimulated to spend more time outdoors. Finally, it can be stated that especially starters, ‘Generation Y’, are the victims of the larger homes. Although a large part of the urban population consists of single-person households of Generation Y, the houses in the cities are unaffordable for them. On the other hand this group has a flexible attitude and the preference is for gaining experiences outside the door instead of having possessions. So small living might be a fitting solution for them.

1.2 Research problem

With regard to the climate, developments in the field of sustainability are becoming increasingly important. A smaller house reduces energy emissions, but the homes in the Netherlands are getting bigger and bigger. At the same time, more and more single-person households are entering the housing market, where mostly young starters have difficulty finding an affordable home that meets their needs. Therefore, the aim of this research is to gain insight into the preferences of young one- and two-person starter households to live in a sustainable Tiny House and which conditions should be met.

1.2.1 Research questions

This research is based on the following main question and sub-questions.

What are the preferences of one- and two-person starter households (Generation Y) with regard to living in a sustainable Tiny House in the Netherlands?

To come to this main question, the following sub-questions need to be answered:

1) What are the main developments on the Dutch housing market, especially for starter households?
2) What is meant by 'small living' and 'Tiny House'?
3) What can make a (Tiny) House sustainable?
4) Who are Generation Y and what are their characteristics?
5) Under what conditions is Generation Y prepared to live in a Tiny House?
6) What are preferences of starter households regarding
    a. the location of the Tiny House?
    b. the design of the Tiny House?
    c. the sustainability of the Tiny House?
7) How are these preferences affected by respondent-related characteristics of Generation Y?

1.3 Research design

Two research methods will be used in the research, namely literature research and a discrete choice experiment (DCE). The data obtained from DCE will be analyzed with different multinomial logit (MNL) models to gain insight into the results.

1.3.1 Literature review

First, a literature review will be conducted to gain insight into the state-of-the-art with regard to small living and Tiny Houses, sustainability and housing preferences. The literature review will give an overview of the existing studies in these fields. In addition, the literature will provide insight into the design decisions for the basic Tiny House in this study and the attributes and levels used in the DCE (see figure 1).

1.3.2 Discrete choice experiment

To carry out the discrete choice experiment, a number of steps have to be taken (see figure 1). Literature is used for the selection of attributes and levels, as well as for the design of a basic Tiny House. The attributes and levels lead to profiles and choice sets and together with the basic Tiny House and demographic questions they will be the questionnaire for the respondents. The data obtained from this questionnaire is then analyzed, after which a conclusion can be drawn from this study.

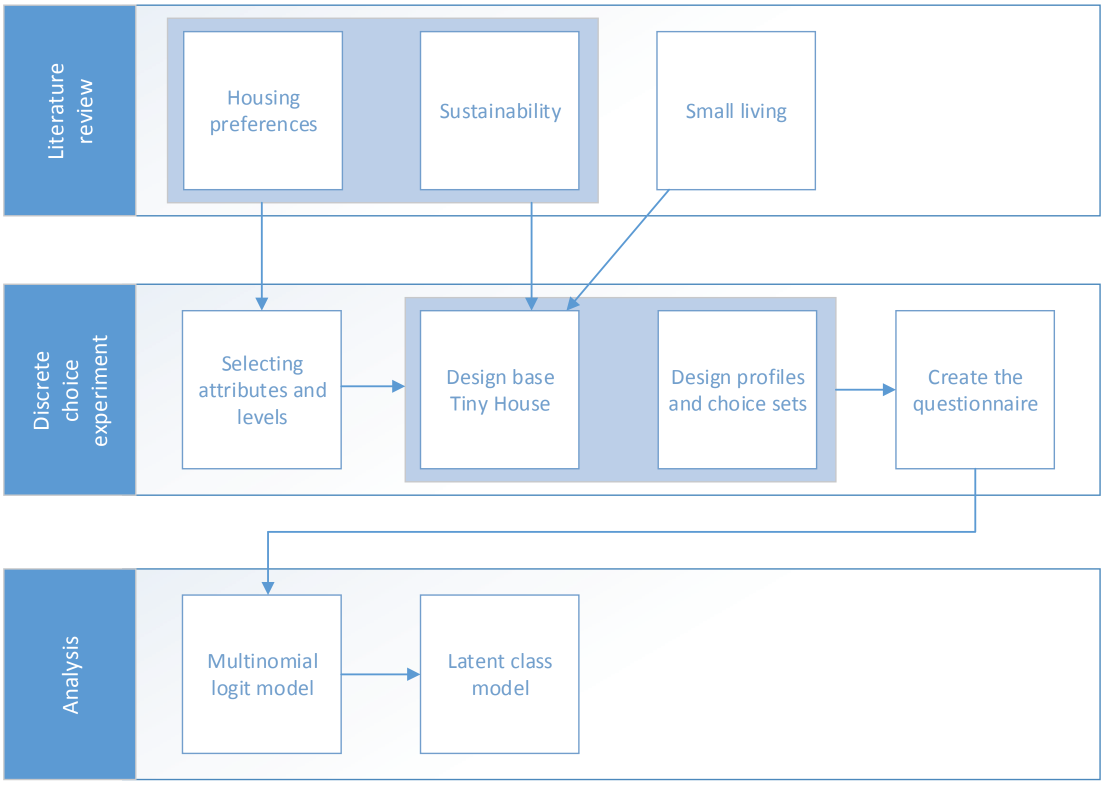


Figure 1 The research design

1.4 Expected results and relevance of the study

Based on the expected results, the added value of this research can be explained. The relevance of this research can be divided into scientific or theoretical relevance and social or practical relevance. The first part will therefore focus on the added (literary) knowledge that this research will bring, while the second part deals more with the insights that the research will provide for municipal institutions and commercial parties such as housing corporations and Tiny House developers.

1.4.1 Expected results

This research will be carried out as a graduation research for the Construction Management and Engineering program at the Eindhoven University of Technology. The goal is to find an answer to the question:

What are the preferences of one- and two-person starter households (Generation Y) with regard to living in a sustainable Tiny House in the Netherlands?

It is expected that this research will provide the following insights:

- Provide insight into some possibilities that Tiny Houses offer with regard to sustainability.
- Provide insight into the preferences of small starters households with regard Tiny Houses.
- Provide insight into sustainable Tiny Houses that are suitable for starters.

1.4.2 Theoretical relevance

Since the Tiny House movement only reached the Netherlands in 2015, this is a relatively new area, where little research has been done. In addition, the investigations undertaken are generally aimed at Tiny House residents or interested parties. Clearly, less research has been done into the sustainable effects of a Tiny House in itself, without the addition of sustainable systems. This research will therefore contribute to the knowledge about Tiny Houses in the Netherlands, with the focus on one and two person households instead of Tiny House residents or interested parties. It will also provide more insight into the positive energy effects that Tiny Houses have compared to larger homes.

Many studies have already been carried out in the area of general living preferences, for example by (Chia, Harun, Wahid Mohd Kassim, Martin, & Kepal, 2016; Hurtubia, Gallay, & Bierlaire, 2010). Some studies have already been carried out in the field of housing preferences of starters (Jhun Kam et al., 2018; Lachman & Brett, 2010). By combining these living preferences with the preferences to choose for a Tiny House, the possibility arises to look at the preferences regarding Tiny Houses of starters in the housing market.

For examining residential preferences, a discrete choice experiment is a suitable method (Kuhfeld, 2010). it gives insight into the relative importance of different attributes and attribute levels (Nijënstein, 2012). A good method to analyze the acquired data is the multinomial logit (MNL) model, where it is also possible to include some interactions between the attributes. In addition, a latent class (LC) model can be used to distinguish between different clusters of respondents (Hensher, Rose, & Greene, 2015).

1.4.3 Practical relevance

With the current growth of the Dutch population, especially in the cities (CBS, 2016) and the growing number of single-person households (CBS, 2016), the shortage of affordable housing for starters will only increase (Dalhuisen-Timmermans, 2013). In addition, the European Union, the Netherlands and individual municipalities are working on various climate schemes to reduce CO2 emissions (Van der Heijden, 2016). This research provides insight into the possibilities that Tiny Houses offer in terms of sustainability, and the degree of interest and preferences for Tiny Houses by one and two person households.

Many young starters are currently looking for a home and have certain wishes, mainly about the location, price and flexibility (Dalhuisen-Timmermans, 2013). By meeting these requirements with small sustainable houses, it is perhaps possible to solve some of these problems. In addition, it is interesting for commercial institutions such as housing corporations or Tiny House developers to have insight into the preferences regarding Tiny Houses in order to be able to respond on these preferences.

1.5 Reading guide

This chapter provided background information about the research. The next chapter, chapter two, will further discuss the state-of-the-art situation around small living, sustainability and housing preferences. In chapter three the used method, discrete choice experiment, is further explained. It provides an overview of the steps taken to get data. Chapter four discusses the analysis of this data using various multinomial logit models. The respondents are described, as well as their preferences with regard to sustainable Tiny Houses. Finally, chapter six, this chapter contains the conclusions regarding this research. It will discuss the relevance of the research. In addition, some recommendations will be made for future (follow-up) research.

CHAPTER 2

LITERATURE REVIEW

One of the first 'Tiny Houses'
Owner: Charles Miller of Ogden, 1929
(Greenless, 2011)

2. Literature review

This chapter examines the state-of-the-art in the fields of small living, sustainability and housing preferences with the help of literature. The meaning, origin and motivations for small living will be described in section 2.1. Section 2.2 will discuss some possibilities for saving energy and generating sustainable energy. Section 2.3 will provide insight into housing preferences in general, as well as from young starters in the housing market. Finally, section 2.4 contain a conclusion about the literature research.

2.1 Small living

Small living can be described in many ways. If there is a search on the internet for small living, then there are various search results, including student houses and holiday homes. These are two examples of living in a small home. However, the concept of small living in literature is often used differently. For example, in her definition of small living, Mutter (2013) assumes that there must be permanent residence, so that the house is occupied throughout the year. This means that a second (holiday) home is not covered in this definition. In addition, Dopper and Geuting (2017) indicates that the choice for small living should be made and that it should not arise from scarcity, such as for example permit holders and students. The choice to live small must therefore also be made intrinsic instead of extrinsic (Dopper & Geuting, 2017). Although small living initially sounds like living in a small home, this report will use the following, more common definition for small living:

"Small living is the conscious choice for living in a smaller permanent home" (Bartlett, 2016).

Often the exact size of the dwelling does not matter for small dwellings, but it is more important that no more space is taken than is considered necessary for the residents (Van der Heijden, 2016). Still, there are several sources that try to assign a value to the maximum area. The Tiny Life Blog (The Tiny Life, 2018) speaks about 100-400 square feet (about 10-35 square meter) and Mutter (2013) about a maximum of about 430 square feet (40 square meter), while in the book 'Tiny Houses minder huis, meer leven' (Van Orden, 2017) is spoken of an area smaller than about 540 square feet (50 square meter) .

Some studies speak of different concepts within small living (Dopper & Geuting, 2017; Van der Heijden, 2016). For example, Dopper and Geuting (2017) speak about the various forms: micro-living and Tiny Housing. According to Dopper and Geuting (2017), the central aspect to micro-living is location, therefore, an urban environment with proximity to facilities is desirable. Regarding Tiny Housing, on the other hand, sustainability is one of the key words and preference is given to an area with a low building density, with possibilities for own initiatives. However, Van der Heijden (2016) only speaks in terms of size when it comes to distinguishing between the different concepts of micro, tiny and small living. A micro dwelling is aimed at a single household, while in a small house a family would fit. Most studies, however, speak only of Tiny Houses or use the terms micro and tiny both in the same way (Ford & Gomez-Lanier, 2017; Pflaumer, 2015). In my research, no distinction will be made between different forms and only Tiny Houses will be discussed.

Just like the lack of clarity about the size of a Tiny House and the difference in denominations, there is no clear definition of what a Tiny House is. While some studies say that Tiny Houses should be on wheels (Bartlett, 2016; Murphy, 2014), others say that this is not necessary (Anson, 2014; Dopper & Geuting, 2017). While some studies say that Tiny Houses are by definition self-sufficient (Bartlett, 2016; Van der Heijden, 2016), or at least partially self-sufficient (Kilman, 2016), others say that most Tiny Houses have extra facilities to ensure sustainability, but that this is not necessary (Dopper & Geuting, 2017). In conclusion, it can be said that a Tiny House is a house with a maximum surface, which may or may not be on wheels and may or may not be (partially) self-sufficient.

2.1.1 Where do Tiny Houses come from?

Just like with almost everything around Tiny Houses, there is also some confusion about the origin of Tiny Houses. Tiny Housing is often seen as a new trend that has arisen to counter current problems (Ford & Gomez-Lanier, 2017). The origin of Tiny Houses, however, appears to lie further in the past. Anson (2014) indicates that there are already American photographs from the 1920's with examples of a form of Tiny House, the house-trucks, with the concrete example of the photo of Charles Miller of Ogden with his 'Tiny House' from 1929 (Greenless, 2011)(see photo on title page chapter 2). Another highlight of this movement in the past took place in the seventies in America (Anson, 2014; Van Orden, 2017).

The recent revival of this trend is also attributed to US soil. The publication of the books 'Tiny, Tiny Houses' by Lester Walker in 1987 and especially 'The Not So Big House' by Sarah Susanka in 1997 are seen as the starting point for the revival of Tiny Housing (Anson, 2014). Susanka won several prizes with her book and as a result she was a guest at Oprah Winfrey's show (Van Orden, 2017). With the publication of these books in combination with the foundation of the first company specializing in Tiny Houses in 2002, namely Tumbleweed Tiny House Company, this trend was gaining increasing recognition (Mutter, 2013). In addition, Jay Shaver, founder of Tumbleweed Tiny House Company, set up the platform 'Small House Society' (Van der Heijden, 2016) that same year. Thanks to this promotion in combination with problems such as homeless people after hurricane Katrina in 2005 (Van Orden, 2017) and unaffordable house prices due to the economic crisis in 2007 (Mutter, 2013), the Tiny Houses quickly became a success.

Japan saw another possibility in the Tiny Houses, namely a solution for the high population density in the Japanese cities. Among other architects, Denso Sugiura has designed at least 135 micro houses in the Japanese urban area in the past 20 years (Ford & Gomez-Lanier, 2017). In America, the Tiny Houses 'only' have been applied in the urban area since 2012. The first project was the Boneyard Studios in Washington D.C., an experimental Tiny House village (Ford & Gomez-Lanier, 2017).
In 2015, the movement of the Tiny Houses also spilled over to the Netherlands (Van Orden, 2017). Partly due to the creation of Foundation Tiny House Nederland in 2016 by Dutch Tiny House pioneers such as Marjolein Jonker and Marcel Hoekstra, Tiny Housing is also becoming more familiar in the Netherlands (Van Orden, 2017).

2.1.2 Why living in a Tiny House?

As previously mentioned Tiny Houses can be used to (temporarily) solving problems such as care for the homeless in a disaster (Van Orden, 2017) or as a response to an economic crisis (Mutter, 2013). However, most Tiny House residents themselves choose to live in a smaller house, instead of being 'forced' by circumstances. This choice for living in a Tiny House often goes hand in hand with the trend called Tiny Housing or the Tiny House movement, based on the houses (Van der Heijden, 2016). The reasons for this choice are different for everyone, but there are some overarching themes to be distinguished.

One of the most frequently heard arguments for living in a Tiny House is sustainability (Mutter, 2013; Wu & Hyatt, 2016). First, it is stated that a Tiny House by its small size is more sustainable than larger dwellings in both construction shaft as during operation (Wilson & Boehland, 2005). This is due to the smaller amount of material needed and the lower energy requirements for heating, cooling and lighting (Mutter, 2013; Wilson & Boehland, 2005; Wu & Hyatt, 2016). Many Tiny House residents are also willing to contribute extra to sustainability and aim to reduce their ecological footprint (Van Orden, 2017). This is for example done by using recycled materials according to the cradle2cradle principle (Van der Heijden, 2016), or by opting for less demanding equipment (Kilman, 2016; Pflaumer, 2015), or by generating electricity in an alternative and more sustainable way (Pflaumer, 2015).

Another recurring argument is costs. The bursting of the housing bubble in 2008 (Mutter, 2013), cutting back on housing allowance (Van der Heijden, 2016), and the growing living area (Wilson & Boehland, 2005), are some examples that have made housing more prohibitively expensive. Because of the small surface area and the lower operating costs, Tiny Houses are more affordable, so this aspect is also important when choosing for a Tiny House (Anson, 2014; Mutter, 2013).

A third, often heard argument for Tiny Houses, is the possibility of freedom. Due to lower housing costs, money remains for other things such as leisure time, friends and volunteer work (Anson, 2014; Mutter, 2013). Also life without debt (Van der Heijden, 2016) and the need to spend more time outdoors in the community (Pflaumer, 2015) are experienced as freedom. Closely connected to freedom is the mobility that Tiny Houses on wheels can bring with (Mutter, 2013). Because of the mobility of the house and the savings on costs, Tiny Houses on wheels makes traveling easier (Mutter, 2013; Van der Heijden, 2016).

Some other arguments that are regularly mentioned are the choice for a simpler life style with less stuff (Mutter, 2013) and with the focus on what is really important (Van der Heijden, 2016). An alternative community with like-minded people (Kilman, 2016; Mutter, 2013), living closer to nature (Van der Heijden, 2016) and focus on design and building, because of the small size it is more feasible to adapt the house to your own (aesthetic) wishes (Anson, 2014; Bartlett, 2016).

A common problem among Tiny House residents is the regulations concerning the homes. These problems include the dimensions, necessary equipment, the financing and the location of the home (Ford & Gomez-Lanier, 2017; Kilman, 2016; Mutter, 2013; Wilson & Boehland, 2005). In the case of a fixed foundation, minimum dimensions that must be met (Wilson & Boehland, 2005) as well as the presence of systems according the regulations (Ford & Gomez-Lanier, 2017), but this can be avoided by putting wheels under the house (Mutter, 2013; Pflaumer, 2015). On the other hand, having wheels under the house ensures that applying for a loan on the home is not or hardly possible (Kilman, 2016). Finally, a Tiny House cannot be placed in any place (Ford & Gomez-Lanier, 2017) and the rules in your area must be taken into account. However, there seem to be more and more opportunities for Tiny Houses (Ford & Gomez-Lanier, 2017; Van der Heijden, 2016) both in America and in the Netherlands.

2.2 Sustainability

Part of the sustainability of a house can be seen in the energy consumption of the property and the way the energy source is obtained. Energy consumption can be divided into electricity consumption and space heating (and cooling) (Schamhart, 2006). There are three aspects that influence the energy consumption of a building and the degree of sustainability of the energy (De Boer, Kaan, Jong, Koene, & Strootman, 2003):

1. Minimization of heat losses
2. The use of renewable energy sources
3. Efficient use of energy

Since the first two aspects focus mainly on the building itself and the third aspect focuses more on the use of the building by the end user, this section will only deal with the first two aspects. This section will first consider the energy losses that occur by heat transfer and then show a few opportunities to generate energy in a sustainable way.

2.2.1 Heat transfer

According to Ozel (2014) approximately 60 percent of the household energy requirement is for space heating and cooling. Research by Kurt (2010) and Bolattürk (2005) indicate that 40 percent of the total energy goes to heating homes. To heat the house heat transport takes place and therefore heat loss. Heat transfer occurs across the building envelope of a system to another system by virtue of a temperature difference between two systems (Kreider, Reddy, Curtiss, & Rabl, 2017). By transferring warm indoor air to cold outside air, a lot of heat is lost through the building envelope. According to Chen (2017) for example, the heat loss from the ground can be up to 50 percent of the total produced heat for space heating, and Schamhart (2006) speaks of potential heat losses by transmission of 75 percent through the building envelope. The remaining heat loss comes from ventilation. To limit these heat losses, it is important to create a building envelope with good insulation that creates both thermal comfort and reduces energy consumption (Ozel, 2014; Schamhart, 2006).

There are three forms of heat transfer, namely heat transfer through conduction, through convection and through radiation (Kreider et al., 2017). In a building, all three forms of heat transfer often take place (Aarts et al., 2005). A radiator sent electromagnetic waves with a strong spectral dependence into the room (radiation) (Kreider et al., 2017), creating a heat flow from heated air through contact with a surface at a different temperature (convection) (Kreider et al., 2017). And when this air flows along the walls, the heat is transferred through the different layers of the walls through conduction (Schamhart, 2006). There are two forms of convection heat transfer, namely natural and forced convection heat transfer. With natural convection heat transfer the air flow is caused by a naturally created temperature difference between surface and air (Aarts et al., 2005). In forced convection heat transfer, the flow is caused by another driving force, such as the wind or a fan (Kreider et al., 2017).

So far there is mainly spoken about heat transfer, moving heat from one place to another. As soon as this air is moved from inside the building shell to the outside of the building shell, heat loss occurs (Aarts et al., 2005). As for electromagnetic radiation in this situation beams are sent out within the same room (Kreider et al., 2017), there is heat transfer, but not heat loss from radiation.

For this research, an estimate of energy costs will be made for various Tiny Houses. Since the measurement of temperatures over a longer period of time is not part of the scope of this study, an average annual temperature for the indoor and outdoor space will be used. The difference in average annual temperature indoor and average annual temperature outdoor thus determines the temperature difference between inside and outside. By assuming fixed values for the indoor and outdoor temperature, no heat generation on a certain moment by, for example, radiators will be included. As a result, these averages will be assumed as temperatures for both the air as well as the walls inside and outside the home. Since there is no difference in temperature between the building shell and the air that flows along it, there is no natural convection in this situation.

Conduction heat transfer

In heat transfer by conduction, conduction takes place through the different layers of the outer shell. The factors that influence this transfer are the build-up of the shell and its material properties, the surface of the outer shell and the temperature difference between inside and outside (Schamhart, 2006). The corresponding formulas are (Kurekci, 2016):

$$q_{con} = U * \Delta T \qquad (1a)$$

$$U = \frac{1}{R_c} \qquad (1b)$$

$$R_c = R_{ins} + R_i + R_o \qquad (1c)$$

$$R_{ins} = \frac{x}{k} \qquad (1d)$$

q = conduction heat loss per unit of the external wall (W/m^2)
U = heat transfer coefficient (W/m^2K)
ΔT = difference in outside air temperature and constant inside air temperature (K)
R_c = total insulation resistance of the element (m^2K/W)
R_i and R_o = heat transfer coefficients of the inside and outside environment (m^2K/W)
R_{ins} = thermal resistance of the insulant (m^2K/W)
x = thickness of the material (m)
k = conductivity coefficient of the insulant (W/mK)

In order to come from the total heat transfer to the total heat loss of the building envelope, the surface of the outer shell must be taken into account. According to the Building Regulations, the requirements for floor, roof and wall are given on the basis of the minimum Rc value, while the requirements for windows and doors are given on the basis of the maximum U-value (Bris Bouwbesluit, 2018). In the formula for the heat loss of a building, these values are also used:

$$Q_{con} = \left(\frac{A_{walls}}{R_{c,walls}} + \frac{A_{floor}}{R_{c,floor}} + \frac{A_{roof}}{R_{c,roof}} + A_{windows} * U_{windows} + A_{frames} * U_{frames}\right) * \Delta T \qquad (2)$$

Q_{con} = total heat loss through conduction (W)
A_{walls}, A_{floor}, A_{roof}, $A_{windows}$ and A_{frames} = total surface of walls, floor, roof, windows and frames (m^2)
$R_{c,walls}$, $R_{c,floor}$ and $R_{c,roof}$ = insulation resistance of the walls, floor and roof (m^2K/W)
$U_{windows}$ and U_{frames}= heat transfer coefficient of windows and frames (W/m^2K)
ΔT = difference in outside air temperature and inside air temperature (K)

Convection heat transfer

As explained earlier, in this situation only forced convection heat transport takes place in the building. The forced convection heat transfer is caused by ventilation (Aarts et al., 2005) and ventilation is necessary for a comfortable indoor climate (Bris Bouwbesluit, 2012b). The Building Regulations sets minimum requirements for the ventilation of a house, of course these requirements should also be met by Tiny Houses. The requirements are aimed at a minimum ventilation per second and a maximum air speed to meet the minimum comfort and health needs (Bris Bouwbesluit, 2012b). The formula that comes with heat transfer through ventilation is as follows (Siemens, 2005):

$$Q_{ven} = \rho * c * V * \Delta T \qquad (3)$$

Q_{ven} = total heat loss through ventilation (W)
ρ = density of the material (kg/m^3)
c = specific heat of the material (J/kgK)
V = volume flow rate (m^3/s)
ΔT = difference in outside air temperature and constant inside air temperature (K)

Heat loss and building shape

The amount of heat that is lost also depends on the shape of the building. To achieve as little heat loss as possible, compact building is a solution (Schamhart, 2006). Compact building is described as: create as much user surface and volume as possible with the lowest possible heat-soiling skin (Schamhart, 2006). This can be expressed in the A/V ratio, the ratio between building envelope (A) and volume (V). A lower A/V ratio gives smaller heat losses. On the basis of this ratio, a shape approaching the spherical shape ensures the least heat loss (Koene, Jong, & Kaan, 2001), as shown in figure 2 (Prokupek, n.d.). A spherical shape, on the other hand, provides little practical user surface (Schamhart, 2006). A building form with an extension provides a higher A/V value and thus more heat loss, while an extension can provide more daylight and a more comfortable living climate (Schamhart, 2006).

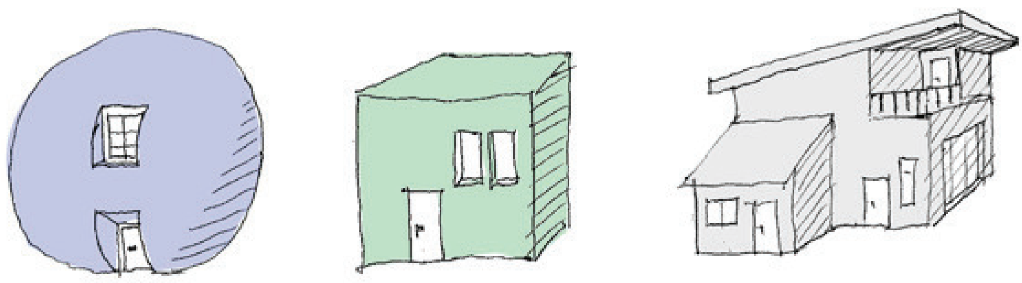


Figure 2 The "compactness" in relation to the A/V ratio. Left: bullet shape (<0.3); middle: dice (approx. 0.5), right: with build-ups (> 0.8) (Prokupek, n.d.)

Placing homes directly on or next to each other often results in a form of compact building (Schamhart, 2006). At this moment, only the outer shell of the entire building counts for the A/V ratio (Schamhart, 2006). Figures 3 and 4 show the A/V values for different placements of the houses (Glücklich, n.d.).

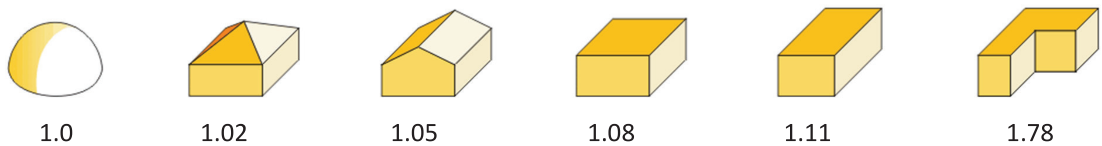


Figure 3 A/V ratio for buildings with the same volume, starting with a hemisphere with r=4.5m (Glücklich, n.d.)

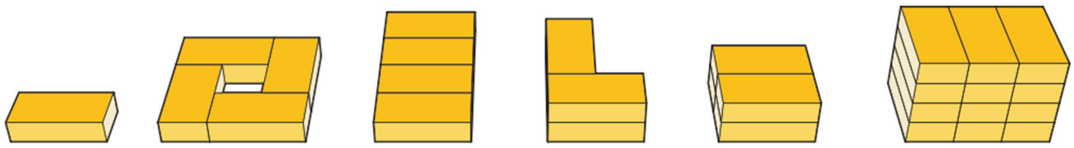


Figure 4 A/V ratio for buildings composed of blocks of 10m x 20m x 4.5m (Glücklich, n.d.)

2.2.2 Alternative energy sources

The generation of energy by traditional sources involves adverse environmental effects. Examples are climate changes, global warming, air pollution and acid rain (Sampaio & González, 2017). A better option for energy generation is energy generation from natural and inexhaustible sources. In the housing construction solar and wind energy is used for this form of energy (Van der Heijden, 2016). However, solar energy brings some advantages with respect to wind energy. For example, the yields of small wind turbines are many times smaller than those of PV panels, so that there must be places many wind turbines to meet the demand. This requires a large space and high costs (Van der Heijden, 2016). In addition, solar energy is a lot quieter and through generation from the roof it is also suitable for the urban environment (Sampaio & González, 2017). However, wind energy in the form of a small wind turbine can be suitable as an addition to the solar panels on sunless days (Van der Heijden, 2016). Due to the strong advantages of solar energy in relation to wind energy and the limited surface area of Tiny Houses, which means that a combination is not possible, this section only deals with solar energy.

Solar energy

Photovoltaic solar energy (PV) is the electricity that is obtained directly from the conversion of solar energy (Sampaio & González, 2017). The most well-known and most efficient generator in the field of electricity from the sun are solar panels or PV panels (Van der Heijden, 2016). PV panels are often placed on the roof to catch the sun, in the Netherlands ideally aimed at the south at an angle of 35 degrees (Van der Heijden, 2016).

To convert the solar radiation into energy, a semi-conductor is usually used, such as silicone, one of the most common materials in the world (Sampaio & González, 2017). The atoms of silicone are in a grid surrounded by 4 electrons that are attached to the neighbors. By fouling the material with a material with a higher or lower number of electrons, two layers can be created with a different amount of electrons. One layer with an abundance of electrons and a layer with a shortage of electrons. By adding PV to the layer with an abundance of electrons, these electrons have the ability to move to the layer with a shortage of electrons, generating electricity (Sampaio & González, 2017). This electricity is converted via a charge controller and an inverter into usable electricity and used for equipment or stored in a battery (Sampaio & González, 2017).

During the generation of energy, PV panels add 35 to 100 percent less damage to the environment than forms of energy generation with exhaustible sources (Balcombe, Rigby, & Azapagic, 2015). With solar energy, the transport of the energy source is also not a source of energy pollution. During the life cycle, however, PV uses a lot of energy, for example during the production of the panels and the transport of the materials (Sampaio & González, 2017). In addition, the production of the battery of PV systems ensures a large depletion of materials (Balcombe et al., 2015). A lifetime increase of 5 to 10 years can already save 45 percent of sources and 32 percent of acidification (Balcombe et al., 2015). With the current lifespan of at least 30 years of the panels (Balcombe et al., 2015; Sampaio & González, 2017) and at least 10 years for the battery (Balcombe et al., 2015), the energy effects of PV systems are limited. In addition, with the current energy yields from solar panels, the energy consumed during the production process is recovered in 3 years (MilieuCentraal, n.d.-c). However, improvements, especially in the area of longevity, remain important (Balcombe et al., 2015).

Partly due to the increasing lifetime of the components of the system and the falling prices, the demand for PV panels is growing (Sampaio & González, 2017). Between 2000 and 2015 the demand for PV panels increased by 41 percent (Sampaio & González, 2017). However, a PV system still converts only 5 to 25 percent of the solar energy into usable energy (Aste, Leonforte, & Pero, 2014). This is partly because the panels perform worse when the temperature rises (Aste et al., 2014). The solar energy that is not converted heats the panels and ensures a lower efficiency (Lamnatou & Chemisana, 2017; Tripanagnostopoulos, Souliotis, Battisti, & Corrado, 2006). Cooling of the panels is thus sometimes necessary for optimum operation. The cooling of panels can be done in a natural way by placing them separately from the roof, allowing wind to cool them (Lamnatou & Chemisana, 2017). This is often done with standard PV panels. Another form of cooling is by allowing water or air to pass through, which drains the heat. This cools the panels and ensures a higher efficiency (Good, Chen, Dai, & Hestnes, 2015; Lamnatou & Chemisana, 2017). This type of system is also called a photovoltaic thermal system (PVT). In addition, the heated water or air can be used for, for example, domestic hot water and heating of the building (Tripanagnostopoulos et al., 2006). The combination of generating electricity and heat creates a system that takes up little space and is very suitable for small surfaces (Good et al., 2015; Lamnatou & Chemisana, 2017). This combined system provides a significantly higher total energy yield, namely 13.2 percent electrical energy and 28.8 percent thermal energy for PVT panels, compared to 13.4 percent electrical energy for PV panels (Aste et al., 2014).

The yield of a solar panel is expressed in Watt peak (Wp): the amount of electricity that 1 kWh / m2 produces under the ideal conditions (Van der Heijden, 2016). Since in the Netherlands there are seldom any ideal circumstances due to, for example, clouds, this is multiplied by a reduction factor 0.90 (Alforte Innovations, n.d.). As mentioned, the ideal placement of PV or PVT panels in the Netherlands is southward at an angle of 35 degrees (Van der Heijden, 2016). Horizontal placement is also possible, but yields 10 percent less energy (Siderea, n.d.). Vertical placement on the facade also occurs. With optimal placement on the south facade, these panels can yield between 60 and 80 percent efficiency (Van der Heijden, 2016; Zandee, 2017).

2.3 Housing preferences

Over the years there has been an evolution in the field of business practices. Where it once began with the simple trading age, it has arrived at the marketing business era today through the production age, the sales age and the marketing department age (Chia et al., 2016). In the current era the focus of companies is on the wishes and preferences of the customers (Chia et al., 2016). Since having a living space is one of the necessities in life (Tan, 2012), this also applies to the housing construction industry. However, the house price inflation is very high, which causes problems to mainly younger starters in getting a house (Dopper & Geuting, 2017), since their income does not follow the same trend as the house price inflation (Tan, 2012). According to (Blijie, Gopal, Steijvers, & Faessen, 2016), the rent ratio for young singles and young couples rose by more than 1.5 times more between 2012 and 2015 compared to the period between 2009 and 2012. An increasing part of the income must therefore be spent on the rental costs for a home. Is this price increase tolerated due to the lack of suitable housing or do these houses meet the housing preferences so much that the price increase is justified? In this section, earlier literature research on residential preferences and in particular the housing preferences of young households aged between 18 and 35 years will be reviewed.

In the area of housing preferences sufficient literature can be found, however, the literature in the area of housing preferences for Tiny Houses is much more limited. An explanation for this can be given on the basis of the diffusion of innovation model of Rogers, first described in 1962 (Doyle, Garrett, & Currie, 2014). The theory divides people on the basis of their character traits into different categories, which describe a moment of participation in a new technology (Doyle et al., 2014). A distinction is made between five stages, namely innovators, early adopters, early majority, late majority and laggards. According to (Rogers, 2003) the innovators and early adopters will participate in a (very) early stage because of their special interest in new ideas, leadership and the courage to take risks, while the largest group, the early and late majority, described as deliberate and skeptical, will wait longer until peer reviews are available. Finally, there are the laggards, described as traditional, and with little interest in taking part in a new technology (Rogers, 2003). At the moment, the developments concerning Tiny Houses are in the Netherlands on the border between innovators and early adopters (Tiny House Nederland, 2017b). As a result, little information is known about the residential preferences for Tiny Houses and the preferences that are known are only from the innovators and a number of early adopters (Boomgaard, 2018). This section will therefore contain literature on the living preferences for Tiny Houses of these early entrants (innovators and early adopters). In addition, this research will conduct additional survey research into the preferences for Tiny Houses of respondents that do belong to the early entrants.

In this section, literature on housing preferences in general will be examined, as well as literature on housing preferences of young households and housing preferences for Tiny Houses according to the innovators. Subsequently, a conclusion will be drawn about which housing preferences are most important for this research.

A lot of literature can be found in the area of housing preferences, both in Dutch literature and in foreign literature. However, the emphasis in each research is on other attributes (characteristics of the house and environment) to determine the preferences for a home. In some studies, the attributes are divided into three groups, namely the location attributes, the neighborhood attributes and the dwelling attributes (Jhun Kam et al., 2018). Some studies, such as (Hassanudin Mohd Thas Thaker, 2016), take the neighborhood and the location together, so there are only two attribute groups. This research is based on the three attribute groups as mentioned in the first instance.

Location attributes

Kauko (2007) indicates that a good location is important for the success of a housing project. In the investigated studies, the location attributes are often expressed by the distance to certain facilities, such as a school or business, (public) transport (Hurtubia et al., 2010; Tan, 2012) and other facilities, such as commerce and services (Hurtubia et al., 2010; Majid, Said, & Daud, 2012; Tan, 2012). Here Hurtubia (2010) indicates that in the field of school the quality is more important than the quantity. In addition, the presence of industry contains job opportunities, however, the nuisance it brings often with causes a negative factor (Hurtubia et al., 2010). However, most studies do not distinguish between the different facilities and speak about the distance to facilities in general. Since the greatest versatility of facilities is in the center of a city, Lachman & Brett (2010) expresses the preference for location by the distance to the city center.

Other location attributes mentioned in some studies are the availability of parking spaces (Lachman & Brett, 2010) and accessibility (Hurtubia et al., 2010; Majid et al., 2012). Accessibility means the lack of traffic congestion (Majid et al., 2012) and the possibilities to visit other locations in the city (Hurtubia et al., 2010). Since these attributes are each mentioned in only a single study, this research will for the location only look at the distance to the city center with associated facilities.

Neighborhood attributes

In the area of the neighborhood, a rough distinction can be made between the public space and the image of the neighborhood. Public space includes among other things housing density and views of an attractive open space (Chia et al., 2016; Hurtubia et al., 2010), but also the condition, quality and attractiveness of homes in the area play a role (Chia et al., 2016).

For the image of the neighborhood there is spoken about the average neighborhood income and race/ethnic groups (Hurtubia et al., 2010), as well as cleanliness, pollution, crime and safety (Chia et al., 2016; Hassanudin Mohd Thas Thaker, 2016; Majid et al., 2012). Tan (2012) confirms this and indicates that in order to meet the wishes of residents, a sense of security in the environment should be created. Preferences regarding race and ethnic groups can be very different. For example, many immigrants seek support from peers, causing segregation effects (Hurtubia et al., 2010).

Choguill (2008) describes the neighborhood as a space in which residents live together for a common interest. A positive image of the neighborhood will therefore be preferred. However, research of Hassanudin Mohd Thas Thaker (2016) shows that the structural characteristics such as size play bigger roles than neighborhood amenities. Since dwelling attributes are considered more important than neighborhood attributes and given the poor measurability of many of the neighborhood attributes, especially in an not (yet) existing district as in this study, no neighborhood attributes will be included in this study.

Dwelling attributes

Many dwelling attributes are mentioned to a greater or lesser extent in the examined investigations. Therefore, a distinction will be made between attributes that occur regularly and attributes that are only mentioned sporadically (see table 1).

This second category includes the amount of bedrooms and bathrooms (Hurtubia et al., 2010), the orientation (Griess, 2009; Majid et al., 2012) and the superstition surrounding the house (Chia et al., 2016; Tan, 2012). Finally, this category includes the image of the developer of the house ((Chia et al., 2016; Hassanudin Mohd Thas Thaker, 2016)).

Table 1 Literature review on dwelling attributes

	Dwelling attributes	
1	Living size	*Chia et al. (2016); Majid et al. (2012); Hurtubia et al. (2010); Hassanudin Mohd Thas Thaker (2016)*
2	Green/garden	*Majid et al. (2012); Hurtubia et al. (2010); Luttik (2000); Tajima (2003)*
3	Number of (bath)rooms	*Hurtubia et al. (2010)*
4	Age of the building	*Majid et al. (2012); Hurtubia et al. (2010); Blijie et al. (2016)*
5	Type of house	*Majid et al. (2012); Hurtubia et al. (2010); Hassanudin Mohd Thas Thaker (2016)*
6	Quality & design	*Chia et al. (2016); Majid et al. (2012); Hurtubia et al. (2010); Hassanudin Mohd Thas Thaker (2016)*
7	Orientation	*Majid et al. (2012); Griess (2009)*
8	Sustainability	*Hurtubia et al. (2010); Hassanudin Mohd Thas Thaker (2016); Tan (2012); Jhun Kam et al. (2018)*
9	Image/brand	*Chia et al. (2016); Hassanudin Mohd Thas Thaker (2016)*
10	Cost	*Chia et al. (2016); Majid et al. (2012); Hurtubia et al. (2010); Griess (2009); Lachman & Brett (2010), Hassanudin Mohd Thas Thaker (2016)*
11	Superstition	*Chia et al. (2016); Tan (2012)*

Hurtubia et al. (2010) indicates that the desired amount of (bath) rooms is related to the size of the household. The larger the household, the more demand for multiple rooms. Regarding the orientation of a home, Majid et al. (2012) speaks about the position of the home within the layout plan, where Griess (2009) speaks about the direction in which large glass surfaces have been placed. Superstition is mainly found in Asian culture. A distinction can be made between superstition numbers and superstition ghost (Chia et al., 2016). As a result, addresses with certain numbers are perceived as more positive or negative (Tan, 2012). The developer also influences the choice of housing: the trend, professionalism and the investments of the developer are examined (Chia et al., 2016).

The attributes that are mentioned in almost all the literature reviews are living size, green/garden, age of the building, type of house, quality & design, sustainability and cost.

The living size is the size of the built-up area (Majid et al., 2012) or the summed size of the different rooms in the house such as the kitchen, the bathroom, the bedroom and the living hall (Chia et al., 2016). A larger floor area could show more luxury through the large private space (Tan, 2012). However, Hurtubia et al. (2010) and Hassanudin Mohd Thas Thaker (2016) both argue that not every household is looking for a larger living space and that it is often consciously chosen for a smaller home, because of practical issues, such as limited (maintenance) costs.

Majid et al. (2012) distinguishes between the size of the land area and the size of the built-up area. This gives a picture of the available private space. Hurtubia et al. (2010) talks about the benefits of living near green space or having a garden as two similar points. Luttik (2000) also indicates that both, having a garden and having (public) green spaces within 400 meters clearly influence the preferences for a home. Tajima (2003) confirms the proposition that the distance to the green space influences the advantages.

The age of the building is also mentioned in many studies as a point of interest when choosing a home. Based on the year of construction, an estimate of an energy label can be made (Blijie et al., 2016), since a newer building probably has better insulation of heat and sound. In addition, less maintenance of the house will be necessary (Hurtubia et al., 2010). However, as tiny houses are a rather new phenomenon in the Netherlands, age of Tiny Houses cannot be considered a relevant attribute.

The type of house can be divided into housing tenure: owner or renter. In here are also the less common forms such as leasing and subletting (Hurtubia et al., 2010). You can also choose between a flat or a house (Hurtubia et al., 2010), where a house can be divided into terraced, detached and semi-detached houses (Hassanudin Mohd Thas Thaker, 2016).

The quality of a home is about both architectural aspects (Hurtubia et al., 2010) and physical aspects (Hassanudin Mohd Thas Thaker, 2016). The architectural aspects are described as the secondary attributes, such as brightness, the view and the interior and exterior design (Chia et al., 2016; Hurtubia et al., 2010). These will not be included in this study because they seem less important in the context of Tiny Houses. The physical aspects, on the other hand, are about the finishing and building of the house (Hassanudin Mohd Thas Thaker, 2016). Since there are rules for new buildings in the Netherlands concerning the quality of a home, the physical attributes of Tiny Houses will meet the requirement and will therefore not be included in this research.

The attribute sustainability can be described at various scale levels. At the global level, for example, it concerns toxification and acidification (Hurtubia et al., 2010), at local level, for example on air quality and waste management (Chia et al., 2016; Hurtubia et al., 2010). At home level it is mainly about having an environmentally friendly home (Hassanudin Mohd Thas Thaker, 2016). To achieve this, there are various possibilities. Hurtubia et al. (2010) mention the presence of a solar or heat pump and good heat insulation, Jhun Kam et al. (2018) complements this with energy efficiency, rainwater harvesting and greywater recycling.

Finally, the attribute costs, including the buying or rental price of the housing unit, but also the possibilities for a mortgage and additional costs for transaction, energy and equipment can play a role (Chia et al., 2016; Hurtubia et al., 2010). The costs for the house and energy are mostly dependent on the aforementioned attributes.

2.3.1 Housing preferences according to Tiny House owners

Tiny House residents obviously have specific reasons why they have chosen to live in a Tiny House. Many supporters of Tiny Housing think according to the principles of "minimizing, de-cluttering, and downsizing" (Ford & Gomez-Lanier, 2017). Since this line of thought probably differs from the 'standard' home seekers, this section pays specific attention to the residential preferences of Tiny House residents. Since there is already a section about the motivations for living in a Tiny House in section 2.1.2, here is only a summary of these motivations. Furthermore, Boomgaard (2018) has been done research into the preferences of Tiny House residents or interested parties with regard to different Tiny House attributes. These will also be discussed in this section.

The motivations most frequently mentioned in section 2.1.2 are the smaller ecological footprint (Van Orden, 2017) and costs (Kilman, 2016) through the smaller living space (Wilson & Boehland, 2005) and the freedom (Anson, 2014) and mobility (Mutter, 2013) that living in a Tiny House entails. Other, less frequently mentioned arguments are the choice of having less stuff to get rest in your life (Mutter, 2013), living closer to nature (Van der Heijden, 2016) or in a community with like-minded people (Kilman, 2016) and having the possibility to build the house yourself (Anson, 2014).

Research from Boomgaard (2018) concludes that Tiny House residents generally prefer a location outside the city, that they like to live together in small groups of Tiny Houses (one to ten Tiny Houses) and prefer to buy their house and surrounding land instead of renting. Finally, they may be willing to share equipment such as a washing machine with their immediate neighbors and a water purification system or garden with the neighborhood.

2.3.2 Housing preferences according young starters

Now the housing preferences both, in general and from the residents of Tiny Houses, were examined. Studies such as Dopper & Geuting (2017) indicate that small living is mainly seen as a solution for starters. That is why in this section the housing preferences of the target group are investigated, the starters in the housing market. This group will first be described, after which their preferences for homes will be discussed.

Starters are people who for the first time independently enter the housing market to buy or rent a home (Dalhuisen-Timmermans, 2013). According to Jhun Kam et al., (2018), this are currently the millenials, or generation Y, born between 1980 and 1997. They experience different 'first-time' moments, such as graduation, marriage, having children and owning an independent living space. Dalhuisen-Timmermans (2013) speaks about a comparable age group, namely the 25 to 35 year old starters, the just-not generation. Since an unambiguous term for the target group is useful, this research will speak about generation Y, defined as: starters in the housing market between the ages of 18 and 35.

Generation Y is the first generation to grow up with technology (Jhun Kam et al., 2018), they are generally satisfied, optimistic and independent (Jhun Kam et al., 2018) and they are tolerant towards homosexuality and other cultures (Taylor & Keeter, 2010). Furthermore, family is seen as very important, while having possessions is subordinated compared to gaining experiences such as festivals and concerts (Taylor & Keeter, 2010), but also dining out or shopping are covered (Jhun Kam et al., 2018). Generation Y saves little, but spends the money on experiences under the motto 'you only live once' (Jhun Kam et al., 2018). Finally, this generation is known for its desire for freedom and flexibility, where changing jobs and home should be possible (Dalhuisen-Timmermans, 2013; Jhun Kam et al., 2018).

However, generation Y runs into a few problems when it comes to finding a home. They often earn too much for a social housing, but too little for a home according to their wishes in the free sector (Dalhuisen-Timmermans, 2013). In addition, buying a home is often impossible or undesirable due to student debt or the desire for freedom and flexibility (Dalhuisen-Timmermans, 2013).

Looking at the housing preferences of generation Y, there is a lot of overlap with the aforementioned general living preferences. Cost, surface and design are mentioned as the most important attributes, followed by, among other things, the safety of the neighborhood, quality, sustainability and age of the home (Jhun Kam et al., 2018; Lachman & Brett, 2010).

More specifically, these studies show that generation Y prefers to live in a nice location in or near the center or in the neighborhoods of a city (Dalhuisen-Timmermans, 2013; Lachman & Brett, 2010). In addition, a rental home gives this generation the possibility of flexibility and no long-term commitment to unit or location (Lachman & Brett, 2015), whereby sharing of facilities can ensure social contacts and lower prices (Dalhuisen-Timmermans, 2013). Finally, the appearance plays a role in the choice, the house should be a unique place where you can be proud of (Dalhuisen-Timmermans, 2013). And all this for an affordable price, about 600 euros per month (Dalhuisen-Timmermans, 2013).

2.4 Conclusion

This section summarizes the findings from the literature research. The most important findings are briefly discussed for each of the fields studied, small living, sustainability and housing preferences.

2.4.1 Small living

Small living can be described as *"the conscious choice for living in a smaller permanent home"* (Bartlett, 2016). A specific form of small living is Tiny Housing, living in a Tiny House with a certain underlying idea. Often the residents opt for this form of living from financial or environmental considerations. A Tiny House in itself is thus a house that may or may not be on wheels and that is permanently occupied. However, living in a Tiny House can, in addition to any space problems, also entail some problems concerning legislation.

2.4.2 Sustainability

Although a Tiny House has a not so clear definition, it can be concluded that a Tiny House is always relatively small. This has consequences for the energy consumption of the home, even as the placement of houses on or next to each other or the shape of the house. Heating homes accounts for about 40 percent of the total energy consumption (Bolattürk, 2005; Kurt, 2010). A large part of this heat is lost by the outer shell, such as floor (Chen, 2017). The heat loss can be divided into heat loss due to conduction and loss of heat due to convection. Conduction heat loss depends on, among other things, the contact surface, the insulation and the temperature difference (Aarts et al., 2005). Convection heat loss is dependent on the temperature difference and the amount of air that is changed per unit time in the space (Aarts et al., 2005). In order to lose as little heat as possible, the ratio between the surface of the outer shell and the volume should be as small as possible (Schamhart, 2006).

In addition to reducing the energy requirement, the required energy can also be generated in a sustainable way, for example with photovoltaic (PV) or photovoltaic thermal (PVT) panels. These panels convert solar energy into electricity, possibly combined with heat (with PVT panels)(Good et al., 2015). Partly due to the growing lifespan, better yields and falling prices, the demand for these systems is growing (Sampaio & González, 2017). With a lifespan of about 30 years, the durable panels can be well recovered (Balcombe et al., 2015).The ideal placement of solar panels in the Netherlands is southward at an angle of 35 degrees (Van der Heijden, 2016). On a small flat roof, however, it can be considered to place the panels horizontally, so that there are no shadows on other panels. However, this reduces yields with about 10 percent (Siderea, n.d.).

2.4.3 Housing preferences

With regard to housing preferences, there are many factors (attributes) that influence the choice of a home. These attributes are often divided into location attributes, neighborhood attributes and dwelling attributes (Jhun Kam et al., 2018). In addition, there are various personal characteristics that can influence these preferences. Table 2 summarizes the literature review on housing preferences from different perspectives. The first column shows the aspects that are in general of importance in the choice of a house, the second column shows the aspects and motivations that are considered important from the perspective of Tiny House residents and the third column shows the specific housing preferences of generation Y.

Table 2 Housing preferences per group

Housing preferences in general (section 2.3)	**Housing motivations towards Tiny House owners (section 2.3.1)**	**Housing preferences towards generation Y (section2.3.2)**
Location, measured in distance to city center	Location, outside the city	Location, in or nearby the city center
Neighborhood image and safety	Small community with like-minded people	Safe neighborhood
Surface	Small surface	Surface
Garden or park nearby	Nature nearby	
Type of house, possibilities are for example a flat and a terraced or (semi) detached house		
Ownership, buy or rent	Prefer buying Tiny House and land	Rental gives possibilities of freedom
Sustainability	Sustainability	Sustainability
Costs	Freedom due to lower costs	Freedom due to lower costs (approximately 600 euros per month)
Quality		Quality
Design	Possibility to design and built it by themselves	Unique appearance
	Mobility	
	Willing to share some facilities with direct neighbors or neighborhood	Shared facilities

It appears that the attributes that are most important when choosing a home are the costs, dimensions, sustainability and location. Both Tiny House residents and generation Y aim for a certain degree of freedom. However, there are clear differences between the standard Tiny House resident and standard starter in the field of location and house ownership. Where the Tiny House residents like to live outside the city and prefer to buy a home, prefers generation Y a rental property in the city. However, both groups prefer a unique, affordable home. To this end, they are both willing to share facilities such as a washing machine or garden.

CHAPTER 3
METHODOLOGY



Het bollenveld:
Sustainable shaped Tiny Houses in Den Bosch
Designer: Dries Kreijkamp, 1984
(Own photo, 2019)

3. Methodology

The purpose of this research is to find out which preferences the respondents have with regard to living in a Tiny House and to what extent particular attributes contribute to this preference. A method should therefore be used that evaluates different attributes separately from each other. Therefore, a stated choice experiment is a suitable approach. Chapter three explains the content and application of a choice experiment and the steps that must be taken to implement this method.

Basic principles of a choice experiment

In a choice experiment, it is important to draw up relevant choice sets in order to achieve the desired results (Hensher et al., 2015). This type of method is mainly used in marketing by institutions, governmental organizations and companies that are interested in predicting which products or services are worthwhile to consumers (Van Beurden, 2013). The method is also called stated preference method or conjoint analysis (Kemperman, 2000), because, in contrast to the traditional economic methods like the revealed preference method, no data is obtained from individual behavior in real markets, but from hypothetical scenarios (Louviere et al., 2010).

There are different types of choice experiments, but in general a division is made into two groups: rating-based approach, also called acceptance-based approach and choice-based approach, also called preference-based approach (Asioli, Næs, Øvrum, & Almli, 2016). With the rating-based approach, the respondent assigns a value, a numerical score, to a bundle of attributes, a profile. With the choice-based approach, on the other hand, the respondent makes a choice between different profiles (Asioli et al., 2016). The main difference between these two types of analysis is that with a choice-based approach there is a direct comparison between profiles and with the rating-based analysis, there is not. As a result, the situation of a choice-based analysis corresponds better to the market (Elrod, Louviere, & Davey, 1992).

Application of choice experiment

The fact that the current research is focused on a new field where few examples are available, namely Tiny Houses, makes choice based analysis, also called discrete choice experiment (DCE), a very suitable method. It gives the possibility to mimic a realistic scenario with hypothetical data. At the moment there are not enough comparable Tiny Houses available to test which requirements a Tiny House should meet to be interesting for young starters. DCE makes it possible to present different hypothetical Tiny Houses to the respondents. By analyzing the choice behavior of the respondents regarding the Tiny Houses, insights can be gained into the preferences of respondents in different choice scenarios around one product. In this case a bundle of varying attribute levels is added to a base Tiny House. Although these different Tiny Houses are not available on the market, they do provide insights for the future development and marketing of Tiny Houses. This method makes it possible to test hypothetical data in a relatively realistic way.

In order to conduct a DCE profiles (or alternatives) will be assembled, which will be presented to the respondents, and of which the choices will be analyzed. The following steps describe the process to perform a discrete choice experiment (Kemperman, 2000):

- Determining the measurement method, i.e. preference- or acceptance-based conjoint analysis.
- Selecting attributes that influence the choice for an alternative.
- Specifying the relevant levels per attribute.

- Designing the profiles and creating the choice sets
- Making the questionnaire
- Analyzing the results

In the next sections, these steps will be dealt with.

3.1 Hypothetical Tiny Houses

After determining the method, it is important to determine the choice options. The current sub-section provides insight into the various options for the hypothetical Tiny Houses. Both the varying attribute levels and the design for the basic Tiny House will be discussed. In section 3.2 these separate choice options will be combined into bundles that determine the choice sets.

3.1.1 Attributes and levels

The attributes are derived from the literature review in section 2.3. A relevant combination of attributes was made based on the general housing preferences of house searchers, the housing preferences of Tiny House owners and the housing preferences of young starters on the housing market. The attributes to be included are: surface, type of dwelling, shared facilities, outdoor space, location, sustainability, energy costs and overall costs.

Surface: with the attribute surface the interior dimensions of a dwelling are meant, the building envelope is not included. The sizes are based on the possibility to transport the separate accommodation units without a permit for special transportation. The requirements that apply for special transportation are that an indivisible load on a semi-trailer may not exceed 2.60 x 13.60 x 4.00 meters (w x l x h) (Tiny House Nederland, 2017a). However, Tiny House Nederland (2018) says that due to the maximum weight requirements of 3500 kg, it is safest to consider a maximum length of up to 8 meters. By assuming a wall thickness of approximately 17 cm, the inner surface will be 30 and 17 m2 in the case of respectively a 13.6 and 8 meters long Tiny House. These are therefore the principles for the minimum and maximum surfaces.

Type of dwelling: According to the literature a distinction can be made between a flat and a house (Hurtubia et al., 2010). The category of houses can be further divided into terraced or (semi-) detached houses (Luttik, 2000). In this study, a distinction will be made between flats, detached and terraced houses.

Shared facilities: this attribute concerns facilities that can be shared with inhabitants of nearby houses. This include facilities that do not have to be used by everyone at the same time and are not sensitive to privacy issues. For example, laundry and storage for bicycles might be shared facilities in this study.

Outdoor space: according to the literature, not only a private outdoor space influences the preference for a house, but also the presence of a nearby park, especially in the city center (Luttik, 2000; Tajima, 2003). Therefore, this attribute will be represented by the presence or absence of a private garden or a shared park in the immediate vicinity (within 400 meters) (Luttik, 2000).

Location: from the literature study it was concluded that it would be best to measure the location by means of the distance to the city center (Lachman & Brett, 2010). Since the exact size of cities differs, but cities often have similar structures, this attribute is not expressed in kilometers to the center, but by the following descriptions: in the city center, on the edge of the city center and in the suburbs of the city (Lachman & Brett, 2010).

Sustainability: as studied in the literature, various factors play a role regarding sustainability and general housing preferences. In this study, sustainability will be represented by the presence or absence of PV or PVT panels.

Energy costs: these costs will not be considered independent from the other attributes as this seems unrealistic. Therefore, energy costs will be determined by the type of property, the surface of the property and the presence of a sustainable system.

Costs: also the cost of hiring the tiny house have been determined given each of the six attributes described above. This means that the rent and the energy costs do no vary independently of the attributes that define the Tiny House. It also means that it will not be possible in this study to determine how these costs affect the preferences for the Tiny Houses.

In summary, table 3 presents the attributes and levels to be used in the current study.

Table 3 Attributes and levels

	Attributes	
	Surface	**Type of house**
Level 1	30 m^2	Detached house
Level 2	23.5 m^2	Terraced house
Level 3	17 m^2	Flat
	Shared facilities	**Outdoor space**
Level 1	Shared laundry and storage	Garden
Level 2	Shared laundry	Park within 400 meters
Level 3	No shared facilities	No outdoor space
	Sustainable system	**Location**
Level 1	Electrical and thermal generation by PVT panels	In the city center
Level 2	Electrical generation by PV panels	On the edge of the city center
Level 3	No sustainable system	In the suburbs of the city

3.1.2 The design of the Tiny House

For the purpose of this research, a basic Tiny House has been designed. To this basic design, extra properties (attribute-levels) can be added based on the attributes discussed in the previous section. The basic Tiny House has been designed as such that it meets minimum criteria according to the Building Regulations and that it allows investigating the effects of the selected attribute-levels. For example, a house with a pitched roof can no longer be stacked, and a house with windows on all sides cannot be a terraced house. Given the importance of building sustainably, a limited space for corresponding installations has been accounted for. In the following paragraphs, some aspects related to the basic design will be discussed.

Heat loss:
As discussed in section 2.2.1, the building shape directly influences the heat loss and therefore the energy consumption of the house. The starting point for the shape of the house is therefore to design a shape that has as little heat loss as possible. This is the case with the lowest possible surface / volume ratio (Schamhart, 2006). Starting from a detached house, the most ideal form is a sphere (Koene et al., 2001). However, this is not a practical form for a home, as a result, the form in which the least heat is lost and still has a practical shape are square blocks with equal sides (Schamhart, 2006). However, in a terraced house or apartment for example, the heat loss is the smallest with the largest possible contact area with the neighbors (Schamhart, 2006). As a result, preference will be given to an elongated house, where the long walls border the neighbors, as in figure 5.

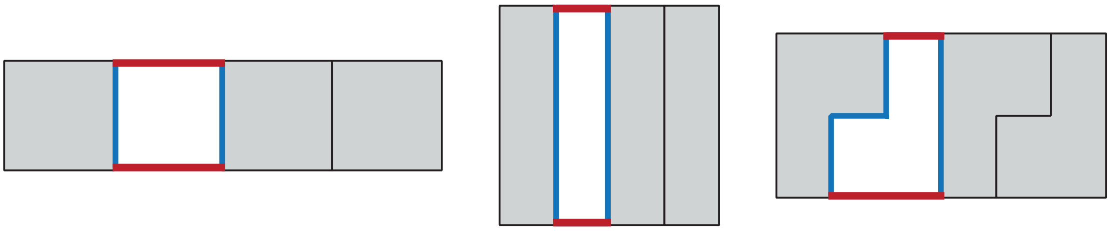


Figure 5 Surface with heat loss (red) compared to the surface without heat loss (blue) for a square, rectangular and L-form house

Daylight:
Looking at the visual comfort, it is important that sufficient daylight can enter the house. This can be measured for example, with the equivalent daylight factor, the amount of usable glass area in relation to the floor area (Bris Bouwbesluit, 2012a). This factor depends on the location of the windows, as well as the presence of an overhang such as a balcony or the presence of daylight opening in an internal partition construction such as a conservatory (Kort, 2009). The formula that comes with this is as follows:

$$A_e = A_d * C_b * C_u \qquad (4)$$

A_e = equivalent daylight factor
A_d = permeable daylight area (m)
C_b = obstacle factor
C_u = external reduction factor

C_b depends on the impedance angles α and β. Here, the obstacle angle α is determined on the basis of an obstacle in front of or next to the daylight opening, such as a tree, and the obstacle angle β on the basis an obstacle above the daylight opening, for example an overhang (Kort, 2009). C_u is only of importance when the window is placed in an internal partition construction. The equivalent daylight area of a room with residence function must be at least 10 percent of the floor area of that space. In addition, the equivalent daylight area in such a room must be at least 0.5 m2 (Bris Bouwbesluit, 2012a).

Furthermore, the orientation of the house influences the number of direct sun hours. To be able to place the house in a row or flat, the daylight openings will be placed on opposite facades. This has consequences for the orientation of the home. For example, a façade on the north will receive very little sunlight. In order to ensure enough daylight for a large part of the day, the houses will be oriented east - west.

Material

As mentioned earlier, limited heat losses are important for a sustainable construction. This can be done by using materials with good insulation and with limited thermal bridges. In addition, the origin and recyclability of the material can be examined. Finally, the limited use of space plays a major role in the design of Tiny Houses.

Two possible constructions are therefore the traditional timber frame construction or the more modern Structural Insulated Panels (SIP). In both constructions insulation material is clamped by plates, often made of plywood (Calluari & Alonso-Marroquín, 2017; W. Chen & Hao, 2015). However, SIPs are prefabricated in the factory, so that the whole, consisting of the insulation with side plates, is a constructive panel. These panels are coupled with the help of insulating springs, creating a mass of insulation material, surrounded by plates (W. Chen & Hao, 2015) (see figure 6). This creates a thin, but structurally strong, lightweight construction with a high heat resistance and few thermal bridges (Pokharel, 2003).

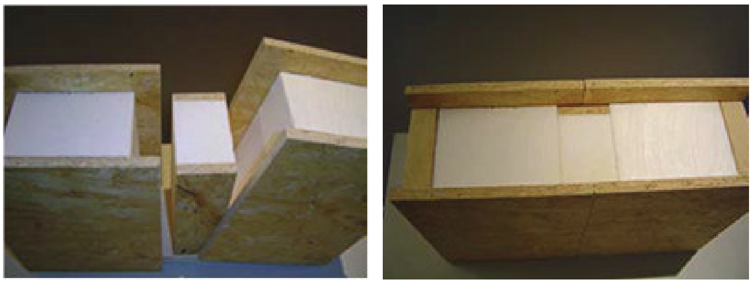


Figure 6 Coupling of SIPs without thermal bridges (SIP Construct, n.d.)

Timber frame construction, on the other hand, consists of a structural (wooden) skeleton of, for example, pine wood, to which the panels are attached and between which insulating material is placed. Pine has low costs, a low carbon footprint and sufficient availability (Calluari & Alonso-Marroquín, 2017). However, on the place of the wooden skeleton there is an interruption of the insulation and therefore there is a thermal bridge (Kingspan TEK, 2018).

In conclusion, when designing the basis for the Tiny House, the durability of the design and the slenderness of the construction are taken into account to preserve as much space as possible. Based on this, the following design choices have been made. For the home an elongated shape has been chosen that meets the requirements with regard to considered housing types and transport. With this form, less heat is lost in the housing types flat and terraced house. In order to meet the requirements regarding daylight, large daylight openings are placed on two facades. To bring the light as far as possible into the house, the 'closed' bathroom block is placed in the middle of the house with the possibility of a (sleeping) loft above. Finally, the walls of the house are built from SIP panels with 93 mm insulation and the roof with SIP panels with 143 mm insulation. The exterior walls are finished with wooden boards of modiwood for a natural look and the roof is covered with vegetation. In order to give an impression of the surface of the Tiny Houses in the various scenarios, a suggestion for furniture (kitchen and sofa) was placed in the different designs, as well as an example person. The entire design can be seen in figure 7.

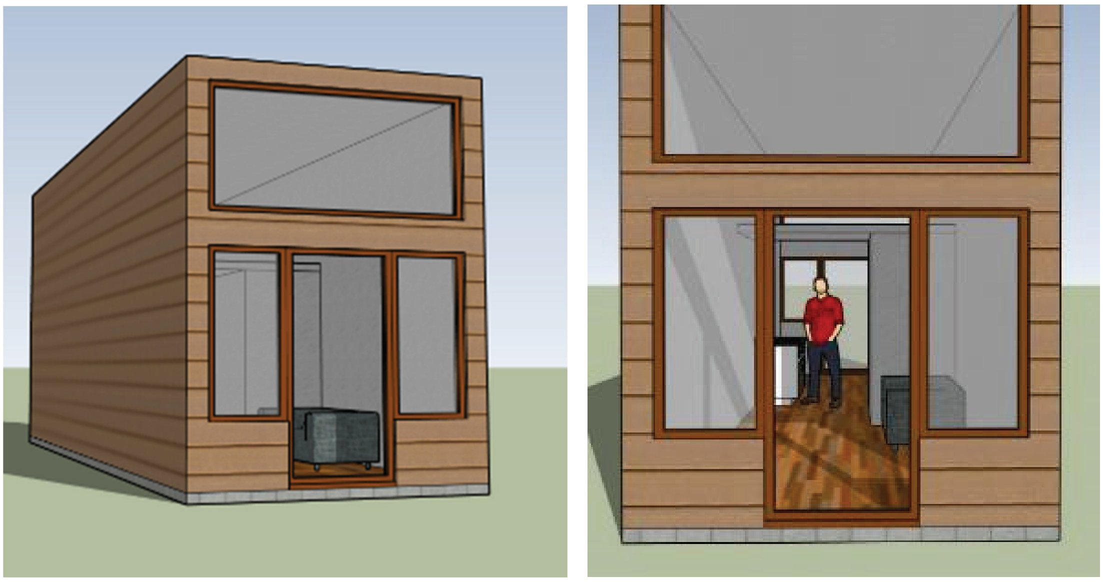


Figure 7 Design of the Tiny House

3.2 Experimental design

A bundle of attribute levels will be added to the designed Tiny House. According to Kemperman (2000) *"Crucial in experimental design is that all attributes must vary independently and thus a research design is required in which there are no correlations between all attributes"*. A so-called full factorial design, including all combinations, consists of 3^6 = 729 possibilities. Since this is a far too large number to use, a fractional design has been used. A fractional design is a specific set of profiles, selected in order to get results for the whole set of profiles (Hensher et al., 2015). In order to be able to estimate the results for the entire set of profiles, a sufficient selection of profiles has to be made. To do this, some templates are available. For this purpose use is made of columns 1, 2, 5, 10, 11 and 13 of masterplan 8 of the template from Hahn and Shapiro (1966). The template for this masterplan consists of 27 profiles. On the basis of this template, 27 profiles have been put together that will form the basis for the discrete choice experiment (see appendix 1). This masterplan makes it possible to include mutual interaction between a few attributes in the study. Since it is only possible to have interactions within the first three columns of the profiles, the attributes surface, outdoor space and shared facilities are placed in these columns because they might interact with each other. Each column represents three different levels, corresponding with the attribute levels.

The profiles are random, but evenly distributed over sets of two profiles. One set of two profiles plus a 'none of both' option together constitute a choice set. Nine such choice sets will be presented to each respondent by means of a questionnaire. There will be three versions of questionnaires. Because in each of the three versions there are nine combinations of two profiles, with a total of 27 profiles, after three respondents all profiles have been presented twice.

Cost calculations
In addition to the independent attributes, two dependent attributes are included in this study, namely energy costs and general rental costs per profile. These costs are calculated in the following ways:

Energy costs:
The energy costs are made up from the costs incurred by the use of electrical equipment, heat loss (depending on the attributes of housing type and surface area) and generation by a sustainable system, which reduces these costs, depending on the sustainable system attribute.

The *heat loss* is calculated by conduction and by convection heat loss. Formulas 2 and 3 from the literature in section 2.2.1. and the sizes 2.6 m for width, 4.00 m for height and 6.54, 9.04 and 11.54 m for the length of the different Tiny Houses have been used for these calculations. The total heat loss is the sum of heat loss due to conduction and heat loss due to convection. The heat loss due to conduction is related to the surface area of the different parts of the separation structure (A), the insulation resistance of the walls, floor and roof (R_c), the heat transfer coefficient or windows and frames (U) and the difference in outside air temperature and inside air temperature (ΔT). The heat loss due to convection is related to the density of the material (ρ), the specific heat of the material (c), the volume flow rate (V) and the difference in outside air temperature and constant inside air temperature (ΔT). For air, under normal circumstances a fixed value of 1200 J/m^{3}K applies to ρ times c (Aarts, Bakker, Schellen, & Hak, 2005) and according to the Building Regulations (Bris Bouwbesluit, 2012b), V must be at least 0.9 x 10-3 m^3/s. Furthermore, the difference in temperature is calculated based on the average indoor and outdoor temperature on an annual basis in the Netherlands. These are respectively 20.75°C (The green age, 2018) and 10.85°C (CBS, 2018c). Finally, the U and R_c values used for the different parts of the outer shell are shown in table 4. The surface of the various structural parts depends on the type and the surface of the dwelling. The total heat loss per type with the associated costs is shown in table 5. The costs are based on a rate of € 0.21 per kWh (price level Q4 2018) (MilieuCentraal, n.d.-b).

Table 4 Insulation resistance and heat transfers coefficients for the different parts of the building envelope

	Floor	Roof	Wall	Window	Door
Total insulation resistance of the element R_c (m²K/W)	4.00	7.10	4.50	0.80	0.80
Heat transfer coefficient U (W/m²K)	0.25	0.14	0.22	1.25	1.25

Formula for the heat loss through conduction and convection (or ventilation):

$$Q_{tot} = \left(\left(\frac{A_{walls}}{R_{c,walls}} + \frac{A_{floor}}{R_{c,floor}} + \frac{A_{roof}}{R_{c,roof}} + A_{windows} * U_{windows} + A_{frames} * U_{frames}\right) + \rho * c * V\right) * \Delta T \qquad (5a)$$

Q_{tot} = total heat loss through conduction and convection (W)
A_{walls}, A_{floor}, A_{roof}, $A_{windows}$ and A_{frames} = total surface of walls, floor, roof, windows and frames (m^2)
$R_{c,walls}$, $R_{c,floor}$ and $R_{c,roof}$ = insulation resistance of the walls, floor and roof (m^{2}K/W)
$U_{windows}$ and U_{frames}= heat transfer coefficient of windows and frames (W/m^{2}K)
ρ = density of the material (kg/m^3)
c = specific heat of the material (J/kgK)
V = volume flow rate (m^3/s)
ΔT = difference in outside air temperature and constant inside air temperature (K)

$$Q_{tot} = \left(\left(\frac{A_{walls}}{4.50} + \frac{A_{floor}}{4.00} + \frac{A_{roof}}{7.10} + A_{windows} * 1.25 + A_{frames} * 1.25\right) + 1200 * 0.9 * 10^{-3}\right) * 9.90 \qquad (5b)$$

Table 5 Total heat loss and costs for heat loss per type and surface

	Total heat loss (W)	Total heat loss (kW)	Total cost for heat loss (€)	Total costs per month (€)
Detached				
17 m2	558.73	4894.47	978.89	81.57
23.5 m2	697.38	6109.04	1221.81	101.82
30 m2	836.03	7323.60	1464.72	122.06
Terraced				
17 m2	443.63	3886.16	777.23	64.77
23.5 m2	538.27	4715.29	943.06	78.59
30 m2	632.92	5544.41	1108.88	92.41
Flat				
17 m2	377.83	3309.80	661.96	55.16
23.5 m2	447.33	3918.60	783.72	65.31
30 m2	516.83	4527.41	905.48	75.46

In addition to heat loss, the *use of electrical equipment* has an impact on energy costs. According to (CBS, 2018b), about 87 percent of the electricity in a household is used for equipment. In addition, in an average household (with 2.16 people ((CBS, 2017))), according to MilieuCentraal (2018), 212 m3 of gas is used annually for hot water showers. This is 80 percent of the total hot water consumption in a household (MilieuCentraal, n.d.-a). The use of equipment is based on a one person household that uses an average amount of hot water and electricity and has the equipment, energy demand and costs as indicated in appendix 2. The electricity consumption per device is according to research from Shift Innovatie (2018). Shift Innovatie (2018) indicated that seven percent of the electricity consumption should be added in the total sum to correct for any calculation errors, so the seven percent is added. As mentioned, about 87 percent of the electricity used in a household is used for equipment, so the total electricity consumption is 1080 kWh.

As the tiny houses will not be connected to the gas-network, the use of gas has been transferred to electricity whereby 1 m3 gas is equivalent to 9.769 kWh (De energieconsulant, n.d.). An overview of the total energy demand and costs can be seen in table 5. In the calculations, the price of electricity is set to €0.21/kWh (price level Q4 2018; MilieuCentraal, n.d.-a).

In addition to the energy consumption of heating and equipment, PV(T) systems provide the opportunity to reduce the energy costs by *generating energy*. In order to keep the costs for these systems as low as possible, while at the same time achieving a high yield, a number of factors have been taken into account. Especially with the flat type there is relatively little roof surface available for the large number of apartments in the building. Because of this small roof surface, the panels will be laid flat, so that they will not cast a shadow on other panels. Also panels will be placed on the south facade of the house. The efficiency is not optimal in both scenarios (10 percent less yield for flat laid placement (Siderea, n.d.) and 30 percent less yield for vertical placement (Zandee, 2017)), but it does ensure that more panels can be placed, resulting in a higher output. Therefore, horizontal flat laid PV panels are used for all types and surfaces as well as that vertical PV panels are used for flats. However, because of the higher costs of PVT panels and the unknown efficiency of PVT panels in vertical installation, they are only placed on the roof to avoid unnecessary (high) costs. An additional issue is that there is a surplus of roof surface in some terraced houses and therefore a surplus in electrical generation. Since the yields you get for selling electricity are very small and therefore the profit that is made from placing PV(T) is reduced, this has to be prevented (MilieuCentraal, n.d.-d). As a result, the same amount of panels is used for the terraced houses as for the detached houses. Figure 8 shows an example of the placement and quantity of panels, the figures per housing type and surface can be found in appendix 3.

The yields can be determined on the basis of the number of PV(T) panels per combination of levels. The full results can be found in appendix 4. The yields per month vary between 12.80 and 46.78 euro for PV panels and 36.27 and 123.68 euro for PVT panels. This is based on the following assumptions with regard to yields.

- There are PV panels of 1 x 1.65 m2 and 1 x 1.95 m2 and PVT panels of 1 x 1.65 m2. The small type produces 250 Wp and the large type 300 Wp (MilieuCentraal, n.d.-c).
- In the Netherlands an average return of 90 percent applies (Alforte Innovations, n.d.)
- Horizontal placement gives 10 percent less efficiency (Siderea, n.d.) and vertical placement 30 percent less (Zandee, 2017).
- PVT panels generate 12.5 percent more electricity than PV panels (Beter Duurzaam BV, n.d.).
- PVT panels generate 60 m3 of gas per m2 on an annual basis (Beter Duurzaam BV, n.d.).

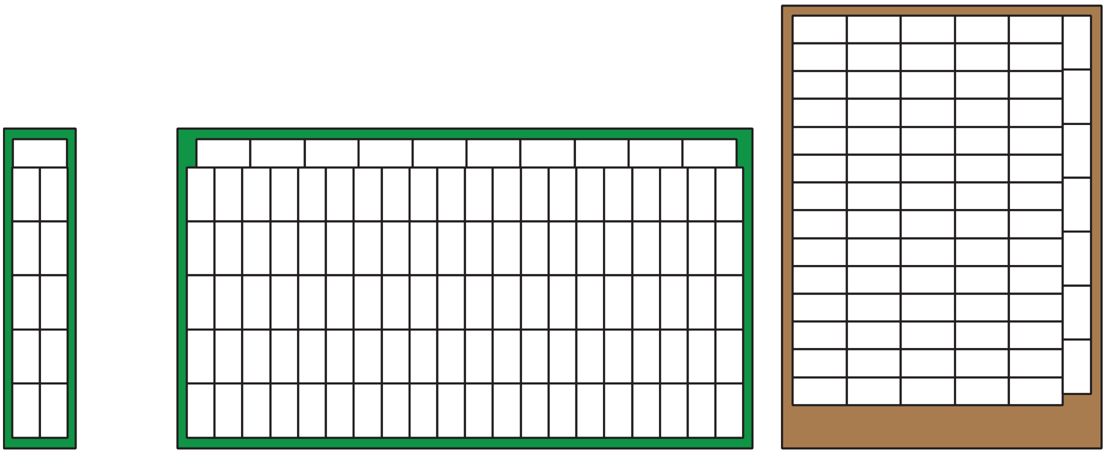


Figure 8 Placement for PV panels on a terraced or detached house (left) and flat house on the roof (middle) and south facade (right)

Costs:

For the cost calculation, the attributes are divided into three groups, the first group influences the number of square meters of the home, the second group assumes a ratio compared to a Dutch average and the third group has a fixed monetary value. This division will be further explained in next paragraphs.

The average cost of a rental home in the Netherlands is € 15.25 per square meter per month (Pararius, 2018) and the average purchasing price is € 2250 per square meter (Weetmeer Buurtinformatie, 2018). A larger number of square meters logically leads to a higher house price. The number of square meters in this study is determined by two attributes: surface area and shared facilities. The area is expressed in an amount of square meters and can therefore be used immediately. The shared facilities attribute is based on the principle that by sharing facilities you can also use the surface where the facilities are, which will increase your surface area. With shared laundry, one m^2 is added to the surface, with a shared storage space, another two m^2 are added.

In addition to the number of square meters, it is also possible to look at a price level in relation to another price level, a ratio or percentage. This is used in the attributes location, outdoor space and house type. For the location, the average purchase price of a home in different neighborhoods of Eindhoven was examined. These neighborhoods are divided on their location; neighborhoods in the center, on the edge of the city center and in the outskirts of Eindhoven (see appendix 5). The costs for the outdoor space and housing types are based on the literature. According to Luttik (2000), the presence of a garden or park provides respectively eight and six percent added value of the house, while the lack of a garden can lead to a four percent loss of value of the house (Huurcommissie, 2018). In addition, according to Pararius (2018), the average costs for a flat, detached and terraced house are resp. € 17.00, € 12.66 and € 11.24 per m2. The costs for a flat are so high because of the high demand for often smaller and conveniently located flats (Pararius, 2018). Table 6 shows for each of these attributes the average values and ratios per level based on the average asking price of an owner-occupied house or rented house per m^2 for the Netherlands.

Table 6 Calculation ratio per attribute level for location, outdoor and type

	Rental price per m2 in €	Purchase price per m2 in €	Ratio relative to average
	Location (L)		
In the city center		3494	1.55
On the edge of the city center		2840	1.26
In the suburbs of the city		2522	1.06
	Outdoor (O)		
Garden			1.08
Park within 400 meter			1.06
No outdoor space			0.96
	Type (T)		
Detached house	12.66		0.83
Terraced house	11.24		0.74
Flat	17		1.11

Finally, there is the attribute with a fixed monetary value, namely the sustainable system attribute. This fixed value is not the same for every combination of levels, but given a specific combination of levels this value is always the same. For the cost calculations of the sustainable system attribute, the number of PV and PVT panels as in the energy cost calculation is assumed (see appendix 4). The costs of the PV panels are mainly given in price per Wp (including all other costs) (MilieuCentraal, n.d.-d; Zonnepanelen-info.nl, n.d.), while the costs for PVT panels are given in the prices per panels, to which the VAT, inverter and installation costs have to be added (Beter Duurzaam BV, n.d.). The costs for PV panels are therefore calculated based on the price per Wp, while the costs for PVT panels are calculated based on the prices per panel. This monthly charge is added to the rent as a fixed value (see table 7). The following assumptions have been used for the cost calculation for PV(T) panels:

- For a system of resp. 6, 8 and 11 panels, the costs per Wp are € 1.74, € 1.63 and € 1.60. For systems larger than 30 panels the costs per Wp are € 1.40 (MilieuCentraal, n.d.-d).
- A PVT panel costs € 450, - excl. 21 percent VAT and installation costs and has a lifespan of about 25 years (Beter Duurzaam BV, n.d.).
- An inverter for PV(T) panels costs € 1200, - excl. installation costs and has a lifespan of about 10 years, which means that it has to be replaced 2 to 3 times during the life of the panels (zonnepanelen-weetjes.nl, 2018)
- The installation costs are approximately 20 percent of the price (zonnepanelen-weetjes.nl, 2018)

Table 7 Calculation values per attribute level for sustainable system

	Number of panels 250 Wp per house	Number of panels 300 Wp per house	Electricity yields in kWh	Gas yields in m3	Costs in euro	Costs in euro per month
PV panels						
Detached						
17 m2		6	1458		3132.00	10.44
23.5 m2		8	1944		3912.00	13.04
30 m2		11	2673		5280.00	17.60
Terraced						
17 m2		6	1458		3132.00	10.44
23.5 m2		8	1944		3912.00	13.04
30 m2		11	2673		5280.00	17.60
Flat						
17 m2		3.19	731		1338.75	4.46
23.5 m2	3.13	1.75	1000		1828.75	6.10
30 m2		5.84	1341		2454.38	8.18
PVT panels						
Detached						
17 m2	7		1595	693	8893.80	29.65
23.5 m2	10		2278	990	10854.00	36.18
30 m2	13		2962	1287	12814.20	42.71
Terraced						
17 m2	7		1595	693	8893.80	29.65
23.5 m2	10		2278	990	10854.00	36.18
30 m2	13		2962	1287	12814.20	42.71
Flat						
17 m2	2.25		869	377	2055.15	6.85
23.5 m2	3.13		1168	507	2851.88	9.51
30 m2	4.13		1538	668	3775.28	12.58

The calculation of the rental costs per profile are then calculated according to the following formula, where L, O, T, S, F and D refer to the costs associated with the level of the attributes location (L), outdoor space (O), type of house (T), surface (S), shared facilities (F) and sustainable system (D):

*Rental price = average of (L + O + T) * average rental price in the Netherlands per m2 * (S + F) + D.*

3.3 Data collection

After the attributes and levels have been determined and the basic Tiny Houses and profiles have been designed, all can be merged into the questionnaire. To ensure that the respondents answer the questions in the questionnaire correctly, it is important that the questions formulated in an understandable way (Kemperman, 2000). In addition, it is advised to give the respondent information about the objective of the experiment (Kemperman, 2000).

The questionnaire (see appendix 6) consists of three parts. In the first part a number of personal questions will be asked about the respondent (e.g. age and gender) and his or her (future) living situation (such as type of home and household composition). The second part asks about the knowledge and interests concerning Tiny Houses and gives information about what Tiny Houses are. Subsequently, in the third part, the respondent receives nine questions in which they are asked to choose from three options. Option 1 and 2 will consist of a profile given the attributes and levels discussed before. In addition, there will always be the option: none of both. This is to imitate the real life choice as good as possible (Hensher et al., 2015). In order to clearly show the alternatives to the respondents, both options are visualized, see figure 9 for an example of a choice task.

The questionnaire will then be distributed among respondents within the target group, i.e. one- and two person starters' households between the ages of 18 and 35 years. Respondents will be recruited via social media, such as Facebook and an online survey exchange site. In addition, flyers containing a link to the online questionnaire (QR code) will be handed to people in the target group at the TU/e-campus and at the Eindhoven railway station. As there are three version of the questionnaire, an equal number of respondents per version is strived for.

Which Tiny House do you prefer? *

Tiny house A has the following characteristics:	
Surface	30 m2
Type of house	Detached house
Facilities	Shared laundry
Outdoor space	Private outdoor space
Sustainable system	No sustainable system
Location	In the suburbs of the city
Price*	€ 475,- per month
Energy costs**	€ 160,- per month

Tiny house B has the following characteristics:	
Surface	17 m2
Type of house	Terraced house
Facilities	Shared laundry
Outdoor space	No outdoor space
Sustainable system	Electrical and thermal generation
Location	In the suburbs of the city
Price*	€ 290,- per month
Energy costs**	€ 40,- per month

** The prices of the Tiny Houses are between € 245, - and € 640, -*
*** The energy costs of an average Dutch household per month for a terraced house are € 205,- based on fully electrical energy.*
The energy costs of the Tiny Houses are between € 10,- en € 160,- based on fully electrical energy.

- ○ Tiny House A
- ○ Tiny House B
- ○ None of both

Figure 9 Example of a choice task

3.4 Analysis description

After the data collection, the data from the discrete choice experiment can be analyzed. First, with the help of IBM SPSS Statistics 23, the socio-demographic data will be analyzed, as well as the current and future living situation and knowledge and interests concerning Tiny Houses. A number of links between these questions will also be examined. With the help of Chi-squared and spearman correlation tests, it will be checked whether these relations are significant. Subsequently, the data of the choice experiment will be analyzed with Nlogit 5. A common model to analyze the choices made by the respondents is the multinomial logit (MNL) model. For each alternative it is assumed that the utility of that alternative consists of an observable or structural and an unobservable or random component (Hensher et al., 2015). The utility of alternative *i* (U_i) is therefore represented by the structural component (V_i) and the random component (ε_i) (Hensher et al., 2015). From the utilities of the alternatives it can be determined which levels are found most important by the respondents.

$$U_i = V_i + \varepsilon_i \tag{6a}$$

The structural component is defined as:

$$V_i = \sum \beta_k x_{ki} \tag{6b}$$

β_k = utility weight for attribute variable k
X_{ki} = attribute variable k of alternative i

3.4.1 Effect coding

To perform the analyzes the attributes are coded using effect coding. This is a data transformation method according to a non-linear coding scheme (Hensher et al., 2015). With effect coding, effects are created per attribute, which together define a level. The number of effects is always one less than the number of levels for that attribute (Hensher et al., 2015). The levels are described as in table 8, where the base level has a coding of minus one for both variables. Since each of the attributes in this survey has three levels, two effects will be used for each of the attributes. The complete coding for all attributes can be found in appendix 7.

Table 8 Effect coding scheme

Surface	S1	S2
17 m2	1	0
23.5 m2	0	1
30 m2	-1	-1

A constant factor has also been added, which determines the value of the neutral 'none of both' option. This constant has a value of one for the neutral option and a value of zero for both Tiny Houses. With the help of this constant it can be determined whether the neutral option is preferred over the two Tiny Houses in the choice set.

The use of a random component indicates the random utility theory (RUT) (Thurstone, 1927). Within the RUT, a distinction can be made based on the distribution of the ε_i component. The probit model assumes that the ε_i component is normally distributed, while the logit model is based on a Gumbel distribution or Type 1 generalized extreme value distribution (Hensher et al., 2015). Although the distribution shape of probit models (normal distribution) is simpler than that of logit models (Gumbel distribution), logit models give more expansion possibilities (Hensher et al., 2015). This gives the possibility to highlight the dataset from different perspectives and to create a more realistic scenario. Since the logit model is more practical in the area of estimating and analyzing (Hensher et al., 2015) and this model has a closed-form solution (Kemperman, 2000), only logit based models will be applied in this study.

3.4.2 Multinomial logit model

The multinomial logit model (MNL) is the most commonly used method to estimate the likelihood that a particular choice alternative will be chosen from a choice set (Kemperman, 2000). It is assumed that the random factors do not have a mutual correlation. The MNL model can be described as follows (Hensher et al., 2015), with P as the probability that option i is chosen by individual n from a set with J options:

$$P_{ni} = \frac{e^{Vni}}{\sum_{j=1}^{J} e^{Vnj}} \quad (7)$$

From this model comes a (partial) utility for each of the attribute levels. The utility value can be positive or negative and indicates how the respondents judged this level in their choice. A positive value indicates a positive assessment and a negative value a negative assessment of the relevant levels. The higher the value (both positive and negative), the heavier the rating counts in the choice.

With the help of McFadden's Rho^2 or ρ^2, the degree of fit of the model can be examined. This measure should not be confused with R^2, which is an indication of the percentage of the dependent variable that is explained by a regression analysis. ρ^2, on the other hand, only indicates the percentage improvement of fit of the estimation model regarding the dataset with respect to the same function with a zero value for all parameters (Train, 2009). That is, the percentage that the estimated model fits better with the dataset compared to a function with zero for all parameters. This ratio is therefore only suitable for comparing models that have been applied to the exact same dataset with the same set of alternatives. Only in this scenario it can be stated that a higher value for ρ^2 stands for a better fitting model (Train, 2009). As soon as there is a difference in data set or choice options, no comparison can be made between the models using ρ^2.

Rho^2 is represented by the following formula, where Rho^2 is always between 0 and 1 and a value between 0.2 and 0.4 indicates an excellent fit (Hensher et al., 2015). The *LL(B)*, the log likelihood of the estimated model, is compared with the log likelihood of the restricted model *(LL (0))*(Train, 2009).

$$\rho^2 = 1 - \frac{LL(B)}{LL(0)} \quad (8a)$$

where $LL(\beta) = \sum_n \sum_i y_{n,i} \ln(p_{n,i})$ *(8b)*

with $y_{n,i}$ representing whether individual n has chosen alternative i (1 if Yes; 0 if No). The probabilities are calculated according to the estimated β-parameters. To calculate *LL*(0), the estimated parameters are replaced by zeros, meaning that all alternatives in the choice set have the same choice probabilities.

3.4.3 Latent class model

An alternative to MNL is the latent class model (LC). In this method some classes are formed, based on the preferences for the attributes. Based on these preferences, a respondent can be assigned to a certain class (Hensher et al., 2015). Since the assumption is that the individual behavior is caused by unobserved factors, the classes are undefined and unknown, and estimated on the collected data (Nijënstein, 2012). In short, for each class of respondents a separate MNL is estimated.

An advantage of this model is that it determines segments of respondents with similar preferences. By investigating the (personal) characteristics of the respondents in these segments, the segments may be defined by their typical characteristics. This allow policy makers or entrepreneurs to optimally deal with each segment.

3.5 Conclusion

For this research a discrete choice experiment will be used. For this purpose, different choice sets with a set of six attributes and three levels per attribute have been put together which were based on a Tiny House, designed for this research. Bundles of these choice sets are distributed through a questionnaire on social media and via flyers on the TU/e campus and Eindhoven railway station. In addition to the choice sets, the respondents will be asked about their personal characteristics, current and (expected) future living situation and experiences with regard to Tiny Houses. The data will be analyzed with conventional and latent class logit models in order to reveal the preferences of (clusters of) respondents.

CHAPTER 4
SURVEY ANALYSIS

Keret House:
World's skinniest house in Warsaw
Architect: Jakub Szczęsny, 2012
(Warsaw insider, 2017)

4. Results

This chapter describes the results of the survey. The chapter is divided into two parts, namely the descriptive statistics of the respondents (section 4.1) and the results of the studied model section 4.2. Section 4.3 then draws conclusions from these two sections.

4.1 Descriptive statistics

In this section, first the amount of respondents in this research were described. Then the respondents were described on the basis of some socio-demographic characteristics, these results were, if relevant, compared with data from Dutch people in their twenties to see how much this dataset differs from the Dutch average. After that, the expectations regarding their next living situation were described and finally the knowledge and interest about and in tiny houses of the respondents will be described. The relations between the different variables in this section are calculated with Chi-square tests and Spearman's Rho correlations. The Chi-square test compares the observed values per combination with the expected value based on the chance that this situation will occur (Field, 2009). This test is suitable for testing a relation between two category variables (nominal or ordinal) (Field, 2009). The Spearman's Rho correlation on the other hand describes whether there is a relationship between two variables, at least one of which has an ordinal measurement level and the other may have an ordinal level as well or a ratio or interval measurement level (Field, 2009).

For the follow-up study in section 4.2 and to identify some relations between variables, infrequently chosen options will be merged. These composite answers are indicated in the graphs and explained in the text where necessary.

4.1.1 Respondents

Using social media (Facebook and questionnaire exchange sites) and handing out flyers at the TU/e-campus and at the Eindhoven railway station, there are obtained 308 respondents divided over three different versions (Version 1: 102 respondents, version 2: 101 respondents and version 3: 105 respondents). Since both versions 1 and 2 appear to have a double reaction and there must be just as many reactions in each version to assess each profile equally, 300 respondents were used in this study, 100 per version. Since this is a higher number than I expected in advance and since it was fairly easy to get interested respondents, this may indicate that it is a topic that appeals to the target group.

4.1.2 Personal characteristics

In this subsection, questions one to three from the questionnaire are discussed. These questions are about the personal characteristics of the respondents.

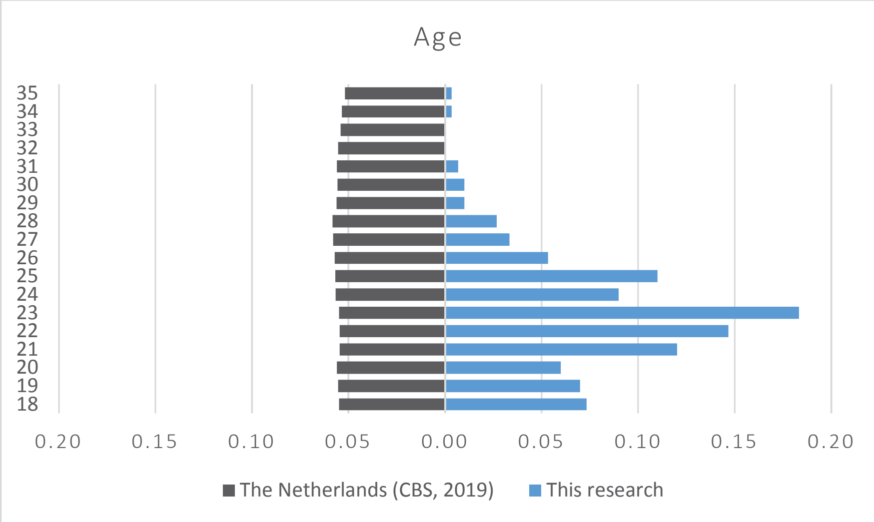


Figure 10 Ratio by age

Of the 300 respondents, 120 were male and 180 were female. In addition, the age range within which the questionnaire was conducted is between 18 and 35 years. Therefore, the oldest and youngest respondents are resp. 35 and 18 years old. However, almost all of the respondents are under the age of 30, except two. Finally, by far the majority of the respondents (79 percent) indicate that they are students in a choice between studying or working (both part-time and full-time).

Compared to numbers at Dutch level, the distribution of both gender and age is unevenly distributed. Both the gender and the number of people per age between 18 and 35 years are approximately the same at Dutch level (CBS, 2018a, 2019). In addition, a remarkably large proportion of the respondents study. In fact, only 25 percent of the Dutch people in their twenties study (CBS, 2015). These differences can mostly be explained by the locations of distribution of the questionnaire, the TU/e campus and the social media network (of the researcher). Both locations contain many students from the early twenties. This could explain both, the skewed ratio between age and occupation. However, according to the 2017 annual report (Technology, 2017), the TU/e has a male / female ratio of about 75 to 25. As a result, a larger number of male respondents is expected. However, in her research Boomgaard (2018) speaks of the possibility that men are less interested in tiny houses due to the low proportion of men (about 30 percent) in her research. The combination of the possibly lower interest in tiny houses and a larger proportion of men at the TU/e could provide this minor gender imbalance.

After performing Chi-squared tests (see appendix 8) between these three variables, there appeared to be only a strong (Phi = 0.428) fully significant (Chi-squared = 0.000) relationship between age and occupation. In the age group 23 years and younger, 94 percent of the respondents are students, in the age group 24 years and older this is 'only' 59 percent.

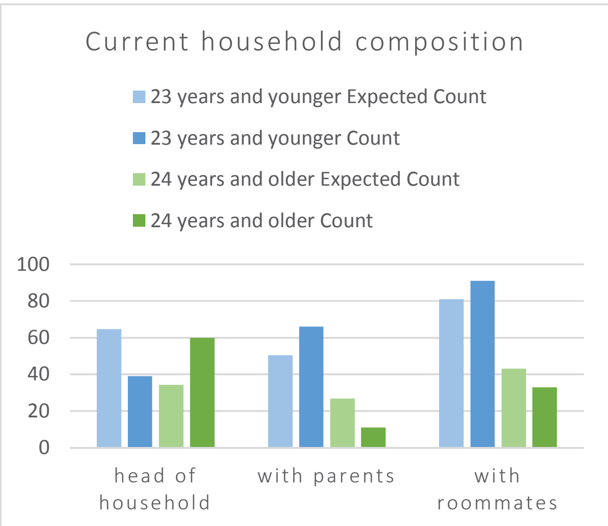
4.1.3 Current house situation

In this subsection questions four to ten of the questions are discussed. These questions are about the current house situation of the respondents.

The proportions of the variables ‘current household composition, type of house and location’ both from the Dutch people in their twenties and de respondents are shown in appendix 9. The answers of the respondents in the questionnaire were compared with the more general residential characteristics at national level.

Particularly striking about these results is the very large number of respondents living together with housemates compared to the Dutch average. With this, the low numbers for living independent and living together with parents are connected. This is probably related to the previously described personal characteristics. Both the Chi-squared tests between age and current household composition (Chi-squared = 0.000, Cramer's V = 0.396) and occupation and current household composition (Chi-squared = 0.000, Cramer's V = 0.299) show a clearly significant relationship. The proportion of respondents living together with housemates is significantly high, both for the young age group and the students (see figure 11 and appendix 8).

The attributes type of house and location are divided equally in this study with the national average. Chi-squared tests do show that these attributes are both (weak) related to age, which makes it possible that another age group has a different relationship with regard to these two attributes. For example, young people (23 years or younger) live more often in a terraced house or detached house than expected and older people in a flat. Older people also live in the center more often, while young people more often live outside or on the suburbs of the city. These Chi-squared test results are shown in appendix 8.



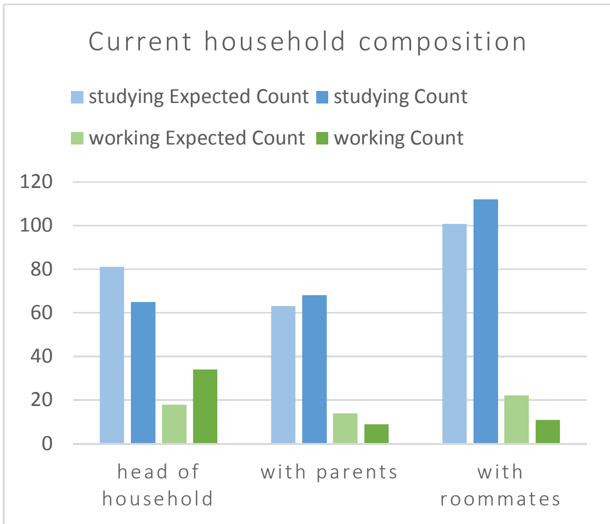


Figure 11 (Expected) counts of current household composition with age and occupation

Surface

With regard to the living space, almost half of the respondents have a surface of between 25 and 75 m^2 at their disposal (see figure 12). The average living space per person in the Netherlands is 65 m2. The most chosen answer is 25 to 50 m2, which is well below the Dutch average. This may be explained again by the high number of students. A Chi-squared test between the two indicates a significant relationship (Chi-squared = 0.02, Cramer's V = 0.162)(appendix 8). Students live on average smaller than working people. Due to the high proportion of students, the average surface area will therefore be smaller.

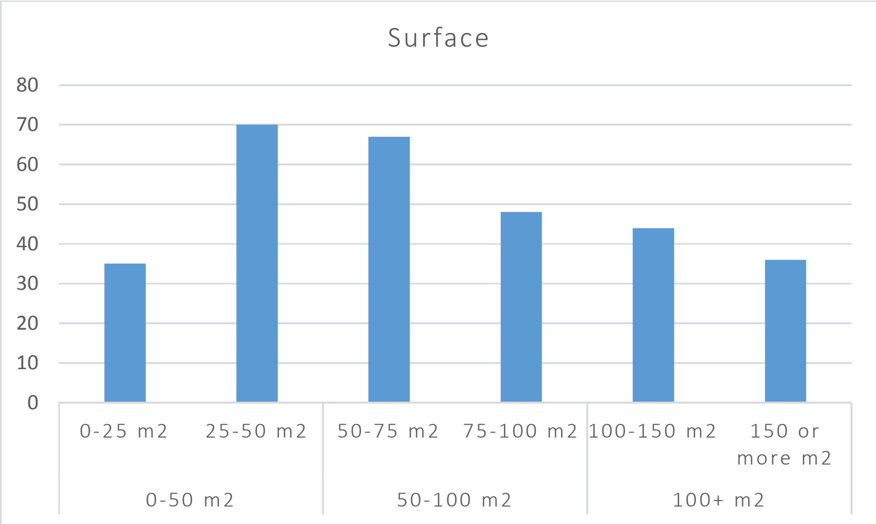


Figure 12 Living surface of the respondents

Outdoor space and sustainable system

With regard to these two variables, there is no clear comparison data. Therefore, only the results from this research are mentioned. For both attributes applies that one option has been chosen clearly more frequently than the other option(s). The majority of the respondents (76 percent) have some form of garden (garden or balcony), another 11 percent have a shared outdoor space and only 13 percent of the respondents indicate that they have no outdoor space. With regard to the sustainable system, only 9 percent of the respondents do have a sustainable system, while the other 91 percent do not. Because of the limited number of respondents (less than 10 percent) with a sustainable system, these variable is considered to be unreliable and not otherwise assessed in this study.

Satisfaction

According to CBS (2015) about 75 to 80 percent of people in their twenties are satisfied with their living environment and, for satisfaction with the area, this percentage is even 85 to 90 percent. Within this study the distribution on a 5-point scale, from very dissatisfied to very satisfied, is resp. 1, 6, 22, 45 and 26 percent. In this study too, the majority is clearly satisfied with their living situation. In total there is found only one significant relation with the satisfaction of the housing situation, namely with the expected moment of moving (see appendix 8). This could be due to the limited number of dissatisfied respondents, only seven percent. Since the described relationship between satisfaction and expected moment of moving does make sense, it is described in section 4.1.4.

After performing a Chi-squared test, there appeared to be many significant links between the residential characteristics (see appendix 8). It is striking that there is no significant relationship between the residential characteristics and the satisfaction with the current living situation. This large amount of interconnections could occur more often, but it could certainly also be related to the distribution of the respondents. Based on the household composition, a clear distinction can be made between three types of respondents, namely the respondents living with their parents, the respondents living independently and the respondents with roommates. Based on these three types, the relations between all residential characteristics can be seen in table 9.

Table 9 Group division based on residential variables

	Head of own family	With parents	With roommates (no family)
Type of house	Flat	Terraced or detached	Flat or terraced
Location	In the city center	Not in the city	In the city
Outdoor space	Mostly with outdoor space	Always with outdoor space	Larger part without outdoor space
Surface	Maximal 100 m^2	Many with more than 100 m^2	Maximal 100 m^2

4.1.4 Expected housing situation

In this subsection questions 11 to 13 of the questionnaire are discussed. These questions are about the expectations of the respondents regarding their next housing situation.

Future house situation

About half (48 percent) of the respondents expect to rent their next house, the rest (52 percent) expect to buy their next house. In addition, the majority (44 percent) of the respondents expect to live together with a partner in their next house, another 9 percent expect to have a partner and children, 27 percent expect to live alone, 5 and 13 percent expect to live together with one or more housemates and only 1 percent expect to live with their parents in the next house. Finally, the majority of respondents (40 percent) expect to move within one to three years and only 8 percent of respondents expect not to move within 5 years.

With these variables different relations can be identified (see figure 13). Corresponding Chi-squared tables can be found in appendix 8.

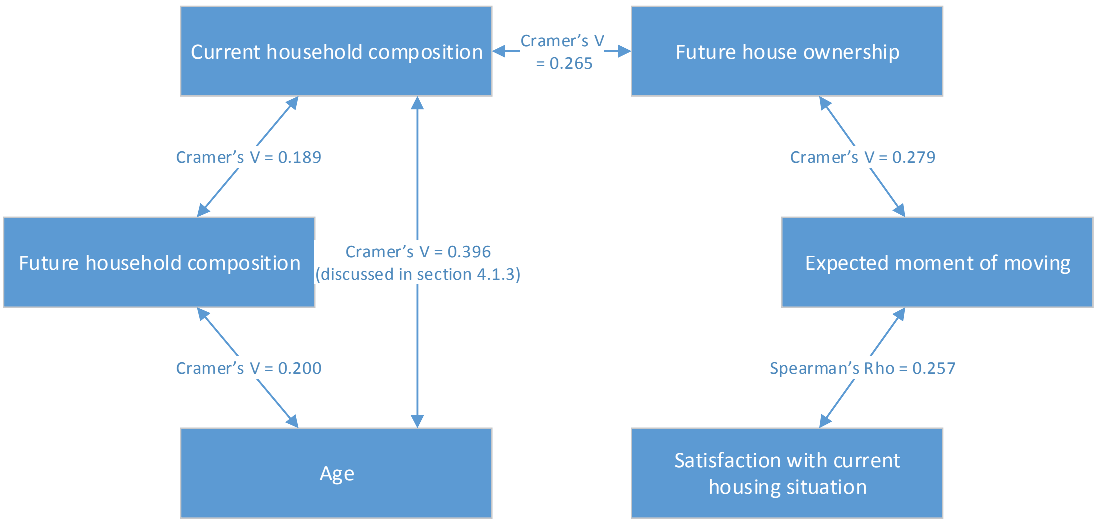


Figure 13 Chain of relations with associated strength

Respondents who are currently heads of a household have a strong preference for buying their next home, even as respondents living with their parents. Respondents who live together with roommates, on the other hand, prefer a rented home in their next living situation. In addition, respondents expecting to move in a short term (within 3 years) expect to rent their next home, while respondents who expect to move later expect to buy their next home. In general, dissatisfied respondents expect to move earlier than satisfied respondents. Looking at their future living situation, older people expect to live in a single-person household or with a partner, while young people would rather expect to live with roommates or a partner. Finally, respondents who live independently in their current situation expect to live with their partner in their next living situation, while respondents living at home are more likely to have a one-person household or household with roommates.

Since this research is about a rental Tiny House, it is interesting to see how this chain develops and which personal or residential characteristics could (in)directly influence the interest in a rental Tiny House. So figure 14 shows an example of this chain of relations, based on the preference for a rental home. Most respondents who prefer a rental home in their next living situation currently live together with roommates (55 percent) or expect to move within three years (80 percent). 95 percent of the respondents who are dissatisfied with their current living situation expect to move within three years. Resp. 47 and 31 percent of the respondents who live together with roommates at the moment expect to live together with their partner or roommates in their next home situation and 73 percent of these respondents are under 23 years old. Both 44 percent of the older age group as well as the younger age group expect to live together with their partner in the next living situation, as well as 33 percent of the younger age group expect to live together with roommates in the next living situation.

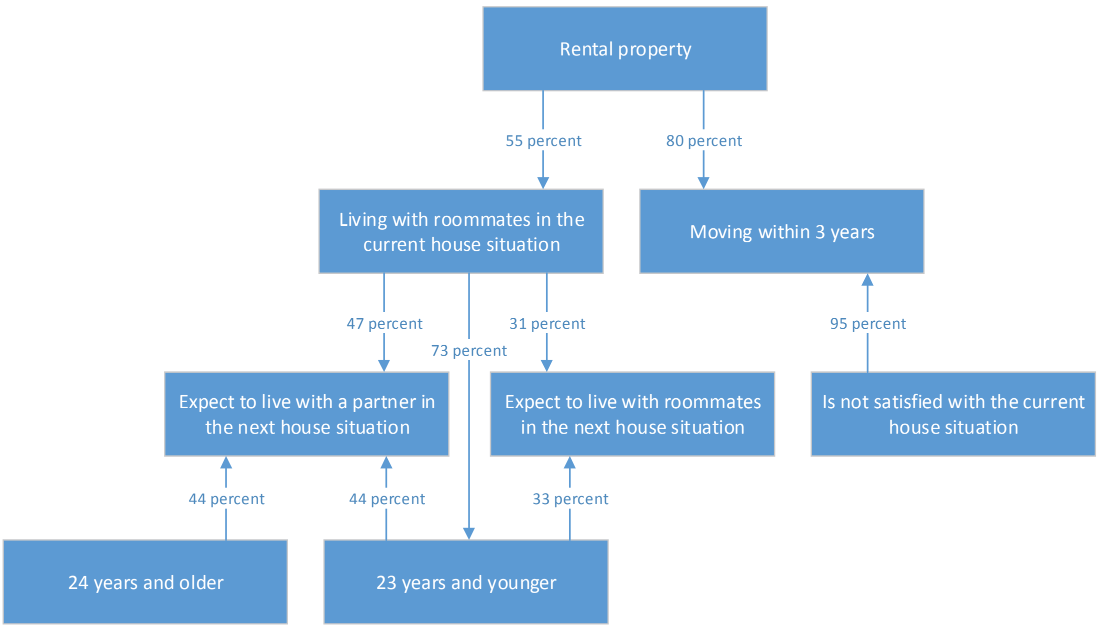


Figure 14 Example of a chain of relations based on the preference for a rental property

4.1.5 Tiny House experience

In this subsection, the questions fourteen and fifteen from the questionnaire are discussed. These questions are about the knowledge and interest of the respondents with regard to Tiny Houses. Nearly half of the respondents (48 percent) indicate that they have limited or no knowledge of Tiny Houses. Nonetheless, only 31 percent of the respondents have limited or no interest in Tiny Houses. It might therefore be still a relatively unknown, but interesting topic among the respondents.
Since this research is about the interest of young starters to Tiny Houses, we look at the variables that are directly related to the interest in Tiny Houses. These variables are the surface area of the current dwelling, the expected house ownership and the expected future household composition.

The figures can be seen in appendices 10 and the corresponding Chi-squared tests in appendix 8. This figures show that people with a small area are more interested in Tiny Houses, as well as respondents that expect to rent their next property. In addition, respondents who expect to live together with a partner clearly have less interest in Tiny Houses, while respondents that expect to live alone or with roommates in their next house are more interested.

4.2 Model results

In this section, several multinomial logit (MNL) models are estimated based on the dataset. First, a basic model is estimated. Subsequently, the influence of certain factors on the preferences of respondents is examined. These factors represent personal characteristics, the current living situation, the future living situation and the Tiny House experiences.

4.2.1 MNL model

The basic model has a Rho² value of 0.176. A value between 0.2 and 0.4 would indicate an excellent fitting model. Although this is not an excellent fitting, it is certainly that the model fits reasonably well with the dataset. The strong negative value of X0 indicates that the respondents preferred at least one of the Tiny House options preferred over the 'none of both' option. Each of the attributes has at least one significant parameter, indicating that each of the attributes has a significant influence on the choice behavior of the respondents. The results of the model estimation are attached in appendix 11.

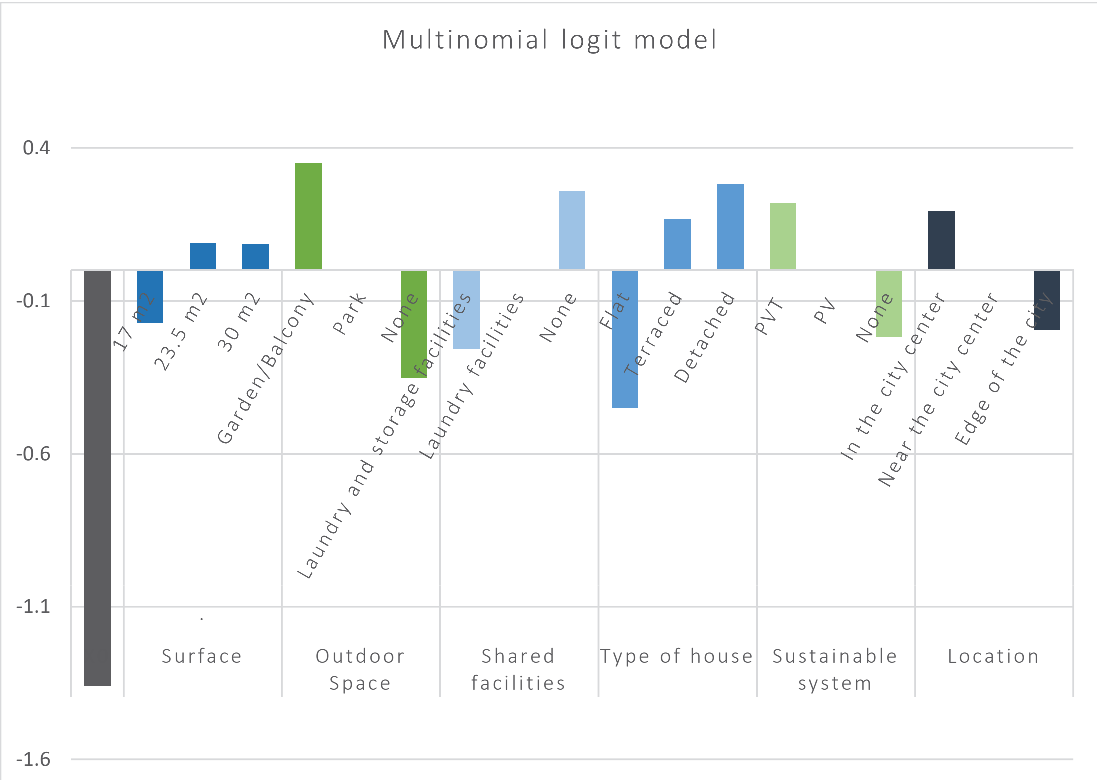


Figure 15 Utility values per attribute level

As can be seen in figure 15, some utility values are set equal to zero. This is because of the fact that the parameter determining this value has no significant value. All the levels shown here are therefore significant at a level of at least 10 percent.

The figure shows that the respondents prefer a Tiny House with a living area of 23.5 or 30 m^2 compared to a Tiny House with a surface of 17 m^2. However, having a garden weighs heaviest on the positive assessment for a Tiny House, while the type 'flat' affects the choice the most negatively. In summary, the respondents prefer a detached Tiny House with a private outdoor space, without shared facilities, but with a PVT system, in the city center and with a minimum surface of 23.5 m^2.

4.2.2 Model with interactions

Since it was assumed that there might be interaction between the attributes surface, outdoor space and shared facilities, an MNL model was estimated in which these interactions are measured. To this end, the basic parameters of all attributes are estimated, as well parameters for any possible combination of levels of the attributes surface, outdoor space and shared facilities. The Rho^2 of this model is 0.179. The interaction model thus fits slightly better with the dataset than the basic model. Further, there are significant interactions between the attributes ‘surface’ and ‘outdoor space’, and ‘outdoor space’ and ‘shared facilities’ (see appendix 12 for the model estimation).

Appendix 13 shows the part worth utilities with interactions between the different attributes. It can be concluded that the combination of the attributes 'surface' and 'shared facilities' has no significant interaction, while the other combinations do have a significant interaction. So, the combination 17 m^2 and a park, is assessed less negatively than according to the main effects only, while the combination 17 m^2 without outdoor space is judged more negatively. On the other hand, the combination of 30 m^2 and park becomes negative when taking into account the interaction effects while 30 m^2 without outdoor space becomes less negative. A small Tiny House is therefore less disadvantageous if there is a possibility to go outdoors, while this is less important for a larger Tiny House.

Appendix 13 also shows that the combination of garden and laundry is assessed more positively taking into account interaction, where garden without shared facilities becomes less positive (but still is the most preferred combination). On the other hand, the lack of an outdoor space in combination with a laundry is more negatively assessed according to the interaction effects and the lack of both a garden and shared facilities is more positively.

Compared to the MNL model with main effects only, the loglikelihood decreased from -2444.40 to -2436.27. The difference in loglikelihood is 8.13. According to the likelihood ratio test, twice this difference (16.26) is Chi^2-distributed with the number of degrees of freedom equal to the number of additional parameters (12). It can thus be concluded that the MNL model with interaction effects does not significantly perform better than the main effect only model at the 10 percent significance level. Therefore, the interaction effects will not be taken into consideration anymore in the remainder of this study.

4.2.3 Influential variables

Of course there are differences between the respondents and the choices will thus also differ. This section discusses a number of personal and residential (respondent-related) characteristics that may influence choice behavior. For this purpose, interactions between the main effects and the respondent-related characteristics have been investigated. For a characteristic with two levels (e.g. gender), the variables representing the attribute levels have been multiplied by 1 or -1, depending on the value of the characteristic. This adds a set of additional variables to the original variables. With all these variables, a new model is estimated, with which the partial utility values can be determined per level for a specific respondent-related characteristic. This is done by adding or subtracting the extra parameters to/from the main parameters.

An example is given for the attribute surface and the two-level characteristic 'age'. Suppose the main effects for the attribute surface are denoted by S1 and S2. These effects are coded according to the coding scheme in section 3.4.1. An extra set of effects (SS1 and SS2) has been added by multiplying S1 and S2 by 1 for the age group '23 years and younger' and -1 for the age group '24 years and older'. This gives the new, more extensive coding scheme as in appendix 14. By adding and subtracting the effects from each other according to this scheme, the part worth utilities of the different respondent-related characteristics can be compared. With a 3-level characteristic this happens in a similar way, but with an extra set of variables (SSS1 and SSS2) and a more extensive coding (appendix 14). By combining the variables as in this scheme, the part worth utilities of the different respondent-related characteristics can be compared.

If an interaction effect is not significant, it indicates that there is no difference between the characteristics with regard to that level. So in the case of a non-significant interaction effect of the characteristic age for the attribute level 17 m2, it does not matter whether the respondents are in the younger or older age group. Both have an equally strong preference or aversion to the relevant level.

After performing the MNL analyses for each of the respondent-related characteristics, a large number of characteristics appeared to have a significant influence on the part worth utilities (see table 10). The values of Rho^2 were slightly higher with individual variables than for the basic MNL model (between 0.179 for gender and 0.210 for type of house). The separate MNL models therefore fit (slightly) better with the dataset. Also almost every characteristic has a significant influence on the X0, the preference for the 'none of both' option compared to the Tiny Houses. However, the parameter for this option never becomes positive, so there is no preference for the neutral option, independent of the respondent-related characteristics. The characteristics ‘sustainable system’ and ‘satisfaction with the living situation’ are not taken into account because of the limited number of respondents for one of the options.

The attribute surface is affected by most respondent-related characteristics, followed by the attributes outdoor space and location. Also some attributes, namely surface, outdoor space, location and shared facilities, are influenced by their own counterpart variable in the questionnaire. So the preference for surface area, for example, is influenced by the current living area of the respondents.

With regard to the respondent-related characteristics, it is striking that the expected moment of moving affects most attributes, followed by current household situation, surface and future house ownership. The characteristics related to the expected living situation of the respondents seem to have the most influence on the individual attributes, while personal characteristics and the current living situation seem to have less influence on the preferences.

Table 10 Influential variables on attribute levels

	X0	Surface	Outdoor space	Shared facilities	Type of house	Sustainable system	Location
Personal characteristics							
Gender							
Age							
Occupation							
Current house situation							
Current household composition							
Type of house							
Location							
Outdoor space							
Sustainable system							
Surface							
Satisfaction							
Future house situation							
Future ownership							
Future household composition							
Expected moment of moving							
Tiny House experience							
Knowledge							
Interest							

Personal characteristics

The personal characteristics, consisting of gender, age and occupation, have a significant influence on the X0 (age and occupation), surface (age and gender) and outdoor space (gender and occupation). Although all variables have a negative X0 and therefore prefer one of the Tiny Houses compared to the neutral option, the working respondents and the respondents aged 24 or older are more inclined to choose the 'none of both' option compared their counterpart respondents (see appendix 16). All model estimations can be found in appendix 15.

Figure 16 indicates the utility values for the basic level (of all respondents) and per personal characteristic for the attributes surface, outdoor space and location. From this it is possible to see how much the preferences of, for example, men differs from women. Again, the non-significant values are set to zero. In addition, the hatched bars represent the value for the variable, but in this case there is no significant difference in choice behavior with respect to their counterpart variable.

Striking concerning the attribute surface is the large difference in preferences between the younger and the older age group with regard to the minimum and maximum level. The older respondents clearly have a very strong preference for the largest surface and do not prefer the smallest surface at all, where the younger group is slightly more averaged and prefers the middle area. In addition, men prefer the largest area, while women are satisfied with the middle surface level. With regard to the outdoor space, women clearly attach more value to a private garden or balcony compared to men. In addition, students see both a park and no outdoor space as negative, while workers also see a park as a positive factor. Finally, both, young people and older people prefer a home in the city center, but younger respondents do not want to live outside the center at all, while older respondents also want to settle for a home near the city center.

Current house situation

This subsection focuses on the influence that residential characteristics have on the respondents' preferences. Again, non-significant utilities are set to zero and the hatched bars show that there are no significant differences between them. All model estimations can be found in appendix 15.

Again, there seems to be a preference for the Tiny Houses compared to the 'none of both' option since all X0 values remain negative (see appendix 16). However, respondents who currently live with roommates seem to have chosen most often for a Tiny House compared to the none option and people without outdoor space least.

The choice behavior with respect to the attributes surface, outdoor space, facilities and location are significantly influenced by the corresponding respondent-related characteristic. These results are shown in figure 17. However, it appears that it is not the case that respondents living on a small surface have less trouble with a smaller Tiny House. The relationship between the current situation and the choice behavior is therefore not always straightforward. The attributes 'outdoor space' and 'location' have a clear relation with the real world situation, while the attributes 'surface' and 'shared facilities' have not.
Figure 17 shows that respondents who have an outdoor space in their current living situation, attach more value to a garden in their choice than respondents who do not have a garden. In addition, respondents who now live in the city center have a strong preference for staying here or at least not moving to the suburbs of the city, while respondents who do not live in the city now prefer to live on the edge of the city compared to the center. With regard to the surface area, respondents who now live on a small surface area prefer the largest Tiny House surface, while respondents who now live on average or large surfaces prefer to opt for a medium-sized Tiny House. Respondents who now live at a medium-sized level even experience a large Tiny House as a negative factor. However, respondents who now live large do see the smallest Tiny House as the most negative of all respondents. The attribute 'shared facilities' has been compared with the current household composition. This shows that respondents who are currently head of a household have the least resistance to sharing facilities such as laundry or storage. On the other hand, respondents depending on their parents have the least interest in sharing facilities and they have the greatest preference for having these facilities individually.

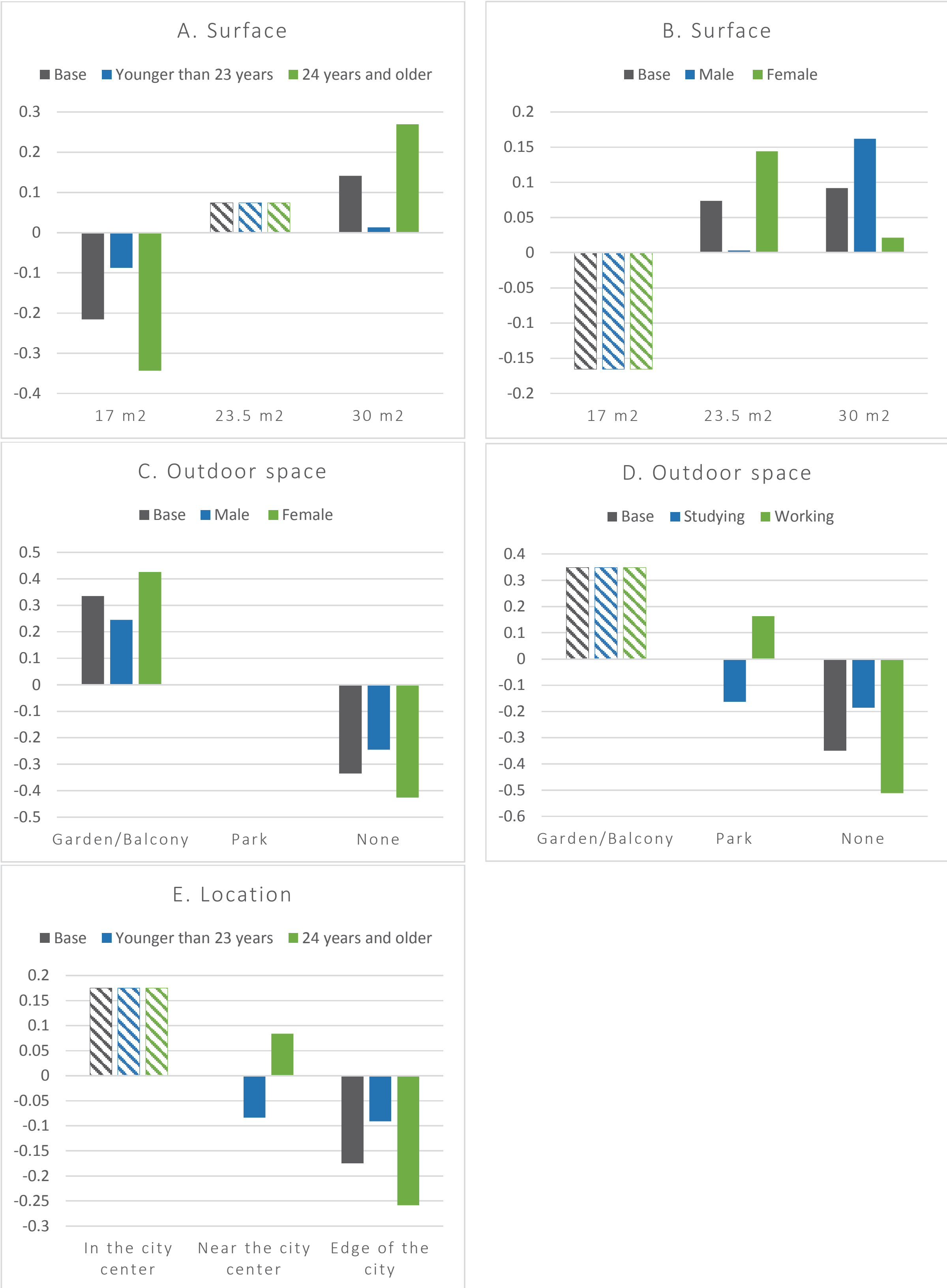


Figure 16 Personal characteristics that influence the attributes surface (A and B), outdoor space (C and D) and location (E)

Figure 17 Housing characteristics that influence the attributes outdoor space (A), location (B), shared facilities (C) and surface (D)

Also some other residential characteristics influences the preferences for several attributes. The figures of these influential characteristics can be found in appendix 17. In addition to the current living space of the respondents, the residential characteristics 'current household composition' and 'type of house' also influence the choice behavior of the respondents with regard to the attribute 'surface'. Especially striking about this is that it is not that the preference is always for a larger surface. Respondents living at home see the level 17 m^2 as most positive, while this level is considered (very) negative by most respondents. Respondents who currently live in a terraced house also experience 17 m^2 as less negative than those in other housing types. Only the respondents who are currently head of their own household or live in a flat prefer the largest Tiny House.

The attribute location is further influenced by the living characteristics 'current household composition and type of house'. Where the general preference is for a home in the city center, respondents who are currently living together with housemates or in an apartment are also satisfied with a home near the city center. Finally, respondents living at home and respondents who live in a detached house at the moment see a house in the suburbs of the city the least negative.

In addition to the attributes 'surface', 'shared facilities' and 'location', the characteristic 'current household composition' has also an influence on the 'outdoor space' attribute. For example, respondents who are currently head of their own households prefer a Tiny House with some form of outdoor space, so garden or park are both positive, while respondents who live with roommates or parents negatively assess a house without a garden, regardless of the presence of a park.

Finally, the attributes 'shared facilities' and 'type of house' are influenced by the residential characteristic surface. Both the sharing of facilities and the housing type flat are considered negative by all respondents, regardless the current surface. However, smaller living respondents are more inclined to share a laundry than larger living respondents and the smaller living respondents perceive the individual facilities as less positive than the larger living respondents. Finally, where respondents who now have a living area of 50 m^2 or more prefer a detached Tiny House, smaller living respondents prefer a terraced Tiny House.

Future house situation and interest in Tiny Houses

Since the variable knowledge about Tiny Houses has no influence on the preferences for Tiny Houses, the variables related to the future living situation and the interest in Tiny Houses have been combined in this subsection. These variables have a relation with the Tiny House attributes according to table 10. All model estimations can be found in appendix 15.

Again all X0 values are negative (see appendix 16). However, respondents who expect to rent in their next home situation, or expect to move within 1 to 3 years or with some interest in Tiny Houses, have a greater preference for a Tiny House compared to the none option.

The variable 'expected moment of moving' affects almost all attributes, except the type of house. The biggest differences are between the group that expects to move between 1 and 3 years and the group that expects to move in more than 3 years. The fast movers (within 1 year) only have a less strong preference for a garden or balcony and a stronger preference for living in the center compared to the average. Respondents who expect to move between 1 and 3 years do not want to share facilities, consider a garden as very important, as well as a PVT system. They do not have a strong preference for a surface and prefer to live in the center or nearby the center. The late movers (3 or more years) do not want a small home, but they do want a garden. In addition, the sharing of facilities is somewhat acceptable and they do not have such a strong preference for a sustainable system or specific location.

The relations that are further elucidated are the preferences of future single and double households since the target group of this study consists of one- and two-person starters households. As well as the preferences of respondents with a preference for a rental home, since the property in this study is a rental home and last, the preferences of respondents with interest in Tiny Houses as being interested is most important for this research.

Respondents who expect to rent in their next living situation have less preference for a garden or balcony than respondents who expect to buy. ‘Renters’ also like both, a terraced Tiny House as well as a detached Tiny House, while ‘buyers’ have a strong preference for a detached Tiny House. Last, renters have a stronger preference for a house in the city center.

As can be seen in figure 18, respondents who expect to live alone or with their partner in their next house both have a preference for an average or large Tiny House. Respondents that expect to live with partner even have a very big preference for the largest Tiny House. In addition, both groups absolutely do not want to live on the suburbs of the city, especially those who expect to live alone.

Finally, respondents with at least some interest in Tiny Houses generally have less strong preferences than respondents without interest. Nevertheless, both groups prefer the same levels, namely at least 23.5 m^2 and with garden or balcony. However, these preferences are stronger for those who are not interested and weaker for those who are interested.

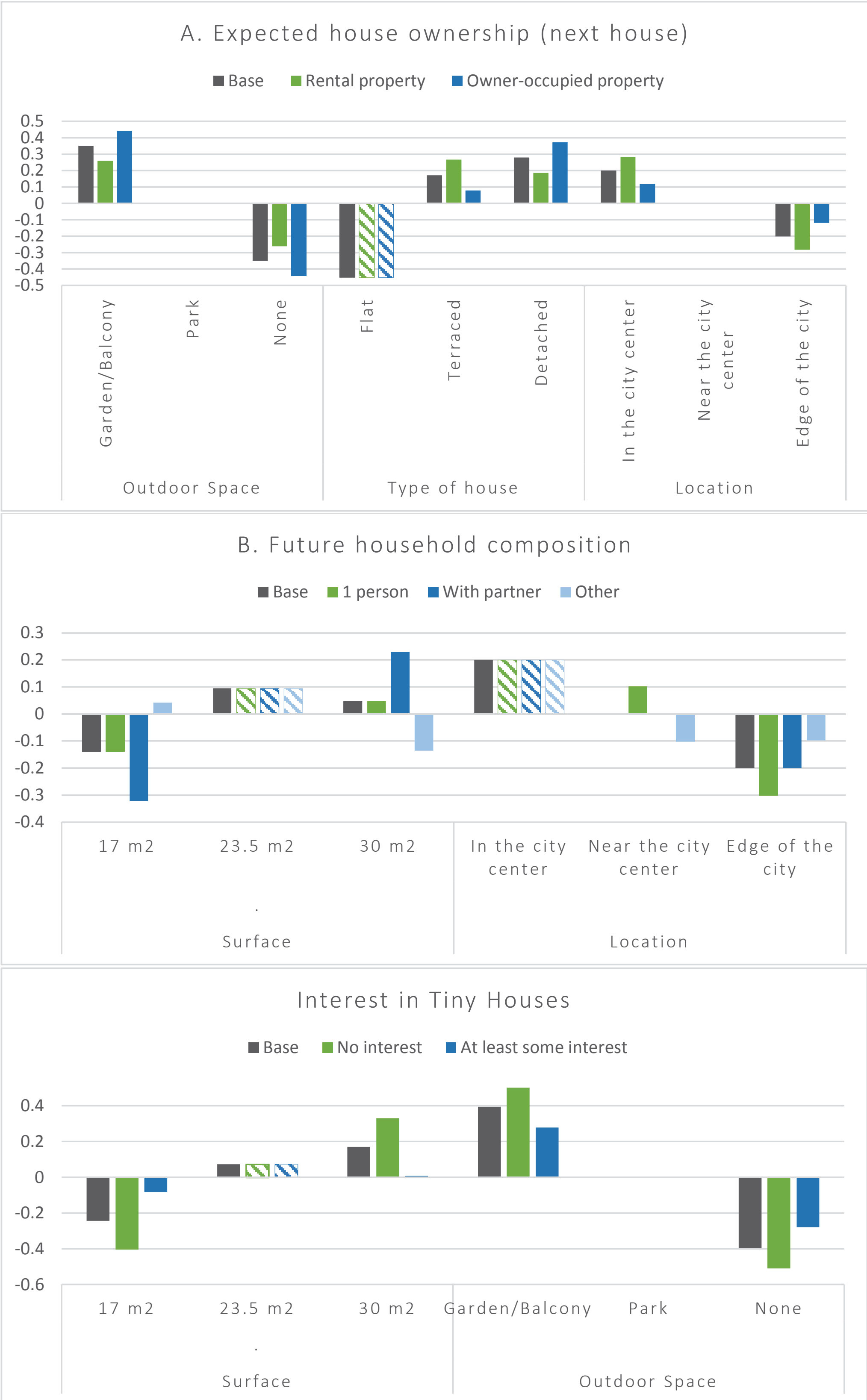


Figure 18 attributes influenced by the expected house ownership (A), future household composition (B) and interest in Tiny Houses (C)

4.2.4 Dependent attributes

In addition to the variables that influence the MNL model, there are also two dependent variables, ‘costs’ and ‘energy costs’. The effects of these attributes are directly related to (some of) the other attributes of the Tiny House and therefore cannot be estimated. However, an idea can be given of the influence of these attributes by comparing the (energy) costs of the profiles with the total utility value per profile. This is done by performing a Pearson's correlation test. This test is similar to a Spearman's test. However, the difference is the measurement level of the variables per test. The Pearson's test tests whether there is a relation between two values at ratio or interval measurement level and the Spearman's test does this for at least one variable at an ordinal level (Field, 2009). Since the (energy) costs and utility values both are on a ratio or interval measurement level, a Pearson’s correlation test is performed.

By means of a gradient, the differences in costs, energy costs and utility value are shown in table 11. The red values represent the highest costs and lowest preference, while the green values represent the lowest costs and highest utility values. After performing a Pearson's correlation test, there appeared to be no significant correlation between the utility values and the (energy) costs per profile. The Pearson correlation value between utility and costs is 0.156 (sign. 0.437) and with energy costs -0.273 (sign. 0.168).

Table 11 Total costs and utility value per profile - MNL model

	Costs	Energy costs	Utility value		Costs	Energy costs	Utility value
Profile 1	312.83	95.04	-0.74	**Profile 15**	412.21	118.46	-0.42
Profile 2	287.68	38.04	-0.14	**Profile 16**	395.41	105.18	0.03
Profile 3	320.52	95.93	-0.69	**Profile 17**	419.77	23.32	0.63
Profile 4	262.78	79.12	0.25	**Profile 18**	479.13	107.67	0.66
Profile 5	288.23	121.45	-0.30	**Profile 19**	486.49	38.25	0.49
Profile 6	385.05	73.63	-0.47	**Profile 20**	532.93	91.87	-0.91
Profile 7	303.59	54.85	0.74	**Profile 21**	545.19	132.28	-0.38
Profile 8	346.67	82.24	-0.08	**Profile 22**	523.08	115.33	-0.52
Profile 9	298.90	104.64	-0.13	**Profile 23**	570.61	8.60	0.67
Profile 10	366.64	84.44	-0.03	**Profile 24**	522.53	115.15	0.11
Profile 11	415.97	141.69	0.00	**Profile 25**	531.53	85.50	1.05
Profile 12	439.23	75.45	-0.75	**Profile 26**	477.48	161.93	0.50
Profile 13	447.12	46.55	1.04	**Profile 27**	591.32	76.08	-0.25
Profile 14	415.84	87.67	-0.36				

4.2.5 Latent class model

As discussed in section 4.2.3 there are many variables, both personal and residential, that influence the preferences for the attribute levels. To get a better overview of the relations between the different influencing variables, two latent class (LC) models have been estimated, one latent class with two clusters and one model with three clusters. (model estimations in appendix 18).

Two-class model

The clusters within this latent class model are unevenly distributed, cluster one contains 83 percent of the respondents and in cluster two only 17 percent. With a Rho^2 of 0.257 this model is more fitting than the basic MNL model with and without interaction. The very negative value for X0 shows that cluster one clearly consists of respondents with interest in Tiny Houses, while cluster two prefers the option ‘none of both’, these are not in favor of a Tiny House.

With regard to the preferences of the two clusters it can be said that cluster two, in addition to the preference for the 'none of both' option, has more extreme preferences (see figure 19). Only if the Tiny House is large enough, contains a garden, is not a flat and is in the suburbs of the city, it might be interesting for this cluster. Cluster one, on the other hand, shows more moderate preferences, which are very similar to the preferences in the basic MNL model. The only contradiction with the basic model is that respondents in cluster one judge the level 30 m^2 as slightly negative instead of positive.

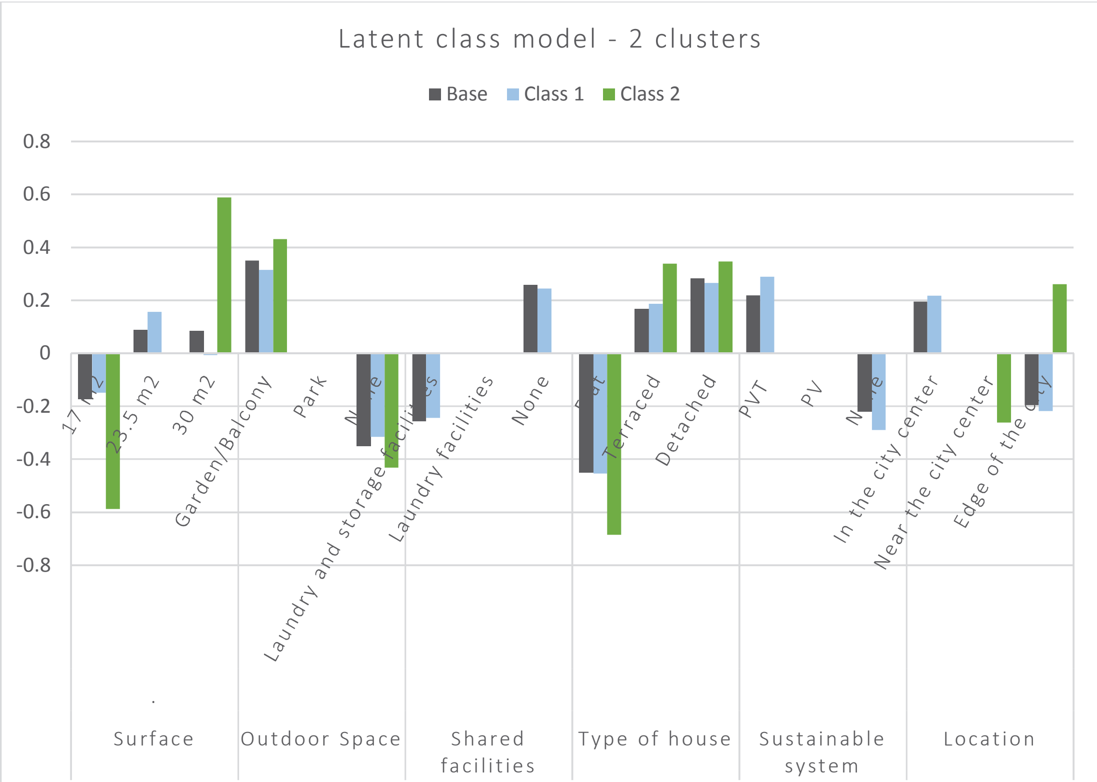


Figure 19 Utility values for two-cluster LC model

Three-class model

The clusters within this model are again unevenly distributed, cluster one consists of 25 percent of the respondents, cluster two out of 58 percent and cluster three of 17 percent. With a Rho^2 of 0.273 this model again has a very good fit with the data. Given the very negative value for X0 of clusters one and two, there is a big preference for a Tiny House. Cluster three, on the other hand, prefers the 'none' option. The model estimation is included in appendix 18.

Looking at the attributes, respondents in cluster one have big interest in Tiny Houses and prefer a small area and a PVT system. They have a number of extreme preferences, namely for 17 m2, a PVT system and not sharing facilities, but for the rest of the attributes there are no significant preferences or the preferences do not differ (much) from the base level. Cluster two, on the other hand, prefers a large detached Tiny House with garden in the city center. In addition, they are interested in Tiny Houses. This preferences suit with the base preferences, but more extreme. The preferences of cluster three are in some ways similar to cluster two, but less extreme. They also prefer a large house with a garden that is terraced or detached. However, cluster three, prefers not to have a sustainable system and these respondents prefer to live on the suburbs of the city. Finally, they do not have much interest in Tiny Houses.

Figure 20 Utility values for three-cluster LC model

After performing a Pearsons' correlation test, there appears to be a significant relationship between cluster two with the costs (Pearson value is 0.531, sign. 0.004) and an inverse relation between cluster one with both, costs (Pearson: -0.629, sign. 0.000) and energy costs (Pearson: -0.738, sign. 0.000) (see appencix 19). So the respondents in cluster one might have taken the (energy)costs into consideration when making their choices, or they might prefer the 'cheaper' profiles. Cluster two, however, seems to prefer the 'more expensive' profiles that offer a higher quality.

Looking at the characteristics per cluster it can be stated, based on Chi-squared tests, that there is a significant relationship between the clusters with the variables age, current household composition, expected house ownership, future household composition and interest in Tiny Houses (see appendix 20). The corresponding figures can be found in appendix 21. Note that these characteristics also significantly influence some of the preferences according to table 10.

From appendix 20 and 21 it can be deduced that cluster two is a relatively average reflection of the total number of respondents. However, cluster two is relatively more focused on living independently in both current and future living conditions.

Clusters one and three deviate more from the mean sample. Cluster one consists mainly of younger respondents who live together with their parents or with roommates. They expect to rent their next home and expect to live together with roommates. Cluster one also has a relatively high interest in Tiny Houses. Cluster three, on the other hand, consists mainly of older respondents who are often heads of their own households or sometimes stay with their parents. They expect to buy a home in their next living situation, with their partner or alone. Finally, cluster three has relatively less interest in Tiny Houses.

Comparison of the three clusters

This subsection will validate the preferences of the clusters by comparing the characteristics per cluster with the influencing factors from section 4.2.3. First the characteristics per cluster will be summarized (section 4.2.5), as well as the preferences based on each of these characteristics (section 4.2.3). The cluster preferences based on their characteristics will be compared with the estimated cluster preferences.

First of all the characteristics per cluster and the preferences based on these characteristics will be discussed, see figure 21. The first (green) column shows for each of the clusters the significantly different characteristics according to a Chi-square test. In general, it seems clear that cluster two differs relatively little from the entire sample and that cluster one and three appear to be counterparts to each other. The second (blue) column shows for each of the significant characteristic levels the preferences based on the MNL models per characteristic. Based on the cluster characteristics (green column) and the preferences per characteristic (blue column), an expectation can be made regarding the preferences per cluster according to the LC model. For example, cluster one consists, according to the green column, of relatively many young respondents living with their parents. The blue column shows that young respondents and respondents living with their parents often prefer a smaller area. Based on this, the expectation is that cluster one would prefer relatively small Tiny Houses. This expectation is made for each of the characteristics per cluster. The 'expected' preferences per cluster based on their characteristics can be seen in the green column of figure 22. Not every attribute level can be predicted by the cluster characteristics. Therefore, some expectations regarding the attribute levels within the clusters are unclear.

In addition to the young age and household composition 'with parents', the expectation of living together with roommates in the future and the great interest in Tiny Houses are also indicators of the preference for a small surface. In addition, the great interest and the expectation to rent in the future are also indicators that a garden is less important. The preference will still be for a garden, but to a lesser extent. Finally, based on the characteristics of cluster one, there could be a stronger preference for not sharing facilities or having a terraced Tiny House. With regard to the location and the presence of a sustainable system, the expectations are unclear.

Characteristics per cluster (section 4.2.5)

Cluster 1:	Cluster 2:	Cluster 3:
Large part of the respondents is in the ***younger*** age group	***Average*** expected age	Large part of the respondents is in the ***older*** age group
Large part of the respondents live ***with parents or roommates***	Large part of the respondents live ***with roommates***, certainly not with parents	Large part of the respondents is ***head of their own household*** (or live with parents)
Large part of the respondents expect to ***rent*** in their next house situation	***Average*** expected 'buyers' and 'renters'	Large part of the respondents expect to ***buy*** in their next house situation
Large part of the respondents expect to live ***with roommates*** in their next house situation	Large part of the respondents expect to live ***with partner***, certainly not with roommates	Large part of the respondents expect to live ***with partner (or alone)*** in their next house situation
Large part of the respondents is ***interested*** in Tiny Houses	***Average*** expected interest in Tiny Houses	Large part of the respondents is ***not interested*** in Tiny Houses

Preferences per characteristic (section 4.2.3)

Age

23 years and younger:
- Smaller surface
- In the suburbs is less negative

24 years and older:
- Larger surface
- In the suburbs is very negative

Current household composition:

Head of own household:
- Sharing is less negative
- Large surface
- Park is positive

Living with parents:
- Sharing is very negative
- Smaller surface
- In the suburbs is less negative

Living with roommates:
- In the suburbs is very negative
- No garden is very negative

Expected house ownership:

House 'renters':
- No garden is less negative
- Terraced
- In the suburbs is very negative

House 'buyers':
- No garden is very negative
- Detached
- In the suburbs is less negative

Future household composition:

One person:
- In the suburbs is very negative

With partner:
- Smaller surface

Other (with roommates):
- Smaller surface
- In the suburbs is less negative

Interest in Tiny Houses:

No interest:
- Larger surface
- No garden is very negative

At least some interest:
- Smaller surface
- No garden is less negative

Figure 21 Summary of characteristics per cluster and preferences per characteristic

Due to the large independence of cluster two, that is to say, not living with parents at the moment and not expecting to live together with roommates in the future, there are the following expectations: this cluster is expected to have a strong preference for a large Tiny House with garden in the city center. For the other Tiny House attributes the expected preferences are unclear.

Finally, cluster three, the cluster with the relatively old respondents with little interest in Tiny Houses. These characteristics are all indicative for a preference for a large surface. Further, the age, the expectation to buy and the expectation to live alone in the future are an indication for a Tiny House in the city center. In addition, there might be a preference for a detached Tiny House based on the characteristics. For the attributes 'outdoor space' and 'shared facilities' the indications are unclear and for the attribute 'sustainable system' there is no indication at all, so the expectations for these attributes are unclear.

The expected preferences for each of the clusters are shown in figure 22 (green column), as well as the estimated preferences per cluster according to the LC model (blue column). The expectations that fully correspond with the estimations are shown in the green column with a dotted frame. For each of the clusters it is indicated per attribute which attribute level (or levels) are judged more positively than by the entire sample (blue column). In other words, in which way do the positive preferences per cluster deviate from the total of the respondents. If two clusters prefer the same attribute level, a distinction is made between 'prefer' and 'strongly prefer' to indicate a difference between the clusters. Finally, the insignificant perceived preferences and preferences with a (very) small difference compared to the base level are not explained further.

As can be seen, a large part of the expectations corresponds with the estimations, only three expectations are (partially) incorrect and more than half of the estimated preferences were already expected. The differences may be explained by the fact that the characteristics correlate with other characteristics. However, all in all, it appears that three clusters of respondents can be distinguished, each with different characteristics and preferences with regard to Tiny Houses. First of all, cluster two is with 58 percent of the respondents the largest cluster. The characteristics of this cluster are also most similar to the entire sample. The preferences of this cluster also correspond reasonably to the preferences of all respondents although they are (slightly) more extreme. The preferences for a larger area, the presence of a garden, a detached Tiny House and a location in the city center are all higher than in the base model. Because of the strong resemblance with the entire dataset, the respondents in this cluster can also be labeled as 'Tiny House moderates’. The second largest cluster, with 25 percent of the respondents, is cluster one. This cluster is relatively young with great interest in Tiny Houses. The preferences of this cluster go out to (cheap), small and sustainable Tiny Houses. That is why this cluster could bear 'Tiny House lovers' as a label. Finally, the smallest cluster, with 17 percent of the respondents. This cluster is roughly the counterpart of cluster one, relatively old and with little interested in Tiny Houses. They expect to live in an independent house without roommates. The preferences of this cluster are mainly large, detached and on the suburbs of the city. The label for the latter cluster is therefore 'Tiny House critics’.

Naming the differences between the clusters and giving a name to a cluster gives a general insight into the characteristics and preferences per cluster. However, it is not the case that all respondents in a cluster have all these characteristics and preferences. Generally, the preferences per cluster match the results of the analyses regarding the effects of personal characteristics (see section 4.2.3).

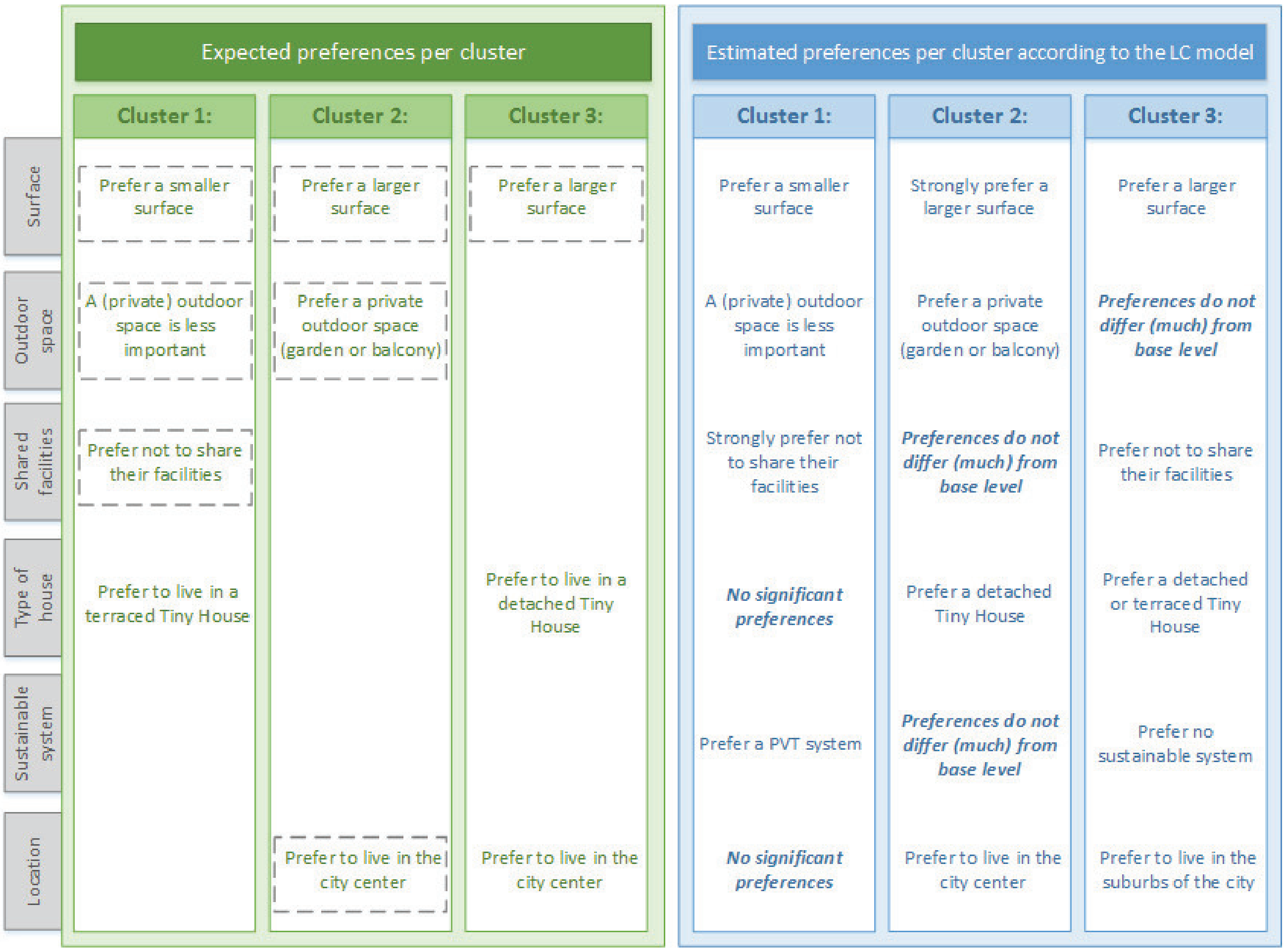


Figure 22 Summary of expected and observed preferences per cluster

4.3 Conclusion

This section summarizes the results from chapter 4. Section 4.3.1 summarizes the description of the respondents and section 4.3.2 summarizes the results from the discrete choice experiment.

4.3.1 Descriptive statistics

The descriptive statistics show that a large proportion of the respondents are female, despite the large number of men in the distribution area of the questionnaire. According to Boomgaard (2018) this could be due to the lesser interest of men for Tiny Houses. The distribution area of the questionnaire could have further influenced the attributes age, occupation, current household composition and living surface of the respondents. For example, the age is lower and more dispersed than average, there are clearly more students among the respondents and the respondents more often live with housemates than on average for Dutch inhabitants in their twenties. In addition, a very large proportion of the respondents live smaller than the Dutch average. Some variables that correspond with the average of the Dutch population in their twenties are the type of home, the location where they live and the satisfaction with the current housing situation of the respondents.

With regard to the residential characteristics, there are various relations. However, all of these relations can be traced back to three types of households, respondents living with their parents, respondents living independently and respondents living with roommates. In their next housing situation, about half of the respondents (52 percent) expect to buy a house, while the rest (48 percent) expect to rent. The 'buyers' are mainly respondents who are now heads of a household, live with their parents, or respondents who do not expect to move within three years. The 'renters', on the other hand, live more often with roommates or expect to move within three years. In addition, by far the largest part expects to live with partner (44 percent) or alone (27 percent). This usually are the older respondents, or respondents who are now heads of a household or live with their parents. Young respondents and respondents who now live with roommates expect to live with roommates in their next home situation (again). Finally, respondents who are dissatisfied with their current living situation expect to move sooner, within one year, compared to the majority of respondents (40 percent) that expect to move within one to three years.

Finally, the characteristics were compared with the knowledge and interest with regard to Tiny Houses. Relatively many respondents indicated that they had limited knowledge about Tiny Houses, however the interest with regard to Tiny Houses was fairly high at almost 70 percent. Mainly respondents with a small living area show interest in Tiny Houses. In contrast, respondents with an average living space have the least interest in Tiny Houses. Looking at the future household composition, respondents who expect to live together with their partner in their next situation are the least interested. So probably the focus of this research should be more at the single-person households instead of the two-person households.

4.3.2 Discrete choice model estimations

With a Rho^2 of 0.176, the MNL model estimation matches the data quite well. In addition, the respondents prefer at least one of the Tiny Houses above the none (none of the two Tiny Houses) option and each of the attributes has a significant influence on the preferences of the respondents. The overall respondents' preferences go to a detached Tiny House of at least 23.5 m^2 with a garden and PVT system, without shared facilities in the center of the city. It appears that having a garden is judged as most important, and a larger surface is the least important. Only four of the eighteen attribute levels, namely park, shared laundry facilities, PV system and near the city center, have no significant influence on the preferences of the respondents.

In addition to the basic model, there appears to be an interaction between the attributes surface and outdoor space, and outdoor space and shared facilities. However, according to a LRS test this model is not significant better than the base model and will therefore not further be discussed. In addition to interaction, we also looked at the respondent-related characteristics and their influence on the preferences. For example, the attribute 'surface' appears to be influenced by most characteristics and the 'expected moment of moving' characteristic appears to influence most of the Tiny House attributes. In addition, there is again the preference for one of the Tiny Houses compared to the none option for each characteristic. In general, it appears that, regardless of the characteristics, the preferences for the attribute levels often remain the same, but the value may vary depending on the characteristic. Especially the characteristics that change the preference for an attribute level or where the difference between the characteristics is very large are discussed in this section.

Older respondents and men in particular appear to have a very strong preference for a larger area, while younger respondents and women are also satisfied with a mediocre surface area. In addition, the attributes of 'outdoor space' and 'location' are directly influenced by their counterpart characteristic. Respondents who currently have a garden or live in the city center appear to have the same preference in the DCE, thus they prefer to have a garden and prefer to live in the city center as well. Especially the future household composition characteristic 'other' has striking preferences. This group includes mostly respondents who expect to live together with roommates in their next living situation. They have a greater preference for a dwelling of 17 m^2 than for a dwelling of 30 m^2. In addition, they have a very strong preference for a home in the city center compared to any other location.

Finally, two latent class models have been estimated, a two cluster model and a three cluster model. With a Rho^2 of 0.273, the three cluster model is the best fitting model for these data. Cluster one (25 percent of the respondents) consists mainly of relative young respondents with a lot of interest in Tiny Houses and preferences for small Tiny Houses with PVT system. This cluster therefore receives the label 'Tiny House lovers'. The largest cluster, cluster two (58 percent), has characteristics and preferences that are very similar to the entire sample. This cluster is therefore labeled as 'Tiny House moderates'. Finally, cluster three, the smallest cluster (17 percent), with relatively old, uninterested respondents. The respondents in this cluster prefer big Tiny Houses in the suburbs of the city. This cluster has therefore received the label 'Tiny House critics'.

CHAPTER 5

CONCLUSION AND DISCUSSION

'Tiny House' support gifts
(Christmas) surprises from family
(own photo)

5. Conclusion and discussion

At this point, the steps described in the introduction were carried out, i.e. conducting a literature review and discrete choice experiment (DCE) and analyzing the results using different logit models. Therefore, chapter 5 takes a critical look at the results achieved; were the goals achieved, were the research questions answered and what could have been done better or differently.

Section 5.1 answers the sub-questions and main question of this research, based on both the literature review and the DCE. Section 5.2 examines in a critical manner which points for improvement or adjustments could be made to the research and for whom and how the results are relevant. Finally, paragraph 5.3 gives some possibilities and recommendations for further research.

5.1 Research questions and answers

- *What are the main developments on the Dutch housing market, especially for starter households?*

The average surface of a house in the Netherlands grows, while the number of people per household shrinks. In addition, the Dutch population is also growing, especially the number of single-person households. This growth will mainly take place in the cities. Starters in the housing market have a preference for living in cities because of the flexible nature of their lifestyle. In addition, they are looking for an affordable house, which is difficult due to the growing surface area and the high demand for nice located city houses.

- *What is meant by 'small living' and 'Tiny House'?*

Small living has been described by Bartlett (2016) as the conscious choice for living in a smaller permanent home. In general, there are few or no exact definitions for small living and Tiny Houses. Roughly a Tiny House can be defined as a house with a maximum surface, which may or may not be on wheels and may or may not be (partially) self-sufficient.

- *What can make a (Tiny) House sustainable?*

The surface of a house directly influences the amount of material needed for the house, as well as the energy requirements for heating and lighting. A smaller home therefore has a smaller energy and material demand. In addition, the shape of the house and the placement in relation to each other influence the energy demand for heating. Finally, the way in which the energy is generated influences the sustainability of the home. A PV or PVT system ensures a sustainable generation.

- *Who are Generation Y and what are their characteristics?*

Generation Y covers the current population of 18 to 35 years. In general, this age group is satisfied, optimistic and independent. They prefer to spend money on experiences, such as traveling or festivals, rather than saving it. Finally, they attach great importance to freedom and flexibility, both in work and in relaxation.

- *Under what conditions is Generation Y prepared to live in a Tiny House?*

To ensure their freedom and flexibility Generation Y prefers a rental property. In addition, they are willing to share facilities if this provides more opportunities to gain experience, for example through lower costs. Finally, they want a unique, affordable home in a good location in the city (center).

- *What are preferences of starter households regarding:*
    - *the location of the Tiny House?*

  - *the design of the Tiny House?*
  - *the sustainability of the Tiny House?*

In general, starters seem to prefer a Tiny House with garden, detached and without shared facilities. In addition, they prefer PVT panels, a home in the city center and a minimum of 23.5 m2. The order of these preferences also determines the degree of preference. Having a garden is therefore the most important, while the size of the surface matters the least.

- *How are these preferences affected by respondent-related characteristics of Generation Y?*

In general, older respondents and men have a higher preference for a larger area. Further, respondents who expect to live together with housemates in their next housing situation have a higher preference for a dwelling of 17 m2 than for a dwelling or 30 m2, as well as for a Tiny House in the city center.

In addition, the respondents can be divided into the 'Tiny House lovers', 'Tiny House moderates' and 'Tiny House critics' clusters based on their preferences. The first cluster, the 'Tiny House lovers' comprises the price-conscious respondents who expect to live with their roommates for a while in a rented house. This cluster prefers relative small Tiny Houses with a PVT system. The second cluster consists of independently living respondents with a varying interest in Tiny Houses. This cluster, the 'Tiny House moderates' meets the preferences of the main sample and therefore prefers relative big Tiny Houses in the city center. Finally, the 'Tiny House critics' cluster, comprises the uninterested respondents and respondents who live with their parents. They prefer big Tiny Houses in the suburbs of the city.

Main question:

By combining the answers of the abovementioned sub-questions, the main question can be answered:

What are the preferences of one- and two-person starter households (Generation Y) with regard to living in a sustainable Tiny House in the Netherlands?

From the literature review came the expectation that this target group would prefer a unique, affordable rental home in or near the center of the city, where the sharing of facilities would be accepted, if it would provide opportunities for gaining experiences. These expectations arose from the characteristics of the target group, namely the desire for freedom and flexibility and the preference to gain experiences, despite of saving money.

The DCE shows that some of these assumptions are correct. Respondents do indeed prefer a Tiny House in the city center. The respondents were also not deterred by the fact that the research concerns a rented home. Certainly the respondents with at least some interest in a Tiny House expect to live in a rented house for still some time. On the other hand, the respondents have a strong preference for a house without shared facilities, contrary to expectations. This could be because the sharing of facilities in the DCE entails extra costs because of the larger usable surface, these extra costs are about 15 euro per month for a laundry and 45 euro per month for a shared laundry and storage.

Looking at the sustainability of the Tiny Houses, the respondents prefer a Tiny House with PVT system. Although the attribute levels 'garden/balcony', 'detached' and 'without shared facilities' have a higher preference than a sustainable system, within the attribute 'sustainable system' the preference is certainly for a PVT system. Finally, preference is generally given to a house in the city center with a medium or large surface.

5.2 Evaluation

The aim of the research was to provide more insight and knowledge about Tiny Houses through literature and a discrete choice experiment (DCE). This objective arose from a number of problems and trends on the (Dutch) housing market. First of all, there is the growth and urbanization of the population. The expectation is that this growth will mainly take place in the cities, with an emphasis on the growth of the number of single-person households. The growing population will provide problems regarding locations for housing, and it will also generate a growing environmental impact through, among other things, more consumption and transport of the population. Finally, not only the population, but also the living area per inhabitant is increasing strongly. This strengthens the problems concerning housing locations and the environment.

Tiny Houses could be a solution for (part of) these problems. Because of their small size, they occupy a limited space and are more sustainable than larger houses. These small houses will be particularly interesting for young starters in the housing market in small households. This age group, Generation Y, often earns too much for the social sector, but too little for the private sector. Generation Y also likes to live in the city, in an attractive and central location that ensures flexibility for, for example, work. Due to the growing demand for housing and larger surfaces, especially in the cities, house prices are rising strongly here, making the houses unaffordable for Generation Y or they should settle with a house not meeting their wishes.

By contributing to the knowledge and insights regarding Tiny Houses and by carrying out a discrete choice experiment (DCE) to the living preferences of Generation Y, this research aims to solve these problems.

Section 5.2 critically examines the results of this research. Sub-section 5.2.1 deals with the objectives of this research and whether these goals have been achieved. Sub-section 5.2.2, on the other hand, looks at the research from a scientific point of view, thus what difficulties have been encountered and what could have been improved.

5.2.1 Evaluation in context

The literature review contributes to increasing the knowledge in the area of, among others, Tiny Houses. It gives a clear overview of what Tiny Houses are, what their origins are and what motivations there are to live in a Tiny House. In addition to the literature on Tiny Houses, literature review has provided new insights into the sustainable possibilities of a small area. Here the heat loss of a house is treated by surface, shape and placement in relation to other (Tiny) Houses. In addition, the durability of PV and PVT panels was reviewed. It can be concluded from the literature that a Tiny House is a relatively new form of living in the Netherlands and that the small area contributes to a more sustainable house due to lower demand for materials and energy.

With regard to the DCE, the aim was to get around 250 respondents for this study. However, the number of received responses is over 300, which may indicate the interest of the target group in the subject. Also from the questionnaire it appears that this target group has relatively little knowledge of Tiny Houses, but is certainly interested in the possibilities. In general, the target group has clear preferences for the different attributes. By making a distinction in different clusters, the preferences and characteristics of each cluster can be further specified, so that there can be further anticipated on the preferences of different clusters of respondents. For example, respondents in (future) single-person households appear to have a greater interest in Tiny Houses than respondents with partners in their current or next housing situation.

In conclusion, it can be said that Tiny Houses could, to a certain extent, be a solution to the problems of housing for the growing population and urbanization. Furthermore it contributes to improvements in the area of sustainability. Within the target group there are certainly many interested parties for sustainable Tiny Houses, mostly among the younger respondents from the 'Tiny House lovers' cluster. In addition to their preferences for small and sustainable Tiny Houses, they have no specific preference for a type of house. The other two clusters, on the other hand, prefer a detached or terraced Tiny House, instead of the most sustainable and space-saving flat Tiny Houses. So it can be stated that Tiny Houses are more sustainable and space-saving than larger versions of the same type. However, since not only the surface influences the sustainability, it might be that a more preferred detached Tiny House, for example, is less sustainable than a larger flat apartment. As a result, the preferences of the respondents regarding the type of house must be raised against the advantages of the flat Tiny House in terms of sustainability and urbanization. In contrast, it can be taken into account that detached and terraced Tiny Houses offer more possibilities for solar panels.

Application of the results

The results of this research can be of value to institutions, such as housing corporations. Many housing corporations are active in densely populated cities with a large housing demand. Therefore, housing corporations are often involved in new housing construction and renovation in the cities. Because of the growing population and limited space, it is interesting for housing corporations to know in which way a house with a small surface can still be attractive. Based on the results from this research, sustainable Tiny Houses can be generated in a fitting way for this specific target group. By offering the right Tiny Houses to the right target group, the housing requirements can be met without following the trend of a growing living surface per person.

In a similar way, this research can provide handles for municipalities to manage the construction of new houses in a targeted manner, adapted to the wishes of young starters. In addition to large, urban municipalities, it can also be interesting for the more rural municipalities from a sustainability perspective to build smaller houses. According to this study, some of the respondents have a specific preference for a Tiny House in the suburbs of the city. This raises the question whether people might also be interested in Tiny Houses in rural areas. This might be subject of future research.

Finally, the results can be interesting for Tiny House designers. Since the trend of Tiny Housing in the Netherlands is relatively new and unknown, little is known about the preferences regarding Tiny Houses. This research provides insight in the preferences of generation Y. By aligning the Tiny Houses with the preferences of Generation Y, new customers may be drawn.

5.2.2 Scientific evaluation

As mentioned, the investigation into Tiny Houses, especially in the Netherlands, is currently still very limited. This research has therefore given insight into the preferences of the target group regarding Tiny Houses.

It has been shown that DCE is a very suitable method to obtain these insights. By submitting the respondents profiles of two Tiny Houses and having a choice between these profiles, a clear picture of the preferences and mutual relations is created. It is important, however, not to make the choices too complicated, so that there is no confusion. The same also applies to the other questions in a questionnaire of course.

In general, the questionnaire seemed quite clear and not to complicated, since there were little comments, while the possibility was there to do. Three respondents indicated that the amount of text was too much and a few gave their positive or negative opinion about Tiny Houses. However, it appears that two questions regarding the respondent-related characteristics were not understood by everyone. This concerns a question regarding the work situation and a question about the current type of housing. In the first question, very many respondents did not make a choice between working or studying, but they indicated that they did both, studying and working part-time. It would probably have been clearer for the respondents to add this option before or not to give them the possibility to enter an answer themselves, so they have to choose between the given options. Further, many respondents have filled in 'student house' when asked about the housing type. However, this does not say whether it concerns, for example, a flat or a detached house, while that was the desired outcome. Perhaps it should have been mentioned explicitly in the question that it does not concern the composition of the household, as in the question before it, but the type of the house.

Further, there might be a point of improvement with the dependent attribute 'costs'. Given the limited amount of information about Tiny Houses (in the Netherlands), it was difficult to calculate the rents per profile. In this study, therefore, a price calculation based on 'standard' housing is assumed. However, a Tiny House will use more materials per square meter than a standard home. On the other hand, the demand for a standard home may be higher. This ensures that prices for Tiny Houses per square meter could differ from prices per square meter for standard homes. However, this has not been included in this study.

Method approach

Although the used method, discrete choice experiment, with logit models and hypothetical alternatives to choose from is a very appropriate method to obtain the desired results, other methods could also be used for a similar research. With DCE also come some risks. For example, due to the hypothetical nature of the method, it cannot be said with certainty that a respondent reacts in a real (market) situation in the same way as in the hypothetical questionnaire. In a real situation, a respondent would rather opt for neither option, or other factors would play a role, resulting that the other option turns out to be more interesting. In addition, it may also be that the respondent opts for the option that is socially most appreciated. This can be done both, consciously and unconsciously. Some possibilities for other research methods are explained in this sub-section and compared with the used method, DCE.

In order to prevent the respondent from making a different choice in a real situation, the real situation must be represented. This is (relatively) impossible in this study, due to the new nature of the market. This makes that there is insufficient variation of Tiny Houses on the Dutch market to be able to conduct a market survey in a real situation. So at this moment the real market situation method is not possible.

To gain more insight into other factors that influence the choice, conducting interviews is a possible method. Through direct contact and interaction, it gives the opportunity to create more depth and it gives the possibility to respond to ambiguities and striking features. Due to the intensive nature of this method, however, it will take a long time to have enough respondents to achieve significant results. In addition, this method is not anonymous, which increases the risk of socially appreciated answers.

A possibility would be to expand the DCE with a few in-depth interviews, for example to find explanations for unexpected results. The interview method could also be used in advance to check whether there is interest in the subject or, for example, to select relevant attributes, or to clarify ambiguities from the questionnaire. This second way was used informally in this research. Prior to the research, informal conversations with the target group were held about the problems surrounding finding a house and the interest in Tiny Houses. Based on this, the subject of Tiny Houses has arisen for the research. This could be enhanced by conducting similar conversations, but on the basis of a pre-prepared questionnaire.

All in all, DCE appears to be one of the most suitable methods to test a new product on the market. To create more depth, it is a possibility to conduct interviews to get deeper insights. However, in both methods, the differences between the simulated hypothetical scenarios and reality must be taken into account as well as the risk of socially appreciated answers from the respondents.

5.3 Recommendations

This research has focused on a rental Tiny House for the target group of one- and two-person starter households. Although this research already provides some insights into the subject of Tiny Houses, these insights can always be extended or improved. In this section some suggestions are made for follow-up studies.

For housing corporations, municipalities and Tiny House developers, it may be interesting to know the preferences of other target groups to. The focus will probably remain with small households, but for example in a different age. Examples may be prospective students, people after divorce or empty nest households. In addition, it may be interesting for more rural municipalities to examine the preferences of a certain target group outside the cities, as well as an owner-occupied Tiny House instead of a rental Tiny House.

Also in the area of shared facilities there are various possibilities for a follow-up study. Certainly since the expectation was that the target group would be prepared to share facilities, whereas this was not reflected in the results. Examples for a follow-up study could be to focus on other facilities or to 'promote' the sharing of facilities in a different way. Finally, it is also possible to include the determination of the costs of the provisions in a different, more attractive way.

In addition, a limited number of Tiny House attributes were included in this study in order to maintain an overview for the respondents. A follow-up study could focus on other or more attributes, for example other sustainable systems or the proximity of facilities such as a supermarket.

Another possibility for a follow-up study is the involvement of people's lifestyles in the interest and preferences regarding Tiny Houses. Do sustainably oriented people have different preferences than, for example, 'bigger is better' oriented people?

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Appendices

Appendix 1: Profile Design

No	Surface	Type of house	Shared facilities	Outdoor space	Sustainable system	Location
1	17m2	Flat	No shared facilities	No outdoor space	No sustainable system	In the city center
2	17m2	Terraced house	Shared laundry	No outdoor space	Electrical and thermal generation by PVT panels	In the suburbs of the city
3	17m2	Detached house	Shared laundry and storage	No outdoor space	Electrical generation by PV panels	On the edge of the city center
4	17m2	Terraced house	No shared facilities	Park within 400 m	Electrical generation by PV panels	In the suburbs of the city
5	17m2	Detached house	Shared laundry	Park within 400 m	No sustainable system	On the edge of the city center
6	17m2	Flat	Shared laundry and storage	Park within 400 m	Electrical and thermal generation by PVT panels	In the city center
7	17m2	Detached house	No shared facilities	Garden	Electrical and thermal generation by PVT panels	On the edge of the city center
8	17m2	Flat	Shared laundry	Garden	Electrical generation by PV panels	In the city center
9	17m2	Terraced house	Shared laundry and storage	Garden	No sustainable system	In the suburbs of the city
10	23.5m2	Terraced house	No shared facilities	No outdoor space	Electrical generation by PV panels	On the edge of the city center
11	23.5m2	Detached house	Shared laundry	No outdoor space	No sustainable system	In the city center
12	23.5m2	Flat	Shared laundry and storage	No outdoor space	Electrical and thermal generation by PVT panels	In the suburbs of the city
13	23.5m2	Detached house	No shared facilities	Park within 400 m	Electrical and thermal generation by PVT panels	In the city center
14	23.5m2	Flat	Shared laundry	Park within 400 m	Electrical generation by PV panels	In the suburbs of the city
15	23.5m2	Terraced house	Shared laundry and storage	Park within 400 m	No sustainable system	On the edge of the city center
16	23.5m2	Flat	No shared facilities	Garden	No sustainable system	In the suburbs of the city
17	23.5m2	Terraced house	Shared laundry	Garden	Electrical and thermal generation by PVT panels	On the edge of the city center
18	23.5m2	Detached house	Shared laundry and storage	Garden	Electrical generation by PV panels	In the city center
19	30m2	Detached house	No shared facilities	No outdoor space	Electrical and thermal generation by PVT panels	In the suburbs of the city
20	30m2	Flat	Shared laundry	No outdoor space	Electrical generation by PV panels	On the edge of the city center
21	30m2	Terraced house	Shared laundry and storage	No outdoor space	No sustainable system	In the city center
22	30m2	Flat	No shared facilities	Park within 400 m	No sustainable system	On the edge of the city center
23	30m2	Terraced house	Shared laundry	Park within 400 m	Electrical and thermal generation by PVT panels	In the city center
24	30m2	Detached house	Shared laundry and storage	Park within 400 m	Electrical generation by PV panels	In the suburbs of the city
25	30m2	Terraced house	No shared facilities	Garden	Electrical generation by PV panels	In the city center
26	30m2	Detached house	Shared laundry	Garden	No sustainable system	In the suburbs of the city
27	30m2	Flat	Shared laundry and storage	Garden	Electrical and thermal generation by PVT panels	On the edge of the city center

Appendix 2: Energy demand for a one person household

Electrical equipment, energy demand and costs for a one person household

Electricity consumption per device (kWh) (Shift Innovatie, 2018)	
Fridge freezer	145
Combi microwave	63
Induction cooker	179
Vacuum cleaner	47
Light	231
Extractor hood	80
TV	37
Laptop	85
Smartphone	5
Other device like a smartphone	8
Electricity demand equipement	880
7 % extra due to calculation error	942

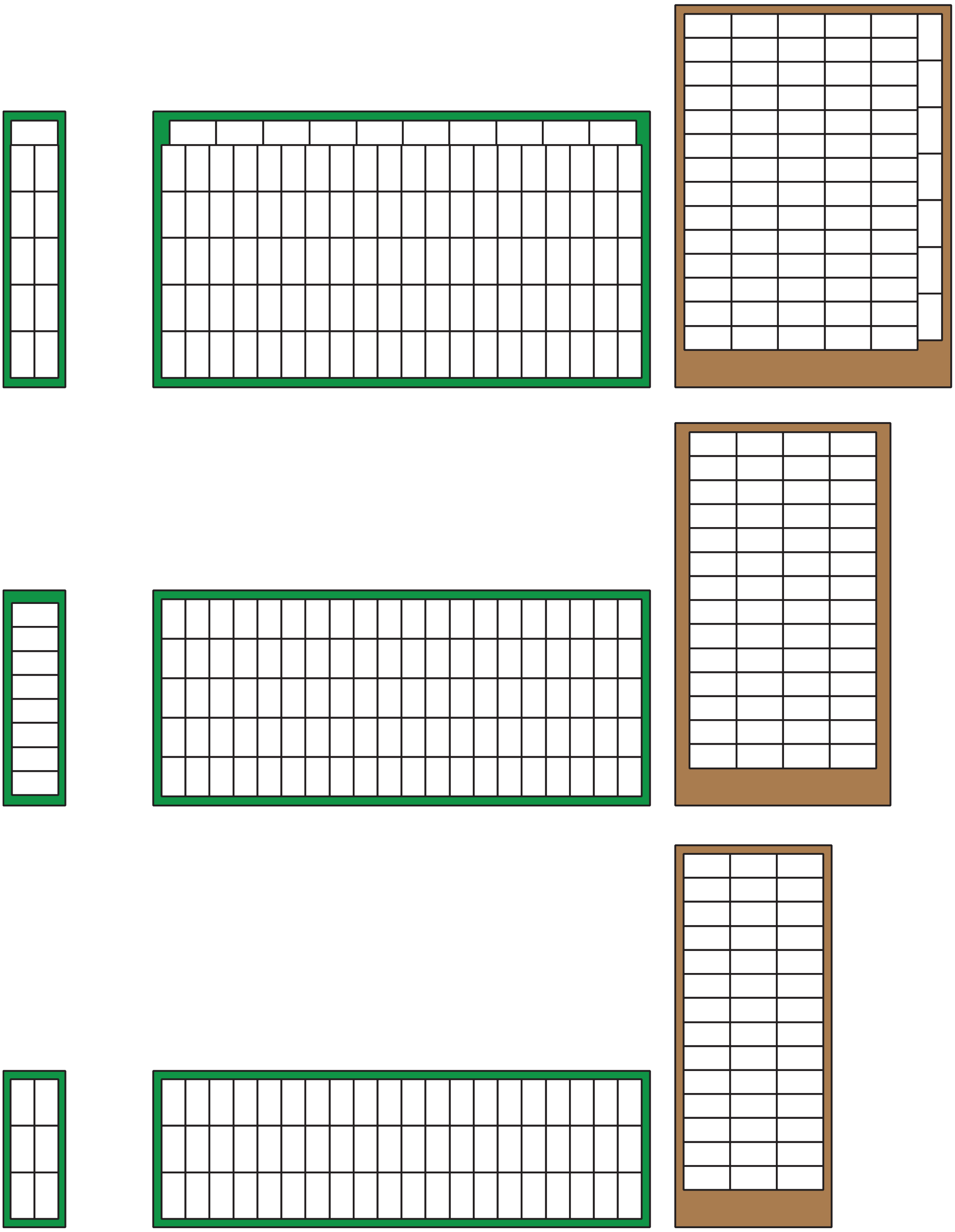
Energy demand and costs (excl. heating)

	Gas demand (m3)	Electricity demand (kWh)
Heating per type of house[1]		n/a
Hot water showering	212	2071
Hot water other	53	518
Equipment		942
Other		141
Total energy demand in kWh (excl. heating)		3671
Total energy costs in euro (excl. heating)		770.93

[1] Depends on type and surface (see section 3.2 table 5)

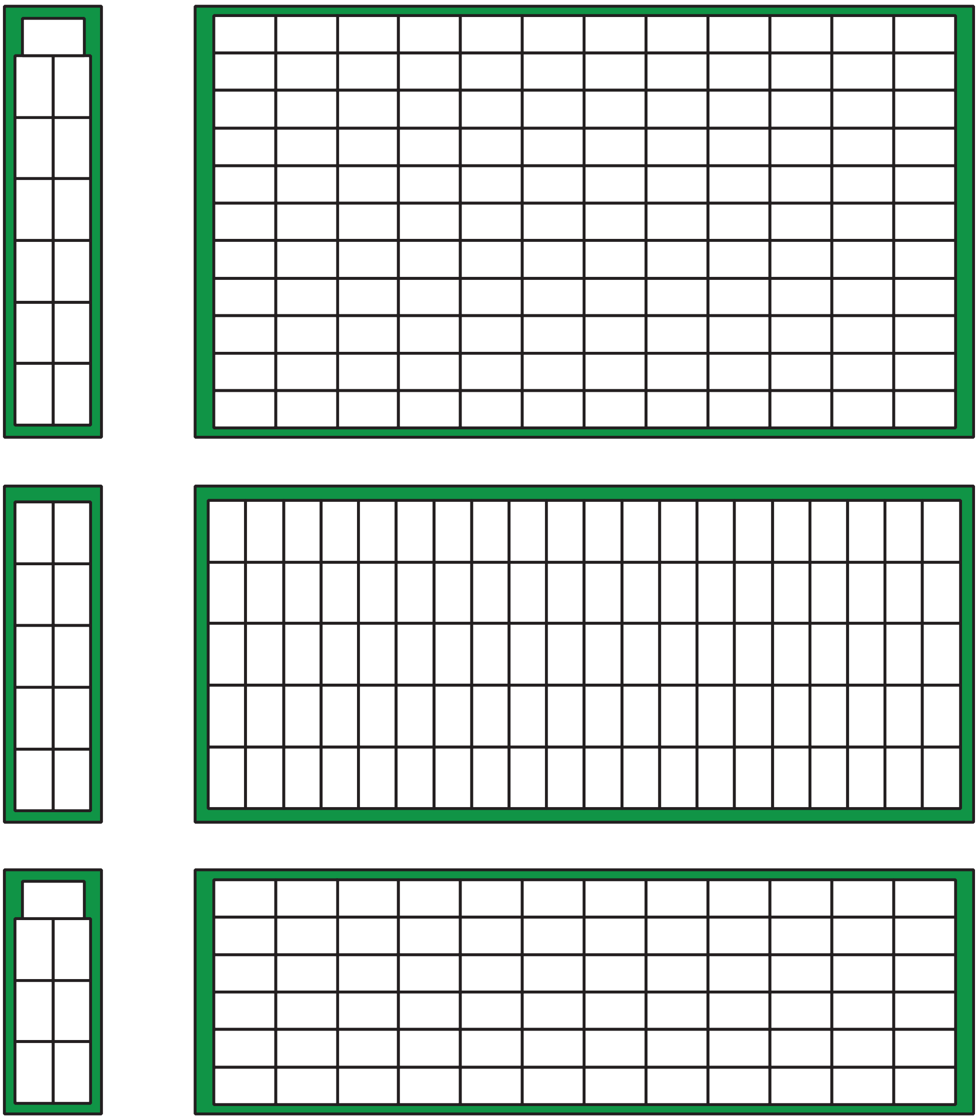
Placement of PV panels per type and surface:

On a terraced or detached house (left) and flat house on the roof (middle) and south facade (right) for the surfaces 17, 23.5 and 30 m² (from top to bottom).



Placement of PVT panels per type and surface:

On a terraced or detached house (left) and flat house on the roof (right) for the surfaces 17, 23.5 and 30 m^2 (from top to bottom).



Appendix 4: PV and PVT panels - yields

Number of panels and yields per type and surface

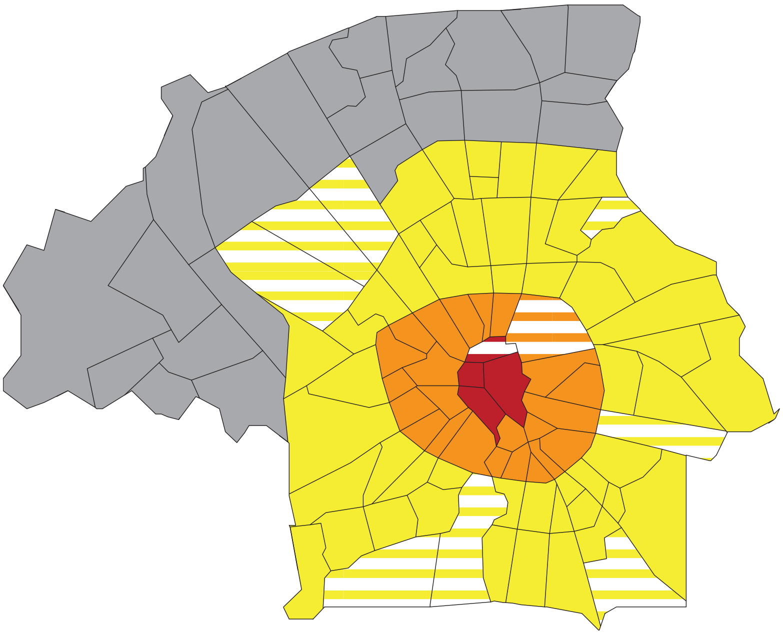
	Number of panels 250 Wp per house	Number of panels 300 Wp per house	Electricity yields in kWh	Gas yields in m3	Cost yields in euro	Cost yields in euro per month
PV panels						
Detached						
17 m2		6	1458		306.18	25.52
23.5 m2		8	1944		408.24	34.02
30 m2		11	2673		561.33	46.78
Terraced						
17 m2		6	1458		306.18	25.52
23.5 m2		8	1944		408.24	34.02
30 m2		11	2673		561.33	46.78
Flat						
17 m2		3.19	731		153.56	12.80
23.5 m2	3.13	1.75	1000		210.07	17.51
30 m2		5.84	1341		281.53	23.46
PVT panels						
Detached						
17 m2	7		1595	693	799.19	66.60
23.5 m2	10		2278	990	1141.71	95.14
30 m2	13		2962	1287	1484.22	123.68
Terraced						
17 m2	7		1595	693	799.19	66.60
23.5 m2	10		2278	990	1141.71	95.14
30 m2	13		2962	1287	1484.22	123.68
Flat						
17 m2	2.25		869	377	435.28	36.27
23.5 m2	3.13		1168	507	585.12	48.76
30 m2	4.13		1538	668	770.65	64.22

Appendix 5: Neighborhood division Eindhoven

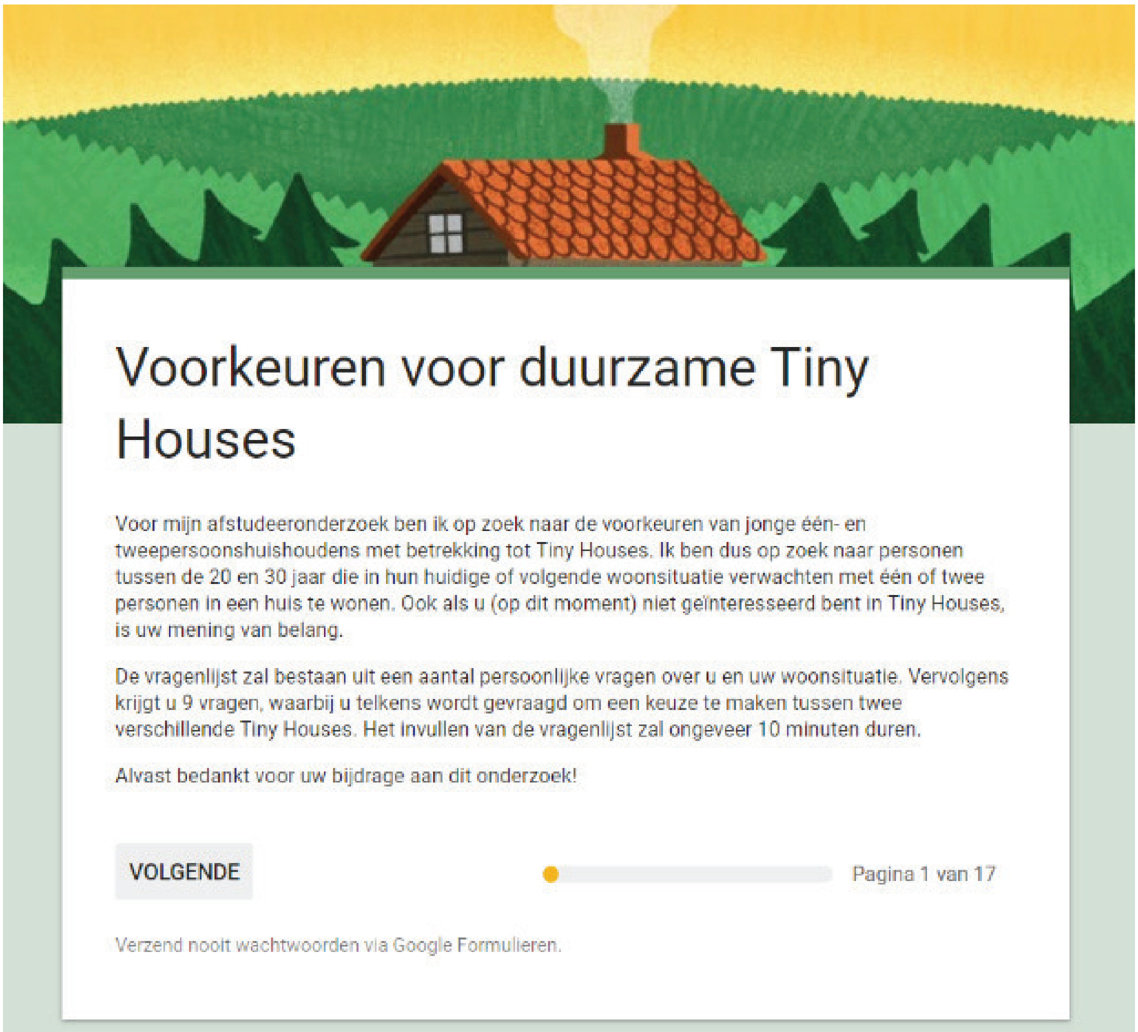
Neighborhood division for the attribute costs for location (Eindhoven)

Red is the city center, orange is the edge of the city center and yellow are the suburbs of the city.

From the hatched neighborhoods no house price data was found



Appendix 6: Questionnaire



Voorkeuren voor duurzame Tiny Houses

Voor mijn afstudeeronderzoek ben ik op zoek naar de voorkeuren van jonge één- en tweepersoonshuishoudens met betrekking tot Tiny Houses. Ik ben dus op zoek naar personen tussen de 20 en 30 jaar die in hun huidige of volgende woonsituatie verwachten met één of twee personen in een huis te wonen. Ook als u (op dit moment) niet geïnteresseerd bent in Tiny Houses, is uw mening van belang.

De vragenlijst zal bestaan uit een aantal persoonlijke vragen over u en uw woonsituatie. Vervolgens krijgt u 9 vragen, waarbij u telkens wordt gevraagd om een keuze te maken tussen twee verschillende Tiny Houses. Het invullen van de vragenlijst zal ongeveer 10 minuten duren.

Alvast bedankt voor uw bijdrage aan dit onderzoek!

VOLGENDE

Pagina 1 van 17

Verzend nooit wachtwoorden via Google Formulieren.

Voorkeuren voor duurzame Tiny Houses

*Vereist

Algemene vragen

Wat is uw leeftijd? *

Kiezen

Wat is uw geslacht? *

- Man
- Vrouw
- Anders: ______________________

Wat omschrijft uw werksituatie het beste? *

- Werkend - fulltime
- Werkend - parttime
- Studerend
- Werkzoekend
- Anders: ______________________

VORIGE VOLGENDE Pagina 2 van 17

Voorkeuren voor duurzame Tiny Houses

*Vereist

Vragen over uw huidige woonsituatie

Hoe is uw huidige huishouden samengesteld en met wie deelt u voorzieningen zoals keuken en/of badkamer? *

- (●) Alleen uzelf
- ( ) U en uw partner
- ( ) U en één medebewoner (niet uw partner)
- ( ) U, uw partner en kinderen
- ( ) U en uw ouder(s)
- ( ) U en meerdere medebewoners (geen familieleden)
- ( ) Anders: ____________________

Wat omschrijft uw huidige woningtype het beste? *

- ( ) Een rijtjeshuis, hoekwoning, twee onder een kap
- ( ) Een vrijstaande woning
- ( ) Een flat, etagewoning, appartement, maisonnette, bovenwoning, studio
- ( ) Een woning met aparte winkel-, kantoor-, praktijk- of bedrijfsruimte
- ( ) Anders: ____________________

Wat omschrijft de locatie van uw huidige woning het beste? *

- In het stadscentrum
- Binnen 2 km van het stadscentrum
- In de buitenwijken van de stad
- In een (middel)groot dorp
- In een klein dorp of landelijke omgeving
- Anders: ______

Wat omschrijft uw huidige buitenruimte het beste? *

- Een privé buitenruimte - tuin
- Een privé buitenruimte - balkon
- Gedeelde buitenruimte met één of meer buren
- Geen buitenruimte

Wat is de oppervlakte van uw huidige woning waar u gebruik van kunt maken ongeveer (incl. berging etc.)? *

- Tot 25 m2
- 25 - 50 m2
- 50 - 75 m2
- 75 - 100 m2
- 100 - 150 m2
- 150 of meer m2

Heeft u op dit moment een duurzame energiebron, zoals zonnepanelen en/of een warmtepomp? *

- Ja
- Nee

Hoe tevreden bent u met uw huidige woonsituatie? *

	1	2	3	4	5	
Zeer ontevreden	○	○	○	○	○	Zeer tevreden

VORIGE VOLGENDE

Pagina 3 van 17

Voorkeuren voor duurzame Tiny Houses

*Vereist

Vragen over uw toekomstige woonsituatie

In deze sectie zullen enkele vragen worden gesteld over uw verwachtingen m.b.t. uw eerstvolgende woonsituatie.

Gaat uw voorkeur uit naar een huurwoning of een koopwoning in uw volgende woonsituatie? *

- ◯ Huurwoning
- ◯ Koopwoning

Hoe verwacht u dat uw huishouden is samengesteld in uw volgende woonsituatie, dus met wie verwacht u voorzieningen zoals keuken en/of badkamer te delen? *

- ◯ Alleen uzelf
- ◯ U en uw partner
- ◯ U en één medebewoner (niet uw partner)
- ◯ U, uw partner en kinderen
- ◯ U en uw ouder(s)
- ◯ U en meerdere medebewoners (geen familieleden)
- ◯ Anders: ____________________

Op welke termijn verwacht u in een nieuwe woonsituatie terecht te komen? *

- Binnen 1 jaar
- OVer 1 tot 3 jaar
- Over 3 tot 5 jaar
- Over meer dan 5 jaar

VORIGE VOLGENDE

Pagina 4 van 17

Voorkeuren voor duurzame Tiny Houses

*Vereist

Tiny Houses

In deze sectie zal gevraagd worden naar uw kennis over Tiny Houses en zal er informatie gegeven worden over Tiny Houses.

Hoeveel kennis heeft u al van Tiny Houses? *

	1	2	3	4	5	
Helemaal geen	○	○	○	○	○	Heel erg veel

Hoeveel interesse heeft u om onder de juiste omstandigheden in een Tiny House te wonen? *

	1	2	3	4	5	
Zeer weinig interesse	○	○	○	○	○	Zeer veel interesse

VORIGE VOLGENDE

Pagina 5 van 17

Voorkeuren voor duurzame Tiny Houses

*Vereist

Eigenschappen

Voor het laatste deel van het onderzoek zal u gevraagd worden enkele malen te kiezen uit twee fictieve Tiny Houses met een wisselende combinatie van eigenschappen. Deze eigenschappen en de drie opties per eigenschap zijn te zien in onderstaande tabel, waarna verschillende eigenschappen verder worden toegelicht.

Opties per eigenschap

	Oppervlakte	Type woning
Optie 1	6,5 x 2,6 m2	Flatwoning
Optie 2	9,0 x 2,6 m2	Rijtjeswoning
Optie 3	11,5 x 2,6 m2	Vrijstaande woning

	Voorzieningen	Buitenruimte
Optie 1	Geen gezamenlijke voorzieningen	Geen privé buitenruimte of park nabij
Optie 2	Gezamenlijke wasserette	Een park binnen 400 meter
Optie 3	Gezamenlijke wasserette en berging	Privé buitenruimte van min. 6 m2

	Duurzaam systeem	Locatie
Optie 1	Geen duurzaam systeem	In de buitenwijken van de stad (2-4 km tot stadscentrum)
Optie 2	Elektrische opwekking door PV panelen	Aan de rand van het stadscentrum (0,5-2 km tot het stadscentrum)
Optie 3	Elektrische en thermische opwekking door PVT panelen	In het stadscentrum

	Prijs	Energiekosten
Minimaal	€ 245,- per maand	€ 10,- per maand
Maximaal	€ 640,- per maand	€ 160,- per maand

Het ontwerp

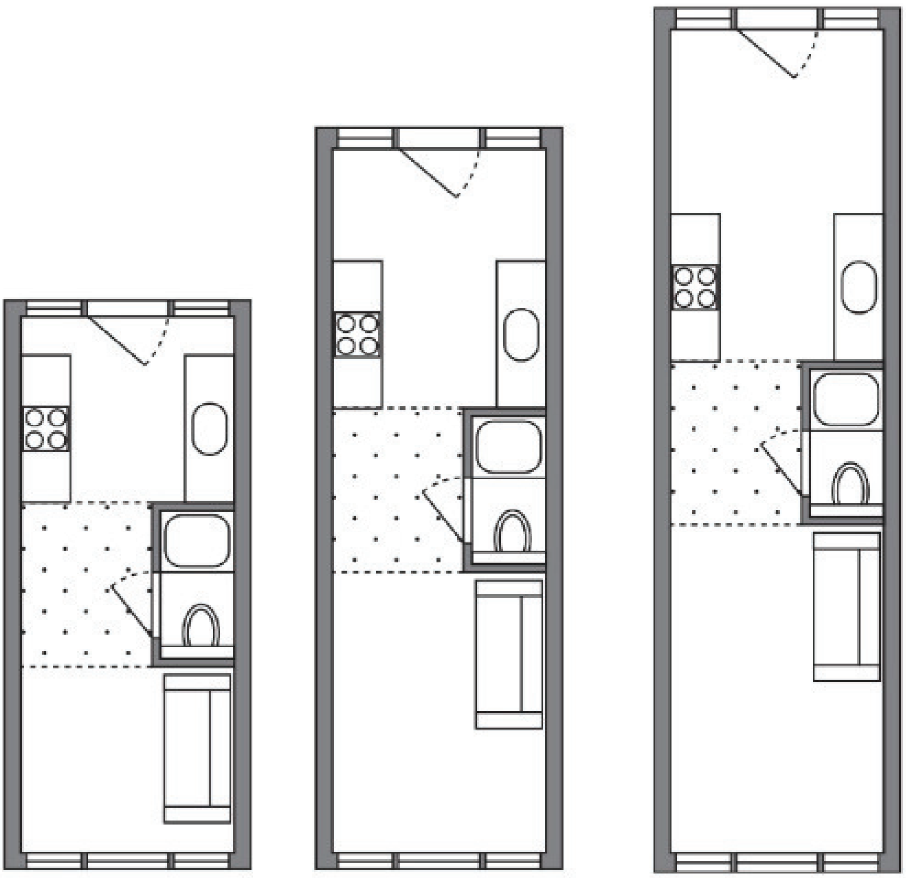
De basis van de Tiny Houses bestaat uit een woonruimte met badkamer, keuken en tussenvloer (gestippelde zone) zoals aangegeven in onderstaande plattegronden. De oppervlakte is gerekend als het vloeroppervlakte exclusief tussenvloer (van ongeveer 5 m2). Door de hoogte van 4 meter is het namelijk mogelijk om een halve verdieping in te bouwen, bijvoorbeeld om te slapen.

De eigenschap voorzieningen geeft de mogelijkheid om ruimte te besparen door voorzieningen te delen met de directe omgeving. Bijvoorbeeld een wasserette met 2 wasmachines per 8 woningen of een berging van ongeveer 2 m2 per woning.

Bij de rijtjeswoningen en flatwoningen gaat het om een woning die aan alle zijden is ingebouwd, dus geen hoekwoningen. Een flatwoning heeft dus buren aan beide zijden naast zich, evenals (schuin)boven- en onder zich. Ter verduidelijking zal bij elke keuze de woning omcirkeld zijn waar het om gaat.

Een duurzaam systeem geeft de mogelijkheid om duurzame zonne-energie op te wekken. Er is hierbij keuze tussen een systeem wat enkel elektriciteit opwekt (PV panelen) of een systeem wat zowel elektriciteit als warm water voor bijvoorbeeld vloerverwarming produceert (PVT panelen).

Plattegrond 6,5 x 2,6 m2 / 9,0 x 2,6 m2 / 11,5 x 2,6 m2



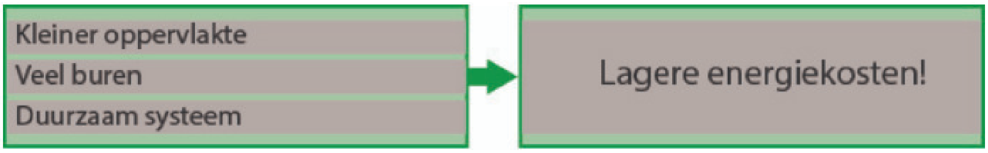
Kosten

De kosten per Tiny House bestaan uit de huurprijs en de energiekosten voor het Tiny House.

De prijs is de huurprijs voor desbetreffende woning per maand. De prijs is opgesteld aan de hand van een combinatie van alle eigenschappen. Zo zorgt een groter oppervlakte voor een hogere prijs en brengt de aanwezigheid van een duurzaam systeem extra kosten met zich mee. De prijzen van de Tiny Houses die getoond worden liggen tussen de € 245,- en € 640,-.

De energiekosten zijn bepaald op basis van de eigenschappen van de woning en aanwezigheid van standaard apparatuur. Op welke manier de eigenschappen van de woning invloed hebben op de energiekosten is weergegeven in onderstaande tabel. De energiekosten liggen tussen de €10,- en €160,-.

Invloed op de energiekosten



VORIGE VOLGENDE

Pagina 6 van 17

Voorkeuren voor duurzame Tiny Houses

Vragenlijst - voorbeeld

Na al deze informatie, zullen nu steeds twee fictieve Tiny Houses voorgelegd worden, waarna u uw voorkeur aangeeft voor één van de Tiny Houses of kiest voor de optie 'geen van beiden'. Kies enkel de optie 'geen van beiden' als beide woningen u niet aanspreken. Kies anders altijd voor één van de twee woningen, ook als de keuze lastig is.

Bekijk de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden. Mocht u de informatie van voorgaande pagina's terug willen lezen, dan kunt u op de link bovenaan de pagina klikken.

Hieronder ziet u een voorbeeld van een vraag die gesteld zou kunnen worden:

Voorbeeldvraag

Naar welk Tiny House gaat uw voorkeur uit?

Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	17 m2
Type woning	Flat
Voorzieningen	Geen gedeelde voorzieningen
Buitenruimte	Geen tuin
Duurzaam systeem	Geen duurzaam systeem
Locatie	In het centrum
Prijs*	€ 312,83 per maand
Energiekosten**	€ 95,04 per maand

Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	23,5 m2
Type woning	Vrijstaand
Voorzieningen	Geen gedeelde voorzieningen
Buitenruimte	Een park binnen 400 meter
Duurzaam systeem	Elektrische en thermische opwekking
Locatie	In het centrum
Prijs*	€ 447,12 per maand
Energiekosten**	€ 46,55 per maand

** De prijzen van de Tiny Houses liggen tussen de € 243,70 en € 639,97*
*** De gemiddelde energiekosten in Nederland per maand bedragen € 170,02 voor een flatwoning, € 223,92 voor een rijtjeswoning en € 388,29 voor een vrijstaande woning*

- ○ Tiny House A
- ◉ Tiny House B
- ○ Geen van beiden

VORIGE VOLGENDE Pagina 7 van 17

Voorkeuren voor duurzame Tiny Houses

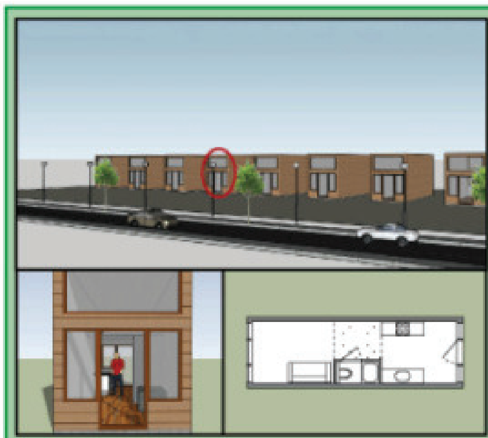
Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
https://docs.google.com/document/d/1zz1VqehcgqusoUQa5rL-1qA98TabX1hKl8SLcM3luwQ/edit?usp=sharing

Naar welk Tiny House gaat uw voorkeur uit? *

Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	17 m2
Type woning	Vrijstaande woning
Voorzieningen	Geen gedeelde voorzieningen
Buitenruimte	Privé buitenruimte
Duurzaam systeem	Elektrische en thermische opwekking
Locatie	Aan de rand van het centrum
Prijs*	€ 305,- per maand
Energiekosten**	€ 55,- per maand



Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	23.5 m2
Type woning	Vrijstaande woning
Voorzieningen	Gedeelde wasserette
Buitenruimte	Geen tuin
Duurzaam systeem	Geen duurzaam systeem
Locatie	In het centrum
Prijs*	€ 415,- per maand
Energiekosten**	€ 140,- per maand

* *De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*
** *De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ○ Tiny House A
- ○ Tiny House B
- ○ Geen van beiden

Voorkeuren voor duurzame Tiny Houses

Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
https://docs.google.com/document/d/1zz1VqehcgqusoUQa5rL-1qA98TabX1hKl8SLcM3luwQ/edit?usp=sharing

Naar welk Tiny House gaat uw voorkeur uit? *

Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	17 m2
Type woning	Flat
Voorzieningen	Geen gedeelde voorzieningen
Buitenruimte	Geen tuin
Duurzaam systeem	Geen duurzaam systeem
Locatie	In het centrum
Prijs*	€ 315,- per maand
Energiekosten**	€ 95,- per maand

Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	17 m2
Type woning	Rijtjeswoning
Voorzieningen	Gedeelde wasserette en berging
Buitenruimte	Privé buitenruimte
Duurzaam systeem	Geen duurzaam systeem
Locatie	In de buitenwijken van de stad
Prijs*	€ 300,- per maand
Energiekosten**	€ 105,- per maand

* *De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*
** *De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ○ Tiny House A
- ○ Tiny House B
- ○ Geen van beiden

Voorkeuren voor duurzame Tiny Houses

Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
https://docs.google.com/document/d/1zz1VqehcgqusoUQa5rL-1qA98TabX1hKl8SLcM3luwQ/edit?usp=sharing

Naar welk Tiny House gaat uw voorkeur uit? *

Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	30 m2
Type woning	Flat
Voorzieningen	Gedeelde wasserette en berging
Buitenruimte	Privé buitenruimte
Duurzaam systeem	Elektrische en thermische opwekking
Locatie	Aan de rand van het centrum
Prijs*	€ 590,- per maand
Energiekosten**	€ 75,- per maand

Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	17 m2
Type woning	Flat
Voorzieningen	Gedeelde wasserette en berging
Buitenruimte	Een park binnen 400 meter
Duurzaam systeem	Elektrische en thermische opwekking
Locatie	In het centrum
Prijs*	€ 385,- per maand
Energiekosten**	€ 75,- per maand

** De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*
*** De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ○ Tiny House A
- ○ Tiny House B
- ○ Geen van beiden

Voorkeuren voor duurzame Tiny Houses

Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
https://docs.google.com/document/d/1zz1VqehcgqusoUQa5rL-1qA98TabX1hKl8SLcM3luwQ/edit?usp=sharing

Naar welk Tiny House gaat uw voorkeur uit? *

Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	17 m2
Type woning	Rijtjeswoning
Voorzieningen	Geen gedeelde voorzieningen
Buitenruimte	Een park binnen 400 meter
Duurzaam systeem	Elektrische opwekking
Locatie	In de buitenwijken van de stad
Prijs*	€ 265,- per maand
Energiekosten**	€ 80,- per maand

Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	23.5 m2
Type woning	Vrijstaande woning
Voorzieningen	Geen gedeelde voorzieningen
Buitenruimte	Een park binnen 400 meter
Duurzaam systeem	Elektrische en thermische opwekking
Locatie	In het centrum
Prijs*	€ 445,- per maand
Energiekosten**	€ 45,- per maand

* *De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*
** *De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ○ Tiny House A
- ○ Tiny House B
- ○ Geen van beiden

Voorkeuren voor duurzame Tiny Houses

Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
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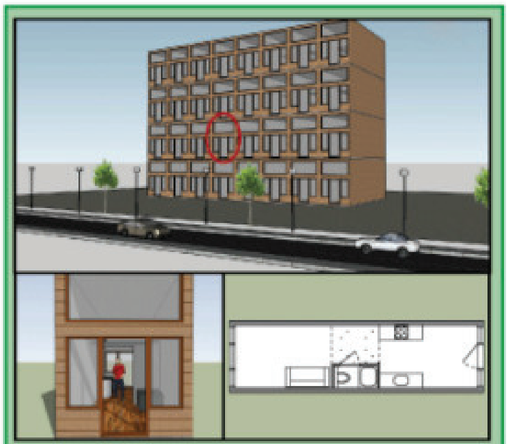
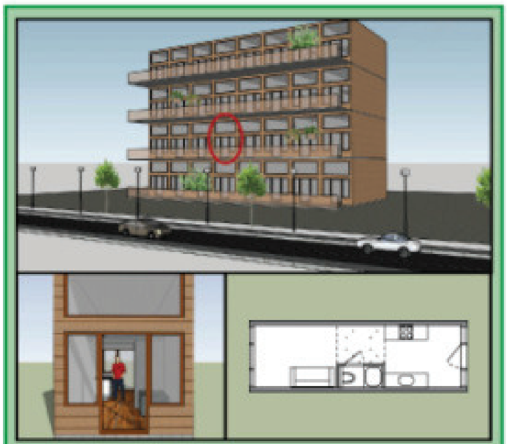
Naar welk Tiny House gaat uw voorkeur uit? *



Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	30 m2
Type woning	Flat
Voorzieningen	Gedeelde wasserette
Buitenruimte	Geen tuin
Duurzaam systeem	Elektrische opwekking
Locatie	Aan de rand van het centrum
Prijs*	€ 535,- per maand
Energiekosten**	€ 90,- per maand



Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	23.5 m2
Type woning	Flat
Voorzieningen	Geen gedeelde voorzieningen
Buitenruimte	Privé buitenruimte
Duurzaam systeem	Geen duurzaam systeem
Locatie	In de buitenwijken van de stad
Prijs*	€ 395,- per maand
Energiekosten**	€ 105,- per maand

* *De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*
** *De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ○ Tiny House A
- ○ Tiny House B
- ○ Geen van beiden

Voorkeuren voor duurzame Tiny Houses

Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
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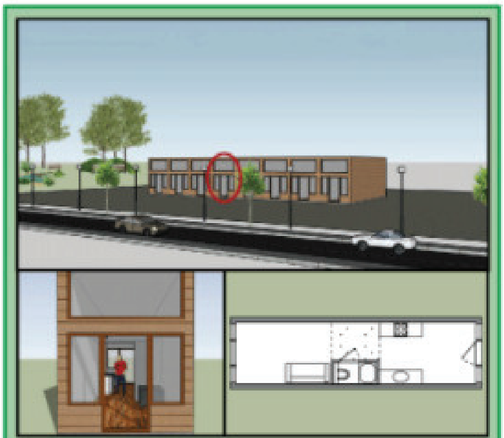
Naar welk Tiny House gaat uw voorkeur uit? *



Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	30 m2
Type woning	Rijtjeswoning
Voorzieningen	Gedeelde wasserette
Buitenruimte	Een park binnen 400 meter
Duurzaam systeem	Elektrische en thermische opwekking
Locatie	In het centrum
Prijs*	€ 570,- per maand
Energiekosten**	€ 10,- per maand

Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	30 m2
Type woning	Vrijstaande woning
Voorzieningen	Gedeelde wasserette
Buitenruimte	Privé buitenruimte
Duurzaam systeem	Geen duurzaam systeem
Locatie	In de buitenwijken van de stad
Prijs*	€ 475,- per maand
Energiekosten**	€ 160,- per maand

* *De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*

** *De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ○ Tiny House A
- ○ Tiny House B
- ○ Geen van beiden

Voorkeuren voor duurzame Tiny Houses

Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
https://docs.google.com/document/d/1zz1VqehcgqusoUQa5rL-1qA98TabX1hKl8SLcM3luwQ/edit?usp=sharing

Naar welk Tiny House gaat uw voorkeur uit? *

Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	17 m2
Type woning	Vrijstaande woning
Voorzieningen	Gedeelde wasserette en berging
Buitenruimte	Geen tuin
Duurzaam systeem	Elektrische opwekking
Locatie	Aan de rand van het centrum
Prijs*	€ 320,- per maand
Energiekosten**	€ 95,- per maand

Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	23.5 m2
Type woning	Rijtjeswoning
Voorzieningen	Gedeelde wasserette
Buitenruimte	Privé buitenruimte
Duurzaam systeem	Elektrische en thermische opwekking
Locatie	Aan de rand van het centrum
Prijs*	€ 420,- per maand
Energiekosten**	€ 25,- per maand

** De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*
*** De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ◯ Tiny House A
- ◯ Tiny House B
- ◯ Geen van beiden

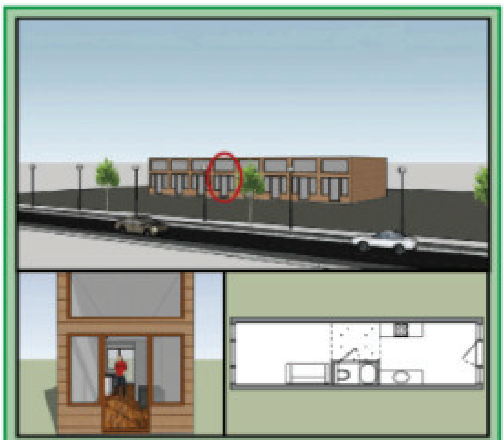
Voorkeuren voor duurzame Tiny Houses

Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
https://docs.google.com/document/d/1zz1VqehcgqusoUQa5rL-1qA98TabX1hKl8SLcM3luwQ/edit?usp=sharing

Naar welk Tiny House gaat uw voorkeur uit? *



Tiny house A heeft de volgende eigenschappen:

Oppervlakte	30 m2
Type woning	Rijtjeswoning
Voorzieningen	Gedeelde wasserette en berging
Buitenruimte	Geen tuin
Duurzaam systeem	Geen duurzaam systeem
Locatie	In het centrum
Prijs*	€ 545,- per maand
Energiekosten**	€ 130,- per maand

Tiny house B heeft de volgende eigenschappen:

Oppervlakte	23.5 m2
Type woning	Rijtjeswoning
Voorzieningen	Geen gedeelde voorzieningen
Buitenruimte	Geen tuin
Duurzaam systeem	Elektrische opwekking
Locatie	Aan de rand van het centrum
Prijs*	€ 365,- per maand
Energiekosten**	€ 85,- per maand

* *De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*
** *De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ○ Tiny House A
- ○ Tiny House B
- ○ Geen van beiden

Voorkeuren voor duurzame Tiny Houses

Vragenlijst

Bekijk bij elk van de volgende vragen de situatie vanuit een eenpersoonshuishouden, tenzij u op dit moment al met uw partner samenwoont of binnen een jaar verwacht te gaan samenwonen met uw partner. Bekijk de situatie dan vanuit een tweepersoonshuishouden.

Voorgaande informatie terughalen:
https://docs.google.com/document/d/1zz1VqehcgqusoUQa5rL-1qA98TabX1hKl8SLcM3luwQ/edit?usp=sharing

Naar welk Tiny House gaat uw voorkeur uit? *

Tiny house A heeft de volgende eigenschappen:	
Oppervlakte	30 m2
Type woning	Vrijstaande woning
Voorzieningen	Gedeelde wasserette en berging
Buitenruimte	Een park binnen 400 meter
Duurzaam systeem	Elektrische opwekking
Locatie	In de buitenwijken van de stad
Prijs*	€ 525,- per maand
Energiekosten**	€ 115,- per maand

Tiny house B heeft de volgende eigenschappen:	
Oppervlakte	23.5 m2
Type woning	Flat
Voorzieningen	Gedeelde wasserette
Buitenruimte	Een park binnen 400 meter
Duurzaam systeem	Elektrische opwekking
Locatie	In de buitenwijken van de stad
Prijs*	€ 415,- per maand
Energiekosten**	€ 90,- per maand

** De prijzen van de Tiny Houses liggen tussen de € 245,- en € 640,-*
*** De energiekosten van een gemiddeld Nederlands huishouden per maand voor een tussenwoning bedragen € 205,- o.b.v. volledig elektrische energie. De energiekosten van de Tiny Houses liggen tussen de € 10,- en € 160,- o.b.v. volledig elektrische energie.*

- ○ Tiny House A
- ○ Tiny House B
- ○ Geen van beiden

Voorkeuren voor duurzame Tiny Houses

Tot slot

Hopelijk was de vragenlijst duidelijk voor u en heeft u alles in kunnen vullen. Op deze pagina hoor ik graag uw feedback en eventuele verwachtingen.

Welke eigenschap is voor u het meest van belang bij de keuze voor een woning? (deze hoeft niet genoemd te zijn in het onderzoek) *

Jouw antwoord

Heeft u nog opmerkingen of aanbevelingen voor dit onderzoek?

Jouw antwoord

Als u op de hoogte gehouden wilt worden van de resultaten van dit onderzoek, vul dan hieronder uw mailadres in. We verwerken uw data strikt anoniem en zullen uw mailadres niet voor andere doeleinden gebruiken of aan derden beschikbaar stellen.

Jouw antwoord

Bedankt!

Bedankt voor uw bijdrage aan dit onderzoek!

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Appendix 7: Effect coding scheme

Effect coding scheme all attribute levels

Surface	S1	S2	Type	T1	T2
17 m2	1	0	**Flat**	1	0
23.5 m2	0	1	**Terraced**	0	1
30 m2	-1	-1	**Detached**	-1	-1
Facilities	**F1**	**F2**	**Outdoor**	**O1**	**O2**
Laundry and storage facilities	1	0	**Garden/Balcony**	1	0
Laundry facilities	0	1	**Park**	0	1
None	-1	-1	**None**	-1	-1
System	**D1**	**D2**	**Location**	**L1**	**L2**
PVT	1	0	**In the city center**	1	0
PV	0	1	**Near the city center**	0	1
None	-1	-1	**Edge of the city**	-1	-1

Appendix 8: Chi-squared tables

This appendix contains the tables with expected and final count of the different Chi-squared tests that have been treated in the text. The tables provide an overview of the relations between different respondent-related characteristics. Above each table is briefly explained which characteristics have been treated in the table and in which (sub-) section they are explained.

A. Personal characteristics

This table shows the relations between the characteristics age, gender and work status (occupation). These relations are discussed in section 4.1.2. The blue, italic numbers indicate that this is a non-significant relation.

			WorkStatus studying	WorkStatus working	Total	Gender male	Gender female	Total
Age		**Significance**			**0.000**			**0.692**
	under 24	Count	184	12	196	*80*	*116*	*196*
		Expected Count	160.6	35.4	196.0	*78.4*	*117.6*	*196.0*
	24 or more	Count	61	42	103	*40*	*64*	*104*
		Expected Count	84.4	18.6	103.0	*41.6*	*62.4*	*104.0*
Total		Count	245	54	299	*120*	*180*	*300*
		Expected Count	245.0	54.0	299.0	*120.0*	*180.0*	*300.0*
Gender		**Significance**			**0.837**			
	male	Count	*99*	*21*	*120*			
		Expected Count	*98.3*	*21.7*	*120.0*			
	female	Count	*146*	*33*	*179*			
		Expected Count	*146.7*	*32.3*	*179.0*			
Total		Count	*245*	*54*	*299*			
		Expected Count	*245.0*	*54.0*	*299.0*			

B. Personal and (current) residential characteristics

This table shows the relations between the characteristics age, work status (occupation) and current household composition. These relations are discussed in section 4.1.3.

			CurHHComp			Total
			head of household	with parents	with roommates	
Age		Significance				0.000
	under 24	Count	39	66	91	196
		Expected Count	64.7	50.3	81.0	196.0
	24 or more	Count	60	11	33	104
		Expected Count	34.3	26.7	43.0	104.0
Total		Count	99	77	124	300
		Expected Count	99.0	77.0	124.0	300.0
WorkStatus		Significance				0.000
	studying	Count	65	68	112	245
		Expected Count	81.1	63.1	100.8	245.0
	working	Count	34	9	11	54
		Expected Count	17.9	13.9	22.2	54.0
Total		Count	99	77	123	299
		Expected Count	99.0	77.0	123.0	299.0

C. Personal and (current) residential characteristics

This table discusses the relations between the characteristics age, current location and current type of house. These relations are discussed in section 4.1.3.

			Age		Total
			under 24	24 or more	
CurLocation		Significance			0.006
	in city center	Count	27	30	57
		Expected Count	37.2	19.8	57
	in city (not center)	Count	121	55	176
		Expected Count	115	61	176
	not in city	Count	48	19	67
		Expected Count	43.8	23.2	67
Total		Count	196	104	300
		Expected Count	196	104	300
CurHouseType		Significance			0.012
	flat	Count	79	58	137
		Expected Count	90.7	46.3	137
	terraced	Count	87	33	120
		Expected Count	79.4	40.6	120
	detached	Count	26	7	33
		Expected Count	21.8	11.2	33
Total		Count	192	98	290
		Expected Count	192	98	290

D. Personal and (current) residential characteristics

This table shows the relations between the characteristics work status (occupation) and surface. These relations are discussed in section 4.1.3 (sub-section: surface).

			CurSurface			Total
			0 - 50 m2	50 - 100 m2	100 or more m2	
WorkStatus		**Significance**				**0.020**
	studying	Count	94	92	59	245
		Expected Count	86	93.4	65.6	245
	working	Count	11	22	21	54
		Expected Count	19	20.6	14.4	54
Total		Count	105	114	80	299
		Expected Count	105	114	80	299

E. (current) residential characteristics

The following two tables show the relations between the residential characteristics current household composition, current type of house, current location, current outdoor space and surface. These relations are discussed in section 4.1.3 (sub-section: satisfaction).

			CurHHComp				CurHouseType			
			head of household	with parents	with roommates	Total	flat	terraced	detached	Total
CurSurface		**Significance**				**0.000**				**0.000**
	0 - 50 m2	Count	44	7	54	105	62	30	5	97
		Expected Count	34.7	27.0	43.4	105.0	45.8	40.1	11.0	97.0
	50 - 100 m2	Count	42	22	51	115	61	49	4	114
		Expected Count	38.0	29.5	47.5	115.0	53.9	47.2	13.0	114.0
	100 or more m2	Count	13	48	19	80	14	41	24	79
		Expected Count	26.4	20.5	33.1	80.0	37.3	32.7	9.0	79.0
Total		Count	99	77	124	300	137	120	33	290
		Expected Count	99.0	77.0	124.0	300.0	137.0	120.0	33.0	290.0
CurOutdoor		**Significance**				**0.000**				**0.001**
	with outdoor space	Count	80	77	104	261	111	111	33	255
		Expected Count	86.1	67.0	107.9	261.0	120.5	105.5	29.0	255.0
	without outdoor space	Count	19	0	20	39	26	9	0	35
		Expected Count	12.9	10.0	16.1	39.0	16.5	14.5	4.0	35.0
Total		Count	99	77	124	300	137	120	33	290
		Expected Count	99.0	77.0	124.0	300.0	137.0	120.0	33.0	290.0
CurLocation		**Significance**				**0.000**				**0.000**
	in city center	Count	26	3	28	57	38	13	2	53
		Expected Count	18.8	14.6	23.6	57.0	25.0	21.9	6.0	53.0
	in city (not center)	Count	57	25	94	176	90	73	10	173
		Expected Count	58.1	45.2	72.7	176.0	81.7	71.6	19.7	173.0
	not in city	Count	16	49	2	67	9	34	21	64
		Expected Count	22.1	17.2	27.7	67.0	30.2	26.5	7.3	64.0
Total		Count	99	77	124	300	137	120	33	290
		Expected Count	99.0	77.0	124.0	300.0	137.0	120.0	33.0	290.0
CurHouseType		**Significance**				**0.000**				
	flat	Count	74	3	60	137				
		Expected Count	44.4	36.4	56.2	137.0				
	terraced	Count	17	50	53	120				
		Expected Count	38.9	31.9	49.2	120.0				
	detached	Count	3	24	6	33				
		Expected Count	10.7	8.8	13.5	33.0				
Total		Count	94	77	119	290				
		Expected Count	94.0	77.0	119.0	290.0				

			CurLocation			Total	CurOutdoor		Total
			in city center	in city (not center)	not in city		with outdoor space	without outdoor space	
CurSurface		**Significance**				**0.000**			**0.000**
	0 - 50 m2	Count	28	71	6	105	78	27	105
		Expected Count	20.0	61.6	23.5	105.0	91.4	13.7	105.0
	50 - 100 m2	Count	21	69	25	115	104	11	115
		Expected Count	21.9	67.5	25.7	115.0	100.1	15.0	115.0
	100 or more m2	Count	8	36	36	80	79	1	80
		Expected Count	15.2	46.9	17.9	80.0	69.6	10.4	80.0
Total		Count	57	176	67	300	261	39	300
		Expected Count	57.0	176.0	67.0	300.0	261.0	39.0	300.0
CurOutdoor		**Significance**				**0.006**			
	with outdoor space	Count	47	148	66	261			
		Expected Count	49.6	153.1	58.3	261.0			
	without outdoor space	Count	10	28	1	39			
		Expected Count	7.4	22.9	8.7	39.0			
Total		Count	57	176	67	300			
		Expected Count	57.0	176.0	67.0	300.0			

F. *Personal and (current and future) residential characteristics*

The following two tables show the relations between the characteristics current household composition, age, future household composition, house ownership (rent or buy), satisfaction and expected moment of moving. These relations are discussed in section 4.1.4 (sub-section: future house situation).

			FutHHComp			Total
			1 person	with partner	other	
Age		Significance				0.003
	under 24	Count	45	85	65	195
		Expected Count	55.4	85.4	54.1	195.0
	24 or more	Count	40	46	18	104
		Expected Count	29.6	45.6	28.9	104.0
Total		Count	85	131	83	299
		Expected Count	85.0	131.0	83.0	299.0
CurHHComp		Significance				0.000
	head of household	Count	25	55	19	99
		Expected Count	28.1	43.4	27.5	99.0
	with parents	Count	32	18	26	76
		Expected Count	21.6	33.3	21.1	76.0
	with roommates	Count	28	58	38	124
		Expected Count	35.3	54.3	34.4	124.0
Total		Count	85	131	83	299
		Expected Count	85.0	131.0	83.0	299.0

			MovementTime			Total	CurHHComp			Total
			within 1 year	in 1 to 3 years	in more then 3 years		head of household	with parents	with roommates	
		Significance				0.000				0.000
RentalOrPurchase	owner-occupied property	Count	32	53	71	156	64	47	45	156
		Expected Count	41.6	62.9	51.5	156.0	51.5	40.0	64.5	156.0
	rental property	Count	48	68	28	144	35	30	79	144
		Expected Count	38.4	58.1	47.5	144.0	47.5	37.0	59.5	144.0
Total		Count	80	121	99	300	99	77	124	300
		Expected Count	80.0	121.0	99.0	300.0	99.0	77.0	124.0	300.0
Satisfaction		Significance				0.000				
	not satisfied	Count	15	5	1	21				
		Expected Count	5.6	8.5	6.9	21.0				
	satisfied	Count	65	116	98	279				
		Expected Count	74.4	112.5	92.1	279.0				
Total		Count	80	121	99	300				
		Expected Count	80.0	121.0	99.0	300.0				

G. *Tiny House experience and (current and future) residential characteristics*

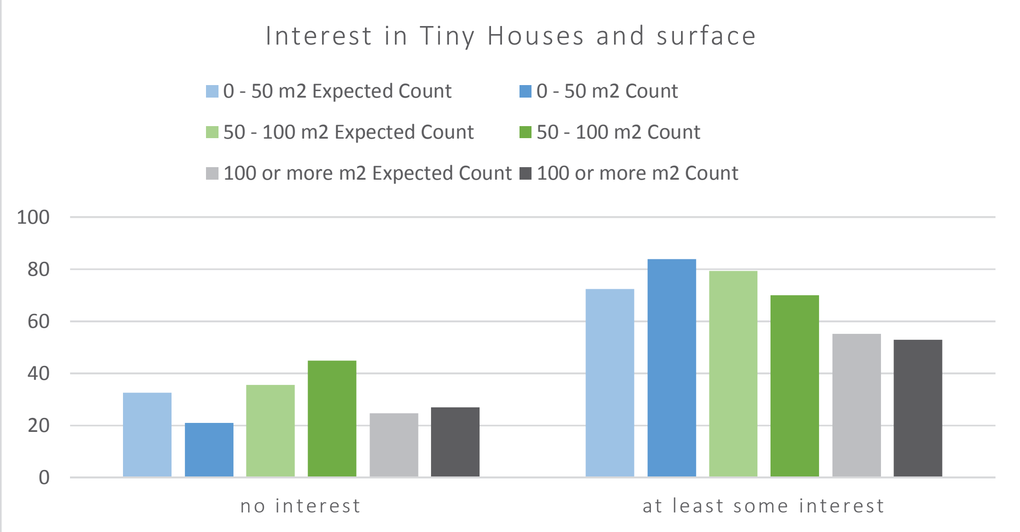
This table shows the relations between the characteristics interest in Tiny Houses, house ownership (rent or buy), future household composition and surface. These relations are discussed in section 4.1.3 (sub-section: surface).

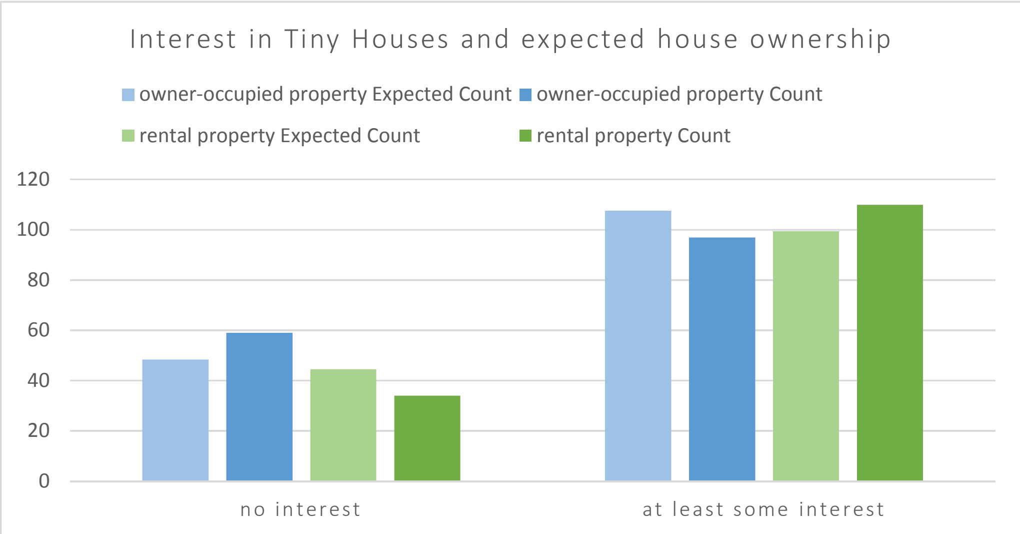
			Interest		Total
			no interest	at least some interest	
CurSurface		Significance			0.008
	0 - 50 m2	Count	21	84	105
		Expected Count	32.6	72.4	105.0
	50 - 100 m2	Count	45	70	115
		Expected Count	35.7	79.4	115.0
	100 or more m2	Count	27	53	80
		Expected Count	24.8	55.2	80.0
Total		Count	93	207	300
		Expected Count	93.0	207.0	300.0
RentalPurchase		Significance			0.008
	owner-occupied property	Count	59	97	156
		Expected Count	48.4	107.6	156.0
	rental property	Count	34	110	144
		Expected Count	44.6	99.4	144.0
Total		Count	93	207	300
		Expected Count	93.0	207.0	300.0
FutHHComp		Significance			0.007
	1 person	Count	17	68	85
		Expected Count	26.2	58.8	85.0
	with partner	Count	52	79	131
		Expected Count	40.3	90.7	131.0
	other	Count	23	60	83
		Expected Count	25.5	57.5	83.0
Total		Count	92	207	299
		Expected Count	92.0	207.0	299.0

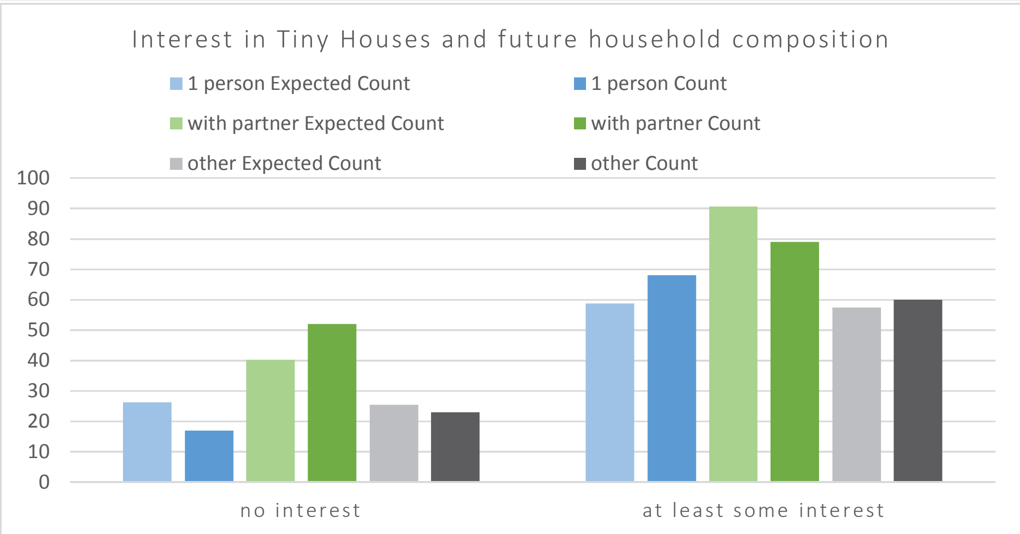
Appendix 9: Comparison with descriptive statistics of the Netherlands

		The Netherlands (CBS, 2015)	This Research
Current household composition			
Independent		59	33
	Only yourself		17
	You and your partner		15
	You, your partner and kids		1
With parents		36	26
With roommates		5	41
	You and one roommate (not your partner)		6
	You and several roommates (not family members)		35
Type of house			
Flat		46	45
Other		54	55
	Terraced house		40
	Detached house		11
	Other		4
Location			
Very urban		58	60
	In de city center		19
	Within 2 km from the city center		41
Moderate urban		15	18
	In the suburbs of the city		18
Little to not urban		27	22
	In a (medium) large village		14
	In a small village or rural area		9

Appendix 10: (Expected) counts for interest in Tiny Houses







Appendix 11: MNL model estimation

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function     -2444.40246
Estimation based on N =    2700, K =  13
Inf.Cr.AIC  =   4914.8 AIC/N =    1.820
Model estimated: Jan 29, 2019, 11:57:32
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
   CHRES|  Coefficient     Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
      X0|   -1.35770***    .06182   -21.96  .0000    -1.47887  -1.23653
      S1|    -.17263***    .04424    -3.90  .0001     -.25933   -.08592
      S2|     .08734**     .04080     2.14  .0323      .00738    .16730
      O1|     .34957***    .04275     8.18  .0000      .26577    .43336
      O2|    -.02183       .04985     -.44  .6615     -.11953    .07588
      F1|    -.25767***    .05087    -5.07  .0000     -.35737   -.15796
      F2|    -.03943       .04394     -.90  .3696     -.12555    .04670
      T1|    -.44995***    .05039    -8.93  .0000     -.54871   -.35119
      T2|     .16701***    .04133     4.04  .0001      .08601    .24802
      D1|     .21814***    .04227     5.16  .0000      .13530    .30098
      D2|     .01987       .04328      .46  .6461     -.06495    .10469
      L1|     .19483***    .04496     4.33  .0000      .10671    .28296
      L2|     .00843       .04102      .21  .8372     -.07198    .08884
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

```
-----------------------------------------------------------------------------
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function     -2966.25318
Estimation based on N =    2700, K =   1
Inf.Cr.AIC  =   5934.5 AIC/N =    2.198
Model estimated: Jan 29, 2019, 12:00:12
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
   CHRES|  Coefficient     Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
    NULL|        0.0     .....(Fixed Parameter).....
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or
had a nonpositive st.error because of an earlier problem.
-----------------------------------------------------------------------------
```

Appendix 12: MNL model estimation with interaction

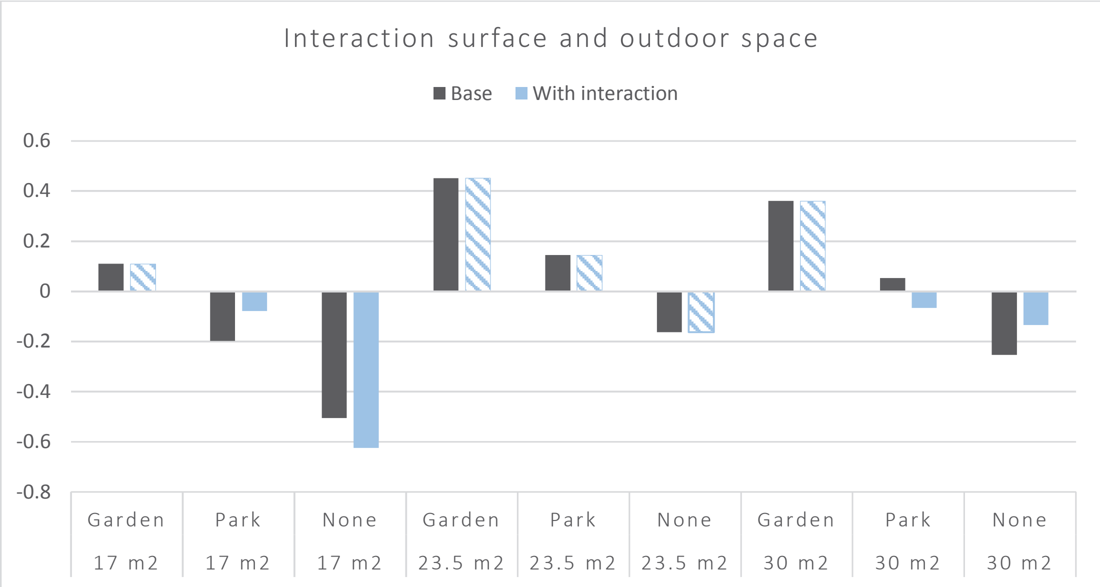
```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function     -2436.26681
Estimation based on N =   2700, K =  25
Inf.Cr.AIC  =   4922.5 AIC/N =    1.823
Model estimated: Jan 29, 2019, 12:01:49
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

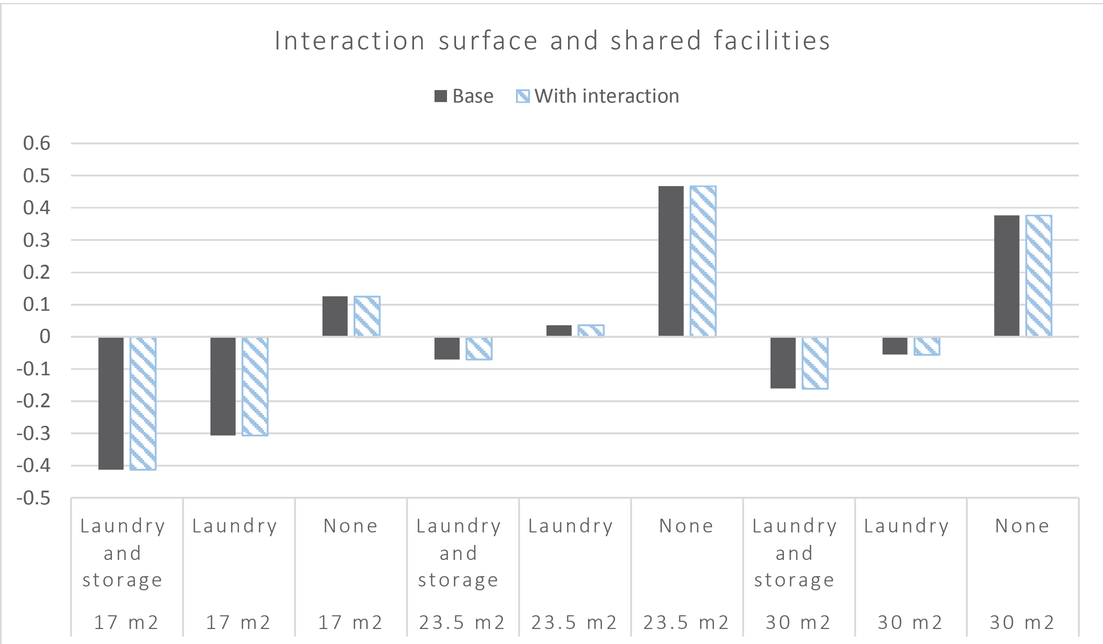
CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.35042***	.06219	-21.71	.0000	-1.47231	-1.22852
S1	-.19786***	.04740	-4.17	.0000	-.29076	-.10497
S2	.14454***	.04500	3.21	.0013	.05635	.23273
O1	.30717***	.05004	6.14	.0000	.20909	.40525
O2	.03591	.05854	.61	.5396	-.07882	.15064
F1	-.21444***	.05731	-3.74	.0002	-.32677	-.10212
F2	-.10877**	.05431	-2.00	.0452	-.21521	-.00233
T1	-.41601***	.06142	-6.77	.0000	-.53640	-.29562
T2	.18667***	.04656	4.01	.0001	.09541	.27793
D1	.23410***	.04747	4.93	.0000	.14105	.32714
D2	.02474	.05199	.48	.6342	-.07717	.12665
L1	.19404***	.05086	3.81	.0001	.09435	.29373
L2	.01519	.04887	.31	.7560	-.08060	.11097
S1O1	.01783	.06070	.29	.7690	-.10114	.13680
S1O2	.11961**	.05459	2.19	.0285	.01260	.22661
S2O1	-.06944	.07864	-.88	.3772	-.22357	.08468
S2O2	.04103	.05134	.80	.4242	-.05959	.14165
S1F1	.04516	.05752	.79	.4324	-.06758	.15790
S1F2	-.07869	.06296	-1.25	.2113	-.20208	.04470
S2F1	-.04723	.07294	-.65	.5173	-.19020	.09574
S2F2	.00265	.07812	.03	.9730	-.15046	.15576
O1F1	-.01763	.06068	-.29	.7714	-.13656	.10130
O1F2	.13566*	.07525	1.80	.0714	-.01182	.28315
O2F1	.02436	.06492	.38	.7075	-.10288	.15159
O2F2	-.09099	.05654	-1.61	.1075	-.20181	.01982

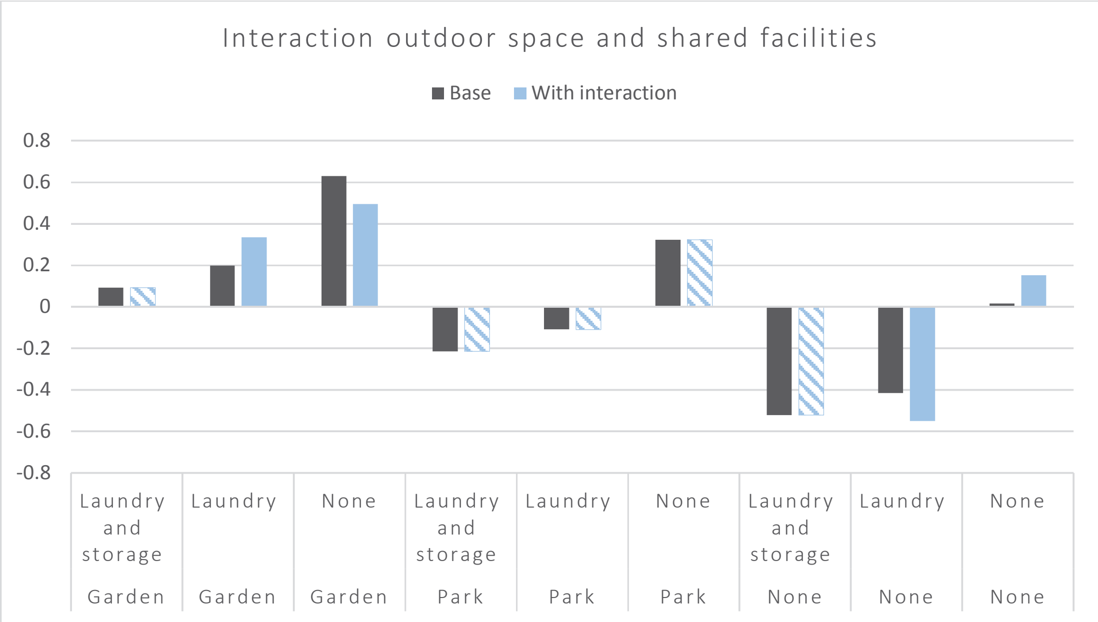
Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Appendix 13: Interactions surface, outdoor space and shared facilities

The hatched bars in these figures represent the effects of the attribute levels, but in this case there are no significant interaction effects, so the value with and without interaction parameters is the same.







Interaction outdoor space and shared facilities
Base
With interaction
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Laundry and storage
Laundry
None
Laundry and storage
Laundry
None
Laundry and storage
Laundry
None
Garden
Garden
Garden
Park
Park
Park
None
None
None

Appendix 14: Coding scheme with additional effects (2- and 3- level)

Age - 2 levels						
23 years and younger						
		S1	S2	SS1	SS2	
Level 1	**17 m2**	1	0	1	0	S1 + SS1
Level 2	**23.5 m2**	0	1	0	1	S2 + SS2
Level 3	**30 m2**	-1	-1	-1	-1	- (S1 + SS1 + S2 + SS2)
24 years and older						
		S1	S2	SS1	SS2	
Level 1	**17 m2**	1	0	-1	0	S1 - SS1
Level 2	**23.5 m2**	0	1	0	-1	S2 - SS2
Level 3	**30 m2**	-1	-1	1	1	- (S1 - SS1 + S2 - SS2)

Current household composition - 3 levels								
Head of own family								
		S1	S2	SS1	SS2	SSS1	SSS2	
Level 1	**17 m2**	1	0	1	0			S1 + SS1
Level 2	**23.5 m2**	0	1	0	1			S2 + SS2
Level 3	**30 m2**	-1	-1	-1	-1			- (S1 + SS1 + S2 + SS2)
With parents								
		S1	S2	SS1	SS2	SSS1	SSS2	
Level 1	**17 m2**	1	0			1	0	S1 + SSS1
Level 2	**23.5 m2**	0	1			0	1	S2 + SSS2
Level 3	**30 m2**	-1	-1			-1	-1	- (S1 + SSS1 + S2 + SSS2)
With roommates (no family)								
		S1	S2	SS1	SS2	SSS1	SSS2	
Level 1	**17 m2**	1	0	-1	0	-1	0	S1 - SS1 - SSS1
Level 2	**23.5 m2**	0	1	0	-1	0	-1	S2 - SS2 - SSS2
Level 3	**30 m2**	-1	-1	1	1	1	1	- (S1 - SS1 - SSS1 + S2 - SS2 - SSS2)

Appendix 15: MNL model estimation per characteristic

Variable age

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function     -2405.71693
Estimation based on N =    2700, K =  26
Inf.Cr.AIC  =   4863.4 AIC/N =    1.801
Model estimated: Jan 29, 2019, 12:08:27
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.28815***	.06251	-20.61	.0000	-1.41067	-1.16564
S1	-.21566***	.04683	-4.61	.0000	-.30745	-.12388
S2	.07435*	.04298	1.73	.0836	-.00989	.15858
O1	.34848***	.04473	7.79	.0000	.26082	.43615
O2	-.01344	.05160	-.26	.7945	-.11459	.08770
F1	-.24858***	.05311	-4.68	.0000	-.35268	-.14449
F2	-.03680	.04642	-.79	.4279	-.12778	.05418
T1	-.44666***	.05274	-8.47	.0000	-.55003	-.34330
T2	.17179***	.04382	3.92	.0001	.08590	.25768
D1	.22872***	.04452	5.14	.0000	.14145	.31599
D2	.00223	.04562	.05	.9610	-.08718	.09164
L1	.17502***	.04715	3.71	.0002	.08261	.26743
L2	.03456	.04323	.80	.4241	-.05018	.11929
XX0	-.43724***	.06251	-6.99	.0000	-.55975	-.31472
SS1	.12775***	.04683	2.73	.0064	.03597	.21954
SS2	.06879	.04298	1.60	.1095	-.01544	.15302
OO1	.00737	.04473	.16	.8692	-.08030	.09503
OO2	-.02300	.05160	-.45	.6558	-.12414	.07814
FF1	-.03723	.05311	-.70	.4833	-.14132	.06687
FF2	-.02574	.04642	-.55	.5792	-.11672	.06523
TT1	-.02965	.05274	-.56	.5740	-.13301	.07372
TT2	-.01207	.04382	-.28	.7829	-.09796	.07382
DD1	-.03432	.04452	-.77	.4408	-.12158	.05295
DD2	.06117	.04562	1.34	.1799	-.02824	.15058
LL1	.05952	.04715	1.26	.2069	-.03290	.15193
LL2	-.08389*	.04323	-1.94	.0523	-.16863	.00084

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Variable gender

```
Discrete choice (multinomial logit) model
Dependent variable              Choice
Log likelihood function    -2435.44347
Estimation based on N =   2700, K =  26
Inf.Cr.AIC  =   4922.9 AIC/N =    1.823
Model estimated: Jan 29, 2019, 12:10:27
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.35350***	.06288	-21.53	.0000	-1.47674	-1.23026
S1	-.16547***	.04502	-3.68	.0002	-.25372	-.07723
S2	.07374*	.04158	1.77	.0761	-.00775	.15524
O1	.33535***	.04352	7.71	.0000	.25005	.42065
O2	-.02582	.05088	-.51	.6118	-.12555	.07391
F1	-.25128***	.05175	-4.86	.0000	-.35270	-.14985
F2	-.04040	.04476	-.90	.3667	-.12813	.04733
T1	-.46054***	.05146	-8.95	.0000	-.56140	-.35969
T2	.16979***	.04202	4.04	.0001	.08744	.25214
D1	.21843***	.04308	5.07	.0000	.13399	.30287
D2	.01603	.04408	.36	.7162	-.07038	.10243
L1	.18772***	.04583	4.10	.0000	.09791	.27754
L2	.00563	.04180	.13	.8928	-.07629	.08756
XX0	.01726	.06288	.27	.7836	-.10598	.14051
SS1	.04099	.04502	.91	.3626	-.04725	.12924
SS2	-.07041*	.04158	-1.69	.0904	-.15191	.01108
OO1	-.09071**	.04352	-2.08	.0371	-.17601	-.00541
OO2	-.02056	.05088	-.40	.6861	-.12029	.07916
FF1	.02714	.05175	.52	.5999	-.07428	.12857
FF2	-.00017	.04476	.00	.9969	-.08790	.08756
TT1	-.04969	.05146	-.97	.3342	-.15054	.05117
TT2	.01788	.04202	.43	.6705	-.06447	.10023
DD1	.00679	.04308	.16	.8747	-.07764	.09123
DD2	-.02423	.04408	-.55	.5826	-.11063	.06217
LL1	-.05108	.04583	-1.11	.2650	-.14090	.03874
LL2	-.01359	.04180	-.33	.7450	-.09552	.06833

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

```
Discrete choice (multinomial logit) model
Dependent variable              Choice
Log likelihood function    -2420.43221
Estimation based on N =   2690, K =  26
Inf.Cr.AIC  =    4892.9 AIC/N =    1.819
Model estimated: Jan 29, 2019, 12:11:23
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped   10 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.17767***	.07168	-16.43	.0000	-1.31817	-1.03717
S1	-.18182***	.05697	-3.19	.0014	-.29348	-.07015
S2	.09407*	.05488	1.71	.0865	-.01350	.20164
O1	.34865***	.05561	6.27	.0000	.23965	.45766
O2	.08989	.06515	1.38	.1677	-.03781	.21758
F1	-.21087***	.06554	-3.22	.0013	-.33933	-.08240
F2	-.05715	.05921	-.97	.3344	-.17319	.05890
T1	-.46971***	.06685	-7.03	.0000	-.60073	-.33869
T2	.12187**	.05417	2.25	.0245	.01570	.22804
D1	.21908***	.05759	3.80	.0001	.10621	.33196
D2	.01694	.05698	.30	.7663	-.09474	.12861
L1	.22292***	.05894	3.78	.0002	.10739	.33845
L2	.00213	.05398	.04	.9685	-.10367	.10793
XX0	-.31841***	.07168	-4.44	.0000	-.45891	-.17791
SS1	.00888	.05697	.16	.8761	-.10278	.12054
SS2	-.00881	.05488	-.16	.8725	-.11638	.09876
OO1	.01324	.05561	.24	.8118	-.09576	.12224
OO2	-.16333**	.06515	-2.51	.0122	-.29102	-.03564
FF1	-.07552	.06554	-1.15	.2492	-.20399	.05294
FF2	.03109	.05921	.53	.5995	-.08495	.14713
TT1	.03037	.06685	.45	.6496	-.10065	.16139
TT2	.06395	.05417	1.18	.2378	-.04222	.17012
DD1	-.00931	.05759	-.16	.8716	-.12219	.10357
DD2	.00203	.05698	.04	.9716	-.10964	.11371
LL1	-.03457	.05894	-.59	.5576	-.15010	.08096
LL2	-.00188	.05398	-.03	.9723	-.10768	.10392

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Variable current household composition

```
Discrete choice (multinomial logit) model
Dependent variable                Choice
Log likelihood function      -2404.71362
Estimation based on N =    2700, K =  39
Inf.Cr.AIC  =    4887.4 AIC/N =    1.810
Model estimated: Jan 29, 2019, 12:13:35
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.39404***	.06478	-21.52	.0000	-1.52101	-1.26707
S1	-.13899***	.04522	-3.07	.0021	-.22763	-.05035
S2	.09498**	.04188	2.27	.0233	.01290	.17705
O1	.35672***	.04403	8.10	.0000	.27043	.44302
O2	-.03830	.05162	-.74	.4581	-.13948	.06288
F1	-.28620***	.05247	-5.45	.0000	-.38904	-.18337
F2	-.02930	.04516	-.65	.5165	-.11781	.05922
T1	-.46270***	.05203	-8.89	.0000	-.56467	-.36074
T2	.16436***	.04232	3.88	.0001	.08141	.24731
D1	.21413***	.04347	4.93	.0000	.12893	.29933
D2	.02169	.04491	.48	.6291	-.06633	.10972
L1	.19785***	.04621	4.28	.0000	.10728	.28843
L2	-.01367	.04281	-.32	.7496	-.09758	.07025
XX0	.33072***	.08317	3.98	.0001	.16770	.49373
SS1	-.22628***	.06166	-3.67	.0002	-.34713	-.10543
SS2	-.07610	.05687	-1.34	.1808	-.18756	.03535
OO1	.00916	.05918	.15	.8770	-.10683	.12514
OO2	.11659*	.06855	1.70	.0890	-.01776	.25093
FF1	.13266*	.07034	1.89	.0593	-.00521	.27052
FF2	-.02057	.06112	-.34	.7364	-.14036	.09922
TT1	.01305	.06960	.19	.8512	-.12336	.14947
TT2	-.02839	.05754	-.49	.6218	-.14117	.08440
DD1	.02039	.05900	.35	.7296	-.09525	.13603
DD2	-.07380	.06033	-1.22	.2213	-.19205	.04445
LL1	.01924	.06259	.31	.7586	-.10344	.14192
LL2	.06360	.05728	1.11	.2669	-.04867	.17587
XXX0	.00205	.09641	.02	.9831	-.18692	.19101
SSS1	.25924***	.06744	3.84	.0001	.12705	.39142
SSS2	.02583	.06278	.41	.6807	-.09721	.14888
OOO1	.02219	.06628	.33	.7377	-.10770	.15209
OOO2	-.09257	.07851	-1.18	.2384	-.24646	.06131
FFF1	-.15643**	.07874	-1.99	.0470	-.31076	-.00211
FFF2	.05852	.06774	.86	.3876	-.07424	.19128
TTT1	-.04182	.07827	-.53	.5931	-.19523	.11159
TTT2	-.02680	.06344	-.42	.6727	-.15113	.09754
DDD1	.02301	.06528	.35	.7245	-.10493	.15094
DDD2	-.01324	.06826	-.19	.8461	-.14703	.12054
LLL1	-.01601	.06959	-.23	.8180	-.15240	.12038
LLL2	-.15920**	.06563	-2.43	.0153	-.28783	-.03057

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Variable current type of house

```
Discrete choice (multinomial logit) model
Dependent variable                Choice
Log likelihood function      -2344.53701
Estimation based on N =    2610, K =  39
Inf.Cr.AIC  =    4767.1 AIC/N =    1.826
```

```
Model estimated: Jan 29, 2019, 12:14:41
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped   90 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.42725***	.08372	-17.05	.0000	-1.59134	-1.26315
S1	-.15495***	.05604	-2.77	.0057	-.26479	-.04512
S2	.11383**	.05112	2.23	.0260	.01364	.21402
O1	.37838***	.05479	6.91	.0000	.27100	.48576
O2	-.09042	.06593	-1.37	.1702	-.21964	.03880
F1	-.31397***	.06589	-4.77	.0000	-.44311	-.18484
F2	-.03490	.05611	-.62	.5339	-.14486	.07507
T1	-.48063***	.06568	-7.32	.0000	-.60936	-.35190
T2	.18148***	.05328	3.41	.0007	.07706	.28591
D1	.23301***	.05296	4.40	.0000	.12920	.33681
D2	.04302	.05846	.74	.4619	-.07157	.15761
L1	.17985***	.05691	3.16	.0016	.06831	.29139
L2	-.04984	.05503	-.91	.3651	-.15769	.05801
XX0	.04990	.09930	.50	.6153	-.14472	.24452
SS1	-.14524**	.06809	-2.13	.0329	-.27869	-.01179
SS2	-.09627	.06207	-1.55	.1209	-.21792	.02538
OO1	-.02375	.06618	-.36	.7197	-.15347	.10596
OO2	.12820	.07848	1.63	.1024	-.02562	.28201
FF1	.11397	.07931	1.44	.1507	-.04148	.26942
FF2	-.00421	.06772	-.06	.9504	-.13695	.12853
TT1	.05548	.07866	.71	.4806	-.09868	.20965
TT2	-.01638	.06447	-.25	.7994	-.14273	.10997
DD1	.05737	.06442	.89	.3731	-.06888	.18363
DD2	-.05924	.06937	-.85	.3931	-.19520	.07671
LL1	.07795	.06900	1.13	.2586	-.05729	.21319
LL2	.13221**	.06538	2.02	.0432	.00406	.26036
XXX0	.22131**	.09931	2.23	.0258	.02668	.41595
SSS1	.16134**	.06876	2.35	.0189	.02658	.29610
SSS2	-.02854	.06351	-.45	.6532	-.15302	.09594
OOO1	-.04787	.06704	-.71	.4752	-.17926	.08353
OOO2	.06257	.08001	.78	.4342	-.09425	.21939
FFF1	.05107	.08008	.64	.5237	-.10589	.20803
FFF2	-.03441	.06898	-.50	.6179	-.16960	.10078
TTT1	-.00377	.08004	-.05	.9624	-.16065	.15311
TTT2	-.01132	.06481	-.17	.8614	-.13833	.11570
DDD1	-.09093	.06566	-1.38	.1661	-.21962	.03775
DDD2	.00489	.07029	.07	.9446	-.13287	.14264
LLL1	-.01237	.07008	-.18	.8599	-.14973	.12498
LLL2	.01039	.06657	.16	.8760	-.12008	.14087

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Variable current location

```
Discrete choice (multinomial logit) model
Dependent variable                Choice
Log likelihood function      -2424.29139
Estimation based on N =    2700, K =   39
Inf.Cr.AIC  =    4926.6 AIC/N =    1.825
Model estimated: Jan 29, 2019, 12:15:29
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.29293***	.06741	-19.18	.0000	-1.42506	-1.16080
S1	-.17447***	.05019	-3.48	.0005	-.27284	-.07610
S2	.10478**	.04656	2.25	.0244	.01353	.19604
O1	.36438***	.04862	7.49	.0000	.26909	.45967
O2	-.01374	.05676	-.24	.8087	-.12499	.09750
F1	-.28661***	.05801	-4.94	.0000	-.40031	-.17291
F2	-.03394	.05038	-.67	.5005	-.13268	.06480
T1	-.45383***	.05775	-7.86	.0000	-.56703	-.34064
T2	.17207***	.04742	3.63	.0003	.07914	.26501
D1	.21194***	.04866	4.36	.0000	.11656	.30732
D2	.02298	.04933	.47	.6413	-.07371	.11967
L1	.22838***	.05094	4.48	.0000	.12854	.32823
L2	-.03162	.04703	-.67	.5014	-.12380	.06056
XX0	.13396	.10235	1.31	.1906	-.06664	.33456
SS1	-.05184	.07812	-.66	.5070	-.20494	.10127
SS2	-.00306	.07235	-.04	.9663	-.14487	.13875
OO1	.06675	.07567	.88	.3777	-.08156	.21505
OO2	.07064	.08650	.82	.4141	-.09889	.24017
FF1	-.03165	.09027	-.35	.7259	-.20858	.14527
FF2	-.02969	.07825	-.38	.7044	-.18306	.12368
TT1	.13872	.08891	1.56	.1187	-.03554	.31298
TT2	.05091	.07408	.69	.4920	-.09429	.19611
DD1	-.05219	.07599	-.69	.4922	-.20114	.09675
DD2	-.01898	.07534	-.25	.8010	-.16664	.12867
LL1	.21874***	.07855	2.78	.0054	.06478	.37269
LL2	.02769	.07211	.38	.7009	-.11363	.16902
XXX0	-.18316**	.08317	-2.20	.0276	-.34616	-.02015
SSS1	-.00238	.06039	-.04	.9686	-.12074	.11598
SSS2	-.05177	.05581	-.93	.3537	-.16116	.05763
OOO1	-.03074	.05849	-.53	.5992	-.14538	.08390
OOO2	-.00730	.06818	-.11	.9147	-.14092	.12632
FFF1	.07471	.06971	1.07	.2838	-.06192	.21134
FFF2	-.01141	.06026	-.19	.8498	-.12952	.10670
TTT1	.01582	.06917	.23	.8190	-.11974	.15139
TTT2	-.00821	.05673	-.14	.8849	-.11939	.10297
DDD1	.01877	.05819	.32	.7471	-.09528	.13281
DDD2	-.00544	.05917	-.09	.9267	-.12141	.11053
LLL1	-.06184	.06138	-1.01	.3137	-.18213	.05846
LLL2	.09947*	.05628	1.77	.0771	-.01083	.20977

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Variable current outdoor space

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function     -2431.66059
Estimation based on N =    2700, K =  26
Inf.Cr.AIC  =   4915.3 AIC/N =    1.820
Model estimated: Jan 29, 2019, 12:16:37
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.19349***	.08146	-14.65	.0000	-1.35314	-1.03384
S1	-.22356***	.06547	-3.41	.0006	-.35188	-.09524
S2	.10357*	.06016	1.72	.0851	-.01434	.22149
O1	.27227***	.06324	4.31	.0000	.14833	.39621
O2	-.01138	.07207	-.16	.8745	-.15263	.12986
F1	-.26730***	.07295	-3.66	.0002	-.41028	-.12432
F2	.00635	.06309	.10	.9199	-.11731	.13000
T1	-.41701***	.07190	-5.80	.0000	-.55793	-.27609
T2	.16443***	.06196	2.65	.0080	.04299	.28587
D1	.24803***	.06150	4.03	.0001	.12748	.36857
D2	.03905	.06386	.61	.5408	-.08611	.16421
L1	.23527***	.06663	3.53	.0004	.10469	.36586
L2	.07275	.06053	1.20	.2294	-.04589	.19138
XX0	-.23544***	.08146	-2.89	.0038	-.39509	-.07579
SS1	.06862	.06547	1.05	.2946	-.05970	.19694
SS2	-.01946	.06016	-.32	.7464	-.13737	.09845
OO1	.10527*	.06324	1.66	.0960	-.01867	.22921
OO2	-.01506	.07207	-.21	.8345	-.15631	.12619
FF1	.01229	.07295	.17	.8662	-.13069	.15527
FF2	-.06258	.06309	-.99	.3213	-.18623	.06108
TT1	-.04663	.07190	-.65	.5166	-.18755	.09429
TT2	.00348	.06196	.06	.9552	-.11796	.12492
DD1	-.03883	.06150	-.63	.5278	-.15937	.08172
DD2	-.02661	.06386	-.42	.6769	-.15177	.09855
LL1	-.04897	.06663	-.74	.4623	-.17956	.08161
LL2	-.08842	.06053	-1.46	.1441	-.20705	.03022

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

```
Discrete choice (multinomial logit) model
Dependent variable                 Choice
Log likelihood function     -2417.05840
Estimation based on N =    2700, K =  39
Inf.Cr.AIC  =    4912.1 AIC/N =     1.819
Model estimated: Jan 29, 2019, 12:17:42
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.33918***	.06226	-21.51	.0000	-1.46122	-1.21715
S1	-.18772***	.04522	-4.15	.0000	-.27635	-.09910
S2	.10255**	.04178	2.45	.0141	.02067	.18443
O1	.36497***	.04365	8.36	.0000	.27942	.45052
O2	-.02831	.05069	-.56	.5765	-.12767	.07104
F1	-.25192***	.05167	-4.88	.0000	-.35319	-.15064
F2	-.05049	.04510	-1.12	.2629	-.13888	.03791
T1	-.46162***	.05122	-9.01	.0000	-.56201	-.36124
T2	.17378***	.04243	4.10	.0000	.09062	.25694
D1	.22359***	.04312	5.19	.0000	.13908	.30810
D2	.01338	.04436	.30	.7629	-.07357	.10033
L1	.20239***	.04602	4.40	.0000	.11219	.29259
L2	-.00358	.04207	-.08	.9323	-.08603	.07888
XX0	-.19066**	.08930	-2.13	.0328	-.36569	-.01563
SS1	-.03685	.06312	-.58	.5593	-.16056	.08686
SS2	-.09947*	.05772	-1.72	.0848	-.21259	.01365
OO1	-.06344	.06117	-1.04	.2997	-.18334	.05646
OO2	.03093	.07076	.44	.6620	-.10775	.16961
FF1	-.09165	.07251	-1.26	.2062	-.23376	.05046
FF2	.12601**	.06231	2.02	.0431	.00389	.24814
TT1	.00526	.07133	.07	.9413	-.13456	.14507
TT2	.10286*	.05949	1.73	.0838	-.01374	.21947
DD1	.08733	.05979	1.46	.1441	-.02986	.20453
DD2	.06803	.06162	1.10	.2696	-.05274	.18880
LL1	.03087	.06404	.48	.6298	-.09464	.15638
LL2	.08727	.05829	1.50	.1344	-.02698	.20152
XXX0	-.15119*	.08704	-1.74	.0824	-.32178	.01941
SSS1	.13606**	.06108	2.23	.0259	.01635	.25577
SSS2	-.01865	.05686	-.33	.7429	-.13009	.09279
OOO1	-.01348	.05922	-.23	.8200	-.12955	.10260
OOO2	.04899	.06915	.71	.4787	-.08655	.18452
FFF1	.07450	.07036	1.06	.2896	-.06340	.21240
FFF2	-.05736	.06147	-.93	.3508	-.17783	.06312
TTT1	.06887	.06994	.98	.3248	-.06821	.20595
TTT2	-.09550*	.05691	-1.68	.0933	-.20704	.01604
DDD1	-.07513	.05875	-1.28	.2010	-.19027	.04002
DDD2	-.01842	.05968	-.31	.7576	-.13540	.09855
LLL1	-.02633	.06221	-.42	.6721	-.14826	.09560
LLL2	-.00811	.05679	-.14	.8865	-.11942	.10320

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Variable expected house ownership i.e. rent or buy (next house)

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function     -2418.79118
Estimation based on N =   2700, K =  26
Inf.Cr.AIC  =   4889.6 AIC/N =    1.811
Model estimated: Jan 29, 2019, 12:21:55
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.38066***	.06323	-21.83	.0000	-1.50459	-1.25672
S1	-.17517***	.04455	-3.93	.0001	-.26250	-.08785
S2	.09321**	.04100	2.27	.0230	.01285	.17356
O1	.35098***	.04315	8.13	.0000	.26640	.43557
O2	-.02034	.05027	-.40	.6858	-.11887	.07820
F1	-.25100***	.05131	-4.89	.0000	-.35157	-.15043
F2	-.04535	.04428	-1.02	.3058	-.13214	.04144
T1	-.45086***	.05072	-8.89	.0000	-.55026	-.35146
T2	.17210***	.04173	4.12	.0000	.09031	.25388
D1	.22006***	.04254	5.17	.0000	.13668	.30344
D2	.01772	.04352	.41	.6838	-.06758	.10302
L1	.20104***	.04537	4.43	.0000	.11211	.28997
L2	.01185	.04127	.29	.7740	-.06904	.09274
XX0	.22369***	.06323	3.54	.0004	.09975	.34762
SS1	-.02415	.04455	-.54	.5878	-.11147	.06317
SS2	-.04759	.04100	-1.16	.2457	-.12794	.03277
OO1	.09061**	.04315	2.10	.0358	.00603	.17519
OO2	.04317	.05027	.86	.3905	-.05537	.14170
FF1	-.01805	.05131	-.35	.7250	-.11863	.08252
FF2	.01986	.04428	.45	.6538	-.06693	.10666
TT1	-.05384	.05072	-1.06	.2885	-.15324	.04557
TT2	-.09395**	.04173	-2.25	.0244	-.17573	-.01216
DD1	-.01410	.04254	-.33	.7403	-.09748	.06928
DD2	.03061	.04352	.70	.4819	-.05470	.11591
LL1	-.08092*	.04537	-1.78	.0745	-.16985	.00800
LL2	-.05642	.04127	-1.37	.1716	-.13731	.02448

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Variable future household composition (next house)

```
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function     -2405.89499
Estimation based on N =   2691, K =  39
Inf.Cr.AIC  =   4889.8 AIC/N =    1.817
Model estimated: Jan 29, 2019, 12:23:04
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    9 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.37912***	.06468	-21.32	.0000	-1.50589	-1.25235
S1	-.14041***	.04569	-3.07	.0021	-.22996	-.05087
S2	.09405**	.04227	2.23	.0261	.01120	.17689
O1	.34032***	.04437	7.67	.0000	.25337	.42728
O2	-.02316	.05198	-.45	.6560	-.12503	.07872
F1	-.27626***	.05293	-5.22	.0000	-.38000	-.17253
F2	-.03173	.04550	-.70	.4856	-.12092	.05745
T1	-.46721***	.05227	-8.94	.0000	-.56966	-.36476
T2	.17708***	.04259	4.16	.0000	.09361	.26056
D1	.22135***	.04378	5.06	.0000	.13554	.30717
D2	.02205	.04509	.49	.6248	-.06633	.11044
L1	.20002***	.04667	4.29	.0000	.10856	.29148
L2	.00079	.04297	.02	.9853	-.08343	.08502
XX0	.02100	.09271	.23	.8208	-.16070	.20271
SS1	-.02472	.06600	-.37	.7080	-.15407	.10463
SS2	-.02791	.06076	-.46	.6460	-.14699	.09117
OO1	-.10140	.06372	-1.59	.1116	-.22629	.02350
OO2	-.09365	.07439	-1.26	.2081	-.23946	.05216
FF1	.01605	.07597	.21	.8327	-.13285	.16495
FF2	.02409	.06527	.37	.7121	-.10384	.15202
TT1	.00811	.07535	.11	.9143	-.13958	.15579
TT2	.07810	.06111	1.28	.2013	-.04168	.19787
DD1	-.05560	.06302	-.88	.3776	-.17911	.06791
DD2	-.00648	.06404	-.10	.9194	-.13200	.11904
LL1	-.02060	.06688	-.31	.7580	-.15168	.11048
LL2	.10229*	.06094	1.68	.0932	-.01714	.22172
XXX0	.13382	.08312	1.61	.1074	-.02910	.29674
SSS1	-.18256***	.06031	-3.03	.0025	-.30076	-.06436
SSS2	-.04231	.05554	-.76	.4461	-.15116	.06654
OOO1	.09543	.05816	1.64	.1009	-.01857	.20942
OOO2	.04174	.06759	.62	.5369	-.09074	.17422
FFF1	.10859	.06901	1.57	.1156	-.02666	.24384
FFF2	-.06699	.05981	-1.12	.2627	-.18422	.05024
TTT1	.05619	.06837	.82	.4112	-.07782	.19019
TTT2	-.06764	.05620	-1.20	.2288	-.17779	.04251
DDD1	-.03219	.05762	-.56	.5764	-.14511	.08074
DDD2	.02734	.05905	.46	.6433	-.08839	.14308
LLL1	-.03058	.06124	-.50	.6176	-.15060	.08945
LLL2	.04989	.05599	.89	.3728	-.05984	.15963

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Variable expected moment of moving (to next house)

```
Discrete choice (multinomial logit) model
Dependent variable                 Choice
Log likelihood function       -2406.63785
Estimation based on N =    2700, K =   39
Inf.Cr.AIC  =    4891.3 AIC/N =     1.812
Model estimated: Jan 29, 2019, 12:24:00
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.34129***	.06211	-21.60	.0000	-1.46303	-1.21956
S1	-.18724***	.04521	-4.14	.0000	-.27586	-.09862
S2	.09149**	.04173	2.19	.0284	.00970	.17328
O1	.34131***	.04373	7.80	.0000	.25560	.42702
O2	-.01398	.05073	-.28	.7829	-.11341	.08546
F1	-.24281***	.05167	-4.70	.0000	-.34408	-.14155
F2	-.04809	.04489	-1.07	.2840	-.13608	.03990
T1	-.44694***	.05122	-8.73	.0000	-.54732	-.34656
T2	.16873***	.04250	3.97	.0001	.08542	.25203
D1	.22231***	.04312	5.16	.0000	.13781	.30682
D2	.02717	.04416	.62	.5384	-.05939	.11373
L1	.20654***	.04597	4.49	.0000	.11644	.29664
L2	.00756	.04191	.18	.8569	-.07458	.08970
XX0	.23691***	.08811	2.69	.0072	.06422	.40960
SS1	-.10452	.06636	-1.58	.1153	-.23458	.02554
SS2	-.03439	.06131	-.56	.5749	-.15455	.08578
OO1	-.18441***	.06423	-2.87	.0041	-.31030	-.05853
OO2	.06726	.07421	.91	.3648	-.07819	.21270
FF1	.12397	.07561	1.64	.1011	-.02421	.27216
FF2	-.05590	.06602	-.85	.3972	-.18530	.07350
TT1	.07321	.07509	.97	.3296	-.07397	.22038
TT2	.08365	.06305	1.33	.1846	-.03993	.20723
DD1	.00111	.06305	.02	.9860	-.12247	.12469
DD2	.01156	.06480	.18	.8584	-.11544	.13857
LL1	.17953***	.06727	2.67	.0076	.04769	.31137
LL2	-.01191	.06145	-.19	.8463	-.13235	.10853
XXX0	-.23569***	.08735	-2.70	.0070	-.40691	-.06448
SSS1	.17662***	.06187	2.85	.0043	.05535	.29789
SSS2	-.10898*	.05684	-1.92	.0552	-.22038	.00241
OOO1	.10278*	.05966	1.72	.0849	-.01415	.21971
OOO2	-.06132	.06878	-.89	.3726	-.19613	.07349
FFF1	-.14668**	.07067	-2.08	.0379	-.28520	-.00816
FFF2	.00157	.06097	.03	.9795	-.11793	.12107
TTT1	-.09441	.06985	-1.35	.1765	-.23132	.04250
TTT2	.07625	.05764	1.32	.1859	-.03672	.18922
DDD1	.13033**	.05903	2.21	.0273	.01463	.24603
DDD2	-.06862	.05968	-1.15	.2502	-.18560	.04835
LLL1	-.09450	.06273	-1.51	.1320	-.21745	.02846
LLL2	.09845*	.05720	1.72	.0852	-.01366	.21056

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

```
Discrete choice (multinomial logit) model
Dependent variable                 Choice
Log likelihood function     -2438.81950
Estimation based on N =   2700, K =  26
Inf.Cr.AIC  =   4929.6 AIC/N =    1.826
Model estimated: Jan 29, 2019, 12:25:03
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.35553***	.06185	-21.92	.0000	-1.47675	-1.23431
S1	-.17010***	.04431	-3.84	.0001	-.25695	-.08325
S2	.08712**	.04088	2.13	.0331	.00700	.16724
O1	.34965***	.04290	8.15	.0000	.26556	.43374
O2	-.02296	.05002	-.46	.6463	-.12098	.07507
F1	-.25674***	.05099	-5.04	.0000	-.35667	-.15680
F2	-.03960	.04405	-.90	.3686	-.12594	.04673
T1	-.44884***	.05049	-8.89	.0000	-.54781	-.34987
T2	.16513***	.04145	3.98	.0001	.08388	.24638
D1	.21413***	.04242	5.05	.0000	.13099	.29727
D2	.01952	.04339	.45	.6528	-.06552	.10455
L1	.19522***	.04509	4.33	.0000	.10684	.28360
L2	.00437	.04116	.11	.9155	-.07630	.08503
XX0	.06599	.06185	1.07	.2860	-.05523	.18721
SS1	.05501	.04431	1.24	.2144	-.03184	.14186
SS2	-.00143	.04088	-.04	.9720	-.08155	.07868
OO1	.01062	.04290	.25	.8045	-.07347	.09471
OO2	-.06390	.05002	-1.28	.2014	-.16193	.03413
FF1	.02152	.05099	.42	.6730	-.07842	.12145
FF2	.00103	.04405	.02	.9814	-.08531	.08736
TT1	.01537	.05049	.30	.7609	-.08360	.11433
TT2	-.04009	.04145	-.97	.3335	-.12134	.04116
DD1	-.03052	.04242	-.72	.4718	-.11366	.05261
DD2	-.00462	.04339	-.11	.9153	-.08965	.08042
LL1	-.00781	.04509	-.17	.8626	-.09619	.08057
LL2	-.05769	.04116	-1.40	.1610	-.13836	.02298

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

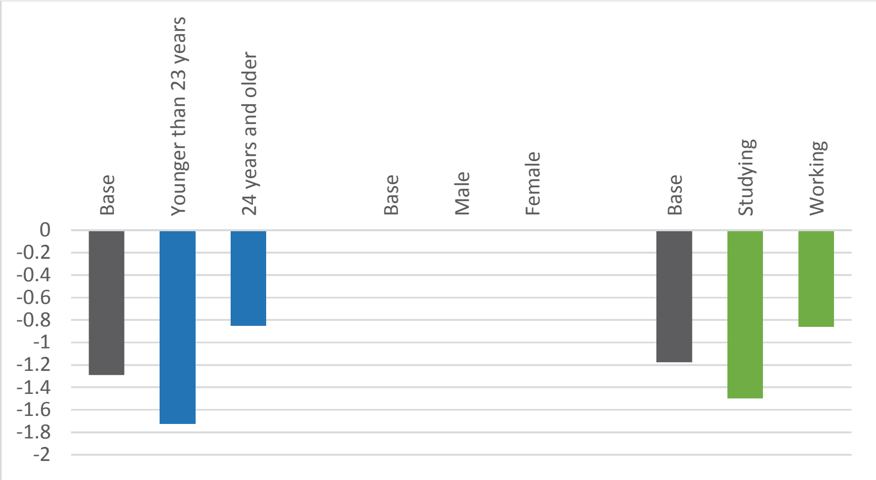
```
Discrete choice (multinomial logit) model
Dependent variable                 Choice
Log likelihood function       -2418.32284
Estimation based on N =    2700, K =   26
Inf.Cr.AIC  =    4888.6 AIC/N =     1.811
Model estimated: Jan 29, 2019, 12:25:49
R2=1-LogL/LogL* Log-L fncn R-sqrd R2Adj
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
Response data are given as ind. choices
Number of obs.=  2700, skipped    0 obs
```

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
X0	-1.27859***	.06393	-20.00	.0000	-1.40390	-1.15329
S1	-.24272***	.04884	-4.97	.0000	-.33845	-.14699
S2	.07342*	.04459	1.65	.0996	-.01397	.16081
O1	.39480***	.04655	8.48	.0000	.30356	.48605
O2	-.00842	.05370	-.16	.8754	-.11366	.09682
F1	-.25328***	.05550	-4.56	.0000	-.36205	-.14452
F2	-.01913	.04846	-.39	.6930	-.11410	.07584
T1	-.43260***	.05490	-7.88	.0000	-.54019	-.32501
T2	.13990***	.04560	3.07	.0022	.05051	.22928
D1	.21081***	.04658	4.53	.0000	.11951	.30211
D2	.00960	.04738	.20	.8394	-.08326	.10246
L1	.19435***	.04882	3.98	.0001	.09867	.29004
L2	-.00572	.04475	-.13	.8984	-.09341	.08198
XX0	.25359***	.06393	3.97	.0001	.12828	.37890
SS1	-.16123***	.04884	-3.30	.0010	-.25696	-.06550
SS2	-.04786	.04459	-1.07	.2831	-.13525	.03953
OO1	.11522**	.04655	2.47	.0133	.02397	.20646
OO2	.01219	.05370	.23	.8204	-.09305	.11743
FF1	.04002	.05550	.72	.4708	-.06875	.14879
FF2	.04866	.04846	1.00	.3152	-.04631	.14363
TT1	.06460	.05490	1.18	.2393	-.04299	.17219
TT2	-.06865	.04560	-1.51	.1323	-.15803	.02074
DD1	-.00953	.04658	-.20	.8379	-.10083	.08177
DD2	-.03536	.04738	-.75	.4555	-.12821	.05750
LL1	-.01174	.04882	-.24	.8100	-.10742	.08394
LL2	-.03459	.04475	-.77	.4395	-.12229	.05311

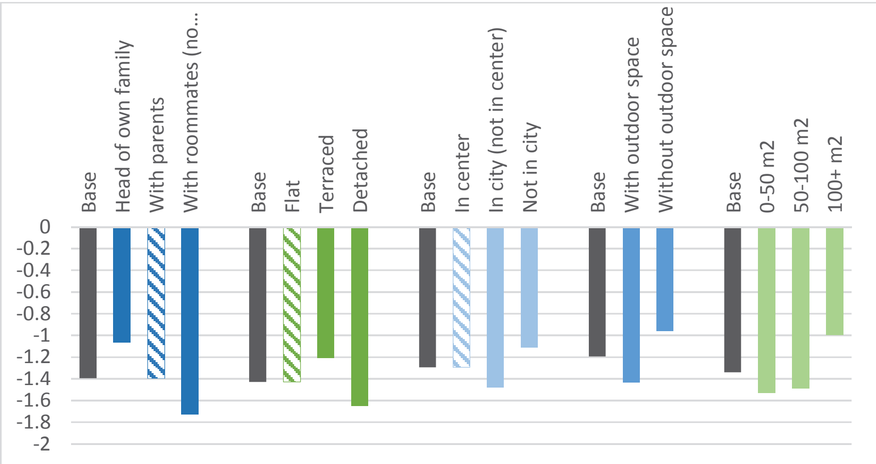
Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Appendix 16: X_0 value per respondent-related characteristic level

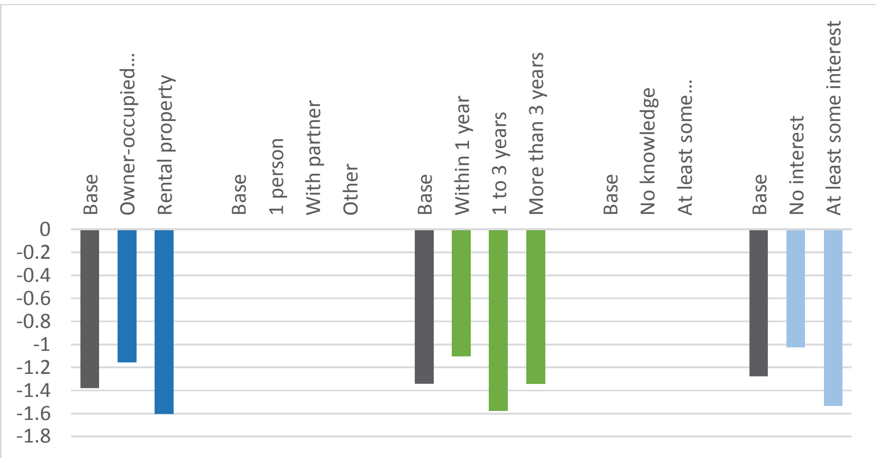
Personal Characteristics



Current house characteristics



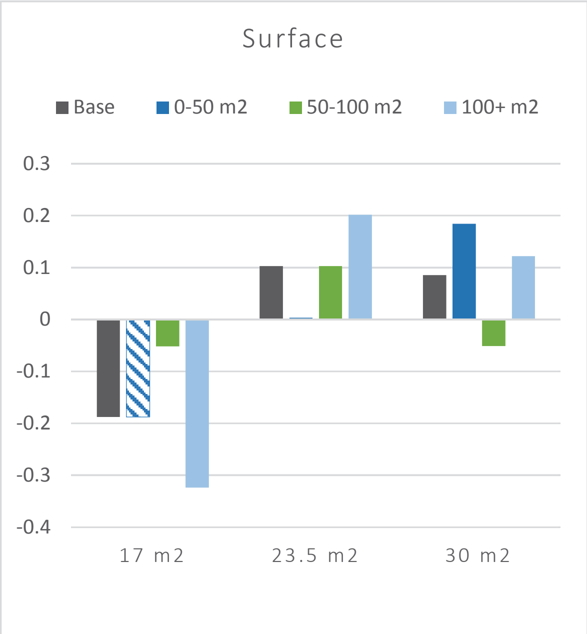
Future house characteristics

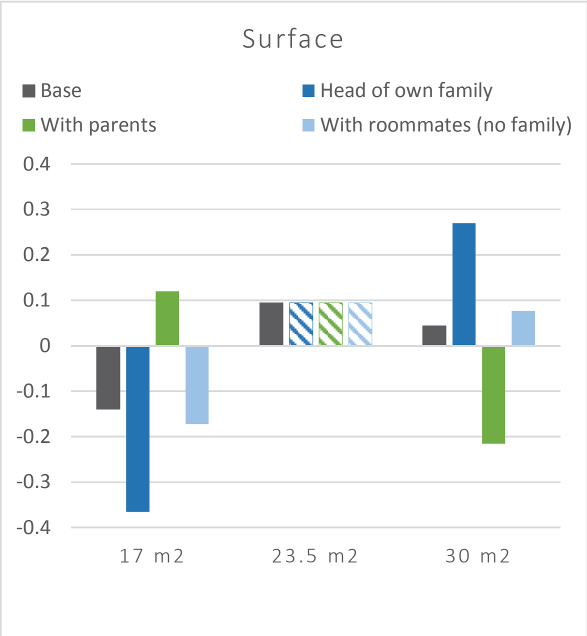


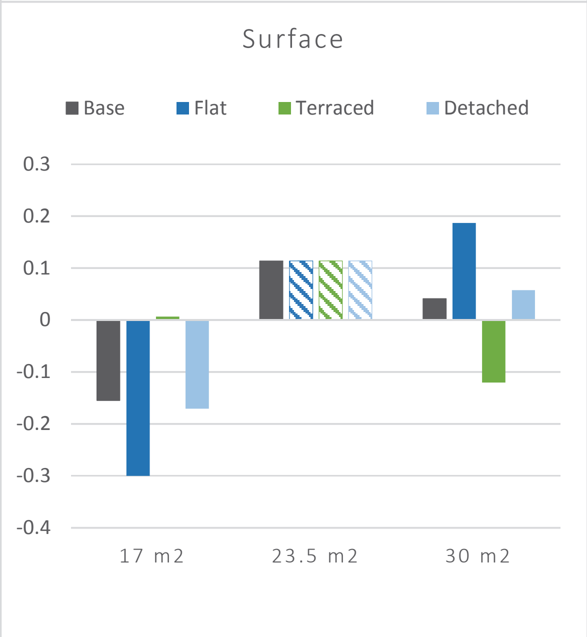
Appendix 17: Utility values for different housing characteristics

Surface

Current housing characteristics that influence the attribute ‘surface’ are current house surface, current household composition and current type of house.

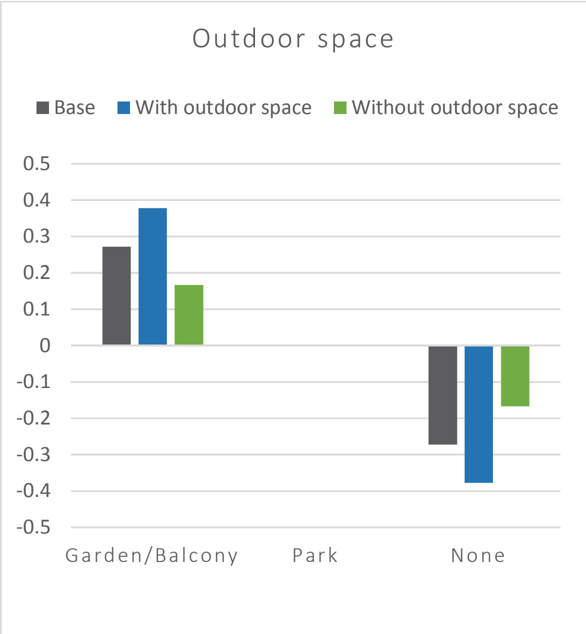


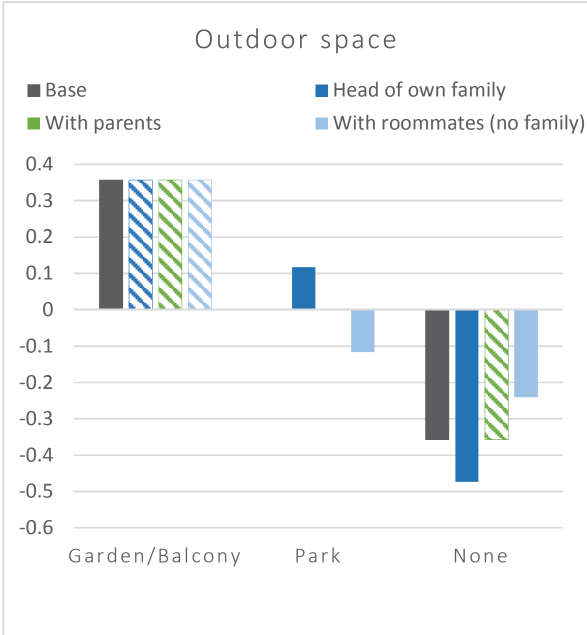




Outdoor space

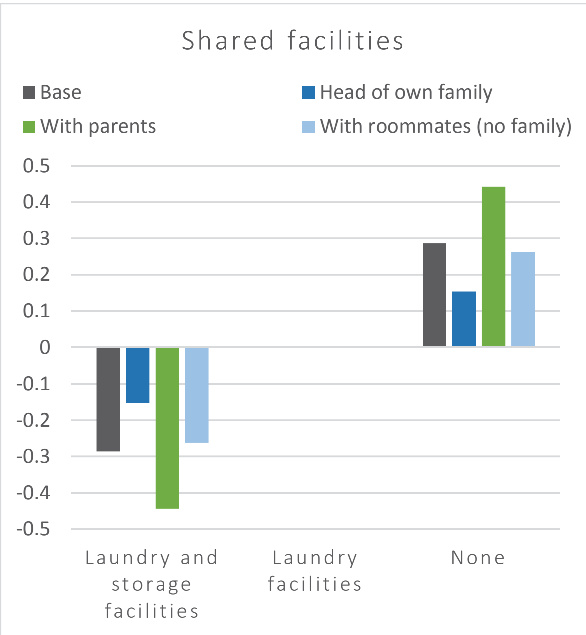
Current housing characteristics that influence the attribute 'outdoor space' are current outdoor space and current household composition.

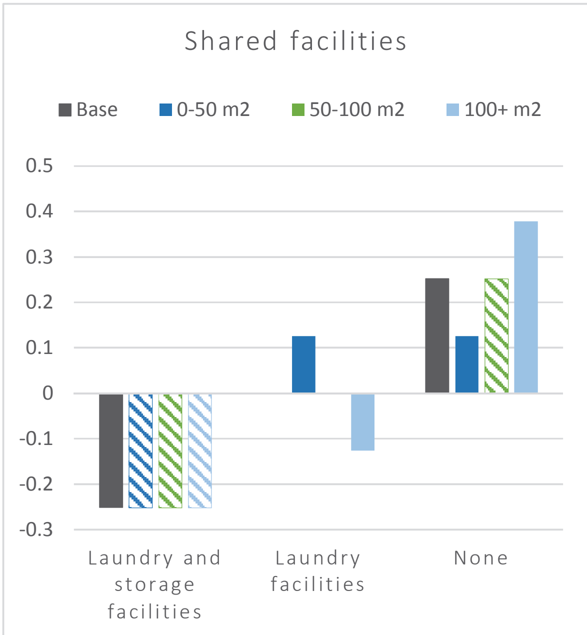




Shared facilities

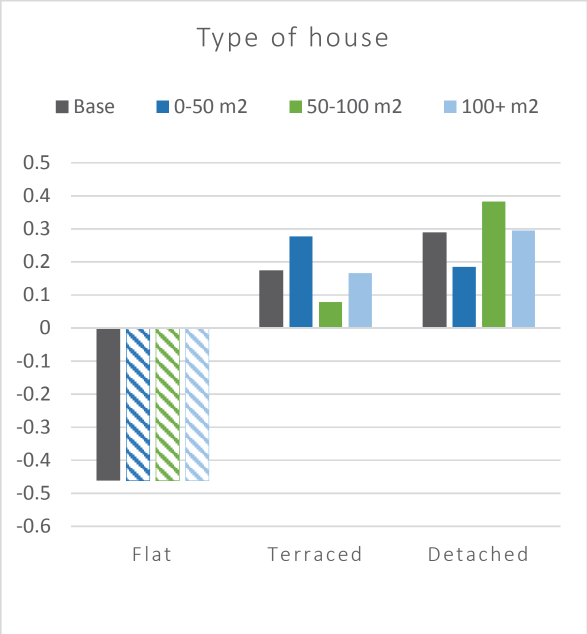
Current housing characteristics that influence the attribute 'shared facilities' are current household composition and current house surface.





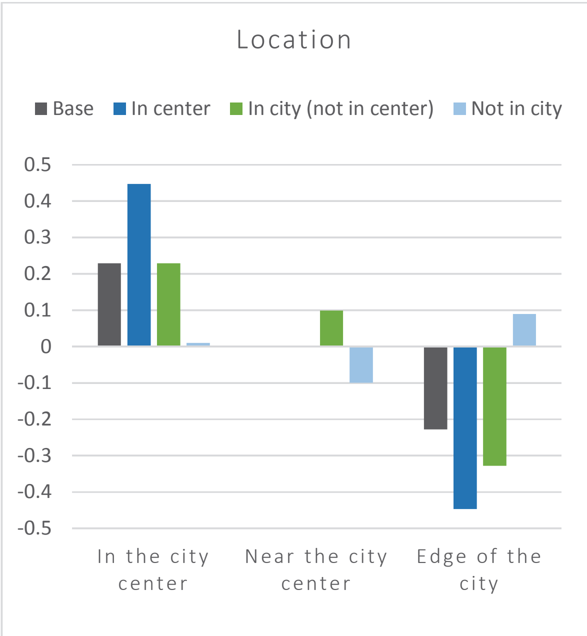
Type of house

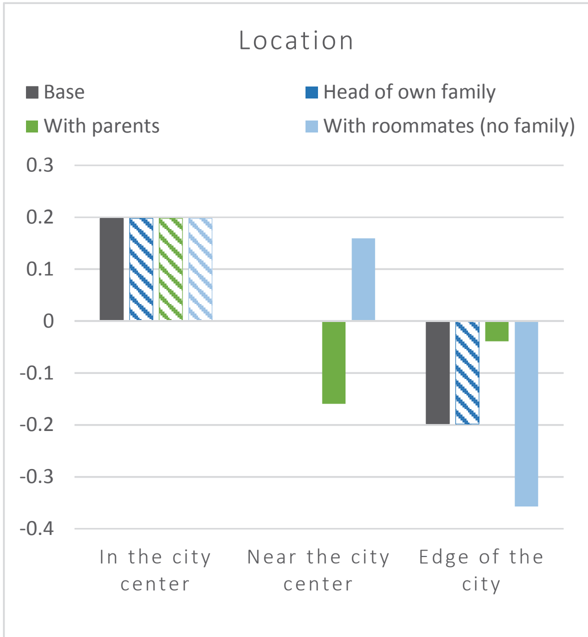
The current housing characteristic that influence the attribute ‘type of house’ is current house surface.

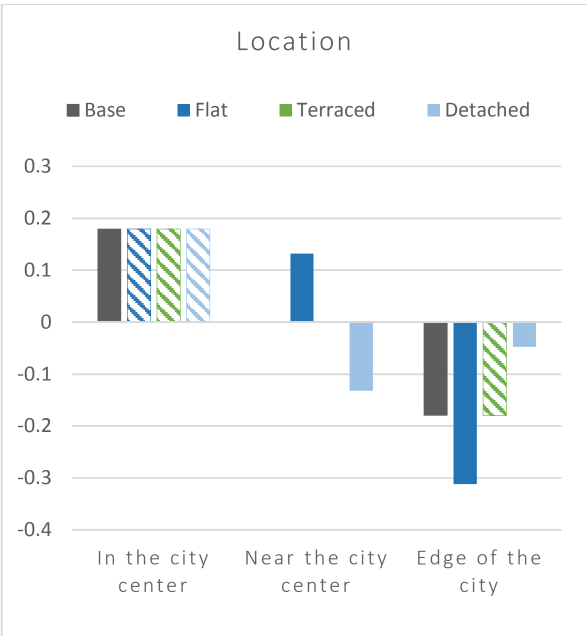


Location

Current housing characteristics that influence the attribute 'location' are current house location, current household composition and current type of house.







Appendix 18: Estimation latent class models

Model with two classes (clusters)

```
Latent Class Logit Model
Dependent variable                 CHRES
Log likelihood function      -2203.50365
Restricted log likelihood    -2966.25318
Chi squared [  27 d.f.]       1525.49906
Significance level                .00000
McFadden Pseudo R-squared       .2571424
Estimation based on N =   2700, K =  27
Inf.Cr.AIC  =    4461.0 AIC/N =    1.652
Model estimated: Jan 30, 2019, 09:47:33
Constants only must be computed directly
               Use NLOGIT ;...;RHS=ONE$
At start values -2444.3462  .0985******
Response data are given as ind. choices
Number of latent classes =             2
Average Class Probabilities
     .834  .166
LCM model with panel has      300 groups
Fixed number of obsrvs./group=         9
Number of obs.=  2700, skipped     0 obs
--------+--------------------------------------------------------------------
        |                  Standard            Prob.       95% Confidence
   CHRES|  Coefficient       Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
        |Utility parameters in latent class -->> 1
    X0|1|   -2.76129***      .14882    -18.56  .0000    -3.05296  -2.46962
    S1|1|    -.12703**       .05213     -2.44  .0148     -.22921   -.02486
    S2|1|     .08862*        .04639      1.91  .0561     -.00230    .17954
    O1|1|     .36801***      .05123      7.18  .0000      .26759    .46843
    O2|1|    -.02916         .06031      -.48  .6288     -.14736    .08905
    F1|1|    -.29997***      .06425     -4.67  .0000     -.42590   -.17405
    F2|1|    -.00628         .05149      -.12  .9030     -.10720    .09464
    T1|1|    -.48023***      .06218     -7.72  .0000     -.60210   -.35835
    T2|1|     .14544***      .04703      3.09  .0020      .05326    .23762
    D1|1|     .25616***      .04834      5.30  .0000      .16141    .35090
    D2|1|     .05428         .05036      1.08  .2812     -.04443    .15298
    L1|1|     .21078***      .05248      4.02  .0001      .10792    .31365
    L2|1|     .05458         .04709      1.16  .2465     -.03772    .14688
        |Utility parameters in latent class -->> 2
    X0|2|     .97526***      .14438      6.75  .0000      .69227   1.25825
    S1|2|    -.56076***      .16289     -3.44  .0006     -.88003   -.24149
    S2|2|     .16299         .13102      1.24  .2135     -.09381    .41979
    O1|2|     .41781***      .12327      3.39  .0007      .17621    .65941
    O2|2|    -.07964         .12975      -.61  .5394     -.33395    .17468
    F1|2|    -.21465         .14297     -1.50  .1332     -.49486    .06555
    F2|2|    -.16757         .13629     -1.23  .2189     -.43470    .09956
    T1|2|    -.73432***      .16236     -4.52  .0000    -1.05255   -.41609
    T2|2|     .36563***      .12687      2.88  .0040      .11697    .61430
    D1|2|     .10711         .12746       .84  .4007     -.14271    .35694
    D2|2|    -.22722*        .13326     -1.70  .0882     -.48841    .03398
    L1|2|     .17098         .14128      1.21  .2262     -.10592    .44787
    L2|2|    -.24081*        .13433     -1.79  .0730     -.50411    .02248
        |Estimated latent class probabilities
 PrbCls1|     .83360***      .02409     34.61  .0000      .78639    .88081
 PrbCls2|     .16640***      .02409      6.91  .0000      .11919    .21361
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
```

Model with three classes (clusters)

```
Latent Class Logit Model
Dependent variable                 CHRES
Log likelihood function      -2155.09609
Restricted log likelihood    -2966.25318
Chi squared [  41 d.f.]       1622.31418
Significance level                .00000
McFadden Pseudo R-squared       .2734619
```

Estimation based on N =   2700, K = 41
Inf.Cr.AIC =   4392.2 AIC/N =   1.627
Model estimated: Jan 30, 2019, 09:49:58
Constants only must be computed directly
Use NLOGIT ;...;RHS=ONE$
At start values -2444.3895 .1183******
Response data are given as ind. choices
Number of latent classes =   3
Average Class Probabilities
.248 .580 .172
LCM model with panel has   300 groups
Fixed number of obsrvs./group=   9
Number of obs.= 2700, skipped   0 obs

CHRES	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
	Utility parameters in latent class -->> 1					
X0|1	-3.42198***	.77119	-4.44	.0000	-4.93349	-1.91048
S1|1	.99385***	.31702	3.13	.0017	.37250	1.61521
S2|1	.12143	.12945	.94	.3482	-.13229	.37515
O1|1	.31146*	.18419	1.69	.0909	-.04956	.67247
O2|1	.02727	.15347	.18	.8590	-.27354	.32807
F1|1	-.44440**	.17571	-2.53	.0114	-.78879	-.10002
F2|1	.15537	.13791	1.13	.2599	-.11493	.42568
T1|1	-.39072	.24288	-1.61	.1077	-.86676	.08532
T2|1	.20087	.13422	1.50	.1345	-.06220	.46394
D1|1	.53368**	.22812	2.34	.0193	.08658	.98078
D2|1	.15025	.13770	1.09	.2752	-.11965	.42014
L1|1	-.09576	.17577	-.54	.5859	-.44027	.24875
L2|1	.06174	.17947	.34	.7308	-.29002	.41350
	Utility parameters in latent class -->> 2					
X0|2	-2.67870***	.22550	-11.88	.0000	-3.12066	-2.23673
S1|2	-.60245***	.14851	-4.06	.0000	-.89352	-.31139
S2|2	.10027	.06245	1.61	.1084	-.02213	.22267
O1|2	.45763***	.09744	4.70	.0000	.26664	.64861
O2|2	-.08813	.08529	-1.03	.3014	-.25529	.07902
F1|2	-.26615***	.08898	-2.99	.0028	-.44055	-.09175
F2|2	-.06584	.06929	-.95	.3420	-.20165	.06997
T1|2	-.57067***	.08851	-6.45	.0000	-.74415	-.39719
T2|2	.11403	.07107	1.60	.1086	-.02526	.25331
D1|2	.20112***	.06976	2.88	.0039	.06440	.33784
D2|2	.02739	.06928	.40	.6926	-.10840	.16318
L1|2	.36115***	.08291	4.36	.0000	.19866	.52365
L2|2	.11309	.07040	1.61	.1082	-.02490	.25108
	Utility parameters in latent class -->> 3					
X0|3	.91259***	.15210	6.00	.0000	.61449	1.21069
S1|3	-.41397***	.15516	-2.67	.0076	-.71808	-.10986
S2|3	.13384	.12908	1.04	.2998	-.11915	.38683
O1|3	.35916***	.12324	2.91	.0036	.11761	.60070
O2|3	-.07245	.12693	-.57	.5681	-.32124	.17633
F1|3	-.29704**	.14464	-2.05	.0400	-.58054	-.01355
F2|3	-.17864	.13234	-1.35	.1771	-.43803	.08075
T1|3	-.74600***	.16151	-4.62	.0000	-1.06256	-.42944
T2|3	.35457***	.12401	2.86	.0042	.11152	.59762
D1|3	.07841	.12692	.62	.5367	-.17034	.32717
D2|3	-.21438*	.12939	-1.66	.0975	-.46798	.03922
L1|3	.17093	.14248	1.20	.2303	-.10833	.45019
L2|3	-.24932*	.13317	-1.87	.0612	-.51032	.01169
	Estimated latent class probabilities					
PrbCls1	.24799***	.06947	3.57	.0004	.11183	.38416
PrbCls2	.58035***	.07277	7.97	.0000	.43771	.72298
PrbCls3	.17166***	.02567	6.69	.0000	.12135	.22196

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Appendix 19: Total costs and utility values

Three latent classes (clusters)

	Costs	Energy costs	Utility values class 1	Utility values class 2	Utility values class 3
Profile 1	312.83	95.04	0.59	-1.20	-1.01
Profile 2	287.68	38.04	1.22	-0.86	-0.67
Profile 3	320.52	95.93	0.24	-1.12	-0.64
Profile 4	262.78	79.12	1.44	-0.34	-0.23
Profile 5	288.23	121.45	0.46	-0.59	0.44
Profile 6	385.05	73.63	1.08	-0.88	-1.46
Profile 7	303.59	54.85	2.28	0.53	0.88
Profile 8	346.67	82.24	1.31	-0.35	-1.02
Profile 9	298.90	104.64	0.33	-0.61	-0.03
Profile 10	366.64	84.44	0.13	-0.55	0.33
Profile 11	415.97	141.69	-0.85	0.27	0.25
Profile 12	439.23	75.45	-0.22	-1.09	-1.65
Profile 13	447.12	46.55	0.98	1.40	0.69
Profile 14	415.84	87.67	0.00	-0.57	-1.21
Profile 15	412.21	118.46	-0.98	-0.83	0.52
Profile 16	395.41	105.18	0.22	-0.05	-0.12
Profile 17	419.77	23.32	0.85	0.30	0.96
Profile 18	479.13	107.67	-0.13	1.12	0.24
Profile 19	486.49	38.25	-0.33	1.18	0.49
Profile 20	532.93	91.87	-1.31	-0.79	-0.66
Profile 21	545.19	132.28	-2.28	0.04	0.33
Profile 22	523.08	115.33	-1.08	-0.26	0.43
Profile 23	570.61	8.60	-0.46	1.16	0.77
Profile 24	522.53	115.15	-1.44	0.91	0.04
Profile 25	531.53	85.50	-0.24	1.69	1.21
Profile 26	477.48	161.93	-1.22	1.43	1.13
Profile 27	591.32	76.08	-0.59	0.06	-0.02

Appendix 20: Chi-squared tests - three clusters

			LC3clusters Cluster 1	Cluster 2	Cluster 3	Total
Age		Significance				**0.003**
	under 24	Count	59	111	26	196
		Expected Count	48.3	114.3	33.3	196.0
	24 or more	Count	15	64	25	104
		Expected Count	25.7	60.7	17.7	104.0
Total		Count	74	175	51	300
		Expected Count	74.0	175.0	51.0	300.0
CurHHComp		Significance				**0.007**
	head of household	Count	14	62	23	99
		Expected Count	24.4	57.8	16.8	99.0
	with parents	Count	26	37	14	77
		Expected Count	19.0	44.9	13.1	77.0
	with roommates	Count	34	76	14	124
		Expected Count	30.6	72.3	21.1	124.0
Total		Count	74	175	51	300
		Expected Count	74.0	175.0	51.0	300.0
Rental or Purchase		Significance				**0.040**
	owner-occupied property	Count	30	94	32	156
		Expected Count	38.5	91.0	26.5	156.0
	rental property	Count	44	81	19	144
		Expected Count	35.5	84.0	24.5	144.0
Total		Count	74	175	51	300
		Expected Count	74.0	175.0	51.0	300.0
FutHHComp		Significance				**0.024**
	1 person	Count	20	50	15	85
		Expected Count	21.0	49.5	14.5	85.0
	with partner	Count	23	82	26	131
		Expected Count	32.4	76.2	22.3	131.0
	other	Count	31	42	10	83
		Expected Count	20.5	48.3	14.2	83.0
Total		Count	74	174	51	299
		Expected Count	74.0	174.0	51.0	299.0
Interest		Significance				**0.019**
	no interest	Count	14	58	21	93
		Expected Count	22.9	54.3	15.8	93.0
	at least some interest	Count	60	117	30	207
		Expected Count	51.1	120.8	35.2	207.0
Total		Count	74	175	51	300
		Expected Count	74.0	175.0	51.0	300.0

Appendix 21: (Expected) counts per cluster – three clusters