Transportable CO$_2$-neutral houses for one-person households

How to house one-person households in CO$_2$-neutral dwellings on vacant land positions in the Netherlands?

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In partial fulfillment of the requirements for the degree of Master of Science in Construction Management and Engineering.

COLOPHON

Voor mijn geweldige ouders,
Jacques en Henny van Beurden.

"The idea that action should only be taken after all the answers and the resources have been found is a sure recipe for paralysis. The planning of a city is a process that allows for corrections; it is supremely arrogant to believe that planning can be done only after every possible variable has been controlled."

- Jaime Lerner Architect, urbanist, former mayor of Curitiba, Brazil
(in Lydon et al. 2011:2)

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PREFACE

Since the age of ten I dreamed of being an architect in order to design wonderful houses for people. I could not wait to see houses being built as a result of my own imagination. During the Bachelor of Architecture, I discovered that managerial aspects within construction projects were of greater interest to me, so I decided to take a turn. I will not be an architect. Instead I am graduating in the field of Construction Management and Engineering (CME). This Master course prepares me for a job in which I have the overview of complex construction projects, with all its dynamic processes.

Within my graduation thesis I have adopted my childhood dream. The question how to house people within current market conditions is a highly relevant topic within the research field of CME. Over the last six months I researched the problematic situation for one-person households on the Dutch housing market. Next to that a realistic solution is presented.

Collaboration with construction company Heijmans was sought to incorporate their professional expertise. Working in both an academic and professional context made the process of this research highly valuable for me. I learned about setting goals, working in different environments and the strength of collaboration versus the need to work individually on a defined research topic.

With this research report I strive to brighten the prospects of single home seekers on the Dutch housing market.

With kind regards,
R.J.M. (Rudy) van Beurden BSc

August 21st 2013

MANAGEMENT SUMMARY

This research report reviews the use of a discrete choice experiment to measure respondents' preferences regarding a proposed housing design to house one-person households on vacant land positions in the Netherlands. The report provides an overview of the research undertaken and presents a business plan for housing one-person households on vacant land positions in transportable CO_2-neutral compact houses.

The housing market in the Netherlands lost its dynamics. Prices of existing houses are decreasing, vacant land positions prove to be unmarketable and customers' in secureness is high which results in little movement of residents. Increased individualization affects the formation of households. This combined with improved awareness of energy consumption of dwellings, presses the desire for new housing solutions.

Construction company Heijmans is faced with the rough climate of the housing sector. Their vacant land positions, about fifty, devalued in price steeply. Possibilities on permanent development are small as companies, institutions and municipalities are resistant to invest in real estate. Still, the company seeks for ways to activate their location with possible developments. Temporal solutions might be beneficial. An answer for the following research question was sought:

> **What are the requirements to house one-person households in CO_2-neutral dwellings on vacant land positions in the Netherlands?**

The leitmotiv for this graduation project was to offer a feasible business proposition. To be more specific: to realize CO_2-neutral houses for one-person households. In collaboration with various experts a draft design of a transportable and compact one-person dwelling is made. Various attributes of the draft design were checked with the market to have better understanding on how to translate the draft design into a final design. For better understanding on respondents' preferences regarding the proposition, an online survey was spread throughout the Netherlands. The goal of the survey was to find which attributes of the proposition affected the design most, based on respondents' choice behaviour. Here for the method of discrete choice experiment has been used (Hensher 2005). The majority of respondents (n=280) perceived the proposed design positively. In general people rewarded an excellent energy label (A^{+++}), a maximum renting period of 5 years and a 2 room apartment as most important in choosing for a certain alternative. These aspects should be implemented in the eventual final design.

A business plan is written to elaborate on details for introducing the transportable CO_2-neutral house on to the Dutch housing market. The total cost for each individual house are set to be €60.000,-. The expected cost for the draft design are still €10.000,- over budget. This money needs to be cut on an improved design. When this becomes possible, chances are high that Heijmans is actually going to develop an x amount of these dwellings, because directors in charge, and even the CEO at Heijmans, are enthusiastic about the concept and the design of the dwelling. Two pilot houses are recommended to be placed on attractive spots like Rotterdam Katendrecht or Amsterdam Overhoeks.

chapter 1 | RESEARCH FRAMEWORK

The goal of this research is to bridge the gap between the positions of Dutch construction companies, the company of Heijmans in specific, owning vacant land positions, and a growing group of potential customers, being one-person households. This chapter covers the introduction on recent developments on the Dutch housing market and its coherent problems. Furthermore the position of Heijmans is elaborated on. Also trends on increased individualization and the build of CO_2-neutral buildings are briefly highlighted on.

1.1 The built environment

Two entities define the starting point of the research conducted within this thesis. Firstly, the Eindhoven University of Technology is the academic institution that initiates this research. Secondly, collaboration with construction company Heijmans is sought to simultaneously place the research topic within a professional context. The research topic is placed in one of the overlapping interests of both entities, namely the built environment.

The specialization of Construction Management Engineering (CME) at the Eindhoven University of Technology (TU/e) consists of Construction Management & Urban Development (CMUD). CMUD is a scientific Master's program, focused on the societal and scientific analysis of real world problems, in which two domains of science are combined: (urban) building sciences and management and innovation sciences. CMUD at Eindhoven University of Technology is aimed at decision-making processes and business concepts for development and management of complex processes within the context of urban area development: modelling technical and organizational systems.

Heijmans is a listed construction company on the Dutch stock market. In size it is the second largest construction company in the Netherlands, employing about 8000 employees. Its

headquarters is located in Rosmalen, near 's-Hertogenbosch. The company offers combined disciplines of engineering, construction management, property development, technical services and infrastructure. For this research, collaboration was sought with the section of land development. This section is placed within the division of Real Estate, and is responsible for developing (vacant) ground positions into feasible property.

Performing a research in the field of the built environment is additionally stimulated by political developments. Politicians within the Brainport region (figure 1.1) have the ambition to convert their region into a zero-energy region by 2040. This means that all energy used within the region comes from local renewable resources, also the energy used by houses and buildings in general. The main motives are:

- Planet earth is running out of fossil fuels;
- CO_2 emissions must be reduced in order to maintain a healthy climate;
- Fossil fuels often come from politically unstable regions, which result in potential political risks.

In order to succeed in this firm ambition, various disciplines have to contribute, as technical, organizational and financial issues have to be dealt with. For this reason Knowledge Cluster Energy Neutral Living and Working in Brainport (KENWIB *Kenniscluster Energie-Neutraal Wonen en Werken in Brainport*) was developed. KENWIB is a partnership between the Eindhoven University of Technology (TU/e), the municipality of Eindhoven and various companies within the Brainport region. Within this cluster knowledge about energy neutral housing is developed and shared. This is achieved by performing research on various relevant issues. CME master students of the TU/e collaborate with regional companies and government agencies to do so.

figure 1.1 | Brainport in the Netherlands (www.brainport.nl)

1.2 Housing market

Within the wide field of the built environment, specifically the housing market is chosen to further unravel within this research. Mainly this is because the situation on the Dutch housing market is far from desirable. There is little movement of residents as few houses are built or sold; uncertainty and fear about near future developments dominate consumers' feelings. Politicians are unclear about their intended line of policy. Residents are unwilling to sell their house for lower prices then they bought it themselves, even though they will not even be left with a dept. For many homeowners, this psychological aspect weights heavy. These causes and their effects on other developments have been captured in figure 1.2.

Financial markets are not showing improvement either. Banks are careful with lending money to both starters on the housing market as well as for the development of real estate projects, as their returned profit is not as certain as it used to be. The level of unemployment has risen to 6,6% and is expected to reach 7,1% by the end of 2014 (www.oecd.org). Less people generate a steady income of which they can afford their mortgage or monthly rent.

Few signals indicate improvement on the job market, which results in little motivating prospects for the housing market. Furthermore, consumer confidence dropped historically since July 2011, (Dutch Central Statistics Office, CBS). Increasing energy prices drive up the overall housing costs for residents. Along with that, the trend of increased individualization is noticeable in the Netherlands. This results in smaller households that generate less income to afford their accommodation. These causes are problematic for people in search for accommodation and companies that operate in this market (also adopted in figure 1.2).

1.3 Consequences for construction companies

Construction companies experience difficulties in getting real estate projects financed due to the uncertainty that also affected stakeholders in their construction projects. Because less buildings are built, sales in the construction sector in the third quartile of 2012 were 4% less compared to the third quartile of 2011. The number of bankruptcies increased by 25% and the number of jobs decreased with 17 thousand. The total number of jobs amounts 355 thousand by the end of 2012. Middle-sized enterprises, with 10 to 100 employees, were affected worst. They suffered a revenue loss of approximately 25%. In large companies (with at least 100 employees), sales decreased by 10 per cent. Small sized businesses in the construction industry, companies with less than 10 employees, did it least bad. They had a revenue loss of about 2%. For construction companies the prospects of better times are small. Especially the construction of new homes and shopping is in the doldrums (CBS).

1.4 Dwellings by Heijmans

The developments on the Dutch housing market affect the business of Heijmans. The division of Real Estate and Home Construction is faced with a downfall of projects over the last three years. The company sold 1081 houses in 2012, compared to 1248 in the same period of the year before. Still in 2010, Heijmans sold 1505 houses. Housing corporations and institutional investors are careful not to risk their investments in real estate as value of property is decreasing in general. Furthermore, about 15% of all Dutch offices are left vacant. As a result, current political policy stimulates developers to convert vacant offices buildings into apartments. The company is experiencing difficulties with developing permanent real estate on their vacant land positions on short term. Besides not building new real estate, the situation is more problematic for the company, as decreasing value of existing real estate also made Heijmans to devaluate its land positions with €35 million euros in 2012[1]. The land positions are bought with borrowed money from banks. As long as no solution is found for generating money involving the vacant land positions, the company continues to make losses. This is problematic for Heijmans. The financial balance of the company is already influenced heavily by the interest that needs to be paid to banks. Due to a major reorganization, 250 employees of Heijmans Home Construction lost their job in 2012.

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[1] Heijmans' annual figures of 2012
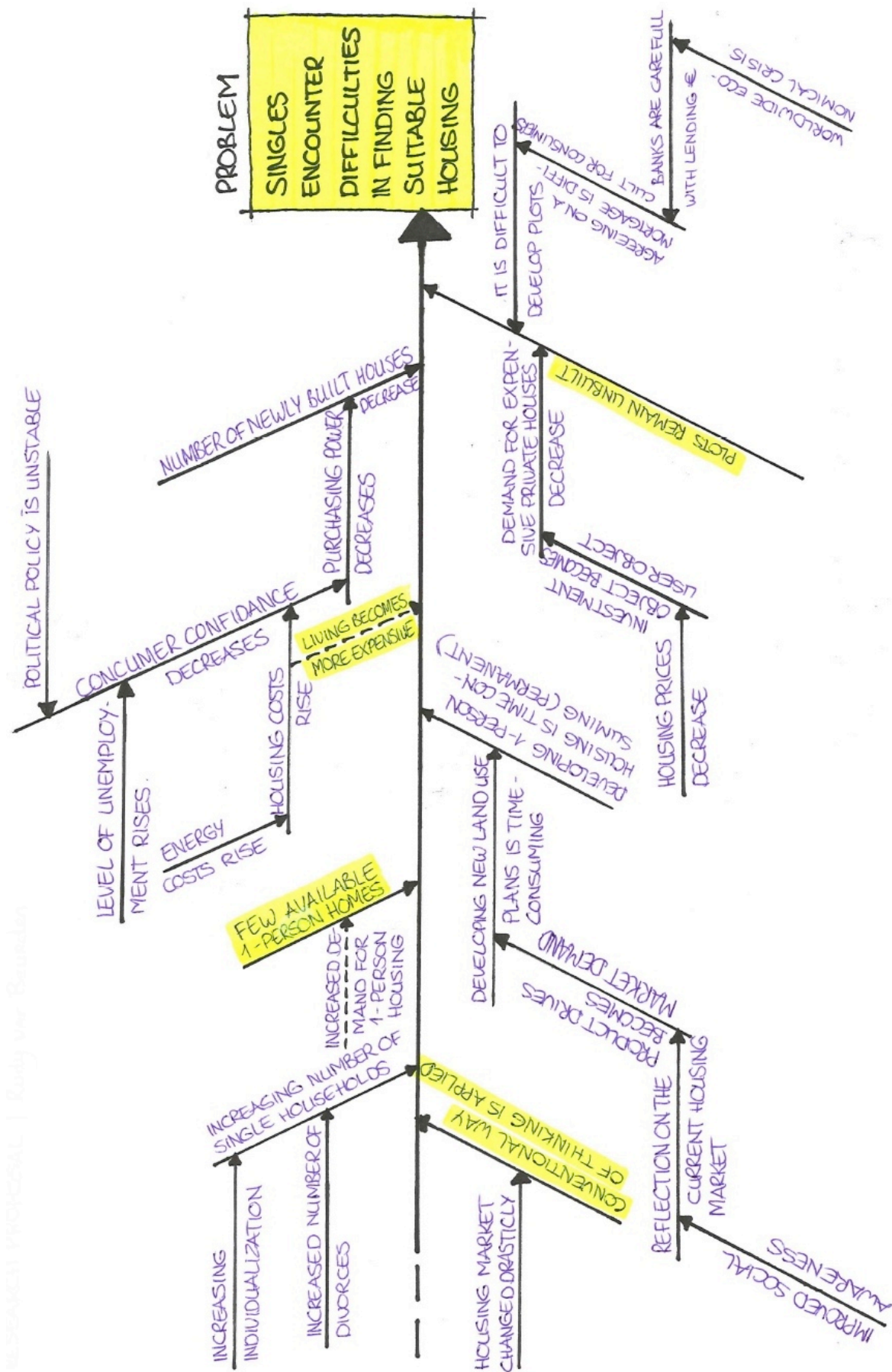
figure 1.2 | cause and effect diagram of why singles encounter difficulties in finding suitable accommodation

1.5 One-person households

Previous paragraphs indicated the need to analyse the current situation for one-person households on the housing market. Still, this remains to be a wide scope for an in-depth research. For example, the accent can be laid on converting vacant office buildings or renovation existing houses. However, three starting points are taken into consideration for defining the scope of this research more specifically (figure 1.3).

(1) Firstly, in preparing this research, literature has been read about increased individualization. Social trends (Poortman 2010) and the current economic situation (Lee 2013) affect our demography and the way people are accommodated. These trends influence choices made by people who are in search for accommodation. As found before, especially one-person households form a vulnerable group as they have difficulties in finding accommodation meeting their (financial) possibilities (WoON 2013). These findings have also been adopted in the cause and effect diagram (figure 1.2).

(2) Heijmans

CO_2-neutral housing for one-person households on vacant land

(3) Sustainable buildings

(1) Social trends
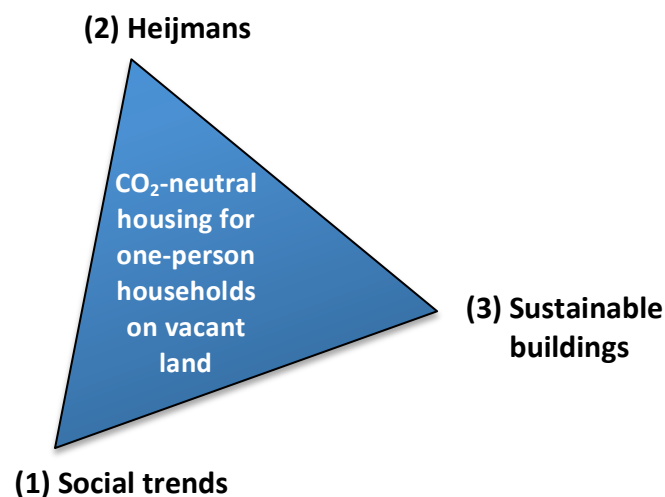
figure 1.3 | scope of the research

A one-person household is defined as an arrangement in which one person makes provision for his or her own food or other essentials for living without combining with any other person to form part of a multi-person household[2]. In general, there is a major rise of one-person households in the world, as well as in the Netherlands specifically. The Dutch Central Statistics Office (CBS) expects the number of one-person households to reach the number of 3,3 million in 2025. This growth equals 500.000 additional one-person households in the upcoming twelve years (CBS).

(2) Secondly, the position of Heijmans is given. The construction company is interested to know how they can use their vacant land positions in order to minimize their losses. With many of their positions they tried to develop permanent buildings. Due to current market conditions this is proven to be a real challenge. Most real estate projects are cancelled or postponed due to the lack of financial capital. Investors are resistant for investing in real estate, as the return of profit is highly uncertain. Therefor the company is interested in researching temporal solutions to be placed on their land positions. Temporal solutions could tone down the losses made on the land positions and at the same time provide in positive marketing for the company of Heijmans. The field of research has to take in consideration these vacant land positions and the ambition to realise temporal solutions on these locations.

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[2] http://unstats.un.org/unsd/demographic/sconcerns/fam/fammethods.htm

(3) Finally, increased awareness on the negative impact of CO_2–emissions on our climate is adopted within this research. CO_2–emissions result in polluted air, which negatively affect the livability of areas. All levels of policy makers, from international to local, developed policy to actively stimulate the decrease of CO_2–emissions and therefor the improvement of livability. The European Union agreed on the ambition to realize a reduction of 80 to 90% of CO_2–emissions in 2050, compared to the emissions in 1990 (Min. EZ L&I 2011). About 30% of all CO_2-emissions in the European Union (EU) are related to the usage of buildings and their installations. The buildings itself are responsible for approximately 40% of the energy consumption in the EU (Majcen 2012). The city of Eindhoven strives to be energy neutral by 2035-2045 (Eindhoven 2012). Furthermore the price for energy is rising. Between 1998 and 2009 prices rose with a factor of 2.5 (CBS). This makes it financially worthwhile to develop buildings that consume little to no external energy at all.

These three positions are used to define the scope, as well as the goal of the research: to bridge the gap between the position of Heijmans, owning vacant land positions, and a growing group of potential customers, being one-person households. A CO_2-neutral solution is to be found to house one-person households on the vacant land positions (figure 1.4).
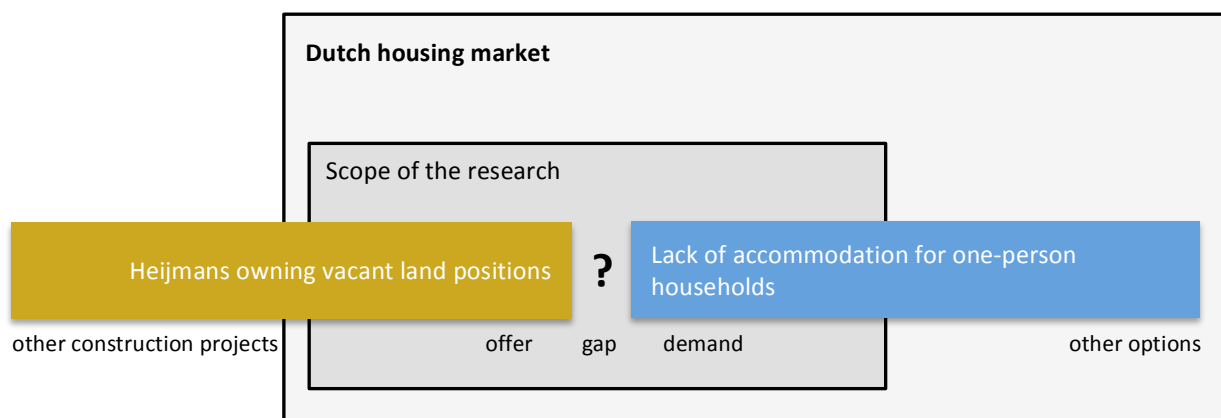
figure 1.4 | there is a gap between the potential offer of Heijmans and the demand of one-person households

1.6 Performed research

Various researches have been undertaken regarding the different components of the proposed research topics: the rise of singlehood, vacant land positions and the build of transportable and/or CO_2-neutral accommodation.

Research institute Euromonitor reveilles a rise of one-person households in both developed as well as in emerging and developing economies. The trend is affecting consumers' spending pattern and the way they are housed. In Western Europe and North America the proportion of one-person households stood at 31.0% and 27.6% respectively in 2011. The percentages are higher than in Asia and Africa, which lay around 10%. Mainly due to factors such as the delaying of marriage, the rise in divorces and single-parent families, and ageing populations the number of one-person households is rising (Euromonitor 2012). This development asks for suitable and affordable accommodation for one-person households. In the Netherlands, Anne-Rigt Poortman and Aart C. Liefbroer, performed a research on singles' relational attitudes in a time of individualization. The authors found that liberal values are strongly related to singles' relational attitudes. Even though mass media cultivated a positive

image of singlehood, less than 5% of the respondents in their research were more positive about singlehood than about having a stable partner relationship (Poortman 2010). Still the number of one-person households in the Netherlands is rising steadily. This will be further elaborated on in paragraph 2.2.

Jeremy Németh and Joern Langhorst published about the temporal use of urban vacant land positions in Northern America (Németh 2013). Even though the article mainly covers urban areas, some lessons indeed can be adopted. The authors define 'temporal use' as 'that which is explicitly and intentionally time-limited in nature'. They adopt the temporary use model in which they present several options for temporally use vacant grounds. When no structure exists, one can consider land vacant if the property is not currently used by humans. Vacant land can been seen as a problem, but as well as a opportunity for transformative social and ecological processes. The benefits from (fast) temporal development are its fast results, producing faster gratification for local stakeholder groups. Temporary uses can generally also generate revenue quickly, of which landowners and developers are benefitting. Furthermore temporal functions on vacant grounds can activate these unused sites, show initiative and progress, and alter the perception of vacant land as derelict, blighted and neglected. The positive activity and perception of vibrancy can create positive attention to abandoned ground positions, significantly increasing their visibility within a neighbourhood. (Németh 2013).

Regarding the aspect of CO_2-neutral buildings, a hot topic, numerous articles have been published worldwide. Most of these cover the behaviour of residents in already existing buildings (Majcen 2012, Banfi 2006, Poortinga 2004). This is not surprising as newly build houses only account to about 0,6% of the total stock of houses (in the Netherlands in 2012, CBS). Still, all new houses will have to be energy neutral, in order to eventually realize a housing stock that is energy neutral. The Dutch government is pressing to have all newly built houses being energy neutral by 2020. This research aims for one integrated approach in which all these components are taken together and researched upon simultaneously.

1.7 Research limitations

Two main requirements are taken in consideration in performing this research. The Eindhoven University of Technology requires scientifically underpinnings of the research and the construction company of Heijmans desires a feasible business proposition. The graduation period is limited to one semester. When these two goals can be researched, then this research can be considered a success.

The two main problems dealt with are the position of one-person households (singles) in searching suitable accommodation and the situation of Heijmans Real Estate. Heijmans stresses the concrete question of how to develop CO_2-neutral houses on their vacant land positions. The scope of this research is limited to the elements needed to present a feasible is business plan, as this is the actual output the company is requesting for. Also a scientific methodology will be used to underpin certain components of the business plan. The research will be limited to the Netherlands as Heijmans operates only nationally with their division of Real Estate.

1.8 Problem definition

As previous paragraphs show, (a) one-person households experience difficulties in finding suitable accommodation as there is a lack of accommodation that meets their financial possibilities. (b) The company of Heijmans owns vacant land position, which they need to exploit in order to make them profitable. There is a gap to bridge between (a) the market demand and (b) the specific offer of the company of Heijmans. The central problem within this research involves these two viewpoints:

> **It is unknown to the company of Heijmans what the requirements are for housing one-person households in CO_2-neutral dwellings on vacant land positions in the Netherlands.**

This problem is spread nationwide. Between 2009 and 2012 this problem became worse (WoON 2013). An increasing number of one-person households are in search for suitable accommodation. This problem makes that one-person households are hindered in choosing independent accommodation, which forces them to share accommodation with their parents or housemates, even if the rather live by themselves. For the company of Heijmans it becomes increasingly important to use their vacant land position as interests of loans negatively influence the company's revenue. They need to generate new income.

Both the company of Heijmans as well as one-person households in search of accommodation are problem owner of this problem. Because this latter group is involved, this problem affects societal matters. Politicians are responsible for appropriate policy regarding the housing market, as it is an essential
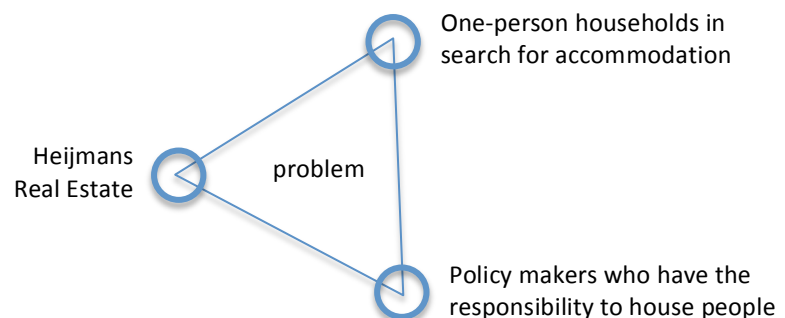
figure 1.5 | three problem owners can be indicated for the central problem of this research (by the author)

task of the government to provide people with decent accommodation. The outcomes of this research can therefor be of interest for policymakers as well. Figure 1.5 provides an overview of the three problem owners of the central problem.

1.9 Purpose of the research

The purpose of this research is to bridge the gap between the position of Heijmans, having vacant land positions in stock, and the needs of a growing group of potential customers, being one-person households. A business plan will be produced to be able to link the demand with a feasible business offer as the home seekers can be accommodated on the vacant land positions. This research provides an overview of residents' preferences regarding a proposed draft design of a one-person dwelling. A business proposal will be presented which is beneficial for both Heijmans as well as for one-person households in search for accommodation. The company and potential residents then help each other as they jointly create a new reality that is profitable for both parties.

1.10 Field of relevance

This research shows possibilities for developing compact transportable CO_2-neutral houses for one-person households in the Netherlands. This topic can be of great relevance for numerous stakeholders. Both the scientific world as well as professional parties like construction companies, housing corporations and investors, can adopt lessons learned from this research.

1.10.1 Scientific relevance

With chancing demographics, residents' preferences become increasingly important for the development of policy by governments and housing associations in order to create a housing stock, which meets the needs of residents. This development opens numerous doors for further research on targeted groups, which can differ in age or their places of residence.

1.10.2 Societal relevance

About 500.000 one-person households are expected to add to the total of Dutch households in the upcoming twelve years. These people need to be housed in accommodation that meets their requirements. Research on this development is of great relevance in order to provide proper housing solutions in the near future, so people can live in the way they desire. Also the development of vacant land positions is of interest for the society because development of these plots offers opportunities for economical growth and additional societal activities. The answers delivered by this research are therefor highly societal relevant.

1.10.3 Commercial relevance

Companies need to make money in order to survive. The current situation on the Dutch housing market proves to be challenging for construction companies. Few projects are in construction. This research covers the possibilities of a temporal solution that can be placed on vacant ground positions. This solution can tone down losses made on the interest, which is often applicable on the vacant land positions. In addition, whether companies focus on satisfying user needs or merely on making profit, it is of high relevance to know about preferences that people have and the choices they make. Formal mathematical models of preference and choice structures built upon empirical data help companies make predictions about the appeal of new products or changes to existing products. These models can help inform intuition and assist businesses in understanding and designing for the market. If transportable CO_2-neutral houses will prove to be both technically and financially feasible, they can pave the way for CO_2-neutral permanent buildings. This would certainly provide new opportunities for construction companies.

1.10.4 Personal relevance

Within the field of construction management engineering, the graduate has a passion for housing people instead of other fields of the sector (working, transportation or recreation). Also the intersection of the scientific world with the professional world is highly interesting as it is challenging to let these worlds reinforce each other. The university is interested in the methodology of finding respondents' preferences; the construction company is especially interested in clear-cut profitable solutions. Furthermore, the author currently shares an apartment in a residence of the Eindhoven housing corporation for students. When he is no longer a student, he will have to move. He then forms a one-person household, in search for accommodation, himself. Besides all other, the content of this research proves to be highly

relevant, as the housing market is facing numerous challenges, so the author might increase his job opportunities for the near future.

1.11 Research question

The central research question is derived from the main problem and will eventually be answered in the last chapters of this research report. The research question is formulated as follows:

> **What are the requirements to house one-person households in CO_2-neutral dwellings on vacant land positions in the Netherlands?**

1.11.1 Sub questions

Additional sub questions were formulated in order to break down the entire problem into smaller sections. These sub questions are listed below. Also it is shown in which chapter these questions will be answered.

- What is the current situation on the Dutch housing market?	chapter 2
- For which specific target group should a solution be offered?	chapter 2
- What are the needs of the target group regarding their accommodation?	chapter 2
- What is the monthly housing budget of the target group?	chapter 2
- What are the characteristics of vacant land positions?	chapter 3
- How should CO_2-neutral accommodation be designed?	chapter 3
- What is the appropriate method to inventory the needs of the potential target group?	chapter 4
- What are the preferences of respondents regarding the draft design?	chapter 5

1.12 Research approach

Previous paragraphs introduced the research topic, the central problem and the main research questions plus sub questions. The research approach, captured in figure 1.6, provides an overview of the steps taken within this research. The graphic is to be read from the left to the right. Blocks on the left provide the input needed in adjacent blocks in the subsequent column.
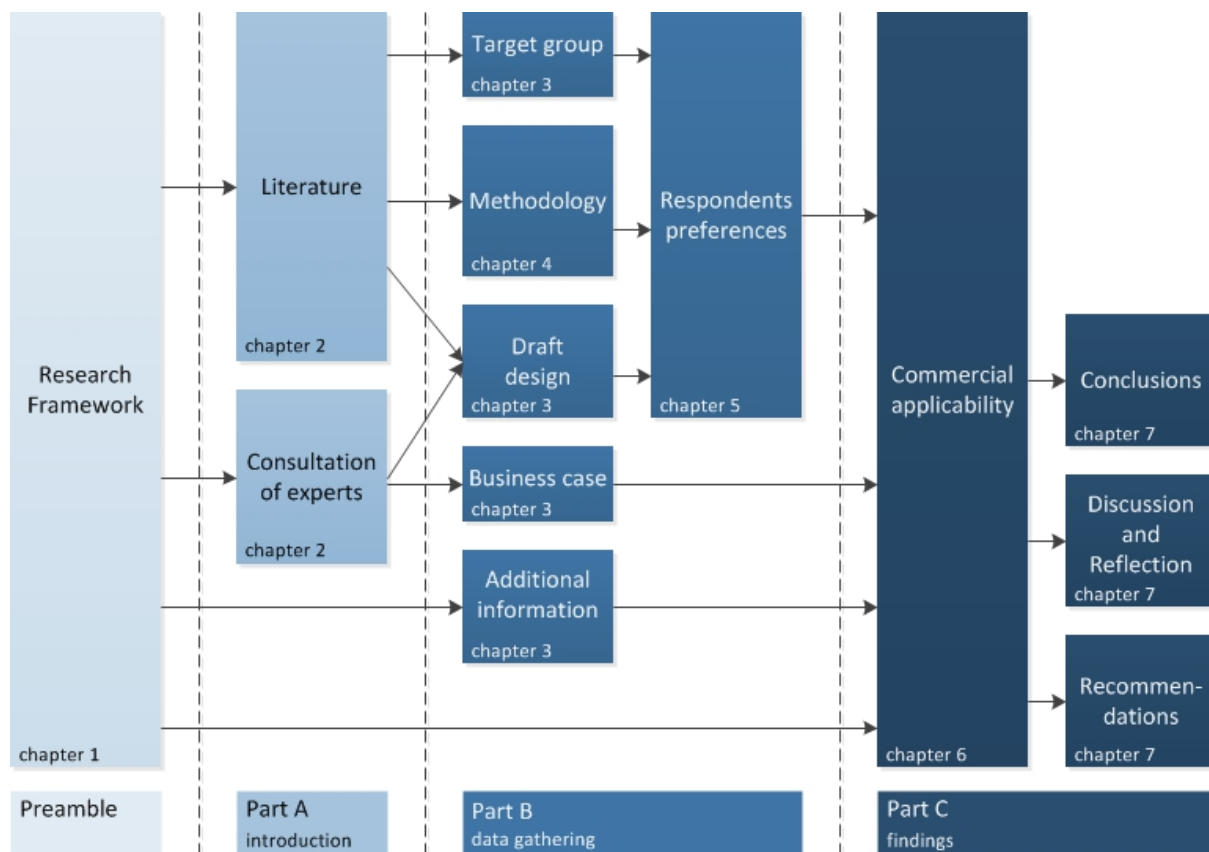
figure 1.6 | research approach

The research can be divided into three main parts. Part A provides an extensive introduction on the research topic based on literature and the consultation of experts (chapter 2). The topics covered in the literature study are the Dutch housing market, the rise of singlehood, energy consumption of (one-person) households, and consumers' values regarding their accommodation.

Part B is used to elaborate on various components that eventually result into an integrated business plan. Chapter 3 elaborates on the target group of the business proposition, the generated draft design that is developed in order to research respondents' preferences and the associated business case. The methodology of discrete choice experiments (DCE) is used within this research. This will be discussed in chapter 4. Both the developed draft design and the specific methodology of DCE are used to undertaken an online survey. Chapter 5 will capture this research on respondents' preferences regarding the draft design.

Eventually, part C holds all findings. Part C presents the integral business plan (chapter 6) on housing one-person households in transportable CO_2-neutral dwellings on vacant land positions. Also the overall conclusions, the discussion and reflection and recommendations are included in part C (chapter 7).

PART A

PREAMBLE

chapter 2 | LITERATURE

The first phase of the research covers an extensive literature study. Also various experts were consulted in order to get better understanding of the research topic and its characteristics. This chapter provides answers on four of the sub question:

- What is the current situation on the Dutch housing market?
- For which specific target group should a solution be offered?
- What are the needs of the target group regarding their accommodation?
- What is the monthly housing budget of the target group?

2.1 Dutch housing market

Over the last decades, until 2008, housing prices have rose steeply in the Netherlands (figure 2.1). Family houses nearly tripled in price since 1996. Especially in the period 1999-2001 prices went up vastly. Also apartments have risen in price steeply until 2008. In 1996 the average price of an apartment was about €75.000,-, in 2012 the average price had doubled to over €150.000,-. Investing in real estate turned out to be profitable.
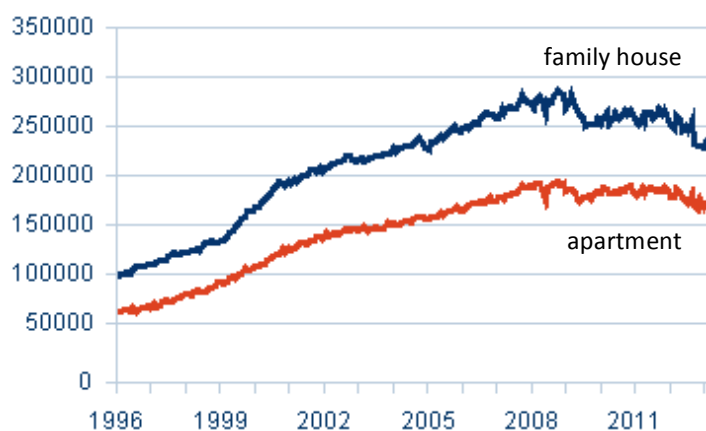
figure 2.1 | price of dwellings in the Netherlands (€)
(www.hypotheker.nl)

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Since 2008 a different pattern emerged. Housing prices started to drop after they reached an absolute top. In the year 2012 overall housing prices declined with 6.7%. An average house was valued €207.000,-. These figures were found by brokers' organisation (*Nederlandse Vereniging van Makelaars NVM*). Even though Dutch housing prices decreased heavily, the decline is little compared to the exceptional growth of the prices in the decennia before 2008. Still it is hard for first time buyers (starters) to acquire a house within the current housing market. Especially when starters lack personal capital. It has become increasingly difficult to acquire a mortgage as banks have become specifically careful with providing mortgages. Housing prices are expected to drop another 6% over the next two years. Even though this might be interpreted as a positive development for starters, it also makes potential buyers weary to enter the housing market right away, as they might loose quite some value in the upcoming years if they purchase right away.

Additional developments add to a high feeling of insecurity of Dutch consumers (figure 2.2). The increased level of unemployment (8,3% in May 2013[3], 7,2% in December 2012[4]) demotivates people to take risks regarding their job (income) or accommodation (housing costs). Because of these developments, many people experience uncertainty about their (near future) financial possibilities. The market shows that people stick to what they have instead of making a move on the housing market. This collective behaviour results in both a rigid job market as well as a locked housing market. And in its turn, the lack of dynamics on both markets makes it hard for consumers to move, it is a reinforcing circle.

figure 2.2 | consumers feel of security until May 2013 (CBS)

Furthermore the housing market experiences political instability. It is unclear which direction the Dutch parliament is heading for regarding their housing policy. On May 23th 2012, four major organisations, Vereniging Eigen Huis (VEH), Woonbond, Aedes, NVM, jointly presented their report: Housing market plan, a plan for the integral reform of the housing market (*Woningmarktplan, plan voor integrale hervorming van de woningmarkt*). The report urges policy makers for a faster reformation of the Dutch housing market. They advocate a

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[3] http://www.nrc.nl/nieuws/2013/06/20/recordwerkloosheid-blijft-oplopen-consumentenvertrouwen-omlaag/
[4] http://www.volkskrant.nl/vk/nl/2680/Economie/article/detail/3378574/2013/01/17/CBS-werkloosheid-opgelopen-tot-7-2-procent.dhtml

more flexible housing market, which runs more efficient and which offers broader choice for residents. The report proves that influential organizations on the housing market find it necessary to collaborate for communicating a common desire. Without clear policy, it is hard for both consumers as well as for professionals to make plans on moving or to invest in project development as it remains uncertain what the (financial) outcome will be. This in secureness adds to the rigid situation of the Dutch housing market.

2.1.1 Dutch housing stock

On April 11th 2013, Minister Stef Blok of the department Housing and Civil Service (*Wonen en Rijksdienst*) presented the WoON 2013 survey (WoON 2013). This nationwide survey focuses on housing and is conducted every three years by the Ministry of Internal Affairs and the Central Statistical Office (*Centraal Bureau voor de Statistiek*). This most recent edition, *Living in unusual times* ("*Wonen in ongewone tijden*"), covers the period 2009-2012 and provides extensive insight into the housing market, housing costs, the number of transactions taken place and consumers desires. A total of 70.000 people have been surveyed.

The WoON 2013 survey stresses some important conclusions, which are worthwhile to reproduce in this report. In 2012 the Netherlands counted 7.266.295 dwellings. 2.236.587 (31%) of these dwellings were owned by housing corporations. These corporations, about 400 in total, are responsible to house people with a minimum income, although they also house people who earn more than a minimum income. Over the period of 2007-2012 housing corporations have built 3.220 dwellings. These are middle priced (rent of €366-524 per month) and expensive (rent of €524-666 per month) rental houses. In the same period, about 1.190 dwellings were demolished and another 1.540 dwellings were sold, for example to starters. It were merely cheap houses which were demolished, houses in the middle priced category were merely sold. This makes that the average dwelling rented through corporations is becoming more expensive.

The desire to move is higher than ever. The number of people willing to move within two years has risen with 14%. People postpone their rehousing in the current financial climate, but they do not cancel their plans. Especially people of >45 years of age are highly represented in the group, partly because the number of moved households has decreased with 19%. This especially affects the transferring homeowners, which (are willing to) move from their current house into another one, a decrease of 47% is measured compared to 2009. As transfers in the owner-occupied sector have halved, in the renting sector they only decreased little, this shows a growing market for rental homes.

The actual number of starters is similar to the number of starters in 2009. Even though, it is found that starters choose to rent more often instead of buying their first house. Since 2009 the demand for rental houses has risen. The share of higher rental dwellings has rose with 12%. Within the social housing sector, the percentage of houses between the capping borer (*aftoppingsgrens*, €524,37 in 2012 for 1 to 2 person households) and the liberalization border (*liberalisatiegrens*, €664,66 in 2012), rose from 15% in 2006 to 21% in 2012. Until the liberalization border, renters (≥23 years of age) have the possibility to apply for housing allowance. In the same period the percentages of houses with a rent above the liberalization border (liberated sector) nearly doubled: from 7% to 12%.

Apartments gain in share on the renting market. The percentage of apartments has risen from 48% in 1986 to 56% in 2012. As a result, family houses (*eengezinswoning*) representing a smaller share in the total stock of rental dwellings. The survey shows that 90% of the households with children live in family houses, while only 43% of the one-person households are living in family houses. Most of the one-person households are housed in apartments. The WoON 2013 survey reveilles that apartments are becoming more expensive in general. Still, the renting sector becomes more and more the domain of low-income groups and older singles, which have smaller budgets to spend on their housing costs.

The term cheap skewness (*goedkope scheefheid*) is used when higher income groups rent dwellings with low rents. This phenomenon has decreased on the rental market. This is due to various causes: firstly the allocation policy, that stricter oversees which dwelling is been assigned to which tenant(s) shows its effects. Secondly, the average income has decreased and average rents have increased, which decreases the gap between income and spending's. Finally the liberal renting sector has grown, so tenants have a wider choice to move to other dwellings so their previous dwelling becomes available for lower income groups. The net housing costs have risen with 4% for both house renters and owners. Due to the shrink of additional costs, the total housing costs have only slightly grown. The actual amount of income spent on housing has risen because of the average decrease of people's income.
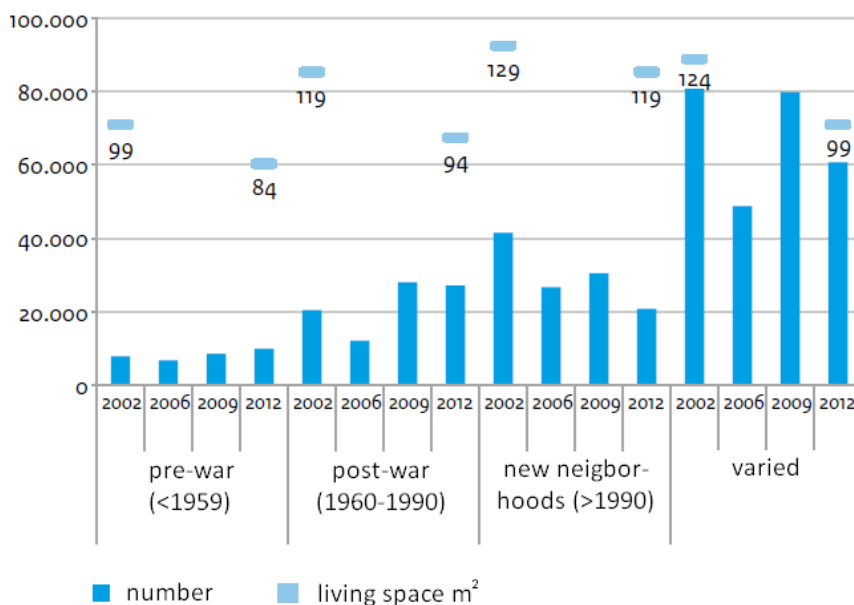
figure 2.3 | number of newly built houses and their size in m^2 (WoON 2013)

In general, fewer dwellings were built in the period 2009-2012, compared to the 2005-2008. In 2011 58.000 houses were added to the housing stock. Still in 2009 a total of 83.000 dwellings were completed. The average dwelling became larger over the past 20 years. Houses that were added to the housing stock after 1990 (figure 2.3) are 15 to 20 m^2 larger than dwellings built in the period 1960-1990. In 1980's apartments were about 60m^2, in the new millennium, the average newly built apartment measured about 90m^2 in size. Larger apartments increased the average renting prices, making them less attainable for starters.

2.1.2 Need for affordable dwellings

From 2009 to 2012, the Netherlands gained 200.000 households while the number of households in an independent dwelling rose with 140.000. This indicates an additional number of about 60.000 households sharing their accommodation. Figure 2.4 shows that the majority of one-person households is to be found in the groups 25-34 and 75+ years of age. Especially the younger group experiences difficulties in finding affordable independent accommodation in their desired location.
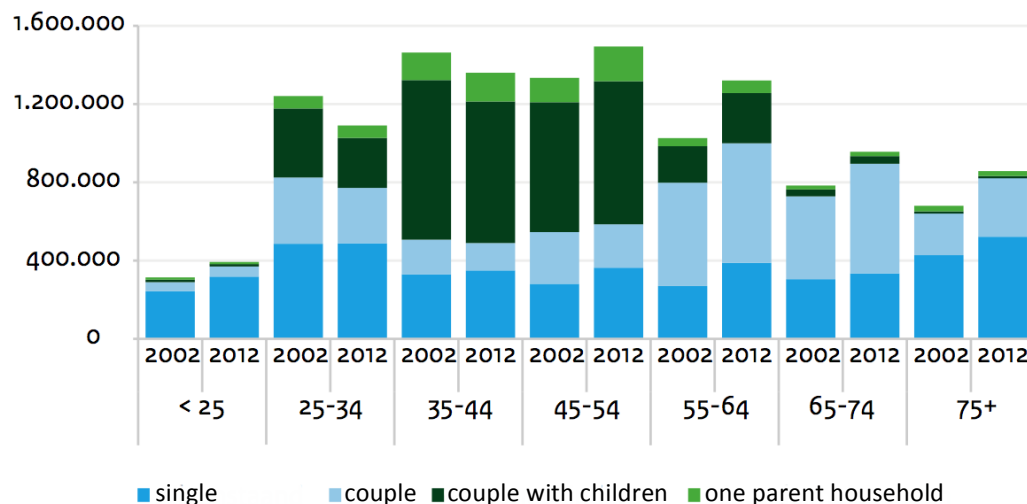
figure 2.4 | type of household per age groups, absolute numbers 2002 compared to 2012 (WoON 2013)

WoON 2013 also shows that children remain to live with their parents longer than they did in 2009 and a new group called 'boomerang' children arises. These people (are forced to) (temporal) move back at their parents place after they finished their study or lost their job or relationship. Also divorced ex partners who are financially forced to live together account to the number of multiple households under one roof. One-person households would surely benefit from smaller dwellings that meet their (financial) possibilities better.

Nibud, the Dutch agency for budget information, provides consumers with information on healthy spending patterns. The affordable monthly rent per person or household is closely related to individual circumstances and choices, although it is possible to draw conclusions on what is reasonable and responsible. Renting quotas are developed to act as guidance. According to the Nibud, households with lower incomes should not spend more than 20% of their income on rent. For all other incomes about 30% is a proper directive. The average renting quote in the Netherlands is 23%. Personal profiles provide insight in various renting quotes (appendix 1). In 2013 the minimum gross income for people of 23 years of age of older is €1477,80 per month. The advisable rent for these people will lie between €296,- and €443,- per month, respectively 20% and 30% of the minimum wage. The average starter will actually earn more than the minimum wage. Jobnet.nl provides an overview of starter salaries ranging from €1500,- to €1800,- for MBO graduates, they indicate roughly between €1800,- and €2500,- for HBO graduates and €2200,- to €2800,- for jobseekers with a WO diploma. For easy calculation €2000,- is taken as an average for all starter salaries. This combined with the average renting quota of 23% results in a monthly advisable rent of €460,-.

As the price for energy (electricity and gas) is rising, it is expected that people have to spend a larger amount of their total spendable budget on housing in the near future. A one-person household now easily spends €100,- per month on its electricity, gas and water. With developing new houses it becomes increasingly important to include the effects of the energy consumption of the dwelling, as this drives up the costs for housing. CO_2-neutral dwellings that generate their own (sustainable) energy are a possible solution, as these require as little (externally produced) energy as possible. When the energy costs are to be involved with the renting price the housing budget of an average starter can be set on roughly €560,- per month.

Especially small counties offer relative little low cost housing. Most low cost apartments are developed within urban areas (WoON 2013). This forces suburban starters with a low budget to move to urban areas, which has a negative effect on the aging (*vergrijzing*) of outer areas. To illustrate this point, findings from the regional *Woningbouwmonitor* are adopted (Woonbouw 2012). The report provides information on the direct surroundings of 's-Hertogenbosch. The researchers advice to both maintain as well as to add affordable rental dwellings (with a rent up to €524,- per month) in this area. It is expected that the group of low incomes will increase as a result of individualization, demographic changes and little economic growth. In general, the growth of our population smoothens; still the number of households is increasing because the average household becomes smaller.

2.2 The rise of one-person households

Thornton et al. suggest that a shift has occurred in family attitudes and values, resulting in a stronger emphasis on individualization and freedom, combined with a reduced commitment to norms. This shift will probably be reflected in an increased diversity in attitudes towards being single and towards commitment within partner relationships and a greater acceptance of non-traditional family forms, such as cohabitation and singlehood. Generally, the relational attitudes of singles will reflect their broader values (Thornton 1989).

The trend of individualization shows its impact. Families used to be the cornerstones of Dutch society in the fifties. Nowadays mostly one-person households arise instead. People living by themselves are also indicated with the terms solo-living or single living. In this research the term of 'one-person households' is adopted, as these form a wider group. The group holds young people who have left their parental home and may later form a household with a partner, it also contains people who have divorced and might remarry, widows and widowers who have lost their partner, and finally it also contains people who have lived most of their life alone and intend to continue doing so. Half a century ago these different groups of people would not normally have had the possibility of living in their own household because of other social and cultural standards. The older widows(-ers) would have lived with their adult children or in an old-age home, the younger ones would have stayed at a pension or lodged with the household where they were employed as maid or farmhand for example. Increased wealth and compartmentalization made individuals more autonomous.

Individualization is a historical social process. A decline of solidarity in a society can be a result of this process. People can also contribute from this development, because it expands their personal freedom. This does not mean that people are willing to have less social relations, people want to be able to decide which social relations they lay, maintain and

what the character of these relations will be. The rise in singlehood among young adults is often seen as an indication that young adults are nowadays more individualized, suggesting that singlehood is viewed as a positive experience (Poortman 2010).

Especially within Scandinavian countries the impact of individualization is high. In Sweden, Denmark and Norway respectively 47,1%, 40,0% and 39,6% of the total households in 2011 was a one-person households. These countries have amongst the highest standards of living in the world. Also the Netherlands is one of the most individualized countries in Europe (Social and Cultural Planning Office of the Netherlands, 2000). Younger adults are most likely to have been affected by individualization. Figure 2.5 shows the growth of Dutch households.
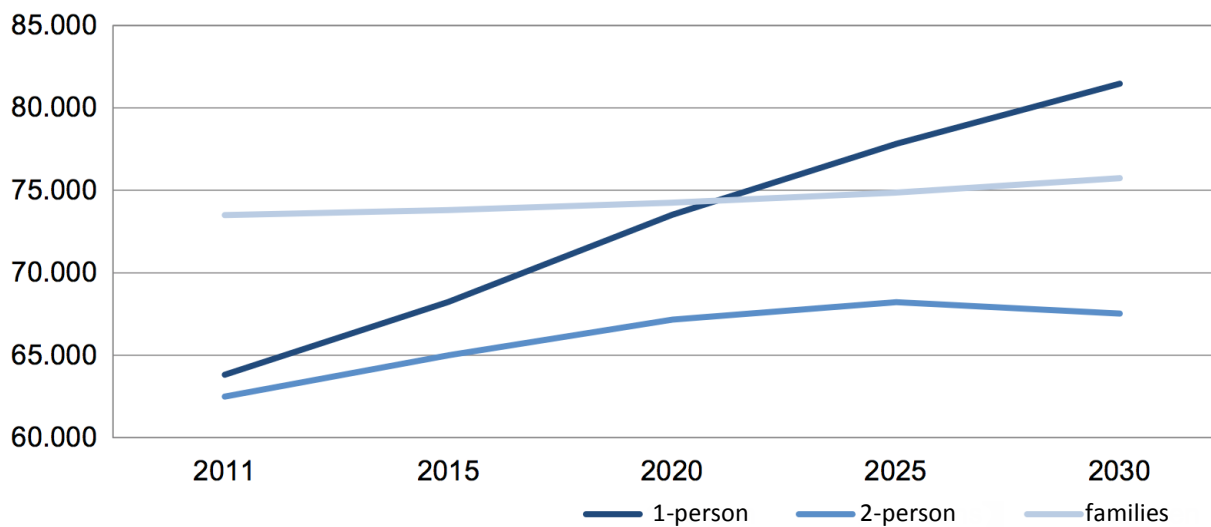
figure 2.5 | development of Dutch households, number of households added each year (CBS)

Economic regression affects the formation of potential households directly. Lee (2013) found that potential households may choose to delay entry into the housing market by remaining with one's parents during times of economic hardship or by combining with other persons to share housing costs. In a regression, the likelihood that a young adult (younger than the age of 35 years) will form an independent household falls by 1 to 9%, depending on the age of the person. If an individual is unemployed, the likelihood of leaving the parental home is up to 11% points lower. Lee (2013) specifically focused on young adults as this group is most likely to have the flexibility in work or school plans to adjust their rate of independence during economic downturns.

2.3 Energy consumption of one-person households

The rise of one-person households is both a boost to the economy and a potential problem for the environment (Gram-Hanssen 2009). One-person households take up more space per capita and consume more energy and resources than shared households. A 2006 study of UK single households found that one-person households consume 38% more products, 42% more packaging, 55% more electricity and 61% more gas per capita than four-person households[5]. During the period 2000-2005, the average increase of energy costs for Dutch households was 42%. With rising prices of energy (electricity and gas) (figure 2.6), The share of household income spent on energy related expenses is therefore increasing (Kroon 2013).

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[5] http://kimpittaway.com/2011/02/13/single-is-the-new-married/

EU-wide research on the relative housing costs of its households showed that the Netherlands has the highest relative housing costs, with a percentage of 30.9%, where the EU average is 22.2%. For the Dutch' lowest incomes, this percentage is even higher with 47.4% (Kroon 2013).
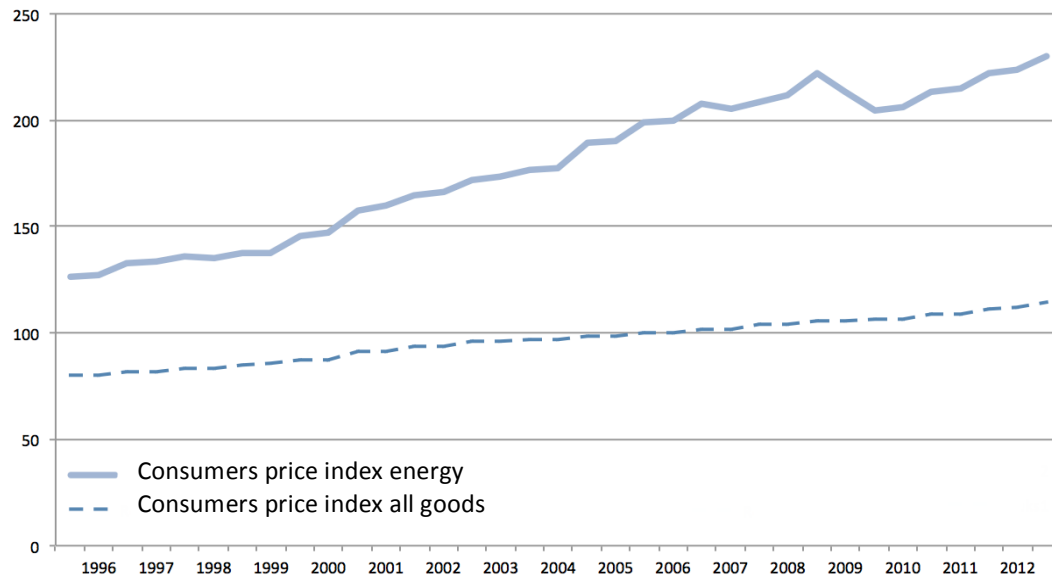
figure 2.6 | consumer price index (2006 = 100)

About 30% of all CO_2-emissions in the European Union (EU) are related to the usage of buildings and their installations. The buildings itself are responsible for approximately 40% of the energy consumption in the EU (Majcen 2012). The European Union stimulates the build of zero energy homes, not in the last place to boost the construction sector (Eurostat 2011). Proven technology is ready to be implemented in both existing and new houses. The roadblock of the steep initial investment decreases steadily; for example photovoltaic panels (solar panels) have dropped in price rapidly (Barbose 2012). The years needed to payback the initial investment have therefore dropped to about seven years. Technical improvements are preferred over behavioural measures or shifts in consumption (Poortinga 2003). This opens doors for offering dwellings in with energy generating installations are included integrally.

Also the Dutch government sharpened their policy. With improved awareness about the negative impact on the environment, as well as rising costs for energy, politicians start to demand for buildings that consume less energy. The government demands that all houses being build from 2020 and on are energy neutral (BZK 2006a and 2006b). This holds that buildings need to generate yearly nearly the amount of energy they need over that same period. With this development, the energy label of houses becomes increasingly important, as it gives potential residents an insight of the energy performance of the dwelling. Monthly rent or mortgage might appear to be attractive, but additional cost for external energy can make quite a difference in the total cost of housing.

The energy consumption of a household is the sum of its electricity, gas and water consumption. The average electricity consumption depends on the size of a household and the (number of) electronic appliances used (table 2.1). The electricity consumption of an average Dutch household (2,2 persons) is 3.500 kilowatt hour (kWh) per year. The average

gas consumption, mainly used for heating, is 1.600m^3 cubic meter per year. In the Netherlands residents are obligated to pay taxes on their energy consumption. Households receive a tax refund on some of this amount each year. This is then calculated with the annual electricity bill. The average energy bill, including standing charge (*vastrecht*) was about €2.200 per household in 2012-2013 (Milieu Centraal 2013).

Number of residents	Average kWh per year	€ per month including tax benefits
1	2.010	30
2	3.360	56
3	4.120	71
4	4.580	79
5	5.450	96
6	5.790	102
Average per household	3.340	56

Amounts include the standing charge (vastrecht), 21% vat (btw) and energy tax payback

table 2.1 | the average consumption of electricity depends on the size of a household (ECN and Nibud 2013)

The electricity consumption of a one-person household in an all-electric house, in which no gas is used, is expected to lie between 2000[6] and 3000[7] kWh per year. When one wants solar panels to produce this amount of energy in the Netherlands, 10 to 15 panels of 245Wp are needed, preferable in a corner of 35° facing South. This takes up 15 to 22 m^2 of the roof surface.

2.3.1 Energy labels

The energy index is the figure that indicates the energy consumption based on an estimated average amount of energy needed for regular consumption, associated with the standardized use of the building. The energy labeling of dwellings plays a crucial role in European and national policies that aim to reduce energy use. The energy label in the Netherlands is based on the 'Decree on Energy Performance of Buildings' (BEG) and the 'Regulation on Energy Performance of Buildings' (REG) which came fully into force in 2008. The method for calculating the energy label is described in (ISSO 82.3, 2009). The first goal of labels is to provide occupants and homeowners with information on the thermal quality of their dwellings. To increase the practical significance of the label, the expected (theoretical) energy usage of the dwelling is also mentioned on all Dutch labels issued after January 2010, expressed in kWh electricity, m^3 gas and GJ heat (in dwellings with district heating) (Kroon, 2013).

Each dwelling is graded with an energy label, ranging from 'A^{++}' to 'G' (table 2.2) of which A^{++} is most energy efficient. The categories are determined on the basis of the energy index, which is calculated on the basis of total primary energy demand (Q$_{total}$). Q$_{total}$ sums up the primary energy consumed for heating, hot water, pumps/ventilators and lighting, subtracting the energy gains from PV cells and/or cogeneration. The energy efficiency of a dwelling is expressed as the Energy Performance Coefficient (*Energie Prestatie Coefficient* EPC) for new dwellings, and is named *Energie Index* (*Energie Index* EI) for existing dwellings. Numerical values are used to determine the energy label of a dwelling. The relation between the Energy Index and the energy label can be seen in table 2.2.

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[6] According to Gijs de Reeper (greenem.nl) roughly 1000 kWh is needed for heating and 1000 kWh for usage. April 5th 2013.

[7] According to Patrick Koch, business developer of Heijmans Home Construction. April 8th 2013.

label	A++	A+	A	B	C	D	E	F	G
EI	<0.50	0.51-0.70	0.71-1.05	1.06-1.30	1.31-1.60	1.61-2.00	2.01-2.40	2.41-2.90	>2.90

table 2.2 | energy labels and underlying energy Index scale (based on www.energieindex.nl)

2.4 Consultation of experts

Within the introduction phase of this research, various professionals have been consulted in order to sharpen the scope of the research topic. Employees of Heijmans provided valuable information on existing housing projects and their characteristics. The division of Home Construction already worked on a sub urban project to provide compact, and therefor affordable, houses for starters, which could be expanded easily over time[8]. Additional information is adopted within chapter 3.

To launch a product or service, a certain desire has to be fulfilled. A product can become successful when many cherish this desire. A crucial question is when and why people buy a product or a service. In other words: when are they most likely to go for it? Total Identity is a company specialized in corporate strategy and branding. Having spoken with Hans Brandt[9], CEO of Total Identity, it became clear that potential residents should recognize themselves in a proposed housing solution unceremoniously. According to mister Brandt, people either identify themselves with a product, or a service, or they turn away from it because they won't find recognition in the proposed good. It is one way or the other. With targeting a certain group of consumers it is crucial to know what their drives and believes are, in order to propose them a solution that they embrace immediately. It has become increasingly important to develop products and services that touch upon the very values of consumers. When consumers are not convinced at once there are mostly dozens of alternatives for them to choose from. Internet has made it very easy to search for alternatives in no time.

2.5 The role of values

Improving quality of life has become a policy goal at regional, national and EU levels. Good quality of life is important to people and is connected to the overall attractiveness of surroundings, which can be houses, places or entire regions. People's preferences when choosing their place of residence and conducting their daily activities are closely related to quality of life (Nordregio 2013).

'Quality of life' is becoming a popular topic. The 2013-2014 curriculum of the Eindhoven University of Technology illustrates this, as it adopted the course sequence labeled exactly with this name. The course sequence is available to every second years' TU/e student. Still, quality of life remains a broad concept that lacks a common definition, making it difficult to implement. Here for the term 'values' are introduced. Poortman (2010) states that value orientation is closely related to how young adults perceive individualization. This paragraph provides insight in the basic meaning of values, which influence people behaviour on a wide scale. Values influence all sorts of decisions we take, also the ones regarding finding accommodation. Several researches have been undertaken regarding this topic.

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[8] Conversation with Olga Görts on March 4th 2013
[9] Conversation with Hans Brandt on March 25th 2013

Values are important in the construction of personal morality and as a basis for living life (Beatty, 1985). Literature suggests that social values are reflected in a large variety of advertisements and can influence audience reactions to advertising appeals (Piiro, 2005). When a choice is tied to a value, that choice then becomes more attractive to people who share that value. People's values resonate in and are observable throughout their daily lives (Beatty, 1985). A perfect example is coffee. People who endorse fun and enjoyment in life may want a cup of coffee for its rich, pleasant taste. Meanwhile, people who value a sense of accomplishment may rather use coffee as a mild stimulant. People who value warm, loving relationships with others may want a cup of coffee to share in a social manner. Perspective and personal beliefs greatly influence behaviour (Gurel-Atay 2010).

Values scales are psychological inventories used to determine the values that people endorse in their lives. They facilitate the understanding of both work and general values that individuals uphold. In addition, they assess the importance of each value in people's lives and how the individual strives toward fulfilment through work and other life roles, such as parenting. Most scales have been normalized and can therefore be used cross-culturally for vocational, marketing, and counselling purposes, yielding unbiased results. Values scales are used by psychologists, political scientists, economists, and others interested in defining values, determining what people value, and evaluating the ultimate function or purpose of values. With better understanding of values of potential residents, houses could be better tailored to satisfy the desires of the target group. Means-end chain analyses (table 2.3) often find that consumers select products with attributes that deliver consequences, which in turn contribute to value fulfilment.

Attributes *what is the product?*	Concrete attributes
	What are the tangible aspects of the product?
	Abstract attributes
	What are the intangible aspects of the product?
Benefits *What does the product deliver to the consumer?*	Functional benefits
	What does the product actually do?
	Psycho-social benefits
	What does the consumer thinks the product does? What does (s)he think others will think of the product?
Values *What does the product aid the consumer in doing?*	Instrumental values
	What short-term goals, if any, does the product help the consumer to achieve?
	Terminal Values
	What long term or life goals, if any, does the product help the consumer to achieve?

table 2.3 | means-end chain analyses (based on www.nibaa.nl)

According to Milton Rokeach (1918-1988), a prominent social psychologist, human values are defined as core conceptions of the desirable within every individual and society. They serve as standards or criteria to guide action but also judgment, choice, attitude, evaluation, argument, exhortation, rationalization, and attribution of causality (Rokeach, 1979). Consequences of human values are manifested in all phenomena that social scientists might consider worth investigating. In order for any type of research to be successful, regardless of the field of study, people's underlying values need to be understood, according to Rokeach. To allow for this, the Rokeach Value Survey (RVS) (appendix 2) has been developed. The RVS has been in use for over 30 years. It provides a theoretical perspective on the nature of

values in a cognitive framework and consists of two sets of values, 18 instrumental and 18 terminal ones (Rokeach 1979). Instrumental values are beliefs or conceptions about desirable modes of behaviour that are instrumental to the attainment of desirable end points, such as honesty, responsibility, and capability.

Clawson and Vinson (1978) further elaborated on this idea by explaining how values are one of the most powerful explanations of, and influences on, consumer behaviour. Values scales are helpful in understanding several aspects of consumption areas and consumer behaviour, including leisure, media, and gift giving. People who endorse certain values more highly than others engage in certain activities or prefer certain programs or magazines. Also the choice to live in a certain dwelling is closely related to consumers' values. Values scales and the study of values could also be of interest to companies who are looking to build or strengthen their customer relationship management. This certainly accounts for the construction sector as well, in order to realize shorter ties to the end users of their products.
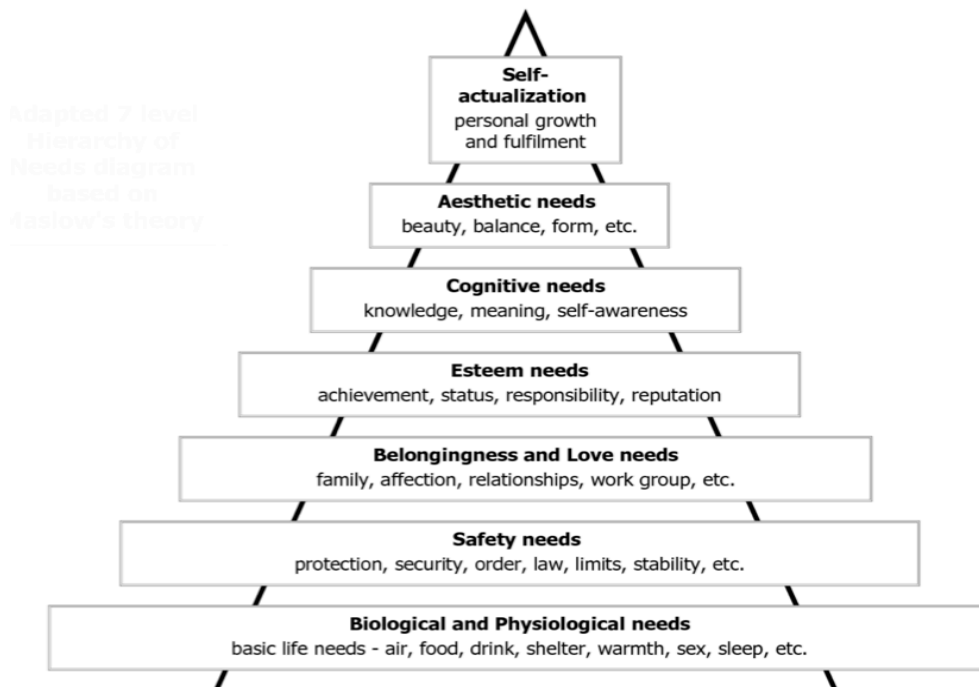
figure 2.7 | Maslow's Hierarchy of Needs

In their paper, Poor Zavei and Jusan (2012) discuss a theoretical framework developed by the authors to summarize the relationship between the user's needs and the attributes of housing units. According to them it is essential to meet the user's needs in housing delivery. Attributes can be thought of regarding fulfilling residents needs, as a house is more than purely its material structure (Schulz, 1985). Poor Zavei and Jusan adopted the findings of McCray and Day (1977), who investigated housing related values, aspirations, and satisfactions based on Maslow's Hierarchy of Needs (figure 2.7). They found that user's satisfaction in a house, although dependent on economic or social status, is related to the gratification of the user's higher psychological expectations such as intimacy, love, sense of belonging and freedom. Years later, Bachelard (1994) wrote about this topic: Although modern houses are practical and healthy, they lack meaningful forms. A housing space

should be something more than a physical structure, in which the users' various levels of needs can be considered (Bachelard 1994).

2.6 Researching residents preferences

Previous paragraphs revealed extensive information on the current housing market and additional topics of interest to take in consideration for housing people. There are certainly chances to plug new initiatives on the current housing market to accommodate one-person households. Obviously, specified information on the market needs and target group preferences are desired. In close collaboration with Heijmans it was decided to first develop a draft design, based on available information. The proposition could then eventually be checked with potential residents. Chapter 3 reports on the process undertaken to present a housing concept and a draft design of a house.

2.7 Conclusions

The current housing market shows a decrease of newly built houses. Renting a house becomes more popular for starters instead of buying a house. As values like freedom and self-expression have become increasingly important, and people become economically more independent, individualization is on the rise. It is expected that half a million one-person households will add to the total of households within the upcoming twelve years (until 2025). All these people will be in need for suitable and affordable accommodation. It is expected that the current housing stock, which mainly consists of one family houses, does not meet the needs and financial possibilities of all these new households. Affordable housing accommodation is requested, especially for single starters on the housing market.

As current market conditions do not show improvement on the short term, it remains difficult to develop permanent buildings on vacant land positions. Still, temporal solutions might be a feasible alternative. Buildings can be temporally placed on vacant land positions for a maximum stay of five years, based on a temporal building permit. Temporal and compact accommodation could be an adequate alternative to satisfy the needs of one-person households in search for affordable accommodation.

Policy makers have improved awareness about the energy consumption of buildings, as the built environment accounts for a large share of all CO_2-emmisions. Residents prefer technical improvements of their dwellings, rather than they have to change their behaviour or consumer pattern. These findings make it worthwhile to emphasize on the development of CO_2-neutral houses.

As consumers identify themselves with products or services that touch upon their personal values, it is of essence to consider the impact of values within any type of industry. With designing a specific accommodation, it is worthwhile to take in consideration the values of one-person households. These can include the need to feel free and to live a comfortable life (terminal values) as well as having self-control and being independent (instrumental values), based on the 36 values found by Rokeach (appendix 2). Architects and real estate developers can use values as guidance in their design process.

chapter 3 | A POTENTIAL DWELLING

The findings presented in part A were used as a starting point for the discussion with professionals about the possibilities on how to proceed. Next to theoretical answers, the company of Heijmans was highly interested in practical solutions for their current situation regarding their land positions. The aim of Heijmans is to house one-person households in transportable houses on their vacant land positions. This chapter covers the process undertaken to develop a draft design of a possible transportable house. The content of this chapter answers two of the sub question, stated in paragraph 1.11.1:

- What are the characteristics of vacant land positions?
- How should CO_2-neutral accommodation be designed?

3.1 Vacant land positions
Németh (2013) considers a piece of land as vacant land when no structure exists upon it, and when humans do not currently use the property. Within this research the definition of vacant land positions are actually limited to the vacant land positions which are (partly) owned by Heijmans and which the company desires to be make profitable. Heijmans owns about fifty land positions throughout the Netherlands, mainly in small (max. 50.000 residents) and middle-sized places (max. 100.000 residents). None of the land positions covered within this research are located in within in inner cities. As permanent development proves to be rather difficult in the current market conditions (chapter 2), temporal solutions might be placed on vacant land positions instead. The company of Heijmans has direct influence and an interest in (temporal) development of their own plots as they can generate income with selling (temporal) real estate. Still, a transportable and location independent dwelling can be placed on various land positions, these do not have to be necessarily be owned by Heijmans.

3.2 Target group

The literature study revealed a great potential to realize accommodation for one-person households. Especially affordable solutions in the renting sector are required for young people starting on the housing market (chapter 2). These dwellings should be easily affordable, which implicitly requires a compact design. Vacant land positions can be used to (temporally) house single starters.

Offering compact rental dwelling in villages and small towns can be especially interesting for local orientated single starters who explicitly are not willing to move to larger towns or cities, but rather live close by their family and friends. For the same reason temporal dwellings can accommodate graduates who return to their hometowns after they finished their studies, so-called boomerang children (paragraph 2.1.2). Furthermore compact houses can be of great relevance for expats, temporal workers or Dutch residents who live too far away from their work and who are in need for (part-time) accommodation near their work. Also senior people could be housed in compact houses, as these people saw there children leaving and find themselves living in a spacious house that needs a fair deal of maintenance and cleaning. Many of these seniors can be convinced of moving to a smaller place where they even can live close together with their dearest friends if they also opt for living near to each other in individual compact houses. When these people grow older, a nurse could residence nearby for required healthcare. Another target group could be groups of psychiatric patients that live under a certain level of supervision but in which setting every individual has their own space. In that case several dwellings could be placed together and caretakers could use one of them to be near to the group.

Finally the concept could be of great favour for divorced people with a small housing budget who want to move away from their ex partner. Some of this last group of people were forced to move to a holiday park, where they rent compact dwellings. To get a better understanding of their circumstances Vinkeloord was visited on April 25th 2013. The park is located about ten kilometres east of 's-Hertogenbosch, and holds compact houses that were used as holiday homes since the '70's. Nowadays most of these houses are inhabited permanently. For Vinkeloord the province of Noord-Brabant approved permanent residence after ten years of litigating by the residents. The approval to inhabit the houses permanently will most certainly increase the prices of the dwellings. Some very basic 40m^2 dwellings are already rented to divorced people as well as seasonal workers for €800,- per month. These dwellings are of poor quality as over the last forty years little has been done to upgrade their quality.

Within this business plan it is believed to target single starters on the housing market first, as they form a large and vulnerable group (paragraph 2.1.2). It is hard for starters to acquire a house within the current housing market. Especially when they lack personal capital. Many of them are obliged to remain to stay with their parents or are financially forced to share accommodation, as rents are too high to pay for individually. Many single starters are unable to find affordable accommodation in their preferred location (WoON 2013). Therefor they should be given the opportunity to rent affordable accommodation throughout the Netherlands. Offering a low budget alternative on various vacant land positions, on the lower end of the housing market, will certainly increase their possibilities of finding a suitable home.

3.3 Business proposal

One of the options to proceed with designing a transportable house was to ask potential residents (one-person households) about how their ideal house would look like. However, it was expected that this would result in answers that describe various types of accommodation that are already on offer. This expectation is in line with car manufacturer Henry Fords world famous saying *"If I had asked people what they wanted, they would have said faster horses"*. To adopt his early twentieth century approach, it was decided to explore new possibilities within a professional context first. The aim was to realize a realistic business proposition with added value on the current market that eventually could be proposed to potential residents.

An informal guideline for successful business within the sector of real estate reads 'location, location, location'. The location of a building is, in general, the very first parameter for which people chose. Regarding the housing market, there can be plenty of beautiful and affordable dwellings available throughout the country, as long as the location is not right (urban versus rural or far away from someone's place of work or study), it most probably will not be the case that people will buy or rent that property. But then what is the forth factor that affects residents choice for a specific dwelling? Ton Hillen, board member of Heijmans pressed exactly this question at the final presentations of the Heijmans Masterclass 2013, May 17th. In a program of four days, twelve master students were asked to think about the theme *Brand New Living*. Three groups presented their answers. Ideas ranged from offering high-end domotica (houses equipped with the latest intellectual ict) in new dwellings, so that a home becomes an experience, to actively involving new residents in the construction process of their house, all together with a party and champagne when the house is completed by Heijmans. The third option zoomed in on improved communication between potential customers and the construction company. These three options did not touch the core of the question, according to mr. Hillen. The question remained, what is the next important aspect influencing residents decision after they already decided on a certain location?

The literature study reports on the high feeling of in secureness within the current housing market. Home owners who are unwilling to sell there house with a loss, housing corporation that are resistant to invest in real estate projects, the rising number of unemployment that affects both homeowners as well as renters in their ability to pay their monthly housing costs. These developments result in one major problem on the current housing market: in secureness. The solution for this problem is to offer secureness instead. Offering secureness of a set monthly housing price is one of the main fundaments of a housing concept that is developed to meet the needs on the market.

3.3.1 Housing concept

As herald to an eventual business plan, a housing concept has been developed to guide the process of business development. The concept aims to offer an affordable and integral housing solution for one-person households for one set monthly price. Especially single starters are an interesting target group as they leave their parents home for the first time, having mostly a small housing budget and do not instantly need many m^2's. The idea of offering transportable houses on vacant land positions is used to think of an integral housing concept. As a certain number of transportable houses can be placed on vacant locations, formally allowed for a period of maximum five years, they could both accommodate one-

person households, as well as mark vacant land positions with activities. New residents are potential consumers for all kinds of sectors that improve the attractiveness of these areas for all sorts of business. Marking locations with new activity could furthermore boost the interest of investors and other stakeholders involved in eventual permanent development. After the transportable houses served their time on a specific location, and permanent development might have become possible, the houses will be transported to another location. By doing so, the houses function as a temporal buffer on local housing markets. Here for the houses should be easily transtransportable. They should be able to be transported on a truck over road and therefor they cannot have wider dimensions than 3.5 meters[10]. Depending on the truck used, the height of the transtransportable piece can be up to 3.5-3.8 meters. The total length of the transport can be 22 meters as transport company Van Riel has a permanent permit for this.

It is well known (within the construction sector) that CO_2-emissions have a negative influence on our environment. On June 26th of 2013, Minister Spies (Ministry of Internal Affairs) agreed on the intention to mainly build energy neutral buildings from 2020 and on, as well as improving the energy performance of 300.000 existing buildings each year. This has to minimize the amount of fossil fuels that needs to be burned in order to generate our demand for energy. Generating energy in an environmental friendly way is needed to maintain, for example, our air quality. Since the price for conventional energy (energy that is produced by burning coal and gas) is rising, it becomes increasingly attractive to equip houses with installations that generate sustainable energy (by using the sun, wind or geothermal power) so that no (or less) external energy should be taken from the grid. After an initial investment in sustainable energy installations, the generated energy is free of charge. Taken these aspects in consideration, the housing concept anticipates on the ambition of building energy neutral dwellings. By doing so, the environment is not harmed by burning fossil fuels (gas by gas burners of most dwellings, coals by power plants in various locations in the Netherlands) and the monthly running costs are kept to a minimum. Including an average amount of electricity within the monthly housing budget was taken as a cornerstone to offer secureness to future residents.

Additional services were contemplated on to facilitate the one-person households. These services could cover domestic choirs like cleaning, washing or doing groceries and cooking. Also a weekly personal trainer or group sports could be integrated within an overall housing concept. Eventual is chosen to leave these extra options out of the initial deal, after having spoken to mr. Hans Brandt, who pointed out than multiple choices would only stress potential tenants. His conviction was first to focus on the core product (the actual house) and then eventually extend that offer with extra services.

3.4 Expert meetings
In first instance the graduate made a sketch study of possible solutions for housing one-person households on vacant land positions of Heijmans. These sketches were used in one to one conversations with employees of Heijmans to initiate creativity and a pro-active mind-set in finding a suitable housing concept. On March 11th 2013 a three-hour expert meeting was planned with all of these consulted employees. Also Tim van der Grinten MSc, independent architect, was asked to participate in the meeting in order to have a qualified

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[10] Conversation by telephone with Van Riel Transportation. April 19th 2013.

architect involved from the very start of the design process. The aim of the meeting was to jointly get to the principles of the housing solution. Fields of expertise varied from architectural design and consumer preferences to business development and technical expertise. The intention was to maintain a wide spectrum of possibilities in the initial sketch phase. Experts were to spark each other with their ideas. Still, with a wide variety of positions and viewpoints it proved to be hard to outline everyone within the one meeting. All pieces of information resulted in an overviewing image of the projected housing solution. For one fixed monthly housing budget a resident should be offered components that makes him/ her to feel at home at once (appendix 3a). The housing concept offers one integral package to residents in which rent, energy, maintenance and additional services are included. The rent, an average amount of energy and standard maintenance will be bundled within one fixed monthly price of about €600,-. This amount was taken as a guidance to fill the gap between the social housing sector (long waiting lists) and the liberated housing market (high rents).

A second meeting was planned on April 10th 2013 with another group of experts, who mainly had a technical background. The point of attention in that meeting was the actual object, the transportable house that is a crucial part of the housing solution. In this meeting a business developer, a project manager of Heijmans Home Construction and experts on building engineering of Heijmans attended. Also in this meeting the experts attending came with various expectations. Many question about the intended design of the transportable house were asked at the start of the meeting. These were inventoried to be of help during the design phase. The minutes of this meeting (in Dutch) can be found in appendix 3b.

3.5 Architectural engineering

The actual design of the dwelling, the appearance and its functionality, are crucial in attracting residents. Architectural design is not an expertise of the company of Heijmans. Therefor Tim van der Grinten had an active role in the realization of the draft design of the intended dwelling. Van der Grinten is experienced with the build of compact and transportable buildings, as his Trek-in and Trek-in Junior prove. Both of these buildings are wooden cabins for recreational use and can be placed throughout the Netherlands. The Trek-in has great quality in its design as well as its engineering and the materials that were used. This is illustrated by the fact that the Trek-in was awarded with the first price of the Wood Challenge 2012[11].

Based on the output of the available information of the literature study (i.a. values regarding residents needs) and the expert meetings, Van der Grinten was asked to develop a draft design of a compact and transportable house, specifically for one-person households. Guidelines for the design were obviously its portability and energy efficiency, but the main task for Van der Grinten was to propose non-graspable design elements that would make the design highly attractive, both at first sight and also in the longer run as people could residence in it for some years. Even though the houses are intended to fit the needs of one-person households, still a two-person bed should be fitted within the design for maximum usability of the houses, partners are able to stay over. The housing concept also involves various aspects to improve residences quality of life. The transportable houses should be in line with this striving for absolute quality. The design and the materials used should be

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[11] http://www.woodchallenge.nl/trek-in

thought trough. By building houses in a cradle to cradle (C2C) way, materials used can be used again after the lifetime of the houses has been expired. The houses can even been build with used materials as has been done by the construction company that builds the Trek-ins. Demolition company Arie van Liempd used mainly second hand materials for building the wooden cabins.

As beauty lies in the eye of the beholder it is uncertain what design results in the optimum wow-factor. Still, an interactive collaboration with both the graduate and Heijmans made each version of the design becoming more space-, and therefor cost-efficient, while it maintained its concept of a sustainable and spacious dwelling. The design focuses on positive architecture, with natural materials that are displayed. Also space, openness and a strong identity (recognisability) where implemented. The draft design, as it was presented in the online survey, is shown in figures 3.1 and 3.2.

figure 3.1 | external view of the draft design (5 houses are shown) ([©]Tim van der Grinten)

figure 3.2 | 3d section of one of the dwellings ([©]Tim van der Grinten)

This design measures about 45-50m^2 and consists of all functionalities needed for an independent house (kitchen, bathroom, two person bed, dining and living space). Integrated closets along one side of the house provide extensive storage space. Each house is equipped with 10 solar panel of each 245 Watt peak, which are able to generate 2000 kWh of electricity each year. These panels take up roughly 17m^2 of the roof surface. Also a solar water heater is suggested as this device can heat water that can be used for both heating the house as well as for showering and doing the dishes.

The process of designing the compact house helped in formulating attributes for the online survey. For example to realize a CO_2-neutral house, the initial investment for photovoltaic cells and a hot water collector will be rather high. It is worthwhile to know how respondents regard CO_2-neutral buildings. It they regard these buildings mostly positive, chances are high

that actual CO_2-neutral houses are received positively as well. In that case it is worthwhile to invest in installations that generate sustainable energy and therefor lower the monthly energy bills. This also holds for furnished designs. These designs have a higher initial investment cost but with integrating furniture, the design becomes more space effective, which eventually results to less square meters and therefor cheaper building costs. Before doing so, the opinion of potential residents should be taken in consideration. The intention is to sharpen de draft design into a definitive design with the feedback of the respondents.

3.6 Conclusions

A housing concept that is tailored for the needs of single starters could be the starting point of a feasible and profitable business plan. As affordability and sustainability are important topics on the housing market nowadays, these aspects should be elaborated within the concept. This can be done to equip houses with photovoltaic panels and solar water heaters that arrange electricity and warm water in an environmental friendly and cost effective way. By doing so, residents can also save seriously amounts of money on their monthly energy costs.

A new integrated housing concept is not easily developed individually. Knowledge from various experts is needed in order to present a realistic proposition. Here for collaboration was sought with various professionals. This intense collaboration eventually resulted in a realistic draft design of a compact transportable and CO_2-neutral house that will be elaborated further on in an eventual business plan (chapter 6). The design is made of timber and is to be transported in two separated modules that are to be placed on top of each other on the eventual location. Photovoltaic panels and a ultra high vacuum boiler are used to generate the required electricity and warm water.

The generated draft design is used to ask about respondents' preferences on certain attributes of the design. Chapter 4 will elaborate on the specific methodology used for that specific research. Chapter 5 will cover the actually research undertaken.

chapter 4 | METHODOLOGY

This chapter elaborates on the academic methodology used to find preferences of potential residents regarding various dwelling configurations. It is important to understand which characteristics of the draft design of the proposed house affect potential residents most, in order to eventually present recommendations for a feasible business proposal. This chapter answers the following sub question:

> - What is the appropriate method to inventory the needs of the potential target group?

4.1 Choice behaviour

Institutions, governmental organisations and companies are interested in choice preferences in order to predict which products or services are worthwhile to offer to consumers. In marketing, economics and psychology various methods are used to research choice behaviour of people. Regarding respondents preferences, a range of scientific research methods is available. Over the last thirty years some of these specific methods has been used interchangeable of their names have been misused for the actual research performed (Louviere 2010). Figure 4.1 provides an overview of the terms and their relation to one other.
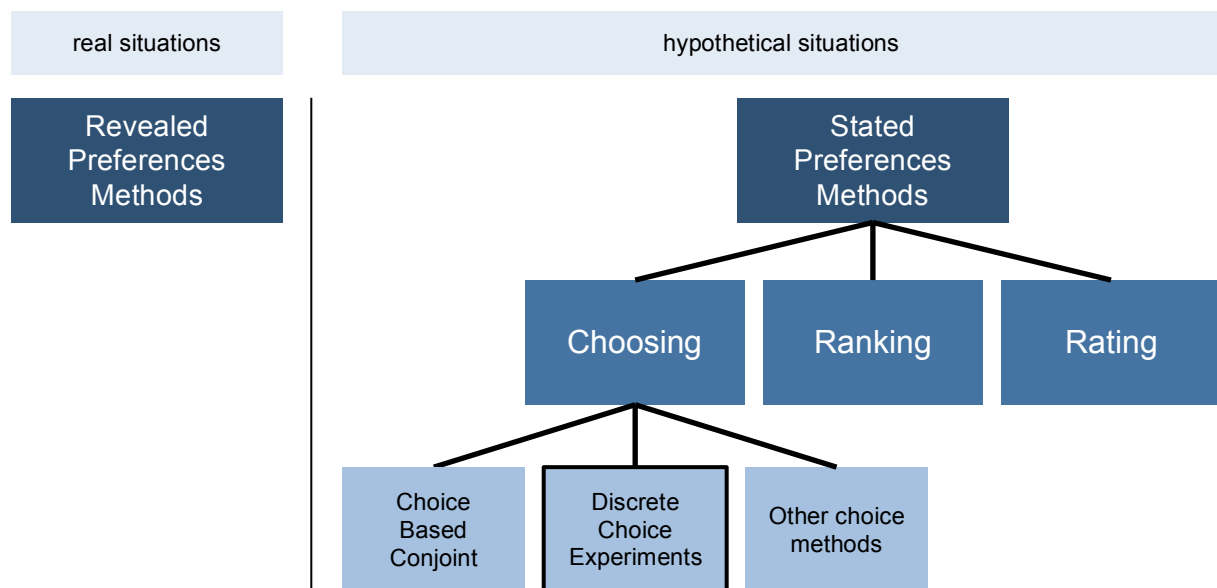
figure 4.1 | overview of methods used in researching respondents' preferences (adopted from Hensher 2005)

4.2 Revealed preferences vs. stated preferences

Conceptually, individuals make choices based on some underlying choice process. It is assumed that rational consumers always chose for the highest level of satisfaction (this term is used in the field of psychology) or the highest level of utility (this term is used in the field of economics). Economists usually use market-based data to obtain information about preferences. Observing individual behaviour in real markets is called revealed preferences (RP). This is shown on the left of figure 1.4. With stated preferences (SP), on the other hand, choices are made or stated given in hypothetical situations (Hensher 2005). The analytical

framework is the same for both. It is based on Lancaster's theory of value, in which it is assumed utility is derived from the underlying characteristics or attributes (Lancaster 1966).

The hypothetical nature of stated preference data offers the analyst a significant benefit over revealed preference data, as researchers are able to ask about intended policy, expected new products or new business ideas. Revealed preference data are constrained to only being able to collect information on currently existing alternatives. As such, the alternatives, the attributes, and the attribute levels are fixed in terms of what is currently on offer. Stated preferences data arise when there are limited or no revealed preference data because the good or service is new, not usually provided in a market context, or there is insufficient variability in actual choices to allow analysis of the attributes of interest. Stated preference data allows exploring issues outside of yet existing products or services. Research on a new type of dwelling for one-person households is a perfect topic to use SP for.

With stated preference experiments the attribute levels are pre-specified by the analyst and given to the decision maker by the researcher. The decision maker (a respondent) is then responsible to rate, rank or choose from different profiles, a hypothetical set of attributes and their levels. The more recent method of choosing is proved to be the most accurate as this method overlaps most what consumers already do in, for example, supermarkets (Green 2001). From a wide choice of different brands of peanut butter customers choose the jar of their preferences based on some internal contemplation.

4.3 Conjoint analysis versus discrete choice experiments

Within the field of stated preferences, the methods of conjoint analysis (CA) and discrete choice experiments (DCE) can be used. They are both stated preference elicitation methods, which are used extensively in the areas of transportation, economics and marketing (Louviere 2010, Viney 2002, Green 2001). Both of the methods elicit an individual's preferences for alternatives (whether these are goods, services, or courses of action) expressed in a survey context. Both of the options use experimental design methods to develop instrument for preference elicitation and the use of statistical models to determine the contribution of each attribute to preferences.

Author	Year	Method used	Topic of the research
Lancaster K.J.	1966	Consumer theory	*A new approach to consumer theory*
Green P.E., Srinivasan V.	1978	CA	*Conjoint analysis in consumer research: issues and outlook*
Louviere J.J.	1988	CA	*Conjoint analysis modelling of stated preferences*
Green P.E., Srinivasan V.	1990	CA	*Conjoint analysis in marketing: new developments with implications for research and practise*
Louviere J.J., Hensher D.A., Swait J.D.	2000	Choice behaviour	*Stated choice methods*
Green P.E., Krieger A.M., Wind Y.J.	2001	CA	*Thirty years of conjoint analysis: reflections and prospects*
Viney R., Lancsar E., Louviere J.J.	2002	DCE	*Discrete choice experiments to measure consumer preferences for health and healthcare*
Louviere J.J.	2010	DCE, CA	*Discrete Choice Experiments are not Conjoint Analysis*

table 4.1 | overview of the consulted articles

As CA and DCE appear to be likewise, this might be the reason that they have been used interchangeable over the last decades. Still, the origins of the methods are different (Louviere 2010) and are worthwhile to be mentioned in this report. Several articles were cited to provide this overview (table 4.1).

4.3.1 Conjoint analysis

Conjoint analysis (CA) is a generic term used to describe several ways to elicit preferences. CA's origins are in psychology, principally associated with research dealing with ways to mathematically represent the behaviour of ranking observed as an outcome of factorial designs of attributes, which are independent factors. CA is originally not a theory about the behaviour of preferences of choices, but instead a theory about the behaviour of sets of numbers in response to factorial manipulations of factor levels (Louviere 2010). Within conjoint analysis respondents can be asked to rate, rank or choose from alternatives. In general, conjoint analysis is inappropriate for economic evaluation. The term conjoint analysis means decomposition into part-worth utilities or values of a set of individual evaluations of, or discrete choices from, a designed set of multi attribute alternatives (Louviere 1988).

Choice-based conjoint (CBC) is a one of the techniques of conjoint analysis. The main characteristic distinguishing choice-based from other types of conjoint analysis is that the respondent expresses preferences by choosing from sets of concepts, rather than by rating or ranking them. The choice-based task is similar to what buyers actually do in the marketplace. This type of CA is similar to discrete choice experiments.

4.3.2 Discrete choice experiments

Discrete choice experiment (DCE) is a research technique originally based in the field of economics. DCE's are distinct from other conjoint methods because preferences are elicited by asking respondents to choose one alternative from those presented, rather than to asking respondents to rank alternatives, or give them a rating. The goal of discrete choice experiments is to understand and model the behavioural process that leads to the respondents' choices (Taneva 2008). Over the last thirty years the technique became increasingly popular in all sorts of research fields, as organizations and businesses benefit from understanding and predicting the behaviour of decision makers when choosing among discrete goods (Hensher 2005). In 2000, Daniel McFadden won the Nobel Prize for economics for his pioneering work in developing the theoretical basis for choice modelling.

Discrete choice experiments have two components; the use of discrete choice analysis to model preferences from data and the use of experiments to generate the required data, eliciting stated preferences for products or programs (Viney 2002). Discrete choice experiments statistically relate the choice made by each person to the attributes of the person and the attributes of all of the alternatives available to the person. Discrete choice experiments are based on the Random Utility Theory (RUT), which is originally initiated by Thurstone, back in 1927. RUT provides an explanation of the choice behaviour of humans, which is applicable to this research. RUT assumes that all individuals will always choose the alternative with the highest utility.

In general, multinomial logistic regression is used to predict categorical placement in, or the probability of category membership on, a dependent variable based on multiple

independent variables. The independent variables can be either dichotomous (binary) or continuous (interval or ratio in scale). Dichotomous variables can only take two possible outcomes. For binary dependent variables, logistic regression will better predict and therefore is a better alternative than normal regression analysis.

Utility (predicting choices) cannot be measured exactly because it may not be able to observe or measure every characteristic of the individual, product, or choice situation that affects choice behaviour. However, if some information about the individual, the product, or the choice situation can be observed, that information can help to predict choice. The overall utility, associated with the *i*th alternative, can be divided into observable (systematic) contributions and a stochastic error component, which are unobserved (random) contributions. This is captured in the Random Utility Theory (RUT) (Thurstone 1927):

$$U_i = V_i + \varepsilon_i \qquad\qquad (1)$$

In where:
  U_i is the overall utility.
  V_i are the observable, systematic contributions.
  ε_i is the stochastic error component (unobserved random contributions).

With the use of RUT, utilities are derived from the properties of goods or services (Louviere 2000). If all other factors (for example time, money etc.) are kept equal, a rational consumer is expected to chose the product with the highest utility when he/ she has a certain choice. If product A has a utility $U_a = 1$, and product B has utility $U_b = 2$, a rational consumer is assumed to pick product B. In general, given a set of alternatives *j* = 1,2,...,*J*, a rational person will choose the alternative that provides the highest utility, so that alternative *j* is chosen if:

$$U_j > U_{jn} , \ \forall \ j' \neq I \qquad\qquad (2)$$

In where:
  U_j is the utility of the chosen alternative.
  U_{jn} are the other alternatives in the choice set that a individual can choose from.

For a number of choice sets the choices made by each respondent can be compared with one other. In this research every respondent is shown 16 choice sets. Two per choice chart. The estimation with MNL results in a set of part worth utilities. With these utilities choices can be predicted for that specific respondent. The utility function for an alternative represents a linear equation corresponding to the functional relationship between the attributes and socio-demographic characteristic(s) and the utility associated with that alternative. The systematic utility of an alternative (V_i) exists of the sum of part worth utilities:

$$V_i = \beta_{0i} + \beta_{1i} \, f(X_{1i}) + \beta_{2i} \, f(X_{2i}) + \beta_{3i} \, f(X_{3i}) + \cdots + \beta_{Ki} \, f(X_{Ki}) \qquad\qquad (3)$$

In where:
  V_i is the systematic utility of an alternative, existing of the sum of part worth utilities.

β_{0i} is called the *alternative-specific constant*, a parameter not associated with any of the observed and measured attributes, which represents the role of all the unobserved sources of utility. This constant is derived from the dataset whether respondents have chosen either 'alternative I' or 'alternative II' ór 'non of both'.

β_{Ki} is the weight (or parameter) associated with attribute X_K and alternative *i*.

X_{Ki} is the value of attribute level *k* of alternative *i*.

β_K can be estimated by running a multinomial logistic (MNL) model with the software program of NLOGIT. This will be further elaborated on in chapter 5.

The estimates can predict the probability P that a certain alternative *i* will be chosen from a complete choice set (all the choices provided to the respondent). The probability *P* is the e-power of the systematic component *i* divided by the sum of the e-power of the systematic utility (V_{jn}) of all alternatives:

$$P\,(i|j) = \frac{e^{\beta_K X_{iK}}}{\sum_j e^{\beta_K X_{jK}} + e^{\beta_K X_{iK}}} \qquad (4)$$

The predicted probability P(Y) of logistic regression is always valued between zero and one. The choice with the highest probability is expected to be chosen:

$$\text{Prob(choice } j\text{)} = \text{Prob}(U_j > U_q), \forall\, q \neq j \qquad (5)$$

Logistic regression attempts to model the probability of a dichotomy outcome using a linear function of the predictors. Specifically, the log-odds of success (the logit of the probability) fit to the predictors using linear regression. Parameters are estimated by `fitting' models, based on the available predictors of the observed data. The fit is determined by the so-called log likelihood statistic that is depicted in formula (5).

$$LL = \sum_{i=0}^{n}\{Yi\ln(P(Yi)) + (1 - Yi)\ln[1 - P(Yi)]\} \qquad (6)$$

The log-likelihood ratio test statistic is used to test the fit of a model (formula 6). The calculations performed with the data are present in an additional data file accompanying this report.

4.4 Designing the discrete choice experiment

The only information about the good provided by the respondent is his choice (or rating or ranking) of these options. The respondent's overall preferences are then decomposed into the value of each attribute and level. This is what makes the design of the questionnaire in general and the selection of attributes in particular so important. Various articles have been published about the exigency to find suitable attributes and to design a survey carefully (Álvarez-Farizo 2002, Hensher 2005).

A discrete choice experiment has several key stages. In designing a discrete choice experiment certain steps have to be elaborated:
   - Identification of attributes and assignment of levels (paragraph 4.2.1);

- Experimental design, deciding what choices (job profiles) to be presented to individuals (paragraph 4.2.2);
- Development of the survey (paragraph 4.3);
- Data input (chapter 5);
- Analysis and interpretation (chapters 6 and 7).

4.2.1 Attributes

There is no accepted standard way to identify attributes and their levels (Louviere, 2010). The researcher must decide on attributes and their levels, and compose whatever explanatory text is desired to make respondents having the same interpretations of the attributes and their levels. The analyst has to make the hypothetical scenarios as realistic as possible, so attributes should be chosen carefully. This is to prevent decision makers from not taken the stated preference task seriously ('Why not, I'll take two helicopters.'). Unrealistic hypothetical scenarios will yield unrealistic output. With stated preference data, respondents are shown multiple choice sets, each of which has different attribute levels (and possibly even different alternatives present, depending on the design). Thus for each respondent, multiple observations are gained over the number of choice sets completed (Hensher 2005).

Following Lancaster (1991), selected attributes must be relevant, that is, 'if ignoring its existence would change our conclusions about choice or ordering of the goods by the consumer'. Alriksson and Öberg (2008) state that priority must be given to demand-relevant, policy-relevant and measurable attributes. In selecting attributes and their levels it is more than convenient to have the co-operation of experts and stakeholders (focus groups), in a guided discussion to provoke people to express their attitudes and opinions on the topic in question (Álvarez-Farizo 2002).

The aim of this graduation project is to determine simultaneously the relative importance of the different characteristics of the proposed draft design. Chosen is to perform an unlabelled experiment as the research entails only one proposed dwelling, which can be configured in various ways. A label attached to an alternative acts somewhat like an attribute for that alternative (albeit an attribute whose level is constant across treatment combinations (Hensher 2005). Therefor labels are not used in this specific DCE.

The chosen attributes are supported by the findings from the literature study (chapter 2) and the process of designing the draft design (chapter 3). In total, six attributes were chosen with a total of 16 levels. Experts from the Eindhoven University of Technology and the company of Heijmans validated the attributes and attribute levels. In this way the most important decision criteria, regarded the proposed dwelling, were taken into account. Furthermore the decision criteria were designed in such a way that they were comprehensible for respondents. The following attributes and levels were integrated within the online questionnaire:

1. The *maximum renting period*:
> *1 year*
> *3 years*
> *5 years*

The proposed housing concept concerns a temporal solution for housing one-person households on vacant land positions. The period for renting the accommodation is limited to a maximum of five years. This holds that dwellings can be rented for a maximum period of these five years. A maximum stay of one year or three years is chosen to check what affects this sort. With shorter periods the concept is more flexible to be replaced on another location, which makes permanent development possible. Also it is expected that a shorter stay will make renters less demanding.

2. The *energy performance* has immediate influence on the housing cost and environment:
  excellent (label A^{+++}) *the dwelling does <u>not</u> need energy from the grid*
  average (label A) *the dwelling needs <u>little</u> energy from the grid*
  poor (label B) *the dwelling needs <u>a lot of</u> energy from the grid*

The energy label of a dwelling becomes increasingly important for residents as the price for energy is rising (figure 2.6). Since January 1st 2008, the energy label (table 2.2) is required for homeowners who sell or buy a house. Even though no specific consumption data is provided yet, as this depends heavily on the final design of the dwelling, some levels of energy performance are suggested to the respondents. Label A^{+++} represents a CO_2-neutral house. All energy needed for heating as well as for consumer consumption, are then generated by installations integrated in the house itself. These can be photovoltaic panels and a solar water heater. Label A is the standard level for new to build houses. Label B is adopted as a check as it is interesting to find out how people perceive this label so it becomes possible to derive conclusions from this attribute.

3. Kitchen and bathroom will be standard included. The *level of completion* of the dwelling:
  non-padded
  padded
  furnished

People can only stay for a set period. It is expected that this influences their expectation of the accommodation. If people will only stay for a short term, will they go through all hassle to move furniture of do they tend to choose for a furnished house? Also the feeling of *home* is closely related with this attribute. When is feeling someone at ease? Do people like to take their own furniture (if they have so already) or do they prefer a turn-key solution?

4. The *total monthly cost* (rent + energy + maintenance) are:
  €550,-
  €600,-
  €650,-

Three levels of total monthly cost have been indicated. Based on figures of NIbud (paragraph 2.1.2) the draft design is developed based on a monthly design of €600,- including the rent, the average needed energy of one person and maintenance. The levels of €650,- were added to check whether people are willing to pay €50,- extra for a better alternative. €550,- was added to check if €600,- was rightly picked. If most people will always chose this cheapest option, a monthly housing cost of €600,- might be to steep.

5. The *type of dwelling*:
  1-room apartment *the bed is located in the living space*
  2-room apartment *the bed is placed in a separate room*

The online survey is not providing information on the square meters of the draft design. Instead it is asked for what type of dwelling respondents prefer most. Does their bed need to be in a separate room or is it no problem for people to have it in their living space? A more compact house, with fewer rooms, can be developed for less money. If it turns out that most people request a separate bedroom, than it is worthwhile to adopt this within the final design.

6. In a *communal space* residents could get together and share functions (washer, pool table, fire place etc.):
  with
  without
Offering a communal space provides the option for respondents to choose for having a place in which they can meet others and share functionalities (television room, large kitchen, fire place etc.). This is an extra service on top of the all-individual dwellings, which is the basic offer. The communal room could be regarded like a lobby in a hotel. People are free to use it, but also have their room to withdraw themselves. Offering a place in which people can meet each other physically can help prevent the downsides of individualization, which are stated by Poortman (2010).

4.2.2 Fractional factorial design
"By careful design and execution of the experiment, the maximum data per test dollar can be obtained." (Shapiro 1966)

This quote illustrates that a research benefits from a proper preparation. In this DCE, four attributes hold three levels, two attributes have two levels. In this way 3^4 x 2^2 = 324 unique combinations (profiles) can be generated. Showing all these options to respondents would take them that much time and energy that chances are small that some people actually complete the survey. Running the questionnaire would then be useless. Only the main effects of respondents' choosing behaviour are of interests in this study, the independence from irrelevant attributes, the IIA assumption, is assumed. This means that the choice probabilities of the alternatives are independent of the appearance of other alternatives in the choice set (Oppewal & Timmermans, 1993). When only the main effects are searched for, experimental designs can be used.

The specific fractional factorial design (a fraction of all possible alternatives) used in this discrete choice experiment can be found in appendix 4. The fractional factorial design decreases the total set of alternatives to only 16 profiles. This is an unbalanced design. Within an unbalanced design the attribute levels do not appear the same number of times within each attribute for the design. The use of balanced versus unbalanced designs is of interest as early research conducted suggests that the unbalanced attributes of an unbalanced design are often found to be statistically significant, not so much because the attribute itself is statistically significant, but because attention is drawn to that attribute at the time of the survey (Hensher 2005).

4.2.3 Effect coding
The data has to be coded in order to fit the eventual analysing method. Three types of coding can be used. Dummy coding, effect coding or orthogonal coding (Kemperman 2000, Hensher 2005). Effect coding has the same advantage of dummy coding in that non-linear

effects in the attribute levels may be measured, but dispenses with the disadvantage of perfectly confounding the base attribute level with the grand mean of the utility function. With effect coding all values for a given attribute sum to zero; in the case of even numbers of code levels, each positive code level is matched by its negative value, in the case of odd numbers of code levels, the median level is assigned the value zero. For the specific case of three attributes with three levels, orthogonal coding is similar to effect coding, but values change for attributes with more levels. For this research effect coding is used. The exact coding is presented in appendix 5.

4.3 Preparing the online questionnaire

The methodology, attributes and fractional factorial design were carefully translated into an online questionnaire, using the Berg software program provided by the TU/e. Appendix 7 shows the complete graphical interface, as was to be seen by the respondents.

Random individuals were able to complete the online survey, as the link to the survey was spread nation wide, through various channels. The provided information and the requested questions were kept to a minimum to make the survey as appealing as possible and to diminish the risk that people would terminate the survey before they would complete it. The language used is Dutch as the questionnaire is spread only within the Netherlands and there was no intention to specifically involve respondents who do not speak the Dutch language. In the first screen respondents were asked to participate. With some basic information about the chosen attributes and two images of the proposed transportable compact house, people were asked to fill out eight unique choice charts. Figure 4.3 shows an example of a possible choice chart.

huisvesting voor eenpersoonshuishoudens

Keuzeset - kies het alternatief van uw voorkeur:

kenmerken	alternatief I	alternatief II	geen van beide
maximale huurperiode	max. 5 jaar	max. 3 jaar	
energieprestatie	gemiddeld (label A)	laag (label B)	
afwerkingsniveau	gestoffeerd	gestoffeerd	
totale maandelijkse kosten	550 euro	650 euro	
woningtype	1 kamer appartement	1 kamer appartement	
gezamenlijke ruimte	zonder	zonder	
UW KEUZE:	◉	○	○

vorige   volgende

figure 4.2 | sample choice chart with explanation of the attributes

In every choice chart, respondents were asked to choose one of the three options available (*alternative I*, *alternative II* or *none of both*). These eight charts contained a unique set of a total of 16 unique profiles, following the fractional factorial design (appendix 4). The (behind the screens) excel file contained 100 uniquely ordered sets of these 16 profiles. Each time a questionnaire was started, the Berg system picked one of the 100 unique sets to show to a single respondent. In this way every one out of a hundred respondents was shown a unique order of the sixteen available choice sets.

Besides asking respondents about their preferences regarding the draft design, also some general social demographic questions were asked (appendix 6). With this basic information it

eventually becomes possible to link social demographical information of respondents to their preferences. This makes that the housing concept can be marketed very specifically.

4.4 Conclusions

A discrete choice experiment (DCE) is a powerful tool for researching the preferences of respondent in hypothetical situations. DCE enables researchers to test the impact of certain aspects (attributes) of a hypothetical product or service. This tool can perfectly be used to research respondents' preferences regarding the proposed housing solution.

As different attributes with each their various labels result in huge sets of alternatives, fractional factorial designs are used to decrease the number of alternatives that are provided to respondents. This makes a discrete choice experiment more attractable to complete by respondents. Based on the experimental design and the specific coding of the attribute levels (effect coding in this) case, eventually generated data can be analysed correctly.

chapter 5 | RESPONDENTS PREFERENCES

Chapter 4 has provided an overview of the method of discrete choice experiments (DCE). The undertaken DCE is the scientific backbone of this research. This chapter covers the process of the actual (online) survey performed. This chapter will answer the last sub question of paragraph 1.11.1:

- What are the preferences of respondents regarding the draft design?

5.1 Survey response

The online survey (see chapter 4 for exact characteristics) ran for three weeks, from June 12th until (and including) July 3th 2013. Because the need for one-person households to find suitable accommodation is spread nationwide (WoON 2013) and the transportable houses can be placed on various locations throughout the country, as Heijmans owns numerous positions, the online survey has been spread nation wide. Various channels were used in order to reach potential respondents:

- 450 people were invited to complete the survey through a call on the personal Facebook account of the graduate, on June 12th 2013.
- On June 13th a Heijmans Real Estate newsletter (with a reach of 760 persons) was sent to home seekers in (the area) of Zutphen. An invite and a link to participate in the online survey were included;
- The url of the online survey and the invitation to participate were shared on the internal social network of Heijmans, called Yammer, which potentially reaches all (about 8000) employees of the company;
- Finally the call is distributed on June 14th by the twitteraccount of @HeijmansNL. This account has 16.000 followers.

The questionnaire reached 625 respondents of which 280 respondents completely finished the survey (table 5.1).

Respondents	Started	Finished
#	625	280
%	100,0%	44,8%

table 5.1 | nearly 45% of the respondents that started, also completed the online survey

5.2 Descriptive statistics

Some basic information is derived at first sight. Slightly more women than men (52,5% vs 47,5%) participated in the survey (table 5.2). The 280 respondents that completed the entire survey, also provided answers on their socio demographic characteristics. The questions asked can be found in appendix 6. The software program of Statistical Products and Service Solutions (SPSS) was used to generate graphical illustrations.

Gender	Male	Female
#	133	147
%	47,5%	52,5%

table 5.2 | representation of men and women in the research

None of the respondents was younger than 17 years. Over have of the respondents (53,6%) was aged between 25 and 34 years of age. Only 7 people (2,5%) indicated they were over 65 years of age (table 5.3).

Age	<17 years	17-24 years	25-34 years	35-65 years	>65 years
#	0	57	150	66	7
%	0,0%	20,4%	53,6%	23,6%	2,5%

table 5.3 | distribution of different age groups

Respondents were asked to indicate what their individual monthly housing budget is. The figures show that all respondents are neatly divided over the three categories (table 5.4 and figure 5.1). Over 70% is able to spend over €550,- per month on their housing budget.

Housing budget	<550 euro	550-650 euro	>650 euro
#	77	100	103
%	27,5%	35,7%	36,8%

table 5.4 | indication of the monthly housing budget
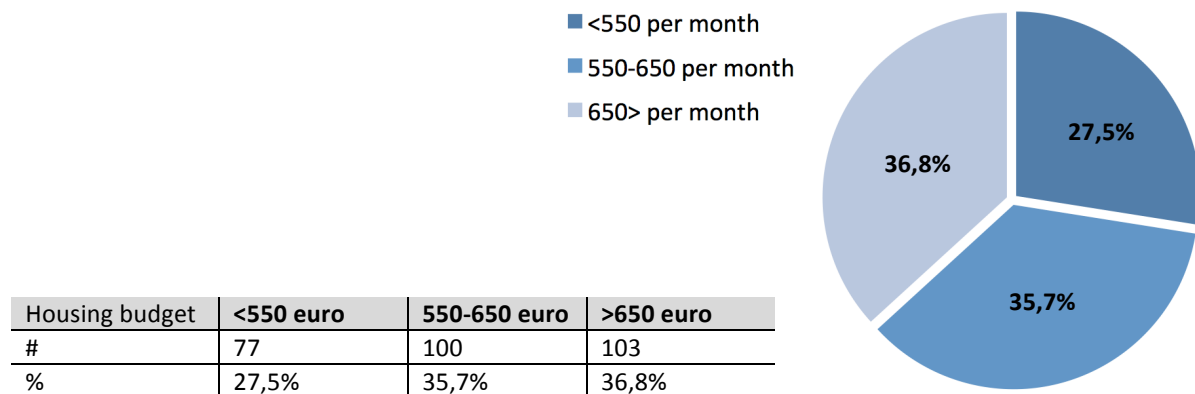
figure 5.1 | pie chart of budget
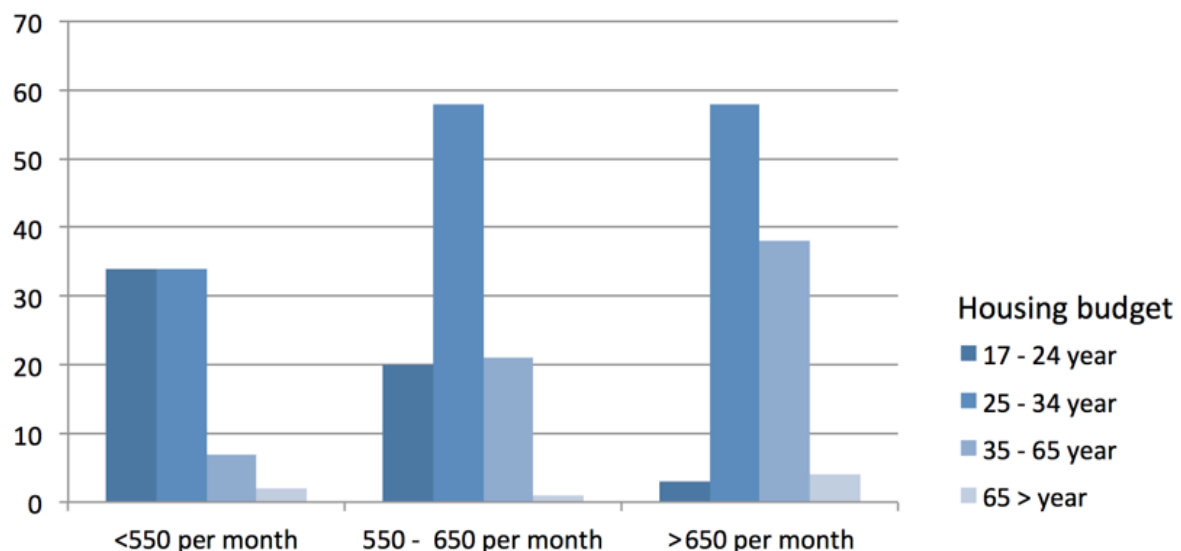
figure 5.2 | division of the spendable monthly housing budget per age category (actual numbers)

The output of the survey shows that people with the age of 17-24 have a maximum housing budget of €650,- per month. The majority of 25-34 years of age is fine with a housing budget which is higher than €550,- euro per month (figure 5.2). Furthermore, men are more likely to spend a higher amount on their monthly housing cost than women do (figure 5.3).
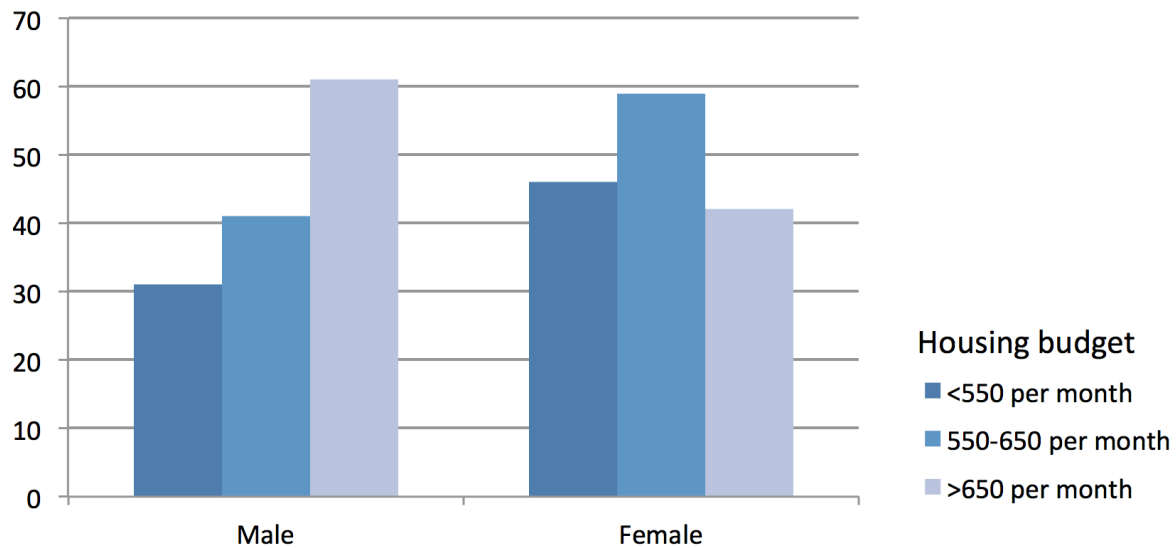
figure 5.3 | monthly housing budget per gender (actual numbers)

Respondents could choose from three options, *positive, neutral* or *negative,* to answer the question '*What is your impression of the design of the dwelling?*' Nearly 75% of all respondents perceived the design as positive. A minority of only 3,2% regarded the draft design with negative (table 5.5 and figure 5.4).

Opinion	Positive	Neutral	Negative
#	280	63	9
%	74,3%	22,5%	3,2%

table 5.5 | impression of the draft design

figure 5.4 | pie chart of impressions
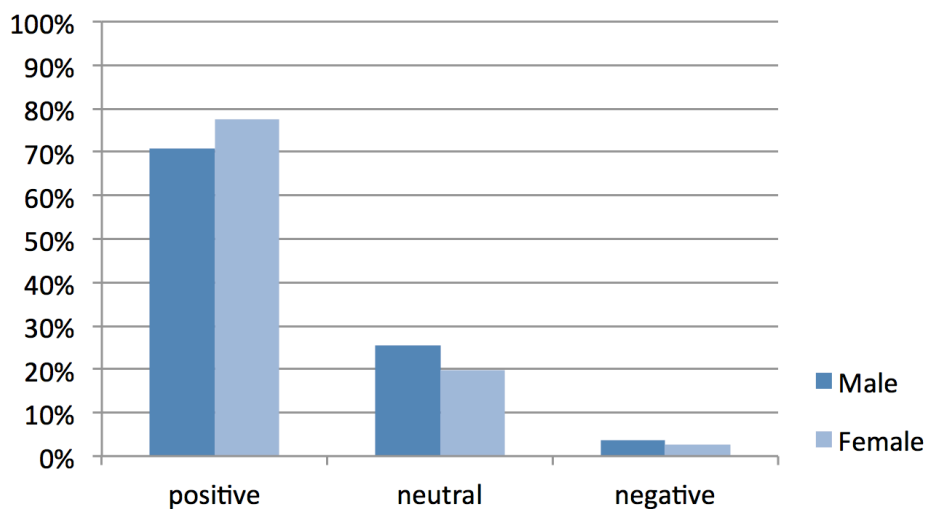
figure 5.5 | impression of the draft design per gender

Women perceive the draft design slightly more positive than men do (figure 5.5).

5.3 Estimation with MNL

In this paragraph the estimation method of multinomial logistic (MNL) regression is introduced. A MNL model can be described as an estimator that calculates parameters for which the observed sample is most *likely* to have occurred. MNL is one of the regression options within the software program of NLOGIT and is used to draw conclusions from the choices made between alternatives by the respondents, based on their actual preferences. First, a comparison with linear regression is provided in figure 5.1.

linear model
$Y = b_0 + b_1 x$

logistic model

$$P = \frac{1}{1 + e^{-(b_0 + b_1 x)}}$$
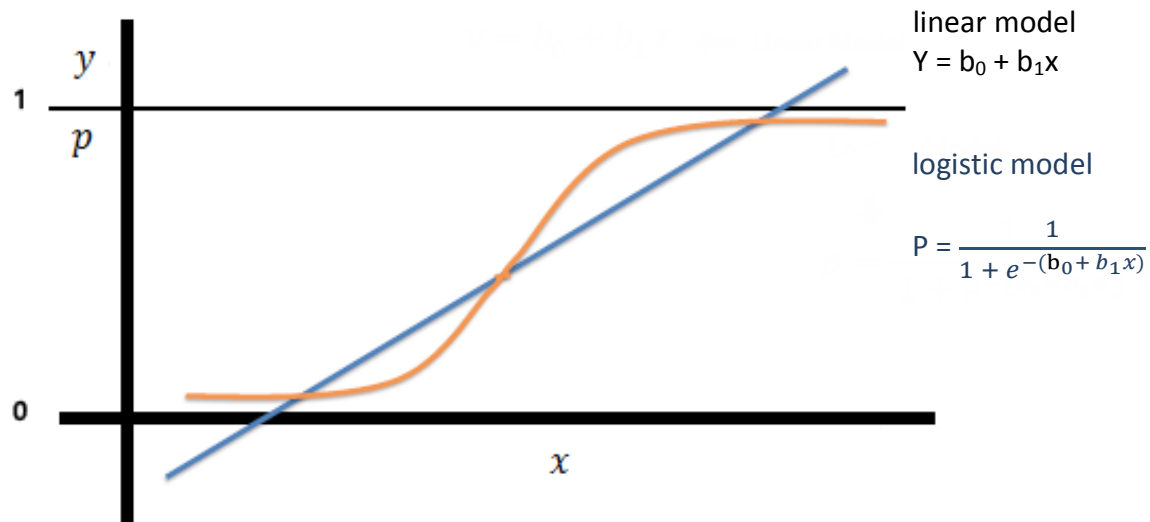
figure 5.6 | difference between linear regression model and logistic regression model
(www.saedsayad.com/logistic_regression.htm)

NLOGIT is the software package that accompanies the extensive primer of Hensher, Rose and Greene (Hensher 2005). Table 5.6 shows the MNL model of the data of all respondents (n=280) (appendix 9). Interaction effects were not measured. The coefficients (second column of table 5.6) represent β_{Ki}. The highlighted rows indicate two insignificant outcomes, as these fail to meet the 95%-level of significance. The value of significance (last column) should not exceed 0.05.

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
CONST	.65821097	.06169757	10.668	.0000
PER1	−.64899415	.05586186	−11.618	.0000
PER2	.15633885	.04413625	3.542	.0004
ENER1	−.55392545	.05452532	−10.159	.0000
ENER2	.00322635	.04479517	.072	**.9426**
OPLEV1	−.01522069	.05224965	−.291	**.7708**
OPLEV2	.16540295	.04564535	3.624	.0003
PRC1	.24680369	.05217846	4.730	.0000
PRC2	.09126583	.04560597	2.001	.0454
TYPE	.63283547	.03579924	17.677	.0000
COMM	−.12308964	.03300800	−3.729	.0002

table 5.6 | direct output of the MNL regression performed with NLOGIT

5.4 Interpretation of the data

The part worth utilities found in this discrete choice experiment (involving all respondents) are shown in table 5.6. These part worth's are found by converting the coefficients (appendix 9) with the use of the coding of the labels (appendix 5).
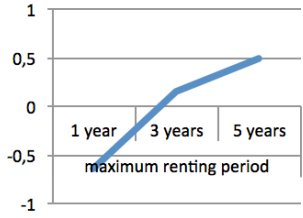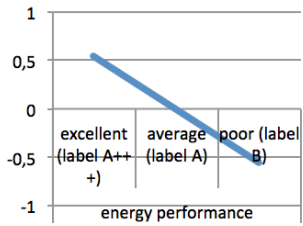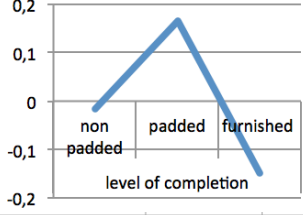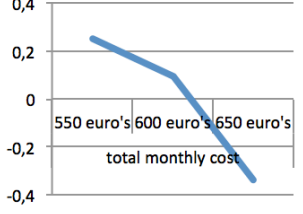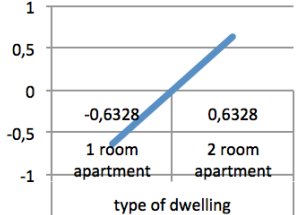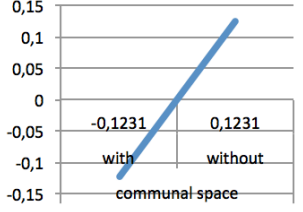
attribute	attribute level	part worth	range	graph
maximum renting period	1 year 3 years 5 years	-0,6490 0,1563 0,4927	1,1417	
energy performance	excellent (label A+++) average (label A) poor (label B)	0,5507 0,0032 -0,5539	1,1046	
level of completion	non padded padded furnished	-0,0152 0,1654 -0,1502	0,1654	
total monthly cost	550 euro's 600 euro's 650 euro's	0,2468 0,0913 -0,3381	0,5849	
type of dwelling	1 room apartment 2 room apartment	-0,6328 0,6328	1,2656	
communal space	with Without	-0,1231 0,1231	0,2462	

table 5.7 | part worth's per attribute level and their range

Some conclusions can be drawn from table 5.7. The heavy negative influence of a renting period of maximum 1 year becomes visible. A maximum stay of one year is probably too short for most people when they search for new accommodation. The output can be interpreted that most people plan to stay longer in their intended next accommodation. Or, at least, that people want to have the possibility to choose when to move on themselves.

The high influence of an excellent energy label (A^{+++}) on respondents' choice is surprising. This could be because the online survey informed about no external energy being needed when the house has an A^{+++} energy label. This saves costs for future inhabitants of the dwellings. An average energy performance (label A) is perceived as the standard as its part worth is as good as zero. A poor energy efficiency (label (B)) is valued negatively by respondents, quite heavily actually. People do care about the energy performance of their house.

Only a small percentage of respondents prefer a padded house above a non padded dwelling. A furnished dwelling, although, has a negative impact on respondents' preferences. This could be because respondents take in consideration the furniture they already own themselves that they like to take along, or they prefer to shop for their own furniture as taste for a certain style can be involved.

It comes as no surprise that the lowest monthly cost, €550,- per month, is perceived as most preferable. A monthly cost of €650,- euros per month has a negative influence on the alternatives provided.

When people have to choose between a 1 room apartment (with the bed placed within the living space, like a studio) or a 2 room apartment (separate bedroom), the overall preference is convincingly in favor of the second option. This decision may have to do with privacy. Visiting friends or family than can be hosted away from the bedroom section. Or this choice is based on traditional views that a bed has to be placed in a separate room as most people are not yet used to the idea of living in a loft.

The presence or absence of a communal space does not have a great impact on respondents' choice. Still it is remarkable that the presence of a communal space is actually perceived as less attractive than having no communal space. This can have various reasons. Either people did not read the explanation on the second page of the survey carefully, which states that the communal space is an extra room, next to the individual compartments. It is also possible that people simply are not willing to share certain space or that they expect to have to pay extra for a communal space, when they do not actually want to.

5.5 Data of sub groups
Respondents have provided their preferences concerning specific alternatives as well as their socio demographic details. Linking this data together makes it possible to distillate valuable information on specific groups and their preferences. Based on the intention of offering the transportable compact houses to single starters in small to average places, some sub groups have been filtered from the complete data file. There are five sub groups:

- People living in places with less than 50.000 residents;
- People with a housing budget of 550-650 euros per month;

- People living in places with less than 50.000 residents <u>and</u> who are between 17 an 34 years of age;
- People living in places with less than 50.000 residents <u>and</u> with a housing budget of 550-650 euros per month;
- People with a housing budget of 550-650 euros per month <u>and</u> 25-34 years of age.

The output of the MNL models of these sub groups can be found in appendixes 10-14. Together with the data from all respondents (paragraph 5.3), the data from the sub groups is combined into a decision support tool, made with the use of Excel. This tool provides the possibility to compare two different alternatives with one other. When one varies only one attribute level, it becomes visible that energy performance label A^{+++} compared to label B result in a 75%-25% probability division of the two alternatives. 2 room apartment versus 1 room apartment result in 78%-22% division. Without a communal space versus with a communal space yields the probabilities 58%-42%.

5.6 Conclusions

An online survey presented the developed draft design to respondents throughout the Netherlands. The aim of the online questionnaire was to inventory which attributes influence the draft design most, as noteworthy conclusions can be implemented in a final design.

625 people started the survey of which 280 people completely finished the survey. Two types of data were gathered. Information was found on respondents' preferences and some of their basic socio economic information. No people younger than 17 years of age participated in the survey. Only 7 people over 65 years of age participated, their input is to be neglected as a (sub) dataset of at least 30 respondents is preferred (Hensher 2005). About 75% of all of the respondents had a 'positive' first impression of the design.

Multinomial logit models were ran to find the desired part worth's. The estimation reveilles that two attributes, energy performance and type of dwelling, have a great affect on respondents' choice behaviour. When a proposed alternative has a poor energy performance (label B), then this option is rewarded negatively. This effect could be a result of social preferred behaviour as the energy consumption of houses is a hot topic so that people are unconsciously choosing for the most efficient energy label (A^{+++}). Also the option of a 1 room apartment was rejected in general. It turns out that people like to have a separate sleeping room. The research also shows that people prefer the 'padded' alternative above alternatives in which the design is non-padded or even furnished, which has actually a negative influence on someone's preference. This latter effect is surprising but it could be argued that people like to bring, of buy, their own furniture instead of having to use others furniture, which also could be a matter of taste.

A communal space that is to be shared with others is not preferred. Respondents indicate with their preferences that they rather have their own individual housing space without having to share (additional) functions. It is found that the lowest prices, €550,-, is rewarded with the highest utility. It is obvious that people prefer the least amount of money for a certain alternative. The most negative influence has the attribute level of a renting period of maximum 1 year. People prefer to be able to stay longer in a next accommodation. A renting period of maximum five years is therefor rewarded positively.

PART C

FINDINGS

chapter 6 | COMMERCIAL APPLICABILITY

Part A and B provided the answers to all sub questions that were introduced in paragraph 1.11.1. This chapter wraps all of the information into an integrated business plan. The aim of the business plan is to provide a clear overview that answers the main research question, as captured in paragraph 1.11:

> **What are the requirements to house one-person households in CO_2-neutral dwellings on vacant land positions in the Netherlands?**

6.1 Business plan

Heijmans Real Estate owns about fifty vacant building plots in the Netherlands, merely in non-urban locations. Current market conditions prove that development of permanent buildings on these plots on short term is rather difficult. In the meantime the company searches for temporal solutions that can generate revenue on these vacant building plots.

Secondly, the inability of one-person households to find affordable accommodation initiates this business plan. The Dutch housing market needs to offer additional (financial) suitable alternatives for this target group (WoON 2013). Proposing specific, affordable houses for one-person households could contribute in solving a societal problem, as home seekers will have a wider choice of living by themselves. Offering accommodation to one-person households is a serious business opportunity for the company of Heijmans.

Before the content of the business plan is elaborated, firstly the basic definition of a business plan is provided. A business plan is a formal statement of a set of business goals, the reasons they are believed attainable, and the plan for reaching those goals. It may also contain background information about the organization or team attempting to reach those goals.

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Mostly, business plan are written to convince investors that a certain annual return can be generated in a certain timeframe, in general three to five years. Business plans may also target changes in perception and branding by the customer, client, taxpayer, or larger community.

6.2 Business proposition

This business plan proposes a realistic solution to house one-person households on vacant land positions throughout the Netherlands, (partly) owned by Heijmans. A temporal solution might be easier to be approved by municipalities, as permanent development proves to be close to impossible in the current market conditions. With a temporal building permit, to be acquired from local authorities, residents could rent dwelling for a set period with a maximum of five years. One-person households (solo residents) will be housed in transportable, CO_2-neutral compact houses. If succeeded, Heijmans benefits directly from generating revenue from the monthly rents, as well as indirect benefits from place making (positive impact) of the temporal activity on their locations.

As the houses can only be located with a temporal permit, they need to be transportable. Each house consists of two modules per dwelling. This proposition follows the ambitions to cut down on CO_2-emissions of the built environment (AgentschapNL 2010, BZK 2006a, BZK 2006b): the houses are CO_2-neutral as they independently generate the energy needed for heating and residents activities. This aim contributes to a less polluted environment and a cheaper energy bill for the renters. As the target group are solo residents, having one income, and therefor restricted financial possibilities, the houses need to be affordable for one-person households. Therefor the designed house is about 45m^2. Furthermore the houses must have an attractive design in order to attract, and to interest, potential renters/ investors immediately. All these principles together sum to the realization of well designed transportable, CO_2-neutral compact houses for one-person households, which are offered for a monthly rent of €600,-, including the electricity and warm water needed by an average habitant. The maximum stay of the houses is five years per location. After this period they will be moved to another location. By doing so, the houses act as a temporal buffer on local housing markets. The houses are designed to exist for at least 25 years.

6.3 Target group

In the Netherlands 70% of the housing stock consist of one family houses, especially developed for an average family consisting of two adults and two children. The current housing stock does not meet the (financial) possibilities of one-person households. Nibud expects the average household purchasing power further to be reduced in the coming years. The erratic market conditions and the homogeneous housing stock, mainly consisting of family homes, make it difficult for one-person households to enter the housing market.

According to the Dutch Statistics Central Office (CBS), the number of households in the Netherlands rises from 7.3 million in 2009 to 8.3 million in 2039, mainly due to the growing number of single-person households. Already within the next twelve years an increase of 500.000 one-person households is expected. Increasing individualization, a high rate of divorces and a growing group of single elderly contribute to this development. In 2050, an estimated 44% of the total number of households is a one-person household, this compared to 36% in 2011. Figure 6.1 shows that nearly every region in the Netherlands shows sharp growth (10% or more) of the number of households until 2040.

2010 - 2040

Sharp decline (-10% or more)

Decline (-10 to -2,5%)

Reasonable stable (-2,5% to 2,5%)

Growth (2,5 to 10%)

Sharp growth (10% or more)
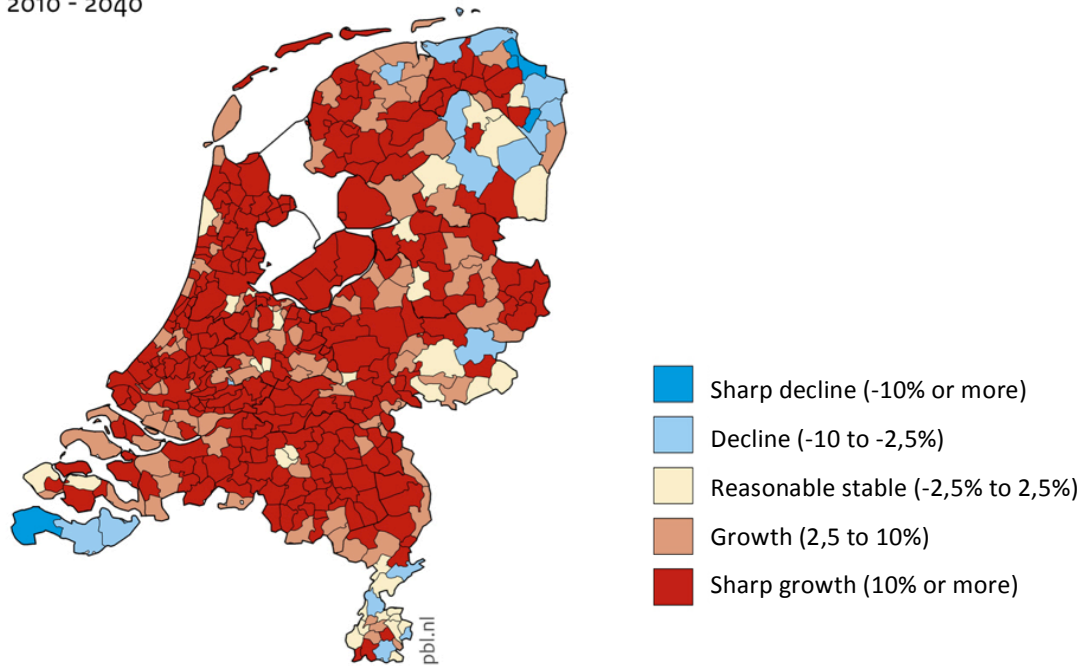
figure 6.1 | growth of households until 2040 (www.ppl.nl)

- Index population
- Index households
- Index one-person households
- Average size of a household
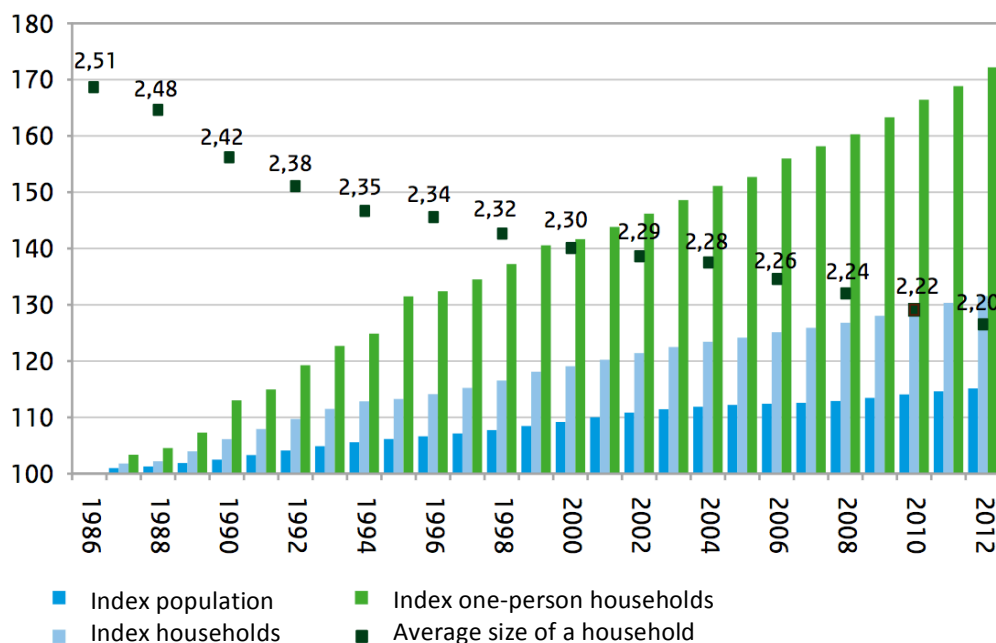
figure 6.2 | number of one-person households in the Netherlands (WoON 2013)

Within the period between 2009 and 2012 the Netherlands gained 200.000 additional households, an increase of 2.7%. 140.000 of these households live in an independent house. The additional 60.000 people either share accommodation with friends, went back to live with their parents or they remained to live together with their ex partner, as they are (financially) unable to move to another dwelling. The majority of this group are singles up to 35 years of age. The survey also indicates an increasing number of one-person households in the Netherlands (figure 6.2). This is a nation wide development (WoON 2013).

People between 20 and 35 years of age are most likely to be affected by the effects of the current rise of individualization With targeting these people we take in consideration the findings of (Poortman 2010), which states that people get in a relationship at an older age. More often people stay single during their twenties in order to focus on their personal development. Here for, the proposed housing concept targets on one-person households between 20 and 35 years of age specifically. Offering tailor fit housing solutions for these people can result in successful business. People within the specific target group meet the following conditions:

- They are between 20 and 35 years of age;
- It is their first solo accommodation;
- They live by themselves (even though they might have a partner living elsewhere);
- Having a housing budget of +/- € 600, - per month (based on a rent of €500,- per month (25% of €2000,- income) and €100,- for electricity, heating and warm water).

The rise of singlehood is a global trend. Especially within cities the percentage of one-person households is high. According to the market research firm Euromonitor International, the number of people living alone globally is skyrocketing, rising from about 153 million in 1996 to 277 million in 2011, an increase of around 80% in 15 years. In the UK, 34% of households have one person living in them and in the US it's 27%. Sweden, Norway and Denmark have traditionally the highest percentages of one-person households in the world. These figures might imply plugging the business proposition into foreign countries as well.

6.4 Current market

From a list of about fifty locations, that are (partly) owned by Heijmans, some potential areas were preselected to plug the housing concept (appendix 15). Online research shows the current stock of apartments and houses for rent in these locations (appendix 16). The average renting price in the liberated sector in place A is about €980,-. For this money, dwellings with an average size of about $144m^2$ are offered. Place B sums to an average renting price of €997,- for an average of $103m^2$. These apartments are spacious for a solo resident. This business proposition offers a new market segment. The compact houses are about $45m^2$ and to be rented for +/- €600,- per month. This is about €400,- cheaper than average renting prices in the liberated sector in the indicated places.

6.5 Competition

Several initiatives have already been plugged in the market. As the rise of singlehood is a global trend, numerous examples of compact houses can be pointed out. These examples can be divided in international and national competition.

6.5.1 International

IKEA is one of the companies who foresaw the rise of singlehood already years ago. Probably because Sweden has the highest number of one-person households in the world: 47%. In Norway the percentage lays at 40%. In cooperation with Skanska, an international project development and construction group, IKEA developed BoKlok, which offers space saving modular building blocks. The concept is sold through IKEA warehouses in Scandinavia. The concept of BoKlok lies perfectly in line with IKEA's practical efficient space saving furniture and design solutions. With ingenious solutions the designers of the multinational are able to convert small living spaces into homes that actual being experienced as spacious. In IKEA stores all over the world, examples of compact apartments are shown, completely furnished and decorated, and perfectly liveable for singles or couples.

6.5.2 National

In the Netherlands several CO_2-neutral or transportable projects have been built. Prototype I in Concept House Village is a semi-permanent houses, built in Rotterdam to experience the possibilities over low energy homes. Also Space Boxes are known to numerous students, as these compact dwellings are placed on several university campuses, including the Eindhoven University of Technology. Contact was sought with De Vijf bv, the company that placed these stacked dwelling throughout the Netherlands. Over the last years less of these Space boxes were placed as the need for student dwellings is measured differently. The Dutch government states that a door to door travel time for students is still acceptable. Therefor many students are not involved in the figures that are presented on students in search of accommodation. Also De Vijf bv experiences the results of converted offices buildings into student dwellings. This makes that the market has decreased over the last years[12].

Dutch companies De Meeuw, Jan Snel and De Groot Vroomshoop offer building modules, which are to be configured into all sorts of buildings. These buildings can be used temporally or permanent for various functions. Schools, offices, hospital or even houses are being created out of several modules. Recently www.verplaatsbaarvastgoed.nl was launched. This company offers modular building blocks made of a composite material. A module consists of only six pieces, transportable in a flat package. Still, these modular blocks have about the same size as the conventional companies offer, about 6 x 3 x 2,8m (l x w x h). All these companies advertise with 'tailored fit housing solutions'. Their flexible concept has endless possibilities, which is a wide message to communicate to consumers. Several other competitors on the market for transportable houses are included in appendix 15.

6.5 The design

In contradiction to alternative offered by competitors, this business proposal aims to present one clean-cut housing solution that end users understand immediately. Lessons can be adopted from the car industry. With buying a car we are not interested in separate parts like seats or airbags, the final product just has to be put together perfectly, it should be safe and affordable and preferably it has to look great as well. Most car drivers are not interested in all sorts of possibilities (business point of view), they just need one solution that meets their personal situation perfectly (customers point of view). This latter position is chosen to start from with designing a transportable compact house.

The draft design, which is elaborated in this business plan, is the concept version of the eventual design of the transportable house. The design measures 11,8 x 3,5 x 5,8m (l x w x h) and consist of two prefab wooden modules, which are to be connected vertically. These two modules are therefor light weighted and transportable over road without needing additional transport permits as the maximum width of transportable goods is 3,5 meters. Paragraph 3.5 provides illustrations of the draft design. The house should be equipped with about $17m^2$ (10 panels) of photovoltaic in order to generate 2000 kWh each year, this should be sufficient for the needs of a one-person household in a extensively insulated house. Also a ultra high vacuum boiler is requested to be integrated in the roof of the house, as this installation ($1.6m^2$) can generate enough warm water to heat the dwelling as well the water needed to shower and to do the dishes with. The initial cost for these installations are expected to be around €6100,- (appendix 19). Eventually all generated energy will be free of charge.

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[12] E-mail conversation with Mart de Jong, owner of design office De Vijf bv. April 24th 2013.

6.6 Monthly housing costs

Without any doubt the business proposition needs to be financially sound in order to become realizable. In developing the housing concept, the financial possibilities of one-person households are taken into consideration. For a single dwelling an integrated monthly price of €600,- is targeted at. This price includes rent and an average amount of electricity and warm water. This price is determined to fill the gap between dwellings in the social housing sector and the offer of the free renting sector (appendix 17). The monthly housing budget is roughly based on a gross income of €2000,-. A monthly rent of €500,- would result in a renting quota of 25%, which is in line with the Nibud advise. An additional €100,- is calculated for electricity and warm water as in a conventional dwelling renters would have spend this money on their bills for external energy. The maximum monthly rent (excluding energy and water) for being able to receive financial support form the government is set at €681,02 in 2013. Offering accommodation under this limit enables renters (≥23 years of age) with the option to request for housing allowance, which makes this proposition financially even more attractive for them.

6.7 Construction costs

The housing concept aims to provide one single bill on which all basic needs of the resident are included. In collaboration with financial experts of the company of Heijmans, an overview of the founding costs is developed. In this overview it becomes transparent which investments have to be made in order to result in a certain profit. With a lifecycle of the dwelling of 25 years and a monthly income of €600,-, each house has to be built for a maximum of €38.000,- in order to result in a healthy business case. This calculation is based on building 20 dwellings at once. Each house should be delivered turnkey for €60.000,-. This price includes VAT (*btw*), transport costs and profit. It excludes the cost for land. Appendix 18 shows the complete overview of this calculation.

Developing a house for €38.000,-. Is highly challenging. Specified calculations show that the draft design should be optimized even further. The draft design is still €10.000,- over budget. An overview of the costs of a single dwelling (based on a production of 20 houses) is shown in appendix 19. One way to drastic lower the building cost is to make the dwellings even more compact. Therefor they might not be in line with the Dutch building regulations. To get a better idea of the differences in legislation the building regulations have checked. An overview of the differences is to be found in appendix 20.

6.8 Market share

The next twelve years (until 2025) will add a half million (500.000) one-person household. All these people need to be housed and the current market provides little possibilities for this specific target group. About one seventh (+/- 71.000 people) of these 500.000 people are within the age group of 25-34 years. Many of them will find accommodation within the existing housing stock. Still, if only for 5% of these people a transportable house would be the ideal solution, then about 3550 dwellings could be realized over the next twelve years.

6.9 Legal

The legal aspects of transportable houses are divided into two main categories: the temporary exemption of the zoning plan (*tijdelijke ontheffing bestemmingsplan*) and the agreement with users. Regarding the temporary exemption of the zoning plan it is assumed that the transportable houses are to be placed in locations where the zoning plan not yet

provides in the function of residence. To be allowed to place the houses thus requires a temporary exemption from the zoning plan, based on Article 2:12 paragraph 2 of the Wabo (*wet algemene bepalingen omgevingswet*). Municipalities can provide these permits for a maximum period of five years. The procedure to be followed is called the "*Detailed Procedure*". This procedure takes at least six months. Situations in which municipalities may grant such temporary exemption are not tightly defined. Important is that can be proved that the function is indeed a temporarily solution, that it provides in a temporary need. The intention to move them away after the granted period should be clearly elaborated on.

National legislation applies to the rental of housing accommodation, regardless if the dwelling is movable or immovable. It is of interest what the intentions are of the parties involved and whether it is clear from the circumstances. The more elements showing that the proposition is not intended to be a permanent one, the more likely it is that the property is not considered as a living space. Elements of importance are how easily the units are to be transported (the less time and effort it takes, the better). Also the temporal solution should not affect the building plot too heavily, modifications made have to be irreversible. Furthermore, the leasing contracts with tenants should have of a temporary nature (extension of the contracts is possible, but no more than x years). People will have to register themselves with the municipal population register (*gemeentelijke basisadministratie*).

The position of the tenant should be secured in all cases. When the national legislation applies to the renting contract, then the possibilities to terminate the lease contract by the landlord are limited. Also the eventual permanent development of the area, and the exact location of roads for example, is of relevance in planning the exact locations of temporal dwellings.

Comparable situations:
- Student housing in stacked container dwellings. Students are offered temporary campus contracts. If the tenant is no longer studying, then the renting contract is automatically terminated.
- Holiday park Landal Greenparks offers Landal business rent. These contracts are basically closed for up to one year. Their compact holiday houses are to be rented by the business sector; it is therefor not possible to use the address of the resort for first place of residence. Renters should have another home address besides the holiday home.
- Temporal workers are working during specific peak periods in, for example, the agricultural sector. The transportable houses can be placed on private grounds and to be offered to temporal workers linking the leasing contract to their temporal stay at the company they work for.

6.10 Decision support tool
Based on the generated information on respondents' preferences (chapter 5) a decision support tool has been developed with the use of Microsoft Excel. The tool provides in comparing two different alternatives against each other. The tool generates the probabilities of the two alternatives being chosen by certain respondents. The decision tool involves the

data set of (a.) all respondents together (n=280), and also the data of five different sub groups of whose preferences can be viewed as well. The included sub groups are:

 b. Respondents living in places with <50.000 residents (n=102)
 c. Respondents with a housing budget of 550-650 euros per month (n=100)
 d. Respondents living in places with <50.000 residents and 17-34 years of age (n=53)
 e. Respondents living in places with <50.000 residents and a housing budget of 550-650 euros per month (n=39)
 f. Respondents with a housing budget of 550-650 euros per month and 25-34 years of age (n=58)

A screenshot of the decision support tool is shown in appendix 21. With the use of drop down menus in the grey area of the two alternatives describes, various alternatives can be compared with one other. The specific example provided shows the impact of an (excellent) A^{+++} energy label compared to an (average) A energy label. The two alternatives, of which all other attribute levels are similar, are rewarded quite different. A difference of 30% (alternative I 65% versus alternative II 35%) has been recorded in the sub group of respondents who have a housing budget of 550-650 euros per month and are 25-34 years of age.

6.11 Conclusion

This business plan reveilles the great potential of bridging the gap between the need for affordable accommodation by one-person households and the potential offer of Heijmans: offering CO_2-neutral dwellings on their land positions. A highly potential design has been developed in collaboration with an architect. This draft design is still €10.000,- over budget. A final design should result in cheaper buildings cost in order to close the business case. The business case is based on a lifetime of 25 years of each dwelling and a monthly pay of €600,- per resident.

There are certainly opportunities for arranging temporary rent, but these come with some risks. In advance it cannot be said whether temporary lease without security of tenure is permitted, given the casuistry. However, contracts with residents can be explicitly focused on the temporal character of the agreement. Municipalities should in any case agree on the temporal placement of transportable houses.

Based on the generated data of the online survey, a decision support tool has been developed which provides a one-screen overview of the different preferences of various sub groups of respondents. Attribute levels of certain alternatives can easily be changed so changing probabilities can be seen immediately. With this tool, the company of Heijmans can easily check which business proposition is most likely to succeed with a certain target group.

chapter 7 | CONCLUSIONS & RECOMMENDATIONS

Conclusions

Current market conditions prove the development of permanent buildings on available vacant land positions to be difficult. Still, or even therefor, temporal solutions might be a feasible alternative. Temporal buildings may be placed on vacant land positions for a maximum stay of five years, based on a temporal building permit. Transportable houses can placed on these vacant land positions to house people that otherwise have less chance in finding affordable accommodation. Investors will not have the risk of investing in permanent real estate that cannot be moved anymore. As the houses are transportable so they can be used in other locations, financial risks are minimized. After five years the temporal houses can be replaced to locations were they are needed more. In this way the transportable houses function as a temporal buffer on local housing markets. This can be in the Netherlands, but the houses can as well be transported to other countries, depending on the need for housing elsewhere.

Renting becomes more popular for starters instead of buying a house. Also individualization is on the rise in the Netherlands. One-person households are in need of affordable accommodation. The next twelve years (until 2025) will add a half million (500.000) one-person household. All these people need to be housed and the current market provides little possibilities for this specific target group. About one seventh (+/- 71.000 people) of these 500.000 people are within the age group of 25-34 years. Many of them will find accommodation within the existing housing stock. Still, if only for 5% of these people a transportable house would be the ideal solution, then about 3550 dwellings could be realized over the next twelve years.

As our society has improved awareness about the energy efficiency of buildings, it has become worthwhile to emphasize on the development of CO_2-neutral housing concepts. Compact, transportable and CO_2-neutral houses could be an adequate alternative to satisfy the needs of one-person households in search for affordable accommodation. As the company of Heijmans (partly) owns about fifty vacant land positions, this idea is of great relevance for their organization. Their houses should meet the standard of being energy neutral. This can be achieved by making the houses all-electric, so no gas connection is needed. Electricity can be generated with photovoltaic cells on the roof. Warm water can be arranged with the use of a ultra high vacuum panel. Such a device is able to heat a dwelling as well as providing warm water to shower or to do the dishes with.

The online survey (n=280) that is performed to gather data about respondents' preferences provides hand on information on how a house should be configured in order to best meet customers demand. 75% perceived the proposed housing design as 'positive'. Respondents participating in the survey especially preferred alternatives with the maximum renting period of five years. Also an excellent energy label (A^{+++} label) has a great positive contribution to a certain proposal. It is worthwhile to invest in energy generating system beforehand as the can also result in lower monthly costs as the prices for energy is rising. A separate bedroom (2 room apartment) is also highly preferred above a studio (1 room

apartment). Preferably, houses are padded and not furnished. Also no communal space is required, as respondents do not appreciate these extra offerings.

In short the conclusions can be wrapped as follows:

- Their is a huge market for solo-living: 500.000 extra households in next 12 years (until 2025, CBS '13). About 71.000 of these will be in the category of 25-34 years of age;

- In order to present a healthy business case, the maximum cost per house should be €60.000,- all-in (transport, profit etc.);

- The building cost per house may be €38.000,- at maximum. The draft design is still €10.000,- over budget;

- A maximum renting period (5 years), having a separate bedroom and an excellent energy performance (label A^{+++}) are rewarded as being very important to potential renters. These aspects should be implemented in the final design;

- Respondents do preferably not require a communal space nor furniture.

Recommendations

The recommendations distillated from this report are addressed to the Real Estate division of Heijmans and additional stakeholders like municipalities and (local) brokers, whose aim it is to house people (vulnerable target groups). These recommendations follow the research that is performed on the housing of one-person households. The research explicitly focused on accommodation one-person households, as this is a growing and highly undervalued target group on the current housing market. The target group is in need for specific housing propositions that meet their need for affordable independent accommodation. As the research shows a significant need for housing of this target group, policy makers, developers and designer should actively start to collaborate in order to realize possibilities to house one-person households.

Heijmans should adopt the findings of this report to launch a pilot project in which at least two actual dwellings will be realized. This could kick-start large-scale development, as municipalities might be convinced on embracing such flexible way of housing. Municipalities should seek for possibilities in their legislation to allow for these pilots. On top of the findings of the discrete choice experiment, which was undertaken in this research, contact should be soughed with local potential renters (possibly via local brokers) to involve them in the process of elaborating the draft design into the final design. With this approach the eventual product will benefit from the improved understanding of residents needs.

Discussion and reflection

Within the sector of real estate the slogan location, location, location is the Holy Grail. The question is what the fourth factor is that influences peoples' behaviour when they search for new accommodation. With reading about in secureness and weak prospects on both the housing and the job market, I personally believe that offering certainty would be a unique buying point (ubp) for potential residents. Instead of offering unique selling points (usp's), developers should act upon the actual demands of (newly arising) target groups. What is their position, what needs and (financial) possibilities do they have? And how can I help them with my business?

The order of first proposing a possible solution and only then inventory respondents preferences might have been a risky choice, but I myself embrace the quote at the beginning of this report entirely. Action is reaction, which eventually will nuance the initial action. This process can be seen within my graduation process as well. I certainly had a clear vision on how I would like to use my final semester to deliver something that would not only satisfy myself, as a researcher, or the university for maybe being able to publish about a relevant topic. I also very much desired that my graduation project would be of relevance for society and the business of Heijmans. With this grand ambition I might have been tempted to making too big steps at a time. Still, as I reflect on the final phase of my graduation project, all lines were naturally connected again, resulting in the integrated research that I anticipated on. I am pleased with the results, the great deal of information I got to know of and the collaboration with various people around me in order to make this happen.

Further research

The methodology of discrete choice experiments (DCE) can be used to present to and to research on other housing concepts for potential residents. The company of Heijmans already started to organize open evenings so that potential residents can be asked about their desires and preferences for a certain building plot[13]. The use of discrete modeling can generate additional, more specific, information that could be of great value for the company and as well for policy makers, developers and designers. Using the internet to spread an online survey could reach a large number of people in no time. Heijmans has access to various channels, their website, Twitter and Facebook accounts and additional newsletters to reached all sorts of target groups. With improved understanding of the preferences and desires of potential customers they strengthen their market position.

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[13] Interactive evening with potential residents of the Dico plot, Uden. February 18th 2013.

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Consulted experts

Besides the graduate commission, consisting of Prof. Dr. ir. Wim Schaefer, Dr. Brano Glumac, Drs. Paul Masselink, Ir. Tom Köhler, Ir. Anneke Dalhuisen, various other experts have been consulted on different topics that have been integrated within this thesis. All of these conversation have taken place in 2013.

Bjorn van Rheenen	SPONGE Architects	February 6th
Martijn van Os	www.martijnvanos.nl	February 6th
Theo Smits	Business developer Heijmans Home Construction	February 19th
Olga Görts	Commercial manager Heijmans Home Construc.	March 4th
Kristel van Haaren	Manager Heijmans Infrastructure	March 6th
Maarten van Duijn	Managing director Heijmans Real Estate	March 12th
Marius van Genugten	Expert on climate installations	March 20th
Hans Brandt	CEO of Total Identity	March 25th
Paul Dijkhuijsen	www.verplaatsbaarvastgoed.nl	March 26th
Gijs de Reeper	www.greenem.nl	April 5th
Patrick Koch	Business developer Heijmans Home Construction	April 8th
Bert van der Els	CEO of Heijmans	August 12th
Tim van der Grinten	Architect	numerous occasions

APPENDIXES

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appendix 1 | RENTING QUOTES

http://www.nul20.nl/dossiers/huurquotes

Single adult with minimum wage

Net monthly income	€ 1,143	Hire Quote	**19.7%**
Rent	€ 375	Remaining per month	€ 927
Rentals	€ 150		

Peter is 23 years old and has never finished a course. He works as a cleaner and deserves minimum wage. Fortunately, he has a cheap house. Thanks to the housing allowance he arrives at a rent of 375 euros on a rent ratio of 19.7 per cent.

Nurse finds it hard to meet the end

Gross annual income	€ 22,025	Rentals	€ 87
Net monthly income	€ 1,336	Hire Quote	**32.8%**
Rent	€ 524	Remaining per month	€ 899

Maroeska became a nurse after her training. She earns 22,025 euros gross per year, exactly the maximum amount by which a single is still eligible for housing benefit. She lives in a dwelling of the housing association and pays 524 euros rent. Despite the housing allowance she is getting a steep rental quote from: 32.7 per cent.

Skew inhabitants live for next to nothing

Gross annual income	€ 50,000	Hire Quote	**15.6%**
Net monthly income	€ 2,683	Remaining per month	€ 2264
Rent	€ 419		

Steve and Maria moved to a dwelling of a housing corporation twenty years ago. They live there - even after their daughter was born - to full satisfaction. Even though the apartment is not spacious, the rent is low and the neighbourhood is pleasant. They earn together 1.5 x the average income. The rent of their apartment is 419 euros, just the average rent of a corporation house in Amsterdam. They are skewed tenants. Their rent ratio is only 15.6 per cent.

Balancing on the border of the social rental limit

Gross annual income	€ 29,000	Rentals	€ 144
Net monthly income	€ 1,815	Hire Quote	**28.7%**
Rent	€ 664	Remaining per month	€ 1295

Hassan has got a good job at the airport. He lives with his family in a beautiful new house of a housing corporation. The rent is the maximum for the social rented sector: 664 euros. Hassan is actually lucky to not earn an additional 1000 euros, as he is now still entitled to a generous housing allowance. The income limit for housing benefit lays at 29,900 euros for multi-person households. The rental quote from the family of Hassan is nearly 29 per cent.

Young professional in mid-free sector

Gross annual income	€ 34,500	Hire Quote	**40.5%**
Net monthly income	€ 1,850	Remaining per month	€ 1100
Rent	€ 750		

Yasmin is graduated and she immediately found a good job at a law firm. But with her campus contract she had to leave her students home. With her income of 34,500 euros she will no longer be eligible for social housing, as she just crossed the limit with her gross annual income. Finding an affordable dwelling will be a challenge. Buying her own dwelling is not an option because of her temporal contract. Miraculously she finds a nice studio for a reasonable price. Well, common for Amsterdam than 750 euros. She is happy, all is well over 40 per cent of her income to the landlord.

Young family in mid-free sector

		Rent	€ 950
Gross annual income	€ 50,000	Hire Quote	**35.4%**
Net monthly income	€ 2,683	Remaining per month	€ 1683

Adam and Gaila both work. This gives a combined gross income of 50,000 euros, half times the average income. For the time they do not want to buy a house because of the economical crisis and the uncertain outlook on the future. They rent a spacious apartment overlooking the river Zaan in Zaandam, which costs 950 euros per month. They remain enough money per month for a good living. The rent ratio: 35.4 per cent.

appendix 2 | VALUES BY ROKEACH

The terminal values in Rokeach Value Survey are:

1. True Friendship
2. Mature Love
3. Self-Respect
4. Happiness
5. Inner Harmony
6. Equality
7. Freedom
8. Pleasure
9. Social Recognition
10. Wisdom
11. Salvation
12. Family Security
13. National Security
14. A Sense of Accomplishment
15. A World of Beauty
16. A World at Peace
17. A Comfortable Life
18. An Exciting Life

The Instrumental Values are:

1. Cheerfulness
2. Ambition
3. Love
4. Cleanliness
5. Self-Control
6. Capability
7. Courage
8. Politeness
9. Honesty
10. Imagination
11. Independence
12. Intellect
13. Broad-Mindedness
14. Logic
15. Obedience
16. Helpfulness
17. Responsibility
18. Forgiveness

heijmans

Agenda

Verzenddatum	5 maart 2013	Contactpersoon	Rudy van Beurden
Onderwerp	Alleenstaanden	Huisvestingsconcept	Telefoon	+31 6 1391 12 21
Vergaderdatum	11 maart 2013, 09.00u - 12.00u	E-mail	rbeurden@heijmans.nl
Locatie	Rosmalen, RM1 Kantine Serre		

Aan	*Mandy Boekhorst, Rogier Boogaard (tot 11.00u), Tim van de Grinten (architectuur TU/e), Clemens Hoedjes, Saskia van Pijnenburg, Theo Smits, Marieke Swinkels, Lonneke Wijnhoven (afgemeld)*

Beste Clemens, Mandy, Marieke, Rogier, Saskia, Theo en Tim,

Maandagochtend 11 maart zien we elkaar in de **serre van de kantine** - **RM1 - 9.00u**. Samen vormen we een bonte groep experts. In een open/ positieve/ creatieve sessie wil ik jullie meenemen in mijn plannen om de (groeiende!) groep alleenstaanden te voorzien van huisvesting. Samen gaat ons dit lukken!

Doel: Door middel van open co-creatie tot de uitgangspunten van een krachtig huisvestingsconcept vastleggen, dat tegemoet komt aan de woonbehoeftes en mogelijkheden van alleenstaanden in middelgrote woonplaatsen.

Hierbij de agenda.

08.45u – 09.00u	Inloop
09.00u – 09.20u	Welkom + voorstellen
09.20u – 09.35u	Verwachtingen + overzicht ambitie + betrokkenen
09.35u – 09.50u	Stukje inspiratie (heb je zelf ook input? neem dit mee!)
09.50u – 10.20u	Doelgroepbepaling
10.20u – 10.50u	Kansen + Randvoorwaarden Huisvestingsconcept
10.50u – 11.20u	Conceptnaam
11.20u – 11.45u	Overige Input en Aanwijzingen business plan
11.45u – 12.00u	Wrap up + Follow up

Laten we er samen een positieve en krachtige werksessie van maken!

Tot maandag,
Rudy van Beurden

1. Huisvestingsconcept
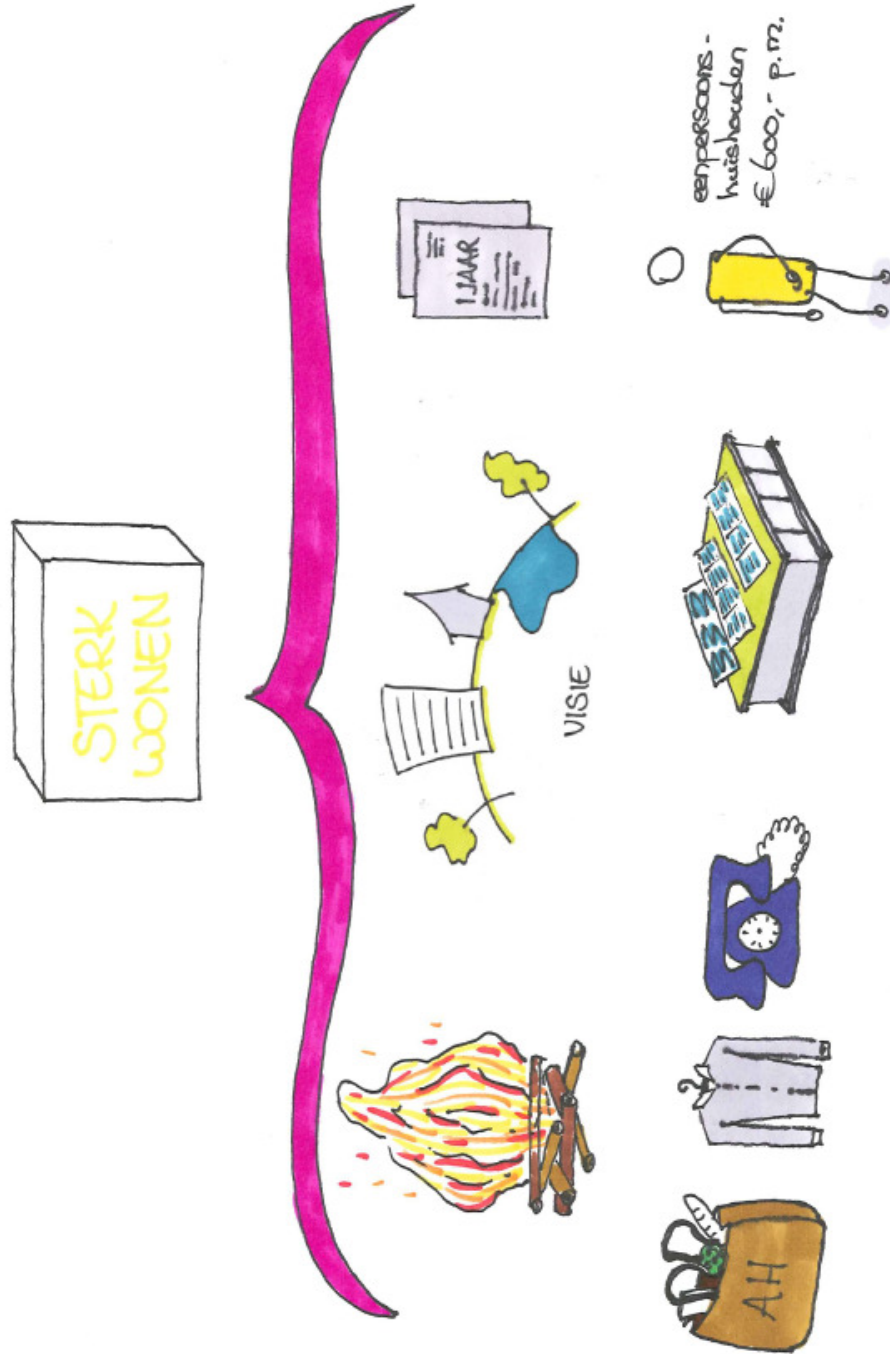
heijmans

Notulen

Verzenddatum	15 april 2013		Van	Rudy van Beurden
Onderwerp	Mogelijkheden		Telefoon	+31 6 1391 12 21
Vergaderdatum	10 april 2013		E-mail	rbeurden@heijmans.nl
Locatie	RM2 01H.05			

Aanwezig	*Rutger Ballhuis, Willem van den Berg, Rudy van Beurden, Olga Görts, Tim van der Grinten, Patrick Koch, Tom Köhler, Jasper Sluis*

Beste betrokkenen,

Woensdag 10 april zijn we samengekomen om de mogelijkheden mbt een energie neutrale verplaatsbare woning te bespreken. Tom en Rudy hebben deze meeting ingepland om beter zicht te krijgen op de praktische haalbaarheid van het voorgestelde plan, Het ontwikkelen van een wooncocept dat voorziet in de huisvesting van eenpersoonshuishoudens.

Doelen
- Enthousiasme genereren
- Wijzer worden van elkaar door te delen in elkaars expertise
- Gezamenlijk randvoorwaarden opstellen

Aanwezigen

Rutger Ballhuis	plancoördinator Heijmans Woningbouw Zuid
Willem van den Berg	business developer Heijmans Vastgoed en Woningbouw
Rudy van Beurden	afstudeerder TU/e + Heijmans Gebiedsontwikkeling
Olga Görts	commercieel manager Heijmans Woningbouw Zuid
Tim van der Grinten	architect (benaderd door Tom + Rudy voor een S.O.)
Patrick Koch	business developer Heijmans Vastgoed en Woningbouw
Tom Köhler	manager Gebiedsontwikkeling Heijmans Vastgoed
Jasper Sluis	accountmanager Heijmans Facilitair Bedrijf

Verwachtingen
- Elkaar enthousiasmeren.
- Definities van 'verplaatsbaar' en 'energieneutraal' helder krijgen.
- Waar is de bouwsom (€35.000,-) op gebaseerd?
  Op de business case die Tom samen met Alwin Snijders heeft opgesteld.
- Hoeveel % van de complete bouwsom (€35.000,-) dient aan installaties gespendeerd te worden?
- Benieuwd naar het ontwerp.
  Tim presenteert vandaag zijn uitgangspunten en schetsen.
- Welke randvoorwaarden hebben prioriteit?
  Leidend is dat deze nieuwe manier van huisvesting (financieel) bereikbaar wordt voor alleenstaanden. Uitgegaan wordt van een maandelijks woonbudget van €600,-.

hei̯jmans

Uitgangspunten

De ontwikkeling van braakliggende bouwterreinen is voor Heijmans Vastgoed van belang om hun locaties te 'laden'. Er wordt zodoende aan de gemeenschap getoond dat het bedrijf bereid is om te ontwikkelen en mensen in hun woonbehoefte te voorzien. Doordat permanente ontwikkeling in de huidige markt erg lastig te realiseren is, is gekozen voor tijdelijke bouw voor een periode van maximaal vijf jaar (tijdelijke bouwvergunning). De objecten dienen na deze periode gemakkelijk te verplaatsen zijn. Door de units te voorzien van technieken die (deels) in de elektriciteits- en warm water behoefte van de bewoner voorzien, worden de vaste lasten voor GWL gedrukt. Energie neutraliteit is een extra ambitieniveau, de financiële investering dient echter wel renderend te zijn over de looptijd van 10 a 15 jaar. Extra gegenereerde kWh's in de zomermaanden (salderen) kunnen wellicht het hogere verbruik in de donkere maanden compenseren.

Concept + ontwerp

Op stedenbouwkundig niveau loont het om woonunits met elkaar te schakelen in een rijtje. Iedere bewoner heeft dan een vrij uitzicht en energietechnisch is dit aantrekkelijk vanwege minder geveloppervlak, voordeliger dan het bij vrijstaande units zou zijn.

Na aanleiding van zijn studie naar aansprekende wooncepten laat Tim een aantal archetypen zien. De loft, met hoge plafondhoogte is één van de opties. Referentieprojecten laten een waardevolle ruimtelijkheid zien. Functies zijn deels boven elkaar gestapeld. In zijn voorstel snijdt Tim de demontabele (en daardoor verplaatsbare) units horizontaal door. Hierdoor ontstaan een universele basisunit en een dakunit die in verschillende varianten uit te voeren is. Met de aaneengesloten dakunits is een dynamisch en aantrekkelijk daklandschap te creëren, waar verschillende technieken, zoals PV-panelen, in opgenomen kunnen worden.

De units kunnen eventueel gebouwd worden met gebruikte materialen. Het hout van Heijmans' schottenketen is een mogelijkheid.
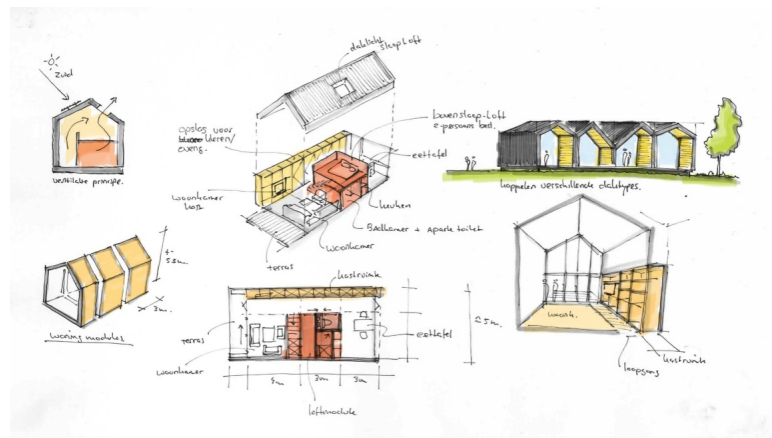
Concept + schetsontwerp door Tim van der Grinten (auteursrechtelijk beschermd)

Overige input

- Waarom pogen om het kwaliteitsniveau van permanente bouw na te streven? Ben helder over je ambitieniveau?

- De woning van 50m^2 is niet realiseerbaar voor €35.000,-. Overweeg minder m$^{2'}$s.

- Heijmans schottenketen zouden omgebouwd kunnen worden naar tijdelijke woningen? De vraag is of je deze ambitie/ uitstraling wilt bieden als kwaliteitsbouwer.

- Overweeg echte innovatie, zoals 3d printen.

- Probeer zelf met een creatieve woonoplossing te komen en daartoe strenge regelgeving te omzeilen of om te buigen, zodat meer mogelijk is voor minder. Dit behoeft kennis van het bouwbesluit, tijdelijke bewoning, geldende wet- en regelgeving etc.

- Gas zou juist een kosteneffectieve technische oplossing zijn.

- Realiseer een centrale technische ruimte om de investering daarvan te spreiden over verschillende units.

- De permanente, compacte woningen in het Mooiland project kosten +/- €100.000,- incl grond.

- Werk samen met interessante partijen, als bijvoorbeeld De Efteling.

- Het concept kan tijdelijker van karakter zijn. Meer een vakantiegevoel, verblijf van een paar maanden tot een jaar. Hotellobby + kamers idee? Algemene collectieve ruimte voor ontmoeting.

Vervolg

- Rudy maakt een handout met daarin de uitgangspunten tot nu toe.
- Patrick kan mee sparren over de benodigde energiesystemen.
- Jasper kent de mogelijkheden mbt Heijmans schottenketen. Evt hergebruik.
- Rutger stelt een SKO huurwaarde berekening voor.
- Tim houdt de kwaliteit/ het belevingsgevoel in de gaten. 'De kunst is om iets aan te bieden dat veel waardevoller aanvoelt dan €35.000,-.'
- Olga is benieuwd naar waar de markt voor voelt. Hierin kan de survey van Rudy aan bijdragen.

Actielijst

Datum	Actie	Door	Gereed	Status
10-04-2013	Notulen verspreiden	Rudy	15-04-2013	Done
10-04-2013	SKO opstellen	Rutger en/of Tom	24-04-2013	
10-04-2013	Hand out opstellen en rondsturen	Rudy	19-04-2013	

appendix 4 | FRACTIONAL FACTORIAL DESIGN

Shapiro (1966) provides detailed information on developing a fractional factorial design. This overview provides the exact location of the 16 attribute levels.

experimental plan code number	total variables	2 levels	3 levels	required tests	masterplan	colomns
46a	6	2	4	16	5	6.7.8.9.24.25

MASTERPLAN 5

columns:	6	7	8	9	24	25
	0	0	0	0	0	0
	0	1	1	2	1	0
	0	2	2	1	1	1
	0	1	1	1	0	1
	1	0	1	1	1	1
	1	1	0	1	0	1
	1	2	1	2	0	0
	1	1	2	0	1	0
	2	0	2	2	0	1
	2	1	1	0	1	1
	2	2	0	1	1	0
	2	1	1	1	0	0
	1	0	1	1	1	0
	1	1	2	1	0	0
	1	2	1	0	0	1
	1	1	0	2	1	1

This specific fractional factorial design (masterplan 5) is derived from Shapiro (1966), see below.


```
PLAN 5:                    16 trials
                11111 11112 22222
12345   678910  12345 67890 12345

00000   00000   00000 00000 00000
01123   01121   00001 10111 01110
02231   02211   00010 11011 10011
03312   01112   00011 01100 11101
10111   10111   01100 00110 11011
11032   11012   01101 10001 10101
12320   12120   01110 11101 01000
13203   11201   01111 01010 00110
20222   20222   10100 01011 01101
21301   21101   10101 11100 00011
22013   22011   10110 10000 11110
23130   21110   10111 00111 10000
30333   10111   11000 01101 10110
31210   11210   11001 11010 11000
32102   12102   11010 10110 00101
33021   11021   11011 00001 01011
```

appendix 5 | EFFECT CODING

This table shows the coding of all attribute levels. This is done using effect coding (Kemperman 2000).

Max renting period	Column1	Column2
1 year	1	0
3 years	0	1
5 years*	-1	-1

Energy performance	Column1	Column2
Excellent (label A^{+++})*	-1	-1
Average (label A)	0	1
Low (label B)	1	0

Level of completion	Column1	Column2
Non-padded	1	0
Padded	0	1
Furnished*	-1	-1

Total monthly cost	Column1	Column2
550 euro*	1	0
600 euro	0	1
650 euro	-1	-1

Type of dwelling	Column1
1-room apartment	-1
2-room apartment*	1

Communal space	Column1
With*	1
Without	-1

*represents the base level per attribute

appendix 6 | SOCIO DEMOGRAPHIC QUESTIONS

The online survey asked respondents for their impression regarding and some additional socio demographic information.

- *What is your impression of the design of the dwelling?*

- *What is your current place of residence?*
- <open text field>
  (the place of residence provided has been converted to the number of residents (<50.000))

- *What is your intended place of residence?*
- <open text field>

- *What is your maximum (individual) housing budget (including rent + gas/water/electricity + maintenance) per month?*

- *What is your gender?*

- *What is your age?*

For analysing the data with SPSS, the data has been coded as follows:

Opinion	Code
Positive	1
Neutral	2
Negative	3

Housing budget	Code
<550 euro	1
550-650 euro	2
>650 euro	3

Gender	Code
Male	6
Female	7

Age	Code
<17 years of age	1
17-24 years of age	2
25-34 years of age	3
35-65 years of age	4
>65 years of age	5

coding of the socio demographical data

appendix 7 | ONLINE SURVEY

Screenshots of the online survey built with the Berg survey system.
URL: vragen1.ddss.nl/q/huisvesting
The survey ran from June 12th until July 3th 2013.

TU/e Technische Universiteit
Eindhoven
University of Technology

huisvesting voor eenpersoonshuishoudens

Beste meneer/ mevrouw,

Tijdens mijn afstuderen onderzoek ik de mogelijkheid om compacte, verplaatsbare woningen te ontwikkelen voor **eenpersoonshuishoudens**. Ik ben benieuwd naar uw voorkeuren. Daarvoor hoeft u niet per se alleenstaand en/ of woningzoekend te zijn.

Het invullen van deze enquête duurt +/- 10 minuten.

Bij voorbaat dank voor uw hulp,
Rudy van Beurden
afstudeerder Bouwkunde TU/e

[volgende]

Berg Enquête System © 2007 Design Systems

First page of the online questionnaire

huisvesting voor eenpersoonshuishoudens

■■■■■■■■■■■

In samenwerking met professionals is een voorlopig ontwerp ontwikkeld. De woningen zijn:

Verplaatsbaar
De woningen worden op een locatie geplaatst voor een periode van maximaal vijf jaar (tijdelijke omgevingsvergunning). Daarna worden de woningen verplaatst naar een andere locatie.

Compact
Het ontwerp van de woning is doordacht en compact. Zodoende is de woning te verplaatsen en betaalbaar voor alleenstaanden. De woning is tegelijkertijd heel leefbaar en ruimtelijk door het slimme ontwerp.

Energiezuinig
De woningen zijn optimaal geïsoleerd en voorzien zelf in hun energiebehoefte door middel van slimme installaties. De energierekening wordt daardoor zo laag mogelijk gehouden of zelfs opgeheven.

Hier ziet u impressies van het ontwerp. De bovenste illustratie toont vijf woningen.

© Tim van der Grinten | http://timvdgrinten.wix.com/architectuur

| vorige | **volgende** |

Second page of the online questionnaire

huisvesting voor eenpersoonshuishoudens

■■■■■■■■■■■■■■■■■■■■■

De woning kan aan verschillende voorwaarden voldoen. Deze worden aan u gepresenteerd als 'alternatief I' en 'alternatief II'. Kiest u telkens voor het alternatief van uw voorkeur óf voor 'geen van beide'. **Voorbeeld:**

kenmerken	alternatief I	alternatief II	geen van beide
maximale huurperiode	*max. 3 jaar*	*max. 1 jaar*	
energieprestatie	*uitstekend (label A+++)*	*laag (label B)*	
opleverniveau	*gestoffeerd*	*gemeubileerd*	
totale maandelijkse kosten	*600 euro*	*600 euro*	
woningtype	*1 kamer appartement*	*2 kamer appartement*	
gezamenlijke ruimte	*met*	*zonder*	
UW KEUZE:	O	X	O

Uitleg van de mogelijkheden:

De *maximale huurperiode*:
* **maximaal 1 jaar**
* **maximaal 3 jaar**
* **maximaal 5 jaar**

De *energieprestatie* van de woning heeft direct invloed op uw woonlasten en het milieu.
* **uitstekend (energielabel A+++)**; de woning heeft <u>geen</u> energie uit het elektriciteitsnet nodig.
* **gemiddeld (energielabel A)**; de woning heeft <u>weinig</u> energie uit het elektriciteitsnet nodig.
* **laag (energielabel B)**; de woning heeft <u>veel</u> energie uit het elektriciteitsnet nodig.

Keuken en badkamer zijn standaard. Het *opleverniveau* van de woning:
* **niet gestoffeerd**; de bewoner kleedt de woning zelf aan.
* **gestoffeerd**; de woning is voorzien van vloeren en gordijnen.
* **gemeubileerd**; de woning is geheel sleutelklaar, zoals ook een hotelkamer dat is.

De *totale maandelijkse kosten* (huur + gas/water/licht + onderhoud) zijn:
* **550 euro**
* **600 euro**
* **650 euro**
Het *woningtype*:
* **1 kamer appartement**; het bed staat in de leefruimte.
* **2 kamer appartement**; het bed staat in een aparte slaapkamer.

In een *gezamenlijke ruimte* kunnen bewoners functies (bijv. professionele wasmachine, pooltafel, haard etc.) delen. Kies uit:
* **met**
* **zonder**

Er volgen nu 8 keuzesets.

vorige	volgende

Third page of the online questionnaire

huisvesting voor eenpersoonshuishoudens

Keuzeset - kies het alternatief van uw voorkeur:

kenmerken	alternatief I	alternatief II	geen van beide
maximale huurperiode	max. 5 jaar	max. 3 jaar	
energieprestatie	gemiddeld (label A)	laag (label B)	
afwerkingsniveau	gestoffeerd	gestoffeerd	
totale maandelijkse kosten	550 euro	650 euro	
woningtype	1 kamer appartement	1 kamer appartement	
gezamenlijke ruimte	zonder	zonder	
UW KEUZE:	⦿	○	○

| vorige | **volgende** |

Page 4 until 11 of the online questionnaire

huisvesting voor eenpersoonshuishoudens

Wat is uw indruk van het ontwerp van de woning?

- ⦿ Positief
- ○ Neutraal
- ○ Negatief

| vorige | **volgende** |

Page 12 of the online questionnaire

Wat is uw huidige woonplaats?

Wat is uw beoogde volgende woonplaats?

Wat is uw maximale (individuele) woonbudget (huur + gas/water/licht + onderhoud) per maand?

○ <550 euro
○ 550-650 euro
○ >650 euro

Wat is uw geslacht?

○ man
○ vrouw

Wat is uw leeftijd?

○ <17 jaar
○ 17-24 jaar
○ 25-34 jaar
○ 35-65 jaar
○ >65 jaar

[vorige] [**volgende**]

huisvesting voor eenpersoonshuishoudens

Hartelijk dank voor uw medewerking!

Misschien wilt u de link van de enquête doorsturen naar een vriend of familielid. De link is:
http://vragen1.ddss.nl/q/huisvesting

Met vriendelijke groet,
Rudy van Beurden
afstudeerder Bouwkunde TU/e
r.j.m.v.beurden@student.tue.nl

Page 13 and 14 of the online questionnaire

appendix 8 | SOCIO DEMOGRAPHIC OUTPUT

The answers of the respondents on their current and intended places of residence has been divided in three categories (1 resident withhold from entering his/her place of residence):
- people living in places with <50.000 residents   n=101
- people living in places with 50.000-100.000 residents   n=14
- people living in places with >100.000 residents   n=164

Most people live in the province of Noord-Brabant (54,6%). No people from the provinces Drenthe and Groningen are represented.

Current province

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		1	,4	,4	,4
	buitenland	3	1,1	1,1	1,4
	Drenthe	0	,0	,0	1,4
	Flevoland	1	,4	,4	1,8
	Friesland	1	,4	,4	2,1
	Gelderland	57	20,4	20,4	22,5
	Groningen	0	,0	,0	22,5
	Limburg	1	,4	,4	22,9
	Noord-Brabant	153	54,6	54,6	77,5
	Noord-Holland	20	7,1	7,1	84,6
	Overijssel	6	2,1	2,1	86,8
	Utrecht	19	6,8	6,8	93,6
	Zeeland	1	,4	,4	93,9
	Zuid-Holland	17	6,1	6,1	100,0
	Total	**280**	**100,0**	**100,0**	

age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	0	,0	,0	,0
	2	57	20,4	20,4	20,4
	3	150	53,6	53,6	73,9
	4	66	23,6	23,6	97,5
	5	7	2,5	2,5	100,0
	Total	280	100,0	100,0	

appendix 9 | DATA OF ALL VALID RESPONDENTS (n=280)

```
--> READ
   ;nobs=6720
   ;Nvar=19
   ;Names=case,ALTI,CSET,const,Obs,per1,per2,ener1,ener2,oplev1,oplev2,
    prc1,prc2,type,comm,opin,budget,gender,age
   ;File=nlogit80.txt$

--> NLOGIT
   ;Lhs=Obs,CSET
   ;Choices=1,2,3
   ;Rhs=const,per1,per2,ener1,ener2,oplev1,oplev2,prc1,prc2,type,comm$
```

```
+-----------------------------------------------+
| Discrete choice and multinomial logit models|
+-----------------------------------------------+
Normal exit from iterations. Exit status=0.
+-----------------------------------------------+
| Discrete choice (multinomial logit) model    |
| Maximum Likelihood Estimates                  |
| Model estimated: Jul 24, 2013 at 01:31:52PM.  |
| Dependent variable               Choice       |
| Weighting variable                 None       |
| Number of observations             2240       |
| Iterations completed                  5       |
| Log likelihood function       -1987.509       |
| Number of parameters                 11       |
| Info. Criterion: AIC =          1.78438       |
|    Finite Sample: AIC =         1.78444       |
| Info. Criterion: BIC =          1.81244       |
| Info. Criterion:HQIC =          1.79463       |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
| Constants only.  Must be computed directly. |
|                Use NLOGIT ;...; RHS=ONE $ |
| Response data are given as ind. choice.       |
| Number of obs.=  2240, skipped    0 bad obs. |
+-----------------------------------------------+
+-----------------------------------------------+
| Notes No coefficients=> P(i,j)=1/J(i).       |
|       Constants only => P(i,j) uses ASCs     |
|         only. N(j)/N if fixed choice set.   |
|         N(j) = total sample frequency for j  |
|         N    = total sample frequency.       |
|       These 2 models are simple MNL models.  |
|       R-sqrd = 1 - LogL(model)/logL(other)   |
|       RsqAdj=1-[nJ/(nJ-nparm)]*(1-R-sqrd)   |
|         nJ   = sum over i, choice set sizes   |
+-----------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
CONST	.65821097	.06169757	10.668	.0000
PER1	-.64899415	.05586186	-11.618	.0000
PER2	.15633885	.04413625	3.542	.0004
ENER1	-.55392545	.05452532	-10.159	.0000
ENER2	.00322635	.04479517	.072	.9426
OPLEV1	-.01522069	.05224965	-.291	.7708
OPLEV2	.16540295	.04564535	3.624	.0003
PRC1	.24680369	.05217846	4.730	.0000
PRC2	.09126583	.04560597	2.001	.0454
TYPE	.63283547	.03579924	17.677	.0000
COMM	-.12308964	.03300800	-3.729	.0002

appendix 10 | DATA OF PEOPLE LIVING IN PLACES WITH <50.000 RESIDENTS (n=102)

```
--> READ
    ;nobs=2448
    ;Nvar=15
    ;Names=case,ALTI,CSET,const,Obs,per1,per2,ener1,ener2,oplev1,oplev2,
     prc1,prc2,type,comm
    ;File=nlogit22c.txt$

--> NLOGIT
    ;Lhs=Obs,CSET
    ;Choices=1,2,3
    ;Rhs=const,per1,per2,ener1,ener2,oplev1,oplev2,prc1,prc2,type,comm
    $
```

```
+------------------------------------------------+
| Discrete choice and multinomial logit models|
+------------------------------------------------+
Normal exit from iterations. Exit status=0.
+------------------------------------------------+
| Discrete choice (multinomial logit) model      |
| Maximum Likelihood Estimates                    |
| Model estimated: Jul 26, 2013 at 03:44:26PM.    |
| Dependent variable              Choice          |
| Weighting variable                None          |
| Number of observations            816           |
| Iterations completed                5           |
| Log likelihood function       -787.0640         |
| Number of parameters               11           |
| Info. Criterion: AIC =           1.95604        |
|   Finite Sample: AIC =           1.95644        |
| Info. Criterion: BIC =           2.01946        |
| Info. Criterion:HQIC =           1.98038        |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj      |
| Constants only.  Must be computed directly.     |
|               Use NLOGIT ;...; RHS=ONE $         |
| Response data are given as ind. choice.         |
| Number of obs.=   816, skipped   0 bad obs.     |
+------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
CONST	.19120519	.09141256	2.092	.0365
PER1	−.50030301	.09043202	−5.532	.0000
PER2	.01631203	.07304469	.223	.8233
ENER1	−.48089111	.09009263	−5.338	.0000
ENER2	.05786056	.07354089	.787	.4314
OPLEV1	−.07020850	.08841885	−.794	.4272
OPLEV2	.09122173	.07532631	1.211	.2259
PRC1	.08850211	.08602439	1.029	.3036
PRC2	.05979076	.07509256	.796	.4259
TYPE	.60127251	.05818949	10.333	.0000
COMM	−.16406074	.05425797	−3.024	.0025

appendix 11 | DATA OF PEOPLE WITH A HOUSING BUDGET OF 550-650 EUROS PER MONTH (n=100)

```
--> READ
    ;nobs=2400
    ;Nvar=15
    ;Names=case,ALTI,CSET,const,Obs,per1,per2,ener1,ener2,oplev1,oplev2,
     prc1,prc2,type,comm
    ;File=nlogit31c.txt
    $

--> NLOGIT
    ;Lhs=Obs,CSET
    ;Choices=1,2,3
    ;Rhs=const,per1,per2,ener1,ener2,oplev1,oplev2,prc1,prc2,type,comm
    $
```

```
+---------------------------------------------+
| Discrete choice and multinomial logit models|
+---------------------------------------------+
Normal exit from iterations. Exit status=0.
+---------------------------------------------+
| Discrete choice (multinomial logit) model   |
| Maximum Likelihood Estimates                 |
| Model estimated: Jul 26, 2013 at 03:50:44PM.|
| Dependent variable            Choice         |
| Weighting variable              None         |
| Number of observations           800         |
| Iterations completed               5         |
| Log likelihood function     -705.2188        |
| Number of parameters              11         |
| Info. Criterion: AIC =       1.79055         |
|   Finite Sample: AIC =       1.79097         |
| Info. Criterion: BIC =       1.85496         |
| Info. Criterion:HQIC =       1.81529         |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj  |
| Constants only.  Must be computed directly.  |
|               Use NLOGIT ;...; RHS=ONE $     |
| Response data are given as ind. choice.      |
| Number of obs.=  800, skipped   0 bad obs.   |
+---------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
CONST	.66194986	.10282944	6.437	.0000
PER1	-.65828633	.09333141	-7.053	.0000
PER2	.10937194	.07433975	1.471	.1412
ENER1	-.53417238	.09128924	-5.851	.0000
ENER2	-.02084812	.07591518	-.275	.7836
OPLEV1	-.07307038	.08816373	-.829	.4072
OPLEV2	.16998415	.07713733	2.204	.0275
PRC1	.22567645	.08871916	2.544	.0110
PRC2	.09194548	.07773389	1.183	.2369
TYPE	.68133262	.06027185	11.304	.0000
COMM	-.11992659	.05596828	-2.143	.0321

appendix 12 | DATA OF PEOPLE LIVING IN PLACES WITH <50.000 RESIDENTS <u>AND</u> 17-34 YEARS OF AGE (n=53)

```
--> READ
    ;nobs=1272
    ;Nvar=15
    ;Names=case,ALTI,CSET,const,Obs,per1,per2,ener1,ener2,oplev1,oplev2,
     prc1,prc2,type,comm
    ;File=nlogit51c.txt
    $

--> NLOGIT
    ;Lhs=Obs,CSET
    ;Choices=1,2,3
    ;Rhs=const,per1,per2,ener1,ener2,oplev1,oplev2,prc1,prc2,type,comm
    $
```

```
+------------------------------------------------+
| Discrete choice and multinomial logit models|
+------------------------------------------------+
Normal exit from iterations. Exit status=0.
+------------------------------------------------+
| Discrete choice (multinomial logit) model   |
| Maximum Likelihood Estimates                 |
| Model estimated: Jul 26, 2013 at 03:52:01PM.|
| Dependent variable            Choice         |
| Weighting variable              None         |
| Number of observations           424         |
| Iterations completed               5         |
| Log likelihood function      -392.0550       |
| Number of parameters              11         |
| Info. Criterion: AIC =        1.90120        |
|   Finite Sample: AIC =        1.90271        |
| Info. Criterion: BIC =        2.00627        |
| Info. Criterion:HQIC =        1.94271        |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
| Constants only.  Must be computed directly. |
|                Use NLOGIT ;...; RHS=ONE $ |
| Response data are given as ind. choice.     |
| Number of obs.=   424, skipped   0 bad obs. |
+------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
CONST	.31342517	.13895382	2.256	.0241
PER1	-.83491085	.13753331	-6.071	.0000
PER2	.20377965	.10231665	1.992	.0464
ENER1	-.51578793	.13088871	-3.941	.0001
ENER2	.15184160	.10380726	1.463	.1435
OPLEV1	-.23977693	.12962824	-1.850	.0644
OPLEV2	.08638353	.10713082	.806	.4200
PRC1	.07625267	.12850456	.593	.5529
PRC2	.16976796	.10576973	1.605	.1085
TYPE	.49748790	.08136017	6.115	.0000
COMM	-.27510962	.07687806	-3.579	.0003

appendix 13 | DATA OF PEOPLE LIVING IN PLACES WITH <50.000 PEOPLE <u>AND</u> 550-650 EUROS PER MONTH (n=39)

```
--> READ
    ;nobs=936
    ;Nvar=15
    ;Names=case,ALTI,CSET,const,Obs,per1,per2,ener1,ener2,oplev1,oplev2,
     prc1,prc2,type,comm
    ;File=nlogit50c.txt
    $

--> NLOGIT
    ;Lhs=Obs,CSET
    ;Choices=1,2,3
    ;Rhs=const,per1,per2,ener1,ener2,oplev1,oplev2,prc1,prc2,type,comm
    $
```

```
+---------------------------------------------+
| Discrete choice and multinomial logit models|
+---------------------------------------------+
Normal exit from iterations. Exit status=0.
+---------------------------------------------+
| Discrete choice (multinomial logit) model   |
| Maximum Likelihood Estimates                 |
| Model estimated: Jul 26, 2013 at 03:53:54PM.|
| Dependent variable              Choice       |
| Weighting variable                None       |
| Number of observations            312        |
| Iterations completed                5        |
| Log likelihood function      -292.5610       |
| Number of parameters               11        |
| Info. Criterion: AIC =        1.94590        |
|   Finite Sample: AIC =        1.94872        |
| Info. Criterion: BIC =        2.07787        |
| Info. Criterion:HQIC =        1.99865        |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj  |
| Constants only.  Must be computed directly.  |
|               Use NLOGIT ;...; RHS=ONE $     |
| Response data are given as ind. choice.      |
| Number of obs.=   312, skipped   0 bad obs.  |
+---------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
CONST	.55326869	.15852599	3.490	.0005
PER1	-.43390282	.13956218	-3.109	.0019
PER2	-.01002783	.11509950	-.087	.9306
ENER1	-.54920135	.14511152	-3.785	.0002
ENER2	.09831145	.11631950	.845	.3980
OPLEV1	-.09543610	.14028665	-.680	.4963
OPLEV2	.15830546	.11931494	1.327	.1846
PRC1	.09212383	.13660480	.674	.5001
PRC2	.01851590	.11964826	.155	.8770
TYPE	.57088975	.09338150	6.114	.0000
COMM	-.15189447	.08801387	-1.726	.0844

appendix 14 | DATA OF PEOPLE WITH A HOUSING BUDGET OF 550-650 EUROS PER MONTH <u>AND</u> 25-34 YEARS OF AGE (n=58)

```
--> READ
    ;nobs=1392
    ;Nvar=15
    ;Names=case,ALTI,CSET,const,Obs,per1,per2,ener1,ener2,oplev1,oplev2,
     prc1,prc2,type,comm
    ;File=nlogit32c.txt
    $

--> NLOGIT
    ;Lhs=Obs,CSET
    ;Choices=1,2,3
    ;Rhs=const,per1,per2,ener1,ener2,oplev1,oplev2,prc1,prc2,type,comm
    $
```

```
+----------------------------------------------+
| Discrete choice and multinomial logit models|
+----------------------------------------------+
Normal exit from iterations. Exit status=0.
+----------------------------------------------+
| Discrete choice (multinomial logit) model    |
| Maximum Likelihood Estimates                  |
| Model estimated: Jul 26, 2013 at 03:53:09PM.|
| Dependent variable              Choice        |
| Weighting variable                None        |
| Number of observations             464        |
| Iterations completed                 5        |
| Log likelihood function     -393.3179         |
| Number of parameters                11        |
| Info. Criterion: AIC =        1.74275         |
|   Finite Sample: AIC =        1.74401         |
| Info. Criterion: BIC =        1.84089         |
| Info. Criterion:HQIC =        1.78138         |
| R2=1-LogL/LogL*  Log-L fncn  R-sqrd  RsqAdj |
| Constants only.  Must be computed directly. |
|              Use NLOGIT ;...; RHS=ONE $ |
| Response data are given as ind. choice.     |
| Number of obs.=   464, skipped   0 bad obs. |
+----------------------------------------------+
```

```
+--------+-------------+---------------+--------+--------+
|Variable| Coefficient | Standard Error |b/St.Er.|P[|Z|>z]|
+--------+-------------+---------------+--------+--------+
 CONST  |     .61797572      .13938482     4.434    .0000
 PER1   |    -.89969358      .13277251    -6.776    .0000
 PER2   |     .20038792      .09946124     2.015    .0439
 ENER1  |    -.66596488      .12375939    -5.381    .0000
 ENER2  |     .02953642      .10227980      .289    .7727
 OPLEV1 |    -.15881287      .12127993    -1.309    .1904
 OPLEV2 |     .17558783      .10502247     1.672    .0945
 PRC1   |     .18056703      .12284161     1.470    .1416
 PRC2   |     .16447803      .10560348     1.558    .1194
 TYPE   |     .69433542      .08232481     8.434    .0000
 COMM   |    -.15709209      .07616261    -2.063    .0392
```
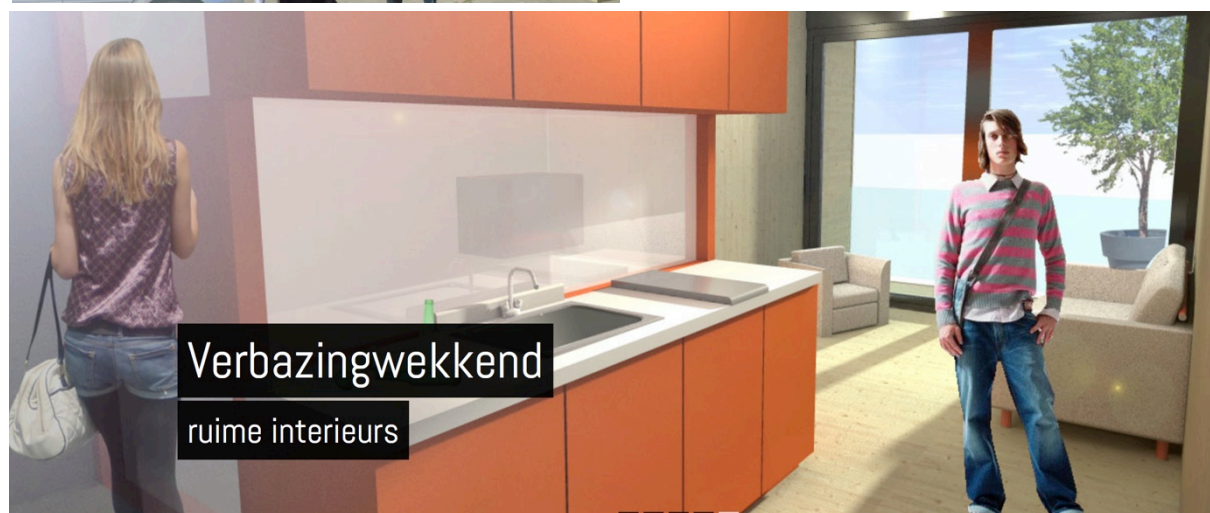
appendix 15 | NATIONAL COMPETITION

WOODSTACKER

Bijzonderheden	50 jaar garantie op casco
Portfolio	44 studentenwoningen in Amsterdam
Website	www.woodstacker.eu
Bouwer	onbekend

VERPLAATSBAARVASTGOED

5^2	60	A^{++}
isolatiewaarde gemiddeld	minuten constructief brandwerend	energie label
5	0.5^{mm}	2.7^m
lagen stapelbaar	tolerantie	interne hoogte

Bijzonderheden	Bouwblokken bestaande uit zes onderdelen. Materiaal: composiet
Portfolio	onbekend
Website	www.verplaatsbaarvastgoed.nl
Bouwer	onbekend (partnering is gaande)

LOOT

Bijzonderheden	concept gebaseerd op zeecontainers
Portfolio	jongerencentrum (5 containers), Rosmalen
	mobiele woonruimte (te plaatsen in twee dagen)
Website	www.loot.nu
Bouwer	Van Niftrik Bouwbedrijf bv

DE GROOT VROOMSHOOP
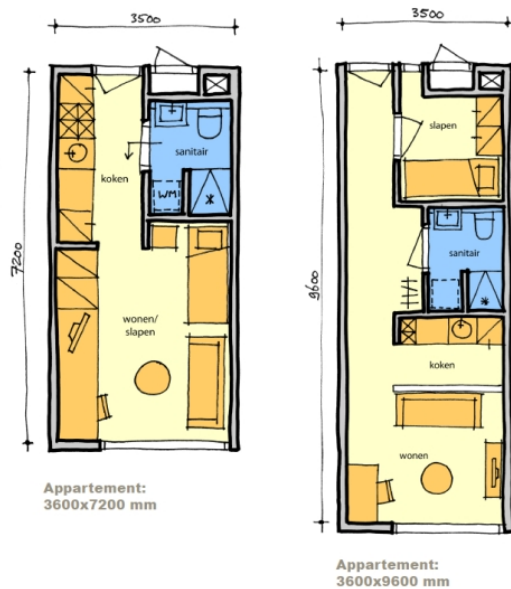
Bijzonderheden	stapelbaar, uitbreidbaar
Portfolio	verschillende (tijdelijke) scholen, allemaal blokkerig, recht toe recht aan
Website	http://www.huisvesting-bouwsystemen.nl
Bouwer	De Groot Vroomshoop bouwsystemen

TWA ARCHITECTEN + VDM WONINGEN

Bijzonderheden	geschikte oplossing voor krimpgebieden (oa. Noord Nederland)
Portfolio	onbekend
Website	http://www.cobouw.nl/nieuws/algemeen/2012/10/12/verplaatsbare-woning-uitkomst-in-krimpgebied
Bouwer	VDM woningen

BALLAST NEDAM

Bijzonderheden	betonnen, schakelbare bouwblokken
Portfolio	verschillende woningbouwprojecten oa. Noordwijkerhout, Hillegom, Rheden
Website	www.iqwoning.nl
Bouwer	Ballast Nedam

appendix 16 | LIST OF POTENTIAL LOCATIONS

From the available vacant land positions of Heijmans, a selection has been made of locations that have high potential to be used to place transportable house on. The demand for affordable houses is an indicator and mostly applicable to the majority of the land positions. Furthermore the characteristics of the land positions and its nearness to existing infrastructure and facilities have been taken into consideration.

A.   Amsterdam Overhoeks plot
B.   Rotterdam Katendrecht plot
C.   Uden Dico plot
D.   Helmond Texdeco plot
E.   Almelo Weggeler plot
F.   Hilversum Villa Industria

appendix 17 | OFFERED APARTMENTS FOR RENT (two random places from overview)

5401 GT	€ 649,-	70	apartment
5401 GT	€ 985,-	100	apartment
5401 HX	€ 659,-	70	apartment
5401 EH	€ 757,-	90	semi detached
5401 GB	€ 800,-	120	apartment
5404 NP	€ 810,-	114	terraced house
5404 PN	€ 830,-	114	terraced house
5401 GT	€ 850,-	100	apartment
5402 LL	€ 850,-	271	semi detached
5406 AA	€ 850,-	83	apartment
5404 LZ	€ 862,-	118	semi detached
5401 ZZ	€ 900,-	81	apartment
5406 DA	€ 952,-	116	bungalow
5402 EA	€ 975,-	110	apartment
5401 XT	€ 990,-	160	apartment
5403 WZ	€ 995,-	160	semi detached
5406 TB	€ 995,-	142	semi detached
5406 XB	€ 1000,-	125	detached
5402 HJ	€ 1023,-	190	semi detached
5403 NG	€ 1050,-	160	bungalow
5406 BZ	€ 1100,-	182	semi detached
5405 AT	€ 1300,-	225	detached
5401 GN	€ 1650,-	220	apartment
5402 EG	€ 1700,-	330	detached
4462 BW	€ 550,-	50	bungalow
4461 CA	€ 760,-	90	apartment
4461 MN	€ 800,-	123	terraced house
4462 CG	€ 800,-	104	semi detached
4461 WZ	€ 825,-	65	apartment
4461 WZ	€ 872,-	65	apartment
4461 BH	€ 875,-	85	apartment
4463 VR	€ 895,-	125	terraced house
4461 DC	€ 900,-	70	terraced house
4463 JB	€ 900,-	123	semi detached
4462 TT	€ 905,-	96	apartment
4463 WT	€ 950,-	110	terraced house
4463 TW	€ 950,-	115	terraced house
4462 TT	€ 1342,-	141	apartment
4465 AJ	€ 1500,-	167	detached
4461 SL	€ 1080,-	120	apartment
4462 JC	€ 1095,-	132	detached
4461 CG	€ 1950,-	80	apartment

appendix 18 | BUSINESS CASE OF 20 TRANSPORTABLE CO$_2$-NEUTRAL HOUSES

In this business case various assumptions have been made in order to calculate the expected investments needed and the eventual revenues projected.

1. The calculation is based on a pilot project of 20 dwellings;
2. The depreciation period is set on 25 years;
3. The total income (housing budget) is set on €600,- per month;
4. The profitability of the investment is set at 5,50%.
5. The total cost per dwelling (all-in) can therefor be €58.422,-.

appendix 19 | BUILDING COSTS (based on 20 houses)

GRONDKOSTEN	**€ 8.400,00**		
aanvraag tijdelijke ontheffing	€ 500,00		
grondwerk	€ 850,00		
nutsaansluitingen	€ 800,00		
rioolaansluiting	€ 750,00		
prefab betonpoeren	€ 1.500,00	€ 75,00	/m1
transportkosten	€ 2.000,00		per verplaatsing
verharding	€ 2.000,00		
BOUWKOSTEN	**€ 48.325,00**		
houten constructie	€ 18.000,00		
vloerplaat (constructief)	€ -		/m²
buitenwanden (thermische schil)	€ -		/m²
dak (thermische schil)	€ -		/m²
gevelpuien (incl glas)	€ 5.850,00	€ 450,00	/m²
gevelafwerking eindgevel	€ 500,00		
gevelroosters achterzijde	€ 375,00	€ 250,00	/m²
voordeur	€ 900,00		
stalen entreetrap voorzijde + bordes	€ 500,00		
terras achterzijde	€ 500,00	€ 50,00	/m²
plantenbak erfafscheiding	€ 250,00		
binnendeur (3 stuks)	€ 300,00	€ 100,00	per stuk
trap	€ 1.300,00		
kastenwanden	€ 600,00		
plafond begane grond	€ 975,00	€ 65,00	/m²
vloerafwerking	€ 800,00	€ 20,00	/m²
wandafwerking	€ 600,00	€ 15,00	/m²
keuken	€ 1.600,00		
sanitair (toilet+badkamer) materiaal	€ 2.000,00		
tegels (toilet+badkamer)	€ 800,00	€ 40,00	/m²
PV panelen	€ 3.625,00		2500Wp = +/-2000kWh/j
UHV zonnecollector **óf** pelletkachel	€ 2.500,00		
boilervat tbv warm water	€ 1.500,00		
anti-koudeval radiator	€ 500,00		
mechanische afzuiging	€ 950,00		
waterinstallatie	€ 250,00		
rioleringsinstallatie	€ 250,00		
elektra (incl. meterkast)	€ 1.800,00		
verlichting	€ 400,00		
aansluitingen elektra + water	€ 700,00		
BIJKOMENDE KOSTEN	**€ 7.202,75**		
acquisitie	€ 500,00		
leges	€ 966,50		
architect	€ 2.000,00		
constructeur	€ 500,00		
bouwfysica	€ 500,00		
onvoorzien	€ 2.736,25		
TOTAAL excl. btw	**€ 63.927,75**		
btw	€ 13.424,83		
totaal incl btw	€ 77.352,58		

appendix 20 | DUTCH BUILDING REGULATIONS

De zwarte tekst is <u>te allen tijde</u> van toepassing op nieuwbouw

De grijze tekst is <u>niet</u> van toepassing op tijdelijke bouw, <u>wel</u> op permanente

NIEUWBOUW

veiligheid
- Tijdsduur bezwijking bij brand min. 30 min **art.2.10**
- Valbescherming trapgat **art.2.16**
- Niet beweegbare afscheiding van de vloer ≥1m **art.2.17**
- Minimale afmetingen trap: zie **art.2.39**
- Stookplaats, brandklasse A1 **art.2.57**
- Een besloten ruimte ligt in een brandcompartiment **art.2.82**

bouwfysisch
- Uitwendige scheidingsconstructie verblijfsgebied geluidwering ≥20 dB **art.3.2**
- Er wordt uitgegaan van een karakteristiek geluidniveau in het verblijfsgebied van ten hoogste 30 dB **art.3.6.2**
- Luchtverversing verblijfsruimte van ≥21dm³/s (ivm koken), toilet ≥7dm³/s, badkamer ≥14dm³/s **art.3.29**
- Toevoer verse lucht in de leefzone niet groter is dan 0,2 m/s **art.3.30**
- Luchtverversing overige ruimten **art.3.32**
- Afvoer rechtstreeks naar buiten **art.3.34**
- Een te bouwen bouwwerk is zodanig dat het binnendringen van ratten en muizen wordt tegengegaan **art.3.68**
- Een te bouwen bouwwerk is zodanig dat daglicht in voldoende mate kan toetreden **art.3.74**

bruikbaarheid
- Een woonfunctie heeft een vloeroppervlakte van ≥18m² aan niet-gemeenschappelijk verblijfsgebied. Ten minste 55% van de gebruiksoppervlakte van een gebruiksfunctie is verblijfsgebied **art.4.2**
- Een woonfunctie heeft een vloeroppervlakte van ten minste 10 m² aan niet-gemeenschappelijk verblijfsgebied **art.4.6**
- Een verblijfsgebied en een verblijfsruimte hebben boven de vloer een hoogte van ≥2,1m. In ten minste een verblijfsgebied ligt een verblijfsruimte met een vloeroppervlakte van ten minste 7,5 m² en een breedte van ten minste 2,4m **art.4.7**
- Een toiletruimte heeft een vloeroppervlakte van ≥0,64m², breedte ≥0,6m en hoogte boven de vloer van ≥2m **art.4.16**
- Een te bouwen bouwwerk heeft opstelplaatsen voor een aanrecht, een kooktoestel, een verwarmingstoestel en een warmwatertoestel **art.4.37.1**
- Opstelplaats aanrecht heeft een vloeroppervlakte van ≥0,7mx0,4m
  Opstelplaats kooktoestel heeft een vloeroppervlakte van ≥0,4mx0,4m **art.4.43**

energie
- Een te bouwen bouwwerk is energiezuinig **art.5.1.1**
- Thermische isolatie buitenwand 3,5m^2.K/W **art.5.3**
- Een voorziening voor drinkwater voldoet aan <u>NEN 1006</u> **art.6.12**
- Een voorziening voor warmwater voldoet aan <u>NEN 1006</u> **art.6.13**
- Een bouwwerk heeft een zodanige voorziening voor de afvoer van huishoudelijk afvalwater of hemelwater dat het water zonder nadelige gevolgen voor de gezondheid kan worden afgevoerd **art.6.15**

veiligheid
- voor elke persoon met zitplaats ten minste 0,5m² vloeroppervlakte beschikbaar is, indien inventaris kan verschuiven of omvallen als gevolg van gedrang **art.7.13**
- Een woonfunctie wordt niet bewoond door meer dan één persoon per 12m² gebruiksoppervlakte (woonwagen max. 6m^2) **art.7.18**

TIJDELIJKE BOUW

brandveiligheid
- Belastingcombinaties **art.2.2-2.4**
- Tijdsduur bewijzen bij brand **art.2.10** (minimaal 30 min. Behoeft nadere studie)
- Een trap sluit bij de bovenste trede, over de breedte van de trap, aan op een vloer met een oppervlakte van ten minste 0,8mx0,8m **art.2.34**
- Een vluchtroute heeft een vrije doorgang met een breedte van ≥0,85m en een hoogte van ten minste de in tabel 2.101 aangegeven waarde. Dit geldt niet voor zover de vluchtroute over een trap voert **art.2.107.8**

bouwfysisch
- Eisen verblijfsgebied geluidwering 10dB lager dan permanente bouw **art.3.6.1**
- Vocht en water worden anders behandeld **art.3.21-3.23**
- Een gebruiksfunctie heeft ter plaatse van een uitwendige scheidingsconstructie, een scherm tot een vanaf het aansluitende terrein gemeten diepte van ten minste 0,6m. Het scherm heeft geen openingen die breder zijn dan 0,01m **art.3.70**

bruikbaarheid
- Een woonfunctie heeft een vloeroppervlakte van ≥18m² aan niet-gemeenschappelijk verblijfsgebied. Ten minste 55% van de gebruiksoppervlakte van een gebruiksfunctie is verblijfsgebied **art.4.2**
- Een verblijfsruimte heeft een breedte van ten minste 1,8m. In ten minste één verblijfsgebied ligt een verblijfsruimte met een vloeroppervlakte van ≥11m² bij een breedte van ten minste 3m **art.4.3**
- Een badruimte heeft een vloeroppervlakte van ≥1,6m² en een breedte van ≥0,8m **art.4.19.1**
- Een doorgang heeft een vrije breedte van ≥0,85m **art.4.22**
- Een te bouwen woonfunctie heeft een bergruimte om fietsen beschermd tegen weer en wind te kunnen opbergen **art.4.30.1**
- Een woonfunctie heeft als nevenfunctie een niet-gemeenschappelijke afsluitbare bergruimte met een vloeroppervlakte van ≥5m² (óf 1.5m² voor woningen tot 50m²) bij een breedte van ten minste 1,8 m en een hoogte daarboven van ≥2,3m **art.4.31.1**
- Een te bouwen woonfunctie heeft een rechtstreeks bereikbare buitenruimte. Bij woningen tot 50m² is de berging ≥4m² en ≥1,3m breed **art.4.34.1**
- Een gebruiksfunctie heeft een opstelplaats voor een warmwatertoestel, waarvan de afmetingen zijn afgestemd op het te plaatsen toestel. Dit geldt niet indien de gebruiksfunctie wordt aangesloten op een publieke voorziening voor warm water **art.4.38.3**
- Opstelplaats aanrecht heeft een vloeroppervlakte van 1,5mx0,6m **art.4.39**
- Opstelplaats kooktoestel heeft een vloeroppervlakte van ≥0,6mx0,6m **art.4.39**
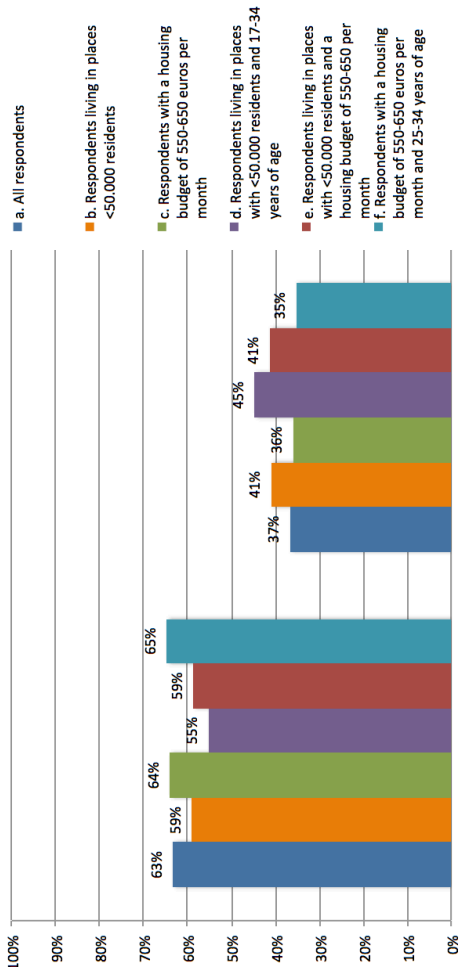
energie
- Een doorgang heeft een vrije breedte van ten minste 0,85m **art.4.22**
- EPC-waarde van 0,6 (verwachting 2015: 0,4) **art.5.2**
- Een te bouwen bouwwerk is zodanig dat de belasting van het milieu door de in het bouwwerk toe te passen materialen wordt beperkt **art.5.8.1**

installaties en veiligheid
- Een bouwwerk heeft een zodanige verlichtingsinstallatie dat het bouwwerk veilig kan worden gebruikt en verlaten **art.6.1**
- Een dak van een te bouwen bouwwerk heeft een voorziening voor de opvang en afvoer van hemelwater met een volgens NEN 3215 bepaalde capaciteit van ten minste de volgens die norm bepaalde belasting van die voorziening **art.6.17.1**
- Een bouwwerk heeft zodanige voorzieningen dat brand tijdig kan worden ontdekt zodat veilig kan worden gevlucht **art.6.19.1**
- Een woongebouw heeft zodanige voorzieningen dat veel voorkomende criminaliteit wordt voorkomen **art.6.50**

appendix 21 | DECISION SUPPORT TOOL (separate Excel file)

a. All respondents

label	coefficient	Alternative I	Alternative II
const	0,65821097		
per1	-0,64899415	Vi	Vi
per2	0,15633885	2,28482391	1,73735116
ener1	-0,55392545		
ener2	0,00322635		
oplev1	-0,01522069	probability	probability
oplev2	0,16540295	63%	37%
prc1	0,24680369		
prc2	0,09126583		
type	0,63283547		
comm	-0,12308964		

b. Respondents living in places with <50.000 residents

label	coefficient	Alternative I	Alternative II
const	0,19120519		
per1	-0,50030301	Vi	Vi
per2	0,01631203	1,80648883	1,44131884
ener1	-0,48089111		
ener2	0,05786056		
oplev1	-0,072085	probability	probability
oplev2	0,09122173	59%	41%
prc1	0,08850211		
prc2	0,05979076		
type	0,60127251		
comm	-0,16406074		

c. Respondents with a housing budget of 550-650 euros per month

label	coefficient	Alternative I	Alternative II
const	0,66194986		
per1	-0,65828633	Vi	Vi
per2	0,10937194	2,41950618	1,84363756
ener1	-0,53417238		

	alternative I	alternative II
renting period	5 years	5 years
energy performance	excellent (energy label A+++)	average (energy label A)
level of completion	padded	padded
total monthly cost	650 euro	650 euro
type of dwelling	2 room apartment	2 room apartment
communual space	without	without

Overview of the probabilities of a certain target groups that prefers either alternative I or II

Legend:
- a. All respondents
- b. Respondents living in places <50.000 residents
- c. Respondents with a housing budget of 550-650 euros per month
- d. Respondents living in places with <50.000 residents and 17-34 years of age
- e. Respondents living in places with <50.000 residents and a housing budget of 550-650 per month
- f. Respondents with a housing budget of 550-650 euros per month and 25-34 years of age

alternative I: a. 63%, b. 59%, c. 64%, d. 55%, e. 59%, f. 65%
alternative II: a. 37%, b. 41%, c. 36%, d. 45%, e. 41%, f. 35%

ENGLISH SUMMARY

Transportable CO$_2$-neutral houses for one-person households
How to house one-person households in CO$_2$-neutral dwellings on vacant land positions in the Netherlands?
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Graduation program:
Construction Management and Urban Development 2012-2013

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Date of graduation:
31-08-2013

ABSTRACT

The housing market in the Netherlands is locked. Vacant land positions prove to be unmarketable and customers' in secureness is high, resulting in little movement of residents from one dwelling to another. Increased individualization affects the formation of households and renting has become more popular among starters instead of buying a house. Construction company Heijmans seeks for possibilities to make their vacant land positions profitable. A draft design of a portable CO$_2$-neutral house, specifically to accommodate one-person households, is developed in close collaboration with professionals. This draft design is presented to respondents in an online discrete choice experiment (DCE). The preferences of respondents gave improved insight in important attributes of the draft design. These will be further elaborated on to translate the draft design into a final design. The final design could eventually be build prefab and placed on various locations throughout the Netherlands.

Keywords: Dutch housing market, Discrete Choice Experiment, rise of individualization, CO$_2$-neutral dwellings, one-person households, vacant land positions.

INTRODUCTION

There is little movement of residents on the Dutch housing market as few houses are built or sold. The number of sold houses is historically low. Uncertainty and fear about near future developments dominate consumers' feelings. Politicians are unclear about their intended line of policy. Financial markets are not showing improvement either. Banks are careful with lending money to both starters on the housing market as well as for the development of real estate projects, as their returned profit is not as certain as it used to be. The level of unemployment has risen to 6,6% and is expected to reach 7,1% by the end of 2014 (www.oecd.org). Less people generate a steady income of which they can afford their mortgage or monthly rent. Few signals indicate improvement on the job market, which

results in little motivating prospects for the housing market. Furthermore, consumer confidence dropped historically since July 2011, (Dutch Central Statistics Office, CBS). Increasing energy prices drive up the overall housing costs for residents. Along with that, the trend of increased individualization is noticeable in the Netherlands. This results in smaller households that generate less income to afford their accommodation.

PROBLEM DESCRIPTION

One-person households experience difficulties in finding suitable accommodation, as there is a lack of low budget accommodation. The company of Heijmans owns vacant land positions, which they need to exploit in order to make them profitable. The central problem within this research involves these two viewpoints: It is unknown to the company of Heijmans what the requirements are for housing one-person households in CO_2-neutral dwellings on vacant land positions in the Netherlands.

RESEARCH PURPOSE

As stated above, two positions of stakeholders on the Dutch housing market have been taken in consideration. The aim of this research is to bridge the gap between the position of Heijmans, having vacant land positions in stock, and the needs of a growing group of potential customers, being one-person households. A business plan will be produced to be able to link the demand with a feasible business offer as the home seekers can be accommodated on the vacant land positions. This research paper provides an overview of residents' preferences regarding a proposed draft design of a one-person dwelling. A business proposal will be presented which is beneficial for both Heijmans as well as for one-person households in search for accommodation. The company and potential residents then help each other as they jointly create a new reality that is profitable for both parties.

RESEARCH QUESTION

The central research question is derived from the main problem: What are the requirements to house one-person households in CO_2-neutral dwellings on vacant land positions in the Netherlands?

RESEARCH LIMITATIONS

The scope of this research is limited to the elements needed to present a feasible business plan, as this is the actual output the company is requesting for. Also a scientific methodology will be used to underpin certain components of the business plan. The research will be limited to the Netherlands as Heijmans operates only nationally with their division of Real Estate.

RESEARCH APPROACH

The research approach, captured in figure 1, provides an overview of the steps taken within this research. The graphic is to be read from the left to the right. Blocks on the left provide the input needed in adjacent blocks in the subsequent column.
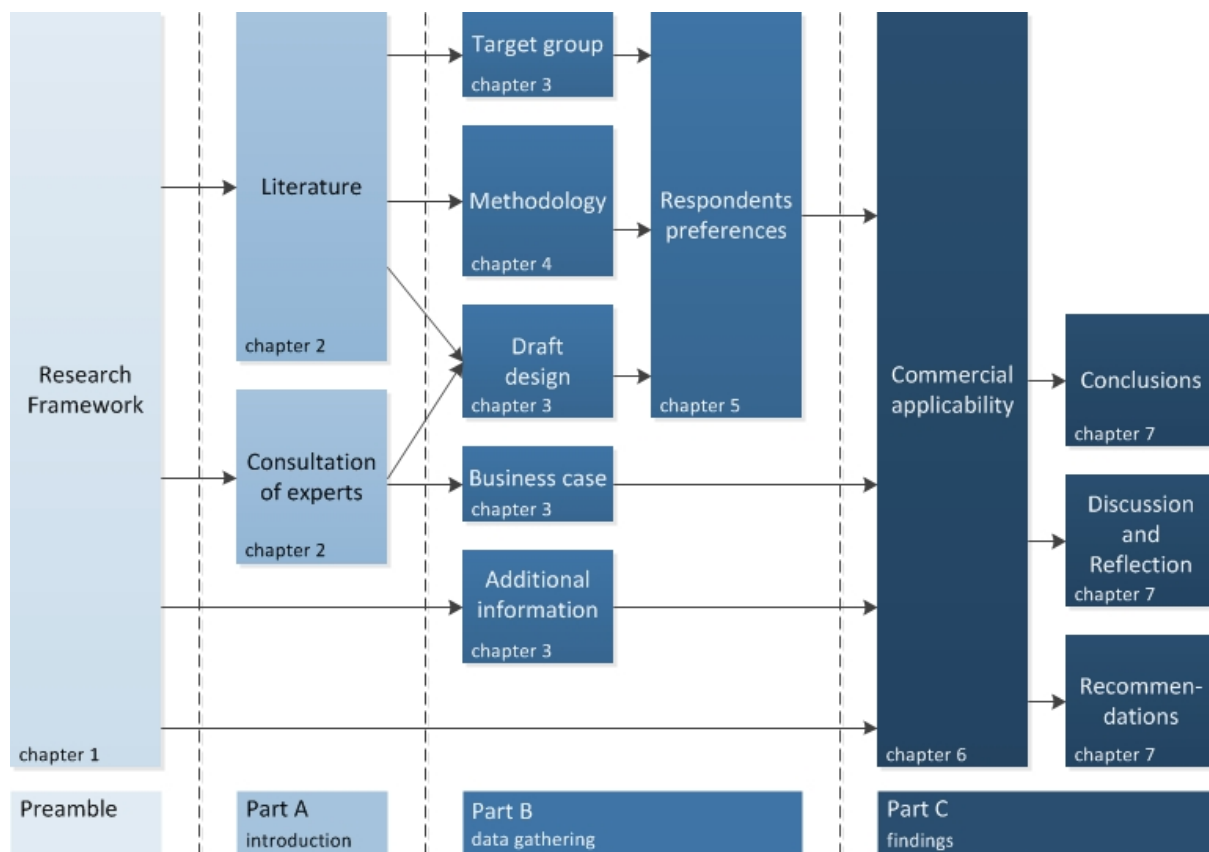
figure 1 | research approach

The research can be divided into three main parts. Part A provides an extensive introduction on the research topic based on literature and the consultation of experts (chapter 2). The topics covered in the literature study are the Dutch housing market, the rise of singlehood, energy consumption of (one-person) households, and consumers' values regarding their accommodation.

Part B is used to elaborate on various components that eventually result into an integrated business plan. Chapter 3 elaborates on the target group of the business proposition, the generated draft design that is developed in order to research respondents' preferences and the associated business case. The methodology of discrete choice experiments (DCE) is used within this research. This will be discussed in chapter 4. Both the developed draft design and the specific methodology of DCE are used to undertaken an online survey. Chapter 5 will capture this research on respondents' preferences regarding the draft design.

Eventually, part C holds all findings. Part C presents the integral business plan (chapter 6) on housing one-person households in CO_2-neutral dwellings on vacant land positions. Also the overall conclusions, the discussion and reflection and recommendations are included in part C (chapter 7).

LITERATURE STUDY

The current housing market shows a decrease of newly built houses. Renting accommodation has become more popular among starters instead of buying a house. As values like freedom and self-expression have become increasingly important, and people become economically more independent, individualization is on the rise. It is expected that

half a million one-person households will add to the total of households within the upcoming twelve years (until 2025). All these people will be in need for suitable and affordable accommodation. It is expected that the current housing stock, which mainly consists of one family houses, does not meet the needs and financial possibilities of all these new households. Affordable housing accommodation is requested, especially for single starters on the housing market.

As current market conditions do not show improvement on the short term, it remains difficult to develop permanent buildings on vacant land positions. Still, temporal solutions might be a feasible alternative. Buildings can be temporally placed on vacant land positions for a maximum stay of five years, based on a temporal building permit. Temporal and compact accommodation could be an adequate alternative to satisfy the needs of one-person households in search for affordable accommodation.

Policy makers have improved awareness about the energy consumption of buildings, as the built environment accounts for a large share of all CO_2-emmisions worldwide. Residents prefer technical improvements of their dwellings, rather than they have to change their behaviour or consumer pattern. These findings make it worthwhile to emphasize on the development of CO_2-neutral houses.

As consumers identify themselves with products or services that touch upon their personal values, it is of essence to consider the impact of values within any type of industry. With designing a specific accommodation, it is worthwhile to take in consideration the values of one-person households (bases on Rokeach 1979). These can include the need to feel free and to live a comfortable life (terminal values) as well as having self-control and being independent (instrumental values). Architects and real estate developers can use values as guidance in their design process.

DEVELOPING A PORTABLE CO_2-NEUTRAL HOUSE
A housing concept that is tailored for the needs of single starters could be the starting point of a feasible and profitable business plan. As affordability and sustainability are important topics on the housing market nowadays, these aspects should be elaborated within the concept. This can be done to equip houses with photovoltaic panels and solar water heaters that arrange electricity and warm water in an environmental friendly and cost effective way. By doing so, residents can also save seriously amounts of money on their monthly energy costs.

A new integrated housing concept is not easily developed individually. Knowledge from various experts is needed in order to present a realistic proposition. Here for collaboration was sought with various professionals. This intense collaboration eventually resulted in a realistic draft design of a compact transportable and CO_2-neutral house that will be elaborated further on in an eventual business plan. The design is made of timber and is to be transported in two separated modules that are to be placed on top of each other on the eventual location. Photovoltaic panels and an ultra high vacuum boiler are used to generate the required electricity and warm water.

RESEARCH METHOD

Discrete choice experiment
Discrete choice experiment (DCE) is a research technique originally based in the field of economics. DCE's are distinct from other conjoint methods because preferences are elicited by asking respondents to choose one alternative from those presented, rather than to asking respondents to rank alternatives, or give them a rating. The goal of discrete choice experiments is to understand and model the behavioural process that leads to the respondents' choices (Taneva 2008). Over the last thirty years the technique became increasingly popular in all sorts of research fields, as organizations and businesses benefit from understanding and predicting the behaviour of decision makers when choosing among discrete goods (Hensher 2005). In 2000, Daniel McFadden won the Nobel Prize for economics for his pioneering work in developing the theoretical basis for choice modelling.

Discrete choice experiments have two components; the use of discrete choice analysis to model preferences from data and the use of experiments to generate the required data, eliciting stated preferences for products or programs (Viney 2002). Discrete choice experiments statistically relate the choice made by each person to the attributes of the person and the attributes of all of the alternatives available to the person. Discrete choice experiments are based on the Random Utility Theory (RUT), which is originally initiated by Thurstone, back in 1927. RUT provides an explanation of the choice behaviour of humans, which is applicable to this research. RUT assumes that all individuals will always choose the alternative with the highest utility.

A discrete choice experiment (DCE) is a powerful tool for researching the preferences of respondent in hypothetical situations. DCE enables researchers to test the impact of certain aspects (attributes) of a hypothetical product or service. This tool can perfectly be used to research respondents' preferences regarding the proposed housing solution.

Data collection
Random individuals were able to complete the online survey, as the link to the survey was spread nation wide, through various channels. The provided information and the requested questions were kept to a minimum to make the survey as appealing as possible and to diminish the risk that people would terminate the survey before they would complete it. The language used is Dutch as the questionnaire is spread only within the Netherlands and there was no intention to specifically involve respondents who do not speak the Dutch language. In the first screen respondents were asked to participate. With some basic information about the chosen attributes and two images of the proposed portable compact house, people were asked to fill out eight unique choice charts. Figure 2 shows an example of a possible choice chart.

■■■■■■■■■■■

Keuzeset - kies het alternatief van uw voorkeur:

kenmerken	alternatief I	alternatief II	geen van beide
maximale huurperiode	max. 5 jaar	max. 3 jaar	
energieprestatie	gemiddeld (label A)	laag (label B)	
afwerkingsniveau	gestoffeerd	gestoffeerd	
totale maandelijkse kosten	550 euro	650 euro	
woningtype	1 kamer appartement	1 kamer appartement	
gezamenlijke ruimte	zonder	zonder	
UW KEUZE:	◉	○	○

vorige		volgende

figure 2 | sample choice chart with explanation of the attributes.

CONCLUSIONS

Current market conditions prove the development of permanent buildings on available vacant land positions to be difficult. Still, or even therefor, temporal solutions might be a feasible alternative. Temporal buildings may be placed on vacant land positions for a maximum stay of five years, based on a temporal building permit. Portable houses can placed on these vacant land positions to house people that otherwise have less chance in finding affordable accommodation. Investors will not have the risk of investing in permanent real estate that cannot be moved anymore. As the houses are portable so they can be used in other locations, financial risks are minimized. After five years the temporal houses can be replaced to locations were they are needed more. In this way the portable houses function as a temporal buffer on local housing markets. This can be in the Netherlands, but the houses can as well be transported to other countries, depending on the need for housing elsewhere.

Renting becomes more popular for starters instead of buying a house. Also individualization is on the rise in the Netherlands. Affordable accommodation is requested by one-person households. The next twelve years (until 2025) will add a half million (500.000) one-person household. All these people need to be housed and the current market provides little possibilities for this specific target group. About one seventh (+/- 71.000 people) of these 500.000 people are within the age group of 25-34 years. Many of them will find accommodation within the existing housing stock. Still, if only for 5% of these people a portable house would be the ideal solution, then about 3550 dwellings could be realized over the next twelve years.

As our society has improved awareness about the energy efficiency of buildings, it has become worthwhile to emphasize on the development of CO_2-neutral housing concepts. Compact, portable and CO_2-neutral houses could be an adequate alternative to satisfy the needs of one-person households in search for affordable accommodation. As the company of Heijmans (partly) owns about fifty vacant land positions, this idea is of great relevance for their organization. Their houses should meet the standard of being energy neutral. This can be achieved by making the houses all-electric, so no gas connection is needed. Electricity can be generated with photovoltaic cells on the roof. Warm water can be arranged with the use

of a ultra high vacuum panel. Such a device is able to heat a dwelling as well as providing warm water to shower or to do the dishes with.

The online survey (n=280) that is performed to gather data about respondents' preferences provides hand on information on how a house should be configured in order to best meet customers demand. 75% perceived the proposed housing design as 'positive'. Respondents participating in the survey especially preferred alternatives with the maximum renting period of five years. Also an excellent energy label (A[+++] label) has a great positive contribution to a certain proposal. It is worthwhile to invest in energy generating system beforehand as the can also result in lower monthly costs as the prices for energy is rising. A separate bedroom (2 room apartment) is also highly preferred above a studio (1 room apartment). Preferably, houses are padded and not furnished. Also no communal space is required, as respondents do not appreciate these extra offerings.

In short the conclusions can be wrapped as follows:

- Their is a huge market for solo-living: 500.000 extra households in next 12 years (until 2025, CBS '13). About 71.000 of these will be in the category of 25-34 years of age;

- In order to present a healthy business case, the maximum cost per house should be €60.000,- all-in (transport, profit etc.);

- The building cost per house may be €38.000,- at maximum. The draft design is still €10.000,- over budget;

- A maximum renting period (5 years), having a separate bedroom and an excellent energy performance (label A[+++]) are rewarded as being very important to potential renters;

- Respondents do preferably not require a communal space nor furniture.

DISCUSSION
Within the sector of real estate the slogan location, location, location is the holy grail. The question is what the fourth factor is that influences peoples' behaviour when they search for new accommodation. With reading about in secureness and weak prospects on both the housing and the job market, I personally believe that offering certainty would be a unique buying point (ubp) for potential residents. Instead of offering unique selling points (usp's), developers should act upon the actual demands of (newly arising) target groups. What is their position, what needs and (financial) possibilities do they have? And how can I help them with my business?

FURTHER RESEARCH
The methodology of discrete choice experiments (DCE) can be used to present to and to research on other housing concepts for potential residents. The company of Heijmans already started to organize open evenings so that potential residents can be asked about their desires and preferences for a certain building plot[14]. The use of discrete modelling can generate additional, more specific, information that could be of great value for the company and as well for policy makers, developers and designers. Using the internet to spread an

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[14] Interactive evening with potential residents of the Dico plot, Uden. February 18th 2013.

online survey could reach a large number of people in no time. Heijmans has access to various channels, their website, Twitter and Facebook accounts and additional newsletters to reached all sorts of target groups. With improved understanding of the preferences and desires of potential customers they strengthen their market position.

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ABOUT THE AUTHOR

R.J.M. (RUDY) VAN BEURDEN MSc
With this highly intensive and instructive graduation project I complete my time at the Eindhoven University of Technology. As I had anticipated, the last semester has been the crown on my entire studies. Various aspects, like market research, architectural design and managerial skills, came together to result in an integrated business plan. With this research report I strive to brighten the prospects of single home seekers on the Dutch housing market.
I would like to take a moment to thank my graduate committee, who most probably had some rough times with this stubborn graduate. Furthermore I would like to thank my parents deeply. They have always believed in me. And now I have achieved.

2006-2011	Bachelor Architecture, Building and Planning TU/e
2009-2010	Member of the University Council Eindhoven University of Technology
2011-present	Founder and owner of GAAF | positieve energie
2011-2013	Master Construction Management and Engineering TU/e
2012-2013	Internship at Heijmans Civil Services
2013-2013	Graduation internship at Heijmans Area Development

DUTCH SUMMARY

Verplaatsbare CO₂-neutrale huizen voor eenpersoonshuishoudens
Hoe dienen eenpersoonshuishoudens gehuisvest te worden in CO₂-neutrale woningen op braakliggende terreinen in Nederland?

Auteur
R.J.M. (Rudy) van Beurden BSc

Afstudeerprogramma
Construction Management and Urban Development 2012-2013

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Afstudeerdatum
31 augustus 2013

ABSTRACT

De Nederlandse woningmarkt bevindt zich in zwaar weer. Braakliggende grondposities blijken moeilijk ontwikkelbaar en er heerst een algeheel gevoel van onzekerheid. Hierdoor is er amper beweging op de woningmarkt omdat men weigert te, of simpelweg niet kan, verhuizen. Toegenomen individualisering heeft haar invloed op de samenstelling van huishoudens en daarbij wordt zichtbaar dat huren steeds populairder wordt bij starters ten opzichte van het kopen van een huis. Bouwbedrijf Heijmans zoekt naar mogelijkheden om hun braakliggende grondposities te benutten. In nauwe samenwerking met professionals is een verplaatsbare CO₂-neutrale woning, speciaal geënt op de doelgroep eenpersoonshuishoudens, ontwikkeld. Dit schetsontwerp is voorgelegd aan respondenten middels een online discrete keuze-experiment. De voorkeuren van de respondenten gaf verbeterd inzicht in belangrijke kenmerken van het schetsontwerp. Deze zullen verder worden uitgewerkt om het voorlopig ontwerp te vertalen naar een definitief ontwerp dat prefab gebouwd kan worden en vervolgens op diverse locatie in Nederland geplaatst kan worden.

Trefwoorden
Nederlandse woningmarkt, Discrete Choice Experiment, opkomst van individualisering, CO₂-neutrale woningen, eenpersoonshuishoudens, braakliggende grond posities.

INTRODUCTIE

Er is weinig beweging op de Nederlandse woningmarkt. Er zijn de laatste jaren weinig huizen gebouwd en slechts mondjesmaat verkocht. Onzekerheid en angst over nabije toekomstige ontwikkelingen overheersen de gevoelens van de consument. Politici zijn onduidelijk over

hun beoogde lijn van beleid. Daarbij tonen ook financiële markten geen duidelijke verbetering. Banken zijn voorzichtig met het uitlenen van geld aan zowel starters op de woningmarkt, alsmede voor de ontwikkeling van vastgoedprojecten. Dit omdat hun verwachte winst niet zo zeker is als het vroeger was. Het werkloosheidpercentage is gestegen tot 6,6% van de beroepsbevolking en zal naar verwachting 7,1% bereiken tegen het einde van 2014 (www.oecd.org). Minder mensen kunnen hierdoor rekenen op een vast inkomen, waarvan zij kunnen hun hypotheek of maandelijkse huur dienen te betalen. Weinig signalen wijzen op verbetering op de arbeidsmarkt, wat resulteert in weinig motiverende vooruitzichten voor de woningmarkt. Bovendien, het consumentenvertrouwen daalde historisch sinds juli 2011, (Nederlandse Centraal Bureau voor de Statistiek, CBS). Stijgende energieprijzen drijven de totale woonlasten voor de bewoners. Parallel aan die trend, vind toenemende individualisering plaats in Nederland. Dit resulteert in kleinere huishoudens die met minder inkomen hun accommodatie dienen te bekostigen.

PROBLEEM BESCHRIJVING

Eenpersoonshuishoudens ondervinden moeilijkheden bij het vinden van geschikte accommodatie omdat er is een gebrek is aan betaalbare accommodatie in het goedkopere segment. Heijmans is eigenaar van onbebouwde grond posities, die ze dienen te benutten om er aan te kunnen verdienen. Het centrale probleem binnen dit onderzoek wordt vanuit deze twee gezichtspunten bekeken: Voor Heijmans is het onbekend wat de eisen zijn voor de huisvesting van eenpersoonshuishoudens in CO_2-neutrale woningen op leegstaande grondposities in Nederland en eenpersoonshuishoudens zijn op zoek naar betaalbare accommodatie.

DOEL VAN HET ONDERZOEK

Het doel van dit onderzoek is het overbruggen van de kloof tussen de positie van Heijmans, met haar onbebouwde grond posities in voorraad, en de behoeften van een groeiende groep potentiële klanten, zijnde eenpersoonshuishoudens. Een business plan zal antwoord geven op de vraag hoe woningzoekenden kunnen worden gehuisvest op braakliggende grondposities. Dit onderzoek geeft een overzicht van de voorkeuren van de bewoners met betrekking tot een voorgestelde ontwerp van een eenpersoonswoning. Een voorstel zal worden gepresenteerd, welke gunstig is voor zowel Heijmans als voor eenpersoonshuishoudens op zoek naar accommodatie. Het bedrijf en potentiële bewoners helpen elkaar dan door gezamenlijk een nieuwe werkelijkheid te creëren, die winstgevend is voor beide partijen.

ONDERZOEKSVRAAG

De centrale onderzoeksvraag is afgeleid van het probleem: Wat zijn de vereisten om eenpersoonshuishoudens te huisvesten in CO_2-neutrale woningen op leegstaande grondposities in Nederland?

ONDERZOEK BEPERKINGEN

De reikwijdte van dit onderzoek is beperkt tot de elementen die nodig zijn voor een haalbaar business plan, want dit is de werkelijke output waar het bedrijf om vraagt. Ook een wetenschappelijke methodologie zal gebruikt worden om bepaalde onderdelen van het ondernemingsplan te onderbouwen. Het onderzoek zal worden beperkt tot Nederland omdat Heijmans voornamelijk actief is in Nederland met haar vastgoed activiteiten.

AANPAK VAN HET ONDERZOEK

De aanpak van het onderzoek wordt weergegeven in figuur 1. Deze figuur geeft een overzicht van de genomen stappen binnen dit onderzoek. De afbeelding dient te worden gelezen van links naar rechts. Blokken aan de linkerzijde geven input aan aangrenzende blokken in de volgende kolom.
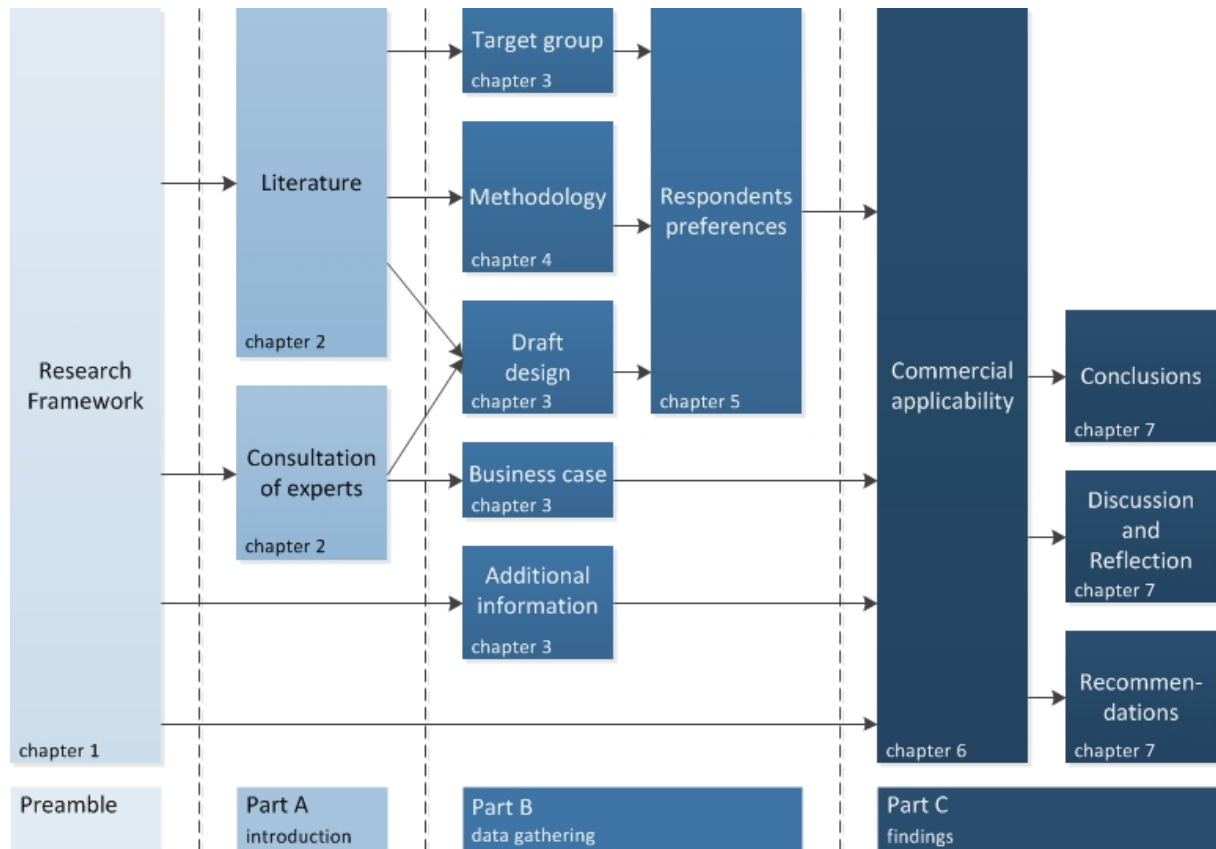
figuur 1 | onderzoek aanpak

METHODOLOGIE

Een discrete keuze experiment (DCE) is een onderzoekstechniek die haar oorsprong heeft in het vakgebied van de economie. DCE's zijn te onderscheiden van andere vergelijkmethodes omdat voorkeuren worden geïnventariseerd door respondenten te vragen om één alternatief uit de gepresenteerde alternatieven te kiezen, in plaats van alternatieven te rangschikken, of ze een cijfer te moeten geven. Het doel van een discrete keuze experiment is om het gedragsproces, dat leidt tot de keuzes van de respondenten, te begrijpen en te modelleren (Taneva 2008). In de afgelopen dertig jaar werd de techniek steeds populairder in allerlei onderzoeksgebieden. Organisaties en bedrijven profiteren van een beter begrip van hun (potentiële) klanten bij het kiezen tussen discrete goederen (Hensher 2005). In 2000 won Daniel McFadden de Nobelprijs voor economie voor zijn pionierswerk in de ontwikkeling van de theoretische basis voor deze methodologie.

Een discrete keuze experiment is een krachtig hulpmiddel voor het onderzoeken van de voorkeuren van de respondenten in hypothetische situaties. DCE stelt onderzoekers in staat om de impact van bepaalde aspecten (attributen) van een hypothetisch(e) product of dienst te testen. Deze methodologie kan perfect gebruikt worden om voorkeuren van respondenten met betrekking tot het voorgestelde schetsontwerp te onderzoeken.

CONCLUSIES

Binnen de huidige marktomstandigheden blijkt de ontwikkeling van permanente gebouwen op beschikbare onbebouwde gronden moeilijk te zijn. Toch, of zelfs juist daarvoor, zouden tijdelijke oplossingen een haalbaar alternatief kunnen blijken. Tijdelijke woningen kunnen op leegstaande grondposities worden geplaatst voor een periode van maximaal vijf jaar, op basis van een tijdelijke omgevingsvergunning. Investeerders zullen niet het risico lopen om te beleggen in duur vastgoed met de kans op leegstand. Aangezien de huizen verplaatsbaar zijn, en ze op andere locaties ingezet kunnen worden, worden financiële risico's beperkt. De verplaatsbare woningen kunnen zodoende functioneren als tijdelijke buffer op lokale woningmarkten. Dit kan in Nederland, maar de huizen kunnen ook worden vervoerd naar andere landen, afhankelijk van de behoefte naar huisvesting elders.

Huren wordt steeds populairder voor starters in plaats van het kopen van een huis. Ook individualisering is nog steeds toenemende in Nederland. Eenpersoonshuishoudens behoeven betaalbare accommodatie. Het CBS verwacht de komende twaalf jaar (tot 2025) een half miljoen (500.000) nieuwe eenpersoonshuishoudens. Al deze mensen moeten worden gehuisvest en de huidige markt biedt onvoldoende mogelijkheden voor deze specifieke doelgroep. Ongeveer één zevende (+/- 71.000 mensen) van deze 500.000 mensen valt binnen de leeftijdsgroep van 25-34 jaar. Velen van hen zullen accommodatie binnen de bestaande woningvoorraad vinden. Maar zelfs als maar voor 5% van deze mensen een verplaatsbare woning de ideale oplossing zou zijn, dan kunnen ongeveer 3.550 woningen gerealiseerd worden in de komende twaalf jaar.

In onze samenleving is het bewustzijn over de energie-efficiëntie van gebouwen sterk verbeterd. Het is daardoor zeer de moeite waard om CO_2-neutrale woonconcepten te ontwikkelen. Compacte, verplaatsbare en CO_2-neutrale huizen zouden een adequaat alternatief zijn voor eenpersoonshuishoudens op zoek naar betaalbare accommodatie. Voor Heijmans, (deels) eigenaar van ongeveer vijftig braakliggende grondposities, is dit idee van groot belang. Hun huizen dienen standaard te voldoen aan de energie neutrale norm. Dit kan worden bereikt door de woning all-electric te maken, waardoor geen gasaansluiting nodig is. Elektriciteit kan worden opgewekt met zonnepanelen op het dak. Warm water kan worden verzorgd door een ultrahoog vacuüm paneel. Dergelijke installaties zijn in staat om een woning te verwarmen evenals warm water te verstrekken om te kunnen douchen of om de afwas mee te doen.

De online enquête (n = 280), die werd uitgevoerd om gegevens over de voorkeuren van respondenten te verzamelen, geeft waardevolle informatie over hoe een definitief ontwerp dient te worden geconfigureerd om het beste te voldoen aan de behoefte van klanten. 75% van de respondenten waardeert het voorgestelde ontwerp als 'positief'. Respondenten die deelnamen aan de enquête hebben een uitgesproken voorkeur voor de alternatieven met de maximale huurperiode van vijf jaar. Ook een uitstekende energielabel (A[+++] label) geeft een grote positieve bijdrage aan een specifieke configuratie van de woning. Het is zinvol om vooraf te investeren in energie-genererende systeem omdat dit resulteert in lagere maandelijkse kosten. Stijgende energieprijzen maakt deze afweging nog interessanter. Verder wordt aan een aparte slaapkamer (2 kamer appartement) sterk de voorkeur gegeven boven een studio (1-kamerappartement). Ook heeft men liever een gestoffeerde woning

(vloer en gordijnen) en niet een volledig ingerichte, omdat men hoogstwaarschijnlijk liefst zelf zorg draagt voor zijn of haar meubels. Ook het faciliteren van een gemeenschappelijke ruimte is onnodig, aangezien de respondenten dit aanbod niet positief waarderen. In het kort kunnen de conclusies als volgt worden opgesomd:

- Er bestaat een enorme markt voor alleenstaanden: 500.000 extra eenpersoonshuishoudens worden verwacht in de komende 12 jaar (tot 2025, CBS). Ongeveer 71.000 personen zullen hiervan vallen in de leeftijdscategorie van 25-34 jaar;

- Met het oog op een gezonde business case, mogen de maximale kosten per woning € 60.000,- bedragen. Dit bedrag is all-in (vervoer, winst, enz.);

- De bouwkosten dienen rond de €38,000,- te liggen per woning. Het voorlopig ontwerp is nog €10.000,- te prijzig;

- Een maximale huurperiode (5 jaar), met een aparte slaapkamer en een uitstekende energieprestatie (label A + + +) worden zeer gewaardeerd door de respondenten van de enquête. Het loont om deze aspecten te integreren in het definitieve ontwerp;

- Respondenten hebben bij voorkeur liever geen gemeenschappelijke ruimte, noch meubilair.

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