

Exploring energy neutral development

Citation for published version (APA):

Han, Q., & Schaefer, W. F. (Eds.) (2015). *Exploring energy neutral development: part 4, KenW2iBrabant*, TU/e 2013/2015. Technische Universiteit Eindhoven.

Document status and date:

Published: 01/01/2015

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

EXPLORING ENERGY NEUTRAL DEVELOPMENT

KenW²iB_{rabant}

part 4

TU/e
2013/2015

Edited by

Dr. Qi Han
Prof. dr. ir. Wim Schaefer

Eindhoven University of Technology, the Netherlands

Contact Detail:

Qi Han

Postbus 513

VRT 8.12

5600 MB Eindhoven

Tel: +31 (0) 40 247 5403

E-mail: q.han@tue.nl

Copyright © 2015 CME@TU/e

Eindhoven University of Technology, the Netherlands

Group of Construction Management and Engineering @TU/e

Printed by

Eindhoven University of Technology Press Facilities

A catalogue record is available from the Eindhoven University of Technology Library

ISBN: 978-90-386-3934-5

NUR code 955

Contents

INTRODUCTION <i>Prof. dr. ir. Wim Schaefer</i>	5
THE WEIGHING IN MIXED HOUSING STOCK – WHAT TO DO WITH IT? Development of a decision support model <i>Thomas Borger</i>	9
DEMAND, SUPPLY AND POLICY; A QUANTITATIVE ANALYSIS OF THE BUSINESS- PREMISE AND LAND MARKET The Creation of a Decision Support Tool <i>Bob van Bronkhorst</i>	19
SUN, SEA, LEISURE, AND ENERGY The knowledge of experts used for the decision making of renewable energies in urban development areas in the North-Eastern part of Morocco, using AHP <i>Uasima Chaïbi</i>	29
FINANCING AND INVESTMENT OPTIONS FOR HOMEOWNERS DEALING WITH PROPERTY MAINTENANCE: foundation damage case in the Netherlands <i>Anika Cristini</i>	39
A STRATEGY TO SETUP ENERGY SERVICES FOR BUSINESS DISTRICTS WITH SMALL TO MEDIUM SIZED COMPANIES: A case study of de Hurk <i>Chris Driessen</i>	49
EXTENDED SHOP OPENING HOURS IN MEDIUM-SIZED CITY CENTRES Gaining insight in consumer shopping preferences and behavior <i>Stefanie van den Heuvel</i>	59
POTENTIAL USE OF PUBLIC TRANSPORT IN THE CONTEXT OF AIR POLLUTION REDUCTION Development of a tool to determine and localize potential bus users <i>Hannely Hortensius</i>	69
THE TRANSFORMATION OF CLIMATE-KIC INNOVATION PROJECTS INTO STARTUPS <i>Nathalie Kerstens</i>	79
MOTIVATING CITY-COMMUTERS TO CARPOOL Exploring the stimulus of various factors and policies <i>Andreas Lem</i>	89
VEHICLE USERS' PREFERENCES CONCERNING AUTOMATED DRIVING Implications for transportation and market planning <i>Ilse Megens</i>	99

STRATEGY ENRICHMENT	
A sustainable transformation of housing associations	109
<i>Marianne Oldenburger</i>	
INVESTIGATION OF THE ROLE OF PRE-TRANSPORT IN TRAVELERS' TRANSPORTATION MODE CHOICE	
A study conducted in the region of the railway station of Eindhoven	119
<i>Koen Sanders</i>	
THE FLEXIBILITY OF THE CONSUMERS AND THEIR PREFERENCES OF THE ENERGY BUNDLES	129
<i>Maike Schut</i>	
POTENTIAL TRANSFORMATION OF VACANT OFFICES INTO HOUSING FOR YOUNG PEOPLE: Optimization of decision making process	139
<i>Mark van Swam</i>	
THE INFLUENCE OF TRAIN STATIONS' ENVIRONMENT ON TRAVELERS' ORIGIN STATION CHOICE BEHAVIOR: a TOD approach	149
<i>Alexandra Tudorica</i>	
IMPROVING THE REDEVELOPMENT PROCESS OF OBSOLETE INDUSTRIAL SITES: An application of urban land readjustment and game theory	159
<i>Guido van Veen</i>	
APPENDIX A: KENWIB – Day Report Study trip China, May 2013	169
APPENDIX B: KENWIB – Day Report Study trip Manchester, May 2014	187

INTRODUCTION

KenW²iB_{rabant} is based upon cooperation between governmental organizations, university and entrepreneurial companies. The program started in September 2009 as the KENWIB project and with just a slightly different name in terms of **KenW²iB_{rabant}** the program has been re-established in 2012 and financial supported for a period of two years by the Province of North Brabant and by the 'Smart Energy Regions – Brabant' program of the EEL at Eindhoven University of Technology.

This 'Summary Book, Part 4' holds the results of the **KenW²iB_{rabant}** graduation projects, realized during the period of September 2013 till August 2015. The projects were all dealing with implementation of innovative technology into complex urban environments: bringing innovative new technology into the real world of urban districts. This urban reality includes stakeholders participation, risk bearing parties, business cases and civil and societal processes.

Since 2010 already three summary books has been produced, containing the graduation project results of 64 research projects. All these reports can be downloaded from the **KenW²iB_{rabant}** website: www.kenwib.nl. They are grouped according to the following keywords: dwellings, buildings, mobility, city models, smart grid and 'special items'.

The individual students, participating in Kenwib were connected to a wide variety of stakeholders and as final graduates they have not only developed knowledge and understanding of this subject, but they also have become a group of 'ambassadors' representing the ideas of sustainable and energy neutral developments. All the students, except for maybe one or two individuals, have found a job after finalizing their graduation project within the **KenW²iB_{rabant}** program. This result also reflects the appreciation of the society for this kind of graduation projects.

Last but not least. Even the still ongoing financial crises and the perception of shrinkage are challenging us: A world wide economy model, based upon growth, growing consumption and growing financial wealth is questioned. To that end, there are constantly debates conducting in different sectors of society, business circles and public institutions such as schools and universities. The topics include issues such as recycling of materials, and sustainable energy and sustainable water use. Although the economic and political developments were due to a rather modest increase of prices of fossil fuels, the international situation regarding safety and peace keeping has become less stable. Making our local national and regional economies more independent from energy import and raw materials, will help to improve worldwide peace keeping.

Wim Schaefer
Chair Construction Management
Eindhoven University of Technology
Coordinator **KenW²iB_{rabant}** program

SUMMARIES

THE WEIGHING IN MIXED HOUSING STOCK – WHAT TO DO WITH IT?

Development of a decision support model

Author: Borger, T.M.W. (Thomas)

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. dr. ir. W.F.Schaefer (TU/e)

Dr. ir. B. Glumac (TU/e)

Ir. B. van Weenen (TU/e)

Date of graduation:

21 August 2014

ABSTRACT

After the Second World War the goal was to produce a lot of dwellings for the people. In this moment in time the quantity was important. Now the visions are changing and the (sustainable) quality of the houses that are built becomes more important. This leads to problems for housing corporations, when they on the one hand have to provide housing for lower incomes and on the other hand have to invest to meet the sustainable desires.

In this research there was looked at the different conditions that play a role during the decision moment if a post- Second World War housing complex is suitable or not for sustainable upgrading. This leads to the introduction of a decision table to advise the housing corporation make the choice.

Keywords: Housing corporations, mixed ownership complex, decision tables, system dynamics, sustainable upgrading

INTRODUCTION

The Netherlands has a unique organisation to support the lower incomes in the society in terms of offering housing. This is the housing corporation. Up until 1988 the government supported the housing corporation financially to make sure the housing corporation's continuity was not in danger and they could continue to carry out their main objective of offering housing. However, this all changed in 1988. At this moment in time the housing corporations had to get the financial means to survive from the private market. This results in a more diverse portfolio, since the housing for the lower incomes is not feasible.

For a long time this was sufficient for the housing corporations to survive. But with the financial crisis in 2008 the housing market collapsed and their tools to get enough financial means were diminishing. This resulted in even trying to sell part of the lower income housing (mostly '60 and '70 buildings) towards either the current inhabitant or to a new person after the tenant left. By selling households to maintain the financial situation of the housing corporation decent, the housing corporations created a new type of complex: a complex with both tenants and private owners (KWH, 2011).

Now we are six years after the crisis and the effects are still around. The housing market is still recovering and at the same time there are new plans brewing by the different governments and housing corporations. So was decided to have the entire portfolio of the housing corporations on an average energy label B at the end of 2020.

Problem definition

Housing corporations made the decision to achieve a more sustainable portfolio by the year 2020. The goal in the 2020 agreement is to reach an average of label B in the complete portfolio of the housing corporation. This means that all the different parts of the portfolio should contribute somewhat so the goal can be reached on time. Achieving this goal is in a large part of the portfolio simple, but in some parts problems arise. Especially in the area of the mixed ownership complexes. These complexes have both regular tenants and private owners living in the same apartment complex. This leaves the housing corporation with a particular complex where they do not have complete control. Therefore the following problem is defined:

“The problem housing corporations are facing is the fact that they have mixed ownership in their portfolio and this is hampering them in becoming more sustainable”

Research structure

In this research we will look into the possibilities of these post-World War Two housing complexes that now house both tenants and private owners alike. This is such a unique combination (along with having a housing corporation as a part-owner) that there is very little research done in the field of these kinds of buildings.

The housing corporation is placed in a dilemma which they feel is (given the current time) not necessary to be addressed at this moment in time. This only makes the situation escalate more when not every part of the complex becomes sold in 2020. Therefore there is a need to address some of these mixed ownership complexes.

To look into the problem, the following research question will be used to guide the research, along with several sub-questions.

“What would be the best approach for a housing corporation to tackle mixed housing complexes in relation to becoming more sustainable?”

To answer this question several sub-questions are defined:

1. What external factors influence the possible actions for energy upgrading in mixed ownership housing stock?
 - a. How do policies (national, provincial, local) influence the action chosen?
 - b. How is future supply and demand influencing the action chosen?
2. What internal factors influence the possible actions for energy upgrading in mixed ownership housing stock?

3. What is the list of possible actions; given the external and internal factors?
 - a. What are the advantages and disadvantages of the different actions?
 - b. How can the different actions be measured?
4. How to support decision makers in housing corporations?

LITERATURE

In the literature review there are two aspects that play a role in finding the solution to the problem of upgrading mixed ownership housing stock. These are the factors that play a role during the choice and the different possible actions.

Factors that play a role in the choice

To investigate the different factors that make up for the choice of a housing corporation to upgrade a mixed ownership complex, literature was used. In total there are seven factors that influence the choice of a housing corporation:

1. Process management innovation
2. Relations with other players
3. User's behaviour
4. Preference for smaller projects
5. Investment costs
6. Ongoing selling process
7. Large amount of '60 – '70 complexes in the portfolio

Housing corporations are, like the construction sector, rather passive in terms of new methods and applying new techniques. Since the housing corporations have the goals to offer housing to people of the social class, this is extra stressing. There is no one to recoup the extra investments of the innovative solutions since the social class has little to spend. This means that the housing corporation would want to achieve a lot with very little investments in the portfolio. To further minimize the risk, the projects are kept to a small size to prevent massive losses if things go wrong (Turcu, 2012; Palma, I.C., Mengual, E.S., Solà, J.O., Montero, J.I., Caballero, C.P., Reiradevall, J., 2013; Mondol, J.D., Koumpetsos, N., 2013).

There is a part of the portfolio that requires extra attention, and this is the part with the mixed ownership complexes. Currently they are used as *cash cows* for the housing corporation. These complexes are relatively old and therefore cost a lot to make them up-to-date to the current demands in the market. This makes that the housing corporations decided that it would be better to sell these apartments in the complex to either tenants or other people who are willing to buy it. This way the housing corporation generates some income from the complex, while they minimize the maintenance to only planned maintenance and direct complains from inhabitants (Vassileva, L., Wallin, F., Dahlquist, E., 2012; Kaygusuz, A., Keles, C., Alagoz, B.B., Karabiber, A., 2013; Osmani, M., O'Reilly, A., 2009; Hester, N., Li, K., Schramski, J.R., Crittendem, J., 2012).

Different actions to undertake

There are all kinds of actions a housing corporation can undertake with the mixed ownership housing complex. In this research there will be three main actions defined (Turcu, 2012; Abdul-Aziz, A.R., Jahn Kassim, P.S., 2011). In the first action state there will be no change in the household situation. So the tenants and private owners that live in the complex all keep on living there (Kyrö, R., Heinonen, J., Junnila, S., 2012; Energiesprong, 2012). If there is chosen to keep the situation as it is, there are two things that can happen. Either there will be a sustainable upgrade in the complex or there will be no sustainable upgrade.

A second option would be for the housing corporation to buy back the private owned households and make the complex completely inhabited by tenants again. This action would require a very unique situation to occur, since this is the riskiest action that can be undertaken.

The third action is what is happening currently in the market. The housing corporation labels the complex as a *cash cow* project and only tries to extract money from it by doing as least as possible. In this situation all the apartments are up on the market to be sold. Sometimes there are even large discounts for the current tenants to buy the apartment (Tiwos, 2013).

METHOD

To see if a mixed ownership complex is suitable for upgrade the decision table will be used. This method offers the housing corporation a way to easily determine the different conditions and an advice is formed by the table (Arentze, F. and Borgers, A., 2003; Batchelder, 1991).

C1. Ownership condition	Positive								Negative				
C2. Portfolio transformation	Need				No Need				Need			No Need	
C3. Investment costs	Low		Med		High	Low		Med	High	Low	Med	High	—
C4. Process time	S	L	S	L	—	—	—	—	—	—	S	L	—
A1. Portfolio action	K	K	K	K	K	K	K	S	B	B	S	S	S
A2. Inform inhabitants	X	X	X	X				X	X	X	X	X	X
A3. Offer removal expenses									X	X			
A4. Look for better techniques	X	X	X										
A5. Buyer identification						X	X	X	X	X	X	X	X
A6. Partnership with other HC		X	X	X									
A7. Look for other projects					X	X	X	X			X	X	X
A8. Sustainable upgrade	X	X	X	X					X	X			
	01	02	03	04	05	06	07	08	09	10	11	12	13

Table 1: complete decision table

Preconditions

The model will only perform under certain preconditions. These are the different rules that make a specific choice possible. When the different preconditions are not met, then the table should not be applied.

Table 2: preconditions of the decision table

Precondition	Description
User's Behavior	The way users use their appliances in their household will not change after the sustainable upgrade. They will act with their best intentions to keep the projected results.
Upgrade process	The housing corporation, in principle, will apply the sustainable upgrades as how they have done previously in other projects.
Regulations	The aim is to contribute towards the regulations that state housing corporations should become more sustainable in the future.
Sustainable plan	The complex that is targeted with the DT is aimed to be sustainable upgraded by using the DT.

Conditions

With the found attributes in literature the different conditions can be determined (table 3).

Table 3: conditions and their description (based on literature)

Condition:	Condition alternatives:	Description:
Ownership condition	Positive / Negative / Very negative	If the population of the complex is positive towards a sustainable upgrade, based on sub-conditions
Portfolio position	No need / Need	How the portfolio is effected by the mixed ownership complex, based on sub-conditions
Investment costs	High / Medium / Low	The total costs and return on investment, based on sub-conditions
Process time	Very long / Long / Short	The time the total project will take, based on sub-conditions

Now are the condition alternatives of these conditions still very vague. To address this problem, the sub-tables are used. In the different sub-tables the conditions are further split up into sub-conditions that are more practical.

Table 4: sub-table for the sub-conditions of the ownership condition

Sub-table for ownership condition				
C. Tenants	< 70%		≥ 70%	
C. Private owners	< 65%	≥ 65%	< 65%	≥ 65%
C1. Ownership condition	Very negative	Negative	Negative	Positive
	1	2	3	4

Table 5: sub-table for the sub-conditions of the portfolio position

Sub-table for portfolio transformation						
C. Amount of mixed ownership complexes	< 20%			≥ 20%		
C. Recent sales in the complex	< 6 months	[6 and 12 months]	> 12 months	< 6 months	[6 and 12 months]	> 12 months
C2. Portfolio transformation	No need	No need	Need	No need	Need	Need
	1	2	3	4	5	6

Table 6: sub-table for the sub-conditions of the investment costs

Sub-table for investment costs								
C. Amount of households	≤ 50				> 50			
C. Investments per apartment	≤ €20.000		> €20.000		≤ €20.000		> €20.000	
C. New energy label	Label B or lower	Label A or higher	Label B or lower	Label A or higher	Label B or lower	Label A or higher	Label B or lower	Label A or higher
C3. Investment costs	Low	Low	High	Med	Med	Low	High	High
	1	2	3	4	5	6	7	8

Table 7: sub-table for the sub-conditions of the process time

Sub-table for process time							
C. Preparation time (process)	≤ 1 year			(1 and 2 years)			≥ 2 years
C. Renovation time (instalment)	< 3 months	[3 and 9 months]	> 9 months	< 3 months	[3 and 9 months]	> 9 months	–
C4. Process time	Short	Short	Long	Short	Long	Long	Very long
	1	2	3	4	5	6	7

With these different sub-tables the actions can be determined and the complete decision table can be formed.

Actions and decision table

In literature the different main action were already found: keep the situation as it is (in terms of inhabitants), buy back the sold apartment or sell the remaining rental apartments. Of course do these actions on itself not that much for a housing corporation. To give more guidance there are some more actions defined that are related to the different main-actions and conditions.

These sub-actions, as they can be called, are simple proceedings that will help guide the project or process. This are actions like informing the inhabitants, offer removal expenses, look for better techniques for sustainable upgrade, buyer identification and partnership with other housing corporations. In the end the decision table will lead to the two different resulting actions, or the actions that are the most important. This is the distinction between either making a sustainable upgrade or look for other projects that are better suitable for sustainable upgrade.

System dynamics: ownership condition estimation

From all the different conditions that are presented in the sub-tables, there is one factor that is tricky to estimate by the housing corporation: *the ownership condition*. To address this, a small system dynamics model will be used by applying the formula of the utility:

$$\hat{U}_{tenant} = \beta_{label}X_{label}\alpha + \beta_{inv}X_{inv}\alpha + \beta_{time}X_{time}\alpha + \varepsilon$$

Where:

\hat{U}_{tenant} = The estimated utility

β = The importance value of the single variable

X = The condition of the variable

α = normalisation factor

ε = The error term

The different utilities will then be modified in a probability so the system dynamics model can calculate the ownership condition.

$$p = \frac{\exp U}{\sum \exp U}$$

This model will use the same conditions as presented in the decision table. Only there interpretation of some terms will be different for the tenants and private owners. The tenants and private owner will have no relation to the energy label and will translate it to something else. Tenants will translate the higher label to an increase in comfort, while owners will translate it to a higher market value of their apartment when they decide they want to sell it.

RESULTS

By using two case studies, the different models were tested and applied. In the different cases the models worked by simply filling in the conditions and reading out the different actions that were advised. What was most interesting to observe was that there can be subtle changes in the process which lead to a completely different advice. This, for example,

was the case in the case of the Surinamelaan. Here inhabitants (tenants and private owners) formed a group against the housing corporation to convince the housing corporation to act. In the end the decision table does what it should do, it weighs the risks, based on the conditions and gives an advice.

CONCLUSIONS AND FURTHER RESEARCH

In this research the goal was to see what housing corporations should do with mixed ownership in their portfolio in relation to becoming more sustainable. What was experienced is that there is no single solution for this problem; every complex should be evaluated individually and based on the conditions a choice should be made. This research merely formed an advice in the form of a decision table, if the housing corporation sticks to the advice is up to them. All that is certain is that there is no ideal situation. There will always be factors that are either unforeseen or unpredictable. The models merely attempt to capture some factors to make an educated guess on what should be done in that particular situation. What is known is that there is still more research needed to investigate this problem completely.

When looking back at the situation, given the 2020 goal of reaching an average of label B in the portfolio in that specific year, the housing corporations are running out of time soon. They should quickly determine which of these mixed ownership complexes are feasible for upgrade and which are not. 2020 is approaching soon and the time it takes to actually make the upgrade is often overlooked or underestimated.

We mainly took the perspective of a housing corporation in the research. This is in contrast to the real world situation where the needs and wishes of the tenants and private owners also play a more direct role on the activities a housing corporation can do. The inhabitants were not the target of this research and require a further investigation.

To finish the research about these mixed ownership complexes; there is the fact if it provides a solid business case. By researching if it is possible to have a solid business case these projects could be seen in a totally different perspective.

REFERENCES

- Aedes. (2013). *Energieakkoord duurzame groei*. Retrieved from Aedes: <http://www.aedes.nl/binaries/downloads/energie-en-duurzaamheid/20130906-energieakkoord-duurzame-groei.pdf>
- Arentze, F. and Borgers, A. (2003). *Evaluation and decisions - DDSS master program*. Eindhoven: Eindhoven university of technology.
- Batchelder, W. (1991). Use of decision tables in tax planning. *Computers in taxation*, 471-473.
- Hester, N., Li, K., Schramski, J.R., Crittendem, J. (2012). Dynamic modelling of potentially conflicting energy reduction strategies for residential structures in semi-arid climates. *Journal of environmental management*, 148-153.
- Kaygusuz, A., Keles, C., Alagoz, B.B., Karabiber, A. (2013). Renewable energy integration for smart sites. *Energy and buildings*, 456-462.
- KWH. (2011). *Visitatierapport de woonstichting*. Rotterdam: KWH – Kwaliteitscentrum Woningcorporaties Huursector.
- Mondol, J.D., Koumpetsos, N. (2013). Overview of challenges, prospects, environmental impacts and policies for renewable energy and sustainable development. *Renewable and sustainable energy reviews*, 431-442.
- Osmani, M., O'Reilly, A. (2009). Feasibility of zero carbon homes in England by 2016 - A house builder's perspective. *Building and Environment*, 1917-1924.
- Palma, I.C., Mengual, E.S., Solà, J.O., Montero, J.I., Caballero, C.P., Reiradevall, J. (2013). Towards a green sustainable strategy for social neighbourhoods in Latin America. *Habitat international*, 47-56.
- Tiwos. (2013). *Jaarverslag Tiwos*. Tilburg: Tiwos.
- Turcu, C. (2012). Local experiences of urban sustainability. *Progress in planning*, 101-150.
- Vassileva, L., Wallin, F., Dahlquist, E. (2012). Understanding energy consumption behavior for future demand response strategy development. *Energy*, 94-100



Borger, T.M.W. (Thomas)

After a false start on a different topic, there was decided to leave that topic and start all over with a fresh start. This was for all the best, in the end. The research, even though, without a direct company, gave a ton of information and experience in the field thanks to roughly ten different company visits for all kinds of information.

Together with the support of fellow students and family, this lead to the results of this research as of how they are presented in this report.

Februari 2012 – September 2014

Oktober 2013 – june 2014

September 2012 – September 2013

September 2012 – September 2013

September 2008 – Februari 2012

Master construction management and engineering

Facilities and financial manager – CME conference

Certificate technology entrepreneurship

Board of CoUrsE!

Bachelor architecture, building and planning

DEMAND, SUPPLY AND POLICY; A QUANTITATIVE ANALYSIS OF THE BUSINESS- PREMISE AND LAND MARKET The Creation of a Decision Support Tool

Author: B. van Bronkhorst

Graduation program:

Construction Management and Engineering 2013-2014

Graduation committee:

prof. dr. ir. W.F. Schaefer (TU/e)

drs. P.H.A.M. Masselink (TU/e)

dr. ir. B. Glumac (TU/e)

ir. M. van Rhee (Brink Groep)

ir. T. Kunen (Brink Groep)

Date of graduation:

15-01-2014

ABSTRACT

After five years of recession, a lot of initial anticipations and aspirations were negated. Among these, the exploitation plans for the expansion locations of municipalities. The poor housing, retail and office markets are ruining private and public parties, but in the market of business locations, there is only one big loser, the municipality. In this thesis the causes, consequences and opportunities of this social problem are analysed. By identifying and analysing large datasets, the real complexity of the problem is brought to light and an attempt is made to quantify relations it in a model.

Keywords: Supply, Demand, Policy, Bayesian Classifier Network, Agent Based Modelling, Land Use Modelling

INTRODUCTION

Now just before printing this thesis, in 2014 the losses allegedly have risen to between 4,0 and 6,0 billion euros. These figures are in stark contrast to the expected profits of 3,6 billion euros. This results in a total deficit between expected income and expenses of at least 7,6 billion euros; as large as the three quarters of the budget cuts in 2012 of the Dutch government due to the economic crisis (10 billion). Dutch municipalities have acquired, over the last eight years, an abundance of land destined for business. Based on optimistic prognoses and conceit, municipalities believed until around 2007 that they had a shortage of land in supply for business purposes. However the demand for all this ground never truly developed as anticipated. Now all across the Netherlands there are plots of land that have been made ready for construction, may never be used and the plots that are to be sold will leave a vacant building in the region. In 2014 the losses allegedly have risen to between 4,0 and 6,0 billion euros.

The land market is, as the name suggests, a system of supply and demand. The surpluses of acquired land have led to a mismatch between this supply and demand. This would not be a problem in any other market, though the land market has some imperfections, which

differentiates it from a standard market. The institutional context for land ownership, exchange and development, combined with high governmental involvement and public funds differs the market as well from a normal market.

Problem definition

There is an oversupply of land purposed for business activities, which instigates vacancy and urban sprawl and strains the budgets of municipalities, which leads to a wide variety of social security problems. Municipal budgets are depending on the profits that are made from city expansion, causing a 'two hats dilemma'. Municipalities must choose between (1) financial or economic considerations and (2) spatial planning goals. Local governmental responsibilities are limited to their territory and as a result, the relatively high supply creates a competition between municipalities to attract companies.

Research Structure

There have been some crucial exclusions in literature so far. None of the articles consider the current stock in their equation for the amount of land needed. In most papers it is assumed that the land grants will be originating from areas outside the current stock. This is however not the case. Another omission is the incorporation of qualitative aspects in the demand and supply. This research attempts to not only create a model which quantifies the problem for municipalities, but the model will also try to predict the qualitative demands and how to best cope with these. Thus the purpose of the research is: Creating a micro economic model which quantifies the relations of policy on business-land grants on the total supply and demand.

Because the province has to supply municipalities in need with their deficits, it is slowly becoming a problem for them. The province cannot directly dictate the land use plans and the municipalities are allowed to heighten the estimations of the province with their own ambitions. Also the scope of the problem suggests that there is something fundamentally wrong and the problem owner is defined as the province. The aspect of competition between municipalities is also not negligible and calls for a higher level of governance. The province will therefore be seen as the problem owner.

To guide the research in the right direction and test the hypothesis, the following research questions are proposed to help achieve the purpose of the research.

Can demand and supply of business-land be modelled; quantifying policy influence on vacancy and losses?

- *What caused the surpluses of business-land and what are the consequences?*
- *What is the financial structure behind business-land development?*
- *What constitutes supply and demand for business-land and can it be quantified?*
- *Can a decision support tool be created and validated?*
- *What are the influences of supply and can the model help create a sustainable policy towards business purposed land?*

THEORETICAL FRAMEWORK

The business space market can be split into two sections: the business land and the business premise market.

Business-Land Development

Business-land development in the Netherlands is highly focused on new developments. More as other markets in which re-use and redevelopment are more prominent options. Municipalities are responsible for the lion's share of the industrial land development. More than 75 percent of the land predestined for industrial granting is owned by the municipalities (Ministry of Infrastructure and the Environment 2012a). To guarantee continuity municipalities have land reserves. The provinces are mainly aiming at estimation of the demand, the designation of sites and encouraging regional coordination in planning and programming. Most of the tasks and responsibilities are focused on the municipalities, which are responsible for a large part of the planning, programming and the development and distribution. Municipalities mostly base their land reserves on their own calculations, of which only one out of three has been made with the formal code for calculating the land needed on reserve. The demand in practice is predicted by waiting lists and informal discussion. Despite that almost all municipalities claim to monitor the existing stock, only one in four municipalities adjusted their demand by considering the current stock and vacancy rates. Mostly this is because small municipalities do not have the man power to keep an eye on the existing stock and accompany entrepreneurs in their search for a suitable location within the current built environment. Also are they not capable of predicting an accurate demand.

The Business Premise Market

Business premise development is different from business land development is based upon speculations of municipalities instead of private developers. This is reflected in the premise development. As private developers do not take up a large part of business land development, they are not likely to develop business premises. After land is developed by the municipality, it is mostly sold to the end-user instead of a developer. The private end-user will commission a contractor to build his premise for own use. The business premise market consists of specialised and tailored premises. As only 29 percent of business premises have been previously owned, it is possible to conclude that the market is dominated by 71 percent first time use

The relocation of a company has several financial consequences. These can be categorised into building costs, furnishing costs and relocation cost. These fluctuate per branch and the actual relocation costs, they are minimal and the building costs and furnishing costs compose the bulk of the costs. As it comes to costs when developing greenfields, they can be separated into land price and construction costs and fees. Municipalities wrongly assume the land price is the determining factor for location choice. Land price is only a small part of their decision, however it plays a role.

Methodology

To try to fathom the complex mechanisms involved an Agent Based Model is created. Agent-based Modelling (ABM) is a modelling technique for complex systems composed of interacting, autonomous decision makers. It will combine the macro economic developments and the micro economic decisions made by companies. All the factors will have to be quantified to serve as input for the ABM. To quantify the qualitative aspects of this demand, random utility theory is applied. To quantify the appreciation of the attributes form a static

dataset, a Bayesian network analysis is proposed. These quantified preferences are then combined with the increase and decrease in demand and supply and the ABM will model the developments of the business land and property market.

ESTIMATING QUANTITATIVE DEMAND

Supply as well as demand are defined as the amount of land (in hectare) with the function business; named 'business-land'. The demand is further refined to the amount of business-land needed for the proper functioning of a healthy entrepreneurial environment. The supply is defined as the offered amount of land composed of the 'iron reserve', considering LID as well as LNID and the current stock. The demand is dependable on a wide variety of variables, since each entrepreneurial activity demands a different amount of land and has a different efficiency. However the demand of business-land is unmistakably connected to employment developments and therefore most method use employment as an input for demand estimation. The Spatial Planning Bureau of the Netherlands (Dutch: Ruimtelijke Planbureau) has created a business-housing location monitor (Dutch: Bedrijfslocatiemonitor; BLM) for the Dutch market. The BLM is by far the most sophisticated method for estimating the demand for industrial land due to its incorporation of almost all involved macro-economic trends. It does not pay any attention to meso-economic trends in sectors. By combining the BLM with agent-based modelling it is possible to introduce these business cycle parameters, locational preferences and policy restrictions.

ESTIMATING QUALITATIVE DEMAND

The theories of supply in the land market should take in account the distinctiveness of land as a commodity. Land is unique because of its location and allocation which makes the location theory is an indispensable aspect of the estimation of demand. In the considerations concerning the location or relocation of a company, two of the factors generally stand out as the most important; location factors and financial factors. This concludes in the list of 14 discretized locational attributes used in the Bayesian Classifier Network to find the utilities. These attributes can crudely be categorised in to (1) land use restrictions, (2) representational characteristics, (3) accessibility and the (4) respective location of consumers and clients.

SUPPLY

The supply of business-land in the Netherlands, concerning working locations, is closely monitored by the 'IBIS Werklocaties'. The existing terrains constitute the first part of the supply the other half of the supply are composed of the land in development and the pipeline supply; land not in development. For this research a case study is done in the area of the conurbation of Eindhoven. The Bayesian Classifier Network analysed 3600 companies in the area to find the utilities for the fourteen attributes. As a result the utilities are known for all 53 terrain in the area for all eighteen branches

THE MODEL

Before the description of the model is given, we first give a set off assumptions on which it is based. The assumptions are: (1) Businesses act only based upon the spatial discrepancy and the best other option. (2) Businesses choose the best option only based upon financial and

locational preferences. (3) New companies come in at a constant rate. (4) Vacancy is evenly spread (due to lack of detailed data).

The model is made in NetLogo. An abstract flowchart of the algorithm is given in Figure 1, followed by a short description of the overall workings of the model.

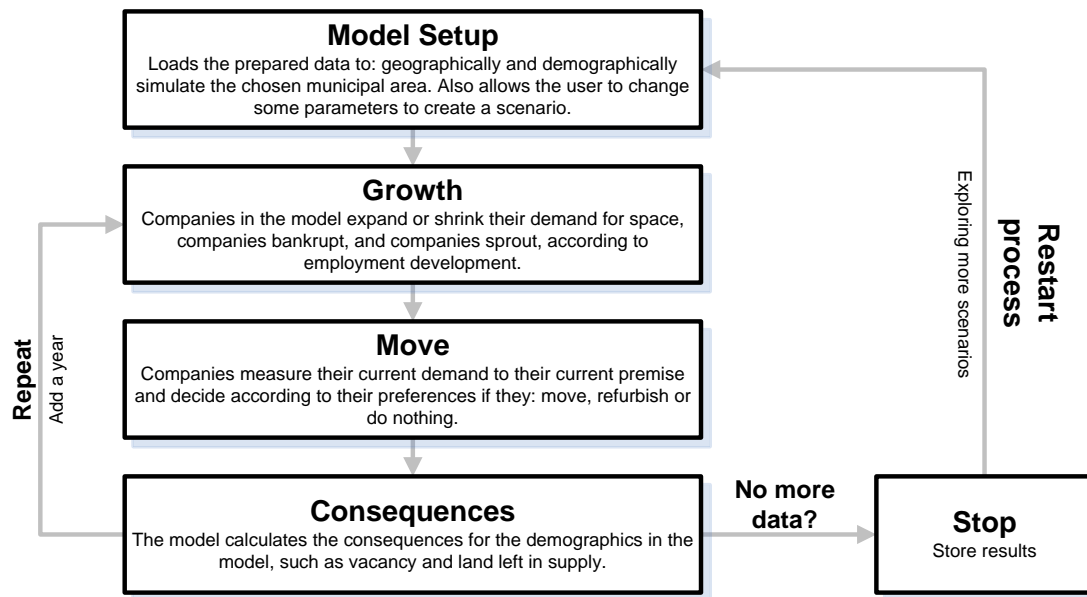


Figure 1: Model structure

In the setup phase the 'world' is created. This world is the simulated area, with the included characteristics. The geographical shapes of the terrains and their characteristics and the companies with their branch, location and size are loaded. As the model is initiated, the simulation will begin each step with a growth command followed with the decision moment of relocation for a company. Each step will be closed by the processing of the consequences and then starts with growth again. In this growth command the companies add or subtract an amount of demand based upon the findings of the quantitative demand analysis. This growth (or shrinkage) will enhance (or reduce) the discrepancy between the demand for space and the space of the premise for each business. This will lead to some sort of dissatisfaction, which is used as input for the 'move' algorithm of the model.

As a result of the growth command, the model has a set of companies which have certain dissatisfaction with the space of their premise and a set of companies with no premise yet. The already settled companies have two causes for their dissatisfaction; their current premise is not spatially satisfying or their current premise is not qualitatively satisfying. Based on these factors combined with financial considerations, the companies will have to decide to take a course of action. The company weighs the costs, spatial discrepancy and the quality to make a decision on their course of action. Therefore four pay-offs have to be generated and are compared. However therefore the quality must be quantified for three locations. These locations are specified in the model as sub-terrains, which are postal code areas (PPC6). The locations are (1) the best available undeveloped patch, (2) the best suited developed patch with a suitable housing location and (3) the rating of the current location.

The payoffs are generated based on satisfaction and are calculated with an algorithm. The company looks up its branch and then searches for the branch's weighting list. This list is compiled of the weights given to the location attribute levels. Then the company asks all sub-terrains to report their variables and the company multiplies them with their respective weights. This results in a list of scores for all sub-terrains and then the highest one is selected as the best option. To prevent that the best sub-terrain excludes a certain branch, all scores of for these branches are disqualified for this list.

REQUIRED DATA

For the creation, validation and use of the model, a lot of data must be gathered and prepared. This data is available from local governments, such as municipalities and provinces as well as some real estate companies. The required data is not found purely in the prepared form usable for Agent Based Modelling and must be prepared through a series of preparations. The incipient models, the BLM and the Bayesian Network will combine rough data and extract the data needed for the ABM. In Figure 2 the flowchart of the data preparation is given and the processes are described below.

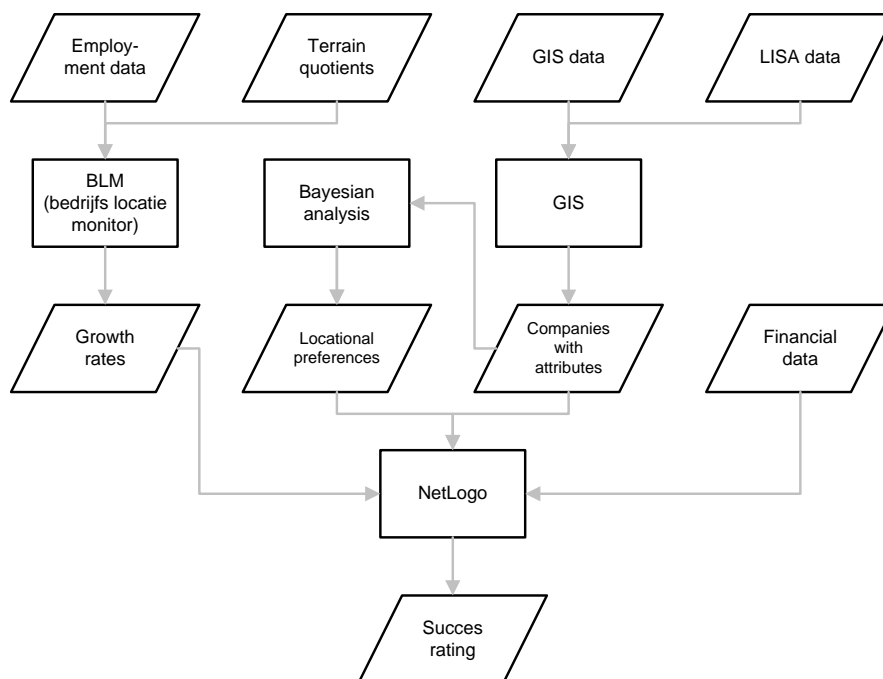


Figure 2: Flow chart of the data flows

RESULTS

Now that the model is validated the predictions of the future can be made and these runs can be analysed and processed. In a scenario under the status quo, it was found that the amount of land granted would be 56 ha. and vacancy will still increase to about 9,9 percent. Some of the growth will be absorbed by investments in companies' premises. But it must be noted that the results are not absolute but are rather distributed as can be seen in Figure 3.

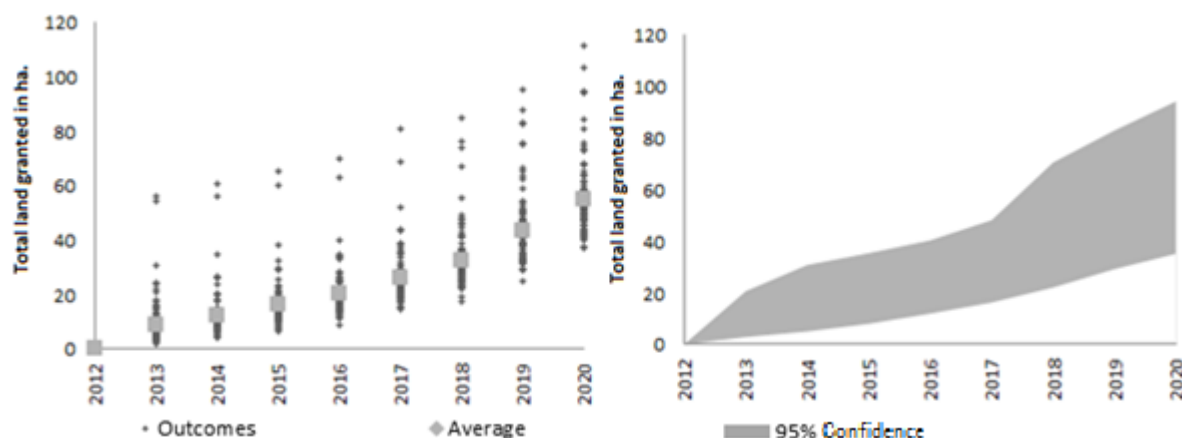


Figure 3: Results of the run status quo land grant outcomes & confidence boundaries

As more scenarios were explored the relations between policy and the market of supply and demand became clearer.

CONCLUSIONS & FURTHER RESEARCH

The problem of an oversupply of land purposed for business activities, has evolved due to a mix of policy, optimism, structure and the unique composition of the land market. It is multifaceted and is not as simple as an recalculation of the amount of hectares needed. Policy can backfire in the form of vacancy. A decision support tool for this complex problem, was realised in the form an agent based model. This model can be of great value for any municipality with business parks within its borders, especially because the plans of many local governments, such as lowering the land prices, will backfire on vacancy. It is suggested that for further research it is proposed to upscale the model to a full COROP region, to use a more unified dataset and to create detailed insight into vacancy.

REFERENCES

- Adams, David, Alan Disberry, Norman Hutchison, and Thomas Munjoma. 2001. Ownership Constraints to Brownfield Redevelopment. *Environment and Planning A*. Vol. 33. doi:10.1068/a33200.
- Alker, Sandra, Victoria Joy, Peter Roberts, and Nathan Smith. 2000. The Definition of Brownfield. *Journal of Environmental Planning and Management*. Vol. 43.
- Allers, M A. 2010. "Rijksbegroting 2010 : Gemeenten Moeten Bezuinigen , Maar Niet Allemaal Even Veel." *Tijdschrift Voor Openbare Financiën* 41 (5): 283–292.
- Ball, Michael, Colin Lizieri, and Bryan D. Macgregor. 1998. *The Economics of Commercial Property Markets*. 1st ed. London: Routledge.
- BBV. 2012. *Notitie Grondexploitatie (bijgesteld)*. The Hague.
- Beckers, Pascal, and Jan Schuur. 2012. *The Long-term Relationship Between Land Use and Employment on Industrial Sites in the Netherlands*. The Hague.
- Beckers, Pascal, Jan Schuur, and Michel Traa. 2012. *Bedrijven En Terreinen : De Voorspelling Van Het Werkgelegenheids-aandeel Op Bedrijventerreinen*. The Hague.
- Brier, Glenn W. 1950. "Verrification of Forecasts Expressed in Terms of Probability." *Monthly Weather Review* 78 (1) (April 10): 1–3. doi:10.1126/science.27.693.594.
- Buitelaar, Edwin, AHJ Segeren, Pia Kronberger, and N Noorman. 2008. *Stedelijke Transformatie En Grondeigendom*. Nai.
- Centraal Planbureau. 2012. *Actualiteit WLO Scenario ' s*. The Hague.

- Chrysochoou, Maria, Kweku Brown, Geeta Dahal, Catalina Granda-Carvajal, Kathleen Segerson, Norman Garrick, and Amvrossios Bagtzoglou. 2012. A GIS and Indexing Scheme to Screen Brownfields for Area-wide Redevelopment Planning. *Landscape and Urban Planning*. Vol. 105. Elsevier B.V. doi:10.1016/j.landurbplan.2011.12.010.
- Court of Audit. 2008. *Herstructureren Van Bedrijventerreinen*. The Hague.
- Dijk, Jouke Van, and P H Pellenbarg. 2000. "Firm Relocation Decisions in The Netherlands: An Ordered Logit Approach." *Papers in Regional Science*.
- Van Dinteren, Jacques, Arnold Posthuma, and Linda Bruin. 2007. *Regionaal Bedrijventerreinenbeleid: Een Inventarisatie*. Nijmegen.
- Ferber, U, D Grimski, K Millar, and P Nathanail. 2006. *Sustainable Brownfield Regeneration: CABERNET Network Report*. Nottingham: University of Nottingham. Nottingham.
- Frayser, Jens, Zhanli Sun, Daniel Müller, Darla K. Munroe, and Jianchu Xu. 2014. "Analyzing the Drivers of Tree Planting in Yunnan, China, with Bayesian Networks." *Land Use Policy* 36 (January): 248–258. doi:10.1016/j.landusepol.2013.08.005.
- Ghaffarzadegan, Navid, John Lyneis, and George P. Richardson. 2010. How Small System Dynamics Models Can Help the Public Policy Process. *System Dynamics Review*. doi:10.1002/sdr.442.
- Glumac, Brano, Wim F Schaefer, Bauke de Vries, and Qi Han. 2012. *Strategic Decision Modeling in Brownfield Redevelopment*. 1st ed. Eindhoven: Eindhoven University of Technology.
- Gorter, Erwin, and Han Olden. 2007. *Beleid Voor Bedrijventerreinen in Vlaanderen, Duitsland, Verenigd Koninkrijk En Frankrijk*. Utrecht: Stogo.
- Halleux, Jean-Marie, Szymon Marcinczak, and Erwin van der Krabben. 2012. The Adaptive Efficiency of Land Use Planning Measured by the Control of Urban Sprawl. The Cases of the Netherlands, Belgium and Poland. *Land Use Policy*. Vol. 29. Elsevier Ltd. doi:10.1016/j.landusepol.2012.01.008.
- Hara, Dan. 2003. *Market Failures and the Optimal Use of Brownfield Redevelopment Policy Instruments*. Presentation to National Brownfields Redevelopment Ottawa.
- Harder, Gertjan. 2013. "Interview Harder."
- Ten Have, Frank J. M., Sjoers W. Berns, E. C. M. van de Bouwhuijsen, and Hakan Celik. 2012. *Financiële Effecten Crisis Bij Gemeentelijk Gronbedrijven*. Amsterdam.
- Heckerman, David. 2008. *A Tutorial on Learning with Bayesian Networks*. 1st ed. Vol. 1995. Redmond: Microsoft.
- Hensher, DA, JM Rose, and WH Greene. 2005. *Applied Choice Analysis: a Primer*. Cambridge: Cambridge University Press.
- Heurkens, Erwin. 2012. *Private Sector-led Urban Development Projects: Management, Partnerships and Effect in the Netherlands and UK*. Architecture and the Built Environment. Vol. 2.
- Keala Group. 2012. *Gemeenten Lopen Jaarlijks Gezamenlijk 70 Miljoen Euro Aan OZB-inkomsten Mis Door Leegstand Op Bedrijventerreinen*. Breda.
- Knoben, Joris. 2013. "Interview with Joris Knoben."
- Knoben, Joris, and Michel Traa. 2008. *De Bedrijfslocatiemonitor Kritiek, Alternatieven En Aanpassingen*. The Hague.
- De Kort, Joop. 2003. *Mondialisering, Regionalisering of Gewoon Internationale Economie?* Leiden.
- Krabben, Erwin Van Der, and Edwin Buitelaar. 2011. *Industrial Land and Property Markets: Market Processes, Market Institutions and Market Outcomes: The Dutch Case*. European Planning Studies. Vol. 19.
- Van der Krabben, Erwin, and Harvey M. Jacobs. 2013. *Public Land Development as a Strategic Tool for Redevelopment: Reflections on the Dutch Experience*. *Land Use Policy*. Vol. 30. Elsevier Ltd. doi:10.1016/j.landusepol.2012.06.002.
- Louw, E. 1996. "Kantoorgebouw En Vestigingsplaats: Een Geografisch Onderzoek Naar De Rol Van Huisvesting Bij Locatiebeslissingen Van Kantoorhoudende Organisaties." *Stedelijke En Regionale Verkenningen* 12: 0–256.
- Louw, E, E. van Der Krabben, and H Priemus. 2003. "Spatial Development Policy: Changing Roles for Local and Regional Authorities in the Netherlands." *Land Use Policy* 20 (4) (October): 357–366. doi:10.1016/S0264-8377(03)00059-0.

- Luijten, Jos. 2013. "Interview with Jos Luijten."
- Manzato, Gustavo Garcia. 2012. Modeling Office Firm Dynamics in an Agent-Based Micro Simulation Framework. Ed. H J P Timmermans. 1st ed. Eindhoven: Eindhoven University of Technology.
- Marcot, Bruce G. 2012. "Metrics for Evaluating Performance and Uncertainty of Bayesian Network Models." *Ecological Modelling* 230 (April): 50–62. doi:10.1016/j.ecolmodel.2012.01.013.
- McCarthy, Linda. 2002. The Brownfield Dual Land-use Policy Challenge: Reducing Barriers to Private Redevelopment While Connecting Reuse to Broader Community Goals. *Land Use Policy*. Vol. 19. doi:10.1016/S0264-8377(02)00023-6.
- Mcfadden, Daniel. 1980. "CONSUMER BEHAVIOR Econometric Models for Probabilistic Choice Among Products." *Journal of Business* 53 (3): 0–17.
- Ministry of Infrastructure and the Environment. 2011. IBIS Werklocaties De Stand Van Zaken in Planning En Uitgifte Van Werklocaties Op 1 Januari 2011 En De Uitgifte in 2010. The Hague.
- . 2012a. IBIS Werklocaties De Stand Van Zaken in Planning En Uitgifte Van Werklocaties Op 1 Januari 2012 En De Uitgifte in 2011. The Hague.
- . 2012b. Ladder Voor Duurzame Verstedelijking. The Hague.
- Ministry of Infrastructure and the Environment, Ministry of Economic Affairs, IPO, and VNG. 2009. Convenant Bedrijventerreinen 2010 - 2020. The Hague.
- Municipality of Groningen. 2009. Grondprijzenbeleid 2010-2012. Groningen.
- Nadkarni, Sucheta, and Prakash P. Shenoy. 2004. "A Causal Mapping Approach to Constructing Bayesian Networks." *Decision Support Systems* 38 (2) (November): 259–281. doi:10.1016/S0167-9236(03)00095-2.
- Norsys Software Corp. 1995. "An Introduction to Bayes Nets." Norsys Software Corp. http://www.norsys.com/tutorials/netica/nt_toc_A.htm.
- Olden, Han. 2010. Uit Voorraad Leverbaar: De Overgewaardeerde Rol Van Bouwrijpe Grond Als Vestigingsfactor Bij De Planning Van Bedrijventerreinen.
- Oort, Frank van, Roderik Ponds, Joep van Vliet, Hans van Amsterdam, Stephaan Declerck, Joris Knoben, Piet Pellenburg, and Jesse Weltevreden. 2007. Verhuizingen Van Bedrijven En Groei Van Werkgelegenheid. Rotterdam: NAI Uitgevers.
- Orme, Bryan. 2002. "Sawtooth Software Formulating Attributes and Levels in Conjoint Analysis" 98382 (360).
- Pearl, Judea. 1978. "An Economic Basis for Certain Methods of Evaluating Probabilistic Forecasts." *International Journal of Man-Machine Studies* 10 (October): 0–8.
- Pellenburg, P H, L J G Van Wissen, and J Van Dijk. 2002. Firm Relocation: State of the Art and Research Prospects. Groningen: University of Groningen.
- Pen, C J. 1999. Improving the Behavioural Location theory—Preliminary Results of a Written Questionnaire About Strategic Decision-making on Firm Relocations. ERSA Congress, Dublin.
- Persky, Joseph, and Wim Wiewel. 1996. Central City and Suburban Development : Who Pays and Who Benefits ? Chicago Brownfields Forum. Chicago.
- Planbureau voor de Leefomgeving. 2009. De Toekomst Van Bedrijventerreinen: Van Uitbreiding Naar Herstructurering. The Hague.
- Ploegmakers, Huub. 2013. "Interview with Huub Ploegmakers."
- Ploegmakers, Huub, Erwin van der Krabben, and Edwin Buitelaar. 2013. Understanding Industrial Land Supply: How Dutch Municipalities Make Decisions About Supplying Serviced Building Land. *Journal of Property Research*. doi:10.1080/09599916.2012.753933.
- Ploegmakers, Huub, and Friso de Vor. 2013. "De Hoogte Van Prijzen Voor Bedrijfskavels." *Real Estate Quarterly*.
- Province of North-Brabant. 2008. Overeenkomst Regionaal Gronduitgifteprotocol. 's-Hertogenbosch.
- Samsura, D. Ary a., Erwin van der Krabben, and a.M.a. van Deemen. 2010. A Game Theory Approach to the Analysis of Land and Property Development Processes. *Land Use Policy*. Vol. 27. doi:10.1016/j.landusepol.2009.07.012.
- Van Steen, P J M. 1998. Bedrijvenlandschap 2000+: Bedrijfsverplaatsingen En De Vraag Naar Bedrijfslocaties in Nederland. Groningen: Rijksuniversiteit Groningen.

- Traa, Michel, and Stephaan Declerck. 2007. De Bedrijfslocatiemonitor Een Modelbeschrijving. The Hague.
- Vakberaad Gemeentefinanciën. 2012. Grondbezit Nekt 15 Procent Gemeenten. The Hague.
- Vakberaad Gemeentefinanciën. 2012. Rapport: 3,2 Miljard Verlies Op Grond. Diemen.
- Vereniging van Nederlandse Gemeente. 2011. Leegstand Te Lijf. The Hague: Ministry of the Interior and Kingdom Relations.
- Vliegen, Mathieu. 2005. Centraal Bureau Voor De Statistiek Grootstedelijke Agglomeraties En Stadsgewesten Afgebakend. Zwolle.
- De Vor, Florus. 2011. "THE IMPACT AND PERFORMANCE OF INDUSTRIAL SITES : EVIDENCE FROM THE NETHERLANDS."
- Walker, Sean, KW Hipel, and T Inohara. 2008. Attitudes and Coalitions Within Brownfield Redevelopment Projects. IEEE.
- Wang, Dongchuan, Jianhua Gong, Liding Chen, Lihui Zhang, Yiquan Song, and Yujuan Yue. 2013. Comparative Analysis of Land Use/cover Change Trajectories and Their Driving Forces in Two Small Watersheds in the Western Loess Plateau of China. International Journal of Applied Earth Observation and Geoinformation. Vol. 21. Elsevier B.V. doi:10.1016/j.jag.2012.08.009.
- Weterings, Anet, Joris Knobens, and Hans van Amsterdam. 2008. Werkgelegenheidsgroei Op Bedrijventerreinen. The Hague: Planbureau voor de Leefomgeving.
- Wilensky, Uri. 1999. NetLogo 5.0.4. Evanston.



ir. Bob van Bronkhorst

This thesis is the result of more than a half year of hard work. After a faltered start the Brink Groep joined me in my research and supplying me with the practical point of view. They were a great source of inspiration and pushed me beyond my limits. The topic was complex and versatile but with the help and guidance of my supervisors, family and friends, I was able to finish my it in six months. The final product is more than I hoped for in the beginning.

- 2007 – 2012 Bachelor Architecture and Building Planning
- 2011 – 2014 Master Construction Management and Engineering
- 2013 – 2014 Internship at Brink Management en Advies

SUN, SEA, LEISURE, AND ENERGY

The knowledge of experts used for the decision making of renewable energies in urban development areas in the North-Eastern part of Morocco, using AHP

Author: U. (Uasima) Chaïbi

Graduation program

Construction, Management and Engineering 2014-2015

Eindhoven University of Technology

Graduation committee

Prof. dr. ir. W. (Wim) Schaefer (TU/e)

Dr. ir. B. (Brano) Glumac (TU/e)

Ir. S. (Sami) Bouhmidi (MarchicaMed)

Graduation date

June 8th, 2015

ABSTRACT

This paper is on decision making in urban development in Morocco in the field of renewable energies. Morocco has the ambition to produce 42% of the total demand of energy from renewable energies in 2020. With the growing implementation of solar and wind energy the application of renewable energies in Morocco is a fact. This research investigates these two renewable energy sources together with hydro energy and geothermal energy. This is done by literature study, application of AHP with i.a. a survey distributed around experts in renewable energies, and a case study.

The most important conclusions of this research were that financial aspects are most important in the decision making, and environmental pressure is not important at all in the decision making in the field of renewable energies. The research ends with weighing of different criteria which could help by choosing a renewable energy form for a specific project in Morocco.

Keywords: renewable energy, solar energy, wind energy, geothermal energy, hydro energy, urban development, MCA, AHP, case study, Morocco

INTRODUCTION

The world population is growing, the energy demand is growing even faster, in contrast the fossil energy resources are exhausting. The oil and gas resources will be exhausted in about fifty years. With the growing knowledge in technology alternatives for the fossil resources are upcoming and necessary to postpone the exhausting of the fossil energy resources.

The City of Two Seas is a new touristic city in the North-East of Morocco. This city covers a development area of 14.5 ha (MarchicaMed, 2013). This city will be developed by MarchicaMed. Since buildings are big consumers of energy it is interesting to analyse the possibilities in the design of buildings to reduce the required amount of energy. Besides the

reduction of the demand of energy it is at least equally interesting to exam possibilities for renewable energy resources as well.

The goal of this research is to find alternatives for fossil energy implementation in urban development areas in North-Eastern part of Morocco, since solar energy is widely implemented in Morocco.

MarchicaMed has preferences for solar energy as well. The blind choice for solar energy will limit the project, since the area of this project gives opportunities for other sources of renewable energy as well. It is for MarchicaMed financially and technically interesting to find the most favourite renewable energy resources for the City of Two Seas according to experts in the field of renewable energies.

RESEARCH DESIGN

The aim of the research is to find and select criteria to be used in the decision making. These criteria will be weighed through the outcomes from a questionnaire. These outcomes will be implemented on a case study. This leads to the following main research question: *What would be the most interesting combination of renewable energies in a new touristic city. Considering the amount of energy needed, the characteristics of the area, technical possibilities and financial aspects.*

Since the advice should be scientific, this research methodology is implemented. Since the research includes qualitative and quantitative subjects, Multi Criteria Analysis (MCA) is implemented. The MCA tool that suits best for weighing the criteria in this research is the Analytic Hierarchy Process (AHP). This research methodology weighs criteria and help to find the most feasible technology for this project. The AHP is developed in the early '70's by Saaty. This methodology became popular throughout a wide field of applications in fields such as government, business, industry, healthcare, education, and construction. AHP is a systematic methodology for multi criteria systems and quantitatively treating complex situations. AHP can be used to decompose complex problems into simple solvable layers and factors, as well as efficiently compare and calculate weights. According to a set of criteria and sub-criteria that have been arranged in a hierarchical structure, AHP compares and ranks the alternatives. The comparison is through natural language and, from this the preferences of different criteria become ranked.

With the implementation of AHP the most preferred renewable energy system will be found. After this an attempt will be made for a combination of renewable energy systems in this case study. This result will be compared with the result from best practice. The results and conclusions derived from the research components lead to recommendations for the implementation of renewable energy sources in the case study.

NORTH-EASTERN PART OF MOROCCO

The northern part of Morocco is used to have small and sometimes intensive earthquakes. These earthquakes have their origin in the plate tectonics. Morocco lies on the African plate which has his cleavage in the Mediterranean Sea. The plates are in movement now and then. These movements generate lots of energy and possible damage. Another side effect are the

many hot springs in this area. These hot springs have a constant stream of hot water of 24 degrees Celsius (Rimi, 2012).

Nador is a coastal city at the Mediterranean Sea. However, the Marchica lagoon lies between the Mediterranean Sea and Nador. The Marchica lagoon has an area of about 115km² (25 km by 7.5 km) and a depth not exceeding 8 m. This lagoon is separated from the sea by a 24km long belt of dunes, also called the cordon. The lagoon is still connected to the Mediterranean Sea through a new artificial channel. The connection of the lagoon with the Mediterranean Sea is 300 meters wide and 6.5 meters deep. Except the stream from the Mediterranean Sea, a continental input exists as well. This input comes from the Salouane River, Bou Areg and the channel that drains the Bou Areg plain (Ben Chekroun, 2012).

The North-Eastern part of Morocco is characterized by a coastal climate, also known as the Mediterranean climate. The Mediterranean climate is characterized by warm, dry summers and mild winters. This climate gives a lot of sun hours yearly. The country is characterized by an intensive solar radiation. In the North-Eastern part of Morocco the annual duration of sunshine hours is about 2700 (Frotzsche, 2011). With an average of 55% clearness, the average over the year is 5540 Wh/m² per month. Furthermore the wind is an abundantly resource in the coastal region. The wind varies from 4.8 m/s up to 5.74 m/s at the Nador coastal region.

Owing to its special geographical and geological position, the North-Eastern part of Morocco, which is endowed by a natural bounty of sunshine and geothermal resources (Rimi, 2012), has a lot of opportunities for solar and geothermal energy. The position near the Mediterranean Sea gives opportunities for implementing hydro and wind energy as well. This makes the renewable energies solar, wind, hydro, and geothermal resources the most interesting for this environment and therefore for the North-Eastern part of Morocco.

RENEWABLE ENERGIES

Renewable energy technologies are resources that consume primary non-carbon energy resources that are not subject to depletion (Frey, 2002). Renewable energies harm the world in a minimum way. The best known renewable energy resources are solar and wind energy. Geothermal, hydropower and biomass follow these renewable energy resources as well-known resources. The aim of the City of Two Seas is to have a sustainable character. It is logical that the energy sources in this project will be renewable. Selecting the potential new energy sources gives that the sources should be: renewable, locally available, and environmentally friendly. The renewable energies that have been selected as most promising and interesting in North-Eastern part of Morocco are solar, wind, hydro, geothermal energy. The most important characteristics that could help by the decision making for renewable energy forms are described in table 1. Since the renewable energies have broad ranges, ranges have been settled down with a specific description. All the renewable energy forms fit in one of the ranges.

Characteristics	Solar energy	Wind energy	Hydro energy	Geothermal energy
Cost per kWh	€ 0.13	€ 0.12	€ 0.08	€ 0.05
Life span	25 years	25-30 years	20 years	20 years
Simple infrastructure	Small distance between the plant and the buildings, easy maintenance, and a direct conversion to useable energy.	A large distance between the plant and the buildings, difficult maintenance of the plant (few times per year, specific maintenance, difficult to maintain (in the water, underground, high)), energy not direct converted to useable energy, and the renewable energy plant is big.	A large distance between the plant and the buildings, difficult maintenance of the plant (few times per year, specific maintenance, difficult to maintain (in the water, underground, high)), energy not direct converted to useable energy, and the renewable energy plant is big.	A large distance between the plant and the buildings, difficult maintenance of the plant (few times per year, specific maintenance, difficult to maintain (in the water, underground, high)), energy not direct converted to useable energy, and the renewable energy plant is big.
Environmental pressure	Between 0 and 0.05 acres of land use per MW, low impact on flora and fauna, life-cycle global warming emissions between 0 and 0.1 (pounds of CO ₂ per kWh).	Middle: between 0.05 and 0.10 acres of land use per MW, middle impact on flora and fauna, life-cycle global warming emissions between 0.1 and 0.25 (pounds of CO ₂ per kWh).	Low: between 0 and 0.05 acres of land use per MW, low impact on flora and fauna, life-cycle global warming emissions between 0 and 0.1 (pounds of CO ₂ per kWh).	Middle: between 0.05 and 0.10 acres of land use per MW, middle impact on flora and fauna, life-cycle global warming emissions between 0.1 and 0.25 (pounds of CO ₂ per kWh).

Table 1: Characteristics of renewable energies

From a description of best practices it has been found that the most implemented renewable energy is solar energy, which seems to be the best to implement in projects. The renewable energy resources hydro, biogas and wind energy can also be also implemented. Furthermore it is interesting to look at the possibilities of a combination of multiple renewable energy resources. An energy could make it less necessary to use expensive and low capacity storage technologies. One combination that is possible is the combination of hydro energy and geothermal energy. Table 2 gives the characteristics of this renewable energy combination.

Characteristics	Combination of Hydro energy Geothermal energy
Costs per kWh	€ 0.08 + € 0.05 = € 0.13
Life span	20 years
Simple infrastructure	A large distance between the plant and the buildings, difficult maintenance of the plant (few times per year, specific maintenance, difficult to maintain (in the water, underground, high)), energy not direct converted to useable energy, and the renewable energy plant is big.
Environmental pressure	Middle: between 0.05 and 0.10 acres of land use per MW, middle impact on flora and fauna, life-cycle global warming emissions between 0.1 and 0.25 (pounds of CO ₂ per kWh).

Table 2: Characteristics of the combination of Hydro energy and Geothermal energy

DECISION MAKING

In this research Multi Criteria Analysis (MCA) is the key methodology. Combining weights with evaluation scores of alternatives is the evaluation method of this research methodology. Analytic Hierarchy Process (AHP) will be used to find the weights of the selected criteria by asking experts from Morocco in the field of renewable energy to prioritize decision criteria by using pair wise comparisons. The experts have been required to score the sub-criteria and ranges in the same way. Finally, the qualitative dominant scores are used to synthesize the weights and evaluation scores. From these results the alternatives are prioritized regarding the criteria.

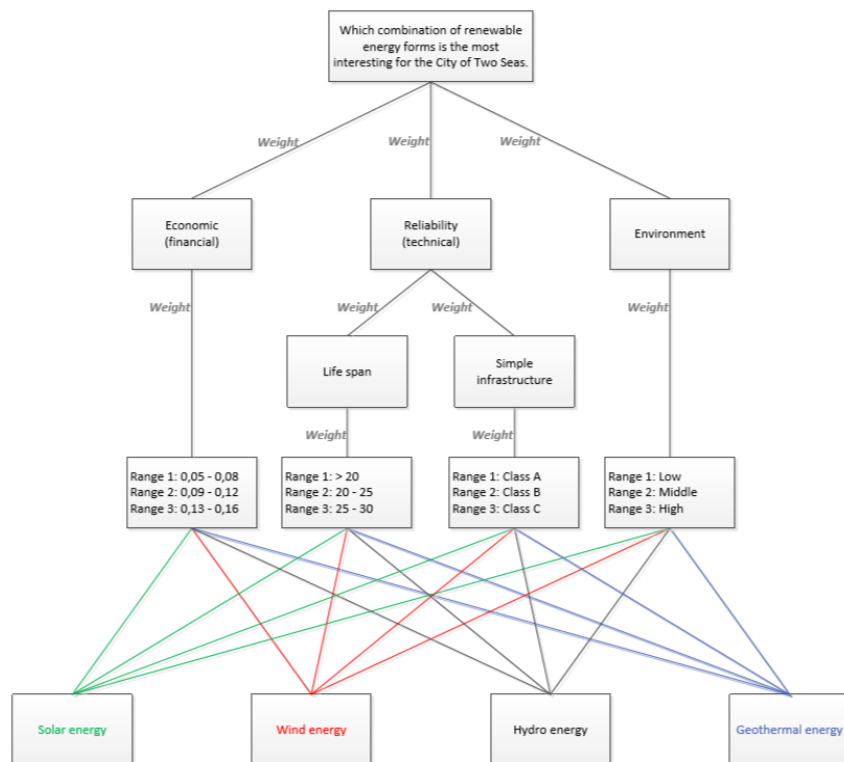


Figure 1: AHP Hierarchy design

The goal of this research is to find which combination of renewable energy resources is the most interesting and suitable for the City of Two Seas project. The most critical decision tends to be renewable energy selection which if not properly done may result in heavy loss for the whole project. This makes the objective of the research as follows: *Which (combination of) renewable energy resources is the most interesting for the City of Two Seas.* Quantity does not always give the required quality. In case of the criteria a selection of a few good criteria is helpful for the decision making. For the implementation of AHP three main criteria are a good number to use for decision making (Wang, 2009). Figure 1 shows the AHP hierarchy design for this research.

CASE APPLICATION

The comparison in AHP is pairwise comparison. The question that is asked is: *Which of the criteria is more important for the decision making, and how much more important in comparison with the other criteria?* The experts score the criteria on the grade of

importance. In these results it can be seen that the expert thinks that the criteria Costs per kWh is moderately more important than the criteria Environmental pressure (*figure 34*).




























	Very strongly more important	Strongly more important	Moderately more important	Slightly more important	Equally important	Slightly more important	Moderately more important	Strongly more important	Very strongly more important	
Cost per kWh per year										Environmental pressure
Cost per kWh per year										Reliability
Environmental pressure										Reliability

Figure 2: Comparison matrix main criteria

The weighing of this answer gives that Costs per kWh are 13 times more important than Environmental pressure. First the main criteria will be compared in this way. Secondly the sub-criteria will be compared, and finally the ranges of the characteristics of the renewable energies will be compared with each other. The data collection has been done through an online questionnaire. The questionnaire has been constructed using *Berg Enquete System 2007*. This is a digital survey tool developed by Eindhoven University of Technology. This questionnaire has been sent to experts in the field of renewable energy. In this research is the knowledge of experts with an average of 11.3 years of experience in renewable energies used, and an average of 5.5 years of experience in urban development projects. All the data can be used by weighing the criteria and the ranges of the characteristics.

Normalisation

To weigh the criteria, the option is to derive these weights from ranks. This is done by ranking first the criteria by implementing pairwise comparison. After the collection of the rank numbers (data), the weight can be computed from this order by normalising the rank numbers. Normalisation assures the weights are between 0 and 1. Following example illustrates the normalisation of the main criteria.

	C1 Costs per kWh	C2 Reliability	C3 Environment
C1 Costs per kWh	1	5.17	2.56
C2 Reliability	0.19	1	0.97
C3 Environment	0.39	1.030928	1
	1.584049	7.200928	4.53

Table 3: Reciprocal Matrix main criteria

In the box which refers to the dominance of Reliability according to Costs per kWh the value 1/5.17 is entered. This gives the relation between the two criteria. Add the whole row gives the Eigenvector (EV). Table 4 shows the result of all these computations.

	C1 Costs per kWh	C2 Reliability	C3 Environment	Eigenvector (EV)
C1 Costs per kWh	0.631294	0.717963	0.565121	1.914378
C2 Reliability	0.12	0.14	0.21	0.475106
C3 Environment	0.25	0.14	0.22	0.610516
Total	1	1	1	3

Table 4: Calculation of the eigenvector (EV)

The normalization of the eigenvector (NEV) is implementing the formula:

$(1 / \text{total EV}) * \text{EV criteria}$.

$(1 / 3) * 1.914378 = 0.638126$

	Normalized eigenvector (NEV)
C1 Costs per kWh	0.638126
C2 Reliability	0.158369
C3 Environment	0.203505
Total	1

Table 5: Normalization EV

With this calculation the eigenvector is calculated, and from this the weighing has been done. The criterion with the highest value of the normalized weigh indicates the highest ranked alternative (Srdjevic, 2013). For the main criteria the Costs per kWh is, according to the experts, significantly more important than the other two main criteria.

Main results

The division of the Main criteria is as follows. Costs per kWh has got the highest value, 0.638, this aspect is most important in the decision making according the experts in the renewable energy branch. The difference between the financial criteria and the other criteria is significantly larger than the other two main criteria. With 0.204 is Reliability is the second important criterion according to the experts. Environmental pressure is the least important of these criteria with a NEV of 0.158.

Reliability has two sub-criteria. These two sub-criteria are weighed too. Life span, with an NEV of 0.749, is significantly more important than Simple infrastructure, with an NEV of 0.251, by the experts.

The third level includes the ranges of the (sub)-criteria. All these criteria have three ranges. When it comes to the Costs per kWh it is obvious that the smallest range € 0.05-€ 0.08, with an NEV of 0.605, is most favourable according to the experts, followed by the range € 0.09-€ 0.012, with a NEV of 0.285, and at last the range € 0.13-€ 0.16 with a NEV of 0.11.

The second set of ranges of the (sub) criteria is Environmental pressure. The range Low, is the least harmful for the environment, and the range High the most. The range Low is, with an NEV of 0.624, most favourable according the experts. With a NEV of 0.26 is Middle secondly favourable and as least the range High with a NEV of 0.115. The range High is least favourable according to the experts. The difference between the range High and the other two ranges is larger than the other two ranges.

The first set of the sub-criteria of ranges of Reliability are the ranges of the Life span. Not logical a shorter Life span, according to the experts, is more favourable. A Life span less than 20 years is most favourable with a NEV of 0.56. A Life span between 20 and 25 years is secondly favourable with a NEV of 0.287. Least favourable is the largest Life span with a range between 25 and 30 years and a NEV pf 0.153.

The last set of ranges of the sub-criteria of Reliability. The ranges are defined by Classes A to C. A is the most simple infrastructure, and C the most complex infrastructure. According to the experts is the Simple infrastructure with Class A most significantly favourable with a NEV of 0.638. Secondly is Class B most favourable with a NEV of 0.218. Least favourable is Class C, with a small difference with Class B, with a NEV of 0.144.

Consistency analysis

After the normalization a consistency analysis should be done. AHP allow some small inconsistencies in judgement. This is because human can never be always consistent. The ratio scales are derived from the principal Eigenvectors and the consistency index is derived from the principal Eigenvalue.

The quality of the data was determined by implementing the consistency check. The formula used for the consistency check is: CI/RI.

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

Computations	
λ_{\max}	3.0731
n	3
Consistency Index (CI)	0.03655
Random Consistency Check (RI)	0.58
Check	0.06 (6%)

Table 6: Consistency check

From this consistency check it can be concluded that main criteria pass the check. The outcome of the consistency analysis should be less than 10%. From the calculations are the following consistencies found (table 19):

Variable	Consistency analysis
Main criteria	6%
Sub-criteria	n.a.
Ranges of (sub) criteria: Costs per kWh	22%
Ranges of (sub) criteria: Environmental pressure	31%
Ranges of (sub) criteria: Reliability – Life span	16%
Ranges of (sub) criteria: Reliability – Simple	36%

Table 7: Consistency check

As table 7 shows, the main criteria are consistent. The sub-criteria are not consistent. The reason therefore is the RI.

All the ranges are inconsistent. This is possibly caused by the selected interval definitions for the ranges.

CONCLUSIONS

According to the experts the criteria Costs per kWh is significantly more important than the other criteria. That influences the rank of the renewable energies highly. The criterion with the lowest Costs per kWh are therefore most favourable. The criterion Environmental pressure has the lowest weight, and therefore this criterion is least important in decision making. Reliability has got a lower weight as well. In contrast to the criteria solar and wind energy score favourable on both criteria. Despite of favourable scores in two out three criteria are these renewable energies nevertheless least favourable. Remarkable is that the most favourable renewable energies, hydro and geothermal energy, are not favourable when they are combined.

In this research the most favourable renewable energy resources for North-Eastern of Morocco and therefore for the City of Two Seas are studied. From this research it can be concluded that hydro energy is most favourable. In economic terms for MarchicaMed it is interesting to consider the implementation of hydro energy in the City of Two Seas. Since ambition of MarchicaMed is to be sustainable, it is good for the image of MarchicaMed to consider the implementation of hydro energy as well.

This research shows that the implementation of MCA and AHP is a good tool in decision making for renewable energies. The use of MCA and AHP, with input from appropriated experts, facilitates the decision making of renewable energies in urban development.

DISCUSSION

The world population grows fastly, the demand of energy is growing even faster. With the knowledge of exhausting fossil energies within about fifty years it is wise to look now for possibilities to postpone the exhausting of the fossil energies, and alternative inexhaustive resources which can be used as supply for the longer term. With this research renewable energies gets a platform. This platform could contribute to convince and inspire decision makers to implement renewable energies in construction projects, and especially in leisure. Decision making is for every construction project a challenge. The way of selection of the decision criteria in this research with the use of MCA could be seen as a starting point that can be a contribution to decision making in other similar projects.

The limitations of this research are in the first place related to the model. The AHP model has some restrictions in the field of criteria selection, range selection, and the consistency check. It will be interesting to simulate the some model better selected criteria and find if the consistency check satisfies. Furthermore experts have huge influence in the decision making. In that way it is interesting to simulate this model with decision makers within MarchicaMed and compare the results with other results in this field.

ACKNOWLEDGEMENTS

This report would not exist without the help of the people who helped me with their knowledge, and experience. My graduation committee Wim Schaefer, Brano Glumac from Eindhoven University of Technology, and Sami Bouhmidi from MarchicaMed. I would also like to thank the experts who participated in the questionnaire of this research.

REFERENCES

- Barkaoui, 2013. Integration of Geothermal Energy in the Case of North Eastern Morocco. *Chemical engineering transactions*.
- Belakhdar, a. e., 2014. The renewable energy plan in Morocco, a Divisia index approach.. *Energy Strategy Reviews*.
- Ben Chekroun, e. a., 2012. Role of macroalgae in biomonitoring of pollution in Marchica, the Nador lagoon.
- Frey, e. a., 2002. Hydropower as a renewable and sustainable energy resource meeting global energy challenges in a reasonable way. *Energy Policy*.
- Frotzsche, 2011. The relevance of global energy governance of Arab countries: The case of Morocco. *Energy Policy*.

- Kazem, 2011. Renewable energy in Oman: Status and future prospects. *Renewable and Sustainable Energy Reviews*, p. 5.
- MarchicaMed, 2013. *Convention relative a la realisation du programme d'amenagement et de mise en valeur du site de la lagune de Marchica*
- MCA, MCA in a sustainability context. RUG.
- Med, M., 2007. *Cérémonie officielle de présentation du projet d'aménagement de la lagune de Marchica à Sa Majesté le Roi Mohammed VI, que Dieu le Glorifie*
- Rimi, 2010. New Geothermal Prospect in North-Eastern Morocco. *Institute de Physique de Globe de Paris*.
- Rimi, e. a., 2012. Towards a de-carbonized energy system in north-eastern Morocco: Prospective geothermal resource. p. 10.
- Saaty, 1986. A note on the AHP and expected value theory.
- Stambouli, e. a., 2012. A review on the renewable energy development in Algeria: Current perspective, energy scenario and sustainability issues. *Renewable and Sustainable Energy Reviews*, p. 16.
- Wang, 2009. Review on multi-criteria decision analysis aid in sustainable energy decision-making.

PERSONAL INFORMATION



U. (Uasima) Chaïbi

This summary is the result of my graduation thesis about decision making in urban development and renewable energies, in Morocco. This research was done as completion of the master track Construction, Management and Engineering at Eindhoven University of Technology and in collaboration with MarchicaMed, an urban development firm. The results led to recommendation for the implementation of renewable energies in urban developments in Morocco.

2005-2009	Bachelor Structural Design, Rotterdam University of Applied Sciences
2009-2011	Board member and initiator, Amani
2012-2013	Leadship Academy, Moroccan Dutch Leadship Institute
2012-2013	Education board member, of CoUrsE!
2012-2014	Certificate programs Management in Technology, and Technology Entrepreneurship, Eindhoven University of Technology
2014-2015	Graduation intern, MarchicaMed
2011-2015	Master Construction, Management and Engineering, Eindhoven University of Technology

FINANCING AND INVESTMENT OPTIONS FOR HOMEOWNERS DEALING WITH PROPERTY MAINTENANCE: foundation damage case in the Netherlands

A.A. (Anika) Cristini

Graduation program:

Real Estate Management and Development

Graduation committee:

Prof. dr. ir. W.F. Schaefer (*Technische Universiteit Eindhoven*)

Dr. ir. B. Glumac (*Technische Universiteit Eindhoven*)

Ir. J.B.M.B. Molenaar (*Rabobank Nederland*)

Date of graduation:

18-06-2014

ABSTRACT

Homeownership has lot of benefits but due to the financial crisis the focus is already moved towards the risks and responsibilities associated with homeownership. With foundation damage the security of a solid foundation falls apart and this problem has a huge impact on the lives of the homeowners and if they want to stop the cracking and sinking of their home, they have to accept it and repair the foundation. This research focuses on the financing of foundation repair. Only 31% of the homeowners can afford a loan for foundation repair. High Loan-to-Income and Loan-to-Value percentages identify problematic households. A high income and value of the property, also correlated with high mortgages, are at the contrary predictors for less problematic households. The variables that influence the household situation are especially the repair costs, Loan-to-Value percentage, and low interest loans. Households with problems with the Loan-to-Income norm are the hardest to help out of a problematic category. When a homeowner is confronted with foundation damage, he has several options on how to deal with this problem. When households have enough lending capacity, the best investment decision is combining the repair activities with value increasing adjustments. For households that cannot afford this extra investment it is recommended to repair the foundation anyway instead of doing nothing.

Keywords: homeownership, foundation damage, mortgage risks, financing policy, investment options.

INTRODUCTION

Large-scale property maintenance problems in The Netherlands are related to foundation damage. Around 750,000 buildings on wooden piles have a high risk on foundation damage and in the next twenty years 400,000 homeowners may have to deal with unexpectedly required high foundation recovery costs. It concerns buildings built between 1890-1945 in areas with weak subsoil, in the Western part of The Netherlands and the areas along the rivers (Deltares, 2012; KCAF, 2012; CURNET/SBR, 2012). At the same time in The Netherlands 89,5% of the owner occupied housing sector are mortgaged houses and for 25% of the mortgaged houses the value of the mortgage is already higher than the actual value of the house (CBS, 2013). Due to high costs of foundation repair the value of the house decreases rapidly and without intervention homeowners see deteriorate their property. In the long-term municipalities can declare the dwelling uninhabitable and the residents are forced to move.

There are actually four major causes of damaged foundations (VROM, 2005):

- Wood decay due to low groundwater level (Dutch: *paalrot*);
- Wood decay under water (Dutch: *palenpest*);
- Negative skin friction;
- Design- and execution errors.

Costs for foundation repair increase the housing costs of the homeowners. For many households repair costs are difficult to fund, and the current situation of general value decrease in the housing market and increasing requirements for funding make the problem more worse. In the meantime, the lack of foundation repair activities causes impoverishment of the neighbourhoods (KCAF, 2012).

The main research question is formulated as follows:

How could financial institutions steer the reconstruction of distressed properties in a declining housing market?

The problems that go along with foundation damage are various and there are many possible solutions. This research focuses only on a part of this problem.

The sub-questions are formulated as follows:

1. *What is the financial situation of homeowners dealing with foundation damage?*
2. *How could financial institutions (and other stakeholders) minimize the impact for the customer and their own organization?*
3. *What will be the best investment decision for homeowners with a mortgage dealing with foundation damage?*

METHODS

Data collection

This research uses data from the Rabobank, Kadaster, and TNO, to obtain a sample with financial information of homeowners in buildings at risk.

The database of the Rabobank available for this research contains mainly transactions of the last 5 years. From this database all homeowners (with a mortgage at Rabobank) in the risk

areas and with a building built between 1890-1945 are filtered. To identify the risk areas on 4-digit zip code level, the TNO surface map (2010) is combined (in ArcGIS software) with the zip-code map of The Netherlands. For the 40 different types of subsoil, according to several literature sources (Erwich & Vliegen, 2001; Deltares, 2012; KCAF, 2012), is defined if they are at *risk* or *no risk*. The result is a list of zip codes of the risk areas. For the houses mortgaged by Rabobank in these areas (matching the BAG-ID, unique property-number), the database of the Rabobank is completed with information of the year of construction and size of the house from the public database Bag Extract of Kadaster. All assumptions in the calculation models are based on literature and/or validated by different field experts.

Statistical analysis

To answer the first research question the data is analyzed with support of software package IBM SPSS Statistics. First, the general descriptive statistics are given and next the more extensive statistical analysis Factor Analysis (FA) and Discriminant Analysis (DA) are used. Both methods produce a coordinate system with axes in a two dimensional space. FA is used to reduce the dimensionality of a data set. From a set of existing variables new artificial variables (factors) are created that account for most of the variance in the observed variables. The factors re-determine the location of the original data on the x-y axis. DA provides a class-separability and draws a decision region between the given classes.

MS Excel Visual Basic

To answer the second research question, MS Excel Visual Basic for Applications (VBA) is used as supporting tool. MS Excel VBA is the name for the programming language of MS Excel. It is especially used to automate repetitive tasks and works by running macros. With VBA a macro is made to standardize and ultimate the data processing in MS Excel, used to analyze and present the data. With input boxes the user can set the input variables and process different simulations with the same macro.

System Dynamics

To answer the third and last research question, the System Dynamics (SD) research methodology is used to develop a model with the software package Vensim PLE Plus. SD is a methodology for analyzing systems and their change over time. Stock and flows are the two central concepts of SD. The stock and flow conventional representation is based on the hydraulic metaphor introduced by Forrenster in 1961.

Stocks are accumulations, *bathtubs of water*. Stock changes by action of the flows and the flows represent changes, *the flow of water into and out the bathtubs*. In mathematics, the stocks integrate their flows: $\text{Stock}(t) = \int [\text{inflow}(s) - \text{Outflow}(s)] ds + \text{stock}(t_0)$

The net flow into the stock is the rate of change of the stock. *The water in the bathtub at any time is the accumulation of the water flowing in though the tab less the water flowing out through the drain.*

SD models are used to improve the understanding of the system and stocks are the basis for decision-making (Ford, 2010; Sterman, 2000). Different aspects of the households are combined in a System Dynamics based model. The sensitivity analysis, Monte Carlo Analysis

(MCA), is used to eliminate the uncertainty related to the assumptions for the different options.

FINDINGS

Financial situation of homeowners

To determine the financial situation of the households the entailed risks of an extra loan are taken into account, assuming that all homeowners in risk buildings need a loan for the foundation repair costs. To get this extra loan a homeowner has to meet Loan-to-Value (LTV) and Loan-to-Income (LTI) requirements. The LTI percentage represents the ratio of the consumer's income that goes toward paying the mortgage and the maximum allowable based on Nibud Standards (maximum 100%). The LTV percentage is the ratio of the mortgage and the value of the property. The maximum allowed is 104% in 2014 (including 2% of capital transfer tax) (Van Middelkoop, 2011).

Four categories of households are set:

- Meet Loan-to-Value and Loan-to-Income requirements (category 1);
- Meet Loan-to-Income but not Loan-to-Value requirements (category 2);
- Meet Loan-to-Value but not Loan-to-Income requirements (category 3);
- Do not meet both requirements (category 4).

The amount of households with problems to get a loan for foundation repair is estimated with the assumption they need a full loan for the repair costs. Private savings are not taken into account. Although the costs for foundation repair depends on several aspects, the below values are used for calculation purposes:

- 60.000 euro for houses;
- 15.000 euro for apartments;
- 35.000 euro for houses in the *Zaanstreek*.

The household distribution over the four categories is showed in table 1 and figure 1.

Table 1: Household distribution in categories in sample

Household category	Frequency	Percent
1. Meet LTI and LTV	3.807	31%
2. Meet LTI and not LTV	5.339	44%
3. Meet LTV and not LTI	1.232	10%
4. Do not meet LTV and LTI	1.802	15%
Total	12.180	100%

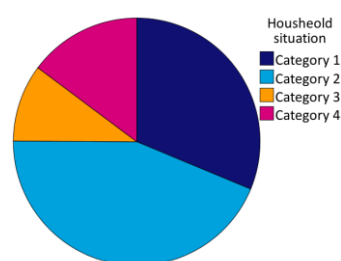


Figure 1: Distribution households

Only 31% of these households can get a loan for foundation repair based on the actual norms. From the FA results that high LTI and LTV percentages identify problematic households. A high income and value of the property, also correlated with high mortgages, are at the contrary predictors for less problematic households. Classification in the four categories is possible with the two following discriminant functions and is accurate for 85,5%:

$$D_1 = -0,787 + (3,641) \text{LG10 Value} + (-0,078) \text{LG10 Income} + (-4,808) \text{LG10 Mortgage} + (9,525) \text{Loan-to-Value} + (-0,013) \text{Loan-to-Income} + (-0,004) \text{Age}$$

$$D_2 = 9,983 + (-0,632) \text{LG10 Value} + (-1,264) \text{LG10 Income} + (-3,484) \text{LG10 Mortgage} + (0,003) \text{Loan-to-Value} + (0,082) \text{Loan-to-Income} + (0,009) \text{Age}$$

Scenarios to improve the household situation

To minimize the impact of foundation damage, all households must be able to provide the necessary maintenance to their property. Different variables (e.g. type of mortgage, price foundation repair, LTI and LTV norm, inflation on property value) influence the household situation and the distribution of the households over the four categories. By active steering on these variables the amount of households that cannot get a loan for foundation repair can be minimized.

The model created using MS Excel VBA calculates for each year the household distribution over the four categories, based on changing variables. The model compares a base scenario, based on actual norms and expectations, and a scenario with custom variables. The results of the base simulation in figure 2, show the changes over time in the household distribution over the four categories, due to income increase or decrease, increase in the value of the property and mortgage repayment. The amount of households in category 1 increases significantly in 15 years, from 35% to 85% of the total households. Especially the amount of households in category 2 decreases significantly, as well in category 4.

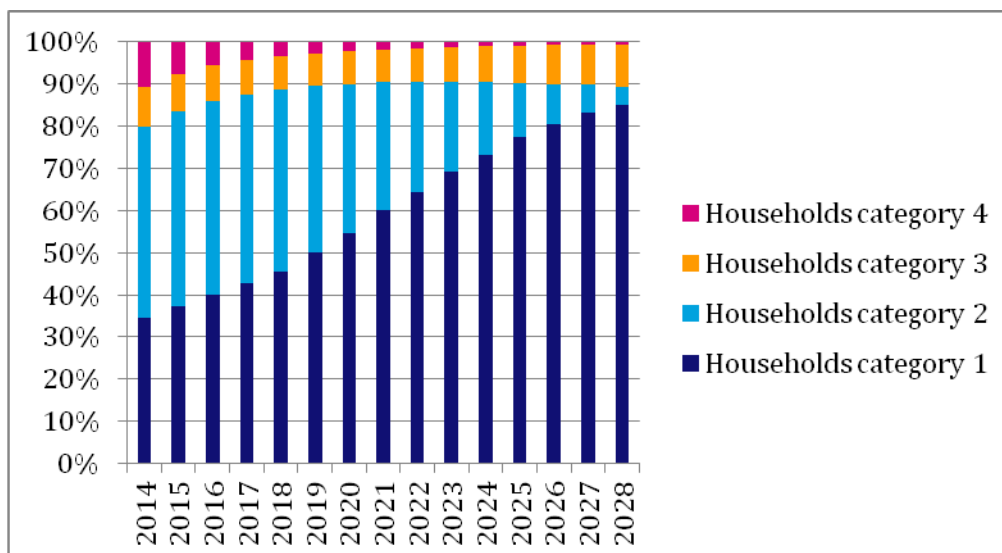


Figure 2: Base simulation household distribution

The impact on the household distribution of the following variables is analyzed:

- Repayment mortgage
- Repair costs
- LTI norm
- LTV norm
- Redemptionfree and interest loan
- Market situation

Figure 3 shows the amount of households in category 1 in the different simulations. All options reveal a growth of the category over time. In 15 years all options are close to each other with about 90% of all households in category 1.

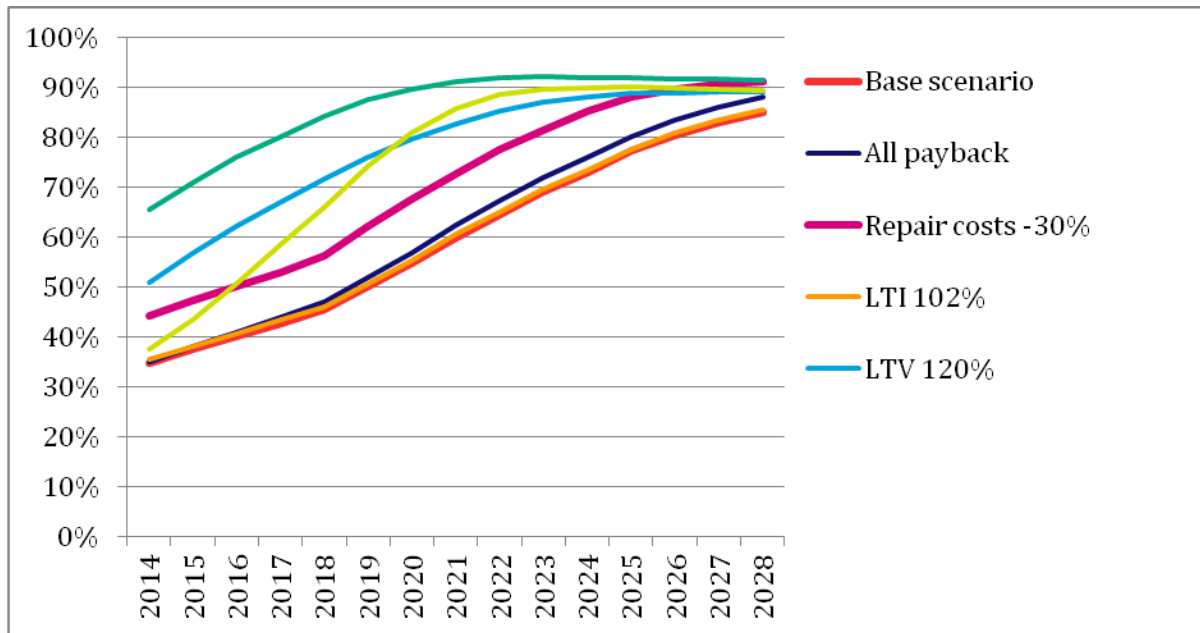


Figure 3: Percentage households in category 1

The variables that influence the household situation are especially the repair costs, LTV percentage and low interest loans. Households with problems with the LTI are the hardest to help out of a problematic category. In fact, the residual 10% of households not in category 1 are mainly in category 3. The amount of households in this category is almost constant. In all simulations the percentage over the 15 years is between 5% and 12% of the total households.

To make an extra loan possible for as many households as possible, still concerning a safe range, the policy for granting loans can be extended. At this moment only households in category 1 can get a loan. Expanding the norms to make a loan possible for more households ensures for the mortgage lender the value of the collateral. Special attention is required for the LTI risks that increases the more loans are provided to customers. Also the National Mortgage Guarantee (Dutch: Nationale Hypotheek Garantie) norms can provide extra risks for the mortgage lender: due to the extra loan, the amount of households that still are covered by the NHG decrease from 38% with 9% in the first year.

Best investment decision for homeowners

When a homeowner is confronted with foundation damage, there are several options on how to deal with this problem. This research focuses on the following options:

1. Do nothing;
2. Repair the foundation (and isolate the basement floor);
3. Repair the foundation and extent the dwelling with a basement;
4. Repair the foundation and install a ground source heat pump.

To investigate the impact of foundation damage on the household situation and the consequences of different investments options, a decision support tool is developed that can be used by financial institutions. The System Dynamics model is divided into four sub-systems: *outstanding amount*, *household situation*, *annual expenditures* and *equity minus expenditures*.

The main criteria for decision-making are the household situation and the equity minus expenditures. The model calculates the difference between the Net Present Value (NPV) of the equity and the cumulative housing expenditures of the household, to identify what an investment actually costs and saves over time and what the accumulated equity is.

The designed System Dynamics model is applied for the simulations of the four different investment options on four specific households, one household of each category. Figure 4 shows the NPV of the equity minus the cumulative annual expenditures for the four investment options for the household in category 1.

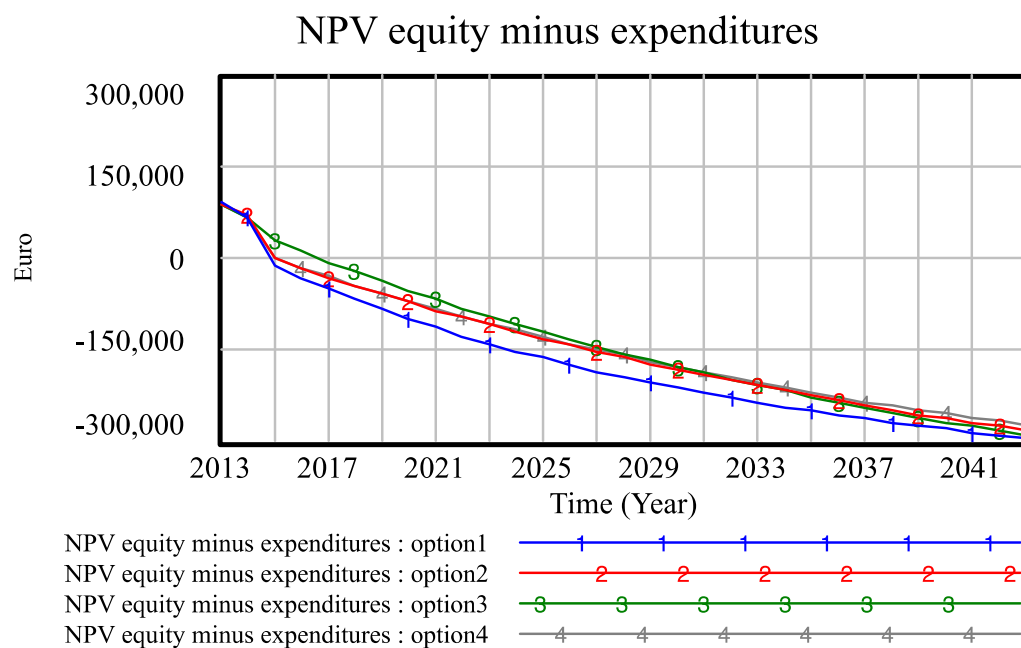


Figure 4: Graph NPV equity minus expenditures; household category 1

Because the results of the analysis are very close to each other, to test the outcomes of the simulation of the NPV of the equity minus the expenditures. For the household in category 1 a Monte Carlo Analysis (MCA) is used to eliminate the uncertainty related to the assumptions for the different options and tests of the conclusions deducted from the model will change when these uncertainties are incorporated. Uncertainties taken into account concern the impact of the foundation damage or are related to the impact of the investments. Figure 5 shows the results of the MCA in year 10.

When households have enough lending capacity, the best investment decision is to extend the property with a basement. Combining the repair activities with value increasing adjustments ensures a better investment and ensures the value of the collateral. For households that cannot afford this extra investment it is recommended to repair the foundation anyway instead of doing nothing.

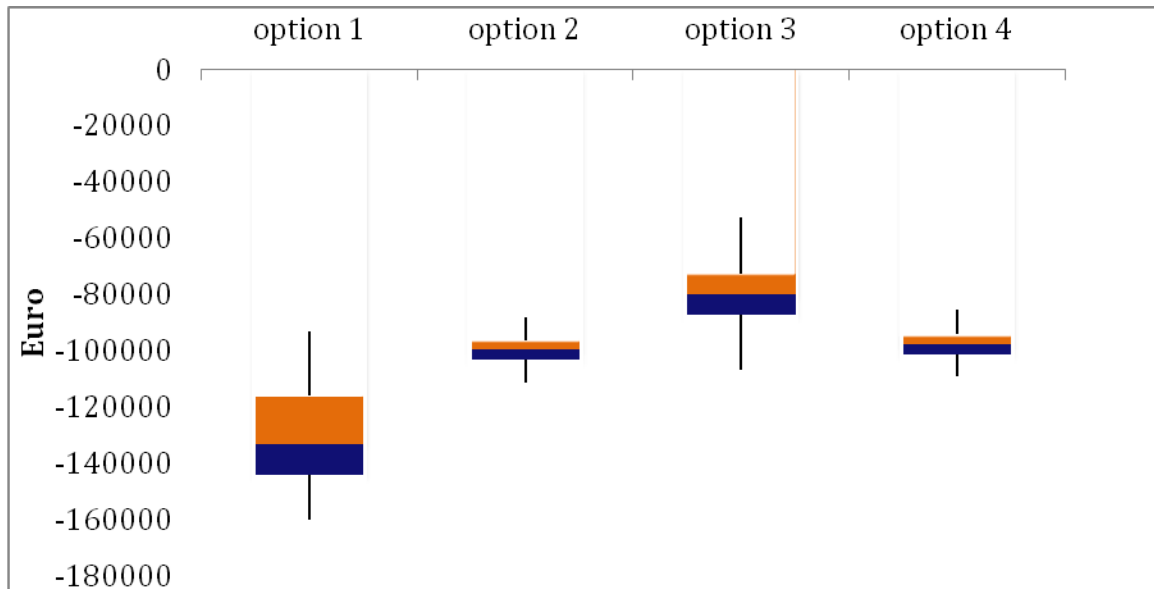


Figure 5: Boxplot results MCA of Equity minus expenditures

DISCUSSION

Practical recommendations

The foundation damage problem requires a collective approach by different stakeholders. Government, municipalities, financial institutions, contractors, homeowners' organizations, brokers, water governance, housing associations, and others, have to work together to approach the problem from different sides but with a common policy. All stakeholders have to take action.

The required approach has to focus on a two-side prevention. On the long term, wooden piles that are not damaged yet have to be protected and groundwater levels need to be monitored to prevent, where possible, new cases of foundation damage. On the short term there must be set up measures and regulations on how to deal with the existing damage. On the one side, homeowners with a property with damage needs to be informed and helped through the process. On the other side, new homebuyers need to be informed about and protected from buying a house with possible damage. This means that there must be created awareness about the problem and new homebuyers have to be alert when they buy a new house in an area at risk. The purchase contract could include a clause about the state of the foundation to protect new homebuyers.

Contractors have to be prepared for the expected large demand for foundation repair in the coming next years. Only a small number of houses are yet repaired. Repair activities have to become more lean and upscaling could reduce the repair costs. The decrease of the repair costs has a significant impact on the amount of households that can afford the repair costs. Investments in research and new technologies are necessary to speed up this process.

For households in a critical situation new options should be developed, such as insurance for foundation damage, or an emergency fund. Especially to make the repair possible for a building block even if there are some households that cannot afford the repair costs. The importance of knowledge and information about the problem is getting more and more

important. The KCAF fulfills an important role in the information of homeowners dealing with foundation damage. Lot of results from inspections (private and from the local municipalities) are not collected or not always public. Also the already repaired properties and the properties with established damage are not recorded at a central point. This problem requires the availability of all this type of information.

The LTV risk is not a risk for the homeowner solely. If there is no repair of the foundation damage the negative equity risk could also impact the mortgage lender. Making a loan possible for all households that meet the LTI, even if they do not meet the LTV norm, has a huge impact on the extent of the financing problem. Financial institutions can help households that are slightly over the LTI norm by extending this norm. Large deviations from the norm can be too risky for the homeowner, because the costs for the mortgage and the loan will be too high for the income of the household. A good alternative could be a national guarantee for households without enough income.

Loans for households that not meet the LTI are currently only available with guarantee of the municipalities. At this moment only 5 municipalities facilitate this loan. There is need for an overall financial arrangement for all households in this category on national level.

Limitations and further research

It is very difficult to make a prediction of the amount of homeowners that will have to deal with foundation damage. This research estimates the worse case scenario and takes into account all possible households dealing with foundation damage. In this research the focus is on making a loan possible for all households and does not take into account the required collective aspect of the repair activities, i.e. the repair activities have to take place for the whole building block. This usually results in a long and laborious process and at this moment lots of repair activities stuck because some households in the building block cannot afford the repair costs.

Further research on the financing of foundation repair is suggested to focus on the financing arrangements for homeowners that have not enough lending capacity based on their income, on the structure of a possible emergency fund, guarantee or insurance for foundation damage, or on the impact of the social damage of foundation damage in neighbourhoods. In all cases it should be important to consider both the costs and profits.

AKNOWLEDGMENTS

This research was not possible without the help and advice of the members of the graduation committee Wim Schaefer, Brano Gluamc and Jan Molenaar. Thanks also goes to all interviewed field experts from Rabobank and other organizations for their input and experience. Special words of thanks go out to Joost Hendriks for his constructive comments, support and love.

REFERENCES

- CURNET/SBR, 2012. *Handboek funderingsherstel*. Rotterdam, The Netherlands.
- Deltares, 2012. *Schades door watertekorten en -overschotten in stedelijk gebied*. The Netherlands.
- Erwich, B. & Vliegen, M., 2001. Klei en veen. *Index*, 3, p.22-23.
- Ford, A., 2010. *Modelling the environment*. Washington: Island press.
- Kennis Centrum Aanpak funderingsproblematiek (KCAF), 2012. *Kapstok refundering*. Dordrecht, The Netherlands.
- Statistics Netherlands (CBS), 2013. Statline. Available at: <http://statline.cbs.nl/StatWeb/?LA=nl> [Accessed November 5, 2013].
- Sterman, J.D., 2000. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. New York: Irwin/McGraw-Hill.
- Van Middelkoop, M., 2011. Hypotheken: individuele en regionale risicofactoren. *Tijdschrift voor de volkshuisvesting*, 1, pp.16-21.
- VROM, 2005. *Mijn huis verzakt... Wat nu? Verslag van het vierde seminar over funderingsaanpak*. Rotterdam, The Netherlands.

ABOUT THE AUTHOR

A.A. (Anika) Cristini



This thesis is the result of my graduation project, which concludes the master program Real Estate Management and Development at Eindhoven University of Technology. This research was conducted with the support of the department of Construction Management and Engineering and Rabobank Nederland. It was a very interesting topic and I enjoyed exploring it.

Jan 2013 – Jun 2014

Graduate intern at Rabobank Nederland

Jan 2013 – Jun 2014

Graduation program Construction Management and Engineering at Eindhoven University of Technology

Sep 2011 – Dec 2013

Certificate program Technology Management, department of IE&IS

Sep 2011 – Jun 2014

Master program Real Estate Management and Development at Eindhoven University of Technology

Sep 2009 – Sep 2010

Board member of student association SSRE

Sep 2007 – Nov 2011

Bachelor Architecture Building and Planning at Eindhoven University of Technology

A STRATEGY TO SETUP ENERGY SERVICES FOR BUSINESS DISTRICTS WITH SMALL TO MEDIUM SIZED COMPANIES

A case study of de Hurk

Author: Chris Driessen

Graduation program:

Construction Management and Urban Development 2014-2015

Graduation committee:

Prof.dr.ir. B. de Vries (TU/e)

dr.ir. Q. Han (TU/e)

ir. F. Dekkers (D-IA)

ir. A. Verboom (municipality of Eindhoven)

Date of graduation:

20-8-2015

ABSTRACT

Business districts with small to medium sized companies show high energy saving potential. Because of lack of knowledge and funds this potential is not used. Combining these small and medium sized companies together will make them interesting for Energy Service Companies (ESCOs). This paper selects which type of ESCo is most suitable for these companies. With the help of the Analytic Hierarchy Process (AHP) and Quality Function Deployment (QFD) the most suited form of ESCo is found. This ESCo should focus on appointing an energy manager and adapting the lighting system with movement sensors and daylight switches.

Keywords: energy services, small and medium sized companies, ESCo, energy efficiency measures, QFD, AHP

INTRODUCTION

The municipality of Eindhoven wants to be energy neutral in 2045. This should be achieved by cooperating with the government, businesses and industry, research institutes and the citizens themselves because these are the important pillars in order to get the city of Eindhoven energy neutral. To achieve this the municipality of Eindhoven set itself a clear goal:

"The municipality has set itself the goal of achieving energy-neutrality between 2035 and 2045. By energy-neutrality, the municipality means that energy demand must be limited as far as possible, and the energy needs within the city's boundaries must be sustainable generated. The municipality has set itself the goal of achieving this ambition excluding mobility before 2035 and including mobility before 2045."

In 2012, the total energy consumption in Eindhoven was 4,55 PJ of electricity and 8,60 PJ of gas. With 55% of the gas consumption and 78% of the total electricity consumption the industrial and institutional sector is responsible for the largest part and in the past years industrial energy consumption keeps increasing.

Despite the enormous saving potential within business districts, developments regarding energy efficiency and renewable energy are slow and fragmented. Awareness of the possibilities is growing but development is often constrained by the complex environment of stakeholders and responsibilities, rules and regulations and uncertainties. In the face of rising energy prices and binding regulation, energy efficiency and renewable energy will inevitably become more important. Large companies have financial means to reach the set objectives individually but they represent only a small number on business districts. The majority of businesses, 99%, belongs to the category medium and small sized businesses (<250 employees). This category has less knowledge, time and money available to invest in any energy measures. This makes them lack behind on sustainable energy development and potentially endanger their business profitability and continuity. The high and concentrated energy use of these companies makes them interesting clients for the energy service industry. (van der Zanden, 2013)

Energy Service Companies

An energy service company (ESCO) is specialized in delivering energy services and can relieve these companies from implementing and financing energy efficiency measures and renewable energy sources.

The first ESCOs were created in the late 1970s and early 1980s. However, most ESCo activity occurred in the late 1980s and 1990s (Vine, 2005). ESCOs have proven their benefit for the industrial sector in foreign countries such as the USA and Germany. In the Netherlands, ESCOs can take away the barriers to the implementation of energy savings and renewable energy as well. In Europe, Germany, Italy and France have a large number of ESCOs while in the Netherlands only a few ESCOs are established. Nevertheless the Dutch ESCo market shows stable growth and focusses on Energy systems in medium-sized and large non-residential new building projects. (Marino, Bertoldi, Rezessy, & Boza-Kiss, 2011)

Unlike other energy service providers, equipment providers or facility managers, ESCOs share or take over the customer's technical and/or financial risk of the project. The ESCo can cover the technical risk by guaranteeing the energy savings, which can lower the cost of financing. Under such an arrangement, the ESCo guarantees a certain level of energy savings and shields the client from any performance risk. The ESCo and the client can also split the technical risk in accordance with a pre-arranged percentage by introducing a shared savings scheme in the contract. The remuneration of the ESCo can also be directly tied to the energy savings achieved.¹ Depending on the resources of the ESCo and on the market demand, ESCOs may finance projects themselves or assist in the arrangement of project financing by means of providing performance guarantees. (Marino, Bertoldi, Rezessy, & Boza-Kiss, 2011)

ESCOs give companies multiple advantages like: lower energy bill, no financial risk, no investment necessary, PR/image improvement and it makes it possible to achieve environmental targets. But as mentioned earlier small and middle sized companies have less knowledge, time and money available to invest in any energy measures. Combining those companies in one district ESCo gives the following extra advantages: Due to scale benefits energy tariffs will be lower, companies do not have to manage the process and can focus on their core business, all the knowledge is available at one spot and savings stay in the area and can be reinvested.

Successful project bundling strategies can help overcome many of the key barriers to financing ESCo projects. To achieve sufficient economies of scale, a strategy is required that allows for the aggregation of individual projects, technologies, service offers, and investments in to a larger and more comprehensive lots, which could be interesting for ESCos financial institutions. (Marino, Bertoldi, Rezessy, & Boza-Kiss, 2011)

Despite the opportunities ESCos offer the development of the ESCo market in the Netherlands is slow. The major barriers in this development are the lack of information and understanding of the opportunities that energy efficiency offer; lack of culture for project financing; public procurement rules that prevent the use of ESCOs; safety and reliability concerns that hinder the introduction of new technologies; burdensome administrative procedures that allow only very large projects to be carried out; and limited understanding of energy efficiency and performance contracting by financial institutions. (Vine, 2005)

Research question

The goal of this research is to find the most suitable type of ESCo to make business districts with small to medium companies more sustainable. This will result in lower CO₂ emissions and better use of renewable energy sources which will help to realize the “energy neutral in 2035-2045” target from the municipality of Eindhoven. It will also give a financial benefit to the participants. The scope of this research will be business districts in the Netherlands and the case study will be of De Hurk.

This results in the following main question:

How can energy management by an Energy Service Company become feasible for business districts with small to medium sized companies?

And sub questions:

Which type of ESCo is suitable for business districts with small to medium sized companies?

How can the municipality convince business owners to participate in ESCo projects?

In order to answer the main question a case study will be conducted on business district De Hurk. This case study answers the following sub questions:

What is the energy saving potential of business district the Hurk?

What do business owners expect from the Energy Service Company?

Why should business owners participate and are they willing to participate in this project?

RESEARCH METHOD

An excellent method to do research with the use of customer requirements is the Quality Function Deployment (QFD) method. QFD is a system used for translating and prioritizing customers' needs and market demands into suitable technical characteristics and ensuring that important ones are prioritized in the design. QFD consists of making quality tables like the House of Quality (HOQ), a matrix used in the process that displays the customers' requirements versus the technical responses to meet them (Figure 1). The relation between the customer and technical requirements come from a literature study.

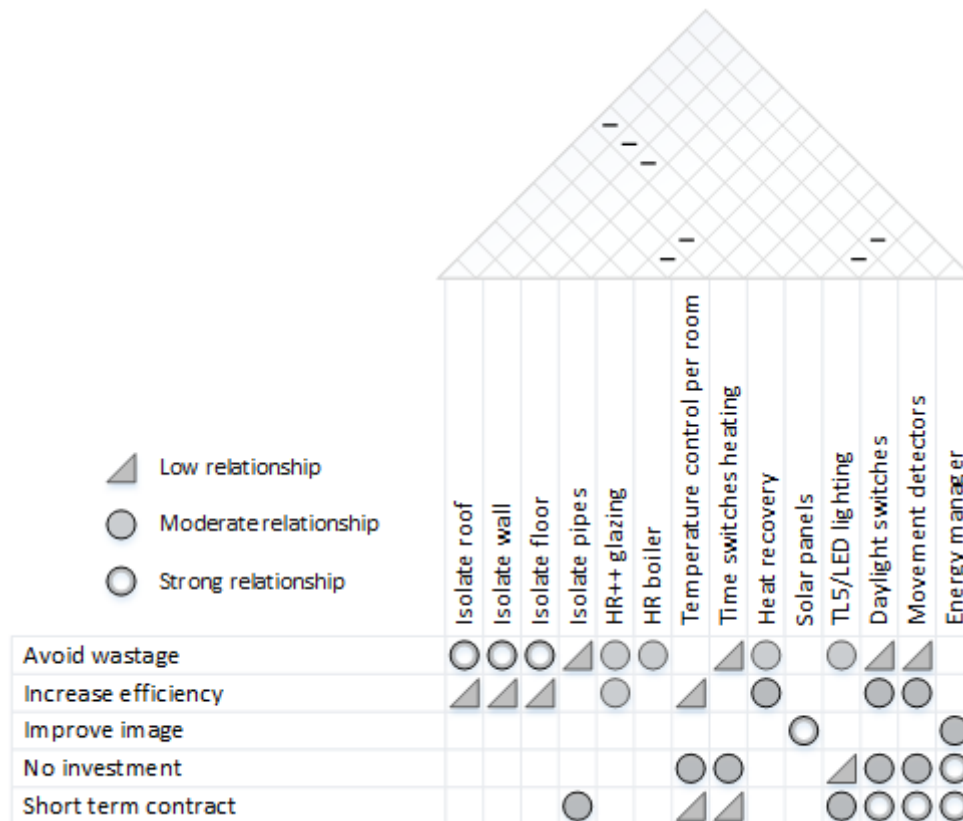


Figure 1: House of Quality

Next step is to rate the customer requirements. This will be done by the questionnaire that is distributed to business owners. The design of the survey and the processing of the data are done on the basis of the AHP method.

The Analytic Hierarchy Process (AHP) is developed by Saaty in 1980. It is a decision support tool for processes that involve multiple alternatives. On top of the AHP stands the goal of the process, followed by criteria and sub criteria, and at the bottom the different alternatives. The criteria can be weight by pair wise comparisons and the best alternative to suit the goal can be calculated. (Saaty, 1988)

All judgments of the various pair wise comparisons are summarized in a Comparison Matrix. In real-life decision problems, pair wise comparison matrices are rarely consistent. Nevertheless, decision makers are interested in the level of consistency of the judgments, which somehow expresses the goodness or “harmony” of pair wise comparisons totally, because inconsistent judgments may lead to senseless decisions.

The customer requirements are related to the technical characteristics. With the use of the house of quality the most important technical characteristics are calculated. This information is used to calculate the financial feasibility together with the energy saving potential found with a questionnaire. This is done with ten different data sets expecting different outcomes because of the different energy saving potential and weight customer requirements.

The questionnaire used for this study consists of three parts: business profile, energy saving potential and business preferences. The business profile gives the economic sector and business size while the energy saving potential gives an estimate of the feasibility of energy services for business district the Hurk. The last part, business preferences, gives pairwise comparisons of the customer requirements of energy services which are divided in three groups:

Corporate social responsibility: Companies can have several reasons to take responsibility for their impact on society. This is focused on four main aspects: meeting objectives that produce long-term profits, using business power in a responsible way, integrating social demands and contributing to a good society by doing what is ethically correct . Working with an ESCo will address those points by avoiding wastage, increase organizational efficiency and Improve the company's image.

Financial aspects: As stated before there are two options for financing an ESCo project customer or ESCo financing (with or without help of a third party). If the companies do the investments they will get the highest profit but not all companies have the means to do the investment or do not want to take the risk.

Term of contract: The efficiency measures have different payback periods. You can divide them in three groups: short-term (0-5 years), mid-term (5-10 years) and long-term (10-15 years) contracts.

The technical characteristics used in this study are the energy efficiency measures (EEM) which the ESCo can accommodate. The energy saving potential part of the questionnaire asks the companies which of these EEM's are already implemented and which are desired. A list with contact information of 114 businesses on business district de Hurk is used to send out a questionnaire. 27 of them belong to the micro sized category, 43 are small sized and 28 are Medium sized. Adding this up gives 98 businesses meaning 16 are large companies.

FINDINGS

Data collection

Of the 114 sent questionnaires 23 were filled in completely giving a response of 20%. Of these 23 companies seven were micro, eight small, five medium and three large sized. To see differences in preferences 10 different datasets are used:

1. all data
2. micro and small sized companies
3. medium and large sized companies
4. building owners
5. renter
6. micro and small sized companies owning the building
7. micro and small sized companies renting the building
8. medium and large sized companies owning the building
9. medium and large sized companies renting the building
10. all companies interested in ESCos

Analysis

First step in the data processing is checking if the data set is complete. With the use of SPSS 22 is checked if all 23 participants filled in all the questions and all the answers are in the range of 1-2 (first 3 questions) or 1-9 (the customer preferences).

Second is looked at the independence of the first three answers. SPSS is used to discover if there is a relationship between two categorical variables with the use of Pearson's chi-square test.

When you choose to analyze your data using a chi-square test for independence, you need to make sure that the data you want to analyze "passes" two assumptions, if it does not, you cannot use a chi-square test for independence. These two assumptions are:

Your two variables should be measured at an ordinal or nominal level (i.e., categorical data). With company size belonging to the ordinal level and interest in ESCo and owner/renter to the nominal level this is passed.

Your two variable should consist of two or more categorical, independent groups. This is also true, all variables consist of two independent groups.

For six datasets the dependence of interest in ESCo on company size and owner/renter is calculated. This tells us that there is a statistically significant association between being owner or renter and interest in ESCo.

To determine the strength of the association the Cramer's V is calculated. The value of .481 indicates a very strong positive association, meaning when more companies are owner of their building more companies are interested in ESCos.

The next data check is about the consistency of the business preferences. When the decision maker thinks $A > B$ and $B > C$, it should be that $A > C$. Saaty (1980) developed a method to calculated the inconsistency of the pairwise comparison matrices. Saaty (1980) concluded that an inconsistency ratio of about 10% or less may be considered as acceptable. For non-expert responds the CR could be relaxed to 0.20, making it easier to answer the pairwise comparisons. Of the 23 filled in questionnaires four proofed to be inconsistent. They are removed from the dataset.

Last step is to look at the robustness of the AHP. The absolute ranking is an quantitative indices for robustness (Deok-Hwan & Kwang-Jae, 2009). The influence of uncertainty on this ranking will determine the robustness of the research. The uncertainty has been simulated using normal distributed random variables with the initial value as mean with different standard deviations (Ghiya, et al., 1999). This uncertainty has a low influence on the ranking of the AHP, only from a standard deviation of 0,4 and onwards you see the ranking shifts. This makes the AHP robust.

Results

The final result of the AHP is given in Table 1. Looking at the three main criteria you see micro and small businesses as well as renters see Corporate social responsibility as most important while medium and large businesses as well as building owners find the financial aspects most important.

If you look closer at the financial aspects the group of medium and large businesses who own the building is the only one interested in investing themselves. Most of these businesses also stated not to be interested in ESCos, so the focus should be on investments by ESCos.

Concerning the term of contract the short-term contract is the most favorable. But the earlier determined target group of micro and small businesses who own the building have no real preference on term of contract.

Table 1: final weight criteria different datasets

	All	micro small	medium large	renter	owner	micro small - renter	micro small - owner	Medium large - renter	Medium large - owner	ESCo interested
CSR	0,38	0,41	0,33	0,40	0,35	0,44	0,37	0,35	0,28	0,30
financial aspects	0,37	0,29	0,48	0,33	0,41	0,28	0,31	0,40	0,60	0,40
term of contract	0,25	0,30	0,20	0,27	0,24	0,28	0,32	0,25	0,13	0,30
avoid wastage	0,13	0,13	0,13	0,14	0,11	0,13	0,12	0,15	0,09	0,13
increase efficiency	0,13	0,14	0,12	0,17	0,09	0,20	0,09	0,13	0,09	0,08
Improve reputation	0,11	0,14	0,08	0,09	0,15	0,11	0,17	0,07	0,10	0,09
own investment	0,16	0,12	0,23	0,14	0,19	0,14	0,08	0,13	0,45	0,11
investment by ESCo	0,21	0,18	0,24	0,19	0,23	0,14	0,22	0,27	0,15	0,29
short-term contract	0,12	0,13	0,11	0,13	0,11	0,15	0,11	0,11	0,08	0,11
mid-term contract	0,08	0,10	0,05	0,07	0,08	0,08	0,12	0,07	0,03	0,10
long-term contract	0,06	0,07	0,04	0,06	0,05	0,05	0,09	0,07	0,01	0,09

Figure 2 shows the final outcome of the QFD for all the company forms. You see clearly the energy manger is best suited for most companies and micro to small sized renters prefer the daylight switches and movement detectors slightly more. After the energy manager movement detector and daylight switches there is a large group equal important: TL5/led lighting, time switches for heating, and temperature control per room.

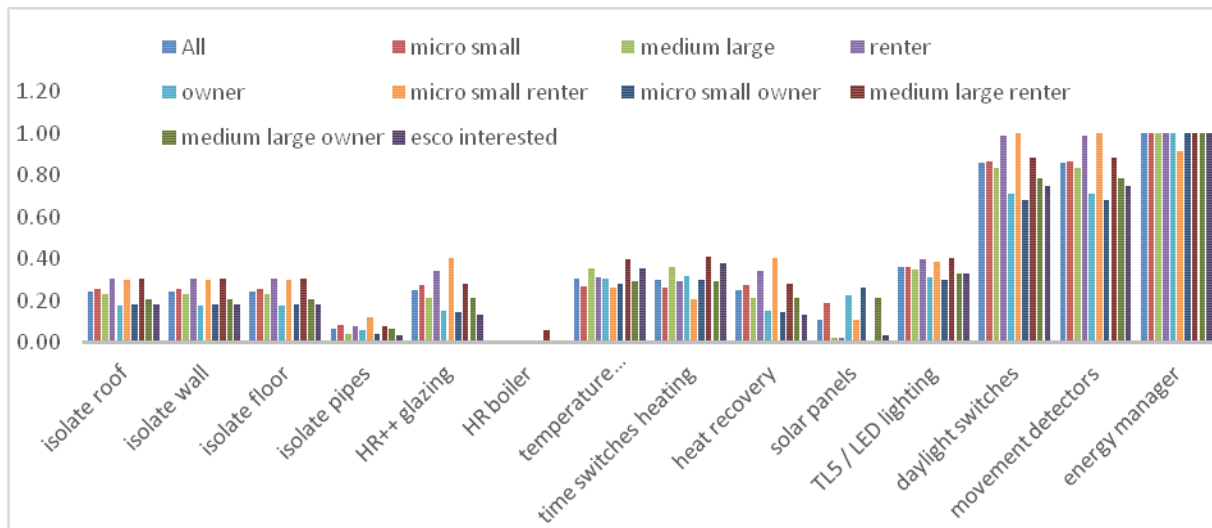


Figure 2: outcome QFD

RETScreen 4 is used to determine if the business case of all interested companies is feasible. This is an Excel-based clean energy project analysis software tool that helps decision makers determine the technical and financial viability of potential renewable energy, energy efficiency and cogeneration (combined heat & power) projects. Users conduct a five step analysis, including energy analysis, cost analysis, emission analysis, financial analysis, and sensitivity/risk analysis.

The data used for this tool are energy use of the companies, used square meters and the costs and effects of the energy efficiency measures. First the energy use was taken from the questionnaire but this information was incomplete, so the average energy use per sector is used. These numbers match with the known energy use of whole the business district.

The results show the emission reduction and financial analyze of all the ESCo interested companies. Together they can save €75.000,- yearly on their energy bill if they invest €397.000,- in adapting their lighting system with daylight switches, movement sensors, energy efficient lighting and appointing an energy manager. The payback time of these investments will be less than 7 years. Doing so they will reduce their CO₂ emissions with 60,4 tCO₂. Which is equivalent 5,6 hectares of forest absorbing carbon. The energy saving potential of these 11 companies is 351 MWh, which is 16% of their total electricity use.

CONCLUSION

RETscreen 4 is used to calculate the energy saving potential of the 11 ESCo interested companies. 351 MWh of electricity can be saved by implementing the following efficiency measures: appointing an energy manager, changing the lighting system and adding movement sensors and daylight switches. The questionnaire is send to one third of all companies on business district the Hurk, making the energy saving potential of this business district around 1000 MWh.

One of the questions of the questionnaire was why the company was interested in energy services. Most answered the cost reduction was important as well as the reduction on CO₂ emission. The research shows the companies expect the ESCo will do the investment and will

work with short term contracts. They also expect the ESCo will increase their corporate social responsibility.

An ESCo will give companies with no capital and little knowledge about energy services an opportunity to reduce their energy use and save money (Bertoldi, et al., 2014). Of all 23 companies 11 said to be interested, which is almost 50%. Most of them belong to the micro/small category and own their buildings.

There is potential for ESCos for business districts. The focus should be on micro and small sized businesses who own the building. This group has no funds and knowledge to implement energy services but are willing to do so. Companies who rent the building face a split incentive between them and the building owner, this makes the process more difficult (van der Zanden, 2013). The awareness about ESCos should be increased by starting with short term contracts and efficiency measures that do not need any investments to let the companies get used to the concept (Bertoldi, et al., 2014).

DISCUSSION

This study gives insight in energy services by an ESCo for business districts. However, this study has some limitations and thereby some opportunities for further research.

If you look at the distribution between micro, small, medium and large companies you see a difference between the distribution in the Netherlands and the distribution of the companies who responded on the questionnaire. This means the findings of this research can't be scaled up to whole the Netherlands.

23 companies responded on the questionnaire, which is a small sample. By dividing the sample in two groups like owner/renter or micro-small/medium-large, the reliability of the answers is just enough. Dividing the sample in four groups; micro-small owner, micro-small renter, medium-large owner and medium-large renter made the sample too small to give a reliable answer.

According to the questionnaire the most desired energy efficiency measure is solar panels while the literature states this is not financially feasible due to governmental rules and legislation. Also the given numbers of energy use seem odd in comparison to average energy use numbers of business district the Hurk. I expect the people filling in the questionnaire did not know the numbers and did not investigate the feasibility of solar energy. This corresponds with the low awareness of their energy saving potential and the advantages an ESCo could give them.

REFERENCES

- Bertoldi, P., Boza-Kiss, B., Panev, S. & Labanca, N., 2014. *ESCO Market Report 2013*, Luxemburg: European Commission.
- Bertoldi, P., Boza-Kiss, B. & Rezessy, S., 2007. *Latest Development of Energy Service Companies across Europe: A European ESCo Update*, Luxembourg: European Commission, Joint Research Center (JRC).
- Deok-Hwan, K. & Kwang-Jae, K., 2009. Robustness indices and robust prioritization in QFD. *Expert Systems with Applications*, Volume 36, pp. 2651-2658.
- Ghiya, K. K., Bahill, A. T. & Chapman, W. L., 1999. QFD: Validation Robustness. *Quality Engineering*, 11(4), pp. 593-611.
- Marino, A., Bertoldi, P., Rezessy, S. & Boza-Kiss, B., 2011. A snapshot of the European energy service market in 2010 and policy recommendations to foster a further market development. *Energy Policy*, pp. 6190-6198.
- Saaty, T. L., 1988. What is the Analytic Hierarchy Process?. *Mathematical Models for Decision Support*, Issue 48, pp. 109-121.
- van der Zanden, H., 2013. *Energy services for business districts*, Eindhoven: TU/e.
- Vine, E., 2005. an international survey of the energy service company (ESCO) industry. *Energy Policy*, pp. 691-704.



Chris Driessen

Born in 1989 in Druten. Chris began his engineering career in Eindhoven at Eindhoven University of Technology in 2008, graduating as Bachelor of Science in 2013. Willing to study further, Chris decided to focus on the management aspect within the construction industry. Arising from this he has successfully completed the Master Construction Management and Engineering at the Eindhoven University of Technology in 2015.

2008 – 2013 Bachelor Bouwkunde
2013 – 2015 Master Construction Management and Engineering
2015 – 2015 Internship municipality of Eindhoven

EXTENDED SHOP OPENING HOURS IN MEDIUM-SIZED CITY CENTRES

Gaining insight in consumer shopping preferences and behaviour

Author: Stefanie M.G. van den Heuvel

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. dr. ir. W.F. (Wim) Schaefer

Ir. A.W.J. (Aloys) Borgers

Dr. ing. P.J.H.J. (Peter) van der Waerden

Drs. J.P. (Jeroen) Verwaaijen

Date of graduation:

26-06-14

ABSTRACT

In the Netherlands, vacancy of retail properties is a relatively new problem in contrast to vacancy in the office market, which has been on the agenda for years. The main reason for this development is the web shop-march. The service economy is no longer bounded from nine to five while opening hours of physical shops still are. By gaining insight in consumer preferences and behavior concerning extended shop opening hours, potential for inner cities to compete with online shops will increase. Resulting in more viable and profitable retail surface.

Keywords: Consumer preferences, retail facilities, opening hours, shopping behaviour, leisure behaviour, stated choice experiment

INTRODUCTION

While most retail areas in the Netherlands have been unchanged the last twenty years, the current retail market is structurally changing from supply-oriented towards demand-driven; consumers are better informed, have different channels for buying the same products and have less time to go shopping or spending free time than twenty years ago. Compared to other European countries, the Netherlands has one of the most advanced retail property markets with over 30 million square metres of retail surface (Detailhandel Nederland, 2013). While the existing retail structure has a good base, it becomes more difficult to respond to the changing needs of the customer. Therefore consumer preferences are more important than before and should be taken into account in order to broaden the chances of existing retailers and investment companies before the situation will even get worse; structural vacancy leads to neighbourhood degradation and declining quality of life. However, consumers are flexible regarding which retail area they visit and the kilometres they are willing to travel. Though, the time of visit is limited by the opening hours. This means that opening hours of physical retail facilities will ask for another way of thinking in order to respond to consumers' demand. Consumers consume on moments in time which are preferable for them. Online retailers anticipate to those needs by being on-line at all times. Since July 2013 new national legislation ensures exemption regarding Sunday openings of retail facilities. With the recently introduced regulation, the attention to the current retail

landscape, especially regarding opening hours, in the Netherlands is revealed; there is need for a service economy no longer bounded to the nine-to-five norm (Taskforce Deeltijdplus, 2010). But less is known about the consequences of a shift in retail opening hours on consumer shopping and leisure behaviour.

An extension of opening hours seems an interesting first step in making the inner city retail areas more attractive and strengthening the competitiveness towards internet shopping. Although, this aspect did not get much attention in scientific research before. It is not known what consequences an extension of opening hours has regarding consumer shopping-, travel- and leisure behaviour in medium-sized city centres. In order to empirically provide insight in consequences for shopping and leisure behaviour when opening hours of shops are extended, the main research question is:

'How do extended opening hours of different types of retail facilities in medium-sized city central shopping areas influence consumer behaviour, and what role do parking tariffs play in this context?'

Leaded by two sub-questions:

- *'What is typical shopping behaviour of visitors in inner city areas of medium-sized Dutch cities?'*
- *'What are ideal opening hours and parking tariffs, and how would these opening hours and parking tariffs influence consumer behaviour?'*

For this research stated choice will be applied, containing three important steps. First, variables will be selected out of literature research. With those variables, or attributes, different scenarios can be designed. After this, a questionnaire will be created, consisting partly of the scenarios where respondents are repeatedly asked to choose between two scenarios. Respondents will also answer extra questions to gain insight in their future behaviour. Discrete choice modelling and logistic regression will be used to analyse the data, in order to gain insight into and predict consumer choices in different scenarios. Resulting in interesting conclusions and recommendations.

THEORETICAL BACKGROUND

The Dutch traditional intricate, fine-woven retail landscape has been highly determined by the central places theory of Christaller. Three main levels of retail agglomerations are distinguished nowadays. In the urban tissue, the level of the city centre and supporting centre, outside the peripheral retail establishment. Without retail, the city centre would not be interesting for a huge amount of visitors. Therefore, it is important to ensure the retail vitality. A combination between leisure facilities, such as restaurants, and shops strengthens the attraction of a city centre. Other aspects such as accessibility and parking facilities are of importance, a prerequisite which can lead to an increase in the service area of the city centre. The more attractive the city centre, the more and the longer consumers stay (Evers, van Hoorn & van Oort, 2005).

While retail areas in the Netherlands have been unchanged the last twenty years, the current retail market is structurally changing from supply-oriented towards demand-driven. Where supply created demand before, the last years consumer-dependency of shopping areas has become quite clear. The last decades are characterized by wish-full thinking; by creating an environment with enough amenity value, it will lead automatically to enough customers. At this moment, the Dutch retail market is saturated which means that

municipalities need to rearrange because of the fact the retail vacancy only increased by the last seven years resulting in a percentage of 6.9% of total retail stock in January 2014; 7.3% of total retail surface, which is seen as problematic (Locatus, 2014). The coming seven years, the retail surface in urban areas will decline with another two million square meters, and in total 17% of the retail surface will disappear perhaps. The main reason for this development is the web shop-march, especially clothes will be bought more often online. Other causes of retail vacancy are affected by social and demographical factors such as aging and rejuvenation of the population, the economic crisis and the aspect of 'consuminderen', the tendency to consume less, resulting from decreased scarcity. Those developments are partly a consequence of cyclical influences, however, a large part will have a structural character and determine the future retail structure. Retail vacancy has a bad influence on the quality of life resulting in decreased community ties and cohesion. With declining social safety and neighbourhood liveability influencing urban sustainability. According to Barata-Salgueiro and Erkip (2014) "urban sustainability has been associated with preserving balanced retail systems set in diverse facilities and shopping environments that are able to respond efficiently to the needs, wants and desires of different kinds of consumers". Therefore, the consumer, although it is not a decision-maker, is an important actor to take into account because of his/her continuously changing behaviour.

Shopping behaviour

Shopping in inner city centres is the second most popular recreational activity in the Netherlands and ensures high employment rates in municipalities. Shopping trips are made for the goal of goods acquisition in a purposeful and efficient process, and purposes such as social interaction, enjoyment, pleasure and entertainment. Economic shoppers are attracted by a convenient retail outlet location for purchasing goods, instead of the recreational shopper who wants experience and an attractive atmosphere (Bellenger & Korgaonkar, 1980). Severin, Louviere and Finn (2001) found out that a convenient location is most important concerning shopping centre choice. Other aspects such as "good quality, wide selection, good service, nice atmosphere and good sales/bargains" have also proven to be significant. When it comes to a recreational shopping day, safety, size of shops and shopping area, comfort, atmosphere, shop attractiveness, accessibility and parking tariffs are important for consumers. The distance consumers are willing to travel depends on the shopping motivation. The consumer will prefer a shopping area with parking facilities and tariffs proportional to the retail offer and seems less sensitive to distance when it comes to a recreational shopping day. Consumers appreciate the extensive assortment of large stores and will travel for longer distances to gain such an environment. Although, parking facilities have to be easy accessible and inexpensive. Besides spatial aspects and motivations, consumer behaviour is influenced by socio-demographic or socio-economic factors such as gender and age; lifestyle-aspects such as time spent working also play a role concerning shopping behaviour (Finn & Louviere, 1990). Influenced by the fact that spare time has decreased by an increase in dual-income households, and also by the rise of internet shopping, the demand for inner city centres offering a complete leisure experience increases (Janssen, 2011). The ability to shop online instead of personally visiting a physical store has largely changed the way shopping is incorporated in consumer's everyday life in the past decade (Hsiao, 2009). Although, physical stores do have advantages over online shopping through the pleasure gained from the combination between retail and leisure which is more attractive and can only be made in the physical environment (Evers, 2011). Especially large

and medium-sized cities are of interest because these areas consist of a mix of both large stores, which have better coordination possibilities to extend their opening hours, and other type of leisure facilities. Therefore it might be interesting to reconsider current opening hours in order to compete with online retailers (Hoofdbedrijfschap Detailhandel, 2011).

Opening hours

It might be beneficial for consumers to have increased freedom in choosing their shopping times. But less is known about the consequences of a shift in retail opening hours on consumer shopping and leisure behaviour. In the Netherlands, already a huge amount of facilities are opened during evening hours, think about supermarkets which extended their opening hours by the new shopping hours regulation in 1996, but also sports facilities, restaurants and cinemas. The opening up of retail facilities in inner city centres can have a significant impact on shopping habits, motivations and behaviours resulting in a change in consumer lifestyles and the Dutch society as a whole possibly resulting in economic growth, employment and welfare gains for consumers by extended opening hours (Dijkgraaf & Gradus, 2004).

METHOD

Especially since the current Dutch retail market is structurally becoming demand-driven, it is important to investigate consumers' preferences in order to broaden the chances of existing retailers and investment companies before the situation will even get worse. Therefore a stated choice experiment is conducted.

Stated choice modelling, introduced by Louviere and Hensher in 1982 and Louviere and Woodworth, in 1983, is a method applied in order to investigate consumers' preferences and market shares regarding hypothetical alternatives. By presenting different mutually exclusive future alternatives, or scenarios (composed by means of experimental designs), respondents are asked to choose the scenario they consider best, a first-preference choice task (Hensher, 1994). Scenarios consist of different attributes and attribute levels. Influential attributes on shopping location choice are distinguished and elicited by literature research, keeping in mind that shopping should be as convenient as possible otherwise people will not visit the inner city centre but will buy elsewhere. Varying attribute levels are combined through an experimental design. All attributes included in this study will have three levels and each level gives information about the part-worth utility. In order to have feasible attribute levels within the range of current experience and believability (a primary consideration), unambiguous attribute level labels are assigned. For this research the following attributes and ordinal levels are distinguished:

- *Retail offer in three types:* An influential and frequently mentioned aspect distinguished by several researchers is the selection of shops, or the assortment, in other words: the completeness of the retail offer. Especially fashion and department stores, multimedia and sports are seen as main triggers attracting consumers to a city centre. In this research, the retail offer is linked to opening hours by three types of shops. Shops in the **fashion** and luxury segment, consisting of department stores, clothing and fashion-, footwear and leather goods-, jewellery and optics, household and luxury items-. **Beauty** shops, marketing personal care goods. Media and **leisure** shops offering items in sports and games, hobby, media, antiques and art. By the fact a

three-level attribute contains more information than a two-level attribute, 6:00 PM and 10:00 PM are chosen as extreme ranges; 8:00 PM is chosen as intermediate level.

- *Parking tariffs:* Because of increased mobility during the last decades, prices of parking facilities become more and more of interest. Parking tariffs have to be proportional to the retail offer and will influence the service area of a city. It is interesting to investigate the influence of parking tariffs in evening hours on shopping behaviour and mode of transport used.

In terms of attribute levels, parking tariff will be normal, which means the prices are the same as for the day-period, 50%- discount, or for free.

Besides, context variables are used for the choice sets; the shop type-variables and the parking tariff together are included in the alternatives and choice tasks, as shown in table 1.

Attribute		Level
Opening hours	Fashion	6:00 PM
		8:00 PM
		10:00 PM
	Beauty	6:00 PM
		8:00 PM
		10:00 PM
	Leisure	6:00 PM
		8:00 PM
		10:00 PM
Parking tariff (after 6:00 PM)		Free
		50%
		Normal

Table 1: Attributes and –levels

By fractional factorial design, twenty-seven alternatives are selected ensuring main effects and first order interaction effects between the first three attributes (closing hours of shops) can be estimated independently. Initially, all possible pairs of the twenty-seven alternatives are used to create choice sets. However, attribute levels of one alternative may outperform the other alternative's attribute levels. Therefore some choice set combinations were seen as less realistic and are precluded from the design. As a sampling strategy, those choice sets are presented randomly to respondents by using an online questionnaire-system. The questionnaire is designed according to the sub-questions:

- *'What is typical shopping behaviour of visitors in inner city areas of medium-sized Dutch cities?'*
- *'What are ideal opening hours and parking tariffs, and how would these opening hours and parking tariffs influence consumer behaviour?'*

With the first part of the questionnaire, current shopping behaviour is investigated. The second part of the questionnaire consists of investigating changes in behaviour by presenting new situations to respondents, followed by five choice set combinations consisting of two unlabelled alternatives and a 'no-choice' alternative. Consumers are asked for their preferences concerning shop opening hours and parking tariffs. The questionnaire is ended with examining demographics. Respondents are gained from Panelclix and snowballing. Data will be analysed using Multinomial Logit Models and Binary Logistic Regression.

The focus of the study will be on the Brabantstad network consisting of the province of Noord-Brabant and the cities Breda, Eindhoven, Helmond, 's-Hertogenbosch and Tilburg. The

Brabantstad network aims at becoming a strong internationally competitive and sustainable growing urban network.

FINDINGS

Considering the sub-questions ‘What is typical shopping behaviour of visitors in inner city areas of medium sized Dutch cities?’ and ‘What are ideal opening hours and parking tariffs, and how would these opening hours and parking tariffs influence consumer behaviour?’ the following aspects are noticed. Most of the respondents visit the city centre between once a month and once per quarter; where younger respondents shop more frequent then elder and women shop more frequent than men. Weekend-days and the shopping night are most popular moments for shopping. The city centre is mostly visited from home, by car and an average visit takes between one and two hours where part-time employees and unemployed shop longer than fulltime workers, students and pensioners. Also females stay longer and visit the city centre more often for fun than males; a higher percentage of males visits the city centre always for efficiency reasons. Regarding opening hours, respondents in general do not have a clear opinion on opening hours and parking tariffs, also respondents are neutral towards opening hours of beauty shops. When the dataset is defined by age, more detailed insights are gained.

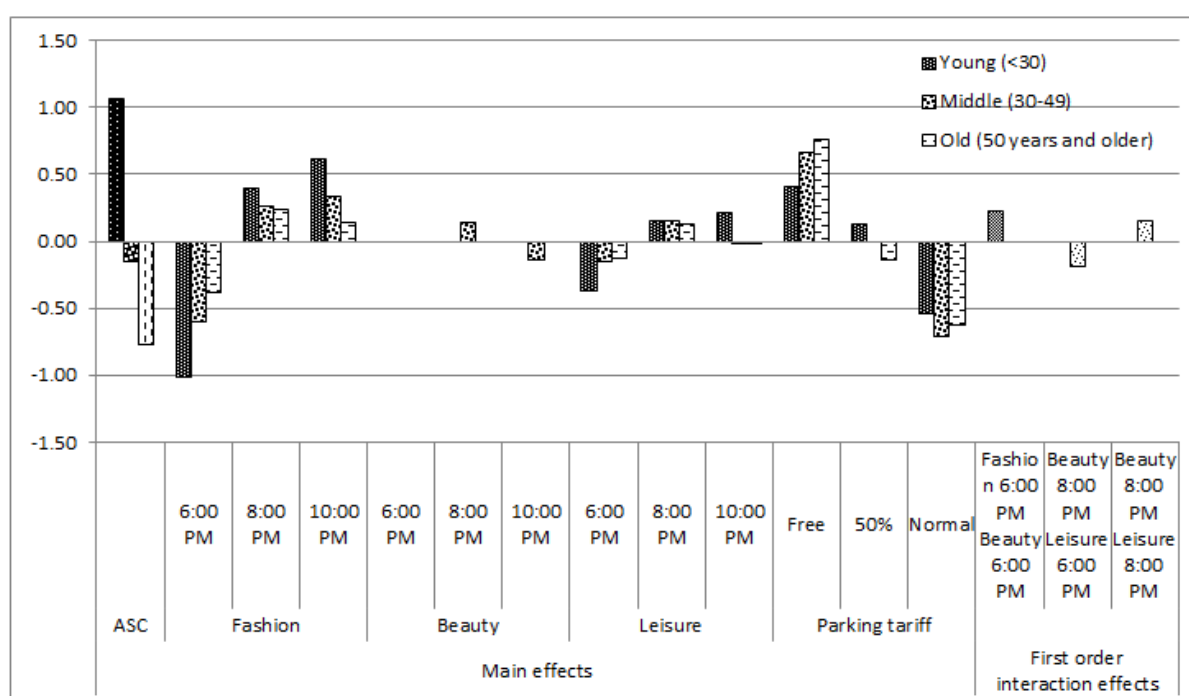


Figure 1: Parameter estimation divided for three age groups

Group Young (229 respondents) LL_M : -999.92 LL_0 : -1257.91 Rho^2 : 0.21
Group Middle (245 respondents) LL_M : -1232.32 LL_0 : -1345.80 Rho^2 : 0.08
Group Old (262 respondents) LL_M : -1272.49 LL_0 : -1439.18 Rho^2 : 0.12

As can be concluded from figure 1, for the youngest group (respondents below 30 years), fashion opening hours are most important. An ideal situation will be gained when all shops are open till 10:00 PM. However, the range between opening hour utilities for 6:00 PM and 8:00 PM is larger as compared to the range between 8:00 PM and 10:00 PM. Meanwhile,

respondents above 30 years value parking tariffs higher, probably because they visit the shopping centre more by car than younger respondents. In terms of type of shops or product categories: clothing and accessories, footwear and leather are the most popular products shopped for in inner city centres.

From here, it follows logically that preferences for specific types of shops concerning extended opening hours do exist as asked by the main research question:

'How do extended opening hours of different types of retail facilities in medium-sized city central shopping areas influence consumer behaviour, and what role do parking tariffs play in this context?'

An extension in opening hours of one of the three types of retail facilities (fashion, beauty and leisure) do all influence consumer shopping behaviour in terms of shopping later and shopping longer, with a relatively large influence of opening hours till 8:00 PM, see table 2. Besides, occupation has effect on those aspects and shopping longer is also dependent on gender. Thereby, gender has an influence on visit frequency. In terms of opening hours, only fashion shops do affect visit frequency; later opening hours result in a higher probability that consumers will shop more often. This finding especially applies to young people (age <30 years), and females (gender) tend to visit the city centre more often, although the difference between 8:00 PM and 10:00 PM is negligible. Parking tariffs might influence consumers to visit the city centre on a later moment during the day, whereby 50% discount results in a relatively higher percentage of visitors shopping later.

		Basic BLR						BLR demographic variables					
		Later		Longer		Often		Later		Longer		Often	
Variables		Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Opening hours	FASHION1	-0.735	0.00	-0.468	0.00	-0.299	0.03	-0.755	0.00	-0.492	0.00	-0.316	0.02
	FASHION2	-0.167	0.21*	-0.096	0.45*	-0.035	0.79*	-0.184	0.17*	-0.108	0.41*	-0.053	0.68*
	BEAUTY1	-0.337	0.01	-0.333	0.01			-0.303	0.03	-0.322	0.02		
	BEAUTY2	-0.111	0.39*	-0.031	0.81*			-0.103	0.43*	-0.019	0.89*		
	LEISURE1	-0.421	0.00	-0.343	0.01			-0.387	0.01	-0.314	0.02		
	LEISURE2	-0.199	0.13*	-0.131	0.31*			-0.175	0.19*	-0.113	0.38*		
Parking tariff (after 6:00 PM)	PTARIFF1	0.370	0.01					0.394	0.00				
	PTARIFF2	0.249	0.05					0.303	0.02				
Age	< 30 years											0.506	0.00
	30-49 years											0.385	0.00
Gender	Female									0.516	0.00	0.359	0.00
Employment	Fulltime							0.758	0.00	0.29	0.05		
	Part-time							0.851	0.00	0.328	0.04		
	Student							1.176	0.00	0.331	0.05		
ASC		0.758	0.00	0.067	0.62**	-0.388	0.00	0.075	0.69**	-0.492	0.01	-0.889	0.00
Log likelihood ratio statistic		1943.232		1965.040		1945.867		1886.177		1935.697		1917.243	
Pseudo R ²		0.052		0.022		0.005		0.102		0.048		0.032	

* non-significant parameters are not removed because the significant influence of the attribute as such according to the Wald-criterion

** parameters removed because of non-significance

Table 2: Parameter estimation of Binary Logistic Regression

Model application

From the calculated parameter values, consumer preferences for particular situations can be computed. Here a hypothetical city centre A is introduced. The structural utilities (V_i 's) and probabilities (P_i 's) for Yes: a respondent may visit the city centre later, longer or more frequent for a specific situation (1 till 6), are calculated and shown in table 3.

			City centre A					
			Situation 1	Situation 2	Situation 3	Situation 4	Situation 5	Situation 6
Predictor variables	Opening hours	Fashion	8:00 PM	8:00 PM	8:00 PM	10:00 PM	10:00 PM	10:00 PM
		Beauty	8:00 PM	8:00 PM	8:00 PM	10:00 PM	10:00 PM	10:00 PM
		Leisure	8:00 PM	8:00 PM	8:00 PM	10:00 PM	10:00 PM	10:00 PM
	Parking tariff (after 6:00 PM)		Normal	50%	Free	Normal	50%	Free
Predicted variables	Later	Structural utility (Vi)	0.28	0.53	0.65	0.76	1.01	1.13
		Probability (Pi)	0.57	0.63	0.66	0.68	0.73	0.76
	Longer	Structural utility (Vi)	-0.26			0.00		
		Probability (Pi)	0.44			0.50		
	Often	Structural utility (Vi)	-0.42			-0.39		
		Probability (Pi)	0.40			0.40		

Table 3: BLR model application

The BLR model gives information about shopping behaviour preferences and changes by introducing new situations. Here the choice to shop later, longer or more often is compared to the choice to not shop later, longer or more often. When opening hours of all types of shops are extended till 8:00 PM and the parking tariff is reduced with 50% the probability that the city centre is visited on a later time during the day is 63%. This means that 63% of the consumers may visit the city centre on a later time the day although it is not known which time. When opening hours of all types of shops are extended till 10:00 PM and the parking tariff is free 76% of the consumers may visit the city centre later, also 50% may stay longer and 40% may shop more often. Shopping frequency and duration are insensitive to parking tariff as did already become clear from table 3; here is shown that the probabilities respondents will shop longer and more often do therefore not increase by decreasing parking tariffs.

Although calculated with the same opening hours for all types of shops, it is also possible to only extend opening hours for one type of shops and predict influences on shopping behaviour. Because of the highest influence of fashion opening hours, an extension of fashion opening hours will be calculated here in table 4:

			City centre A					
			Situation 1	Situation 2	Situation 3	Situation 4	Situation 5	Situation 6
Predictor variables	Opening hours	Fashion	8:00 PM	10:00 PM	8:00 PM	10:00 PM	8:00 PM	10:00 PM
		Beauty	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM
		Leisure	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM
	Parking tariff (after 6:00 PM)		Normal	Normal	50%	50%	Free	Free
Predicted variables	Later	Structural utility (Vi)	-0.17	0.00	0.08	0.25	0.20	0.37
		Probability (Pi)	0.46	0.50	0.52	0.56	0.55	0.59
	Longer	Structural utility (Vi)	-0.77	-0.68	-0.77	-0.68	-0.77	-0.68
		Probability (Pi)	0.32	0.34	0.32	0.34	0.32	0.34
	Often	Structural utility (Vi)	-0.42	-0.39	-0.42	-0.39	-0.42	-0.39
		Probability (Pi)	0.40	0.40	0.40	0.40	0.40	0.40

Table 4: BLR model application

As can be concluded from the table 4, an extension of opening hours of fashion shops till 10:00 PM and free parking tariffs will result in a higher probability (59%) consumers that may visit the city centre later than extending opening hours of all types of shops by two hours with a normal parking tariff (57%). Less consumers will stay longer if only fashion stores open up their shops as compared to opening up all types of shops. Because fashion shops are the only predicting variables concerning shopping frequency, the outcomes for the 'often'-variable from table 4 do not diverge from the outcomes from table 3.

DISCUSSIONS

In the Netherlands, since July 2013 new national legislation ensures exemption regarding Sunday openings of retail facilities. With the recently introduced regulation, attention to the opening hours of the current saturated, and by vacancy threatened, retail landscape, is shown. For retailers, it is important to deliver value and satisfy people-based needs to gain a stronger position and to strengthen the competitiveness towards internet shopping. A questionnaire including a stated choice experiment is distributed to gain insight into current consumer shopping behaviour and changes in behaviour regarding shop opening hours and parking tariffs. Data is analysed using MNL models and binary logistic regression.

Regarding preferred opening hours, in general respondents do not have a solid opinion on opening hours and parking tariffs. Although there are differences between age groups, where especially young respondents do have a strong opinion. As can be concluded from the stated choice experiment, stores will gain a greater attractiveness when opening hours are extended from 6:00 PM to 8:00 PM or 10:00 PM. Whereby 10:00 PM is mostly preferred by respondents below 30 years; respondents from 30 years and above prefer opening hours until 8:00 PM. Especially stores in the fashion and luxury segment are influential concerning preferred choice. Also, shops in the leisure segment are sensitive to an extension. Although for the elder visitors parking tariff is the main trigger to visit a city centre in the evening hours. When opening hours are shifted, consumer shopping behaviour will change. At least for some specific demographic groups. For example the fulltime workers and students are able to visit a city centre on another day than weekends and the shopping night; they have preferences to visit the city centre on other evenings and an extension of opening hours may influence them to shop later and longer than in the current situation. Especially for the young age group extending opening hours of fashion shops seems an interesting option to strengthen the competitiveness of medium-sized inner city retail areas; they may visit the city centre more often. The elder age groups prefer to shop more often in mornings and afternoons instead of evenings. Therefore extended opening hours will not have significant impact on their shopping behaviour. Also gender does have an influence on shopping behaviour and possibly changes in shopping behaviour, especially women are more sensitive to shopping longer and more often after opening hour extensions. Although, an extension of opening hours in evenings and a lowering of parking tariffs is an interesting first step in improving the inner city retail areas' attractiveness and strengthen the competitiveness towards internet shopping and subsequently retail vacancy, it will not solve the entire retail vacancy problem the Netherlands is confronted with currently. However, with an opening hour extension (combined with a reduction of parking tariffs) as a first measure, the remaining retail surface may become more viable and profitable.

From this research it becomes clear that the demand side (the consumer) is positively influenced by evening shopping possibilities, although it is not known what this means for the supply side. Consumers may shop later, longer and more often, but do they spend more? Will it be cost effective for retailers, investment companies and leisure facility owners when opening hours are extended? The same applies for parking companies and infrastructure managers in terms of reduced parking tariffs. It might be interesting to investigate this economic side to know what the exact value of the measures will be. Another aspect will be the difference between an opening hour extension or a shift in opening hours. This research focussed on an opening hour extension, although it might be more profitable for retailers to

shift opening hours to a later moment the day. Preferences are now investigated in general and for specific age groups, although occupation seems to be a more influential factor in changing shopping behaviour by extended opening hours. Besides, this research is carried out on city centre level, it could also be extended to the supporting centre level mainly used for daily needs.

REFERENCES

- Barata-Salgueiro, T., & Erkip, F. (2014). Retail planning and urban resilience – An introduction to the special issue. *Cities*, **36**, pp. 107-111.
- Bellenger, D.N., & Korgaonkar, P.K. (1980). Profiling the Recreational Shopper. *Journal of retailing*, **56**, pp. 77-92.
- Detailhandel Nederland. (2013). *Winkeliers: "Provinciale regie detailhandel nodig!"*. Retrieved June 19, 2014, from http://www.detailhandel.nl/images/pdf/012_Winkeliers_-_Provinciale_regie_detailhandel_nodig.pdf
- Dijkgraaf, E., & R.H.J.M. Gradus (2004). *Explaining Sunday shop policies*. Rotterdam: ODFEB.
- Evers, D. (2011). *Detailhandel en beleid: een continue wisselwerking*. Retrieved October 7, 2013, from http://www.pbl.nl/sites/default/files/cms/publicaties/Detailhandel%20en%20beleid%20definitief%200711_0.pdf
- Evers, D., A. van Hoorn & F. van Oort (2005), *Winkelen in Megaland*. Rotterdam/Den Haag: NAI Uitgevers/Ruimtelijk Planbureau.
- Expertteam Detailhandel Noord-Brabant. (2013). *Ambitie vereist keuzes*. Retrieved September 20, 2013, from <http://www.ivbn.nl/viewer/file.aspx?FileInfolD=599>
- Finn, A., & Louviere, J.J. (1990). Shopping-Center Patronage Models. *Journal of Business Research*, **21**, pp. 259-275.
- Hoofdbedrijfshap Detailhandel. (2011). *Het nieuwe winkelen*. Retrieved October 25, 2013, from <http://www.hbd.nl/websites/hbd2009/files/Technologie/Rapport-HBD-het-nieuwe-winkelen.pdf>
- Hensher, D.A. (1994). Stated preference analysis of travel choices: the state of practice. *Transportation*, **21**, pp. 107-133.
- Hsiao, M.-H. (2009). Shopping mode choice: Physical store shopping versus e-shopping. *Transportation Research Part E*, **45**, pp. 86-95.
- Janssen, I.I. (2011). *Adaptive Decision Making in Multi-Stakeholder Retail Planning*. Eindhoven: University of Technology Eindhoven.
- Locatus. (2014). *Persbericht – Winkelleegstand stijgt zevende jaar op rij*. Retrieved January, 2014, from <http://www.locatus.com/nederland/nieuws-en-informatie/nieuws-en-pers/persbericht---winkelleegstand--jan-2014>
- Severin, V., Louviere, J.J., & Finn, A. (2001). The stability of retail shopping choices over time and across countries. *Journal of Retailing*, **77**, pp. 185-202.
- Taskforce DeeltijdPlus. (2010). *De discussie voorbij*. Retrieved September 30, 2013, from <http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2010/04/06/de-discussie-voorbij-eindrapport-taskforce-deeltijdplus.html>



STEFANIE M.G. VAN DEN HEUVEL

Stefanie van den Heuvel was born in 1988 and grew up in a warm and protected environment. After her high school she started studying in the faculty of Architecture and Building Sciences. Besides her study, she always had one addiction: called shopping. In this project she got the opportunity to integrate her shopping-hobby with an academic research. *'There would not have been a research subject fitting me more than this, I am definitely sure about that'.*

- 2007 – 2010 Bachelor Architecture and Urban Design (TU/e)
- 2010 – 2011 Courses in Urban Design and Planning Master (TU/e)
Courses in Landscape Architecture Master (TU Delft)
- 2012 – 2014 Master Construction Management and Engineering (TU/e)

POTENTIAL USE OF PUBLIC TRANSPORT IN THE CONTEXT OF AIR POLLUTION REDUCTION

Development of a tool to determine and localize potential bus users

Author: Hannely Hortensius

Graduation program:

Construction Management and Urban Development 2014-2015

Graduation committee:

Prof. dr. ir. W.F. (Wim) Schaefer		Chairman Master Program CME, TU/e
Dr. ing. P.J.H.J. (Peter) van der Waerden		First graduation supervisor, TU/e
Dr. Q. (Qi) Han		Second graduation supervisor, TU/e
Ir. J.J.F. (Joris) Hoogenboom		Advisor, BonoTraffics bv.

Date of graduation:

25-02-2015

ABSTRACT

Since the air pollution situation in Europe is getting worse, some measures should be taken. More than a fifth of the greenhouse gas emissions is due to traffic-consumption and therefore this research will make an attempt to optimize the transport effectiveness by supporting public transport. This will be done by developing a model which determines and localizes potential bus users. To make this tool a model is estimated with the use of personal, trip, and areal characteristics. The tool could be used by public transport agencies or traffic engineering consultancies to optimize the existing bus network or implement the model by creating future networks in new neighborhoods.

Keywords: Air quality; Environment & Health; Public Transport; Geo-Marketing; Multinomial Regression Model.

INTRODUCTION

In Western Europe very high air pollution levels are measured, and since the need for transport only grows, higher levels are expected. In the near past, especially France, Belgium and Germany suffered from very bad air quality, but if no measures are taken the Netherlands will surely follow their paths (European Environment Agency 2014).

Motor vehicles are a very significant source of urban air pollutions (Health Effects Institute 2010). In 2011 a third of all final energy consumption in Europe was accounted by transport, this traffic-consumption was responsible to more than a fifth of the greenhouse gas emissions (European Environment Agency 2011). So, one option to tackle the air pollution problem is to make an adjustment regarding the use of transport.

Problem Definition and Research Questions

Many papers are written about the attitude of travelers, but still the public transportation agencies have little to no insights towards the potential of their nodes. Important questions for these businesses are whether they reach all the possible travelers, where potential users are vested and how they can be reached and how sensitive their customers are towards

different facilities. Therefore this research will combine the elements of attitude towards transport modes, the effects of measures and the potential for customers in a certain area.

The target of the research is to develop a tool, which gives public transport agencies more information about the potential users of public transport. Then, they can anticipate on this, and the amount of private car-users can be reduced. The research questions that follow this target are:

“Which research methodology should be used to develop a tool which determines and localizes potential bus users?”

“Which personal, trip and areal characteristics should be used to model potential users of public transport?”

“Can the Air Quality in the Netherlands be improved by stimulating the use of Public Transport?”

To answer these main questions several sub-questions are drafted concerning the definition of potential, behavior of travelers explained by areal characteristics and measurements to attract travelers towards the public transport.

Relevance of the Research

The use of more public transport can reduce the amount of private car-users, which will reduce emissions and will lead to a cleaner and healthier environment. Public transport agencies can locate potential users by the use of the tool. They can anticipate to the new information by changing their services and facilities in their operating areas which can switch the potential users into actual users.

The practical relevance can be, for example, the implementation of the model when a municipality is expanding. If a municipality wants to expand their city a consultancy could use the model to visualize the number of future potential public transport users. From this information a plan can be made about the public transport facilities in the new neighborhood which will fit the prospective demand.

Expected Results

The expected result for this research is the obtaining of a tool, which will not only state whether there are potential public transport users, but also where they are located. The tool will determine whether potential users are present and which policy could be implemented to reach a certain effect where the latent potential will become manifest potential. When this model is made all the potential users can be localized and the expected need for bus lines and maybe even bus stops can be modeled. This could be used by traffic accounting agencies which advice governments with new public transport routes in existing or future neighborhoods.

THEORETICAL FRAMEWORK

Sustainability

The actual influence of transportation to the environment is analyzed with special attention to the impact which public transport can have regarding this problem. The air quality depends on the presence of air pollutants. If the concentrations of this pollutants are too high air pollution can be harmful for the health. The most important pollutants are: particulate matter (PM_x), nitrogen dioxide (NO_2), ammonia (NH_3); sulfur dioxide (SO_2); nitrogen oxides (N_xO), heavy metals and hazardous substances which are difficult to degrade.

The European Union (EU) has limits and target values for several pollutants. The limits apply to sulfur dioxide, particulate matter, nitrogen dioxide, lead, benzene and carbon monoxide. The targets are for ozone, arsenic, cadmium, nickel and benzo (a) pyrene. The limits must not be exceeded, and all EU Member States should ensure to remain below the target values.

The Netherlands meets almost all European air quality limit values, except for a few places where the concentrations of particulates and nitrogen dioxide are still too high. Road traffic causes a large part of the emission in the Netherlands. Because the traffic in the Netherlands has the biggest share of the emissions, this is still an important issue on the governmental agenda.

Public transport is often seen as an important air pollution reduction strategy. This is not only because of the strategies which can be implemented in the systems, but also about the amount of people transporting per vehicle. When more travelers travel by Public Transport, the less personal car-trips will be used and the air pollution will be reduced. The target is not only to make transit service more appealing but also to lower the attention of the automobile.

Public Transport

In order to carry out this research a demarcation should be made. The air quality in the Netherlands is worst in cities, and the increase of citizens living in cities which predicted will only worsen the case. The most pollution emissions in cities are because of freight and busses. Therefore the bus networks will be investigated in this research, this refers not only to the local inner-city networks, but also to rapid bus transport systems which transfer between cities and/or villages.

The trends from the transportation of the last few years are subtracted from the 'Onderzoek Verplaatsingen in Nederland (OVIN)' (Travel Research in the Netherlands). This is an annual research performed by the 'Centraal Bureau voor de Statistiek (CBS)' (Central Statistical Office from the Netherlands). This researches show that the car is by far the most popular transport mode, after this the train and bicycle, and only after these three the bus/tram/metro. The most important motive is commuting and after this visit trips or recreational trips.

Multiple advantages and disadvantages can be found in literature for both public transport and private car usage. The most important advantage of the private car is the flexibility which it gives to a driver. Also motivations and barriers are found for public transport users. A conclusion here was that most barriers are formed by aspects regarding comfort and convenience. Also several measurements have been implemented in the public transport market, but only some of the time the effect of these measures are investigated after the implementation. And only in a very limited number of cases the potential effects are estimated before the implementation of the measure.

The potential users of public transport are the travelers who, at the present, do not use the public transport, but which could switch towards it when certain measures are taken. This switching possibility depends on several aspects which mostly relates to the willingness of people to switch. The aspects are about the distance between origin or destination and bus stops, frequency of busses, whether the connection can be traveled directly or there is a need for transfers, ratio between travel time/distance/costs from bus or other transport mode, the ability to bring belongings and other comfort aspects like crowdedness and service (Waerden & Bérénois 2010).

Marketing

The previous discussed variables affecting the use of public transport and possible policies and measures. However, nothing will change regarding to transport mode choices from travelers if they are not aware of the newly implemented measures. To deliver this knowledge marketing can be used.

The role of marketing in the Public Transport has increased much in the recent past because of the evolution of transit. First, most people had to use the Public Transport because of few other alternatives. Now is the time of high car ownership and the Public Transport has to make an effort to attract customers.

To implement an individualized marketing strategy, the potential costumers should be selected and contacted directly. To do this, it is not only necessary to know who are possible users, but also where they are located. When the location of potential is not known it is not possible to directly focus the marketing to the potential. This location bounded marketing can also be referred to as 'Geo Marketing'. This is a marketing technique which is proven to be functional and has multiple advantages compared to general marketing.

RESEARCH APPROACH

Theory

In this research behavioral theory is used, the purpose is to understand why people choose a specific transport mode and to get to know where potential users are vested. With this knowledge the public transport agencies can participate to the behavior of the travelers and thereby promote, among others, the bus usage. Individual choice behavior, discrete choice modelling and switching-behavior are the most important theories used during the research.

Research Method

Earlier attempts on modelling public transport were almost always about the actual use of public transports instead of the potential users, nevertheless there are some exceptions.

Sugiki et al. developed a potential traffic demand model using a binary logit model, but this model is very limited because of the use of only three variables which are all on the same level: household age, household type and residence type (Sugiki et al. 2001). Another attempt was made by Zhou et al. using a two-leveled nested logit model, eight different market segments were identified which were linked with several areas and the market share per market area was calculated (Zhou et al. 2004). However, in this model no directly relation is made between the areal characteristics and the market shares.

In 2005 Van der Waerden et al. made an attempt to make public transportation potential maps (Waerden et al. 2005). This paper uses a simple approach to identify potential customers of public transport by the use of GIS-based public transport potential maps. However this research and following researches involving Van der Waerden et al. only use variables with areal characteristics and none about personal behavior of the subjects.

In this research this earlier attempts will be used and expanded. At first a model using only the possible personal, trip or areal variables will be made and after this combinations of these levels are included to see whether the model improves. Also several variables can be implemented both as an areal variable or personal variable. In such a case both scales will be checked and then the most suitable scale will be used in the final model. The intention is to firstly make a multinomial regression model and after this the more complex hierarchic regression model.

Potential Models

Because several research methods are used to describe potential in the past it is not clear which method is the best. Therefore, to get the most out of this research, several models can be created with the use of different research approaches.

The dependent variable in this model will be the potential for replacing the car-trip by a bus-trip. This is one of the questions asked in the enquiry and therefore the answers are clear. Now this variable should be connected to the independent variables: the personal -, trip -, and areal characteristics. Because the dependent variable, public transport potential, is categorical, this can be done by the use of logistic regression. If the categorical variable has exactly two categories the analysis is called binary logistic regression, and when the outcome has more than two categories it is called multinomial logistic regression (Field 2013). The dependent variable 'Bus Potential' has four different categories, so the latter will be used.

If these kind of logistic regression models are used, the model does not take the multiple levels of characteristics into account, the personal and areal variables are both used in the same level. When this occurs several aspects of the reality are not captured in the model. Personal variables are all individual and on the same level, however the areal variables are also individual but there can be groups of individual clusters by the area they come from. To implement these multiple levels a multi-layered hierarchic regression model should be used like a hierarchic regression model.

No measurements to change the transport mode of the user will be taken into account in this model. The model will only identify potential bus users, regarding the characteristics of

the circumstance. So, the two models described before do not take the measurements to switch potential into actual users into account.

DATA

The data used for this research is mainly from an enquiry about travelers' behavior from a case study performed in 2009. Next to this, other data was needed about areal and travel aspects to create the bus potential models. A data analysis was done to check whether the data fits for this research.

Enquiry Data

The most recent and comprehensive dataset is from 'verplaatsingsonderzoek Nuenen 2009' ('travel survey Nuenen 2009') presented by van der Waerden and Bérénos (Waerden & Bérénos 2010). This survey was performed in the context of the Transumo project 'Regionale Openbaar Vervoer Bereikbaarheid Consumentgericht (ROVBECO)' ('Regional Public Transport Accessibility Project') (Waerden et al. 2009).

The models were created by the use of multiple possible variables divided in four different categories. Two of these categories are extracted from the enquiry dataset, these categories refer to the personal and trip characteristics.

Areal Data

Next to the data of the questionnaire, data about the characteristics of the area were needed. This data was taken from open source databases like CBS, processed by Irias Informatiemanagement. Additional data about households was obtained from Bridgis, and data of bus services in an area came from Goudappel Coffeng combined with open data.

Nuenen only exists of four different four position ZIP code areas, from which three of the areas form the center and the rest of Nuenen is the fourth area. When using these four areas the level of detail is quite gross and little variance is present in the variables. Therefore these four position ZIP code variables were discarded and the research was done with another scale, six position ZIP code variables where sought and used. The two categories of variables from the areal data regard the areal and bus characteristics.

Data Analysis

The data was analyzed by the use of the golden standard, and it is not equally distributed as the actual population in Nuenen. However a sample can never be perfectly representative for the population, but in this case there are rather large differences. It can be doubted whether the data is a good fit for the area.

MODELS

To make a hierarchic regression model, first the variables that should be used had to be selected. This is done by the use of crosstabs which show the correlation between different variables and the use of multinomial logistic regression models. When the variables are picked using these methods, the chosen variables should be checked whether they fit the right assumptions.

Correlation Crosstabs

To study the correlations between the possible variables IBM SPSS Statistics was used. An analysis is done with the Descriptive Statistics Crosstabs. The Chi-square is the most important aspect in this analysis because this will tell whether the correlation is significant. If this is the case, it may be better not to use the two variables in the Crosstab together in the model because they could affect each other.

Almost all variables, over all categories, do correlate to each other. Therefore, it can be said that most variables cannot be combined in a model, for they correlate to each other. However quite a lot of variables, 19 out of 30, do significantly correlate to the dependent variable 'Bus Potential'. At first none of the variables regarding bus characteristic did correlate to the dependent variable, but after a new categorization also one of these variables seemed to have a significant effect on the 'Bus Potential'.

Multinomial Logistic Regression

After the correlation tests, multinomial regression models were made. First all individual variables were tested into a model. All continuous variables did get a warning regarding subpopulations with zero frequencies, this problem could be solved by the use of only categorical variables. All significant individual models were put together in integral models, however none of these models could be used because of even more warnings. The last attempt for a model was done by step by step models, these models were made by manually putting variables in the model. Only three models which combined multiple variable groups could be made, and none of these included areal variables. Therefore the aim of the research, to combine areal and personal characteristics into a model, was not achieved.

Findings

The final model has three variables: 'Family Size', 'Public Transport Subscription' and 'Transport Mode'. The first two variables are personal, the last variable regards trip characteristics. When analyzing the part-worth utility of all variable's categories, the model does not seem to be very stable. However the model does not violate any of the assumptions regarding multinomial regression models. Due to lack of time and tools no hierarchic regression model was made.

CONCLUSIONS

Conclusions which can be made from the research, recommendations for future research and a discussion will be discussed in this final paragraph.

Conclusion

The methodology to develop a tool which determines and localizes potential bus users includes a model which regards the switching-behavior of travelers. This switching behavior can be extracted from personal variables, and areal variables are needed to link the potential to their location.

The final multinomial logistic regression model used three of these variables, regarding family size, public transport subscription and present transport mode. So, it can be concluded that these variables are significant for the estimation of the dependent variable 'Bus Potential'. However, the aim of the model was to combine personal, trip and areal

characteristics into the model, this was not succeeded. Probably the dataset used in this research is not fitting for the model, at least not for a multinomial regression model.

Public transport is often seen as an important solution to reduce air pollution, because of the lower emissions per passenger than an average car has. In Nuenen 61.2 of the non-bus trips, had potential to be changed to a bus trip, this is a very big opportunity for the public transport sector if these kind of numbers can be found in whole of the Netherlands. Therefore, the air quality in the Netherlands can probably be improved by the stimulation of public transport use.

As encountered very early in the modelling process the four position ZIP code scale was too gross and could not lead to a significant model for the bus-potential. A smaller scale should be used, in this research the six position ZIP code areas were used. However none of the bus related characteristics did initially have a significant effect on the model. This could be because very little areas have bus stops when using the six position ZIP code. For this reason perhaps medium scales for the areal variables could be examined, like neighborhoods.

Besides the scale of the areal characteristics, the usage of areal characteristics in the same level as personal behavior was doubted. To solve this a hierarchical model could be used, however due to time constraints and lack of tools such a model was not made during this research. The lack of tools refers to the software available via the university. Statistical models are usually done in IBM SPSS Statistical, but this is no ideal program for hierarchic models. HLM will be a more fitting program, but could not be figured out in the short amount of time available. However the hierarchic regression model could still be a good solution to create a fitting model for both areal and personal variables. The warnings about missing data will be solved this way because, hierarchic regression models can estimate parameters by the use of the available data.

Altogether, the research did show signals which were detected before by Waerden et al. In this research for 'Regionaal Openbaar Vervoer Bereikbaarheid Consumentgericht (ROVBECO)' ('Regional Public Transport Accessibility Consumer Oriented'), an attempt was made as well to realize a planning tool for bus potential. The model made by ROVBECO also contained only three significant variables (Waerden et al. 2009).

Recommendations

The first pitfall of this research was the missing of tools to perform a hierarchic regression model. So, the first recommendation will be to try to make such a model and see if more variables could be implemented in a model, and whether areal and personal variables could be combined in this way.

The second pitfall of this research was probably the dataset itself. It was from an enquiry which was done five years ago, the data was raw and many adjustments had to be made for the data to be useful in a model. After analyzing the data with the gulden standard showed the data did not really fit the actual population of the area. Next to this the bus potential was already specified, it was classified by whether a respondents thinks their non-bus trip could be done by bus. However, whether it is possible to take the bus, does not mean people will actually make this switch. Finally, the survey was held in Nuenen, a small village which can

be referred to as a car town. Because the village lies between the cities of Eindhoven and Helmond, many people live in Nuenen, but travel to the city to work. Nuenen does not have a very extensive public transport service yet. Therefore, if the first recommendation about the hierarchical regression model did not result in a better model, the advice will be to disregard this dataset and use other data to make a model. However, it is very time consuming and expensive to make such an extensive dataset as used in this research.

Probably the primary recommendation when investigating bus potential in the future is the use of open data. Open data continues to extend and it is available, so why not use it? The largest open data set about travelers behavior is the before mentioned 'Onderzoek Verplaatsingen in Nederland (OVIN)' (Travel Research in the Netherlands). Which is an annual research performed by the 'Centraal Bureau voor de Statistiek (CBS)' (Central Statistical Office from the Netherlands). However, the dataset does not individually discuss bus transport, but only bus/tram/metro. Next to this the research scale should be expanded, for example provincial scale, because of the limited amount of respondents.

Next to het OViN, new developments are made with open data in the field of traffic. November 2014 the first results of the 'Mobiliteitspanel Nederland (MPN)' ('Dutch Mobility Panel'), performed by 'Het kennisinstituut voor Mobiliteitsbeleid' ('Knowledge Institute for Mobility Policy'), the University of Twente and Goudappel Coffeng, were presented. This research does not only focus on present travel behavior, but aims to increase the understanding of factors which play a role in changing travel behavior. Therefore, this can be an opportunity to investigate switching-behavior towards public transport usage.

One of the main goals of the model was to combine areal and personal characteristics. However, multiple researches did not succeed in this. Maybe the areal characteristics should be disregarded and only personal characteristics should be considered.

The research is carried out because of an important social problem, air pollution. Therefore, the target to reduce private-car usage by the stimulation of public transport seems important enough to continue the research to develop a bus potential tool. Maybe the air quality problem will in the future not be as stressing as nowadays, because all transport continuously becomes more sustainable, and maybe in the future green transportation is achieved by the use of alternative fuels or electric driving. However, the stimulation of public transport can have multiple other positive effect on society. For example solutions for congestions, parking problems and livability of residential areas.

Finally can be concluded that this research did explore one path to make a bus potential model, the multinomial regression model. However many paths are still out there, ready to be discovered.

REFERENCES

- European Environment Agency, 2011. Transport. Available at:
<http://www.eea.europa.eu/themes/transport/intro> [Accessed May 5, 2014].
- European Environment Agency, 2014. Very high air pollution levels across Western europe. Available at: <http://www.eea.europa.eu/highlights/very-high-air-pollution-levels> [Accessed May 5, 2014].
- Field, A., 2013. Logistic Regression. In *Discovering Statistics Using IBM SPSS Statistics*. London, United Kingdom: Sage Publications Ltd, pp. 760 – 813.

- Health Effects Institute, 2010. *Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects*, Boston, Massachusetts, USA. Available at: pubs.healtheffects.org/getfile.php?u=553.
- Sugiki, N., Furusawa, K. & Aoshima, N., 2001. Location Behavioral Model Considering Transit Characteristics in Life Stage of Households. In *9th World Conference of Transportation Research, Seoul, Korea*. Gunma, Japan: Gunma University.
- Waerden, P. van der & Bérénos, M., 2010. *Houd Nuenen Bereikbaar; Verplaatsingsonderzoek Nuenen 2009*, Eindhoven, Netherlands.
- Waerden, P. Van Der, Bérénos, M. & Tromp, H., 2009. Regionaal Openbaar Vervoer Bereikbaarheid Consumentgericht. In *Colloquium Vervoersplanologisch Speurwerk*. Antwerpen, Belgium.
- Waerden, P. Van Der, Timmermans, H. & Bérénos, M., 2005. In search of the Public Transport Users : Towards Public Transportation Potential Maps. In *Transportation Research Board*. Washington D.C., USA.
- Zhou, Y. et al., 2004. Transit Customers – Who , Why , Where , and How : A Market Analysis of the San Mateo County Transit District. In *83rd Annual Meeting of the Transportation Research Board and Publication in the Transportation Research Record*. Chicago, USA. Available at: http://www.camsys.com/pubs/SAMTRANS_Market_Analysis.pdf.

H. (Hannely) Hortensius, BSc.



This thesis is the result of a six month graduation project carried out in collaboration with Eindhoven university of Technology and Bonotraffics B.V., innovative traffic consultancy. This report represents also the end of my five and a half years of studying at the TU/e, beginning with the bachelor program 'Bouwkunde' and finalized with the master program of 'Construction Management and Engineering'. The first I started for it combined technical and creative aspects, but it resulted in a master which concerns the process and project management of construction projects. I do not know yet where my career will take off and where it will lead me, I only hope I will keep doing what I love to do, and that I can keep learning all the way.

THE TRANSFORMATION OF CLIMATE-KIC INNOVATION PROJECTS INTO STARTUPS

Author: N.M.J.M. (Nathalie) Kerstens

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. Dr. Ir. W.F. (Wim) Schaefer (Chairman TU/e)

Dr.ir. I.M.M.J. (Isabelle) Reymen (Graduation Supervisor TU/e)

Drs. P.H.A.M. (Paul) Masselink (Graduation Supervisor TU/e)

M.J.G. (Anne-Marie) Spierings (Graduation Supervisor ARCADIS)

Date of graduation:

07-07-2014

ABSTRACT

Transforming Climate-KIC innovation projects into startups is a challenging solution for the problems that innovation projects currently face in reaching the goal of commercializing new products and services. This research identifies these problems by conducting interviews with innovation project managers, entrepreneurs from startups and business developers within the KIC environment. Based on this information, opportunities for the Climate-KIC regulation to facilitate the transformation are discovered and consist of an improvement of partnership regulation, intellectual property right administration, grant funding guidelines and lifetime regulation of the innovation project. The occurring problems cannot only be averted by improving the Climate-KIC regulation, but also by using the KICs FIT ME business model template designed in this research. This model is able to avert the problems that currently occur, even before the innovation project starts. It handles the commitment of partners, key value of the innovation, intellectual property regulation and stresses the need of an entrepreneur in innovation projects to reach the commercialization goal.

Keywords: Climate-KIC, innovation project, business model, startup

INTRODUCTION

Innovation is the key to economic growth and social well-being in the global knowledge economy we live in. The capacity of a society to innovate is crucial to compete on a global scale to solve emerging societal problems in this economy. In order to stimulate the development of innovations, Europe is facing a challenge to change the mind-set towards promoting an innovative and entrepreneurial culture. Despite excellent research institutes and dynamic companies, good ideas rarely reach the market in the form of new products and services. To stimulate the creation and commercialization of innovations and encourage entrepreneurship, the European Union has set up the European Institute of innovation and Technology (EIT) in 2008.

This institute is funded by the European Union and brings together leading knowledge institutes and companies to form dynamic cross-border partnerships to develop innovative products and services, start new companies and train tomorrow's generation of entrepreneurs. These partnerships for Knowledge and innovation Communities (KICs) and

are set up around key societal needs, being climate change mitigation (Climate-KIC), renewable energy (KIC Innoenergy) and the next generation of information and communication technology (EIT ICT Labs). Each of these communities is funded by the EIT to bring research, business and education together to work on the commercialization of new products and services. This can be done through the formation of new startups or with innovation projects, which consist of a collaboration between research and business partners that develop innovations together for a limited amount of time and launch these to the market.

Problem definition and research questions

Collaboration between research and business faces enormous challenges. Despite considerable government financing and support, the development of such partnerships has proven to be difficult and does not always lead to products or services that are necessary to grow the global knowledge economy (Boehm and Hogan, 2013). There is an increasing interest in Europe to fund the collaboration between knowledge institutes and business to create innovations. These types of funding have a positive effect on the commercialization outcome. However how the regulation of the European funding organizations improve the rate of commercialization is unknown. The innovation projects from the KICs also bring together knowledge institutes and businesses and they are funded by the EIT. If the funding from the EIT stops at the end of these projects, it is possible that they land 'on the shelf' without reaching the commercialization goal. A sustainable solution is therefore needed to ensure that at the end of an innovation project the developed innovation is brought to the market. Climate-KIC has acknowledged the opportunity to transform these projects into startups as a possible solution.

One of the innovation projects from Climate-KIC that ends in 2014 that has the ambition to be transformed into a startup to reach the commercialization goal is Eurbanlab. This innovation project deals with the challenge to accelerate innovative developments within urban areas to achieve low carbon, sustainable and resilient cities. Eurbanlab signaled there is a lack of attention on business models for research and industry collaboration in literature and therefore requested the design of a business model template for Climate-KIC innovation projects. This model should have a positive influence on the transformation of innovation projects into startups.

To determine how the Climate-KIC regulation can influence the transformation of innovation projects into startups and to design a business model template for Climate-KIC innovation projects, the following research questions need to be answered:

- How does the Climate-KIC regulation influence the transformation from Climate-KIC innovation projects into startups?
- What is an appropriate business model template for Climate-KIC innovation projects that also has a positive influence on the transformation of innovation projects into startups?

Research design

This research starts with a comprehensive literature study on technology commercialization and business models. Next a case study research is conducted for which the data collection is based on semi-structured interviews and Climate-KIC documents. The collected data is

analyzed to formulate opportunities for the Climate-KIC regulation in the transformation of innovation projects into startups. This analysis is used to design a business model template for Climate-KIC innovation projects. The practical use of this template is tested with the Urbanlab innovation project and guidelines for the implementation of this business model template in the Climate-KIC organization are further elaborated. With this analysis and design, conclusions are drawn and recommendations are made.

THEORETICAL FRAMEWORK

Technology commercialization

Technology commercialization is the process of translating research knowledge into new or improved products or services that are introduced into the market, with the goal to generate economic benefits. The global knowledge economy is characterized by fast technological change, high innovation speed, shortening product life cycles and increasing complexity of products. This has caused knowledge and research to become the center of the economy. Knowledge institutes are therefore also changing their position in technology commercialization and are no longer only focused on the traditional knowledge transfer through education and basic research, but also show more interest in entrepreneurial activities to contribute to economic development (Powers and McDougall, 2005).

Despite the increase in entrepreneurial activities from knowledge institutes, inventions arising from these activities are rarely immediately ready to be converted into commercial products and services. This is a difficult process that consists out of a number of activities, being technology development, product development and business development. Technology development improves the performance, usability and other technological characteristics. Product development involves the transformation of these technologies into a product and service that can be launched to the market and fits the customer needs. Business development is about other capabilities that are needed to develop, produce and sell the technology based products or services. Since the transformation to commercial products and services needs significant investment, development and market expertise, a collaboration between knowledge institutes and the industry can facilitate the commercialization of technology (Combs and Link, 2003).

This collaboration can take several forms, like for instance research contracts, know-how and patents under license, consulting and new venture creation. The projects that show cooperative research, rather than licensing the technology are most important for the knowledge transfer. These forms of collaboration are not very obvious; since both knowledge institutes and firms need to learn to cross their organizational boundaries and build the capabilities to work with partners with a different incentive system (Bruneel et al., 2010).

The project management is different for both parties; for firms the financial performance for a project is higher when it is managed in a formal and structured way, and is negatively associated with loosely managed projects. For knowledge institutes this is the other way around, giving these projects an extra challenging dimension.

Both parties also have different goals and incentives for cooperation, which could lead to conflicts and can make the collaboration possibilities harder. When making policies of

collaborating, both the knowledge institutes and businesses need to create incentives for both actors to cooperate. Current policies are mainly made up to create incentives for collaboration, with no acknowledgement that in the absence of a market demand, little will be achieved. It is therefore important to address an innovation that fits the market. Publicly funded research programs could offer a solution to the challenges that these types of collaborations currently face. These research programs should bring together key partners to create innovations that address predefined market demands. Together with a framework for regulations on developed intellectual property rights and project management, publicly funded research projects could increase the commercialization of technology. In this way the EIT and the KICs offer a good platform to support the creation of new products and services.

Business models

Research has shown that business models are the key to the success of a business (Amit and Zott, 2001). These business model concepts typically capture the sources of costs and revenues together with descriptions of the products, services, market participants and the value chain position with the customers' and suppliers' benefits. However, the theoretical foundations of the business model concept still display some inconsistencies in the underlying assumptions and the term 'business model' has been used for many different terms from management literature. A central focal point in these definitions is the attempt to define business models as a term within the business' strategy.

Once a design of this business model is set, it is difficult to change due to inertia and resistance of change of the involved parties. It is therefore important to use an appropriate business model template at the start of a project that fits within the strategy of the organization. To capture, visualize and understand the organization logic in an easy and structured way, business model concepts are designed (Osterwalder and Peigner, 2010). In this research the business model perspective is examined with the 'Osterwalder business model canvas', due to the practicality and clearness of the model and the fact that this model is used within Climate-KIC to discover business opportunities for innovation projects. The Osterwalder business model canvas is visualized in figure 1 and consists of nine different building blocks, which are explained in table 1.

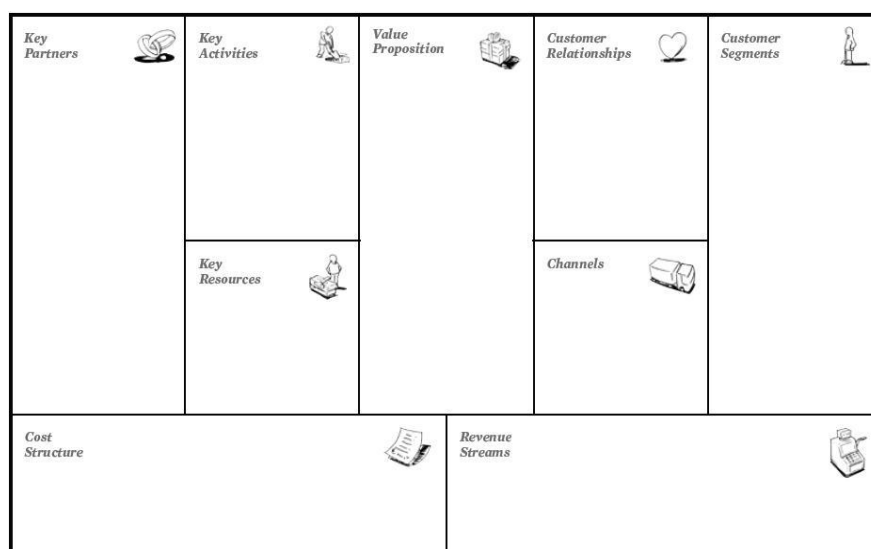


Figure 1 Osterwalder Business Model Canvas (Osterwalder and Peigner, 2010)

Table 8 Building blocks of the Osterwalder Business Model Canvas

Building blocks	Explanation
Value proposition	The value proposition identifies the design, price, cost reduction, risk reduction, accessibility and convenience when using or buying the product or service. It describes the product in a way that customers are satisfied with the product and that it creates value for them.
Customer segments	The center of all business models is the customer. To satisfy the needs, a business needs to know the potential customers and have a grip on their social, financial and geographical situation.
Channels	Channels have the purpose to create awareness of the product or service among the customers, can handle evaluation on the delivered value and are a mean for purchasing and delivering the product or service and handles after sales services.
Customer relationships	Customer relationships can be identified in different ways for specific customer segments. This can be for example personal assistance, self-service, automated services, communities to help solve each other's problems and co-creation, which consist of creating value together with the customers (e.g. YouTube).
Revenue streams	The revenue streams determine the strategy a business uses to generate cash from each customer segment.
Key partners	For determining the key partners it is necessary to know what the partners deliver and what the business has to do in return.
Key resources	The key resources are meant to create value for the customer. They are key assets for business operation and can be physical, intellectual, human or financial resources.
Key activities	The key activities consist of the actions to keep the business model running and to execute the value proposition. Examples are: production, problem solving, consultancy or networking.
Cost structure	This building block represents the costs for running the business.

When identifying the main three factors of interest for the design of a business model, the content, structure and governance are crucial (Bock et al., 2011). The content reflects the selection of activities within the project. The structure describes how these activities are linked together and governance reflects on which parties lead the activities. The Osterwalder business model canvas is suited to capture these three factors for startups. The canvas is also used for innovation projects, however due to the complex nature of the governance structure of these projects and the heterogeneous partnerships, this canvas might not be the basis of an appropriate business model template.

CASE STUDY RESEARCH

An exploratory case study research is conducted to analyze how Climate-KIC regulation has an influence on the transformation of Climate-KIC innovation projects into startups. The data that is collected consists of semi-structured interviews among innovation project managers, entrepreneurs from startups and business developers within the three KICs. The quality of this research is improved by determining the reliability and validity of the data collection.

The conducted interviews and documents from Climate-KIC, EIT and other European institutes, form the base to perform the data analysis. The analysis of the quantitative interview data consists of a grounded theory approach, based on open coding, theoretical coding and selective coding.

ANALYSIS OF THE CLIMATE-KIC REGULATION OPPORTUNITIES

The analysis points out that the Climate-KIC regulation still has room to improve in order to facilitate the transformation of innovation projects to startups. Interviews with innovation project managers, entrepreneurs from startups and business developers have brought to light the opportunities that Climate-KIC has in terms of regulation about partnerships, intellectual property, funding, the lifetime of the innovation projects and the involvement of a business coach. The current Climate-KIC partnership regulation does not always include organizations with relevant specialized knowledge to create new products or services as a partner of innovation projects. This has an influence on the transformation into a startup, since new products or services form a commercialization base of a startup. Most of the times the specialized organizations are SME's with limited financial means. An opportunity to involve these parties in innovation projects could be to create a funding program to support the SME's to develop the innovation. To middle out the financial investment of the other partners of the innovation project, they could receive shares on the developed innovation.

The Climate-KIC intellectual property regulation has an influence on the transformation of innovation projects into startups, because this regulation can hinder the commercialization of new relevant products and services, which is the base for a startup. An opportunity to solve this is handing over all created intellectual property to the startup that is formed after the termination of the innovation project. All the partners from the innovation project consortium would then receive shares of this startup. These shares are based on the commitment of each partner and input in the innovation project.

For the funding regulations another system can be used that is much more attractive for Climate-KIC, as well as for the partners. Instead of refunding partners for worked personnel hours, travel and accommodation costs, the funding should be based on deliverables. If the partners are fully responsible for these overhead costs and are being paid for delivered quality instead of the worked hours, the quality of the innovation will be higher for Climate-KIC, also meaning higher potential revenues for the partners. This has a positive effect on the transformation of innovation projects into startups, since this delivers higher quality products and services that can be commercialized.

The lifetime of an innovation project represents the time that the consortium partners of an innovation project have to develop new products or services. It is not always viable to create innovations that are ready to be commercialized within the scope of an innovation project. This has a negative impact on the transformation into a startup. To ensure viable products or services, the innovation projects should be preceded by Climate-KIC pathfinder projects. These projects cost significantly less than the innovation projects and are created to investigate whether there is a market demand for the innovation in question. If there is no market demand, the project can be terminated without wasting valuable EIT funding.

A last good opportunity for Climate-KIC to have a positive influence on the transformation of Climate-KIC innovation projects into startups is the intense involvement of a business coach from the start of an innovation project. If these are involved, a better view on the market potential is obtained and the scalability options in Europe are clearer. The business development can support the innovation project managers in all problem areas they face in creating a sustainable business from this innovation project.

DESIGN OF A BUSINESS MODEL TEMPLATE FOR INNOVATION PROJECTS

The business plan of 2014 for Climate-KIC has as a point of action to focus more on the business model for innovation projects to ensure ideation leads to commercial application and success. The business model that I designed is visualized in figure 2 and is called the 'KICs FIT ME' model. The five main building blocks are: Finance, innovation, Team, Market and Entrepreneur. The four problem points are Key value, IPR, Commitment and Sales. These are further elaborated in table 2.

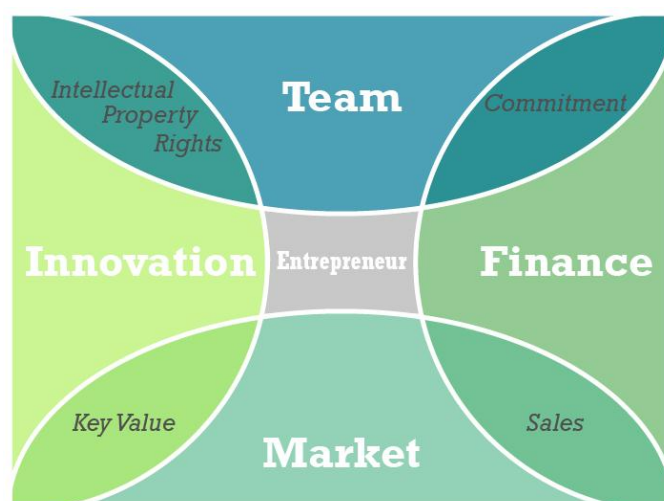


Figure 2 KICs FIT ME model

Table 2 Explanation of the KICs FIT ME model

Building blocks	Explanation
Key value	The market with the customers and the created innovation must have the overlap that the innovation addresses a need from the customers. To get insight to see if the innovation really solves one of their problems or needs, customer research is done by addressing potential customers.
IPR	The problems for the intellectual property arrangements of the innovation projects can be solved by stating in the consortium agreement that all intellectual property will be handed over to the startup after the termination of the innovation project. All the partners in the innovation project could then receive shares of this startup, that are based on annual reporting of their commitment and input in the innovation project.
Commitment	One of the first challenges at the beginning of an innovation project should be to ensure that all partners bring a relevant investment in the project according to their own incentives and the common goals of the project. This means that the different parties need to collaborate and invest in long-

	term relationships to overcome barriers in time, place and academic disciplines to create a maximum synergy between all parties. It is also necessary to trigger sufficient trust among the partners and create an organizational structure with an intelligent performance indicator system to ensure the success of the project. The commitment for the launch of the startup should take a center role. Who is responsible for financial support after the innovation project ends if the startup cannot be a self-sustaining business yet? A plan should be set up on how this startup will be financed and which partner will be responsible for the search of investors, paying customers, grants, etc.
Sales	It is important to create a self-sustaining business, so before creating the innovation, the team should ask themselves: are customers going to pay for this innovation? How can revenues be created? It is important to create something the market is going to pay for.
Finance	The financial input of the different partners remains the KIC Added Value Activities and KIC Complementary Activities that are registered for each partner in the annual Partner Grant Agreement. However, it would be more interesting to refund the partners based on their deliverables instead of worked hours of personnel, etc.
Innovation	The product or service that is developed needs to be an innovative climate-relevant solution that has the ability to be launched to the market in the form of a self-sustaining economic activity after the innovation project ends. It is created based on research of the university or knowledge institute and supported by the marketing skills and customer knowledge of the industry and needs to fulfill the Climate-KIC quality criteria for innovation projects.
Team	In order to create an innovative climate-relevant solution that has the ability to be launched to the market in the form of a self-sustaining economic activity, it is important that the collaboration between the consortium partners is good enough to form a solid base for the creation of a startup. The individual representatives from the different partners in the consortium of an innovation project have an important effect on the collaboration, since one of the most prominent factors that predicts a successful university-industry interaction is related to inter-personal exchanges.
Market	When searching for market opportunities, next things should be kept in mind: what are the market needs, what is the size, who are the competitors and is there growth potential (Blank and Dorf, 2012)? Since this business model template is used for the creation of new innovative products and services, it is hard to know if there are really customers for the developed products and services and thinking in terms of solving the customers problem, it is interesting to know why competitors did not already address it and why the problem is so hard to solve.
Entrepreneur	There is a need for an entrepreneur to take the innovation project to a startup. There are different opinions regarding what type of person this should be. However, some common characteristics are necessary to be fulfilled in

order be successful. First it is necessary that it is someone that knows the market and has marketing skills to bring the product/service to the market. This person should be a member of the team from the beginning and have leading skills to guide the team. The most important aspect is that this person needs to be technical; a technician can be taught how to do marketing and finance, but the other way around is much harder and maybe even impossible. It might be challenging to find people like this, however if someone is involved in the beginning of the project, this person can be trained in the skills he or she lacks. In this way the entrepreneur has the chance to develop himself during the lifetime of the innovation project in order to prepare to lead the startup. A nice opportunity could be to provide Climate-KIC master students and PhD students with entrepreneurial training and in a later stage involve them in the innovation projects to make them ready to be the next generation of entrepreneurs.

This model was validated with the Eurbanlab innovation project, which is ending in 2014 and has the ambition to be transformed into a startup. Since the KICs FIT ME model captures the problems that Eurbanlab is facing in becoming a startup, this could be an appropriate business model template for the research industry collaboration of Climate-KIC innovation projects. More research on other innovation projects is needed to support the validity. Within the scope of this research it was only possible to perform one test case. The implementation of the KICs FIT ME model in the Climate-KIC organization is also examined and the result is that this can be done relatively easy. There is time enough to brief the partners of the organization on how this model works and what the purpose is.

CONCLUSION & DISCUSSION

Transforming Climate-KIC innovation projects into startups is a challenging solution for the problems that innovation projects currently face, regarding the commercialization of new products and services. At the moment the Climate-KIC regulation has a negative influence on this transformation, due to the restricted partnership regulations, intellectual property right administration, grant funding guidelines and lifetime regulation of these innovation projects. The KICs FIT ME business model that is designed within the scope of this research can be seen as an appropriate business model template for the research and business collaboration in Climate-KIC innovation projects. This template has a positive influence on the transformation of Climate-KIC innovation projects into startups, since it addresses problems that the innovation projects are currently facing in this transformation. Climate-KIC innovation projects are publically funded collaborations between research and industry partners for a limited amount of time. Since the innovation projects of KIC Innoenergy and EIT ICT Labs are based on the same characteristics, the KICs FIT ME model can be generalized for this purpose and can also be used for these innovation projects.

The commercialization through a startup is not the only commercialization option and forming a startup is not a specific goal for these innovation projects. It would therefore also be interesting to explore other options, like having the commercializing partner within the project consortium or licensing the intellectual property to Climate-KIC, who can then chose a partner or startup to commercialize it. The influence of the formal and informal organization within the KICs might also be a challenging topic to explore, due to the

statements of the different interviewees regarding the importance of this subject. A last interesting topic to examine is the viability of the KIC organizations, since it is alarming that Climate-KIC has to cut costs due to increasing debts. How does this influence the future of the organization and what is a sustainable solution to solve this challenging financial burden?

REFERENCE

- Amit R and Zott C (2001) Value creation in e-business. *Strategic Management Journal*, 22, 493–520.
- Blank S and Dorf B (2012) *The Startup Owners Manuel*. K & S Ranch.
- Bock A, Opsahl T, George G, et al. (2011) The Effects of Culture and Structure on Strategic Flexibility during Business Model Innovation. *Journal of Management Studies*, 49(2), 279–305.
- Boehm DN and Hogan T (2013) Science-to-Business collaborations: A science-to-business marketing perspective on scientific knowledge commercialization. *Industrial Marketing Management*, Elsevier Inc., 42(4), 564–579.
- Bruneel J, D’Este P and Salter A (2010) Investigating the factors that diminish the barriers to university–industry collaboration. *Research Policy*, Elsevier B.V., 39(7), 858–868.
- Combs K and Link A (2003) Innovation policy in search of an economic foundation: the case of research partnerships in the United States. *Technology Analysis & Strategic Management*, 15(2), 177–187.
- Osterwalder A and Peigner Y (2010) *Business Model Generation*. John Wiley and Sons Ltd.
- Powers JB and McDougall PP (2005) University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship. *Journal of Business Venturing*, 20(3), 291–311.
- Shane SA (2004) *Academic entrepreneurship: University spinoffs and wealth creation*. Edward Elgar Publishing.



Nathalie Kerstens

nathalie.kerstens@hotmail.com

After finishing the master of industrial building sciences in Belgium, I wanted to broaden my horizon and focus more on the management of construction projects. The master Construction Management & Engineering enabled me to do so and also gave me the opportunity to explore the world of research and industry collaboration. This thesis gains insight in the complex KIC organizations and contributes to policy formation in this field.

- | | |
|-------------|--|
| 2007 – 2011 | Bachelor & Master Industrial building sciences (Association KULeuven, Belgium) |
| 2012 – 2013 | Technology entrepreneurship & Technical Management certificates (TU/e) |
| 2012 – 2014 | Master Construction Management and Engineering (TU/e) |
| 2014 – Now | Internship at ARCADIS for the Climate-KIC innovation project ‘Eurbanlab’ |

MOTIVATING CITY-COMMUTERS TO CARPOOL

Exploring the stimulus of various factors and policies

Author: A. (Andreas) Lem

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. dr. ir. W.F. (Wim) Schaefer

Dr.ing. P.J.H.J. (Peter) van der Waerden

Ir. A.P. (Peter) Baas

Date of graduation:

15-07-2014

ABSTRACT

Congestion on urban main roads occurs due to a limited infrastructural capacity as compared to the supply of vehicles. Two action plans exist to reduce the magnitude of congestion issues on urban main roads: reducing the supply of vehicles and thus the demand for infrastructure, or expanding the size of the network's capacity by constructing new roads. Since space scarcity is opposing a problem in densely populated urban centers, the first option is considered a more promising alternative in this context. Reducing the supply of vehicles can be achieved by combining trips and increasing the average vehicle occupancy. Factors and policies are studied that affect the commuter's travel mode. Incentives for carpooling (sharing vehicle capacity) and the link with travel time (uncertainty) savings caused by a reserved high-occupancy-vehicle lane are researched. Travel time, waiting time and trip costs have the most (negative) impact on the probability that carpooling is chosen as the travel mode. A tool is created that is able to predict the proportion of commuters that will carpool when certain physical facilities, policies or a combination of the two are in place.

Keywords: carpooling, urban congestion, average vehicle occupancy, multinomial logistic regression, stated adaptation, Eindhoven

INTRODUCTION

In this study, structural bottlenecks on the outskirts of the city, where multiple provincial roads and highways converge, are of main focus. Various trends in The Netherlands give cause to the belief that congestion problems will continue to grow in the coming years. Car ownership and use of private motor vehicles is growing and recent active carpool policies failed. At the same time, the attention for sustainable ways of transportation is widely increasing. Most private cars are occupied by a single person, meaning a high amount of underutilized capacity. In this study ways to motivate travelers to change their travel habits are identified. As many different factors and public policies affect travel patterns, this study tries to estimate their relative importance.

Problem definition

The trends described in the introduction are expected to result in an increased level of congestion, which in turn lead to increased travel times (uncertainty), increased vehicle

emissions and nuisance, reduced urban accessibility and a decrease in the level of environmental quality and available green space. Especially when new infrastructure is to be constructed, scarce urban space will need to be used. As the level of congestion will drop, travel times are reduced and more people will as a result make use of the newly created infrastructure, leading to a new equilibrium with a fixed intensity/capacity level. Clearly, this is not the right way forward (think of land scarcity, air pollution and energy use issues). Therefore, the focus of this study is on improving the utilization of existing – unused – capacity to reduce congestion. The exact problem definition can be described as follows:

‘A low average vehicle occupancy causing congestion on urban main roads’

As policies aimed at stimulating the use of public transport are not achieving their desired effects, some intermediate form of transportation (between driving alone, associated with privacy and freedom, and driving with a group of strangers, associated with dependency and discomfort) will have the best chances in solving congestion problems (whether combined with the aforementioned types of transportation or not). Carpooling and car-sharing are two examples. However, the everyday potential and effect of carpooling will be much larger than car-sharing. Carpooling is a way of sharing already available capacity of commuting vehicles (which are mainly responsible for congestion issues). It combines multiple trips that would have been carried out independently into one single trip. As carpooling fills this already available capacity, the average vehicle occupancy of cars that are currently on the road. This will result in fewer cars on the road and a smaller requirement for infrastructure.

Research questions

The research objective of the report is to study which factors can stimulate city-commuters to carpool in order to increase the average occupancy rate of vehicles. As a result, the amount of vehicles per piece of infrastructure (intensity/capacity ratio) is reduced. The main research question that corresponds with the identified research objective is:

‘What are the most important factors influencing the travel mode choice made by city-commuters, between solo driving and carpooling?’

Sub-research questions are derived to find an answer on the question above, of which some will be answered mainly by literature, and other questions will be dealt with based on survey results or by using the created tool for predicting the number of carpoolers for a specific case-study. These questions are at a lower abstraction level and focus on defining carpooling with its main characteristics, stimulating factors and policies, and the definition and benefits of a HOV lane. Furthermore, hypotheses regarding the expected importance of trip characteristics are derived.

Research structure

In the first chapter of the thesis, some general trends in the recent past and for the short-term future of the Dutch mobility sector are sketched. The current importance of reducing congestion issues and its negative effects on the environment and economy is emphasized. ‘Sustainabilizing’ today’s transport is the right way forward, since this sector is responsible for a large part of the national CO₂ and NO_x emissions. The same chapter describes the research objective, research questions, hypotheses, limitations and used methodologies.

The report continues with a literature review that focusses on urban congestion, structural bottlenecks, carpooling typology, and researches important motivation factors for commuters to switch to carpooling. As the HOV lane is expected to be such an important factor in this light, an elaborated review of these lanes including its characteristics, implementation examples and success and failure factors of implementation are presented.

The next chapter explains the discrete choice modeling methodology and applies it in the context of this study. A stated adaptation based questionnaire is developed in which respondents are asked to make a choice between their current trip and making the same trip in carpool formation. The questionnaire development, selection of respondents and data collection processes are presented. Expected results are formulated as well. In the following chapter, the obtained data is analyzed and a sample description is given. Analysis of the stated adaptation results is carried out by estimating a multinomial logistic model, which describes the relative importance of all identified variables on the choice behavior of commuters to select their commute travel mode. These estimates are subsequently compared to figures obtained from literature sources. The obtained estimates of the MNL model are the basis of a created tool that is able to predict the proportion of commuters that are motivated to carpool for any case-study. This case-study should be a large Dutch city currently encountering congestion on its main roads. The tool can predict the effect on the number of carpoolers of for example a travel time saving in minutes due to HOV lane construction to the city center. From this predicted switch from driving solo to carpooling, and knowing the origin-destination pairs of commuters, the reduction in vehicle kilometers traveled can be calculated, together with the effects of this reduction of both trips and total kilometers traveled on the level of vehicle emissions.

The two final chapters present a conclusion of the report, including an answer on the research questions and hypotheses. A discussion is started on the subject questioning the assumptions that were done during the study, its (prediction) results, expectations, and a trade-off of investment – benefits of a HOV lane, when it is to be implemented. Limitations and recommendations for further research and recommendations for potential applications the study results can be of added value are discussed.

THEORETICAL FRAMEWORK

The literature review build on the problem background as sketched in the introduction. The section is basically divided into two main parts: urban congestion and bottlenecks, and carpooling. These two constructs will be separately explained below.

Congestion

Congestion is defined as *'an excess of vehicles on a roadway at a particular time, resulting in speeds that are slower than the normal or free flow speed'*. Direct effects of congestion for its users consist of a loss of time and increased travel time uncertainty. However, indirect effects like nuisance for local residents, decreased accessibility of the urban center for local municipalities, and lost time (which can be translated in money) for the national economy are also a result. A wide variety of causes exist for congestion to occur, which can be grouped to i) traffic-influencing events, ii) variations in traffic demand and iii) physical infrastructural features (also known as structural bottlenecks). Potential solutions for reducing congestion and its negative side-effects range from increasing infrastructure

capacity to decreasing the supply of vehicles. The option of adding capacity is often hampered by either a lack of resources, a lack of space, or environmental or political issues. Therefore, other solutions to change the demand for infrastructure by decreasing the total amount of vehicles on the route in a certain timespan have been proposed in literature. These include: charging peak-time tolls, using intelligent transportation devices, restricting the outward movement of new developments, stimulating transit oriented (parking) programs, and creating HOV lanes. Many of these options are focused on increasing the average vehicle occupancy of vehicles by motivating people to drive together. To make this solutions work, car-sharing or carpooling has to be stimulated.

Carpooling

Different definitions of carpooling exist. In The Netherlands, a person is considered a carpooler when he or she drives at least two times a week to work, in one vehicle, with other occupants that are also on their way towards work. Two main groups of carpoolers can be identified: internal or fam-pooling, and external carpooling. The latter excludes household or family members driving together in one car as to be labeled carpoolers. Hitchhiking, slugging, flexible carpooling, real-time ridesharing and traditional carpooling are different forms of external carpooling. As can be seen, many different forms of carpooling exist. However, literature sources do present some general characteristics. On average, carpoolers work full time, are living further away from their work location as solo drivers, are mainly originating from densely populated areas with a bad public transport connection, have a lower education level and income as solo drivers, drive a less expensive car, have a hard time finding a parking spot and are originating from households with low levels of vehicle ownership. Commuters assign different values to various stimulating factors for carpooling, therefore, a wide variety of factors need to be studied and targeted to motivate commuters to carpool.

The most important carpool stimulating factors that are influencing or can be combined with this physical possibility to stimulate carpooling are identified. A total of eight variables grouped in three larger constructs are established. Travel time to and waiting time at the meeting location is the first variable, which is an aspect of the pre-carpool trip. The minimum required number of occupants to drive on the HOV lane, travel time in the carpool vehicle, travel time uncertainty, costs of the trip, and flexibility of the carpool travel times can be grouped as aspects being part of the actual (carpool) trip. The parking situation (distance and ease of finding a parking place) and availability of a car or bike at the work location are labeled as aspects belong to the after-(carpool) trip or at the work location. In figure 1 all attributes are displayed.

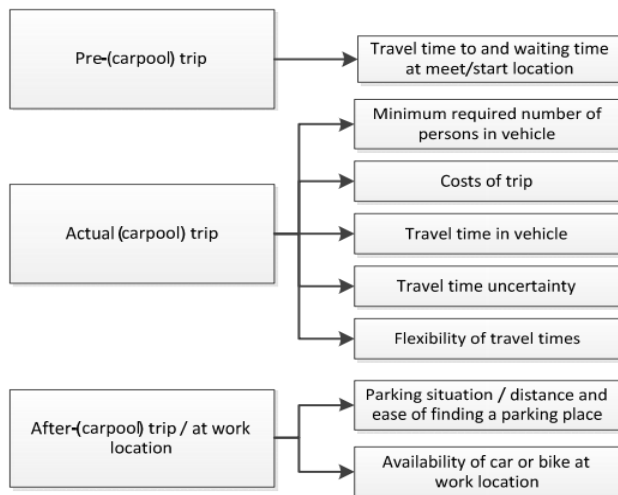


Figure 1: Identified important variables in stimulating commuters to carpool

RESEARCH METHODOLOGY

To study the importance of carpool stimulating factors in the perceptions of commuters currently driving solo in their vehicle towards work, multiple techniques are used. The literature review as explained in the previous section was the first step. The report continues with using the constructs identified from literature sources and expert interviews to create a stated adaptation based questionnaire, in which respondents are asked to choose if they would solo drive or carpool to work when different trip characteristics are presented. Those trip characteristics are created by using the identified variables and predetermined levels. Stated adaptation leans on the theories of discrete choice modeling and random utility theory. All mentioned techniques are shortly discussed.

Discrete choice modeling

This technique attempts to model the decision process of an individual in a particular context. In this case, the available alternatives the respondent can choose between are driving solo and carpooling. Discrete choice modeling enables the use of an experimental design to reduce the number of choice profiles that need to be surveyed to capture all relevant scenarios and combination. In this report, a fractional orthogonal design was used. Using discrete choice modeling enables implicit coefficient to be estimated for attributes. It reduces the possibility of a respondent to behave strategically and therefore it can be used to estimate the value of the carpooling alternative in the perception of the respondent. Outputs of the discrete choice model are a utility model equation and a set of marginal utilities for each identified attribute of interest, describing the relative importance of each variable. In figure 2 below, required input data and decisions are displayed together with the outputs the discrete choice model delivers.

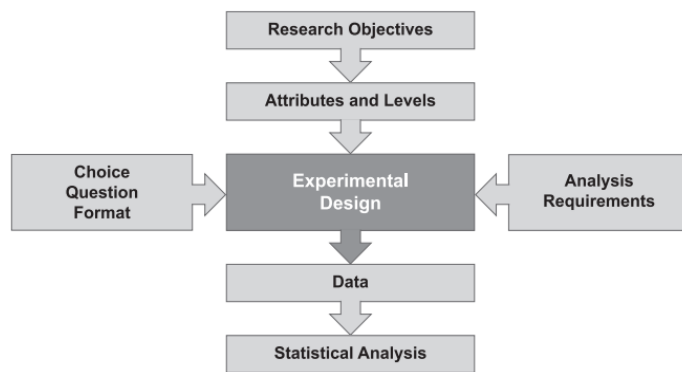


Figure 2: Key stages for developing a discrete-choice experiment

Two mainstream discrete choice based research types can be identified to carry out effective behavioral research on the potential effects of their choices. Revealed preferences (RP) observes actual behavior of the respondent, whereas stated preferences (SP) asks what a respondent would do in a fictitious situation. The method that is used in the report, i.e. stated adaptation is largely based on this latter type, as explained in the next paragraph.

Stated adaptation

Stated adaptation presents choice experiments in which one alternative that the respondent can choose is based upon information of the current commute trip he or she is making, provided at the first part of the questionnaire. This alternative does not differ between the choice profiles. The other alternative that is presented is the carpooling alternative, in which the levels of the various identified variables are altered. The respondent compares both configurations to what best fits his or her preferences. The central question in the presented stated adaptation based survey is (xxx Arentze, et al., 2003):

“Would you, as a consequence of the presented scenarios with corresponding parameters, choose [carpool option] instead of your current mode of travel, for conducting your home-work trip? How would you rate [carpool option]?”

The study assumes answers on the above questions are given by respondents on the basis of random utility theory, which entails a maximization of their individual utility.

Questionnaire development

The developed questionnaire consists of four main parts. The first is about asking respondents how they are currently commuting. Their current travel mode, travel distance, costs, type of car, current carpool frequency, etc. are captured. In the second part of the questionnaire, respondents are presented the stated adaptation choice tasks. To develop this part of the questionnaire, a choice needs to be made on the model type that will later be used to estimate variable’s importance. In the report, a multinomial logistic model will be used. Two labeled alternatives (driving solo and carpooling) are considered, and eight attributes with three levels each. This resulted in a total of 6,561 choice tasks to be evaluated by respondents, which could be reduced to 27 by employing an orthogonal design. The 27 choice tasks were divided over three choice sets. Effect coding was used for the ordinal variables.



Figure 3: Illustration of the carpool alternative in the stated adaptation choice situation

The third part of the questionnaire captures attitudes of respondents towards five main aspects: organization and formation of the carpool trip, characteristics of the carpool trip itself, psychological factors of carpooling, economic factors of carpooling and characteristics of the special HOV lane. This information can be used in later studies to segment commuter groups and to build separate models for each segment. The last part of the questionnaire captures socio-demographic factors like gender, age, city of employment, car availability in the household, etc.

Data collection

As the questionnaire had a quite strict target audience, selection questions to determine if a respondent belonged to the target group were necessary at the beginning of the questionnaire. Only respondents were selected that work in a relative large city (>75.000 residents) which is not the city they live in, and drive at least one time per week to work alone in a private motor vehicle. The questionnaire was sent out to commuters working in large cities all over The Netherlands. Datasets from different sources (personal network, company's network and other sources) was combined and the dataset was cleaned by removing extreme outliers.

Analysis of the data

Basic findings include an average commute time between 20 and 40 minutes and a scheduled extra time for uncertainties between 5 and 15 minutes. When a parking spot is difficult to find, travel time uncertainty increases. The safety and comfort of the trip is valued as being very important when choosing the travel mode. 38% of all respondents did never choose the carpool alternative. From this it can be concluded that a certain amount of commuters will never be motivated to carpool. Reasons can be a strong attachment to the luxury and privacy of the private car, or the 'impossible' nature of their job to carpool.

Two different MNL models are estimated. The first uses effect coding for all identified attributes, since pre-defined levels for variables were used. This is the more traditional method as substantiated in literature. In this model the utility for the solo alternative is fixed at zero, making the coefficient estimates for all attributes in the carpool alternative totally relative to the solo alternative. Since the scale of this model corresponds closely to the scale of values that can be realized in real life, it is possible to directly compare coefficients as displaying the importance of the different variables. Results that can be derived from this model, the travel time and waiting time at the meet location is the most important factors influencing the choice of commuters to carpool. Secondly important is the actual travel time in the carpool vehicle. Subsequently, costs of the trip, the parking situation and policy in place and the level of flexibility in travel times are important. Less important are the required minimum number of persons in the carpool vehicle, the uncertainty in the travel time and car or bike availability at the work location. As the variables in the carpool

alternative are derived from the current (reference) commute trip, these variables can take any value. The second model uses the exact figures as presented to the respondent, instead of the percentage levels in the effect coded model. The model is estimated on the basis of these values, resulting in coefficient estimates that reflect an increase of 'one' in the considered variable. The estimates of this model are displayed below in figure 4.

Variable name		SOLO	CARPOOL
Alternative specific constant		Fixed (0)	-0.953
Travel and waiting time start location		Fixed (0 min)	-0.0760
Travel time in (carpool) vehicle, main route			-0.0626
Uncertainty in travel time			-0.0562
Costs of trip			-0.0923
Number of persons in vehicle		Fixed (1)	-0.0209*
Parking situation at work location	Good	0.392	0.130
	Average	-0.194	0
	Bad	-0.198	-0.130
Car/bike availability at work location	Car or bike	Fixed (car)	0.0855*
	Bike only		0
	None		-0.0855*
Flexibility of travel times	High	Fixed (high)	0.138
	Average		0
	Low		-0.138
Null log-likelihood: -2158.460			
Final log-likelihood: -1638.512			
<i>* means insignificant effect level at 95% confidence level</i>			

Figure 4: Estimates for the MNL model in which original attribute values were used

Tool development and application

For application purposes it is possible to use the model's results for predicting the proportion of carpoolers for a specific case-study. This is because input data that is available for each case-study consists of distances, travel times and the number of trips. This data is expressed in kilometers, minutes and numbers. Filling in these values in the MNL model estimation results in a utility for a specific commuter, originating from a location with a specific distance and travel time to the city center and when certain parking and other policies are in place. This utility can be translated into a probability that he or she will choose to carpool. As the number of trips from each origin to each destination is known, the total carpool trips from a certain geographical zone to the city center can be calculated. Since origin-destination pairs and distances are known, a total reduction in vehicle kilometers traveled and thus vehicle emissions can also be predicted. First a universal model is created, which can be applied to any case-study resembling a large city in The Netherlands. The tool that is created in the study is applied to the implementation of a HOV lane at the Noord-Brabantlaan in Eindhoven, The Netherlands. Since bus lanes already exist at this location, investment costs are expected to be low. However the intensity on the bus lane that is currently reserved for busses only will increase drastically as a result of allowing HOVs on this lane as well. Other implications exist as when a bus requires stopping at frequent intervals and the current priority that is given to busses. When all HOVs on this lane receive priority at junctions, the normal functioning of junctions will be seriously hampered. Reducing the original travel time by 50% motivates 128 commuters driving solo in the current situation to carpool (15%). When the parking situation is improved to good (e.g. a reserved parking location close to the work location) this motivates 12% to carpool, and changing the meet location can motivate up to 26% of current solo drivers to carpool when the location is at the home of the commuter. Also, a combination of the most optimal

attribute levels is studied, resulting in a theoretical maximum of 57% of respondents that can be motivated to start carpooling for the Noord-Brabantlaan case-study.

Results

A standard aversion for carpooling exists in the perception of city-commuters; this negative utility for carpool equals -1.06. This value is derived from the alternative specific constant in the MNL model. This value represents the basic utility level if no other factors are considered. A negative utility of -1.06 can be translated into a change that someone driving in a private car to work will carpool of 26%; meaning 74% will drive solo. 38% of all commuters state it is not possible to carpool or they will never be motivated or willing to carpool, this corresponds to about the same percentage as found in literature. As stated, the most important variables that have been identified in this study that influence the decision to carpool are (in order of most to least important): travel and waiting time at/to carpool meet location, actual travel time in (carpool) vehicle, costs of the trip, the parking availability and distance at work location, and the level of flexibility in travel times. Not significantly important are: the number of required persons in the vehicle (minimum occupancy level), the availability of a car or bike at the work location, and (reduction of) uncertainty in travel time. In the stimulated base scenario, the average vehicle occupancy is 1.12, in the most optimal scenario this level can be increased up to 1.41 people per private vehicle. The stimulating effect of separate policies (HOV lane with travel time savings, parking policy, number of persons) on the achieved number of additional carpoolers relative small (AVOs between 1.14 and 1.19 compared to the original 1.12) however combined with other facilities this effect (and the proportion of carpoolers) can be increased. Vehicle kilometers traveled savings of 20% to 50% can be achieved by motivating sufficient commuters to carpool and when meeting closer to home (i.e. traveling largest proportion of commute trip in carpool formation). This VKT savings can be directly translated in about the same degree of savings in CO₂ and NO_x emissions caused by road traffic.

CONCLUSIONS AND RECOMMENDATIONS

Since a more sustainable approach in reducing congestion issues is desired and urban space is becoming scarcer due to increase urbanization, reducing the amount of vehicles by raising the average vehicle occupancy is the right way forward. Carpooling is an intermediate form of transport between the luxury private car with feelings of freedom and flexibility associated with it, and the public transport system which is not utilized at the desired level due to its unattractiveness. Carpooling combines both methods by keeping some form of independency while at the same time increasing the average vehicle occupancy. Physical, political, procedural and fiscal measures exist that are able to stimulate carpooling of which the most important are travel, waiting and deviation time, and cost reduction. A HOV lane can be an extra stimulus by avoiding congested roads and achieving free flow speeds and priority at junctions. A tool is created that can predict the proportion of commuters that is motivated by different factors and policies to carpool, which can at the same time estimate total vehicle kilometer traveled and emissions reductions. Municipality and traffic advising agencies like Goudappel Coffeng can use this tool and other knowledge gained in this report to start thinking about giving carpooling a more active role in the planning and decision-making process of new (public) transportation systems. For example, the new bus lane plans of the city of Eindhoven can perfectly be combined with HOV lanes if proper research is done. The creation tool can serve as starting point in this context.

A. (Andreas) Lem, BSc.



This report is the result of a six month graduation project carried out in collaboration with Eindhoven University of Technology and Goudappel Coffeng BV, advisors in mobility. This report signals the end of a genuinely learnful five and half years that I have been a student at the TU/e. This graduation process helped me to experience the everyday life in a company, and I have to admit that I enjoyed putting what I have learned during my time at the TU/e into practice. As this report will signal the start of my working career, it will at the same time help me to remember that learning new things will never stop being part of my job, wherever I may go next.

EDUCATIONAL CURRICULUM VITAE

2009 – 2012 Bachelor Industrial Engineering

2010 – 2011 Minor Economics

2012 – 2012 Bachelor graduation project at Scholtze Horecagroothandel VOF

2012 – 2014 Certificate program Technology Entrepreneurship

2012 – 2014 Master Construction Management and Engineering

2014 – 2014 Internship at Goudappel Coffeng BV

VEHICLE USERS' PREFERENCES CONCERNING AUTOMATED DRIVING

Implications for transportation and market planning

Author: I.C.H.M. (Ilse) Megens

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. dr. ir. W.F. (Wim) Schaefer

Dr. Ing. P.J.H.J. (Peter) van der Waerden

Drs. P.H.A.M. (Paul) Masselink

Drs. M.H.W. (Marcel) Clerx

Date of graduation:

20-08-2014

ABSTRACT

Automated driving could highly benefit society by improved safety, traffic flow and increased environmental savings. To enable this, vehicle users should release their driving control to automated driving systems. However, it is not granted that vehicle users are willing to release control in all driving circumstances. Results from a discrete choice experiment show that vehicle users willingness to release control is highly dependent of the level of automation, as users strongly only prefer a low level of automation. Furthermore, vehicle users only want to release control on highways, on roads they are familiar with and only when they do not perform a secondary task.

Keywords: automated driving, passenger vehicle mobility, driving circumstances, stated choice, discrete choice models.

INTRODUCTION

Passenger vehicle mobility provides economical and personal growth by enabling daily activities. However, mobility also exposes society to some dangers. These are the results of the everlasting demand for mobility. This leads to three key societal challenges.

Societal challenges concerning passenger vehicle mobility

Firstly, every year, accidents cost Dutch society around 12,5 billion euro. Motorized vehicles have a high share in this. They are involved in half of the traffic accidents. These accidents mainly occur due to human errors. Secondly, the distance vehicle users travel, as well as the amount of vehicles on the road is expanded. This results in increased congestion and delayed traffic flow. Total congestions costs were between 1,8 and 2,4 billion euro in 2009. More than two-third of these costs are on account of passenger driving. Thirdly, vehicles emit greenhouse gasses, which have negative influence on people's health and cause damages to the environment. One-fifth of the total CO₂ emissions in the Netherlands is caused by traffic, of which more than half is due to passenger vehicles. In total, the costs of emissions and pollution by traffic were around 5,1 billion euro in 2012 (Kennisinstituut voor Mobiliteitsbeleid, 2013).

Technological solution

One of the solutions for the above mentioned challenges are Intelligent Transportation Systems (ITS). These benefits have been recognized by different Dutch platforms. ITS systems are based on information and communication technologies and enable a flexible and dynamic traffic system. A successive step different stakeholders are working on to further aid society is the implementation of automated driving. An automated driving experience is enabled by systems that take over driving control from humans. The introduction of automated driving results in a new role division between the vehicle user, the vehicle and the driving environment. Within this new role division, vehicle users have to release control. However, literature indicates that vehicle users are not always eager to do this. They seem to trust themselves more in correctly carrying out control than they trust automated systems in doing this. Therefore, no matter how intelligent the technology may be, not trusting the system may be rejected. Hence, the vehicle user's willingness to release control regarding the level of automation and the driving circumstances, determine the benefits levels of automated driving for society (Muir, 1987; Secretary Schultz van Haegen, 2014; SWOV, 2010).

Research questions

Literature lacks insights in the preferences concerning automated driving. Therefore this research aims to answer the following main question:

Which level of automation and which driving circumstances contribute to the willingness of different vehicle user groups to release driving control?

To support the main question, four sub-questions are defined:

- What is automated driving and what are current and expected technological capabilities?
- What are the benefits of automated driving for society, regarding safety, traffic flow and environmental savings?
- How do the level of automation and driving circumstances determine usage rate of automated driving systems?
- What are the preferences concerning automated driving for different user groups?

Besides theoretical insights in the preferences of vehicle users, answering these questions offers insights which provide managerial guidelines for successful implementation of automated driving. Transportation and market planners can take measures that are in accordance with preferences of vehicle-users and hence maximize the potential benefits of automated driving.

This research provides insights concerning automated passenger driving. It does not involve freight traffic or automated parking. Furthermore, it only explains how automated driving could benefit society, and does not pay attention to the benefits for individuals. In addition, it does not describe how individual motives such as costs, liability and privacy have influence on the willingness to use automated systems. The research focuses on the Netherlands as the Dutch road network copes with very dense traffic conditions and automated driving can have high benefit levels. Additionally, Dutch government is aiming at a leading role in implementation of automated driving and therefore will stimulate the use of automated driving systems (Secretary Schultz van Haegen, 2014).

Outline

The thesis will firstly provide answers to the first three sub-questions by obtaining knowledge from literature. Next, a discrete choice experiment aims to answer the main question and the last sub-question. Therefore, first theory on discrete choices is described, after which the design of the experiment is explained. From the experiment, preferences of vehicle users are identified, which leads to conclusions and recommendations for stakeholders. The thesis is finalized with a discussion of the results .

AUTOMATED DRIVING

In recent years, vehicle manufacturers seem to have developed a technologies that can enable people to travel without being constantly attentive. The development of these kinds of technology started with systems that could sense and react with an appropriate movement. Later on, technological developments accelerated and then also the outside driving environment could be managed. Between 2003 and 2008, several automated driving challenges were embraced that resulted in vehicles that could drive with automated systems in a mock city environment. Currently, many well-known vehicle manufacturers are working on fully automated vehicles and have started test drives on real roads (Anderson, et al., 2014).

Technological developments

Technologies behind automated driving depend on three factors. Firstly, in-car systems provide information. Secondly, applications that allow communications between other vehicles and with infrastructure. Thirdly, autonomous systems that independently respond to situations, by sensors, scanners, etc. Therefore, the term 'automated' refers to vehicle being operated by a machine, by using communication as well as own sensors (Timmer, et al., 2013). Automated control can be split up to different levels. BAST expert group has categorized these levels as shown in Table 1. Currently only assisted driving and partial automation are available to public.

Table 1. Concise description of levels of automation (Gasser, et al., 2013)

Levels of automation	Role-division of driver and system
Driver only	The driver continuously (throughout the complete trip) accomplishes longitudinal (accelerating/ braking) and lateral (steering) control.
Assisted	The driver continuously accomplishes either lateral or longitudinal control. The other/remaining task is – within certain limits - performed by the system.
Partial automation	The system takes over the lateral and longitudinal control (for a certain period of time and/or in specific situations).
High automation	The system takes over lateral and longitudinal control for a certain period of time in specific situations.
Full automation	The system takes over lateral and longitudinal control completely within the specification of the application.

Implications for society

Main benefits of automated driving are increased traffic safety, improvement of traffic flow, and increased environmental savings. Traffic safety can be improved as automated systems can detect and neutralize safety-critical events more adequately than human drivers. The systems prevent unsafe traffic participation, unsafe actions during traffic participation, and reduce the impact of accidents (SWOV, 2010). The number of road fatalities could decline

with 25% when ITS work together (Arem, et al., 2008). However, as 90% of the accidents occur due to human errors, some experts predict that the safety benefits could eventually be higher. The second main benefit concerns an improved traffic flow. Automation in following vehicles can communicate and therefore respond on each other by smooth braking and fine speed adjustments. This leads to reductions in destabilized traffic shockwave propagation. Additionally, automation enables existing roads to be more efficiently used. Collaborating ITS could reduce congestion with 50% (Arem, et al., 2008). The third main benefit is the reduction of energy use and emissions. Energy use can be decreased by more efficient driving, lighter and more fuel-efficient vehicles and efficient infrastructure. CO₂ is reduced by an improved composition of the fleet and less influence of negative human driving behavior. This could result in 20% less pollution and 10% less CO₂ when ITS work together (Arem, et al., 2008).

Future planning and challenges

A roadmap concerning automated driving implementation is set up by Secretary Schultz van Haegen (2014). The Secretary's aim at testing highly automated driving between 2015 and 2020. Around 2025, highly and fully automated driving is assumed to be enabled. Litman (2014) predicts that between 2040 and 2060 the level of the exact benefits are tangible. Additionally, between 2060 and 2080 most vehicles will be fully automated and society will highly profit from the benefits. However, still many issues need to be addressed before this can become reality.

INFLUENCING USAGE RATE OF AUTOMATED DRIVING SYSTEMS

Vehicle user, vehicle, driving environment

Driving is a cohesion between the user, the vehicle, and the driving environment, which is depicted in Figure 1. For a large extent, these elements determine the task requirements for vehicle users. Automated driving changes the role of the vehicle user within this interaction framework. Under high influence of trust in automation, the preferred interaction with the vehicle and driving environment is determined.

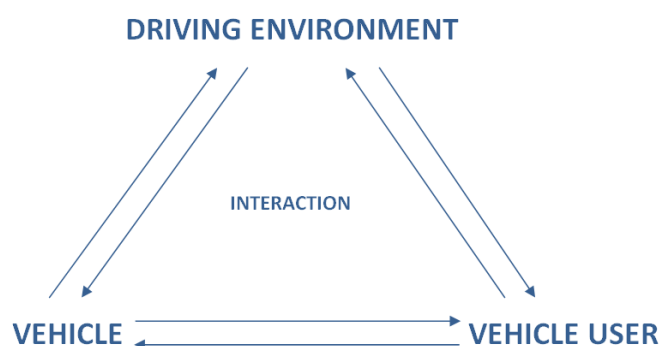


Figure 1: Traffic interaction framework

There is a strong relationship between trust and automated systems. Driving does not allow a margin of error as vehicles pass humans on little distance. Therefore indicates that people will only release driving control when they experience sufficient trust in the driving circumstances (Muir, 1987). Seven different attributes are identified from literature which have influence on how vehicle users experience driving. These are shortly explained below.

Weather and light circumstances - Driving risks increase when it is dark, rainy, snowy or foggy. Vehicle users will adapt their driving behavior to this (Mesken, 2012).

Road type - The uniformity of the road type influence vehicle users perception of safety. Therefore, the task requirement is higher when driving in urban areas, than on regional roads, or even more higher when driving on highways (Mesken, 2012).

Density of traffic on the road - The higher the density on the road, the more task requirements vehicle users experience. However, also the more advanced the automated driving systems should be (Mesken, 2012).

Length of the trip - During long distance driving, vehicle users have to be concentrated for a longer time, therefore they experience long trips different than short trips (Sanchez, et al, 2012).

Familiarity with the route - Vehicle users pay less attention to the driving environment when they are familiar with the route. The difficulty level of driving which is experienced decreases when familiarity increases (Yanko & Spalek, 2013).

Secondary task - Besides maintaining safety while driving, vehicle users are also often involved in more comfort related tasks, such as making phone calls or talking to a fellow passenger.

Implementing automated driving in line with users' preferences

Achievement of potential benefit levels depends on whether or not a critical user mass is willing to release control. Therefore, the use of automated driving systems should spread among vehicle users. This usage is expected to gradually happen over an S-curved line, and is explained as a diffusion process. The uptake by vehicle users can be divided in different user categories. First a certain niche will use automated driving systems. Within this niche, often people with high education, high social status, and high financial means are found. This niche will provide stakeholders with knowledge to improve transportation and market plans. Identified stakeholders that have influence on transport and/or market plans are policy makers, regulators, transportation planners, consumer supporting organizations, vehicle manufacturers, and vehicle users.

Choice process

Insights in which driving situation vehicle users would choose to release control, can be obtained by discrete choice modeling. A discrete choice model can describe the decision process of a vehicle user in a particular driving situation. Compared to more traditional approaches, an advantage of a choice-approach is that individuals will less overestimate the importance of unimportant attributes, as well as underestimate the important attributes (Hensher, et al., 2005). For this research, the driving situation is determined by the level of automation and different driving circumstances. The level of automation and the driving circumstances are referred to as the attributes, the individual is represented by the vehicle user, and a driving situation is the alternative context.

MEASURING DISCRETE CHOICES

According to the random utility theory, individuals will base the preferred choice amongst alternatives, on the alternative with the highest utility. The utility of an alternative, and part-worth utilities per attribute can be derived with discrete choice models. The Multinomial logit (MNL) model is the most basic and widely used model. It has a short estimation time, computation is simple, and it is easy to measure how well it predicts the data. Additionally, it

gives one set of globally optimal parameters and is therefore easy to interpret. However, the MNL model is homogeneous of degree zero in attributes. Therefore it could be useful to (also) model the data with a Latent class (LC) model. Compared to the MNL model, heterogeneity can be observed by discrete parameter variation. Respondents who have similar observed variable distributions are implicitly grouped into the same latent class with parameters to be estimated. The drawbacks of this model are that it is not known by the researcher which particular individual contains which class. Additionally, an extra analysis is needed to decide the number of classes (Greene & Hensher, 2003). A more adequate model than the LC model is the Mixed logit model. This model is more useful in terms of its overall flexibility and range of choice behavior it can accommodate. It can explain individual differences in the mean of the attribute levels (Greene & Hensher, 2003). It differs with MNL as Mixed logit does also not require to make specific assumptions about the distribution of parameters across individuals. The disadvantage is that the application of this model is not easy. Estimating the parameters is time consuming and parameters are difficult to interpret (Hensher, et al., 2005).

EXPERIMENT DESIGN

To obtain data for the choice models, a discrete choice experiment is done by the distribution of an online survey throughout Dutch speaking people that possess a passenger drivers license. The experiment construction is based on guidelines of Hensher, et al. (2005). The survey consists of four parts. The first part aims to get insights in the respondent's driving experience and personality traits regarding driving. Next, the following part pays attention to the respondent's view on Intelligent Transportation Systems. It will invite respondents to give importation about their familiarity and experience with ITS, and measures how important three trust aspects are to respondent. The third part uses stated choice response to find the automated driving preferences of respondents. Stated choice data derives choices that are made in given hypothetical situations (Hensher, et al., 2005). It allows robust understanding of how individuals make choices by observing multiple choices from individuals. Within these hypothetical situations, six attributes with associated levels are presented to the respondent. The six attributes with associated levels can be found in Table 2. For only the experiment, the level of automation corresponds with the level of released driving tasks, as this label is more easy to interpret for respondents. The respondents are asked to choose the situation that have their preference. In the last part, socio-demographic and psychographic factors are asked. Socio-demographic factors include gender, age, education level and household situation. Insights in psychographic factors are based on a division of lifestyles, to which consumption behavior is often closely linked.

Table 2. Selected attributes and corresponding levels

Attribute	Level			
Level of released driving tasks	Very little tasks	Little tasks	Many tasks	All tasks
Road type	Local road	Regional road	Highway	
Length of trip	<20 km	20-100 km	>100 km	
Density on road	Low	Average	High	
Familiarity with route	Familiar	Unfamiliar		
Secondary task	Yes	No		

IDENTIFYING VEHICLE USERS' PREFERENCES

Description respondents

With the survey, data from 673 respondents is collected. A concise description of the respondents can be seen in Table 3.

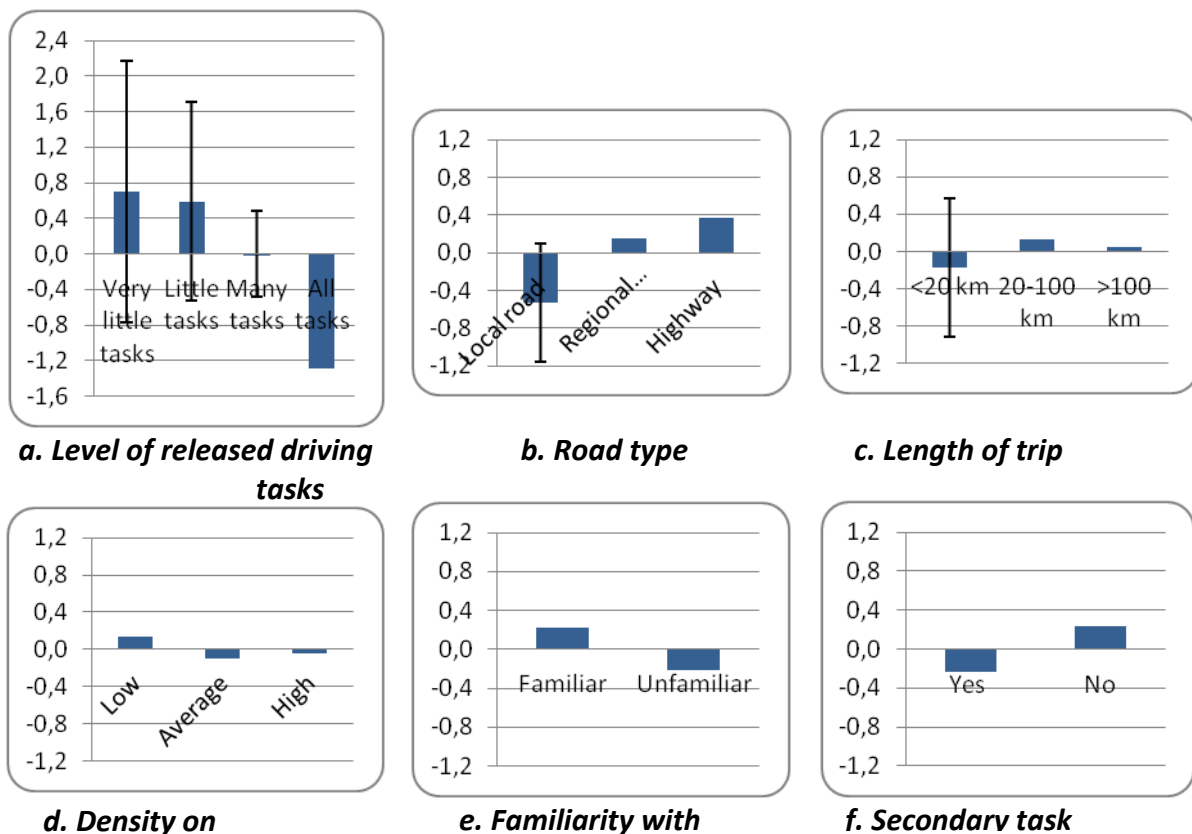
Table 3. Characteristics of the sample

User group	Research sample
Gender	
Male	51%
Female	49%
Age ¹	
18-24	17%
25-39	35%
40-54	47%
55 +	
Education	
Primary education	1%
Secondary education	12%
Lower education (MBO)	34%
Higher education/university	54%

¹ The total sample of the different characteristics is not always 100%. This is caused by rounding-off.

From further descriptive analyses it appears that several user characteristics are found to explain possible differences in the willingness to release control of driving tasks. These characteristics are gender, age, education, driving experience, familiarity and experience with ITS, trust and two personality traits. Because of time constraints, only gender, age, education level and experience with ITS are taken in account for the model analysis. The Multinomial logit model appears to have a very weak model fit. Therefore, this model will not be further examined. The results of the Latent class model show to have a better fit. The Latent class model includes two classes that take in account gender and age. This results in one class that is negative about automated driving, and a second class that is positive about automated driving. The level of released tasks and whether or not to perform a secondary task are very important to the first class. The second class emphasizes the importance of level of released control and road type.

To get more insights in taste heterogeneity with different user groups, Mixed logit is applied. Mixed logit models are described for the total sample and for respondents with different gender, age, ITS experience and education level. The means of all attribute-levels of the model for the total sample are shown in Figures 2a-f. The means of other described model quite overlap with the presented model. The figures show that the level of released driving tasks, road type, familiarity with the route and whether or not to perform a secondary task contribute to vehicle users willingness to release control to automated systems. The Mixed logit models are further described in the conclusions.



Figures 2a-f: Means of the attribute-levels

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

With a discrete choice experiment, insights have been gained concerning which level of automation and which driving circumstances contribute to the willingness of vehicle users to release driving control. Vehicle users' choice process is eventually described by two choice models: Latent class model and Mixed logit model. The Mixed logit model gives most useful insights in the preferences of different users groups and therefore the following conclusions are drawn from this model. The model for the overall sample indicates that the level of automation is most important for vehicle users' choice to release driving control. On average, vehicle users do not yet prefer full automation, only assisted driving or partial automation is preferred. High heterogeneity is observed which indicates that there could also be users that are already willing to release full control. What the characteristics of these vehicle users are that are willing to release full control is not explained by their gender, age, level of education or experience with ITS. Furthermore, also the road type contributes to the willingness to release driving control. Vehicle users are most willing to cede driving tasks on highways, but vehicle users are on average also neutral to positive about releasing control on regional roads. Again, for this attribute much heterogeneity is observed. This heterogeneity is partly explained by the education level. Moreover, familiarity with the route as well as not performing a secondary task contribute, although in less extent than previous attributes, to the willingness of vehicle users to release driving control. Low heterogeneity is observed for both attributes. This indicates that vehicle users do quite agree that they are not willing to release control when they are not familiar with the route and when have to perform a

secondary task. Lastly, the length of the trip and the density on the road do not provide a compelling contribution to vehicle users' willingness to cede driving tasks.

Managerial recommendations

Several stakeholders have high stakes concerning automated driving. Therefore, the following guidelines are given to successfully implement automated driving. Vehicle users with a high education level or much ITS experience are most willing to release driving tasks. Therefore, it is recommended to focus marketing plans on vehicle users with high education and with much ITS experience.

The following recommendations concern transportation planning. Most support to release control can be found on highways. For this reason it is advised to stakeholders to first focus on creating strong collaborations and feasibility studies for automated driving on highways. Eventually public parties should aim at also enabling automated driving on regional roads, because this could offer highest safety benefit levels. Additionally, it is advised to enable automated driving on dense roads. Here the benefits for society are highest. The density on the road does not have much influence on the willingness of vehicle users to release control, therefore vehicle drivers will agree with this implementation plan. Stakeholders should be careful with implementing partial and high automated driving. Although vehicle users indicate that they prefer not to perform a secondary task while driving automated, many accidents have happened because drivers were distracted. In addition, vehicle users have indicated to prefer automated driving on familiar routes. However, people tend to pay less attention to the driving environment when they are familiar with the route. Hence, although highly automated technology should provide sufficient lead time to obtain the drivers attention when necessary, this is risky as small human errors could lead to fatal accidents.

DISCUSSION

This thesis adds insights in vehicle users preferences to current research. However, it has some limitations which offer opportunities for further research. Not much research is done regarding vehicle users preferences of automated driving. Literature disagrees on the gender and age levels of users that are often associated with the preference level for automated driving. The models within this research indicate that there is not so much difference between these characteristics concerning their preferences. The first limitation of the research concerns the lack of insights in interaction effects upon choice. Interaction effect could show the effect multiple levels of different attributes could have upon each other. Moreover, only people that possess a passenger vehicle driving license are taken in account. However, when fully automated driving is enabled on Dutch roads, it may also be possible that people without a driver's license can use an automated vehicle. Their preferences could influence the recommendations. Additionally, the heterogeneity within the Mixed logit models could not be explained by researching the preferences of vehicle users with differentiated gender, age, experience with ITS or education level. However, literature suggests that users' social status and financial wealth could explain the differences in preferences. Furthermore, with this research insights are gained in which situation users are willing to release control. However, for actual acceptance, also other elements are important. This includes elements such as costs, safety effects, liability, and privacy. Moreover, insights in more precise safety, traffic flow and environmental implications could lead to implementation plans that are more accurately adjusted to desired benefits.

REFERENCES

- Anderson, J. et al., 2014. *Autonomous Vehicle Technology: A Guide for Policymakers*, s.l.: RAND Corporation.
- Arem, v. B., Jansen, B. & Noort, v. M., 2008. *Slimmer beter - de voordelen van intelligent verkeer*, Delft: TNO.
- Eyben, F. et al., 2010. Emotion on the Road - Necessity, Acceptance, and Feasibility of Affective Computing in the Car. *Advances in Human-Computer Interaction*, pp. 1-17.
- Gasser, T. et al., 2013. *Legal consequences of an increase in vehicle automation: English translation of BAST-Report F83 (Part 1)*, Bergisch Gladbach: Bundesanstalt für Straßenwesen.
- Greene, W. & Hensher, D., 2003. A Latent Class Model for Discrete Choice Analysis: Contrasts with Mixed Logit. *Transportation Research Part B*, Volume 37, pp. 681-698.
- Hensher, D., Rose, J. & Greene, W., 2005. *Applied choice analysis. A primer*. Cambridge: Cambridge University Press.
- Kennisinstituut voor Mobiliteitsbeleid, 2013. *Mobiliteitsbalans 2013*, The Hague: Ministry of Infrastructure and Environment.
- Litman, T., 2014. *Autonomous Vehicle Implementation Predictions: Implications for Transport Planning*. s.l., Transportation Research Board Annual Meeting.
- Mesken, J., 2012. *Risicoverhogende factoren voor verkeersonveiligheid: Inventarisatie en selectie voor onderzoek*, Leidschendam: SWOV Institute for Road Safety Research.
- Muir, B., 1987. Trust Between Humans and Machines, and the Design of Decision Aids. *International Journal of Man-Machine Studies*, 27(5-6), pp. 527-539.
- Sanchez, D. et al., 2012. *User Acceptance and User-Related Aspects: Deliverable 6.3 - Final Results*, s.l.: euroFOT Consortium 2012.
- Secretary Schultz van Haegen, 2014. *Letter to Dutch Second Chamber: Grootchalige Testen van Zelfrijdende Auto's*, The Hague: Ministry of Infrastructure and Environment.
- SWOV, 2010. *Intelligente Transportsystemen (ITS) en Verkeersveiligheid: SWOV-Factsheet*, Leidschendam: SWOV Institute for Road Safety Research.
- Timmer, J. et al., 2013. *Op advies van de auto: Persuasieve technologie en de toekomst van het verkeerssysteem*, The Hague: Rathenau Instituut.
- Yanko, M. & Spalek, T., 2013. Route Familiarity Breeds Inattention: A Driving Simulator Study. *Accident Analysis and Prevention*, Volume 57, pp. 80-86.

ABOUT THE AUTHOR



I.C.H.M. (Ilse) Megens

ilse.megens@gmail.com

"Often, humans believe that their driving capabilities are superior to that of technology. However, human errors such as distraction, tiredness or drunkenness do not apply for automated vehicle technology. These are crucial issues that vehicle users could wonder about while considering to use automated driving systems. Implementing automated driving to the extent that vehicle users feel that they can release control, could eventually change mobility as we know it today."

sep 2007 - aug 2012 Bachelor Architecture, Building and Planning
sep 2010 - sep 2011 Fulltime member of the board of student union SSRE
sep 2012 - aug 2014 Master Construction Management and Engineering
sep 2013 - jan 2014 Exchange semester Istanbul Technical University
feb 2014 - aug 2014 Graduation project

STRATEGY ENRICHMENT

A sustainable transformation of housing associations

Author: Marianne (M.L.) Oldenburger

Graduation program:

Construction Management and Urban Development 2014-2015

Graduation committee:

Scientific Committee (Eindhoven University of Technology):

1st Dr.ir. B. (Brano) Glumac

2nd Prof.dr.ir. W.F. (Wim) Schaefer

Company Committee (Gielsing Consultancy)

1st Ir. E. (Eline) Fraters

2nd Ing. T. (Therus) Gielsing

Date of graduation:

February 24th, 2015

ABSTRACT

Transforming the CANVAS business model sheet into a social and dynamic business model structure, as tool for housing associations' board, is a challenging ambition for the problems the organization is currently facing. Regarding the broad available research perspective, and besides the available qualitative and quantitative insights, the integral collection and the further structuring of knowledge and variables, was in need of specific events, activities and moments of choices to downgrade the size of the research and make it feasible in time. The developed model is able to visualize the proposition of the entity and makes them able to think and communicate future-oriented and 'out of the box'. Maintenance of stability, control and certainty; towards a sustainable strategy. 'The start of exploiting opportunities'.

Keywords: Housing associations, social and dynamic business models, system dynamics, strategy support, sustainable organizations.

INTRODUCTION

The opportunities, role and the context of housing associations (HAs) is in development and in light of many dynamics of the surrounding world the housing associations are changing too. Every day it is a well-spoken subject in newspapers and operating questions are surrounded. After the reading of paper news, articles and literature about the housing association (HA); their future right to exist, the 'Novelle van Blok' and societal changing housing preferences, the subject attracted more and more of my interest. The interest in; causations between global and local trends, the innovation in field of data/knowledge, real estate and housing, the changing housing preferences, vacancy versus overcrowded and the unclear policy decisions. The principles and strategies of Housing associations are set long time ago and we might should be wondered about the necessity and efficiency of their operating nowadays. What should be done and possibly be changed in the inter-organizational, internal business? What about the organizational structure and role, the collaboration, partners and the opportunities in our rapidly, continuing changing society?

Strategy enrichment

Through an enlightening and refreshing look at the housing associations' business model and acting, a sustainable insight on their operational and management strategy can be gained to ensure and sustain their right to exist. The enrichment through proper insights in strategy opportunities. Insight in their future possibilities and high-potential (new) ways to go.

'Future-proof' in a way that they will be able to act sustainable on their market (pro-) position, financial feasible within their authorized borders and (social-) profitable, in our rapid changing society in coming years.

Research 'circle' (simon sinek' golden circle)

Why?

Maintaining stability, control, value and certainty, towards the strategy of housing associations – 'the start of exploiting opportunities!' Embedding the improvement of business case modeling, from the societal point of view, could be the way to focus on organizations' needed capacity, unique selling points, focus and so their sustainable and enriched strategy.

How?

The strategy-decision-support model will be used for understanding organizations' range of change-opportunities from an actual business model environment.

What?

Social and Dynamic business case modeling;
Strategy Enrichment.

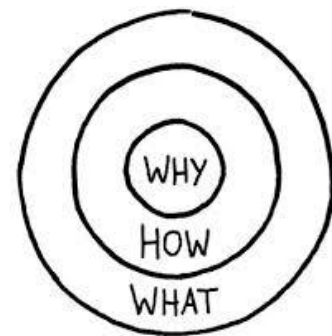


Figure 1. Sinek' Golden Circle

Problem definition and research context

Housing associations are facing a problem, 'through societies' dynamic and continuous change, and their static acting as missing strategy-response to it. Without improved development of their value chain, revenue streams and the assurance of their future-oriented business proposition within a few years, housing associations will be forced to lower their investments in new buildings, restructuring, and social and project-oriented development. These strategy decisions need to be made in addition to the urgent lowering of their expenses, on the themes as; maintenance, service, quality of life and (organizational) sustainability'. Housing associations are civil society organizations with their task to facilitate housing for those that are not sufficient to finance it by themselves. Facilitating housing, living environments and service are the key activities of HAs. Housing associations are committed to facilitate affordable and good living. Their social economic task is stabilizing those facilities (Weijer & Bervoets, 2012-5). Through political and social debates about the financial continuation abilities of housing associations, the polarized discussion arises on their entrepreneurial business decisions last years. The financial position and capabilities of HA reached their authorized limits. Governmental regulation and development, and the cost increases in today's society, and additional the locked housing market, are causing the deterioration of the finance and business proposition of the sector. The governmental agreement is reinforcing this development. Investments by housing associations are and stay under pressure.

The challenge of this research is to gain insight in the ever-changing (social) business organization model and the development of a strategy-decisions support model in the field of Housing associations' policy and context. The model should give insight in the organization's needed capacity, unique business proposition, focus and so their strategy (Teece, 2010). A model for understanding organizations' 'range of change-opportunities', from an actual business model environment. The key-trends, industry forces, market forces and macro-economic forces are affecting variables of the model that are influencing the present business proposition of housing associations.

'Our ever changing society calls for an ever changing (evolving) business model.'
(Problems' solution - M.L.Oldenburger)

Research objective and question

This research could strengthen the business proposition of a housing association by the development of specific insight in their dynamic and complex operation. Insight in the future trends and development that are influencing the business model of housing associations, and the policy restrictions should be taken into account. The developed decisions-support structure should support the strength and integrality of in- and external operational opportunities, the strategy of the organization and should besides strengthen the insight in housing associations' 'status- quo' and their future perspectives (Tegel & Hoof, 2011).

The research objective can be therefore formulated as follows: 'To gain insight in the business model structure from the societal point of view, defined by the sustainable transformation of housing associations, as main goal of this thesis, is combining economic prosperity and sustainable resource management to maintain dynamic stability in time. Proper insight in this strategy-decisions-support model, which besides can be used as valuable support tool (Figure 2), is the research object to be gained '.

The research objective to create proper insight in strategy decisions is visualized in Figure 2. The HA analysis should be approached (left hand) as organization in a complex and dynamic context, the society. With HAs' mission to stabilize and ensure housing for them whose are not (financial) able to facilitate housing by themselves (right handed), their strategy should be well founded in both; external variables within society, and future oriented mission development. Their strategy should be adapted and used as tool to manage their ambitions.

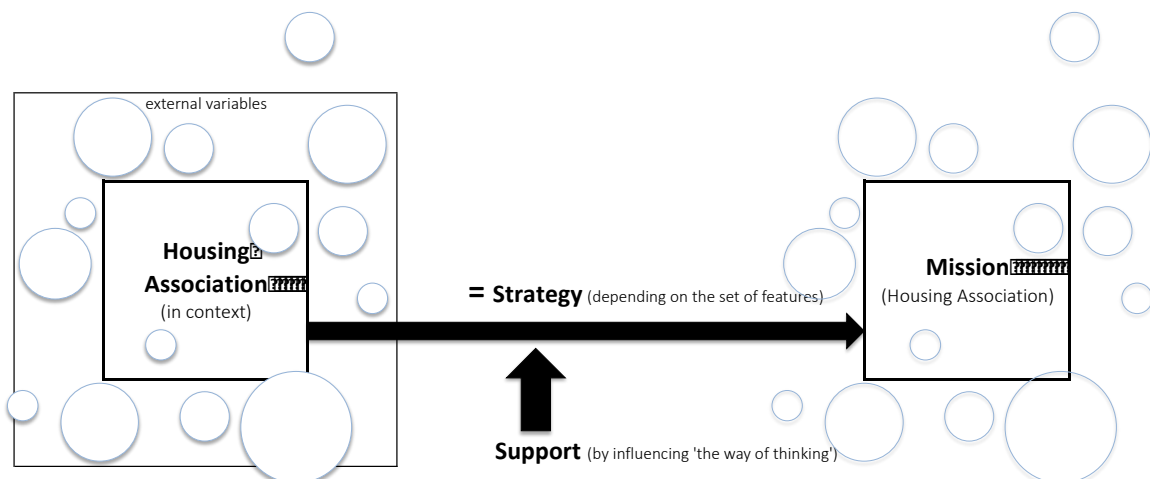


Figure 2. *The research objective is to create 'strategy-support' through insights in the HA' actual proposition and strategy decision process, towards their mission.*

Based on the context, problem definition, research perspective and research objectives, following research question is formulated and should be answered:

- *How should the future-proof, 'sustainable, feasible and (social)-profitable', Dutch Housing Association operate?*

PROBLEM FRAMEWORK

Housing associations

Entities do exist in many different ways. Organizations, Companies and Enterprises related to their profit, non-profit and 'not for profit' character. Housing associations are developed and raised for society-oriented targets with their non-profit, governmental character. In time their primary focus on social profit is changed and nowadays they are taking conscious and the more 'entrepreneurial focused' decisions. Their ideology regarding to their customer relationship and users' satisfaction stands, but business efficiency and social targets are getting the more energy in their entity. Housing associations are trying to balance between their social interpretation, their financial glasses and their role in the creation of a powerful city. A balance between; a defensive vs. a prospective character, and the social profit vs. the financial profit (Koolma & Gerrichhauzen, 2011; Gruis V. , 2010). The balancing in between various strategies will result in HA that will focus on the operation as a real estate company or as the housing association as social intermediary. The housing association is searching towards their true appropriate identity in which they secure their future proof business case.

Business Models

Sustainable, future-oriented entrepreneurship is becoming the more and more important as operational challenge for society and organizations. To support and motivate new initiatives that can arrange new opportunities of collaboration, work and business; new application and use of business models is necessary. The core business of business modeling is enclosed in the sustainable perspective, feasible character and business proposition (core competence). Besides the logic and clear character of operation value creation is forming continuity, in which plural, collective and shared should be central pillars of new business development. Multiple profit, founded in social-shared objectives.

The structured and interconnected design of the (social and/or sustainable) business model should be used as design tool in the process of business development, generating and maintaining. Besides the tool should help to understand the dynamic complexity of the environment, social, and economic system. The inability of humans to anticipate on the dynamic consequences of policies adopted today, and to oversee causations; is requiring abstraction and will be supported/covered by the model. An appropriate business model is flexible and dynamic. The CANVAS business design approach should facilitate observing the effects of strategy decisions on the business model's building blocks and their interrelated factors. This whole process redefined, may improve and sharpen the business model and strategy, 'social business modeling', of housing associations.

Future exploration vs. data analysis

The research is formed through predictions based on numbers and data analysis, on elaborated future scenarios and on the knowledge and experience of the spoken experts during the comprehensive, pioneering, and exploratory research. The research meets qualitative and quantitative through; emotion vs. ratio, alpha vs. beta, story telling vs. data.

Concluding research is highly strengthening policy and management through enriched or new insights, but future explorations stay clear in a limited way.

RESEARCH DESIGN & PROCESS

Strategy support model for HAs

This support model should support in strategy decisions (to targets), regarding the future-oriented ‘environmental-awareness’ of housing associations. Once, the diversified housing association could simply point its business units as particular strong end-products and services and admonish them to become leading in the (social) residential market. But since residential market, innovation and policy boundaries changing even more quickly, enterprise targets are hard to capture and ensure (Dorr & Wittenberg, 2012). In most practices, the internal portfolio management and the maintaining of organizations’ stability, control and certainty is viewed apart from the societies’ key-trends, industry forces, market forces and macro-economic forces. However, those external affecting variables are influencing the present state, business proposition and so the sustainability of the housing association. This lack of alignment possibly leads to incorrect strategy decisions, towards housing associations’ needed portfolio development and partnerships. Therefore, the aim of the strategy support model is to gain insight in the interdisciplinary relations between the overarching society with its law and regulation, residents’ needs and preferences (changes), and the housing association’s value proposition, quality and way of acting. The HA should be able to quickly implement the changes of needs and social requirements by law and regulations.

Strategy support model’ development process

There is no unique instruction to follow making sure that a designed business model is successful. Indeed, modeling is basically an innovative process and there are different methods and approaches to design a dynamic model (Sterman J. , 2000). As validity of the results in a model-based study, it is crucially dependent on the validity of the model for which several validation steps need to be taken (Barlas, 1996). In this research, following logical ‘process-theory’ steps have been applied in the reliable research and modeling process, knowing that entities/variables participate in the ‘events’ and will change over time. The process approach steps will be explained, and are layered and incorporate both immediate and distal causations (van de Ven, Engaged Scholarship, 2007). Parallel and sequential steps together will form the translation of the housing association’ organizational and societal variables, towards insight in their strategizing and operating within their social and dynamic business model.

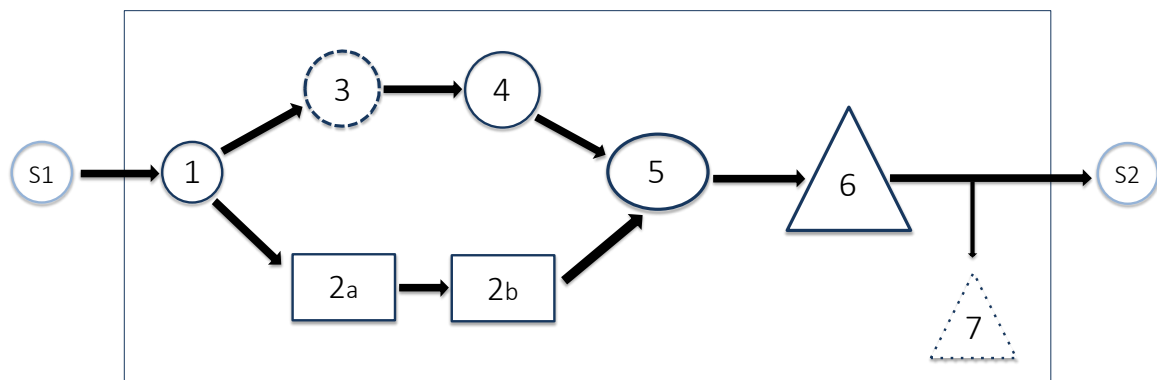


Figure 3. Visualization of the strategic decisions and path changes (flow-chart) in this process oriented, pioneering, research.

1. 'Activity' | The reflection of housing associations business concept to societies change. A pioneering research to gain insight in the problems and challenges, and their internal and external changing variables that are influencing HAS' business proposition. Expert interviews from broad perspective and literature, helped to formulate and validate the problem;
2. a&b 'Choice & Activity' | Decided in to apply the Business Model CANVAS concept / thinking on the housing association as organization and possible social enterprise. That resulted in the translation to/application of a social business model (SBM) in which the Surplus is added as measurable variable and management tool in the organizational and entrepreneurial planning and aspired Social Return On Investment;
3. 'Choice' | The formulation of housing associations' social business model influencing variables within the SBM building blocks, feedback (on the level of importance of the variables) from the experts is given on the earlier identified variables to validate the decision making, subsequently research focus of the qualified model. A number of variables are chosen from the total;
4. 'Activity' | The in average most-high graded number of variables are translated to 'measurable'/specific HA-variables to work with;
5. 'Event' | Formulating the HA-specific variables to generic variables and the positioning of these identified HA-variables in the Social Business Model structure;
6. 'Event' | Connecting the HAS' generic variables to the generic causal loop diagram within the SBM structure. The reflection of system dynamics to the social business model structure of the housing association enables the business model and so the HA to reflect on their SBM in time (coming). Valuable insight in appropriate business opportunities and strategies are aspired;
7. 'Activity' | The starter-design of the Stock and Flow model is developed in which the problem of Law and Regulation (L&R) implementation on HAS' portfolio management (towards residential need change) in time is studied. This step should be elaborated in subsequent study.

Variables collection and selection enabled through experts (Step 1-3-4)

Through expert' interviews and literature research, subsequently through expert graded variables the research focus is determined. The found variable focus of this research had to be translated to measurable, concrete variables to be used in the social business model development for the HA. The through experts '*high level of impact on housing associations' business model*' graded variables, are hereby translated into a variable that can be used and measured in the social business model. The following variables are labeled as the ones with the most powerful impact, and are used in the further model design process.

- Return to core Business (proposition change);
- Law and Regulation (impact - Novelle van Blok);
- DAEB, niet-DAEB separation;
- Migration to cities (combination of growth cities and shrinkage on country side);
- Change of residential demand (growth of (social) rent needs);
- Emi-/Immigration;

Business Modeling and housing associations (Step 2 a&b)

The structured design by building blocks will frame and control the business proposition of the housing association. The business model will help to understand the organization in the complexity of the environment; social, and economic system of HAs. The social enterprise model is nearly to the concept of the 'not for profit' organization. They want to create as many social impacts, as well as the financial and commercial sustaining of their independency and continuity. The balancing in between social profit and financial investment is used as the concept to deal with HAs' challenge of change. The challenge is to improve and sharpen their sustainable business model and strategy, 'social business modeling'; they want to quantify their social impact and (social) return on investment (SROI), also known as surplus (Tegel & Hoof, 2011). The Surplus reflected on the CANVAS business model in case of the business case of housing associations enables the HA to think and communicate about their social business organization model in a structured, and clearly substantiated way. The addition of the 'Surplus' is resulting in the 10th business model building block (figure 4, based on the 9 CANVAS + 1 building block), according to the 'financial aspects', the Surplus.

10. (financial aspects) The Surplus building block represents the SROI, social-profit a housing association generates and/or aspires. Besides / Within there should be the surplus management and planning of the social results, about how to gain, qualify, grade, and reinvest them;
 - a. How much Surplus do you plan to create?
 - b. Where do you plan to reinvest your social profits?

Because of the strict dependence between the Value Proposition, and Customer Segments in the Social Business Model, the Value Proposition and Customer Segments need to be transformed as well in case of the applied social business model. The interrelationships are resulting in following building block addition:

1. (customer interface) The Beneficiary and Customer Segments:
 - +. Who are the people and/or organizations that are will to pay to address this issue?
 - +. The HA need to ensure that they have laid out a 'compelling rationale' that will turn in customers and/or investors to 'pay' without forgetting about the impact on society.
2. (product) The Customer and Social Value Proposition:
 - +. What value do we deliver for society, the customer, and how will we show that we are creating the aspired impact?
 - +. Clear thinking around what kind of social impact will be created and how it could be measured should be addressed and (internal) maintained?

System Dynamics applied to the Social Business Model CANVAS (Step 5-6)

The development of a system dynamics social business model will help to understand housing associations' complex strategy problems towards their sustainable character in nowadays changing societal impacts, as residential market change and the new Law and Regulations initiations. The model will capture and visualize these key-interrelationships as qualitative causal relations, and should besides help to understand business challenges.

The information gained about the research topic made it possible to develop the needed generic variables within the building blocks to design a generic causal loop diagram for housing associations' operations. The set so-called 'generic variables' are formed, based on their causations, in the Social Business Model structure. The diagram is giving an abstracted

A business model strategy support structure, should be approached as dynamic acting model, since the housing association need to be able to sustain their value proposition in our rapidly, and continuous changing world, and should operate as follows: the future-proof; sustainable, feasible and (social-) profitable, Dutch housing associations should;

1. Firstly, the housing associations need to become aware of their actual business proposition ('status quo') in our ever- changing society, by the use and design of a social business model structure; as more precisely explained above Figure 4.
2. Secondly, the HA should focus on their sustained value chain through future oriented and 'out of the box' market orientation - in movement & development - and the exploration of (new) commitment(s) and partnership opportunities.

It has been proven that the problem is integral, multidisciplinary, and is changing in time, and so the solution should be integral and multifaceted as well. The goal of the research: 'to gain the desired insight in the business model structure from the societal point of view, defined by the sustainable transformation of housing associations', is realized through an innovative approach of the business modeling. Innovation and creativity in combination with social 'not for profit' business in business modeling, and the reflection of system dynamics on the defined social business model structure made new insight transparent. The strength of this reflected approach lies in the incorporation of external impacting, and continuous changing variables, causations, feedback loops, and strategic management in the dynamic stability in time.

The strategy support structure/tool reflects on and identifies critical issues relevant for changing and developing the business organization strategy within today's changing society. This allows housing associations' policy makers to see the causations and consequences of for example certain law and regulations development, and the impact of economic and demographic developments on organizational acting.

DISCUSSION

The results show that the decisions for strategic, future-oriented business development in field of housing associations lead to complex integral systems in which many variables need to be taken into account, and will further lead to research choices, uncertainties and assumptions. But especially looking at the conclusion of results, the dynamic approach of the social BM makes HAs able to create clear integral organizational insights and evaluate the impact of specific societal changes.

Ultimately for further research it is proposed to get the needed insight in each model-causation to upgrade the models' abilities and absolute insights. The dynamic and social business model represented in this research could be further elaborated, be implemented and tested in different contexts to be fully applied in organizational strategy processes. When the model is fully represented by the system dynamics methods up too a valid running stock and flow structure, then housing associations' managers could be enabled to fully investigate and communicate about their future oriented, aspired strategy, by use of absolute scenarios through fully verified and validated variables input, endogenous as well as exogenous.

The business model structure is used to be used in field of (new) business generation for every (new) enterprise, it would be therefor interesting to explore other options of general business dynamics, so the revised business model approach will be available for 'every organization' and/or start-up. How should a dynamic business model approach influence the way enterprises are developing and sustain their business?

REFERENCES

- Gruis, V. (2010). De corporatie als katalysator. *Building Business* .
- Koolma, H., & Gerrichauzen, L. (2011). Ander leiderschap en woningcorporaties. *Tijdschrift voor de volkshuisvesting* .
- Osterwalder A., P. Y. (2005). Claryfing Business Models: origins, present, and future of the concept . *Communications of the Association for Information Systems* , 16.
- Sterman, J. (2000). Business Dynamics - System Thinking and Modeling for a Complex World. Boston, MA: Irwin McGraw-Hill.
- Tegel, K., & Hoof, J. v. (2011). *Idealisme mét een businesscase*. Branchegroep woningcorporaties. KPMG Advisory N.V.
- van de Ven, A. H. (2006). *In Engaged Scholarship: Creating Knowledge for Science and Practice*. Carlson School of Management - University of Minnesota. Minneapolis: Carlson School of Management - University of Minnesota.
- Weijer, M. v., & Bervoets, W. (2012-5). *Een brede blik op hedendaagse woonpatronen*. AGORA.



Marianne Lodi Oldenburger | 19-12-1989

marianne.lodi@gmail.com

mol@gc-bv.nl

After finishing my Bachelor I was motivated to find my 'future way to go' in which I would become 'good', motivated and most of all happy. I wanted to broaden my horizon, and my knowledge about business and organizations through which I would be able to make aligned decisions. My internship enriched my experience within the field of business operations and confronted me with my strengths and weaknesses; and with the things I want to develop further, to become an expert. Besides, that there were things those were not in line with my ambitions. Subsequently, decided to study my Master CME in which I get challenged in the entrepreneurial thinking and business acting of societal questions. And for now: Consultant at Gieling Consultancy is the result of my academic career, decisions and personal growth.

2009-2012	Bachelor Architecture & Urban Development
2012-2013	Internship Projectburo B.V.
2013-2014	Master Construction Management & Urban Development / Engineering
2014-2015	Graduation intern Gieling Consultancy & junior Consultant GC
2013-now	Consultant GC

INVESTIGATION OF THE ROLE OF PRE-TRANSPORT IN TRAVELERS' TRANSPORTATION MODE CHOICE

A study conducted in the region of the railway station of Eindhoven

Author: K. (Koen) Sanders

Graduation program:

Construction, Management and Engineering 2014-2015

Graduation committee:

Prof.dr.ir. B. de Vries	(Chairman master CME, TU/e)
Dr.ing. P.J.H.J. van der Waerden	(1 st Graduation Supervisor, TU/e)
Dr.ir. B. Glumac	(2 nd Graduation Supervisor, TU/e)
Dr.ir. M. de Bruin	(3 th Graduation Supervisor)

Date of graduation:

17-08-2015

ABSTRACT

It is desirable to reduce private car use in the Netherlands because of the consequences it has for environmental and societal costs. The increase of motorized vehicle use brings many problems with it globally, while alternative transportation modes are less harmful for the environment. Travelers changing their transportation mode choice from the private car to less harmful alternatives like the train could contribute to solving the previously mentioned problems. Many travelers are deterred from using the train due to aspects of the railway journey they do not like. It is important to know which characteristics of different journeys affect transportation mode choice in order to address the problem. A stated preference experiment is used to collect data of travelers transportation mode choice. This data is analyzed using a multinomial logit model to see which characteristics of the journeys affect transportation mode choice the most. Time and monetary cost related characteristics proved to be the most important in transportation mode choice.

Keywords: Transportation mode choice, human behavior, Multimodal railway journey, Railway station accessibility, Car travel

INTRODUCTION

Car ownership and use in the Netherlands have increased tremendously since the 1960's. Between 80% and 90% of all passenger kilometers are made by car. Traffic and transportation nowadays are serious causes of an increase of environmental and societal costs such as congestion, noise, air pollution, depletion of energy, and substantial use of land. In many urban areas these consequences already lead to urgent problems e.g. (Redman, et al., 2013). Especially congestion is a major issue. It is often cited as the most important concern of urban dwellers of large metropolitan areas. Congestion involves not only personal costs, but also major social costs. Therefore it is desirable to reduce private car use in the Netherlands. Reducing private car use has been one of the objectives of the environment policies of the Dutch government over the last few decades e.g. (Buehler, 2011). The amount of vehicle kilometers and vehicle hours lost will remain to rise if no more additional lanes will be built. And even if there would be built more lanes, this would cause

more people to use the private car and therefore increase pollution and other environmental disadvantages. Therefore it would be desirable to promote an alternative transportation mode that is more sustainable and safer. The most commonly used alternative for the car is public transport, and for longer distances especially the train.

Governments and people are increasingly interested in a sustainable and healthy environment in the future. Therefore transportation policies in the Netherlands and Europe are differencing. Pre-transport as an access mode to the railway station has been researched for the last decades. In these past decades the amount of use of different modes of pre-transportation shifted over time. But what modes of pre-transport are used nowadays what characteristics of pre-transportation modes influence transportation mode choice the most is only partly known.

RESEARCH AIM

The aim of the research is to investigate how potential train users perceive pre-transport, how they make choices for the transportation mode they tend to use and how are these choices influenced by the characteristics of the different types of pre-transport. The most important objective of this research is to determine the influence of different pre-transportation modes on the choice between train and car, for a large distance (50 to 150 kilometers) journey, of travelers.

This has led to the following research question:

What is the role of the characteristics of pre-transport in the travelers' decision making process of using the train as transportation mode instead of the car?

The main research objectives are to investigate the role of pre-transport and its characteristics in a multimodal railway trip and to what extent it influences transportation mode choice. Important is that the research is not conducted from existing railway users only, but from a target group that has divers characteristics and use many types of transportation modes.

THEORETICAL FRAMEWORK

presents the most important definitions, explanations and descriptions of specific methods that are used in the research and are related to the problem that is defined. First the different types of journeys that are applicable for the research are illustrated. The following two types of journeys are important for the research, the car journey and the multimodal railway journey. Finally the research framework will be explained, this part consists of an explanation of the used research methods and the analytical framework that is used to achieve the goals that are set.

Journeys

A journey is a continues travel from door-to-door that consists out of one or more transportation modes from the start-point to the end-point or activity. In the research two different journeys are considered. The first journey is the car journey and the second is the multimodal railway journey (Givoni & Rietveld, 2007).

A car journey consist of a few different parts, also called trips. The most important and time consuming part is the car trip. The trip from home to the parking place near the end destination is the car trip. The route that is chosen for the car trip is mostly the route that takes the least time. Sometimes monetary costs and congestion are also taken into account when the route is chosen. The advantage of the car that it has no fixed route and its flexibility gives the opportunity to take another route when desired. It is also possible and more convenient to use the car for multipurpose journeys where different travel purposes are combined (Ye, et al., 2007).

A railway journey includes a trip to, the access mode, and later from, the egress mode, the railway station by different modes of transportation. So the railway journey is a multimodal trip with the train as main transportation mode. The access trip is the trip from starting point to the Railway Station (RS), this trip is in the research called, the *pre-transport*. The train trip runs between the railway stations. Within this train trip there are possible transfers at a railway stations. The final trip from the railway station to the end point is the egress trip.

Both type of journeys that are included in the research are shown in Figure 1.

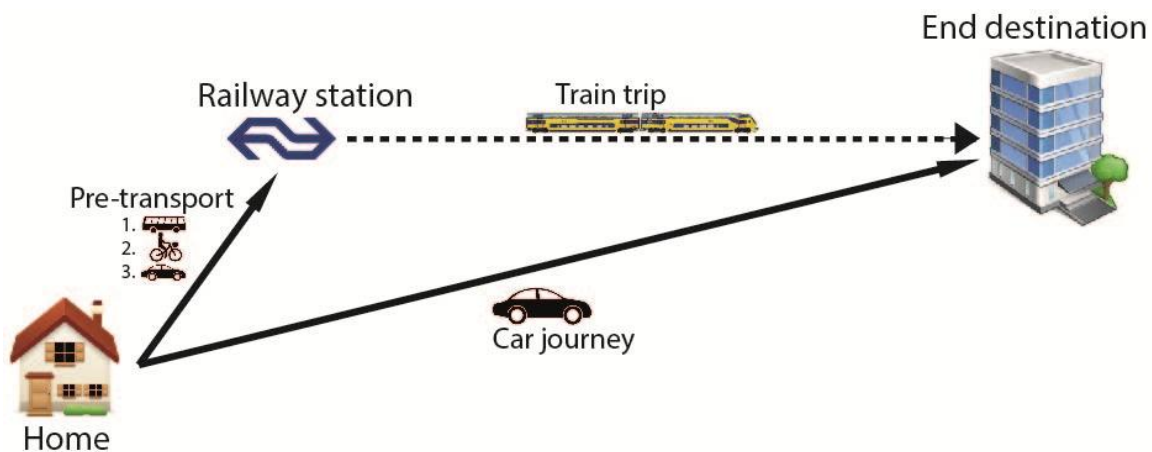


Figure 2. Different types of journeys that are included in the research.

The car journey is a single modal journey, but the railway journey is multimodal. An important part of the multimodal railway journey is the pre-transport trip. The pre-transport is the access trip that people have to make to get to the railway station. In the research it is investigated to what extent the overall quality of a railway journey depends on the quality of the pre-transport. It is concluded that travelers place importance on the pre-transport, which indicates that some people avoid using the railway due to the discontent about the railway station and its accessibility.

Transportation mode choice

To describe how people choose a transportation mode for their travel purposes, a theory of mode choice decisions is described by Schneider (2013). In his theory is suggested that there are five steps in the transportation mode choice decision process. The first part, awareness and availability, determine the possible transportation mode choices available for the travel. The following three elements, basic safety and security, convenience and cost, and enjoyment assess situational tradeoffs between the possible transportation modes. These three elements, in this theory known as the situational tradeoffs may be considered

simultaneously in the choice sequence. The first four elements are all influenced by socioeconomic factors. A fifth element is of influence in the transportation mode choice, habit has the effect that people that choose a particular transportation mode regularly, are more likely to consider it as an option in the future.

Household and individual socio-demographics have a strong influence on transportation mode choice decisions for commuter traffic, which is a large share of the total traffic in the Netherlands. Specifically, income, lifestyle, perceived service level, willingness to pay, type of journey, travel time, gender, employment status and car ownership affect transportation mode choice.

Methods and techniques

A stated preference approach is used to collect the data from respondents. Multinomial logit will be used to analyze the collected data because it is a discrete choice model that can help to understand and predict choices between several alternatives. A stated preference (SP) approach is considered to be a good method to perform a hypothetical study. The attribute values are controllable, therefore SP can be used to research hypothetical situations. So unlike revealed preference (RP), which is based on individuals' real choices, SP can give insight in situations that do not exist yet, it allows us to explore issues outside of the technological frontier. This information can be used to predict the consequences of changing and adjusting the current situation. The stated preference approach is based on individuals' choices of hypothetical transportation mode alternatives. This approach is widely used and accepted in travel behavior research and practice to identify behavioral responses of travelers to choice situations which are not revealed in the market. So to collect the data that is needed for the research SP will be used.

The data that is collected with a stated preference experiment can be analyzed with a discrete choice model. For the data analysis a Multinomial logit (MNL) model will be used to estimate the parameters of the stated preference experiment. A MNL model is a discrete choice model which can help to understand and predict choices between several alternatives. Train (2009) states that it is by far the easiest and most widely used discrete choice model in the world. The popularity of MNL is due to the fact that its formula for the choice probabilities take a closed form and therefore is readily interpretable.

MODEL

The experiment is about a journey from the home of the respondents to one of the following large cities of the Netherlands: Utrecht, Amsterdam, Nijmegen, Arnhem, Heerlen, Maastricht, Rotterdam and Den Haag. All these cities are accessible by car, but also by train via the railway station of Eindhoven. Key to the experiment is the transportation mode choice. In the SP experiment the target group respondents will make a choice out of four different modes of transportation. Each alternative mode of transportation has attributes that characterize it.

Stated preference experiment

The experiment consists of four transportation alternatives to make a journey, shown in figure 1. The first alternative is using the train with bus as mode of pre-transportation. Second is using the train with bicycle as mode of pre-transportation. The third alternative is

the last one, it has train as main transportation mode and the car as a form of pre-transportation. The pre-transport of this alternative is divided into two different possibilities. The car is used to get from home to the railway station, at the railway station the car can be parked, or the traveler can be dropped off by someone at the railway station. These are the two different forms of pre-transport with the car. The last alternative is to use the car for the journey instead of the train.

For the SP experiment 81 profiles were randomly created with each its own characteristics. The profiles are created by combining one of the three possible attribute levels for each attribute with each other. In each profile four alternative transportation mode options are presented from which the respondent has to choose one. 32 Attributes are defined for the experiment in order to give a good impression of the influence of all characteristics of transportation modes. Because of the amount of attributes and attribute levels that are included in the research, it is desirable that each of the 81 profiles is valued about 30 to 40 times to make the research representable. Each respondent is presented with 9 profiles, so to desired minimal number of filled in questionnaires is $(9 \times 40) = 360$. Because the questionnaire is designed for a specific target group in the Netherlands, the questionnaire is completely in Dutch. The questionnaire consists of three different parts, each part has a particular purpose. The first part is intended to find out what the current travel behavior of the respondents is. In the second part of the questionnaire the stated preference experiment is presented to the respondent. After the explanation of the attributes and attribute levels the respondents will be presented with decision tables in which they each time have to choose one of the four presented alternatives. Figure 2 shows an example of a decision table in the questionnaire.

Vervoermiddelkeuze en voortransport



Vink onderaan in de tabel de vervoersoptie aan die uw voorkeur heeft.

Kenmerken	Trein		Auto
Reistijd in het voertuig	55 minuten		60 minuten
Wachttijd/zoektijd naar parkeerplaats	15 minuten		3 minuten
Kosten trein-/autoreis	18 euro		10 euro
Kosten parkeren auto			4 euro per uur
Kans op vertraging	15 procent		20 procent
Veiligheid	Extra bewakingscamera's		Geen maatregelen
Mogelijkheid tot werken	Geen maatregelen		
	Voortransport		
	Bus	Fiets	Auto drop-off /parkeren
Tijd om bij halte te komen	1 minuut		
Reistijd in/op het voertuig	25 minuten	25 minuten	20 minuten
Tijd om op het perron te komen	5 minuten	4 minuten	2 minuten
Rit-/stallingskosten	2 euro	1.50 euro per keer	3.50 euro per dag*
Kans op vertraging	30 procent	10 procent	20 procent
Bustype	Gewone bus		
Veiligheidsmaatregelen	Extra bewakingscamera's en beveiligingspersoneel	Gemiddelde aanwezigheid fietsvoorzieningen	Extra bewakingscamera's en beveiligingspersoneel
Veiligheidsniveau omgeving	Gemiddeld	Laag	Hoog
Uw voorkeur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* Dit tarief geldt enkel indien u uw auto in de buurt van het station parkeert.

Vorige

Volgende

Figure 3: Decision table in questionnaire.

In the third and last part of the questionnaire some personal characteristics of the respondents' situation are asked. These personal questions are asked at the end because the respondents are almost done with the questionnaire and the focus may be a little bit less than before. The personal questions are only facts and therefore easy to fill in for the respondents.

The data is not randomly collected for the SP experiment. Because of the design of the research the data will be collected from a target group. The target group of the experiment is specifically, residents from the urban and suburban areas around the railway station of Eindhoven. Veldhoven, Nuenen, Valkenswaard and the city of Eindhoven except for the city center are areas around the railway station of Eindhoven that have a bus connection, car connection and bicycle connection with the railway station of Eindhoven and do not have another railway station nearby. The target group is chosen because of the following reasons. First, people that live in the suburban areas have to use a certain pre-transportation way to get to the railway station if they use the train as transportation mode. Therefore the pre-transport affects the transportation mode choice of these people. When a decision has to be made whether to use the train or car for a journey, the pre-transport will be taken into account. Second, there is no other large railway station present in any of the areas of the target group. So when the train is used as transportation mode, they are presumed to use a form of pre-transport. Third, the distance between the respondents and the railway station of Eindhoven is from about one to 17 kilometers. Within this range three forms of pre-transport are most likely to be used, the bus, bicycle or car. The postal code of the respondents will be asked in the questionnaire, so the transportation mode and possibly the pre-transportation mode choice can be linked to geographical characteristics of respondents.

DATA ANALYSIS

Table 1 shows a part of the output table of the Multinomial logit model. In the table only the attributes that are significant are included, so the attributes that are not included are left out. The first thing that was noticed when looking at Table 1 is that none of the attributes of the train trip are included and thus none of these attributes have a significant contribution to the transportation mode choice. This could be due to the decision making process of the respondents. When using between the car and one of the three train alternatives the characteristics of the pre-transportation modes may have been more important for the decision than the characteristics of the train trip. So this indicates that the pre-transport has more influence on the transportation mode choice than the train trip itself.

Table 9. Significant results of multinomial logit model

Transportation mode	Attributes	Attribute levels	β	Sign.
Car	In vehicle time (IVT)	50 minutes	0,15205	0,0046
		60 minutes	-0,08857	0,1083
		70 minutes	-0,06348	
	Costs of travel	10 euro	0,09140	0,0901
		14 euro	0,07656	0,1566
		18 euro	-0,16796	
	Parking costs	2 euro per hour	0,12914	0,0156
		4 euro per hour	0,00571	0,9167
		6 euro per hour	-0,13485	

Pre-transport Public transport	Time to get to bus stop	1 minutes	0,13531	0,0074
		4 minutes	0,01923	0,7027
		7 minutes	-0,15454	
	In vehicle time (IVT)	15 minutes	0,08758	0,0809
		20 minutes	0,05365	0,2912
		25 minutes	-0,14123	
	Costs of travel	1 euro	0,16690	0,0009
		2 euro	-0,10278	0,0460
		3 euro	-0,06412	
	Chance of delay	0 percent	0,18281	0,0003
		15 percent	-0,04436	0,3837
		30 percent	-0,13845	
	Type of bus	Regular bus	0,04151	0,4145
		Express bus	-0,08505	0,0970
		Shuttle bus	0,04354	
Safety measures	No additional measures	-0,11817	0,0212	
	Additional security cameras	0,09765	0,0511	
	Additional security cameras and staff	0,02052		
Safety level of the environment	Low	-0,09016	0,0769	
	Moderate	0,05239	0,3033	
	High	0,03777		
Pre-transport Bicycle	On vehicle time	20 minutes	0,14824	0,0052
		25 minutes	0,02722	0,6140
		30 minutes	-0,17546	
	Costs of parking bicycle	0.50 euro per time	0,12766	0,0163
		1.00 euro per time	-0,05090	0,3508
1.50 euro per time		-0,07676		
Pre-transport Car	In vehicle time (IVT)	10 minutes	0,21124	0,0002
		15 minutes	-0,00732	0,9011
		20 minutes	-0,20392	
	Time to get to railway platform	2 minutes	0,15203	0,0085
		5 minutes	-0,05007	0,3987
		8 minutes	-0,10196	

Inspecting Table 1 a little bit more reveals that most attributes that contribute to the transportation mode choice are travel time and monetary cost related. Only some attributes of public transport as mode of pre-transportation deviates from that. The outcome that most attributes related to travel time and monetary costs contribute to the transportation mode choice is in accordance with the expectations because transportation mode choice strongly depends on the time and money a journey or trip costs (Schneider, 2013). Besides the time and money related attributes, public transport as pre-transportation mode has more attributes that are of significant importance for the mode choice. First, chance of delay proves to be important, this attribute is related to time, but it has also to do with the uncertainty which travelers dislike. According to Brons and Rietveld (2008) travel time reliability is one of the most important aspects of quality for public transport trips. So if the travel time is uncertain due to a high chance of delay, it is less likely for travelers to choose

that alternative. Second, the type of bus is of importance, people are less likely to choose the express bus. This could be due to the fact that people like to choose what they know, which is probable the regular bus. Third, the safety measures influence the transportation mode choice.

The impact that attributes have indicate the weight of the contribution to the mode choice. Figure 3 shows the relative importance of each significant attribute of the research. The in vehicle time of the car as form of pre-transportation is the attribute with the highest impact of all. So it is likely that if the in vehicle time of this transportation mode is short, this mode will be chosen. Also the chance of delay and costs of travel for public transport as pre-transportation mode is of high influence. The in vehicle time for the car as well as the on vehicle time of the bicycle as mode of pre-transportation are two important characteristics in transportation mode choice.

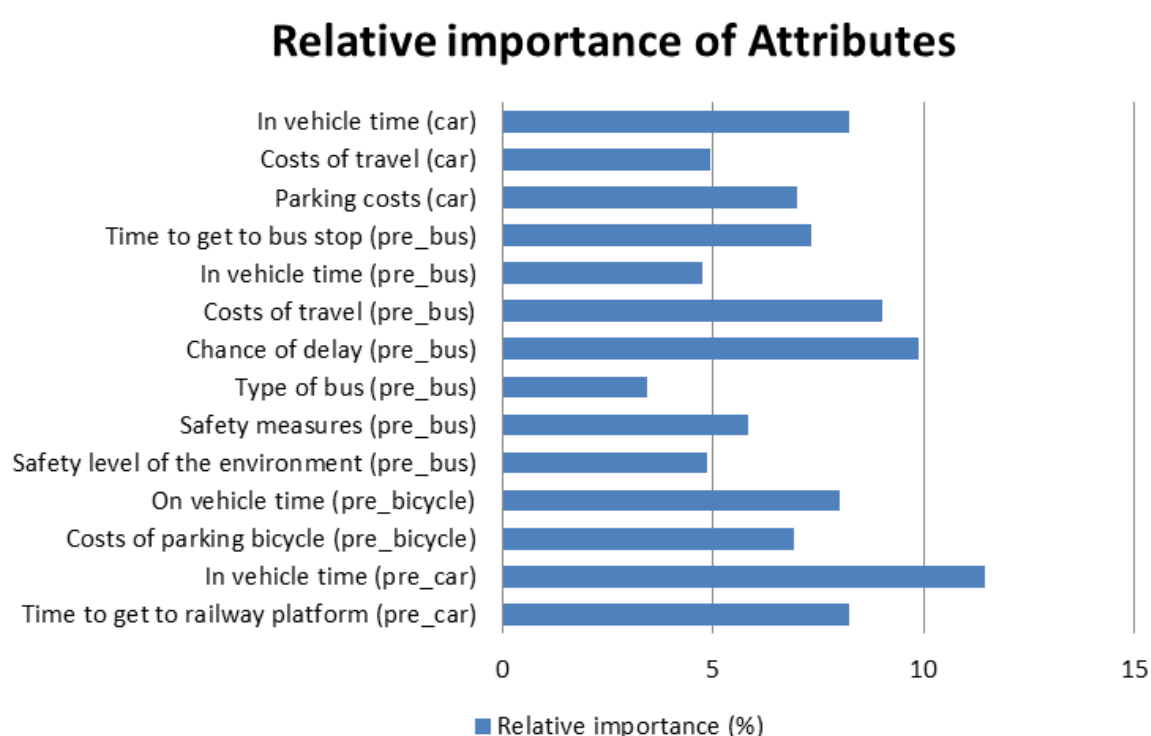


Figure 4. Relative importance of significant attributes include in the research.

CONCLUSIONS

The research in this thesis addresses a study of the influence of transportation mode characteristics on transportation mode choice. To collect data about the transportation mode choice, a research was set up and conducted in the region of Eindhoven. Respondents that are likely to use a form of pre-transportation when traveling with the train from the railway station of Eindhoven were approached to fill in a questionnaire including a stated preference experiment.

The results of the sample description of the research showed that the research reached the target group that was aimed for, people that live on a distance from the railway station that ensures a pre-transport trip when the train is used. These group of potential travelers proved to be a group with a wide variation and many different travel behaviors. The distribution of characteristics of the respondent group that was aimed for proved to be

present. The respondents that participated in the research are a pretty good representation of the Dutch population according to the sample description, this is useful information for parties that tend to use the research results for specific purposes. The current travel behavior of the respondents showed that journeys to cities could have different travel purposes. Each city has a different distribution of travel purposes. Also, the type of city seems to influence transportation mode choice. Cities with a high 'omgevingsadressendichtheid' tend to be visited more by public transport relative to the car. The pre-transportation mode of respondents shows a big difference with previous researches about the use of pre-transportation modes. Comparing the results with a research from Givoni and Rietveld (2007) that was based on the Dutch Railways (NS) customer satisfaction survey carried out in 2005, differences in pre-transportation mode use are present. In the research from Givoni and Rietveld the bicycle was used much more and public transport less. The differences between the researches are probably due to the differences in respondents characteristics. The pre-transportation modes that is used most by respondents in this research about the railway station of Eindhoven is the bus, followed by the bicycle.

The MNL model proved to be significant relative to the null-model according to the likelihood ratio statistics, but the ρ^2 was pretty low which indicates that it is not a really good fit on all aspects. Noticeable about the results was that attributes related to time and costs were most important on the transportation mode choice, this was expected due to previous researches that revealed that time and monetary costs are important aspects in choosing a specific transportation mode. Striking was that none of the attributes of the train trip were of significant importance to transportation mode choice. This indicates that the decision between the car and train as transportation mode choice depends on the characteristics of the car trip and the pre-transportation trips. So the characteristics of the pre-transport are really important factors for the transportation mode choice of the train and thus of the railway journey. If it is tried to influence transportation mode choice, changing time and money related characteristics would have the most influence.

RECOMMENDATIONS

The main conclusions of the results is that monetary cost and time related characteristics of trips are the most important in transportation mode choice. So when changes in transportation mode choice have to be achieved, it is best to make a change in those characteristics. To make a transportation mode more attractive, characteristics that influence transportation mode choice could be made more appropriate for the customers. Also, considering that push measurements are often much more effective than pull measurements, maybe the characteristics of transportation modes that should be used less, could be influenced negatively to reach the goal.

For governmental parties the results and conclusions of the research are relevant information about transportation mode choice of people. In policymaking the information can be used to form strategical policies and a tactical approach to address current problems. Governments have influence on many aspects and characteristics of transportation mode, direct as well as indirect. Increasing, e.g. excises and taxes, could be really useful ways of changing transportation mode choices of people and reducing private car use. Governments

could also promote the positive aspects of public transportation and the benefits it has to use them with the help of literature that is reviewed and shown in this thesis.

The Dutch Railways (NS) and other public transport facilitators, i.e. bus companies, could also benefit from the research. The most important characteristics for transportation mode choice are revealed and shown. These stakeholders could respond to the available information about the base of the transportation mode choice. Especially for bus companies it is important that the safety measurements are improved and the chance of delay is as low as possible. These proved to be two relatively unknown factors that are really important for the transportation mode choice.

REFERENCES

- Brons, M. & Rietveld, P., 2008. *Rail mode, access mode and station choice: The impact of travel time unreliability*, Amsterdam: Vrije Universiteit Amsterdam.
- Buehler, R., 2011. Determinants of transport mode choice: a comparison of Germany and the USA. *Journal of Transport Geography* 19, pp. 644-657.
- Givoni, M. & Rietveld, P., 2007. The access journey to the railway station and its role in passengers' satisfaction with rail travel. *Transport Policy* 14, pp. 357-365.
- Redman, L., Friman, M., Gärling, T. & Hartig, T., 2013. Quality attributes of public transport that attract car users: A research review. *Transport Policy* 25, pp. 119-127.
- Schneider, R. J., 2013. Theory of routine mode choice decisions: An operational framework to increase sustainable transportation. *Transport Policy* 25, pp. 128-137.
- Train, K., 2009. *Discrete choice methods with simulation*. Cambridge: Cambridge University Press.
- Ye, X., Pendyala, R. M. & Gottardi, G., 2007. An exploration of the relationship between mode choice and complexity of trip chaining patterns. *Transportation Research Part B* 41, pp. 96-113.

PERSONAL INFORMATION



K. (Koen) Sanders

This summary is the result of my graduation thesis about the role of pre-transport in travelers' transportation mode choice. I conducted this research about mobility and transportation aspects because the current relevance of these subjects and my personal interest in it. The graduation research was interesting and inspiring to do. I gained a lot of knowledge and experience while working on it and I hope that the conclusions of the research contribute to a better understanding of the transportation mode choice.

2015	Graduation project TU/e
2013-2015	Master Construction Management and Engineering TU/e
2010-2013	Bachelor Architecture, Building and Planning TU/e

THE FLEXIBILITY OF THE CONSUMERS AND THEIR PREFERENCES OF THE ENERGY BUNDLES

Author: Maaïke Schut

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. dr. ir. W. F. Scheafer (Chairman TU/e)

Dr. Ing. P.J.H.J. van der Waerden (Graduation Supervisor TU/e)

Dr. ir. E.G.J. Blokhuis (Graduation Supervisor Stedin)

Ir. A. Rijnveld (Graduation Supervisor Stedin)

Date of graduation:

25-02-2015

ABSTRACT

In the future, energy supply and demand will grow and be in greater flux than today. To prevent the network operators from reinforcing their energy grid, it is necessary to find new solutions; otherwise the energy systems will be unaffordable. One of the possible solutions is the energy bundle. This study developed an energy bundle based on the energy behaviour and the activity patterns of the energy consumer in the Netherlands. Through a survey, respondents were questioned about the preferences regarding the energy bundle and their activities. Ordinal regression analyse is used to analyse the preferences of the consumer and the willingness to change their activities by the energy bundle. As the last part this research explains the possibilities to introduce this energy bundle for Stedin, one of 8 the network operators in the Netherlands.

Keywords: Energy, Flexibility, Consumer behaviour, Network operators, Energy transition,

INTRODUCTION

The current energy systems in the Netherlands are demand-driven. Consumers can use energy every moment of the day for a fixed price. The current system consists of the network operator, the energy supplier, the energy consumer and the supervisor. Network operator is responsible for the pipes and the connections with the households, one of 8 network operators is Stedin. The suppliers take care of the consumer through the contract and the supply of energy. The consumer has contract with a suppliers. (ECN, Energie-Nederland en Netbeheer Nederland, 2014). Stedin ensures that consumers of Stedin are always provided with energy. The network operator is responsible for the transportation of electricity and gas. Stedin is the owner of all the stations, cables and pipes required for energy distribution in its region. It is the owner and responsible party for the meters at the consumers' houses. They are responsible only up to the point of transportation in industrial connections.

Traditional energy usage behaviour is changing, and new energy systems have been and will be developed. The use of renewable energy will increase. Consumers, private initiatives, and other collective projects will produce their own energy and will have an impact on the energy grid. The increasing use of solar panels, heating pumps, and electric transport has major consequences for our current energy system. Generating energy from renewable sources means that the energy network has to deal with large variability in supply of energy through solar and wind energy. The current energy systems are not designed for large-scale variable supplies of electrical energy and variable increases in demand. Technological innovations in combination with new services should make energy affordable and reliable in the future. And the energy systems need to be resistant to transition of fluctuation of the sustainable produced energy.

PROBLEM DEFINITION AND RESEARCH QUESTION

In the future, energy supply and demand will grow and be in greater flux than today. To prevent the network operators from reinforcing the energy grid, it is necessary to find new solutions; otherwise the energy systems will be unaffordable. One of the possible solutions is demand response. *Demand response* is defined as a customer's ability to alter electricity demand by reducing or shifting consumption in response to market prices or other market conditions (Chao, 2010).

An energy bundle is developed to determine whether it could provide a solution to the energy transition. At this moment is not known under what kind of conditions consumers change their behaviour. This research will investigate the flexibility of the energy consumer by identifying activity patterns and willingness to change their activities. And there will be investigated what kind of recommendations in the concept of the energy bundle preference the energy consumer. The following research question will investigate if the energy bundle can be a solution for the energy transition.

Under what conditions are consumers willing to give up their flexibility in energy consumption in the concept of the energy bundle?

Sub-questions:

To provide an answer to the main question, the following sub-questions will be investigated:

1. What will be the desire of consumers regarding energy use in the future based on energy consumption, future home technology and innovations?
2. Which energy bundles and attributes can be developed to meet the requirements of the consumer, the requirements of the network operators and the expected innovations in the future?
3. Which energy bundles and attributes do the energy consumers prefer?
4. How can the conditions of different consumers be merged into one business plan for a particular group of consumers. And what are opportunities for Stedin regarding the energy bundle.

ENERGY CONSUMPTION – ENERGY TRANSITION – ENERGY BUNDLE

Activiteiten, energie verbruik

Several studies have investigated behavioural changes and attitudes and have included experiments by energy consumers with new technologies. It appears that attitudes and behaviour do change—and change quite radically—over time. Understanding this process will be important in the area of energy consumption (Owens & Driffill, 2008). Research suggests that consumers often are not informed or are not sufficiently informed about their energy consumption and about energy saving possibilities in their houses.

Energy-saving behaviour is related to household energy conservation and can be divided into two categories: efficiency behaviour or investment behaviour and curtailment behaviour. *Investment behaviour* is about spending money on improving energy efficiency, such as on insulation. *Curtailment behaviour* involves repetitive efforts to reduce energy use, such as lowering thermostat settings. Contextual factors, knowledge, motivations, abilities and socio-demographic variables may influence energy-saving behaviour (Han, et al., 2013) (Abrahamse, et al., 2005). To develop a bundle for consumers, it is important to understand how consumers behave and what strategies have an effect on their behaviour.

The energy supply is in transition. We are slowly working towards electricity without CO₂ emission in 2050. Sustainability is the norm; fossil sources are slowly disappearing. It is expected that by 2020 there will be more wind onshore, offshore wind, co-firing biomass and solar energy, and less production of electricity with gas and coal. Consumers and businesses are increasingly producers of energy. Supply appears more and more on the demand side with changing demand patterns as a result. In upcoming years, the energy sector will state for the challenge to keep the balance between the supply and the demand 24 hours per day. Not only is the consumption of electricity uncertain; the presence of wind and clouds determines how much sun and wind power is available from moment to moment. Possibilities exist for storage and to influence energy demand through financial incentives and compensation systems to ensure that there is sufficient capacity. Converting to a solid system—in which energy remains affordable and the principles of the free market remain intact—seems a difficult puzzle at this moment.

The ability to shift demand moments to a lower electricity price or to a greater supply of renewable electricity will be very important in the future can be possible solution for the energy transition. In addition, flexible consumer behaviour and future potential of electricity storage are essential. To establish flexible behaviour among consumers, different motivations should be taken into account. Some consumers want to contribute to a more sustainable energy system, while others prefer to get a discount on their utility bill or will be happy to be self-sufficient. At the moment, there is no possibility for the consumer to use new developments as they want. The good news is that the government encourages the arrival of the new technologies such as subsidies for pilot projects and the rural import of the smart meter.

Through the smart meter, the consumer has more control over their energy consumption. It is possible to connect the smart meter with new smart technologies such as TOON¹ through apps on your cell phone (Stedin, sd) (ECN, Energie-Nederland, Netbeheer Nederland, 2013).

The behaviours of consumers and changes of the energy sources constitute a problem at this moment and will in the future. The problems that occur are mentioned. A possible solution to the energy transition: the energy bundle. An *energy bundle* consists of several characteristics, see figure 1. That can ensure the energy-behaviour change of consumers. In table 1, the characteristics of the energy bundle and the impact of these characteristics on consumers will be described. How can consumers be affected and how can an energy bundle use the characteristics of the consumers to change their behaviour?

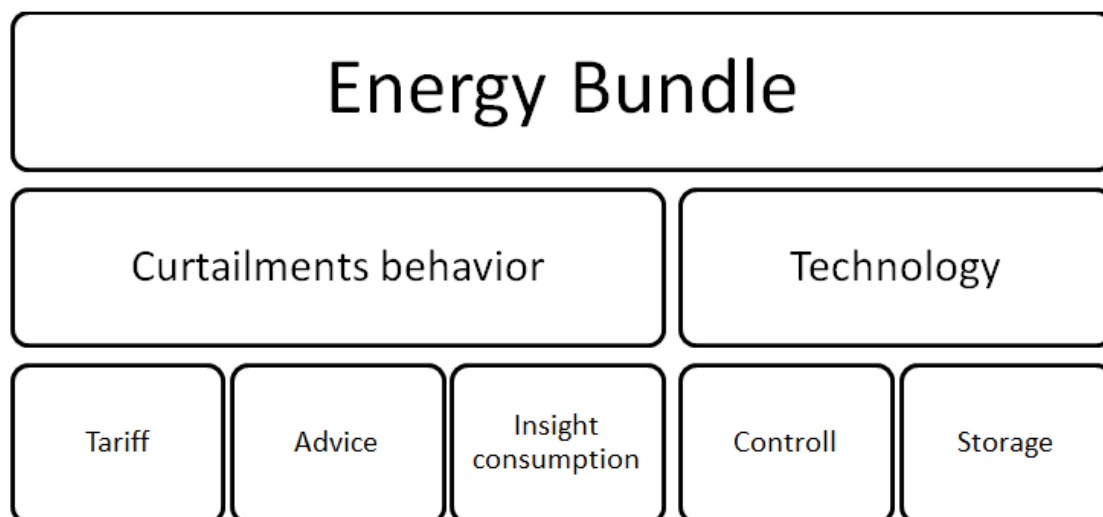


Figure 1 Energy bundle with the 5 attributes

¹ TOON is the smart thermostat of Eneco. More information about TOON on the website of www.eneco.nl/toon

Characteristics	Explanation
Variety of tariff	The variation of tariff shows what kind of flexible tariff the consumers have and whether or not they have moments where the energy tariff is lower than at other times. Because of this attribute, it is checked whether people change their activities on the basis of the variation of tariff.
Control	Control is an important attribute for the network operator. But Control can make life easier for consumers. Devices can search automatically for the best moment go on or out, based on the energy price. Network operators can thus control the devices or influence the devices on the basis of the amount of energy that is available. For example, the car can be recharged at times when there is a surplus of energy and not be recharged when there is a shortage. It is important to mention that consumers here obviously do not have any adverse effects.
Advice	As mentioned before, consumers are influenced on the basis of certain behaviour strategies. The curtailment strategies are described in paragraph 2.3. The conclusion of this paragraph, specific information about energy savings can ensure that a household can save energy depending on the level of advice. (Abrahamse, et al., 2005)
Insight energy consumption	Research shows that when consumers receive information about their energy costs or their consume energy that energy will be saved. Conscious as well as unconscious. (Abrahamse, et al., 2005). If consumers have a clear picture of when energy is cheaper or more expensive, they might adjust their activities. This is of course possible in combination with tariff.
Storage	Energy can be stored both for the benefit of network operators and for consumers. If consumers store energy when there is a surplus to use if there is shortage, then consumers save money. At this time a pilot is being carried out called Project Storage Of Energy. There is development going on. At this time, it is still not usable, but it will probably be useful for anyone in the future.

Table 1 Characteristics and the explanation of the Energy bundle

EXPERIMENTAL DESIGN

Stated-preference modelling, which was introduced by Louviere and Hensher in 1982 and by Louviere and Woodworth in 1983, is a method applied to investigate consumers' preferences and market shares regarding hypothetical alternatives by presenting different, mutually exclusive, future alternatives or scenarios (composed by means of experimental designs). Respondents are asked to choose the scenario they consider best: a first-preference choice task (E.g. Hensher, 1994 cited in (Heuvel van den, 2014)). In the Stated Preference survey, the respondent is asked what he or she would do in a specific situation that the researcher designed. This study uses stated preferences instead of revealed preferences, both because of the need to investigate preferences of consumers regarding non-existing energy bundles, and because it examines the impact of energy bundles on certain activities. The experimental design has led to further developments of the energy bundle and created the different attribute-levels and the questionnaire of this research.

The attributes of the energy bundle

▪ **Tariff**

This attribute indicates the type of energy tariff: flexible or fixed. From the literature study, it is clear that consumers can be influenced through price. In previous studies, different ways of investing were investigated. Consumers can invest their money to save energy (investment behaviour), or can be influenced by price curtailment. To investigate whether consumers are influenced by price, tariff type has been added to the energy bundle with the following levels.

- Fixed price: Always a fixed price. This is the current situation in the Netherlands.
- 4 day parts: The tariff is predetermined per day-part. Per day part, a certain price will be established. Four day parts have been chosen so that the moments when the sun is shining and when few people use power will be cheaper than the other two parts.
- Flexible: The day before, the tariff is determined for the next day.

▪ **Control**

Control specifies whether a consumer has the possibility to monitor his/her energy consumption by using a smart thermostat, smartphone, and other devices that can communicate with each other. The following levels are defined.

- No control: The consumer has all the control, but this means that the consumer cannot use devices that communicate with each other or with thermostats. This is a typical situation in the Netherlands.
- Self-Control: Using tools can exercise control on the consumers' devices and appliances, allowing them to communicate with each other to ensure that the consumer can make optimal use of energy. The consumer always has the control.
- Automatic: Smart devices are set to take advantage of the most favourable times without their users doing something. This method of energy consumption is the most optimal, because the devices ensure that energy is used at the lowest tariff.

▪ **Insight-energy consumption**

Specifies how often a consumer can view his/her energy consumption. The following levels are defined.

- Yearly: the consumer gets the final payment every year. This is the current situation in the Netherlands.
- Monthly: the consumer can check energy consumption every month.
- All time: the consumer can check energy consumption whenever he/she wants.

▪ **Advice**

Advice indicates at which level you can get advice to ensure that you know how to save energy and which possible beneficial investments you can make at your home or environment.

- No advice at all: the consumer gets no advice.
- General advice: the consumer gets general advice.
- Personal advice: the consumer gets personal advice concerning the most profitable way to save energy given their current situation.

▪ **Storage**

Storage specifies whether the consumer can use energy storage, whether the consumer can save energy when the energy price is low or when the consumer generated his/her own energy and used the stored energy at different times.

- Yes
- No

Attributes 2, 3, and 4 are based on the curtailment behaviour of the energy consumer. As discussed in chapter 2, Identifying The Energy Consumer, these intervention strategies can influence the energy consumption of the consumer. They can also ensure that the consumer saves energy. Attribute 1 is chosen to stimulate the behaviour the consumer based on the variety of tariff. And attribute 5 is a possible solution for the future.

Through using a questionnaire, information is collected about the respondents are collected. The respondents is questioned about their social and demographic characteristics, the performed activities and the preferences of the energy bundle. **Error! Reference source not found.**, shows the total questionnaire of this research.

RESULTS

The data from the questionnaire is collected and described and analysis by ordinal regression analysis. For this research 4 models were estimated: the general model, differences between male and female, the activities in relation to the energy beam, and a household's activity in relation to the energy bundle. The general model shows that self-control and insight into energy consumption are the most positive attributes of the energy bundle. However, automatic control and no storage also ensure a positive approach. However, this value is very small and thus less important. See **Error! Reference source not found.**. When the energy bundle includes self-control and no storage, respondents thus tend to approach the bundle positively. When the energy bundle consists of control, yearly insight into energy consumption, and storage of energy then they will value the energy bundle negatively. When examining whether respondents will adjust their activities to the energy bundle, it was revealed that none of the activities are significant. This means that the respondents are not prepared to adapt all of their activities to the energy bundle. Upon examining whether consumers like to adjust their household activities, it appeared that the activity washing machine is significant. The characteristics tariff and insight into energy consumption are important for determining whether respondents like to change the activity washing machine.

BUSINESS CANVAS

In this section of the research is investigated what the opportunities of the energy bundle can be for Stedin. **Error! Reference source not found.**, shows the summary of the business canvas. For Stedin can be the energy bundle a success, but they need to find a partner. For further investigation about the energy bundle. Also there is made a start with merging groups of people. It is also important to examine how groups can be merged. Because of the limited timespan of this research, it is not possible to group respondents out of the data. However, the possible options can be given concerning what will be possible combinations. So these options can investigated in further research. An important category is research into smaller regions. We can investigate what kind of people live in those regions, what their activities are, and what their preferences are regarding the energy bundle. In addition,

groups can be formed on the basis of the composition of the energy bundle. Furthermore, we can look into groups according to degree of energy awareness. Further research is needed to make a success of the energy bundle.

CONCLUSION AND FINDINGS

This study shows that consumers approach the developed energy bundle positively when the consumer has insight into energy consumption and self-control. However, consumers are not always willing to change their activities. This means that the offered composition of the energy bundle does not affect changes in the activities. The respondents will not adapt their activities to the provided energy bundle, and the proposed attributes. It is possible that other attributes can ensure that respondents change their activities. Further research is needed to investigate the other options.

However, consumers are willing to adapt their household activities to the energy bundle. In addition, the tariff 4 day parts and insight energy consumption yearly are important for those changes.

In general, the energy bundle can be a success for Stedin as well for the consumer. From the data it can be concluded that the energy bundle does not yet contain the desired attributes to allow consumers to change their activities. But the data indicate that consumers are willing to give the energy bundle a chance.

This study provides new insight into the preferences of energy consumers regarding their activities and the development of the energy bundle. It is not realistic to expect that the energy transition will be completely solved by the introduction of the energy bundle. The first limitation of this research concerns the questionnaire. The survey provided some form of disability. New products or unfamiliar topics can often not part of a survey, because a survey should be clear and easy to understand for every respondent. So the survey cannot contain too much explanation, which often is needed when introducing new or unfamiliar topics. So it is with the new products or innovations. See **Error! Reference source not found..**

An important limitation of the study is that it made clear how one person behaves in the household. Therefore, preferences in relation to the behaviour of one person were investigated. But 67% of the households of the research sample consist of two or more people. This study does not show how other people in households react. For example, a man fills in the questionnaire. He proves to be very flexible and is also willing to use his flexibility in relation to the energy bundle. However, he also has a wife and a child. The woman works part-time and takes care of the child. The woman is not at all flexible. But this is not known, because this research only questioned one person about his activities and did not consider the activities of his entire household. Further research is needed to see how total households will respond to the energy bundle and their flexibility.

It is possible to investigate the energy bundle further. It is possible to add the attributes price as one of the attributes of the composite energy bundle. And also it is important that consumers are able to calculate what their rewards are if they can be flexible. It can also be determined under which conditions consumers are prepared to change their activities.

REFERENCES

- Abrahamse, W., Steg, L., Vlek, C. & Rothengatter, T., 2005. A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, Issue 25, pp. 273-291.
- Chao, H.-p., 2010. Price-Responsive Demand Management for a Smart Grid World. *The Electricity Journal*, 23(1), pp. 7-20.
- ECN, Energie-Nederland en Netbeheer Nederland, 2014. *Energie Trends 2014*, Den Haag: ECN, Energie-Nederland en Netbeheer Nederland.
- ECN, Energie-Nederland, Netbeheer Nederland, 2013. *Energie Trends 2013- Vier gevolgen van de groei van hernieuwbaar voor het energiesysteem*, s.l.: ECN, Energie-Nederland, Netbeheer Nederland.
- Han, Q. et al., 2013. Intervention strategy to stimulate energy-saving behavior local residents. *Energy Policy*, Volume 52, pp. 706-715.
- Heuvel van den, S., 2014. *Extended shop hours in medium-sized city centres*, Eindhoven: University of Technology.
- Owens, S. & Driffill, L., 2008. How to change attitudes and behaviours in the context of energy. *Energy Policy*, Issue 36, pp. 4412-4418.
- Stedin, sd *Stedin- Netbeheerder, information about the smart meter*. [Online] Available at: <http://www.stedin.net/slimme-meter> [Geopend 14 January 2015].



Ing. Maaïke Schut

Born in 1990 in Heiloo. Maaïke began her engineering studies in Alkmaar in 2007, graduate as Bachelor of Built Environment in 2011. Willing to study further, Maaïke decided to focus on management aspect within the construction industry. Arising from this he has successfully completed the Master Construction Management and Engineering at the Eindhoven University of Technology in 2015.

2007 – 2011	Bachelor of Built Environment (minor: Project- and Process management
2009	Assistant planner at Teerenstra Bouw bv in Heiloo
2010 – 2011	Assistant Projectmanger OIII Architect and IQNN vastgoed in Amsterdam
2011 – 2015	Master Construction Management and Engineering
2015 – Now	Projectcoordinatior at Draaijer + Partners in Utrecht

POTENTIAL TRANSFORMATION OF VACANT OFFICES INTO HOUSING FOR YOUNG PEOPLE:

Optimization of Decision Making Process

Author: Mark van Swam

Graduation program

Construction Management and Urban Development 2013 – 2014

Graduation committee

Prof. dr. ir. W.F. Schaefer (Chairman TU/e)

Dr. ir. B. Glumac (Graduation Supervisor TU/e)

Prof. dr. ir. B. van Weenen (Graduation Supervisor TU/e)

Date of graduation

13-08-2014

ABSTRACT

Both vacancy and transformation of existing buildings are of all ages. However the last few years the market is changed into a so called replacement market. The office stock in use is fairly stable, there is no demand for expansion. So the new buildings are mainly built to replace the old stock. This construction of new real estate leads to oversupply and so we can speak of a buyer's market. An increasing proportion of this supply is outdated and will be difficult to rent without any adjustments, even with a strong economic recovery. In order to prevent extended vacancy, it is necessary that a substantial portion of the outdated stock on the market will be removed. (Voordt & Geraedts, 2007) This imbalance can be explained due the fact that the labor force stops growing, the "new way of working" is gaining popularity and the surface area per workplace per employee decreases. (Besselaar, 2011)

Transformation of existing offices is a sustainable way of addressing vacancy; either through residential conversion or within use adaption. The solution for vacancy can be different for each case because not every property is vacant for the same reason. Transformation of vacant offices is related to multiple factors and actors with many conflicting interests, involvement or investments, which results in a complicated process. But the most important part is that transformation only makes sense when the new function(s) provide in need. The supply must match demand, in terms of characteristics and location of building. This research gives an overview of the most important factors and barriers that influence the transformation potential of vacant offices into housing for young people, from both supply and demand side. The results of this research form the input for a support tool which allows an investor to make a substantiated financial feasibility study in a quick way at an early stage of the transformation process.

Keywords: Office vacancy, transformation, housing choice behaviour, decision making process, Discrete Choice Experiment, Pairwise Comparison, DCF

INTRODUCTION

A small oversupply within the office market is necessary to react on the dynamics of the market. A “healthy” vacancy rate should be around 5% till 7% of the stock (Besselaar, 2011). It is well known that the vacancy rate in the Netherlands related to the office market is “unhealthy” for several years. To indicate the size of this problem, some facts will be addressed. The office stock within the Netherlands consists of 49,4 million m² of which 7,3 million m² is vacant. This means a vacancy rate of 14,7%. (Zadelhoff, 2013)

Stock in use

x 1.000 m² (≥500 m² lettable floor area)

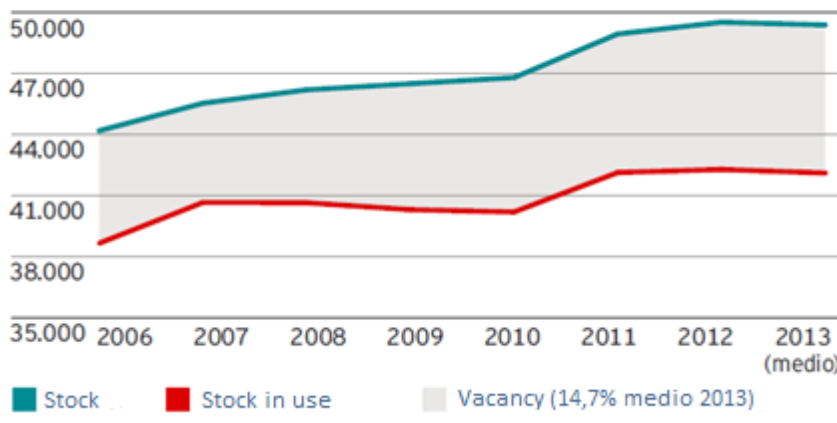


Figure 1 Office stock in use (source: Bak, DTZ Zadelhoff)

This imbalance can be explained due the fact that the labor force stops growing, the "new way of working" is gaining popularity and the surface area per workplace per employee decreases. (Besselaar, 2011) In order to prevent extended vacancy, it is necessary that a substantial portion of the outdated stock on the market will be removed. (Voordt & Geraedts, 2007) One way to do this is through transformation of vacant real estate. However it is not realistic to expect that the vacancy problem will be completely solved by transformation. Location and quality play a crucial role in this issue. For example transformation of one building located on a mono-functional office locations into housing units will not be feasible in both financial and social way. (Besselaar, 2011) Most common problems that ensure that a project is not feasible are depreciation, the location and layout or the collaboration with the municipality. (Besselaar, 2011; Heath, 2001; Houtveen, July 2002)

Problem definition and research question

For an investor it is important to distinguish vacant buildings with potential for transformation as early as possible in the process. This is important because feasibility studies during the initiative and definition phase need a large investment of both time and money, while there is no guarantee for success. An large amount of vacant real estate is “available” for transformation, but an investor must determine quickly whether the vacant offices are suitable for other purposes and if transformation is financially feasible.

An investor has the goal to optimize the exploitation of vacant offices by maximizing returns and minimizing risks. A lot of vacant offices are “available” for transformation which gives difficulties in the quick assessment process regarding the potential for transformation into housing for young people.

This potential is based on many parameters and sub-parameters, for example market, location, building and finance. All these factors collectively determine the possibilities and potential of transformation. Despite everything, transformation of vacant offices only makes sense when the new function(s) provide in need. The supply must match demand, in terms of their characteristics and location of the building. (Dam, 2013; Voordt & Geraedts, 2007)

So successful transformation of vacant real estate depends on several factors and characteristics. Physical attributes as building depth, accessibility, facades and the structural frame are important factors but also location, age and legal and social attributes are important factors to take into account. (Voordt & Geraedts, 2007) Besides these building characteristics there is a significant influence through the dynamic working of the market, tenants wishes, the risk factor, requirements and the strategy of the investor. Because of these multiple factors and actors the process is complicated which makes it difficult for an investor to investigate whether a project / transformation is feasible or how to minimize the risks. (Besselaar, 2011) It is obvious that the financial aspect is one of the many factors that influence this process. This context leads to the following research question:

“How can the process of assessing the suitability of vacant offices for transformation into housing for young people be optimized?”

In order to understand the problem better, the problem is divided into sub-questions:

- Sub question one:* Which factors have influence on the transformation potential of vacant offices?
- Sub question two:* What are the main preferences / needs of the target group (young people) regarding transformation and housing?
- Sub question three:* Which (success-) factors need to be examined regarding the suitability for transformation into housing for young people before a justified and non-binding offer can be made on a property?
- Sub question four:* How could a (structural) vacant office be evaluated regarding the suitability for transformation into housing for young people? Suitability on technical, geographical, legislative and financial level.
- Sub question five:* What is the best way to optimize the project management with respect to the process of transformation to maximize the returns and minimize the risks that these kind of investments entails? How can a Decision Support Tool be composed to support this decision from the perspective of the investor?”

TRANSFORMATION PROCESS

The biggest differences between the traditional construction process and the transformation process occur during the initiative phase. The goal during this research is to optimize the decision making process at the beginning of the actual transformation process, within the initiative phase. This means that the right information is generated at an early stage of the initiative phase, so that it is easier to control the process and risks can be reduced.

The available knowledge and experience of experts can be used during the transformation process through a QuickScan that effectively assesses the building on building related factors

and attributes. By using the experience and knowledge of experts, the influence of these factors and attributes on the potential of the building regarding transformation may be determined. Combined with the housing needs of a specific target group, the feasibility of a specific building can be tested by using a QuickScan. Hereby it is important that the decisive criteria (called Vetocriteria) of a building are tested in the earliest stage that is possible. (Andriessen cited in Voordt & Geraedts, 2007) This optimization of the initiative phase is included in figure 2.

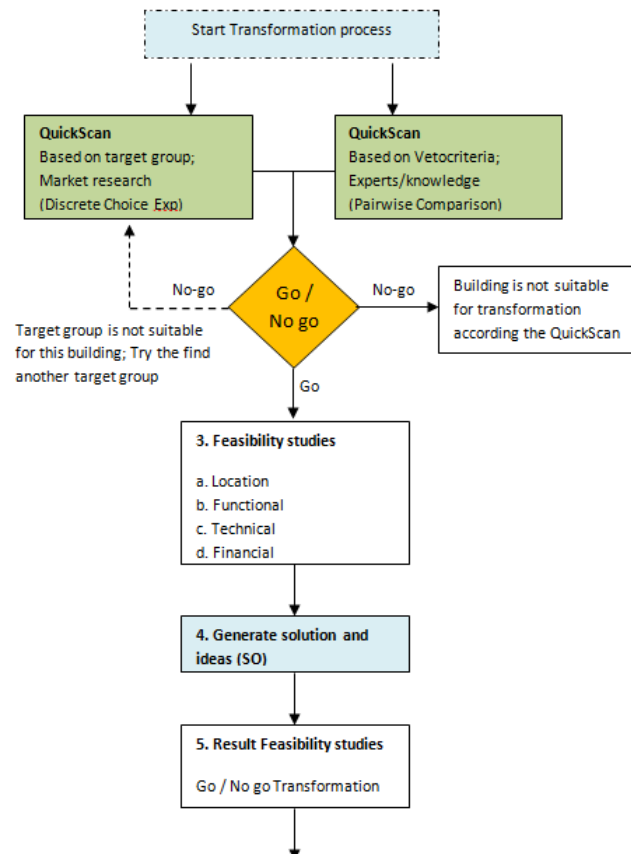


Figure 2 Optimisation initiative phase

When the housing needs and demands of the potential target group are known, based on a market research (Discrete Choice Model), a housing alternative can be assembled that gains the highest utility. Also the Willingness To Pay for this specific alternative could be calculated, the WTP will be used as a guideline for the potential rent. On the other hand the building can be evaluated based on criteria set by various experts, arising from the literature study and by using Pairwise Comparison.

Financial feasibility plays a central role in the investing decisions of companies and investors. During this research the Discounted Cash Flow (DCF) model will be used to calculate this financial feasibility. The conclusion of the QuickScan (Go or No-go) is based on this financial result. The (potential) rent is based on the Willingness To Pay arising from the DCM and the investment costs are based on a cost indicator which is justified by the use of a Pairwise Comparison experiment under experts.

DISCRETE CHOICE ANALYSIS

Housing choice decisions are complex in which many attributes are involved (Jansen et al., 2011 cited in Nijenstein, 2012). However, not all attributes are equally important from the perspective of the different actors in the transformation process. For example attributes regarding the Dutch building decree and other necessary permits are (most of the times) only concerning the developer and investor. Next to this there are also certain attributes and characteristics that will give the potential tenant (target group) sufficient utility so that they are more willing to rent certain housing units. These attributes depend upon the defined target group(s), but will always include price and location. Overall, these attributes can be divided into the following categories: Functional, Technical, Cultural, Legal and Financial.

The aim of this Discrete Choice Experiment is understanding the preferences of future tenants regarding possible housing units realized with transformation. Knowing the desired mix of attributes that a target group is looking for, might guarantee the success of the transformation project. As previously indicated in the report the focus is on the market segment existing of young people, a rapidly mutating and moving target group.

Influencing attributes

In housing choice decision research, four life-course careers are defined: labour career, family career, educational career, and housing career. Changes in each of these life-course careers influence the probability of moving: households will reconsider their housing situation because of changing needs. Young people, are in a unique life stage which is very dynamic with many occurring life events in all career paths (Coulter et al., 2010; Geist & McManus, 2008; Lee & Waddell, 2010 cited in Nijenstein, 2012).

Several studies have been conducted about the influence of housing characteristics and their influence on the choice to live somewhere or not. Housing characteristics such as **price** and **size** are thought to influence housing preferences and housing choice behaviour substantially (Dieleman, 2001; Lee & Waddell, 2010; Lindberg et al., 1989; Louviere & Timmermans, 1990; Molin et al., 1996; Molin, Oppewal, & Timmermans, 2001; Timmermans, Borgers, Van Dijk, & Oppewal, 1992 cited in Nijenstein, 2012; Voordt & Geraedts, 2007). Next to that, aspects of the residential environment and **location aspects** as **green areas**, parking facilities and **accessibility** are from a lesser extent but still influential on the housing choice behaviour (Kim, Pagliara, & Preston, 2005; Lee & Waddell, 2010; Louviere & Timmermans, 1990; Molin et al., 1996; Lindberg et al., 1989 cited in Nijenstein, 2012; Bouwmeester, 2006)

More functional attributes that are mentioned often within the different literature are the **type of housing units** (apartments, studio, etc.) and the **outdoor space** (garden, balcony, etc.) (Voordt & Geraedts, 2007; Nijenstein, 2012; Vasilache, 2013; Beurden, 2013). Student housing providers and organisations in the Netherlands have conducted quite some research on students' housing choice behaviour in the Netherlands (e.g. Gjaltema, Vijncke & Poulus, 2009; Laagland'advies, 2009; Poulus, 2011; Rabobank, 2006; Van Alphen, 2010; WonenBreborg, 2009, 2011 cited in Nijenstein, 2012) (Voordt & Geraedts, 2007). In these studies, price, size, condition of the complex, **shared versus private facilities** and accessibility of city centre, facilities and campus were found to be important in housing choice decisions for students. In addition to these frequently mentioned attributes, it is interesting to see if the **formerly use** of the building influence the housing choice behaviour of the potential user. The formerly

use influences the exterior, the appearance and the layout of the building. But does the former use of the building also affects the housing choice behaviour of the potential target group. Preferences and wishes of each individual within the target group can be translated into a choice. Choices are based on income combined with the degree of satisfaction, utility, that the product offers. (Hensher, Rose, & Greene, 2005)

A common objective in the use of discrete choice models is the derivation of measures designed to determine the amount of money individuals are willing to forfeit in order to obtain some benefit from the undertaking of some specific action or task. Such measures are referred to as measures of willingness to pay (WTP). Hensher, Rose, & Greene (2005) state that the WTP can be calculated as the ratio of two parameters estimates, holding all else constant. Provided at least one attribute is measured in monetary units, the ratio of the two parameters will provide a financial indicator of WTP. (Hensher, Rose, & Greene, 2005)

The attributes that are used within the Discrete choice experiment to calculate the Willingness To Pay are given in table 1. The attribute levels represent the levels assigned to an attribute as part of the experimental design process. These are represented by numbers that will have no meaning to the decision maker being surveyed. That is why, attribute level labels are assigned. These labels may be numbers (quantitative) or words (qualitative). (Hensher, Rose, & Greene, 2005)

For the complete explanation of the research method Discrete Choice Modeling (DCM) and the application of DCM within this research it is recommended to read chapter 4 of the complete report.

Results

The WTP table should be read as follows. Each attribute has a basic level, which is level 1. This gives the basic value that a potential tenant is willing to pay for this attribute level. The WTP for the 2 remaining levels of each attribute are values that a potential tenant is willing to pay more or less comparing to the base level. Within the column WTP per level, the real price is given that young people are willing to pay when this level occurs in the offered housing alternative.

Attributes	Levels	β_{levels}	Price	WTP ($\beta_{\text{levels}} / \beta_{\text{price}}$)	WTP per level
			[PR=0] β_{price}		
Facilities	Shared facilities	-1.527	-0.261	-5.85	2.77
	Semi-private fac.	-0.723	-0.261	-2.77	5.85
	Private facilities	2.250	-0.261	8.62	8.62
Housing unit	Room	-0.718	-0.261	-2.75	1.59
	Studio	-0.416	-0.261	-1.59	2.75
	Apartment	1.134	-0.261	4.34	4.34
Outdoor space	None	-0.844	-0.261	-3.23	1.07
	Balcony	-0.278	-0.261	-1.07	3.23
	Garden	1.122	-0.261	4.30	4.30
Distance to City Centre	3km < Distance	-0.441	-0.261	-1.69	0.51
	1km < Dist. ≤ 3km	-0.133	-0.261	-0.51	1.69
	Distance ≤ 1km	0.574	-0.261	2.20	2.20
Distance to Puclic Transport	3km < Distance	-0.493	-0.261	-1.89	0.38
	1km < Dist. ≤ 3km	-0.099	-0.261	-0.38	1.89
	Distance ≤ 1km	0.592	-0.261	2.27	2.27
Storage space	Not available	-0.306	-0.261	-1.17	0.37
	Outside the building	-0.096	-0.261	-0.37	1.17
	Inside the building	0.402	-0.261	1.54	1.54

Table 1 WTP Calculation attribute levels

PAIRWISE COMPARISON

It is often desirable in decision analysis problems to elicit from an individual, the rankings of attributes according to the individuals preference and to understand the degree to which each attribute is preferred to the others. A common method for obtaining this information involves the use of pairwise comparisons, which allows an analyst to convert subjective expressions of preference between two attributes into numerical values indicating preferences across the entire group of attributes. (Ozgur, Catak, Karabas & Yildirim, 2012)

By means of the weighting of various assessment criteria relative to each other, a relationship can be established between the various transformation attributes and the importance that is attached by the investor. Based on the assessment of the building in relation to this criteria a final judgment can be made about the transformation potential of the building . The class distribution shows with a number from 1 to 5 the potential that the office building has regarding transformation. 1 = very suitable for transformation, high level of potential; 5 = not suitable for transformation, low potential. This class distribution is based on the distribution used in the “Transformatiepotentiometer” from Geraedts and Van der Voordt (2004). Pairwise Comparison will be used to justify the level of intervention.

Translation of construction costs per transformation class is based on Van Dam (2013), Geraedts, Voordt & Thorn (1998) and Voordt & Geraedts (2007), calculated with known cost indicators. The translation is shown in table 2.

Transformation class	Intervention	Costs	Cost indicator transf.*
1 = Very suitable for transformation	Light	Low costs	40% * modernization
2 = Suitable for transformation	Modernization	Limited costs	50% * SPA
3 = Limited suitable for transformation	Strong	Moderate costs	145% * modernization
4 = Hardly suitable for transformation	Very strong	High costs	200% * modernization
5 = Not suitable for transformation	Strip-rebuilt	Very high costs	120% SPI

Table 10 Building costs

In solving a multi-attribute decision problem, one needs to know the importance or weights of the not equally important attributes to evaluate alternatives with respect to the attributes. All judgments of the various pairwise comparisons are summarized in a Comparison Matrix. In real-life decision problems, pairwise comparison matrices are rarely consistent. Nevertheless, decision makers are interested in the level of consistency of the judgments, which somehow expresses the goodness or “harmony” of pairwise comparisons totally, because inconsistent judgments may lead to senseless decisions. It was shown by Saaty (1980) that a pairwise comparison matrix is consistent if and only if it is of rank one. When a pairwise comparison matrix is consistent, the normalized weights computed from this matrix are unique. (Bozoki & Rapcsak, 2008) In order to keep the total score of a building regarding the Pairwise Comparison organized, the score will be rescaled to a transformation score with a range from 0 to 100.

Results

Looking at the results, the following can be concluded. The experts found the main categories, functional (46%) and technical (29%) the most important categories in terms of transformation potential. The underlying idea to consider the category functionality so important could be that this category includes several criteria that are not able to change and on which the investor has no influence. In addition to this, the technical category is important because these criteria could bring high potential construction costs, what could make it harder to realize financial feasibility.

From a functional point of view, the criteria expansion possibilities (26%) and flexibility (24%) are the most important. Expansion possibilities, may increase the chance of financial feasibility, when basic transformation without expansion is not feasible. The investor does not need to make more acquisition costs, to realize more lettable floor area. In addition to this, it is advantageous when a vacant building consists out of large flexible rooms. In this case the investor does not need to demolish a lot of the interior and the layout of the building can be organized freely.

From a technical point of view, the criteria state of construction (23%) and asbestos (17%) are the most important. The state of construction is clearly important because it could bring high cost when the state is not good. Also asbestos plays an important role. When a building is older than 1992 there is a risk of presence. In advance an investor does not know to what extent asbestos can be present, that is why it is important to do an asbestos inventorying for building older than 1993. Another conclusion to be made is that in terms of importance all other criteria are equal to each other.

Criteria that have very little influence on the transformation potential are the main category cultural (8%) and the criteria Administrative support (14%) under the main category legal

(17%). Both categories contain aspects which are less important to the transformation potential of a building, but are more important in the personal feeling towards the location and building comparing to the investor.

FINANCIAL FEASIBILITY

Rental of office space delivers more rent per square meter than for living space. In relation to this, a high book value of an office building can therefore constrain the economic profitability of a transformation project.

The financial feasibility is a critical success factor during a transformation process. (Voordt & Geraedts, 2007) This financial feasibility is based on an exploitation calculation. (Remoy H. , 2010) When the Net Present Value (NPV) is zero or greater than zero, the redevelopment is financially feasible.

The aim of the discounted cash flow models is to approximate intrinsic value and the main principle of the models to find the present value of the future expected cash flows on an asset. To find the present value of an asset the models require the knowledge of the life of the asset, expected annual cash flows over the life of the asset, and an appropriate discount rate as inputs. Based on empirical evidence, these models can be found to work best when the cash flows produced by an asset are positive (Damodaran cited in Perek & Perek, 2012).

CONCLUSION AND FINDINGS

The results of both the Discrete Choice Experiment as the Pairwise Comparison method are used in a support tool that can help an investor to give an substantiated answer to the question whether a vacant office building is suitable for transformation into housing for young people or not. So the potential of a vacant building is observed from both perspectives, demand and supply side. This ensures that the process of assessing the vacant building is more efficient. Financial feasibility plays a central role in the investing decisions of companies and investors. In the support tool the financial feasibility is tested according the Discounted Cash Flow (DCF) method. Hereby the (potential) future rent is based on a Discrete Choice Experiment that will be translated into the Willingness To Pay (WTP). Next to this, the investment costs will be based on a cost indicator which is justified by the use of a Pairwise Comparison experiment under experts.

Regarding the target group preferences it is remarkable that not the high level of price but the attribute levels concerning shared facilities, semi-private facilities and no outdoor space have the biggest negative influence on housing choice behaviour. The attribute levels as private facilities, apartment and garden have the biggest positive influence. Of course this is also reflected in the willingness to pay.

Resulting from the Pairwise Comparison method the experts found the main categories, functional and technical the most important categories in terms of transformation potential. From a functional point of view, the criteria expansion possibilities and flexibility are the most important. From a technical point of view, the criteria state of construction and asbestos are the most important. Criteria that have very little influence on the transformation potential are the main category cultural and the criteria Administrative support under the main category legal.

REFERENCES

- Andriessen, J. (1999). *Procesmanagement van transformatie*. Delft: TU Delft.
- Besselaar, M. (2011). *Structurele leegstand, Voorkomen is beter dan genezen*. Amsterdam: Amsterdam School of Real Estate.
- Dam, L. v. (2013). *Leegstand in verzorgingshuizen*. Delft: TU Delft.
- Heath, T. (2001). Adaptive re-use of offices for residential use. *Elsevier*, 173-184.
- Hensher, D., Rose, J., & Greene, W. (2005). *Applied choice analysis: a primer*. Cambridge, UK: Cambridge University Press.
- Houtveen, H. (July 2002). *Upgraden, renoveren of herontwikkelen van kantoren*.
- Nijenstein, S. (2012). *Determining the role of values in students' housing choice behaviour with latent class and mixed logit conjoint analysis methods*. Eindhoven: Technische Universiteit Eindhoven.
- Voordt, T. v., & Geraedts, R. (2007). *Transformatie van kantoorgebouwen*. Rotterdam: Uitgeverij 010.
- Zadelhoff, D. (2013). *Nederland compleet, Kantoren- en bedrijfsruimtemarkt*. Amsterdam: DTZ Zadelhoff.



Mark van Swam

Born in 1990 in Tiel. Mark began his engineering studies in 's-Hertogenbosch at the Avans Hogeschool in 2007, graduating as Bachelor of Built Environment in 2011. Willing to study further, Mark decided to focus on the management aspect within the construction industry. Arising from this he has successfully completed the Master Construction Management and Engineering at the Eindhoven University of Technology in 2014.

- | | |
|-------------|---|
| 2007 – 2011 | Bachelor of Built Environment (minor: Building economics) |
| 2010 – 2014 | Assistant planner at De Vree & Sliepen in Tiel |
| 2011 – 2014 | Master Construction Management and Engineering |
| 2014 – Now | Management traineeship at Heijmans |

THE INFLUENCE OF TRAIN STATIONS' ENVIRONMENT ON TRAVELERS' ORIGIN STATION CHOICE BEHAVIOR: a TOD approach

Author: A. V. (Alexandra) Tudorica

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. Dr. Ir. W.F. (Wim) Schaefer (Chairman Master CME, TU/e)

Dr. Ing. P.J.H.J. (Peter) van der Waerden (Graduation Supervisor TU/e)

Dr. Ir. B. (Brano) Glumac (Graduation Supervisor TU/e)

Ing. Jildou van der Sluis (Research Manager NS Stations)

Dhr. Willem van Heijningen (Station Developer NS Stations)

Date of graduation:

15-07-2014

ABSTRACT

The purpose of this research is to determine the influence of the surrounding environment of train stations on Dutch travelers' origin train station choice behavior. The area surrounding the stations is characterized according to TOD theory. The research data was collected using a questionnaire distributed in 8 stations located in Amsterdam. A multinomial logit model was estimated to describe the effect of independent variables (station, trip related, personal and surrounding environment characteristics) on the dependent variable (origin station choice). The results show that distance, density, proximity and P+R play an important role in deciding to use a train station as origin station. Age, frequency of use, and travelers' general opinion about the station have an effect on the choice of an origin station as well. Understanding how travelers choose a departure station can help NS – Dutch Railway Company, to redistribute the flow of travelers from crowded stations towards less crowded stations.

Keywords: train station choice behavior, Transit-Oriented Development (TOD), revealed preference (RP), Multinomial logit (MNL), sustainable transport

INTRODUCTION

Transport infrastructure and urban development have always had a strong and complex connection and in the Netherlands, great interest has been shown in defining this relationship. Dutch urban planners sensed the benefits of a compact development around transport infrastructure since 1980s, but nowadays another planning method captured their attention, namely Transit-Oriented Development (TOD). TOD theory emphasizes how public transport and urban planning can favor each other, providing the means, the directions in which the environment around a station *can* (as opposed to *must*) be organized. TOD is characterized in terms of 5Ds: density, diversity, design, distance to transit, and destination accessibility. By focusing on the implementation of TOD, sustainability is enhanced. Another reason for which TOD received increased attention is the economic crisis, which limited the means to invest in large-scale spatial development and infrastructure projects, as well as the demand for new housing and office locations.

Not only contributes the organization of the station's surrounding area to a better (sustainable) urban development, but it is demonstrated in the literature that it plays a role in travelers' station choice behavior as well (Debrezion, et al., 2009; Cascetta, 2013). The focus of the present research is on train, as a transport mode, since railway transport represents a considerable proportion of daily travel mode chosen by Dutch travellers (Debrezion, et al., 2009). Moreover, one particularity of the Dutch context is the centrality of train stations for TOD approach.

Problem statement and research questions

Nederlandse Spoorwegen (NS) is the Dutch national Railway Company which operates in public transport sector, providing trains and busses, in the Netherlands. Nowadays, NS is confronting with congestion-related issues at the main station level (e.g. Utrecht Centraal, Amsterdam Centraal etc.), while alternative stations that offer less opportunities in terms of shops, cafes, train frequency, connecting public transport etc., are not very well used. An increased demand for particular station is affecting not only the station itself (high crowding level on the platforms, access-way, in-vehicle, etc.), but also the surrounding area of a station: crowded buses, taxis, no available spaces for parking the bikes and cars. This situation is affecting travelers' experience of the station in a negative way, which might lead to a decrease in the number of people using the train and a decrease in the turnover of the company. One solution to prevent travelers to move to alternative transport modes (e.g. car) is to redirect the flow from main stations towards other stations. In analyzing this possibility, NS is interested in extending its focus, from station only to the surrounding environment of the station as well, since it plays a role in the travelers' satisfaction. In order to determine which characteristics describing the surrounding environment of a train station are attracting the travelers, it is important to understand how travelers choose their train station. Being one of the first attempts to determine the role of the surrounding environment in the station choice decision-making process of the travelers, the focus is on the origin station of their trip with the train since on the short-run the choice stays the same and the station (and the area around) is (well) known by the traveler. However, additional developments at the other stations can determine the travelers to choose differently.

In order to address the issue stated above, the main research question can be formulated as follows: *"What attributes of train stations' environment are influencing travelers' origin station choice behavior?"*

To give an answer to this central question, some sub-questions need to be addressed as well:

1. How can train stations and their surrounding area be characterized in the context of travel behavior related aspects?
2. What influence do these features have on Dutch passengers' choice of origin station to enter a train?

Relevance

The relation between urban form and travel behavior is not amply addressed (e.g. Estupiñán & Rodríguez, 2008). As far as the author knows, limited literature is available on station choice behavior in connection with built environment/urban form. This study aims to determine characteristics from the available literature regarding urban form and transportation and build a measure instrument to determine their influence on travelers' station choice behavior. Moreover, this research project emphasizes how travelers can be

redistributed to other stations if new services or improvements are introduced. By redistributing travelers among the stations, the usage of stations is leveled, leading to more benefits: decrease congestion at the big stations, increase the usage of smaller stations, and achieve regional success as opposed to node or station success for the service operator (here, NS).

RELATED WORK

Railway station choice behavior

Once the choice is made for the train as a transport mode to travel from A to B, the next issue to decide upon is which station to use; train stations are the access points to train service. Nevertheless, even if it is the next logical step, the choice of the departure station did not receive a great attention from researchers.

One of the firsts to address the issue of rail transit station choice was Kastrenakes (Kastrenakes, 1988). The results of the choice model developed for New Jersey transit agency (NJ TRANSIT) indicated that the location of the station in the residential area of the travelers and the frequency of service had a positive effect, while the access time to reach the station and the generalized cost of the rail trip from the departure station had a negative one on the choice of a particular departure train station. Even though it is not focused on train, but metro station and it is closer to the idea of TOD, the study of Cascetta (2013), of the present research thesis, analyzed the value of beauty/design, travel and access time, service frequency and monetary costs in Naples. The findings suggested that the choice is influenced by the aesthetics of the station/area, total waiting time and ticket fare. Access, egress and transfer time, as well as total in-vehicle time parameters proved not to be statistically significant.

In the Netherlands, two studies are of special interest. Debrezion et al. (2007) applied a multinomial logit model to analyze the choice behavior. The results revealed that distance, calculated as a Euclidean measure between the centroid of the post-code center and the station in the choice set, frequency of service, intercity status of the station and the presence of park and ride facilities have a significant effect on the choice of departure station. The intercity status of the station has the biggest effect on the choice of the departure station, followed by the presence of a park and ride facility in the station. The probability of choosing a specific station diminishes with the distance, while it increases as the service frequency increases. One of the latest researches on railway station choice is provided by Givoni & Rietveld (2014). Amsterdam region was used as a case study, data from NS customer satisfaction survey and a discrete choice model was employed. Their findings reinforced the idea that not many Dutch passengers are choosing the nearest departure station. To estimate the choice of a departure station, a nested logit model was applied, built upon two factors: railway service (number of destinations served directly, the service frequency at each station level and travelers' direction) and the accessibility of the departure station. The results suggested the importance of accessibility of the station and that distance plays an important role. Regarding the quality of the train station facilities in relation to the access modes, the coefficient for the quality of the bicycle parking was found "positive, relatively very high and significant" (Givoni & Rietveld, 2014).

As a general conclusion, one of the features defining the literature on train station choice is

scarcity, as Debrezion et al. (2007) noted in their article. The above brief literature review highlights some shortcomings. The present research thesis is trying to address and indicates in which way this research differs from previous efforts to address the choice of a departure station. First, the focus in the past research was on station's features (facilities and level of service) and mainly on accessibility. In addition the latter, was examined in relation to mode choice decision. The other TOD characteristics were included as variables in a model, but in a different manner that the present study does, and on international level, not for the Netherlands case. In the present research thesis, the analysis of the organization of the surrounding environment of the station is made from TOD perspective. A literature review about the concept of TOD is presented in the next section.

Transit-Oriented Development

In their highly acclaimed paper, Cervero & Kockelman (1997) grouped the TOD planning strategies in relation to transportation objectives into 3 dimensions (3 Ds): increased *density* to stimulate the transit ridership, enhancing *diversity* of land use for a better coverage of public transport, and pedestrian-oriented *design* to increase the number of non-motorized trips. Later on, Cervero & Murakami (2008) added two more dimensions (4th D and 5th D): *distance to travel* and *destination accessibility*, referring to the extent to which public transport is connecting in an efficient manner the station area and the activities within it. Regarding distance to travel, Cervero & Landis (1993) found that more people are using public transport instead of their own cars if the public transport stop is close to their home/work. By overlapping all this 5 Ds, sustainability and high quality of environments can be achieved (Cervero & Murakami, 2008).

In order to determine the 5 Ds sub-attributes characterizing the built environment in relation to transportation objectives and in particular affecting travel behavior, a literature search was realized. The reason for focusing on the general view of travel behavior and not only station choice behavior is the scarcity of the literature available for the latter purpose mentioned. The review of the available literature revealed the fact that travel behavior is not affected only by the built environment, but by station characteristics, personal characteristics of the traveler and trip attributes, as well. The main feature defining the analysis related to the relationship between urban form and built environment is diversity. Some selection rules needed to be developed and these criteria are presented in the "research approach" section of this summary.

RESEARCH APPROACH

A conceptual framework was developed to define the way in which the answers to the questions will be sought. The review of the literature represents the starting point of this research project. This phase gave an insight into the theory of TOD and station choice behavior; besides, it helped in the identification of the built environment dimensions, station aspects, travel makers and trip characteristics and their definition in relation to travel behavior. Therefore, the conceptual framework proposed here assumes that there is a relationship between the station choice and the attributes divided into the presented four categories and it can be seen in Figure 1.

This study represents an effort to determine the attributes of a surrounding area of a train station which are attracting travelers to use the train station as origin for their train trip. The

travelers' preferences were collected by employing revealed preference approach, in a relevant context (a multi-station city from which the travelers can consider feasible alternatives). A case study was set up, consisting in 8 stations (included in Table 1) from Amsterdam Metropolitan area. These 8 stations formed the choice set. The targeted respondents were asked in a paper-based questionnaire to indicate their most often used origin station and the alternative train station. The collected data is analyzed by using a discrete choice method, Multinomial Logit Model (MNL).

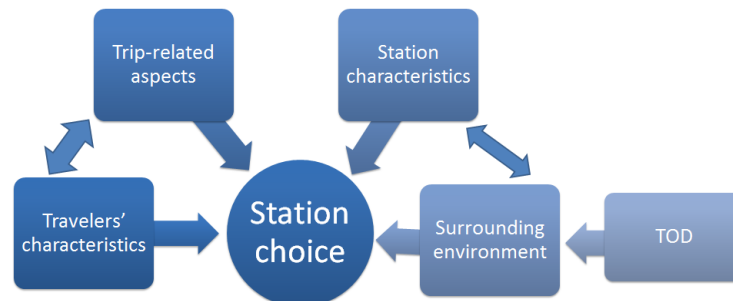


Figure 1. Conceptual framework

Based on the findings from the literature review, some characteristics defining trip-related aspects, travelers' characteristics and stations' surrounding environment were selected as attributes to be included in the questionnaire. Station characteristics were not considered at this stage due to the widespread analysis of them in the literature and within NS. Due to the lack of "standardized" descriptions for the 5Ds some selection rules were developed. An overview of the attributes describing the surrounding environment of a train station is given in the table 1. The main principles used for the selection are: the built environment dimensions are categorized under the 5 Ds (core dimensions), the selection of the attributes under the 5D categories will take the issue of multicollinearity into consideration and discussions with experts involved in TOD domain. Regarding the respondents' characteristics and travel related aspects, these were selected based on the assumption that they can explain station choice behavior.

Built environment (5Ds of TOD)	Density	Number of people in the catchment area
	Diversity	Presence of supermarkets
		Provision of a variety of shops
		Presence of restaurants, fast-food restaurants and cafes
		Overall (shops offer)
	Design	Presence of sidewalks, sidewalks quality, width, and presence of crossing aids
		Presence of pedestrian friendly amenities (benches, trash bins etc.)
		Bike-friendly design (presence of bike lines, speed, quality and width of them, presence of crossing aids)
		Car-friendly design (presence of roads, their quality, traffic speed, safety, stoplights provision etc)
		Aesthetics of the station's environment (art/architecture/building height)
		Presence of open/green spaces
	Destination accessibility	Overall design
		Provision of bike shelters
		Public transport connectivity
		P + R provision
	Distance to transit	Kiss and Ride provision
		Overall accessibility of the station
	The distance between the origin point of the trip and the origin station	

Table 11. Selected built environment variables

The questionnaire has three parts aiming to collect data about the travel experience - actual origin station choice and reason to choose it (part I), the composition on choice set (question

2) and reasons why it is chosen (part II) and data on personal travelers' characteristics (part III). The influence of built environment dimension on travelers' choice station behavior is assessed using a five-points rating scale (very negative, negative, neutral, positive, and very positive). The questionnaire was distributed by the fieldwork company Almere Marktonderzoek Advies B.V., in the selected stations during 2 working days in April 2014. According to Hensher et al. (2005), the choice-based sampling (CBS) is suitable for the collection of RP choice data and the rule of thumb suggests that at least 50 decision makers must be sampled for each alternative. Therefore, in each station, 50 respondents were asked to fill in the questionnaire. A total of 382 respondents were approached. The minimum 50 respondents was met for all the station, except for Amsterdam Sciencepark.

ANALYSIS

Only three stations were chosen as origin stations more than 50 times (Amsterdam Central, Amsterdam Amstel and Amsterdam Muiderpoort), out of which Amsterdam Central is by far the most used one (25,4%). This finding it is not surprising, but reflecting the real case and supporting the problem statement of this research paper: high crowding level at the stations offering more opportunities, while the stations with fewer opportunities are not among travelers' preferences. Table 2 presents a brief summary of the travelers' characteristics (research sample) and trip-related aspects (current travel experience).

Attribute	Level	Frequency	Percentage (%)
Gender (N=380)	Women	173	45,5
	Men	207	54,5
Age (N=380)	Younger than 45 years old	299	78,7
	Older than 45 years old	81	21,3
Education (N=376)	Middle-educated	105	28,1
	Higher- educated	271	71,9
Car owners (N=347)	Yes	134	38,6
	No	213	61,4
Travel time to the station (N=377)	Less than 8 minutes	118	31,3
	9 to 12 minutes	120	31,8
	More than 13 minutes	139	36,9
Frequency of use (N=382)	More than 4 days/week	162	42,4
	1-3 days/week	118	30,9
	1-3 days/month	45	11,8
	Less than 2 days/month	36	9,4
	Less than 2 days/year	21	5,5
	Walking	100	26,2
	Bike	109	28,5
Access mode (N=382)	Car as a driver	5	1,3
	Car as a passenger	7	1,8
	Public transport	161	42,1

Table 2. Travelers' characteristics and trip-related aspects

In what concerns the research sample, it can be stated that there were a large proportion of younger than 45 years old travelers filling in the questionnaire than old travelers and more

women. The present research sample is not a particular sample in comparison with the NS's sample. The majority of the respondents are living in Amsterdam and surrounding areas of Amsterdam (almost 80%), do not own a car (more than 61%) and are higher-educated. To arrive at the station, the highest number of travelers have a time duration of more than 15 minutes and are using as transport modes public transport (42,1%), followed by bike (28,5%) and walking (26,2). Public transport as being the most used transport mode to access the station is not a surprising finding for the Amsterdam case. In addition more than 70% are frequent travelers, using the train between 1 to more than 4 days/week.

The findings related to the influence of the surrounding area on Dutch travelers' origin station choice behavior revealed that all the attributes included under the 5Ds category have a positive effect, rather than negative. Distance and Destination accessibility (2 out of 5Ds) have the highest influence on the origin station choice. The other 3 Ds (Diversity, Design, and Density) have less influence, but they still affect the choice in a positive way. The positive influence of proximity and intensity (density) is supported by the model results as well. On the other hand, the Distance attribute has a negative influence on the choice. "Sidewalks", "Bike-friendly design", "Pedestrian amenities", "Public transport" and "Bike shelters" are attracting travelers, while "Presence of a variety of shops" and "Car-friendly design" sub-attributes have a negative influence. "Buildings", "Open Space", "P+R" and "K+R" have a more neutral influence on travelers' station choice behavior.

The outcome of the questionnaire and the findings from the literature review were combined in a characterization of the train stations in station-choice behavior context (see Table 3). The levels of these variables for each station (not detailed in this summary due to confidentiality reasons for some of them), together with respondents' age, frequency of use, main origin train station and their alternative were the input of the MNL model.

Characteristics	Type of variable	Levels					
		Level1	K1	K2	Level 2	K1	K2
Station	Station type	Continuous	Number				
	Types of trains*	Discrete	Sprinter*	1	0	Sprinter+Intercity*	0 1
	Number of trains/hour	Continuous	Number				
	Crowding level	Discrete	High*	1	0	Average*	0 1
	Transfer station	Discrete	Yes*	1	0	No*	-1
	Monument building	Discrete	Yes*	1	0	No*	-1
	General opinion	Continuous	Number				
	Atmosphere	Continuous	Number				
	Functionality	Continuous	Number				
	Safety	Continuous	Number				
	Number of passenger (average on a working day)*	Continuous	Number				
	Distance (average in minutes)	Continuous	Number				
	Proximity*	Continuous	Number				
	Intensity*	Continuous	Number				
Surrounding environment	Offices (nr of people working)*	Continuous	Number				
	Residential location*	Continuous	Number				
	Eateries/cafes/hotels	Discrete	Many*	1	0	Average*	0 1
	Shops	Discrete	Many*	1	0	Average*	0 1
	Supermarkets	Discrete	Yes*	1	0	No*	0
	Leisure/touristic attractions	Discrete	Many*	1	0	Average*	0 1
	Parks	Discrete	Yes*	1	0	No*	-1
	Public transport connectivity*	Continuous	Number				
	Bike shelters	Continuous	Number				
	P+R	Continuous	Number				
	K+R	Continuous	Number				

Table 3. Variables characterizing the station and its surrounding environment; coding (*effect coding) (Source: NS 2012, OPS Type 4,5,6, 2013, *Maak Plaats, 2013)

Some steps were taken before the modeling process (effect coding, correlation checks). Effect coding was used to represent the discrete variables. By employing this coding system,

a two level variable is represented by one parameter, while a three level variable is represented by two levels. For example, the presence of parks (named “Parks” in table 3) has two values -1 (level one for “No”) and +1 (level 2 for “Yes”), while crowding level has three levels coded as: “low”=1 (level 1: -1 -1), “medium”=2 (level 2: 0 +1) and “high”=3 (level 3: +1 0). Due to high correlation among the variables (a drawback of the data collection approach –RP), several alternative choice models were estimated.

An optimal model was selected to further analysis, based on some relevant criteria (high log likelihood value; should include at least one alternative-specific constant (due to its role of capturing the unobserved effect associated with a particular alternative, and include more variables describing the built environment dimension). An overview of the statistically significant variables which entered the utility function underlying the model is given in Table 4 (age and frequency of use proved to be significant as well, but they can be employed further only for group corrections for which the alternative-specific constant is referring to – here, Amsterdam Rai). The parameters (β coefficients for the variables) have the expected directions. The alternative-specific constant is referring to Amsterdam Rai station and has a positive sign because it needs a correction, an increase to reach the average of selected stations (it has been chosen 33 times by the respondents, in comparison with Amsterdam Central 97 times). The other positive coefficients of the variables mean that the higher the variable’s value, the more chances the station has to be chosen. On the other hand, the negative values of the coefficients for the rest of the variables suggest that a decrease in the value of the variables leads to a decrease in the chances that a station it is chosen (e.g. distance: the longer the distance, the lower the chance of a station to be chosen).

To illustrate the working of the model, the model was applied for a choice situation of two train stations: Amsterdam Central and Amsterdam Amstel. The utilities related to these stations and the probabilities of being chosen were calculated according to the formula:

$$V_i = \beta_{0i} + \beta_{1i} * f(X_{1i}) + \beta_{2i} * f(X_{2i}) + \dots + \beta_{ki} * f(X_{ki}) \quad (1)$$

The results did not match entirely the expected findings since the model predicts the higher likelihood of Amsterdam Amstel to be chosen by the travelers instead of Amsterdam Central.

Xi	Coefficient value	Amsterdam Central station	Amsterdam Amstel
Alternative specific constant (X3=1)	6,04686	0	0
General opinion	13,7204	0,1368	0,1408
Distance	-75,8923	0,1601	0,1413
Proximity	12,3546	0,03	0,31
Intensity	27,1067	0,29	0,12
P+R	4,92334	0	0
Vi		-2,04182551	-1,70901967
		0,129791559	0,181043188
P(Vi)		0,417558076	0,582441924
100 travelers		41,75580761	58,24419239

Table 4. The choice details of Amsterdam Central and Amsterdam Amstel

After calculating the probabilities of choosing the station revealed that the model is not predicting that Amsterdam Central is still the station with the highest chance to be chosen, but Amsterdam Amstel (0.42 probability of choosing Amsterdam Central, in comparison with 0.58 for Amsterdam Amstel). Some explanations for this outcome are being discussed. Firstly, in the file used as a input for the MNL model containing the origin and alternative stations for all the respondents, Amsterdam Central is more often not chosen than chosen (108 times not chosen versus 63 times chosen). Secondly, in the research sample, the proportion of travelers choosing Amsterdam Central vs Amsterdam Amstel is 1.89, while in the reality this value is 6.76. Therefore, the research sample used in this study is not entirely reflecting the reality, fact leading to this uncommon prediction.

Scenario	Number of travelers using Amsterdam Centraal	Number of travelers using Amsterdam Amstel	Total number of travelres
Increase to 65% the general opinion about Amsterdam Amstel Station	40,49	59,51	100
Increase with 50 the number of available parking spaces at Amsterdam Amstel Station	24,23	75,77	100
Decrease with 1 minute the travel time to Amsterdam Amstel Station	29,62	70,38	100
Increase to 22% the proximity at Amsterdam Amstel Station	27,72	72,28	100
Increase to 250 the intensity around Amsterdam Amstel Station	18,67	81,33	100

Table 5. Forecasting the use of stations analysis under 5 scenarios

Table 5 represents a summary of the scenarios and their outcomes. It can be seen that under all of the scenarios the probability of choosing Amsterdam Amstel (since one of the goals of the project was to determine how the flow of travelers could be redirected from Amsterdam Central to other station, or Amsterdam Amstel in this case) is increased at least with 1.27% in case of an increase to 65% of the general opinion. Two of the best improvements that can be developed at Amsterdam Amstel station level in order to determine more travelers to use it are: increase the number of available parking spaces and increase the intensity around the station.

CONCLUSIONS

This research thesis addresses a study of travelers' choice of a train station as an origin station in the Netherlands. The selection of the 5Ds's, sub-attributes, and insights in the travelers' origin station choice behavior in relation to the surrounding area of a station are significant results of this research. The lack of "standardized" sub-attributes for the 5Ds forced the development of selection criteria. The selected sub-attributes can be employed in further research. The results presented in this thesis , together with the literature review, provide the answers on two research questions that were the input to define the outline of the main question of this research: *"What attributes of train stations' environment are influencing travelers' origin station choice behavior?"*

The results indicate that the distance has one of the highest effects on the choice. Destination accessibility can be considered as a trigger, while the other 3 Ds (Diversity, Design, and Density) have less influence, but they still affect the choice in a positive way. The positive influence of proximity and intensity (density) is supported by the model results as

well. One special sub-attribute is “P+R” because the outcome of the questionnaire is that it has a neutral influence on the station choice behavior, while the model showed that it has a positive effect.

This research provided valuable insights about origin train station choice behavior of the travelers and how the surrounding environment of a station can be characterized in the context of travel behavior. Moreover, the present study suggests some developments through which the travelers can be stimulated to choose another origin station. Additional collection of data and the inclusion of destination station in the analysis are recommended for further research.

REFERENCES

- Cascetta, E., 2013. *The regional metro system (RMS) of Naples: design, implementation and impact*. Amsterdam, Community of Research & Practice (CORP) Area Development around stations GO-Spoor
- Cervero, R. & Landis, J., 1993. Assessing the impacts of urban rail transit on local real estate markets using quasi-experimental comparisons. *Transportation Research Part A: Policy and Practice*, 27(1), pp. 13-22.
- Cervero, R. & Kockelman, K., 1997. Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment*, 2(3), pp. 199-219.
- Cervero, R. & Murakami, J., 2008. “Rail + Property Development: A model of sustainable transit finance and urbanism”. *UC Berkeley Center for Future Urban Transport. A VOLVO Center of Excellence*. < <http://www.its.berkeley.edu/publications/UCB/2008/VWP/UCB-ITS-VWP-2008-5.pdf> > Accessed 30-10-2013
- Debrezion, G., Pels, E. & Rietveld, P., 2007. Choice of departure station by railway users. *European Transport \ Trasporti Europei*, Volume 37, pp. 78-92.
- Debrezion, G., Pels, E. & Rietveld, P., 2009. Modelling the joint access mode and railway station choice. *Transportation Research Part E*, Volume 45, p. 270–283.
- Estupiñán, N. & Rodríguez, D. A., 2008. The relationship between urban form and station boardings for Bogotá’s BRT. *Transportation Research Part A: Policy and Practice*, 42(2), pp. 296-306.
- Givoni, M. & Rietveld, P., 2014. Do cities deserve more railway stations? The choice of a departure. *Journal of Transport Geography*, Volume 36, pp. 89-97.
- Hensher, D. A., Rose, J. M., & Greene, W. H., 2005. *Applied choice analysis: a primer*. Cambridge, UK: Cambridge University Press.
- Kastrenakes, C. R., 1988. Development of a Rail Station Choice Model for NJ Transit. *Transportation Research Record*, Volume 1413, pp. 49-59.



ALEXANDRA VIOLETA TUDORICA

“In a sector in which smart meters, smart grids, solar panels and photovoltaic cells are the means for sustainable developments, TOD comes to extend the list. The difference is the fact that TOD is less tangible.”

2007 – 2010 Bachelor's Degree in Economics (Romania)

2008 – 2012 Bachelor's Degree in Civil Engineering (Romania)

2012 – 2014 Master in Construction Management and Engineering (The Netherlands)

January 2014 – June 2014 Intern at NS Stations

IMPROVING THE REDEVELOPMENT PROCESS OF OBSOLETE INDUSTRIAL SITES: AN APPLICATION OF URBAN LAND READJUSTMENT AND GAME THEORY

Author: Guido van Veen

Graduation program:

Construction Management and Urban Development 2013-2014

Graduation committee:

Prof. dr. ir. W.F. (Wim) Schaefer	[TU/e]
Dr. ir. B. (Brano) Glumac	[TU/e]
Ir. G.A.H.J. (Guido) Kuijer	[Kadaster]

Date of graduation:

22-08-2014

ABSTRACT

The Dutch government has a growing interest in (1) the prevention of cluttering, (2) better efficiency and intelligent use of space and (3) improvement of spatial quality. Thus, the government created the 'Mooi Nederland' ('Beautiful Netherlands') policy, in which the redevelopment of obsolete industrial sites in collaboration with market parties is placed high on the agenda. However, the economic crisis has caused problems in the execution of this policy: a decline in demand, problems with financing issues, and restraining attitudes of both public and private parties. As a result, projects have stagnated and some were even cancelled. The days of major redevelopment projects are over, and a growing interest in redevelopment initiatives by private parties is observable. Especially in the spotlight are entrepreneurs, who are looking for (joint) customizations of their industrial sites due to a growing business, poor business climate caused by vacancy or problems with the premises, for example. Problems arise with fragmented ownership of property and the conflicting interests of involved actors who are often blocking initiatives. As a result, the Dutch land registry Kadaster is detecting stagnation and missed opportunities. The question in this report is how the Kadaster, by using 'interventions', is able to improve the redevelopment process of obsolete industrial sites in the Netherlands. For this research, two possible ways of providing interventions have been attracted, namely via 'Urban Land Readjustment (ULR)' and 'Predictions (with the help of Game Theory)'.

Keywords: Urban Land Readjustment (ULR), Obsolete Industrial Sites, Decision-Making, Ownership of Property, Game Theory, Dutch Spatial Planning

INTRODUCTION

The Netherlands is facing a serious social problem: the obsolescence of industrial sites. One-third of the industrial sites are worrisome, because approximately thirty percent are not meeting the requirements of the present day. The sites are in poor condition, are obsolete, are cluttered, lack coherency due to individual sales of plots and provide poor accessibility. The poor condition of these sites is leading to fast depreciation and also affects the spatial quality. But municipalities are still trying to offer many hectares of new industrial land. The Dutch government, especially the Ministry of Infrastructure and Environment, noticed that scarce land in the Netherlands is unnecessarily in danger. The government took actions as

part of the policy program named 'Mooi Nederland' (*'Beautiful Netherlands'*): the redevelopment of obsolete industrial sites by the 'Taskforce for the Redevelopment of Industrial Sites'. This taskforce identified four large problems in the industrial market: (1) fast aging of industrial sites, (2) a large and inexpensive supply of greenfield locations, (3) lack of demand-driven developments by private parties and (4) an often lacking spatial quality and poor landscaping of greenfield developments. The taskforce advised the government that new industrial sites are needed in the future, but that the government must take into account the problems with existing industrial sites, in order to prevent the same problems occurring in a few years on newly developed industrial sites.

To counteract the problems, the taskforce proposed that the redevelopment and maintenance be commercialized, whereby sustainable industrial sites must be the final result. An intensive collaboration between public and private parties was created for a large-scale redevelopment project of 15,800 hectares. Unfortunately, not long after the new approach was used, the economic crisis developed, and this brought about enormous changes. As a reaction to the financial crisis, both public and private parties reduced their investments and tried to reduce their financial risks. The redevelopment tasks stagnated due to a lack of demand, budget cuts and the development of other governmental priorities. This stagnation eventually resulted in a low completion rate of only 20% of the total amount of planned redevelopment activities. The period of major redevelopment projects is over, and a growing interest of public parties in private party investments (by *developers, investors and property owners*) for redevelopment tasks is observable. Entrepreneurs are currently seen as a potential group; their demand is evident when they are experiencing problems with, for example, expansion possibilities, an affected business climate due to vacancy or problems with premises.

Problem Statement and Research Questions

The Kadaster is noticing the stagnated redevelopment process of obsolete industrial sites, but also stagnation in the whole urban development practise. It appears that the Kadaster is trying to find a positive stimulant for a joint approach, where fragmented ownership of property, unwillingness of participation, and problems with conflicting interests are not blocking initiatives for a redevelopment project between multiple (*private*) parties. The shifted focus towards the redevelopment of existing industrial sites requires a different approach than Greenfield development. The Kadaster is noticing that existing land management strategies are failing and new approaches are needed to support these (*new*) kinds of (re)development initiatives in order to reduce the number of vacant plots, improve the spatial quality, and economize. Therefore, the problem statement has been defined as follows:

'The Kadaster detects stagnation and missed opportunities in the redevelopment process of obsolete industrial sites'.

This thesis has been written with the purpose of stimulating the redevelopment process of obsolete industrial sites. Special attention will be paid to the above three underlined topics. The question is how the Kadaster is able to intervene to improve the redevelopment process of these sites. Therefore, the following central research question has been formulated:

How is the Kadaster, by using 'interventions', able to improve the redevelopment process of obsolete industrial sites in the Netherlands?

For the delineation of the research two possible ways have been used for providing interventions for the improvement of the redevelopment process of obsolete industrial sites in the Netherlands. These are (1) 'Urban Land Readjustment (*ULR*)' and (2) 'Predictions'. First, *ULR* is an experimental land management instrument which is currently under development by the Kadaster in collaboration with e.g. the Dutch government and private parties. The Kadaster is able to support the usage of *ULR* and thus able to provide interventions with the tool. Second, the Kadaster is interested in instruments that can predict. Prediction provides the Kadaster with a strategic advantage, as a particular scenario can be analysed before it occurs. The Eindhoven University of Technology provided the Game Theory as a tool for the analysis and prediction of complex decision-making. The following sub-questions have been formulated:

The following sub-questions have been formulated:

- How is the Kadaster able to improve the redevelopment process of obsolete industrial sites by interventions with 'Urban Land Readjustment'?
- How is the Kadaster able to improve the redevelopment process of obsolete industrial sites by interventions with 'Predictions' during decision-making processes with the aid of Game Theory?

Research Structure

This first chapter presented the problems with obsolete industrial sites in the Netherlands and the large influence of the economic crisis. The importance of fighting aging is emphasized. In addition, the research design is explained, including the problem statement, research questions, boundaries, and methodologies.

Chapter two presents a tripartite literature review. Part A is dedicated to the experimental land management strategy Urban Land Readjustment. In this part the changing urban development practise, the origin and process of *ULR*, and *ULR* compared with existing land management strategies in the context of Dutch spatial planning will be discussed. With the knowledge of *ULR* and the changing context of the urban development practise, the report will continue with part B wherein we will return to obsolete industrial sites in the Netherlands. In this part a brief overview will be given about the emergence of aging on industrial sites in the Netherlands and other problems. Afterwards, *ULR* will be linked with the redevelopment process whereby the study will examine how the Kadaster is able to improve the redevelopment process of obsolete industrial sites by interventions with help of *ULR*. In part C a side step will be made towards decision-making in the urban development practise which is needed to understand how prediction can be used for interventions. We will see that collaboration and decision-making is one of the most complex parts of the redevelopment process. In addition, the negotiation process during *ULR* will be presented and afterwards the Game Theory will be introduced. The Game Theory will be used as research method for the analysis and prediction of a certain decision-making moment.

In chapter three the case study 'wet industrial site' in Maasbracht will be analysed. The redevelopment process of the industrial site is one of the eleven pilot projects of *ULR* in the Netherlands. Maasbracht is a 'wet' industrial site in the province of Limburg where *ULR* has been applied due to problems with the expansion of the companies on site.

The fourth chapter will go deeper into the 'prediction of interventions' by using the Game Theory to analyse and predict a specific decision-making moment in the case study of Maasbracht. The question that will be answered is: what will the optimal strategies for the involved stakeholders, both public and private parties, be during the redevelopment process of the case study in Maasbracht? By predicting this development in advance, the Kadaster is able to adjust and steer decision-making and behaviour towards an optimal result. And thus the Kadaster is able to improve the redevelopment process by interventions with 'predictions'. The aim is to create a three-player bargaining Game Theory model. First, the stakeholders of Maasbracht will be grouped and translated to players, which are more useful for the Game Theory. Second, a bargaining game about the influence level of two chosen negotiable attributes will be constructed. The interests, payoffs, and strategies of involved actors will be made visible. For the prediction the Fuzzy Delphi Method will be used to receive usable data from experts in the field of urban development. Based on the outcomes, advice will be provided about the predicted optimal influence level of both parties in order to reduce problems. Hence, the possibility to steer the process will improve the redevelopment of Maasbracht.

The fifth and final chapter consists of the most important research conclusions and summarizes the answers to the research questions. Afterwards, the recommendations for the Kadaster will be written, a discussion will be started, and further research will be suggested.

LITERATURE RESEARCH

Interventions with Urban Land Readjustment

Urban Land Readjustment (ULR) is an experimental instrument used in the Netherlands for the rescheduling of property, such as land and real estate, with the aim of taking initiative or facilitating the (re)development of an area. Literature research shows that ULR is an instrument that is based on the German '*Umlegung*', where the focus lies on the reorganization of corporate rights and not specifically on collaboration, such as the France AFU. However, ULR is different compared to existing land management strategies (e.g., building claim model, traditional model, concession model and joint venture model) due to its ability to reduce limitations from fragmented ownership of property and its ability to enforce participation by the vast majority. Existing land management strategies are failing, mainly due to the lack of (legal) support but are more effective during greenfield development whereby limited ownership of property exists and fewer owners are involved. Existing tools are not sufficient, and only one tool in Dutch spatial planning is able to deal with fragmented ownership of property: expropriation. But this tool is often avoided by public parties due to the time-consuming and expensive activity involved. In addition, ULR is able to provide a well-managed process of decision-making and negotiation whereby interests and wishes of the involved stakeholders will be aligned through the use of a bottom-up approach. Property owners and end-users possess a high level of influence during the process, whereby public parties are merely facilitating (i.e., facilitating land policy) the process.

Five approaches of ULR can be distinguished, namely: (1) small scale exchange of property (in Dutch, '*kleinschalig ruilen op maat*'), (2) usage land readjustment ('*gebruiksverkaveling*'),

regarding leasehold), (3) Umlegung (new allocation of parcels in the new situation occurs in proportion to the value), (4) trade chain ('*ruilketting*') and (5) integral planned land trade readjustment ('*integraal planmatige ruilverkaveling*', even between regions). The tool is able to facilitate in the exchange of land, buildings, construction and development rights, and users; the ceding of land for public or collective facilities; the joint realization of collective or semi-collective facilities and of redevelopment and maintenance of real estate; and the organisation of joint direction. The process has been designed as a chain of cyclic negotiation, whereby the results of one negotiation will form the basis for the next step in the process. The outlines of the process can be summarized in five phases, namely (1) initiative phase, (2) capturing the initial state, (3) creation of a new program, (4) creation of allocation variants and (5) financial settlement. The legal protection of the individual owners is an important factor and is therefore protected by an independent party, such as the Kadaster. It must be noted that ULR is not yet an official tool in the Netherlands, and therefore in 'experimental phase'. Probably from 2018 onwards, it will be seen as an additional tool for public parties.

Obsolete Industrial Sites in the Netherlands

It can be stated that obsolete industrial sites are a societal problem in the Netherlands. The government is seeing the necessity of fighting obsolescent and vacant old industrial sites. Both public and commercial parties are responsible for the aging and deterioration of the spatial quality of many industrial sites. The aging and deterioration is causing depreciation of property (*and often a reduced pension due to the higher expected valuation of property by the entrepreneur*), poor spatial quality, and reduced economic position of the region. Redevelopment projects are often not started, despite the large amount of money provided by public parties. Private parties are simply waiting, because in their opinion their site is still functioning, and thus there is no drive for investments. But the crisis caused a large drop in demand whereby entrepreneurs merely focussed on their production process in order not to go bankrupt. Times of major redevelopment projects are over and a growing interest by public parties in redevelopment initiatives by entrepreneurs can be observed. Mainly because of the many private properties caused by fragmented ownership of property. The impetus to start a redevelopment process is often caused by a growing business, poor business climate due to empty premises, or other problems. Municipalities are needing a different approach to trigger investments by using 'uitnodigingsplanologie' instead of 'toelatingsplanologie'. Problems arise when entrepreneurs are hindered by fragmented ownership of property. The Kadaster is able to provide an important contribution to stimulate redevelopment projects by implementing ULR.

CASE STUDY MAASBRACHT

For analysing the implementation of Urban Land Readjustment in practise, this research examined the case study of Maasbracht in the province of Limburg, municipality *Koeweide-Battenweg*. This is one of the eleven pilot projects of the Dutch Commission for Urban Readjustment (*Commissie Stedelijke Herverkaveling*). The municipality of Maasgouw, the Middle Limburg Development Company (*Ontwikkelingsmaatschappij Midden-Limburg B.V.*, or *OML*) and the Limburg Restructuring Company (*Herstructureringsmaatschappij voor Bedrijventerreinen B.V.*, or *LHB*) reached an agreement in early 2013 to begin redeveloping their so-called 'wet industrial sites'. The term refers to the maritime-related business activities and location next to the Maas River. The interests of these three stakeholders are

the improvement of the local and regional economies, a special focus on Maasbracht due to the highly reputable shipbuilding and repair companies and a counteraction of vacancy and pauperisation. In addition, there is a changing focus towards sales of pleasure boats and ship repair due to the closure of the mineral extraction industry. The goal is to make the industrial site future-proof. Unfortunately, the municipality does not possess enough resources for the redevelopment, and the fragmented ownership of property also produces problems. The parties, in collaboration with the Kadaster, explored the possibilities to facilitate the redevelopment of the industrial site and ULR was selected. The entrepreneurs see the necessity for action and therefore they will voluntarily join the redevelopment process. But it must be noted that the entrepreneurs (who are land and property owners, as well as users) have been somewhat forced by the municipality to actively participate. Because official legislation for Dutch spatial planning does not yet exist, the municipality used a clever trick: the municipality is regulating the industrial area using the masterplan and permits. The entrepreneurs situated on the site possess, for example, permits to moor boats only one row deep at the quay. The number of rows has increased over time due to the expansion of business activities, and the municipality condoned this for many years. But the municipality is now able to threaten with enforcement of the rules.



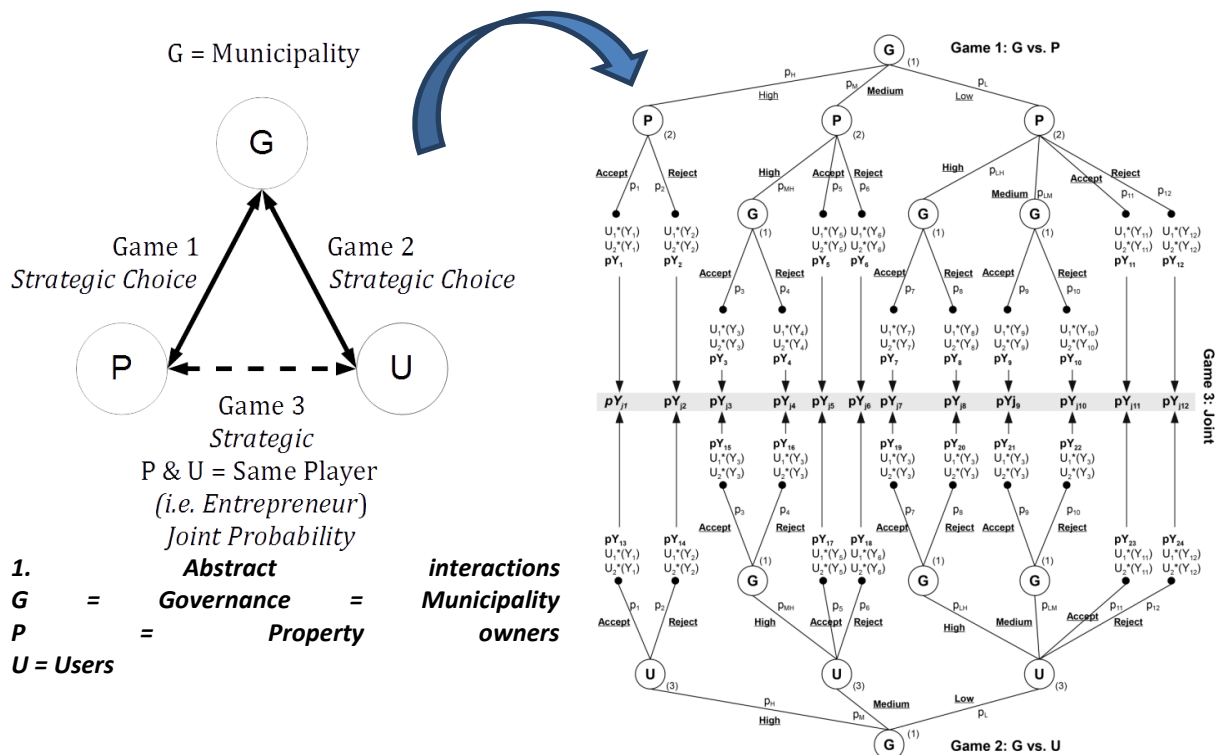
Figure 1 | Current (left) and future (right) ownership situation (Kadaster, 2014)

On the other hand, there is an incentive for the private owners to participate in the redevelopment process because they do not have many possibilities to expand in the current situation. With the just finished enlargement of the locks in the Maas River, it is now possible for the entrepreneurs to expand their business activities. Because all parties are seeing the necessity to change, this study assumes that all parties are participating on a voluntary basis. Despite the fact that public and private parties are pursuing their own interests, they are dependent upon each other. With the help of ULR, all stakeholders jointly created a new plan for the exchange of land and settled their wishes and interests. See Figure 1 for an overview of the present and future situation.

Interventions with ‘Prediction’ using Game Theory

The Kadaster has a growing interest in theories and models that are able to analyse and predict complex decision-making scenarios. It wants to understand social interactions and interactive decision-making. And, thus, the Kadaster may be able to intervene to improve the redevelopment process of obsolete industrial sites by ‘prediction’. Prediction provides the Kadaster a strategic advantage, because a particular scenario can be analysed in advance.

The Kadaster is able to intervene by 'steering' (e.g., advising) in the correct and most optimal direction during the redevelopment process. Literature shows that analysing and predicting strategic competition between stakeholders is possible by using the Game Theory research method. Game Theory is a research methodology of interdependent decision-making in which the involved decision-makers possess conflicting interests and the outcome of their decisions cannot be determined by only one actor or group. Game Theory is not yet widely used in the field of urban development, which may be due to the especially context-driven environment. But there is a growing interest in the use of Game Theory in the practise of urban development.



2. Extensive form + Strategic Choice Model

Game_1_Governance-utility1-input 6.30 4.20 5.60 4.70 6.50 5.00 3.9 0 4.30 5.70 4.20 5.10 5.40	Game_2_Governance-utility1-input 6.30 4.20 5.60 4.70 6.50 5.00 3.90 4.30 5.70 4.20 5.10 5.40
Game_1_Property-Owners-utility2-input 6.50 4.00 6.80 4.30 5.40 4.90 4.0 0 3.30 6.00 3.40 4.00 6.00	Game_2_Users-utility2-input 6.70 4.60 6.60 4.60 5.70 5.20 4.30 3 .60 6.30 3.70 4.30 5.40

Run Game Theory Model

Command Center

```

observer: [0.6282664330212769 0.003925701577446105 0.07391537380071
observer: [0.5956024441402173 0.010833629056040968 0.06645510963891
observer: [0.3741970230787287 4.2529594674765986E-5 0.0049120542695
  
```

3. Modelling in Netlogo

Figure 2 | Game Theory modelling overview

The Eindhoven University of Technology provided to this research study its knowledge of Game Theory. This research attempted to predict a complex decision-making scenario based on the case study of Maasbracht. The goal was to predict the optimal influence level on the

‘future land uses’ and ‘reparcellation’. The influence level can be divided into three measurements, namely high, medium and low. High represents a maximum influence level of the two attributes and low reflects a minimum influence level. This is important for multiple reasons: (1) If a player possesses a high influence level, then he is able to maximize his payoff. But it is possible that he will bear all the financial risks, and even other problems, such as the fact that other parties are not willing to cooperate. (2) If a player possesses a low influence level, he is not able to maximize his payoff, but he has no financial risks. It is possible that he will become a free rider. And (3) a medium influence level suggests that both players may possess a certain amount of influence. And thus both parties are able to steer their payoffs. This could eventually result in an optimal collaboration. Therefore, by using the Prediction with Game Theory tool, the optimal influence level of the players in Maasbracht can be determined. The prediction can eventually be used as advice from the Kadaster towards the involved stakeholders.

To create the prediction, a Game Theory model needs to be created. The model in Figure 2 has been constructed based on an eight-step procedure:

- (1) **Selection of a Game Class:**
Non-cooperative, conflicting interests game;
- (2) **Selection of a Game Form:**
Extensive form;
- (3) **Selection of a Game Solution Concept:**
Sub Game Perfect Nash Equilibrium;
- (4) **Description of Institutional-Economic Context of the Game:**
Urban Land Readjustment and the case study of Maasbracht;
- (5) **Game Conditions and Environment:**
Five different negotiable attributes have been identified whereby ‘future land use’ and ‘reparcellation’ have been chosen. Bargaining form.
- (6) **Validation of Game Structure:**
By the Kadaster;
- (7) **Estimation of Payoffs:**
Using the Fuzzy Delphi Method and experts’ input;
- (8) **Analysis of the Final Outcomes:**
With the use of NetLogo and Excel.

Fuzzy Delphi Method (FDM)

The model requires utilities that allow the model to calculate the probabilities of the game. ‘A utility refers to some ranking, on a specified scale, of the subjective welfare or change in subjective welfare that an agent derives from an object or an event. The term ‘welfare’ refers to some normative index of relative well-being, justified by reference to some background framework’. To gain the utility values, the Fuzzy Delphi Method (FDM) was used. The Fuzzy Delphi Method allows the subtraction of the utilities by a group understanding approach by weighting for example attributes. Five experts in the field of urban development were asked for their contribution in an expert meeting session. First, the case study of Maasbracht was explained in detail, including the decision-making moment (the model). The experts were asked to weight the utilities for each of the three players and for each of the end branches, based on the two attributes. The weighting was done on a scale of 1 to 10. Weighting was not based on one single number, but on four different weights by using two

specific ranges: the maximal range {1 and 5} and the optimal range {2 and 3}, which lies within the maximal range. These weights were stored in an Excel sheet for each expert consisting of four rows with, for example, the numbers {a=4, b=7, c=8, d=9} as a weighting overview of one utility of a single player. In this way, a better and more detailed overview of the experts' opinions can be created instead of simply weighting by a single number. Thus, the experts had to provide their weighting figures 36 times: $12 \text{ outcomes} * 3 \text{ players} = 36 \text{ utilities}$. Afterwards, the data was converted into an overall fuzzy number for each specific end branch and players. The fuzzy numbers were 'defuzzicated' for the last step by using the simple centre of gravity method.

Analysis of the Final Outcome

The last step is the analysis of the final outcomes of the model. The values of S have been entered into the NetLogo model for the calculation of all the probabilities. The final probabilities have been put in an Excel table (Table 1) to provide an overview of the prediction of the outcome of the game. Game 1 represents the game *Governance vs. Property Owners*, Game 2 represents the game *Governance vs. Users* and Game 3 reflects the *joint probability* of both games.

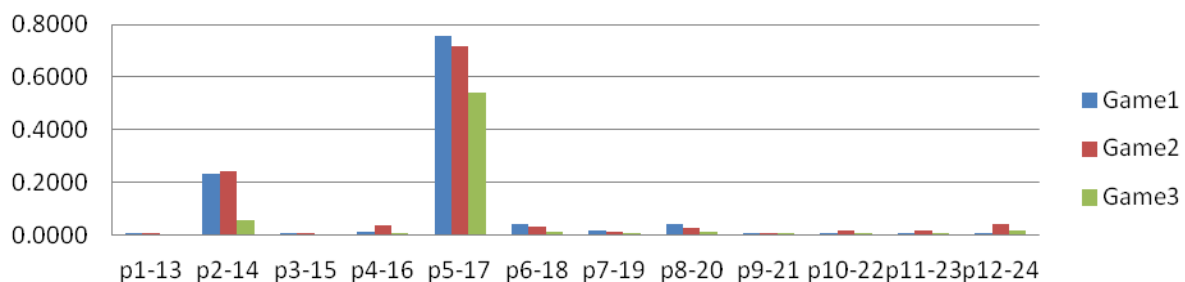


Table 1 | Final probabilities from NetLogo to Excel.

The prediction has showed that a medium influence level of the public parties (*especially the municipality*) is the most preferred outcome, whereby the private owners are accepting and willing to collaborate. This can be seen as an equal level of influence on the 'future land use' and 'reparcellation' of the industrial site Maasbracht. It can be stated that a 'dominant leading' position must be avoided by the public parties. The outcome of the model supports the high probability that a high level of influence (p_2 - p_{14}) of the Governance player will be rejected by the players Property Owners and Users. And besides, a low influence level by the Government, and even by the other two players, scores very low probabilities which are close to 0. The final conclusion: public parties may not start the redevelopment process of the wet industrial area on the basis of a dominant strategy. This will eventually cause aversion by the private parties and stagnation of the redevelopment process. By offering a medium influence level, the private parties will also receive a medium influence level, and the redevelopment will be accepted.

Optimal collaboration is required, but in this case both parties are able to steer and maximize their payoffs. And therefore, the Kadaster is able, by prediction, to intervene during a redevelopment process, for example by providing this advice to the public parties. And thus the process can be steered for optimal results. As for the Game Theory part, the Game Theory provides an abstraction of a real-world situation. The aim is to use the tool to create and understand behaviour of the stakeholders, but not in full detail. Furthermore, the

models are simplifications and many assumptions need to be made. Some argue that modelling of behaviour in the context of urban development makes no sense due to the context-driven environment. But this research shows that the Game Theory can be useful for specific chosen scenarios. Unfortunately, creating the models is time consuming due to the amount of statistics and mathematics involved. Software is not yet available to create easy Game Theory Models of this scale. And thus: Game Theory in the used form is not advisable for the Kadaster, because a specialist would need to be hired for the creation and usage of the models, which would result in high investments for the Kadaster.

CONCLUSION

To answer the central question of this report, *How is the Kadaster, by using 'interventions', able to improve the redevelopment process of obsolete industrial sites*, the final conclusion of this report is to be followed. The Kadaster is able to improve the redevelopment process of obsolete industrial sites by using interventions with: (1) 'Urban Land Readjustment', for removing limitations in situations with fragmented ownership of property, for enforcement of player participation and for creating mutual agreement by using guarded negotiations during ULR and (2) 'Prediction' using, for example, Game Theory for interventions before/during decision-making scenarios. Prediction provides the Kadaster with a strategic advantage, because it allows a particular scenario to be analysed in advance. The Kadaster is then able to intervene to steer in the correct and most optimal direction. Advice: In the case study of Maasbracht, the Kadaster may offer an issue to the initiator, the municipality of Maasgouw, that a dominant 'leading' position in this case is a 'no go'.



G. (Guido) van Veen

In front of you lies the result of my final project of the master program Construction Management and Urban Development at the Eindhoven University of Technology. The last six months of the master track were dominated by intensive research towards the application of the experimental land management instrument Urban Land Readjustment and its application on industrial sites in the Netherlands. Writing this thesis was not possible without the help of many people. Therefore I would like to thank everyone who helped me.

Curriculum Vitae (GuidovnVeen@gmail.com)

2001 – 2007	Oostvaarders College, VWO, Almere
2007 – 2011	Hogeschool van Amsterdam, Construction Management, Bachelor
2009 – 2010	Wessels Rijssen BV., Internship, project L' Hermitage Almere
2010 – 2011	Dura Vermeer Bouw Hengelo, Graduation Internship, Lean Management
2011 – 2014	TU/e, Construction Management and Urban Development, Master
2014 – 2014	Kadaster, Graduation Internship, Stedelijke Herverkaveling

APPENDIX A

KENWIB – Day Report Study Trip China, May 2013

Day Reports

As stated earlier this first part of the booklet will contain all day reports. This is a bit of an informal way of introducing you to our activities on the trip. Of course many more things happened during the trip, but it is impossible to list everything in this booklet. If you are curious about more inside information you should contact the committee or one of the participants of the trip.

Day 1 - Tour Begins!

It's a Saturday and still dark outside as numerous alarm clocks wake various CME students in the wide area of Eindhoven between 3.30h and 4.15h in the morning. Finally the long anticipated day arrived. The CME China Tour 2013 is about to start!

Different strategies were chosen as on how to go through the last night. Some chose to go to bed early, others chose to accept less sleep and some even chose to stay awake for the whole night thinking they were able to sleep during the long plane flight. Still, showing up at 5.00h in front of Vertigo turned out to be a challenge which not all of us were able to handle. We knew the bus would leave at 5:30 am and wouldn't wait for any latecomers. Not all participants managed to accomplish the task of showing up on time... It was one small dark-haired participant who had had some Campoepel too much on the previous night. Despite setting his alarm, doorbell ringing of the cab driver and missing 28 phone calls he managed to sleep through all of that. The chaos was complete when we accidentally called the wrong person's parents because of a little mix up with people who had the same name. Eventually his girlfriend could be reached on her mobile phone. She was able to drive over to his place and to wake him up in person. They managed to get to Schiphol in time, even though the bus with all others had already left Eindhoven. Lucky him...

Eventually we joined at the airport where we also met up with the second supervisor of this trip. We then went on to check in our luggage and after passing the customs we had some spare time to wander around the airport and drink some coffee. When we could finally board our plane and had to switch off our mobile phones, our trip to China was really to get somewhere.

Flying from Amsterdam to Zurich was done within no time. The amazing Swiss airport in Zurich was a peaceful haven in between the two flights. Within the relaxing environment we prepared ourselves for the flight to Shanghai, which was to take about twelve hours. For many of us, a first timer. Still, we managed. In the early morning of Sunday 28th of April, we stepped onto Chinese ground.

Day 2 - Shanghai

Because we made a step in future time, the start of these second day is somewhere between Zurich and Shanghai. Caused by the time zone, the victim of these day(s). To the point... the start of the day was in the plane by a good game of 'Who is the man' (the game was related to the TU/e ;)). Beside this entertainment the flight to Shanghai was well, with less sleep, but lots of possibilities to get to know each other better.

Finally around 7 o'clock in the morning (local time) we arrived at the Shanghai Pudong international airport, despite the ruff looks of some participants we passed customs without any problems quite fast (in order to protect our own safety we not mentioned their names). Before leaving the airport we made the ATM machines crazy by withdrawal all the cash, this with only one purpose, stimulating the Chinese economy, especially the local entrepreneurs.

During the bus trip to the Hostel we already figured out the difference of Urban planning in China compared with the Netherlands. Most of the people thought this is caused by the booming economic and the big demand for (industrial) real-estate. Multiple times we spotted a concrete factory in the middle of a residential area. Beside this the esthetic value at the suburbs was much less compared with the Netherlands, lots of designs (e.g. for apartments) are repeated often in the same neighborhood. Out of this quick analysis we can conclude the system of Urban development in China is based on facilitating the growth of the economic instead of creating a health market.

Eventually we arrived at the hostel, a place of rest in an overcrowded city, on the rooftop bar we can't imagine that we are in one of the biggest metropolis of the world. After arrival everyone had the opportunity to clean up and (re)furbish their rooms. After this tough job there was some spare time, some of the students were eager to discover the city, other were more eager to test the quality of their beds.

At the end of the afternoon the chairman of the study trip board started the formal program of the China trip by an inspiring speech. Hereby the man, who should give the right example was too late, this resulted into an hour walking around in the Lions suit (Brano, it fits perfect, maybe you can borrow it next Carnaval?). This was also the start for a chaotic lesson of the Shanghai subway, for this we shall repeat the most easy but also essential rules:

- Be quick by entering and leaving the train;
- Always go to the next exit, after arrival:
- Shanghai: Exit 1; Nanjing: Exit E; Beijing: Exit A.
- If you do not have a good directional sense, follow the tall blond guys (Erik, Bob, and Tim).

After this journey into the Shanghai Subway there was some time to discover the biggest shopping street of Shanghai (which could be compared with the: Kalverstraat, Champs Élysées, and Ramblas). While the guys became exited by the shops of Gucci, Prada, and Channel, the girls went to the bar for drinking beer ;). For the formal program we went to the Bund river to make some group pictures having as background the Shanghai skyline. Unfortunately the Chinese people also spotted this event and almost shoot their complete memory full with pictures of us, especially Bob van Thiel in the Lion suit had a lot of interest (it almost looks of he was eager for attention).

At the end we made a phenomenal boat trip near the Pudong skyline by night, great landmarks were: the TV-tower, the world financial center, and the Jin Mao Tower.
(Tim Jansen and Geert Lamers)

Day 3 – Bicycling Tour Shanghai

The first day of the Study Tour 2013 in China started after the first night in Shanghai. The beds were quite hard and the day before was very busy and intensive. But dispute that, the briefing of this day started at 10.15 AM. After the committee finished the briefing we left the hostel at 10.30AM to the metro station. After traveling with the metro for approximately 10 minutes, and a lots of walking instead of traveling with this metro, we arrived at the place

where we would pick our bikes. Together with 24 bikes the Chinese guide of the day was waiting for us. We tested the bikes to check if these bikes were okay to make the tour comfortable and safe. The "Tour de Shanghai" was starting from this moment! Despite our experience and knowledge about cycling, the unexpected happens. After 100 meters an accident already occurs within our peloton. Erik Vijverberg our most experienced and practiced cyclist has been involved with a one-sided crash. The first question everybody asked him/herself was how was this possible? Is the bike on the wall within the house of Erik's only for the show? Fortunately the damage were only some scrapes and scratches. The cycle tour led us to the small traditional alleys of Shanghai as well to the new business part of the town. This was a very impressive and a nice way to see (but also feel and smell) and learn more about the city Shanghai. We did see a lot of traditional Chinese culture and specific Chinese buildings, but we also had to look at the new characteristics of this impressive city. The only thing that separates these two areas in Shanghai is the well-known river Huangpu/the Bund.

First we saw the "normal" streets of the city Shanghai included with a big amount of cars and electric scooters. The first thing we noticed was the many honking towards and backwards between the various participants in the traffic. After this we went into some small traditional alleys where lots of Chinese families live in small houses. The laundry is hanging across the alleys so it was sometimes necessary to bend or to move away for this. Also the smell was not always pleasant to smell. But besides that it was quite an experience to see how these people live with almost nothing. After these streets we ended up at a small market where various Chinese products were sold. Here it became clear that this tour was not only an experience from our side but also for the locals it was quite an experience to see a large group of westerners cycling on their market. After cycling through the old part of the Shanghai we went to the new business district of the town. This part was built since the 90's. Here we saw a lot of modern office buildings that we admired the previous evening during the boat trip on the river.

After the cycle tour we would visit the World Financial Center Tower. However, this did not happen because of the poor visibility through the amount of smog! We still hope to visit the center later in the week. But no worry because we did not get bored, Shanghai has lots of impressive things to see. So after the canceling of this activity we went to the Golden Temple called the Jing'an Temple. The half of the temple was under construction but there was enough to see. Some of us made some wishes by trying to throw a coin into a wishing well well others did this by lighting some incense.

At the end of the day we all eat with each other in a traditional Chinese restaurant. This was a nice moment to evaluate the cycle tour and all impressions of the day.
(Mark van Swam & Maaïke Schut)

Day 4 - Queensday

Our National Holiday April 30th started with an early breakfast and a subway trip to the Peoples Square area where our first company visit was scheduled: UNstudios. This architectural office is founded in Amsterdam and another location was opened in Shanghai

in 2010. About 35 architects are employed in this office. The company is situated at the 46th level of the Raffles City building and offers a spectacular view of Shanghai and its famous skyline. After we introduced ourselves in a short presentation, Marcus van Aalderen (the associate director Asia) elaborated on what UNstudios' activities are and what projects are developed in the last few years and are still to be realized. Besides this, the differences between the Chinese and Dutch (building) culture were highlighted and we experienced talking about the development of Shanghai from a birds' eye perspective; the difference between the 'old' houses and new skyscrapers looks even more contrasting from above. It is amazing to realize that the complete skyline was only developed from 1990 on.

After the company visit we went to the Royal Urban Planning Exhibition Centre. While we'd just heard about Shanghai's lack of urban planning, this enormous building was completely full of information on the city's urban development. The scale model of the city centre of Shanghai, around 25x15 square meter, included some Dutch heritage (i.e. John Körmelings Happy Street on the World Expo 2010), uncountable residents towers, numerous flyovers and of course the impressive skyline in the very middle. The Exhibition Centre also showed an animation plus a model of the gigantic harbour, 27 kilometres out of the coast. Since 2010 this harbour left Rotterdam behind in being the largest harbour in the world. The Exhibition was mind boggling because of the astonishing pace of the city development. In 1930, one of the buildings on Peoples Square was the highest in the Far East, now the thirty stories building can only make you smile while seeing it being surrounded by some of the tallest buildings in the world.

Some of the group members left the Peoples Square area to experience a ride on the unbelievable fast Maglev train, which boosted 430 kilometres per hour. Others enjoyed a stroll (and powernap) in the beautifully maintained park next to the Exhibition Centre. Our rude Dutchies dared to lay on the perfect kept grass, which looked like a massive green carpet. Soon after the field was filled with locals joined us in enjoying the sun. Unfortunately an hour later police showed up to order us away. It turned out not to be allowed to enter the lawns...

After having diner in various smaller groups, we gathered again in the hostel to celebrate Queens Day at a local students party. All dressed up and even joined by an orange lion, we made a real attraction on the subway trip to the party location. At the party many Dutch exchange students, Holland lovers and other interested people made the evening to be international, fun and filled with Dutch songs from Doe Maar, Marco Borsato etc. Even though being away for only a few days, being surrounded in such an orange surrounding makes you aware of so many small aspects that make you feel part of a society or culture. It is amazing to experience that all this way from home the Dutch identity is so easily expressed and shared with others. After the Dutch party, most people made it over to Club Sky to finish the day in style and here and there experience China even further.

Day 5 - Yuyuan Gardens

Today was the international day of labour, and it seemed as if the entirety of China had come to Shanghai. It started early in the morning when we were woken by a bombardment

of firework, a 'welcome' alarm for our little hangover. We gathered on the roof to set out to Pudong again to visit the World Financial Centre and its observation deck. With its 474 m height the observation deck was certified as highest observatory of the world (in 2009). With its characteristic shape the tower is lovely called the 'beer opener'. After a tight squeeze in the metro we arrived on the other bank and walked over the elevated footpaths towards the tower, enjoying the view of the skyscrapers. At the arrival at the tower, we were checked by the (already familiar to us) security before entering. Before going up, we had to go to the basement which showed Disneyland-like proportions of waiting rooms and shows about the construction of the skyscraper and Shanghai. We saw an astonishing summary of the growth and geography of Shanghai compared to other metropolitan cities, showing the sudden explosion of the city since the nineties. Hereafter we were sent into the elevator and were rushed up to the 87th floor to be sent up again to the observation deck. The view was superb, the sky was clear and there was little smog. After a long photo session we grouped for a group photo and took the elevators down. We squeezed ourselves in the metro to head to the Yuyuan Gardens.

When we got off the metro the yellow sea of Chinese people did not dissolve and we were trapped in a slow chaotic movement out of the maze of corridors. Even in the streets the mass did not decrease it was clear that the majority of the Chinese had a day off. When we finally managed to get to the gardens, we were starving and massively stormed a food stand across the entrance and ordered large amounts of fried spring rolls and dumplings. Sometimes it is hard to see what the content of the Chinese fast food is which we can buy on the street, but we get more and more familiar with the taste and enjoy the Chinese snacks. The gardens themselves were beautiful and an oasis of rest trapped in a city of anonymous chaos. We, as group of tall Dutch students, attracted attention from day one and many Chinese people make pictures of us. However, nothing could have prepared the Chinese for the event to come. A significant part of the group had stumbled upon the possibility to dress themselves with traditional Chinese costumes. We changed into the costumes and headed out in to the gardens to take pictures of the absurd dresses and hats on our bodies. We soon found out that the Chinese visitors in the gardens had even more fun and interest in us than we had. A small crowd gathered around us taking pictures of us. Suddenly we decided to give these people a show of Dutch humour. We started to run around in the garden screaming and surprising visitors all around the park, pissing their pants from laughter and some of fear. The rest of the group posed like experienced pop stars in front of the paparazzi of Chinese people and kept laughing. The show ended abruptly when the shop owner wanted the clothes back. However, some of us were almost unable to return to the shop because people were pulling on their clothes to get them to take a picture with them. After enjoying the laughter and telling the story afterwards, we returned to our hostel in taxis to avoid the masses.

Although we were tired from the party evening yesterday and the culture during the afternoon, most of the group wanted to have a taste of the luxury and decadence of this cosmopolitan place. So we dressed up and went to Cloud Nine, a lounge bar at 87th floor of the Jin Mao tower (the second highest tower of Shanghai). With beer and champagne we enjoyed the view of Shanghai by night. However, the prices were as high as the building so we didn't stay very long. The evening ended by taking a cab back to the hostel where we laid down and rested.

Day 6 - Royal HaskoningDHV

This was already our last day in Shanghai after five days of great experiences in China.

Everybody woke up after a night with expensive drinks and impressive views at Cloud9. We had breakfast at 8 a.m. and at 9 a.m. everybody had packed their bags for the trip to Wuhan at the end of the day. First the visit to the DSM campus was on the program.

This campus was designed in collaboration with Royal HaskoningDHV and therefore, Larry Li and ... from Royal HaskoningDHV took us on a bus to the campus. The campus exists of three buildings. A 'blue' material sciences building, a 'green' life sciences building and an office, "our three beautiful beauties". The three buildings form the headquarters of DSM Asian Pacific.

After a short introduction from our side, Ronnie from DSM presented the work of DSM and his work on the buildings. Larry of Royal Haskoning DHV further explained the specifics of the building design and the structure of Royal Haskoning DHV. He stated: "I treat a project in the way I treat my baby". Also, he was proud of achieving the LEED gold certificate in 2009. With this building, Royal HaskoningDHV was the first to receive this, where we applauded for.

After a small break, we got a tour through the building of DSM. We have seen the necessary facilities of the labs, how they deal with ventilation, safety and floor layout. Some doubts about the fresh air were mentioned by the students by making comparisons between the needed air in the labs and the 'fresh air' produced by the Chinese employees. It was hard not to laugh. This morning trip ended up with a nice picture with our new network in China in front of the DSM campus.

It was time for lunch and sun. So 'living the good life' was a fact. Once back at our hostel, the group split up to spend free time. Some were enjoying the sun, while the committee took some time to review the first days. The sun was very strong and therefore, drinking a cold beer was the best way to spend our time.

At 4 p.m. time had come to travel to the train station where we left Shanghai. Our next destination was Wuhan, the former capital of China. It is remarkable that one can familiarise itself with such a large city as Shanghai in such short notice. Once at the train station we prepared ourselves for the four hours high speed train voyage and we bought ourselves some drinks and food for the trip. With a dazzling speed of almost 300 kilometres per hour we approached Wuhan while the sun set in the west.

Day 7 - Wuhan

After a long train trip we arrived at Wuhan Hankou Train Station where we queued for a taxi together with hundreds of other Wuhanese. Competition for a taxi was fierce because everyone was eager to get into a taxi as soon as possible without regarding other passengers. In contrast to the proper cars in Shanghai the taxis in Wuhan were rather old

and not able to carry more than one suitcase in the booth. As a result we were packed on the backseat together with our luggage. Luckily the taxi drive to the Hilmon Hotel was short and cheap; although Guido lost his cell phone in the taxi but fortunately he got it back shortly after. To recover from our journey we had some drinks in the lobby instead of the much more spacious bar where we were not allowed to be. (Once in the rooms it turned out that besides ordering Chinese food it was also possible to order a Chinese).

The next morning we had a traditional breakfast with dumplings, warm orange juice and fried ice. During breakfast it turned out that the rooms were not as comfortable as perceived on first sight. Especially the tall ones among us had to squeeze themselves under the shower because the ceiling was less than two meters in height. Eric found a clever way to deal with this problem by lifting the ceiling with his head while showering.

After breakfast and packing our bags, a bus arranged by Grontmij awaited us to bring us to the New Energy Institute of Wuhan. Getting our entire luggage inside the bus was quite a challenge and eventually we had to use a couple of seats as storage. The size of Wuhan struck us by surprise because it was much larger than we expected; it took us almost two hours to reach our destination and all of this time we travelled through urban areas. Wuhan is the scientific and educational centre of China. With its many universities and research institutes 1,2 million people out of the 10 million inhabitants are students. Around noon we arrived at the New Energy Institute where Mr. Li Bin and a beautiful Chinese lady welcomed us. Mr. Li Bin is the country manager for Grontmij in China and provided us with a very nice presentation of the development process of both the building and its surrounding area. The New Energy Institute design is inspired by the Calas flower and it is designed to be a zero emissions building with many techniques for sustainability such as solar panels, wind turbines and rainwater usage. The building will be finished in October 2013 and it will be used by renewable energy institutes with laboratories and offices.

After a quick look at several scale models of the building and its surrounding, Mr. Li Bin accompanied us to our next destination; the European Center in the East Lake High-Tech Development Zone which is called Optics Valley. A well-prepared lunch was served, and directly after Mr. Zhao Jia Xin, the president of the European Center of Optics Valley (ECOV), and other ECOV employees joined us. A short introduction about the company was presented and showed us that ECOV is the service communication platform institution specialized in advising European enterprises entering central China for development, and the vice versa; advising companies in Hubei Province entering Europe. Next we went into dialogue and we had some discussions. Communicating was not as usual, because talking with Mr. Zhao Jia Xin required an interpreter. This way of communication gave an extra dimension to the question and answers session and increased our awareness of being abroad once again. After a short photo session initiated by Mr. Zhou we rushed back to the Hankou train station to catch the train for Nanjing just in time.

Day 8 - Ming's Tomb

Big and lofty train station, a nice start for a Nanjing. After a good night sleep only for those that could afford it we planned to spend our day in a green resort next to the Jiangsu

province capital, the Purple Mountain. Just 30 minutes away from the city centre we started moving up with a cableway. A great ride it was! Getting some fresh air or smog troubled many. After discussion we democratically decided that it was a fresh air at the end. Getting down was a painful but interesting experience that needed a great rest afterwards. This influence the will to visit all the cultural sites at the Purple Mountain. We end up with one, Ming's Tomb. It is a reconstruction of the reconstruction from the 17th century. Original tomb was destroyed due to the wars for a throne as usual. Although link to the original version is doubtful a strong impression remains. After a short rest we refilled the batteries and were ready to try a traditional Chinese food at the kung-fu chain restaurant! Great food and nice hosts. Finally, party-time arrived. This time, an Asian style party. KTV or a karaoke place a concept not seen in Europe. Instead of podium you have your VIP room. Some ideas start emerging...

Day 9 - Ghost City

Today we had the luxury to get up late, which was necessary because of the karaoke night. Some students took great advantage of this and most were too late to get breakfast at the hotel. We gathered at 12.30 hour in the lobby to take the bus to Europ ghost city. We had to wait a short while for our Chinese friend who joined us. Our bus trip went through Nanjing and we enjoyed a nice view of the city. The ride was not that comfortable as the condition of the roads was similar to those in Belgium. Despite the uncomfortable ride many people found a way to get some extra sleep. After a quiet 1,5 hour drive we arrived at Europ city.

We had to present ourselves as possible buyers to make it seem like we were interested in buying any of the newly developed houses. As many were wearing shorts and t-shirts we weren't dressed as real businessmen. When we entered the main building with a large maquette of the construction project, we were approached almost instantly by various brokers that wanted to sell the accommodations. The brokers were dressed formally despite the sunny 27 degrees weather outside. After taking a quick look at the maquette, we were offered some tea and invited to go visit the area. We first went to a villa. These were designed as Mediterranean semi-detached houses. We went inside a model house and the first thing we noticed was that the speed the houses were built with affected the quality in a negative way. We saw cracks and footprints in the concrete structures, holes in the plaster and when we touched something we got scared it would break off. Different sized villas exist ranging from 165m² to 227m² with prices from 1.5 to 2.5 million RMB. The house we visited costs around € 300.000 which is quite cheap compared to the Dutch equivalents.

We then took a short walk through the area and saw some gardeners maintaining the greenery. The area was also fenced together with barbed wire and glass shards. Camera surveillance was also heavy, and as we agreed only Guido was authorized to make pictures, we could not make any pictures ourselves but some of us did anyway (obviously out of sight). We then visited a model apartment which was situated in a separate building. These apartments ranged from 400.000 RMB to 600.000 RMB. This was also the reason why Erup city is a ghost town, since the average employee in Nanjing earns around 2.000 RMB per month. Chinese can generally borrow a maximum of 10 times their yearly income from the bank. Far from enough to be able to acquire an apartment. Another remarkable thing is that

if you want to buy an apartment you'd have to pay when you sign the contract, however you have to wait 9 months before you can move into your new apartment. An 80m² apartment in the inner city of Nanjing costs around 1.4 million RMB, compared to 400.000 RMB for an apartment in the 'ghost city'. A big disadvantage of living in the new isolated city is that no metro station is planned and the trip to Nanjing centre takes 10 minutes by bus, followed by a 30 minute metro ride. On the way back the bus driver hit the mirror of another bus. It was our first accident in the busy Chinese traffic.

In the evening we had an authentic Chinese dinner together in a restaurant close to the hotel. There were some misunderstandings with the food ordering (one group received too few dishes). However, with the help of Qi Han, problems were solved quickly and we managed to order some extra food. Some people had some energy left after the dinner and went for a run. Most people took it easy and enjoyed a calm evening.

Day 10 - Eco city, university, farmer city and football match

We left the hotel around 8:40 am to go to the eco village on this not so friendly weather day. We arrived 70 minutes later on the destination, somewhere out of Nanjing. There we were welcomed by the representatives of the municipality. After starting with a Chinese presentation and some technical issues, we went to the construction site. The eco village is divided into two areas. At the moment, the first part will be constructed. The main focus of this village is the green technology including underground heating pumps. Also the green roofs and wall insulation are important aspects into this village. It has a strategic position (25 minutes away from the urban area), because of the intensive research environment and benefits of the local economy. The total costs of this part is about 250 million Yuan. It has been started in February 2013 and is going to be finished in October 2013, the second part will be started in 2014. We can talk about a win-win situation, since the environment will capture less building emissions and people will live in a more comfortable place.

After visiting the eco village, we went to the Nanjing University of Technology by bus. Because it was a free day, not many students were on the campus. During the tour over the big campus we saw the gym. In this building we played badminton with some Chinese students. Beside ping pong badminton is also a famous sport in China. After that we visited the swimming pool.

Further, one of the contact persons knows a finished project of this University. It is a farmer's village. The farmers who are living over here get a dwelling in trade of their land. All these plots will be used for urban development. Nowadays, these farmers are working in especially factories in the surrounding area. By the time we visited the village, the most people were working. That is why the village looks so empty, beside a few people who were chilling in the park. In one house a few women were playing a typical Chinese game, for us too difficult to understand. Moreover, we had the chance to visit one house. From the outside the houses look pretty poor, but we were surprised about the decorations inside.

In the evening some people went to a football match, while some others had a nice and cosy dinner. Jiangsao Sainty, the football club of Nanjing who is in the highest league of China,

played in the Olympic Stadium of Nanjing. After the first half of the game standing in a pretty boring part of the tribune, we moved to the hooligans part of the tribune. The last half was great because of the atmosphere and the supporters' attention for us and not for the game. (Bob v. T. & Alexandra)

Day 11 - Visit municipality of Nanjing & Urban Planning Exhibition Nanjing

Our day started with the all too familiar dumplings and rice for breakfast although some of us visited the starbucks for a more common western breakfast. When we were gathering for our visit to the municipality of Nanjing some of the commissionaires, read Eric and Jakko, showed up too late because the temptation of Nanjing's nightlife was too great that night. Although Ilse didn't join the nightlife diehards she was also delayed. All of them drew a lot of attention with the pink ducky tie and the orange lions head. At the hotel we were picked up by Vincent Liu, he is staff of European and African affairs of the municipality of Nanjing. His job is to assist company from abroad to settle in Nanjing. After a short walk we arrived at Nanjing's city hall where we met the president of urban planning and the project leader of environmental planning. They ushered us into a luxurious conference room where we received an introduction by the president of urban planning. Within this introduction he explained the spheres of China's governmental system which were national, provincial, municipal and districts. In his introduction he also explained that the purpose of this meeting was not merely to inform us but also to create a dialogue to exchange knowledge about urban planning from both countries.

After the introduction a lecture about Nanjing's situation and ambitions was given. The main objective in a nutshell was to find a balance between rapid new urban and suburban developments and the preservation of Chinese historical and cultural heritage. Besides that the focus was also on creates a sustainable and healthy living environment. To sketch an idea of the situation: for the next two years 11 million square meters of green building are planned and their aim is to supply inhabitant with green areas within the range of 500 meters or 5 minutes walking.

Soon we started the discussion which was a questions and answering session. First we discussed the interaction and relations between the spheres of Chinese governments. We learned that most of the decisions about urban planning and future development where made by the national government and that they are mandatory for the lower spheres. Although mandatory there is space for interaction and discussion between the spheres. Since the cities in china are developing remarkably fast we discussed the dilemma between rapid development and qualitative development. It turned out that the government are now starting to realize that they have to focus more on quality and durability instead of speed. Lastly we talked about the ratio between private and public investments. We learned that the majority of investments are public.

After this intensive and also exhausting meeting (especially for the diehards among us) we crossed the streets for a lunch. Han Qi advised Vincent Liu to have a non-Chinese lunch because Brano Glumac was craving for different tastes. The lunch at the taco restaurant was very nice and all of us were ready for the afternoon after it.

Shortly after we visited the Nanjing Urban Planning Exhibition we were guided by an enthusiastic Chinese young woman. Her presentation was like the rapid Chinese way of urban development; fast, efficient, top down and without too many possibilities for question, interaction or small talk. Her presentation clearly showed the history, present and future of Nanjing in terms of urban development and planning. Especially the video about the future of Nanjing was very ambitious and maybe even utopic at some points. Despite this mind blowing video some of us could not resist the temptation of sleep.

When we left the exhibition we had some time for ourselves and we visited the ancient wall of Nanjing. Most of us enjoyed the island in the lake and climbed the wall while visiting the Jimingsi Temple which is an ancient Buddhism Temple built in the early 6th century. Since Nanjing represents the 7th tallest building in the world some of us could not resist to climb this landmark and they ended up in the city's highest club and restaurant.

Last but not least we had a lovely traditional Chinese dinner from the Sanxi region which we all enjoyed greatly. We all finished our day by exploring the nightlife of Nanjing one more. With our exotic European dancing moves some of us had a close encounter with the Chinese girls.

Day 12 - University and Train to Beijing

Today, Wednesday 8 May 2013, day 12 from the 16 days. The program consisted of visiting the university and traveling to Beijing by night train.

We woke up not that early, the morning was cloudy and smoggy. The morning started by packing our suitcases so after the university visit we could directly go to the train station. After hearing some interesting stories about the night before, we left the hotel at 11 together with our hosts from the university. After a nice walk we arrived at the university campus, located in the middle of the city. We were welcomed with an outstanding lunch in the university's hotel, accompanied by the head of the School of Environment and Energy and a few PhD-students. Some of us were still not used to the Chinese food, but after trying every dish on the table some of us found out that they can get used to this cuisine. Although, others still have some doubts about the 'black eggs', prepared in mud. With satisfied stomachs we could start the formal day program with the staff of the University. It was very nice to notice they appreciated our presence at the campus. A poster that announced our visit including a 'TU/e' logo was placed on several locations on campus. Also the extensive lunch as a start, the snacks and drinks during the day and the 'west-adapted' dinner showed their hospitality and will to build up a good relationship.

The program was filled with some nice presentations from both universities by different directions and levels. There was a big difference between the both universities but it was still very interesting to learn something about the new developments in the technological sector. Material research and systems were discussed during the presentations of the Southeast University. The PhD student from Germany told us some useful information about living in Nanjing as a student and the possibilities to develop yourself. China will be the new

technological center of the world. Visiting the other parts of the campus 'dropped into the water'. We have seen some parts of the library and made a group picture.

After visiting the library there was time for an informative program, namely a 'Pizza meeting' between Dutch master students and Chinese master and PhD students. This to share different experiences of both universities but even more to share the experience of the both different lifestyles. The Chinese students are more subdued and serious (most of their effort is put into improving their knowledge), the Dutch students are more ingenious and flexible. The best example is the study trip organized by OfCourse, a Chinese student should never take the initiative to organize this.

These visit gave insight in the difference between the Dutch and Chinese students, whether the Dutch students mostly collaborating together in groups, the Chinese were more focused on their own work (laptop). Despite the unique chance to study at a great University and the strict regime they also had some bad habits, namely surfing on QQ (Facebook) and looking movies instead of studying.

Finally it was time to discover 'the adventure of the night train'. By entering the train we directly felt some hard feelings about the travel comfort during this night. Piling up the CME students was a fact and comparisons with the feelings of squeezed animals was already made. Luckily it was Rudy's Birthday tonight!

Day 13 - Forbidden City

At 12 o'clock the night train turned into a party train because we'd to celebrate Rudy's birthday in style: with champagne, balloons and lang-zal-hij-leven-songs! The local Chinese people and Rudy were a little surprised, and the champagne resulted in a good night sleep for all of us. In the morning we caught the train employees playing with our balloons, which were sucked underneath the airco grid. Nevertheless the little shock of the crowded train and the noises of spitting Chinese, most of us slept very well.

At 10 we arrived in Beijing, where a bus was waiting to take us to our hostel. Immediately a difference with the other visited cities was noticeable: less tourists, more noisy and a real 'china'-feeling. The buildings are less high and the road wider. Our hostel is located in the north and is in a beautiful Chinese style where the rooms are situated around a courtyard with picnic benches. After freshen up and a brunch we left the hostel for the first exploration of Beijing city.

We headed to the Forbidden City with the metro, where we got lost in the enormous amount of people. The area of the Forbidden City was a no-go area for citizens for a long time; a visit without invitation resulted in immediate execution. Nowadays it is almost fully publically accessible and this was clearly visible in the mass of people within the walls of the city walls. We were all quite impressed by the size of the area and the number of buildings that were once all part of the emperor's (home) complex. After the Forbidden City, we went to the Tiananmen Square: the largest square worldwide which played an important role in the history of Chinese leadership and revolution. In our opinion, we experienced the

ultimate China-feeling on the square. The enormous size, propagandistic movies on huge screens, soldiers marching around, and the large buildings around the square made us feel like walking around in a communistic country. To imagine that over a million people can gather there to listen to the speeches of their leaders was a bit strange.

After the impressions of the afternoon, we went back to the hostel, but first we had to eat. Used to the Chinese food, we were not afraid to step into a small restaurant without an English menu whereby Han Qi composed a nice meal for us with dumplings, beans, sweet pork, dumplings, fish, tofu and more dumplings. When we entered the place, three tables of Chinese men were already sitting, eating and especially drinking there. This resulted after an hour in a loud shouting of drunken Chinese cheers and shouts. To give you an impression, it could have sound like 'hooohoochoioioiheheheechoo' on high volume.

After our meal, we went back to the hostel. No clubbing tonight because we have to get up early tomorrow, but relaxing, chatting, and playing games, playing pool and drinking a (little) beer. The committee had a little surprise for the birthday of Rudy and had bought a birthday cake, which we all had a piece of. After that we went to bed to be fit for the day after.

Day 14 - The Great Wall Mutianyu

Today we got up early to have a six o'clock breakfast before leaving to the great Chinese wall. All of us were ready to go at 7am. Our guide had arrived already however our bus was missing because of Beijing rush hour. Somewhere around eight we left the hotel and headed to Mutianyu, 70 km northeast of central Beijing. Because of our rhythm and the few hours of sleep almost all of us fell asleep as soon as we sat down in the bus. The guide tried to keep us awake with some interesting fact about the Chinese wall and its history.

The Mutianyu section of the Great Wall is one of the best-preserved parts of the Great Wall. The Mutianyu section used to serve as the northern barrier defending the capital and the imperial tombs. It was first built in the mid-6th century, in the Ming dynasty (1368-1644) construction of the present wall began. In 1404, a pass was built in the wall and in 1569, the Mutianyu Great Wall was rebuilt and till today most parts of it are well preserved. In the 1980s it was reconstructed again and this is the wall we were going to see today. The wall consists mainly from granite and it is 7–8.5 metres high and the top is 4–5 metres wide. Watchtowers are densely placed along this section of the Great Wall - 22 watchtowers on this 2,250-metre-long stretch. Both the outer (Northern) and inner (Southern) Wall are covered with merlons, so that shots could be fired at the enemy on both sides (a feature very rare on other parts of the Great Wall).

Finally after a two and a half hour drive we arrived at the village at the bottom of the mountains near the wall. As soon as we got off the bus we felt the burning presence of the clear sky and sun. It was a beautiful day maybe too beautiful for climbing. The guide advised us to take the cable cart upstairs to save our strength for climbing the wall instead of the mountain towards the wall. The wall consists namely of 4000+ steps. The view was magnificent and the weather as well, there was no smog or abundant Chinese blocking our view. For Chinese standard it was quite calm and we had enough space to travel a significant

part of the wall. We had three hours to explore as much of the wall and its views as possible before grouping at watch tower 10 for a group picture. There were some difficulties with this because of an injury and fear heights. After the almost group picture we set out the toboggan, a single rider bobsleigh like downhill track. After a dreadful slow downhill race (Chinese are chicken shits) we arrived at Mr Yang's. Some of us set out to buy some souvenirs at the stall around the village others went to the restaurant immediately. The lunch at Mr Yang's was great it seemed that Beijing had a more western acceptable taste.

Around 3:30pm we arrived at the hostel and were granted a small contribution of the committee to buy some dinner. Some were daring enough to try the street-life dinner-style, while other chose a more safe approach, franchise food or restaurant food.

We agreed to group at 22:30pm to go and explore Beijing by night for the first time. Together we set out to Club Red. Upon arrival the question arose: are we at the right kind of bar? It seemed as if we had arrived in a gay bar with a dancing pole on which guys showed their moves. After a while we decide to go and find a better club and found it just across the street. We swarmed the podia and started claim the dance floor. Mingze was kind enough to bargain for us and drastically reduce the beer price. It was a good last party night.

Day 15 - Last Day in China

This warm and sunny day - warmer than 30 degrees centigrade - was our last day in China. Most group members spent the previous night in a bar and therefore took the opportunity to sleep late on this free day. However, some did already have breakfast at 8 in the morning to see more of the Chinese sights and culture.

The group split up into several smaller assemblies that made their way to different spots. A big part went to the Olympic stadium (known as the Bird's nest). Some others took a view into the Summer palace, which used to be a very peaceful part of land, including several traditional buildings and a big lake. But on this Saturday it was very crowded with, mostly, Chinese tourists. Luckily there were good spots to relax in the lawn with a view over the lake. The more adventurous ones went to both and also took a glimpse in an ancient Hutong, a traditional Chinese village consisting of narrow streets or alleys.

Around 7 p.m. we gathered to have our last diner. In a highly exclusive restaurant we enjoyed a pre-ordered meal in the company of Mingze Hou. He is a Chinese guy, working in Eindhoven, who helped the committee in organizing the activities. After Mingze was thanked, Brano and Qi Han took the opportunity to thank the committee for their effort, also by giving the committee members a Chinese notebook.

The evening ended in the bar of the hostel, where the funniest pictures made this trip were shown on a screen. This was a very enjoyable first review of our impactful experiences in the People's Republic of China.

Day 16 - Journey Home

The bus to the airport of Peking was leaving this day at four in the morning. Some of us did not go to bed at all and continued playing games like: Jenga, the Chinese game Go, and card games. Others got social with some Chinese night guests for the last time and played a pool game. Some people that managed to get any sleep had to be woken up by others or they would've missed the bus to the airport. This was not easy; some students had to knock for 10 minutes on the door and window of a teacher whose name will not be mentioned here. When everyone was accounted for (20 minutes too late), the procession moved slowly to the bus which was parked at the end of the street. After all the heavy suitcases were loaded in the bus, it departed to the airport. The trip was a very quiet one, since most people had already fallen asleep again. Outside, the sun had already risen and a new day had begun.

After we checked in, we checked our places and neighbors in the plane. Some people were very happy having a seat to the window so that they could sleep in peace. Brano had too little space for his legs and got relocated to another seat where he fell asleep almost instantly. The flight went okay; we only had a small delay waiting for transfer passengers at Zürich. When we arrived at Schiphol, the level of stress increased as we had to wait a little while for our suitcases. Luckily however, all suitcases ended up on the belt. After everyone received their suitcases, some students were finally reunited with their worrisome but especially cheerful parents. A handful of students have finished the journey towards home by train.

After all, this was the end of a beautiful learning experience where fun and “education” played a central role. We want to thank the committee for organizing this great trip to China.

APPENDIX B

KENWIB – Day Report Study Trip Manchester, May 2014

Preface

The climate is changing. That is no surprise. The climate on Earth is not constant. Cosmic influences, such as for example the tilt of the axis around which the Earth rotates, the periodically changes of the orbit around the sun and the wandering of our solar system in the galaxy provide varying climatic conditions, in which human being is at the most a modest spectator. Parallel to the ongoing climate discussions, the need for the establishment of a sustainable economy becomes emphatic recognizable. A world wide economy model, based upon growing consumption is questioned. To that end, there are constantly debates conducting in different sectors of society, business circles and public institutions such as schools and universities. The topics include issues such as recycling of materials, use of sustainable energy and sustainable water use. The importance of this development is significant, perhaps also links to us personally. We know that the major international conflicts, evoking terrible acts of violence, which we can observe every day, are related with the availability and distribution of raw materials and energy stocks.

The 'Kenniscluster Energie Neutraal Wonen & Werken in Brabant' is a project based upon cooperation between governmental organizations, university and entrepreneurial companies. The partners are: the Municipality of Eindhoven, the Province of Noord Brabant, the Promotie InstallatieTechniek and the University of Technology of Eindhoven. The **KenW²iB _{brabant}** project started in September 2009 and the final evaluation of the project is planned at the end of 2014. The aim of this project is to stimulate and realize energy neutral and sustainable urban districts by joint interdisciplinary development and dissemination of knowledge.

Therefore during a period of five years several groups of master graduation students have been and will be directed to execute dedicated investigations and research on combined technical, organizational and socio-technical subjects. Each of the graduation projects is also guided by a dedicated company or institution giving input from practical, societal points of view.

Already during the last couple of years four international study trips have been organized by the **KenW²iB _{brabant}** graduation students together with involved staff members of the MSc Program Construction Management & Engineering (CME) at the TU/e. Previous destinations were Denmark, Freiburg, China and London. This fifth trip is more specifically addressed to (re-)development of urban- and industrial area's, regarding sustainable issues. All the 70 graduation projects reports, the study trips reports can be downloaded from www.kenwib.nl.

The results of all the graduation projects and study trips reports will help to structure discussions and policy making activities. Graduation students, staff and involved real world experts have not only developed knowledge and understanding of the theme, but they may also represent the personal feature of 'ambassador'. This new group of young engineers has, now with internationally recognized academic qualifications, positive attitudes and skills to realize this mission of sustainable development.

Wim Schaefer, July 2014

Chair Construction Management & Engineering, Eindhoven University of Technology

Introduction

With great pleasure we present to you the of CoUrsE! Tour 2014 booklet which contains the day reports and case studies from our study trip to Liverpool and Manchester.

This study trip was organized by the of CoUrsE! Tour 2014 committee for all of CoUrsE! Students. of CoUrsE! is the study association of the Master of Science Program: 'Construction Management and Engineering' (CME) at Eindhoven University of Technology (TU/e).

The first and most important aspect the committee had to tackle while organizing the tour was the destination of trip for this year. Every other year the trip can go intercontinental or should stay in Europe, the latter was the case this year. Therefore possibilities were kind of limited, but there is plenty to do in Europe! Then the cities of Liverpool and Manchester came to mind. Both big cities which had a centre role in the industrial revolution, but have kind of collapsed after this. Therefore Liverpool and Manchester are (re)developing themselves in order to become and stay attractive for (large) firms to settle within their municipal borders. For this reason the following theme was used during the trip:

The Sustainable Reinvention of the City

'The use of smart- and sustainable redevelopment to increase a city's attractiveness'

The eight day trip started at the 22nd of May by spending four days in the city of Liverpool. After this the tour continued with four days at Manchester City and thereby ended at the 29th of May. The program made for this trip was carefully thought through so that every participant will have an educational, interesting and above all pleasant trip to the UK.

The tour contributed to an increase of our general knowledge, gave insight to international structures and experiences. Hereby we would like to thank all participants who helped making the of CoUrsE! Tour 2014 the success it was. We think everybody can look back to an unforgettable trip. For more information about the tour please visit our website www.ofcoursecme.com/study-trips

In this booklet you will first find all day reports which describe all activities that were done during the trip and after this the case studies that were performed by the students are presented. This case studies are about companies we visited in the UK and will describe the companies, their activities and the possible contribution these can have for the Netherlands, in particular Noord-Brabant.

We wish you a nice time reading the booklet and maybe we see you sometimes at of CoUrsE!

Kind regards,

The of CoUrsE! Tour 2014 Committee

Hannely Hortensius, Erik Vijverberg, Andreas Lem, Daan Stoop, Ruben Dieten, Bob van Bronkhorst

Day Reports

As stated earlier this first part of the booklet will contain all day reports. This is a bit of an informal way of introducing you to our activities on the trip with the use of pictures made during the study tour. Of course many more things happened during the trip, but it is impossible to list everything in this booklet. If you are curious about more inside information you should contact the committee or one of the participants of the trip.

The first four day reports about our days in Liverpool were written by Daan Stoop, the last four day reports about our visit to Manchester were written by Ruben Dieten.

For the pictures we would like to thank all participants who gave their photos to us and especially Guido van Veen.

Day 1 | Thursday | 22nd of May | Liverpool

After months of planning the trip, weeks of preparing the cases and one night of poor sleep due to the nerves, the of CoUrsE! Tour was ready to depart for 8 wonderful days in the UK. At dawn the first students trickled in at the Eindhoven Central Station to take the earliest train to Schiphol Airport. Once arrived at Schiphol we were completed with the last three students whereby the Liverpool fellowship, consisting of 18 students, was complete and ready to go true customs.

At 9:10am everybody had taken their seats and so the plane took off to Liverpool John Lennon Airport. About 20 minutes later, according to the UKs' time zone, the plane already landed at Liverpool Airport and by 11:30am we arrived at the International Inn Hostel in Liverpool.

After spending some time in the city or in the pub at the corner, we gathered at the hostel at 14:00pm to subsequently depart to the first company visit of the trip. At 15:00pm the Liverpool Local Enterprise Partnership (LEP) hosted us at their head office close to the waterfront. The LEP is a non-profit organization which is mostly financed by (local) enterprises. Due to the financial input of these local parties the LEP is able to stimulate Liverpool's economy; focusing on the key sectors: knowledge economy, low carbon economy, SuperPort and visitor economy. On behalf of the LEP, Mr. Alan Welby (executive director at LEP) gave a presentation about LEPs' goals and activities. He gave insights in how a local enterprise partnership works and why (local) partners are willing to contribute to this initiative. Mainly because Mr. Welby was very enthusiastic in telling his story a nice question and answer session came into being. After approx. 1,5 hours of presenting and discussing it was time to thank Mr. Welby for his nice presentation.

The first visit was finished so we headed back to the hostel in order to prepare for dinner. Around 19:00pm it was dinnertime at Uncle Sams bar. While enjoying our pints, our ciders and 'The eye of the tiger' (a song by Survivor, written in 1982) we had our meals. (Probably only the participants know the relationship between Uncle Sams and 'The eye of the tiger', so feel free to ask them about it). After dinner it was time to spend our first minutes in nightlife and where better to start than in Liverpool's most famous club: 'The Carvern Club'. Since the schedule of the next day was quite busy, most people took it easy and listened to some live Beatle music.

Day 2 | Friday | 23rd of May | Liverpool

At this second day the program started early. The schedule of the day looked as follows: in the morning we would bring a visit to the University of Liverpool and in the afternoon we would visit the Liverpool2 terminal project from PeelPorts Group.

Prof. David Shaw welcomed us at 9:00am at the campus of the University of Liverpool. He started with a brief introduction of their 'Urban planning' master program which shows some similarities to the CME program. After explaining their program, Mr. Shaw told that their group is doing a lot of research regarding urban planning aspects in the Liverpool area. The latter is a very relevant and interesting topic since the population of Liverpool is almost halved since the 19th century. This results in a lot of residential vacancy and Brownfield areas.

After our visit to the University we went back to the hostel, which was only a 10 minutes' walk. Since we arranged with the PeelPorts Group to pick us up at 12:30pm, we decided to spend some time on visiting the Liverpool Metropolitan Cathedral. This Cathedral is a very striking building within the Liverpool skyline and it is often called a giant tepee. After having a walk around the cathedral, have a look inside it or enjoying a cup of coffee the taxis were there to pick us up and to bring us to the office of PeelPorts Group which was situated in the Port. The first impression of our visit was immediately fantastic. Besides a 'simple' minibus, they arranged two more sophisticated cars including private driver.

Around 13:00pm Ms. Lyndsey Maloney from PeelPorts Group, Mr. Luuk de Boer and Mr. Mark Schoonheim both from Van Oord welcomed us on site. Before starting the presentation about the project, we enjoyed a very nice lunch. After lunch, we got three presentations. The first presentation was held by Ms. Maloney and contained among other the project goals of PeelPorts regarding the project. The second presentation went into more detail and was held by Mr. Stoneham. He briefly described the phasing and execution of the project. At the end Mr. de Boer closed with his small presentation about Van Oords' trainee program.

After approx. 1,5 hours of presentations the hosts decided that it was time to go outside and to have a look at the construction site. After a short drive we arrived at the site office where one of the safety officers gave us a quick safety pitch. Everybody putted on their safety boots, safety jacket, life jacket, earplugs, safety goggles, safety gloves and last but not least their helmet. After some final checks everybody was ready to visit the construction barge. On board the working staff explained about the project and after a 1 hour visit it was time to leave the barge and to head back to the hostel. Luckily everybody returned safely. After two exciting days of company visit it was time to enjoy the weekend!

Day 3 | Saturday | 24th of May | Liverpool

Our third day focussed on exploring the English culture and that's why we visited a horse race. We gathered at 12:00 in the afternoon at the hostel and from there on we walked to the bus stop at St. Johns Lane near the city centre. At this stop, bus 520 would pick us up to bring us to one of England's national sports: horse racing. At around 13:00pm we arrived at Haydock Park for the Betfred Temple stakes. The first thing that strikes when you visit a horse race is that there is a variety of visitors: chic and very well-dressed, chic but smart casually dressed, normal dressed and visitors who were dressed as students. As a matter of course we belonged to the last category.

With only an hour to go before the first race some people tried to master the tactics of betting on horses. Hoping for the best, everybody went to the large stand which was situated close to the track. In this first race there were already some winners so the upcoming 6 races looked promising.

Around 17:00pm the races were finished so it was time to leave Haydock park and to head back to Liverpool. After arriving in Liverpool we had a free evening in which most people decided to watch the Champions League final. After that exciting match it was time to discover Liverpool's nightlife.

Day 4 | Sunday | 25th of May | Liverpool

Day four, our last day in Liverpool has dawned. The program of this day consisted of activities to get to know Liverpool and its history. After packing our suitcases and after we had breakfast, everybody gathered at 10:00am at the hostel. Being on time was important this day because our tour guide, Mr. Daan Stoop, was very precisely with respect to the time.

First stop of the tour was the Liverpool Cathedral, one of the largest Cathedrals in the world and recognised as one of the eye-catchers of Liverpool's skyline. Because all the highlight in Liverpool are within walking distance, we walked to our second destination: 'the St. George Hall'. After exploring both the in- and outside of this historical building we went to the Central library. After pending around 30 minutes in the library it was time to leave to Liverpool's waterfront. The walk towards the waterfront was nice because of all the old building and warehouses. On the waterfront the 'three graces' are the first buildings you see. 'Three graces' is a collective noun for three of Liverpool's most iconic building: Royal Liver building, Cunard building and Port of Liverpool building. In Liverpool's heyday those three building were part of the most important buildings in the world when it came to trade.

Around 12:00 the 'group program' came to an end and from then on everybody was free to go. Some went to the Anfield football stadium and others visited some of the museums Liverpool offers. The spare time came at a good moment since we already had to leave Liverpool at 8:00pm. All in all we enjoyed our stay in Liverpool because we visited educational projects/companies and because the city is an undiscovered treasure of cultural heritage!

Day 5 | Monday | 26th of May | Manchester

After a fun night in the Irish pub, everybody woke up at 08:00. At the breakfast everybody was relieved that the breakfast was a lot better than the dry toast and jam we had in Liverpool. We had milk, orange juice and even yoghurt!

At 10:00 the tour guide picked us up at the hostel. The enthusiastic tour guide led us through Manchester in 1,5 hours and told us about the history and top sights of Manchester. After a quick lunch at a sandwich bar where we had the day of our lives we arrived at the hostel again, where everybody could get their things for the next part of programme: visiting Charlie Baker from Urbed.

Arriving by train we walked a short distance to where we would meet, a room on the first floor in pub Charlie arranged. While we waited for Charlie to arrive, we were kindly served with coffee. Waiting was no big deal when water started leaking from a crack in the roof. Quickly after, a few other cracks started leaking and buckets were placed all around the room. Apparently the up floor neighbour left his bathtub tap open, resulting in an amusing fifteen minutes.

Now it was time for Charlie to give an inspiring presentation about his vision and work on retrofitting (upgrading the housing stock), while sipping from a pint of beer, at 1 pm. After the presentation he took us to his house where he tries all the different insulation methods which he told us about in the presentation. It was a chaotic house, but interesting to see how a passionate person implements all available techniques by himself in his own house.

After the tour around and in the house, we went back to the pub and had some drinks and a discussion between Charlie, the tutors and the students. From Nuclear power, to electric cars and an enthusiastic Charlie this was a very interesting setting.

Around 5pm we went back by the train and had a dinner with the entire group at a restaurant. Afterwards, everybody was free to do what they want. Some went to the hostel and others wanted to try more different beers.

Day 6 | Tuesday | 27th of May | Manchester

At 8:30 the group was ready again for the next packed day programme. From the hostel we walked to the bus station where we took a 30-minute bus drive to the Hexagon Tower (the name sounds spectacular, but it's an ugly building).

At the hexagon tower we met with people from the Northwards Housing Company, Greater Manchester and Digital Strategy. After the presentation we went by taxi to the Whitebeck Court. The Whitebeck Court is a elderly home which has been completely redeveloped. It has been stripped completely from the inside and outside and now it is a very sustainable building with around 90 single or double apartments for elderly. After a tour around the building we walked to a bus stop which was recommended to us that it could take us to the Manchester Town Hall.

After a busdrive of 1 hour instead of the planned 20 minutes we were a bit late at the Town Hall. Finally we arrived and we got a presentation in a amazing beautiful reception room about the massive renovation project of the Town hall and the Central Library. A 170 million pound project with an amazing result. The modern style is beautifully combined with the old style. We had a extensive tour around the huge building and the library.

Around 4pm we left again, and went to the Manchester university where Andy Korvonen gave us a presentation about central heating systems for cities. After the presentation and discussion, Andy wanted to take us to his favourite pub nearby. At the pub many wanted to try the real British Ale, with no big success, the beer without gas fell out of favour in the Dutch thirsty mouths.

From thereon everybody was free to do whatever they wanted. Some had dinner at the same pub and some went to some other pub/restaurant. Afterwards some met in a club that night to finish the (already) exhausting day.

Day 7 | Wednesday | 28th of May | Manchester

May 28th 8:00 everyone was getting ready at the hostel lobby. Some had their eyes half closed still. From the hostel the group walked to the Piccadilly train station. From there we took the train to the Manchester airport. At the airport we went to the CBRE real estate investment firm.

Once arrived, we entered a beautiful office into a room where we got a presentation about the development of the Airport City. This project is being executed and is aiming to develop an extensive business park. Mr. Alex Russell and Mr. John McHugh presented the project mostly on basis of the scale model.

After the presentation the tutors had to catch their airplane back to Holland. The rest of the group had the rest of the day off to do whatever they liked. Most went to the Old Trafford Stadium. Others went to the Manchester cathedral and the old and beautiful John Ryland's Library.

At diner time the whole group gathered again at a restaurant where we again had cosy dinner with everyone. After diner the group went to a pub nearby the hostel. From here the group split up again and some went to the Hard Rock café, and others went to the hostel to play some board games or to relax.

Day 8 | Thursday | 29th of May | Manchester

The last day! For this day we had our last company visit planned: The City Football Academy. Dutch contractor BAM is building this prestige project for Manchester City.

Once we found the entrance of the site the project and differences between a regular building site and all the new sport technologies and sub-contractors used in this project were first shortly presented to us by Ms. Julie Bratt, Community Engagement Co-ordinator. After this one of the construction managers showed us around. Unfortunately we could not get a tour around the site but we could go on top of the site office where we could have a good look at the project site.

Afterwards the group went to the nearby original Etihad Stadium for a group picture. From hereon the program of the of CoUrsE! Tour had ended and there was the possibility for everybody to do what they wanted before we gathered at the hostel to go to the airport. Some went to the Museum of Science & Industry, and others went to grab some lunch.

At around 15:00 everybody gathered at the hostel and left to the airport. At 17:25 the plane departed back home to Amsterdam. All together it was a great journey where the awesome group learned a lot about the built environment in Great Britain and truly experience the British culture.

Again a successful trip with study association of CoUrsE!

