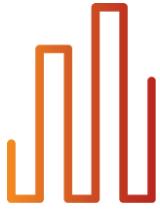


dr. Brano Glumac

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# A method to test acceptance of new housing concepts discrete choice model for a small, transportable and energy efficient dwelling



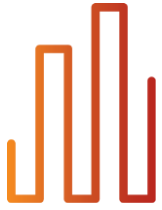
# Summary

1. Project Background
2. Housing in the Netherlands
3. Project Questions
4. Research Question
5. Measuring Housing Preferences and WTP
6. Discrete Choice Method
7. Setting-up Experiment
8. Respondent's Characteristics
9. Results
10. Conclusions



# 1. Project Background

- Heijmans – a **construction company**
- **Financial** status of **municipalities** after **2008**
- **Temporary use** of municipal space



# 1. Project Background

- **Fixed production costs**



<https://www.heijmans.nl/en/heijmans-one/>



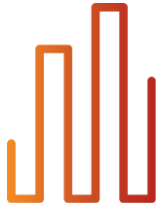
- Find out **services** and **suitable rent**

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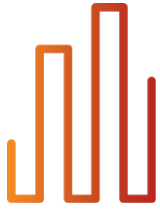
## 2. Housing in the Netherlands

- One-person households:
  - **3,3 millions** by 2025 (CBS, 2013)
  - different **requirements** of living space
  - **causes**: delaying marriages, increase divorce, aging pop.
  
- Environmental policies:
  - **reduction 80% to 90% of CO<sub>2</sub> emissions** in **2050** compared to the emissions in 1990 (Landbouw & Innovatie, 2011)
  - **30% of all CO<sub>2</sub> emissions** in the **EU** are related to **buildings**
  - **40% of the energy consumption** (Majcen et al., 2013)
  
- Vacant land is a problem



## 3. Project Questions

- Target group
  - one-person households
  
- Technical measures
  - energy efficiency
  - use of space
  - transportable (temporary use of vacant land)
  
- Financial feasibility (fixed expenses / suitable rent)

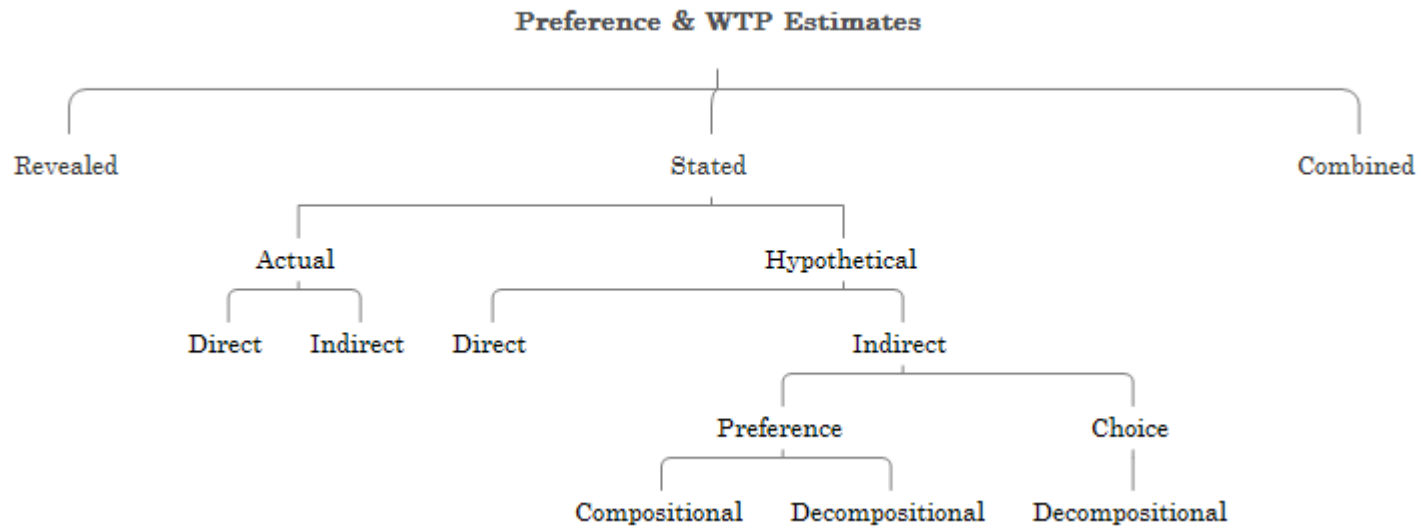


## 3. Research Question

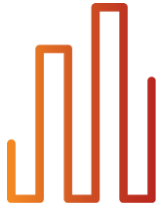
- What are the **preferences** of **one-person household renters** regarding **transportable CO<sub>2</sub>-neutral homes**?



## 4. Housing Preferences and WTP

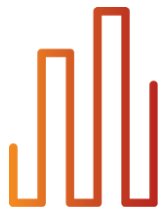






## 5. Discrete Choice Method

- Pros
  - conjoint analysis is purely mathematical DCM relies on **micro-economic theory** (Louviere, 2010)
  - ranking in **conjoint analysis does not mimic accordingly** behavior of choosing a dwelling (Myrick Freeman III, 1991)
  - **most** housing choice **researchers** use DCM
  
- Cons
  - stated preferences are **less price sensitive** (Wardman, 1988)
  - **socially desirable bias** compared to true behavior or estimates based on revealed preferences



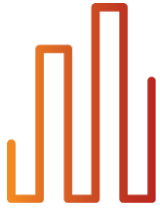
## 5. Discrete Choice Method

- Random Utility Theory
  - assumes that **all individuals** when able to choose they will **choose** the alternative with the **highest utility**

$$U_{in} > U_{jn}, \forall j \neq i$$

- **utility** of an alternative consists of a **systematic** (explainable) and **random** (not explainable) **part**

$$U_{in} = V_{in} + \varepsilon_{in}$$



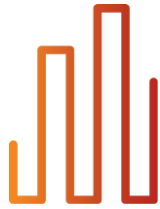
## 5. Discrete Choice Method

- Random Utility Theory
  - **systematic component** can be modeled as the **sum of part-worth utilities**

$$V_{in} = \beta_0 + \beta_1 X_{in1} + \beta_2 X_{in2} + \dots + \beta_k X_{ink} = \sum_k \beta_k X_{ink}$$

- because of the random component, the **probability** that an individual will choose a certain alternative (dwelling) **can be calculated**, but the exact choice cannot

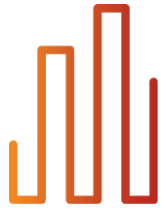
$$P(i|j) = \frac{e^{\beta_k X_{ink}}}{\sum_j e^{\beta_k X_{jnk}} + e^{\beta_k X_{ink}}} = \frac{e^{V_{in}}}{\sum_j e^{V_{jn}} + e^{V_{in}}}, \forall j \neq i$$



## 6. Setting-up Experiment

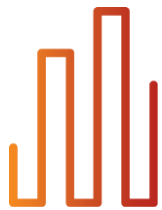
- Stage 1: Problem definition refinement
- Stage 2: Stimuli refinement
- Stage 3: Experimental design considerations
- Stage 4: Generating experimental designs
- Stage 5: Allocating attributes to design columns
- Stage 6: Generation of choice sets
- Stage 7: Randomizing choice sets
- Stage 8: Survey construction

(Hensher et al., 2005)



## 6. Setting-up Experiment

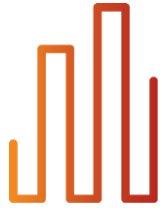
- Stage 2: Stimuli refinement (alternatives & attributes)
  - conditional attributes
    - it is movable
    - well isolated and energy efficient thus lower bills
    - design (interior/exterior)



## 6. Setting-up Experiment

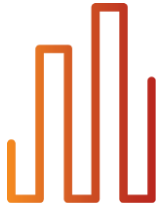


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## 6. Setting-up Experiment

- Stage 2: Stimuli refinement
  - attributes: literature, experts



## 6. Setting-up Experiment

Attribute	Level
The maximum renting period:	<ul style="list-style-type: none"> <li>- 1 year</li> <li>- 3 years</li> <li>- 5 years</li> </ul>
The energy performance has immediate influence on the housing cost and environment	<ul style="list-style-type: none"> <li>- excellent (label A+++) the dwelling does not need energy from the grid</li> <li>- average (label A) the dwelling needs little energy from the grid</li> <li>- poor (label B) the dwelling needs a lot of energy from the grid</li> </ul>
Kitchen and bathroom will be standard included. The level of completion of the dwelling:	<ul style="list-style-type: none"> <li>- non-padded</li> <li>- padded</li> <li>- furnished</li> </ul>
The total monthly cost (rent + energy + maintenance)	<ul style="list-style-type: none"> <li>- €550,-</li> <li>- €600,-</li> <li>- €650,-</li> </ul>
The type of dwelling	<ul style="list-style-type: none"> <li>- 1-room apartment the bed is located in the living space</li> <li>- 2-room apartment the bed is placed in a separate room</li> </ul>
In a communal space residents could get together and share functions (washer, pool table, fireplace etc.)	<ul style="list-style-type: none"> <li>- with</li> <li>- without</li> </ul>





## 6. Setting-up Experiment

- Stage 8: Survey construction
  - a choice set

### Housing for one-person households

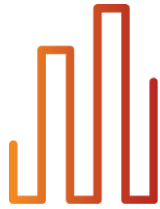


Choice set - choose the preferred alternative:

	alternative 1	alternative 2	neither
maximum renting period	5 years	3 years	
energy performance	average (label A)	poor (label B)	
level of completion	non-padded	non-padded	
total monthly cost	550 €	650 €	
type of dwelling	1-room apartment	1-room apartment	
communal space	without	without	
<b>YOUR CHOICE:</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

previous

next



## 7. Respondent's Characteristics

- Reached 625 respondents of which **280** completed (~ 45% response rate)

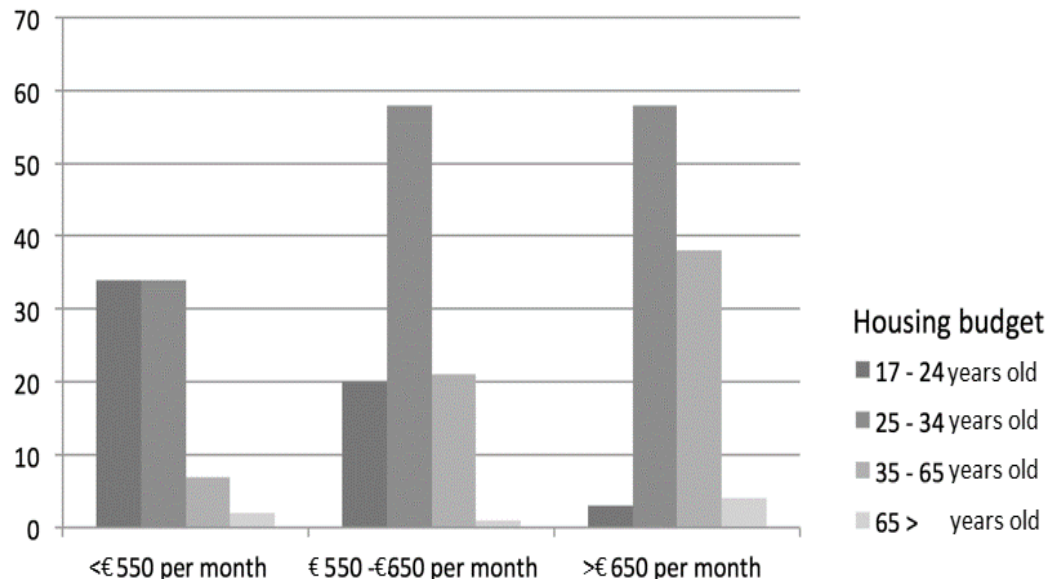
Socioeconomic variables			
Description	Value	Frequency	%
<b>Gender (dummy)</b>	Female	147	52.5%
	Male	133	47.5%
<b>Age (years)</b>	<17	0	0%
	17-24	57	20.4%
	25-34	150	53.6%
	35-65	66	23.6%
	>65	7	2.5%
<b>Place (inhabitants in 1000s)</b>	<50	102	36.4%
	50-100	14	5.0%
	>100	164	58.8%
<b>Monthly housing budget (€)</b>	<550	77	27.5%
	550 - 650	100	35.7%
	>650	103	36.8%
<b>Design satisfaction (ordinal)</b>	Positive	208	74.3%
	Neutral	63	22.5%
	Negative	9	3.2%

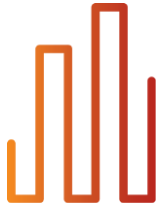


## 7. Respondent's Characteristics

- **53,6%** was aged between **25 and 34** years of age

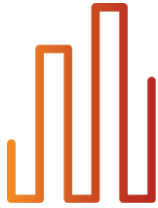
- **housing budget versus age**





## 8. Results

Variable	Coefficient	St. Error	b/St.Er.	P[Z>z]
<b>CONST</b>	0.65821097	.06169757	10.668	.0000
<b>PER1</b>	-0.64899415	.05586186	-11.618	.0000
<b>PER2</b>	0.15633885	.04413625	3.542	.0004
<b>ENER1</b>	-0.55392545	.05452532	-10.159	.0000
<b>ENER2</b>	0.00322635	.04479517	0.072	.9426
<b>OPLEV1</b>	-0.01522069	.05224965	-0.291	.7708
<b>OPLEV2</b>	0.16540295	.04564535	3.624	.0003
<b>PRC1</b>	0.24680369	.05217846	4.730	.0000
<b>PRC2</b>	0.09126583	.04560597	2.001	.0454
<b>TYPE</b>	0.63283547	.03579924	17.677	.0000
<b>COMM</b>	-0.12308964	.03300800	-3.729	.0002
<b>Model parameters</b>				
Number of observations = 2240				
Iterations completed = 5				
LL function = -1987.509				
LL (null) = -2461.1155				
-2LL = 947.213				
Chi-square perc. [9] = 16.92				
Pseudo R <sup>2</sup> = 0.1924				
Info. Criterion: BIC = 1.81244				



## 8. Results

Attribute (VAR)	Level	PWU	Range
<b>Max renting period (PER1; PER2)</b>	One year	-0.6490	1.1417
	Three years	0.1563	
	Five years	0.4927	
<b>Energy performance (ENER1; ENER2)</b>	A+++	0.5507	1.1046
	A	0.0032	
	B	-0.5539	
<b>Level of completion (OPLEV1; OPLEV2)</b>	Non-padded	-0.0152	0.3156
	Padded	0.1654	
	Fully furnished	-0.1502	
<b>Total monthly cost (PRC1; PRC2)</b>	€550	0.2468	0.5849
	€600	0.0913	
	€650	-0.3381	
<b>Type of dwelling (TYPE)</b>	Studio	-0.6328	1.2656
	One bedroom	0.6328	
<b>Communal space (COMM)</b>	Yes	-0.1231	0.2462
	No	0.1231	

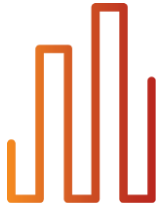


## 9. Conclusions

- Temporal space solutions can be feasible (singles)
- Discrete choice method explains well the preferences of target group
- Understanding preferences helps designers, developers and policy makers
- Can contribute to similar investigation of new housing services and products



Merci fir Är Opmierksamkeet.



# 10. Appendix

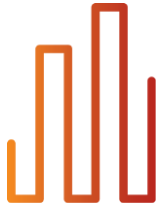
**Table 1:** MNL regression estimate for respondents with a housing budget of 550-650 euros per month ( $n=100$ )

Variable	Coefficient	St. Error	b/St.Er.	P[Z>z]
CONST	0.66194986	.10282944	6.437	.0000
PER1	-0.65828633	.09333141	-7.053	.0000
PER2	0.10937194	.07433975	1.471	.1412
ENER1	-0.53417238	.09128924	-5.851	.0000
ENER2	-0.02084812	.07591518	-0.275	.7836
OPLEV 1	-0.07307038	.08816373	-0.829	.4072
OPLEV 2	0.16998415	.07713733	2.204	.0275
PRC1	0.22567645	.08871916	2.544	.0110
PRC2	0.09194548	.07773389	1.183	.2369
TYPE	0.68133262	.06027185	11.304	.0000
COMM	-0.11992659	.05596828	-2.143	.0321

Model parameters

Number of observations = 800  
 Iterations completed = 5  
 LL function = -705.2188  
 LL (null) = -878.9698  
 -2LL = 347.358  
 Chi-square perc. [9] = 16.92  
 Pseudo R<sup>2</sup> = 0.1976  
 Info. Criterion: BIC = 1.85496





# 10. Appendix

**Table 2:** MNL regression estimate for respondents living in places with <50,000 residents (n=102)

Variable	Coefficient	St. Error	b/St.Er.	P[Z>z]
CONST	0.19120519	.09141256	2.092	.0365
PER1	-0.50030301	.09043202	-5.532	.0000
PER2	0.01631203	.07304469	0.223	.8233
ENER1	-0.48089111	.09009263	-5.338	.0000
ENER2	0.05786056	.07354089	0.787	.4314
OPLEV 1	-0.07020850	.08841885	-0.794	.4272
OPLEV 2	0.09122173	.07532631	1.211	.2259
PRC1	0.08850211	.08602439	1.029	.3036
PRC2	0.05979076	.07509256	0.796	.4259
TYPE	0.60127251	.05818949	10.333	.0000
COMM	-0.16406074	.05425797	-3.024	.0025

Model parameters

Number of observations = 816

Iterations completed = 5

LL function = -787.0640

LL (null) = -896.5492

-2LL = 218.9704

Chi-square perc. [9] = 16.92

Pseudo R<sup>2</sup> = 0.1221

Info. Criterion: BIC = 2.01946