Best living concepts for elderly homeowners: combining a stated choice experiment with architectural design

Network for Studies on Pensions, Aging and Retirement

NETSPAR ACADEMIC SERIES

Best living concepts for elderly homeowners

Combining a stated choice experiment with architectural design

Ioulia Ossokina, Theo Arentze, Dick van Gameren, Dirk van den Heuvel

DP 06/2018-033

Best living concepts for elderly homeowners: combining a stated choice experiment with architectural design[1]

Ioulia Ossokina*, Theo Arentze*, Dick van Gameren**, Dirk van den Heuvel**

*Eindhoven University of Technology

**Delft University of Technology

26 June 2018

Abstract

In this paper we combine the insights from social sciences and architecture to design best living concepts for a specific target group, elderly homeowners. We perform a stated choice experiment to study residential preferences of this group and translate the results into an architectural design of senior-friendly housing. This methodological approach is novel to the literature. We derive the willingness-to-pay for different residential attributes and show how these attributes can be traded off against each other to create best living concepts. We discuss how these concepts can be translated into customized architectural design while making use of standard architectural elements.

Key words: Residential preferences; Elderly households; Homeownership; Architectural design

JEL classification: D12, R21, R31

* Corresponding author: i.v.ossokina@tue.nl

[1] We thank Arjen Deetman and Giorgio Larcher for excellent research assistance. The authors gratefully acknowledge financial support from the 4TU Lighthouse grant.

1 Introduction

In various countries, the demand for senior dwellings is expected to rise. While the proportion of 65+ citizens in the population increases sharply,[2] governments make arrangements to stimulate the elderly to live independently at home for as long as possible (Mosca et al., 2017). Such policies may increase the motivation of people entering the third age to move to another home which will better suit their needs as they become older and in need of help.[3] This paper applies a novel methodology to design living concepts for the elderly, based on the research in their residential preferences.

Our methodology combines insights from two disciplines: social sciences and architecture. First, we run a stated choice experiment to retrieve the willingness-to-pay of the elderly for a set of relevant attributes of the dwelling, the building and the location. Then the attributes with the highest valuation are used as input for a flexible architectural design. The output of our research is also twofold. The stated choice experiment results in a *consumer toolbox* including a range of attributes of the dwelling, the building and the location. Each attribute is specified at multiple possible levels. For every attribute-level combination a monetary valuation of the willingness-to-pay is estimated. This allows to construct best living concepts consisting of most valuable combinations of the attributes. The architectural design results in an *architectural toolbox* that consists of construction elements that can be flexibly put together to realise the specified living concepts and their various combinations.

In selecting the dwelling, building and location attributes for the analysis, we account for the changes in the residential preferences that may take place near the third age. First, in anticipation of reduced mobility and increased health problems, people may find *comfort, accessibility and safety* of a dwelling and the surroundings more important than before (Gobillon and Wolff, 2011, Feng et al., 2018, Costa-Font, 2013, Liu et al., 2017).[4] Second, people may want to *downsize* because the need for living space decreases when children leave the house, or due to a fall in revenues after retirement (Bian, 2016, Eichholtz and Lindental, 2014, Painter and Lee, 2009, Ong et al., 2015). Finally, a new preference for *shared facilities* where elderly can meet each other, may arise (see Bohle et al., 2013 and the references therein). Reason is that retirement reduces a person's network, creates more time available for leisure, and thus increases the importance of social contacts in the direct neighbourhood. In constructing the choice situations for the choice experiment we assume that comfort and accessibility are necessary conditions to move. Thus, all the alternatives are specified as apartments in a building with a lift and equipped with senior-friendly facilities such as broad doors, no doorsteps, elevated toilets, etc. The attributes concerning safety, size, social cohesion vary between the alternatives and are subject of the analysis of this paper.

Our paper is related to different streams of literature. First, there is a small literature on designing dwellings that meet the needs of specific population groups. Cambell (2017) studies what design of

---

[2] In Europe, for instance, one in four people is expected to be older than 65 in 2040 (Eurostat, 2017). In China and in USA, one in four people will be older than 60 in 2030 (UN, 2015).

[3] Tatsiramos (2006) reports yearly housing mobility rates for elderly to lie between 1% and 5% in different European countries. Gobillon and Wolff (2011) document substantial housing mobility at retirement for France: 31% of the surveyed elderly aged between 68 and 92 claim to have moved around their retirement age. Abramsson and Andersson (2012) document a 25% mobility rate of Swedish elderly within a five year period 2001-2006.

[4] Hillcoat and Ogg (2014) find that a bad 'fit' of the home to changing physical needs increases the propensity to move.

social places is successful to support ageing in place. Wright et al. (2017) develop principles to house people with complex physical and cognitive disability. Nagib and Williams (2016) design physical elements of the home environment that can alleviate challenges faced by children with autism. These studies base architectural design on a qualitative research into housing needs. Our paper shows how quantitative research in housing preferences that uses a large sample of individuals and a stated choice experiment, can contribute to architectural design.

Second, a growing literature studies the residential preferences of the elderly based on their residential moves. Much of this literature focusses on location choices. It shows that the seniors move to places with highly valued consumer amenities including health care, high temperatures and low taxes (Chen and Rosenthal, 2008, Önder and Schlunk, 2015, Dorfman and Mandich, 2016), closer to their place of birth (Schaffar et al., 2016) or to their children (Bonnet et al., 2010). Housing attributes discussed in this literature include: dwelling size (Bian, 2016, Eichholtz and Lindental, 2014, Painter and Lee, 2009), shared living (Engelhardt and Greenhalgh-Stanley, 2010), rental housing (Herbers et al., 2014) and institutionalized housing (Rouwendal and Thomese, 2013). The revealed preferences approach used by these papers allows to examine the preferences for those residential attributes that are broadly adopted on the market and documented in the available databases. Our stated preferences approach makes it possible to study the valuation of attributes that are not yet widely adopted (like e.g. shared facilities), as well as characteristics of the building and the dwelling that are not well documented in databases (like e.g. the layout of the dwelling).

Third, our paper is related to stated choice experiments on residential preferences of specific population groups. See Hoshino (2011) for an extensive overview as well as later studies by Ibraimovic and Masiero (2013), Ibraimovic and Hess (2017) on ethnic minorities, and De Jong et al. (2018) on the elderly. We add to the insights of De Jong et al. (2018) by studying preferences for dwelling and building attributes that are specifically connected to safety, social cohesion and shared facilities. We show furthermore how to translate insights about residential preferences into architectural design.

Finally, several studies show that the well-being of the elderly is closely related to their living comfort. Morris (2017) and Colleman et al. (2016) find for the elderly in respectively Australia and New Zeeland that uncertainty about the quality of the dwelling leads to stress and anxiety and reduces well-being.[5] Our paper offers new insights into how a dwelling design can be used to increase the living comfort and thus the well-being of the elderly.

Our results suggest that residential attributes connected to safety (e.g. indoor parking or a smaller building) and social cohesion (e.g. a common meeting space or a communal garden) play an important role for the elderly. The consumer toolbox shows how different residential attributes can be traded off against each other to create best living concepts that meet certain conditions. Imagine that a valuable for the elderly facility like an indoor garage is not feasible due to cost considerations. The consumer toolbox allows to calculate what other attributes (e.g. a smaller size of the building or shared facilities) can be added to the living concept to keep it attractive for the target group. The architectural toolbox translates attributes from the consumer toolbox into flexible architectural elements. For illustration, these are put together into two possible dwelling-building-block compositions, a low density (semi-urban) setting and a high density (urban) setting.

[5] See also Feng et al. (2018) and Liu et al. (2017) for China.

There are two reasons why our results may be especially interesting for practitioners working in the area of elderly housing development. First, we offer developers new insights into the senior residents' priorities and the way these can be translated into the living concepts. Hu et al. (2013) suggests that developers do not always have a complete overview of these priorities, and anecdotal evidence provides support to this conclusion.[6] Second, our study contributes to solving the trade-off between standardization and customization that developers might face when constructing elderly dwellings (see Hofman et al., 2006). The consumer toolbox and the architectural toolbox we have developed, allow to design various customized living concepts while making use of standard elements. This can be especially interesting in the situation when large numbers of elderly dwellings need to be constructed within a limited time span.

The rest of the paper is organized as follows. Sections 2 to 4 discuss the study into the residential preferences of the elderly. Section 2 deals with the model and the data. Section 3 introduces the stated choice experiment. Section 4 reports the results and discusses the consumer toolbox. Section 5 discusses the development of an architectural toolbox based on the results of the previous sections. Section 6 concludes.

2 Study into the residential preferences: model and data

To empirically estimate residential preferences of senior households we use as a baseline the traditional multinomial logit model developed by Daniel McFadden (1978). In this model, utility person *i* obtains from dwelling *h* is defined as:

(1) $$U_{ih} = \beta X_h + \varepsilon_{ih},$$

where X_h is a vector of the attributes of the dwelling, building and location, β is the vector of coefficients and ε_{ih} is a Gumbel-distributed error term.

The probability that person *i* chooses dwelling *h* out of the choice set *H* of alternative dwellings, can be derived as:

(2) $$\Pr[h] = \frac{\exp(\beta X_h)}{\sum_{m \in H} \exp(\beta X_m)}.$$

Coefficients $\beta_j \in \beta$ describe the relative importance individuals attach to the *j*-th element of the vector X_h. Let β_0 be the coefficient by a monetary attribute of the dwelling, e.g. the rent or the price. Then the willingness to pay for attribute *j*, expressed in monetary terms, can be written as:

(3) $$WTP_j = \beta_j / \beta_0.$$

We estimate the parameters of (2) using data from a stated choice experiment performed among elderly Dutch homeowners. We focus on homeowners for several reasons. First, they are an important group in the housing market: some 50% of elderly Dutch households are homeowner. Second, in the Netherlands, homeowners are more likely than renters to have means to realize their residential

[6] For instance, a new town Blauwestad designed in early 2000's in the North of the Netherlands, had richer elderly as an important target group, but failed by far to attract the expected number of residents (Noordelijke Rekenkamer, 2010).

preferences. Some 80% of homeowners have medium and high income, against 25% of renters.[7] Third, using information on housing prices we can calculate the willingness-to-pay for various residential attributes.

The experiment was administered in an on-line survey and offered to the participants of a large national Dutch on-line panel in the age group 65-74. In the Netherlands, in 2017, the age of 65 was the average retirement age, so our respondents are on average people who have recently retired. Given the target group of our study, we selected participants who are homeowner and whose current dwelling has a value between 100.000 and 500.000 euro. The respondents were first asked for information on their socio-economic characteristics and their current dwelling; afterwards they were offered the stated choice experiment.

The responses were collected on working days during the period 6 June to 7 July 2017. Our initial sample consisted of 460 respondents. We have removed the questionnaires with missing information about the socio-economic characteristics of the individual, as well as questionnaires that were completed in less than 10 minutes. The 10-minutes threshold was chosen to filter out respondents who did not take sufficient time to read the questions thoroughly. After these corrections, 437 respondents were left. Table 1 reports the descriptive characteristics of the respondents and their current dwellings. The majority of our respondents are people aged between 65 and 70 living together with a partner in a single-family dwelling. High educated are somewhat overrepresented, as well as persons with higher than median income.

Table 1. Description of the respondents

Socio-economic characteristics of the respondent		**Current dwelling and moving preferences**	
% age 65 to 69 % age 70 to 74	63% 37%	% apartment % one-family dwelling	15% 85%
% couple % alone	86% 14%	size dwelling, median	120 m^2
% low educated % middle educated % high educated	22% 38% 40%	size of garden, for one-family dwellings, median	100 m^2
% household yearly gross income less than ∊30000 % household yearly gross income ∊ 30000 to ∊ 50 000 % household yearly gross income more than ∊ 50000	3% 71% 26%	value of the dwelling, as specified by the fiscal authorities, median	∊ 225000
% retired	87%		

To obtain more information about the extent to which our respondents are concerned about their living comfort and current living conditions, we have asked a number of questions about the moving preferences. We also asked respondents whether they think the dwelling will stay suitable for their needs when they get older. Table 2 reports the results. Some 60% of the respondents think that they will not be able to live in their current dwelling with sufficient comfort when they get older. Most of these people expect though that the necessary comfort can be achieved through adjustments. Furthermore, some 20% of the respondents considers moving.

[7] See Statistics Netherlands (2017). In the Netherlands, the majority of rented housing is social housing available to people with lower income only.

Table 2. Current living comfort and moving preferences

Current living comfort		**Moving preferences**	
% dwelling not suitable when getting older and less mobile	9%	% actively looking for a new dwelling	5%
% dwelling is suitable when getting older, but adjustments are necessary	51%	% would like to move, but are not actively looking	17%
% dwelling is suitable when getting older, without adjustments	29%	% not thinking about moving	78%
% does not know	11%		

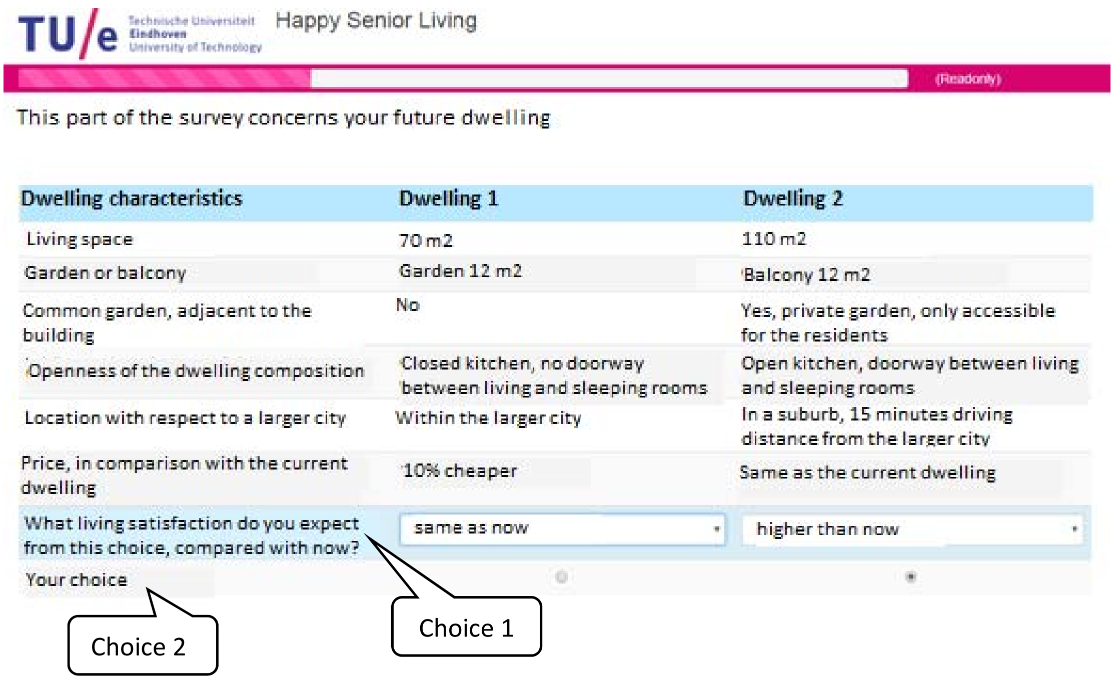
3 Set-up of the stated choice experiment

The toolbox we develop in this study focusses on a specific sector of the housing market, namely owner-occupied apartments in multi-family houses (flat buildings). We choose to focus on apartments because these are easier adjustable for physical needs of seniors. Although we focus on a specific segment, the method we develop can be applied to other product-market combinations as well.

In the stated choice experiment, respondents were offered twelve randomly composed choice sets, consisting of two alternative dwellings each. The alternative dwellings were specified as apartments sized between 70 m^2 and 110 m^2, situated in a building with a lift and specifically designed for elderly needs (broader doorways, elevated toilet, etc.) The price levels were pivoted around the self-reported market value of the current dwelling of the respondent. The experiment required first that for each choice set, the respondents indicated the living satisfaction they expected to obtain in each of the two alternatives, as compared to their current dwelling (choice 1). They could select out of 5 values: much lower than now, lower than now, equal to now, higher than now, much higher than now. Afterwards, the respondents were asked to make a choice between the two offered alternatives assuming the current dwelling was no longer available as a valid option (choice 2). Figure 1 presents a print screen of a choice situation; choice 1 and choice 2 are indicated there with arrows. In this paper we mainly focus on choice 2. We use choice 1 as a robustness check: we test whether our results also hold for the subsample of those people who expect their living satisfaction to increase in one of the offered dwellings as compared with the current dwelling. Furthermore, we drop inconsistent observations, in which choice 1 and choice 2 do not result in the same preferred alternative.

The twelve choice sets the respondents were offered, were divided in three separate groups of four choice sets each. In the first group the alternatives were specified in terms of the dwelling attributes, keeping the building and the location characteristics fixed. In the second group the alternatives were specified in terms of building attributes and in the third group the alternatives were specified in terms of location attributes. In this way, the choice experiment was split up in three separate sub experiments to reveal the preferences on dwelling, building and location level, respectively. This partitioning allowed us to estimate the preferences for a large set of dwelling attributes without introducing too much complexity into the stated choice questions. In this paper we focus on dwelling and building attributes only.

Figure 1. Print screen of a choice set.



TU/e Technische Universiteit Eindhoven University of Technology — Happy Senior Living

(Readonly)

This part of the survey concerns your future dwelling

Dwelling characteristics	Dwelling 1	Dwelling 2
Living space	70 m2	110 m2
Garden or balcony	Garden 12 m2	Balcony 12 m2
Common garden, adjacent to the building	No	Yes, private garden, only accessible for the residents
Openness of the dwelling composition	Closed kitchen, no doorway between living and sleeping rooms	Open kitchen, doorway between living and sleeping rooms
Location with respect to a larger city	Within the larger city	In a suburb, 15 minutes driving distance from the larger city
Price, in comparison with the current dwelling	10% cheaper	Same as the current dwelling
What living satisfaction do you expect from this choice, compared with now?	same as now	higher than now
Your choice		

The definitions of the attributes of the dwelling and the building are reported in Table 3 and 4 below. Each attribute was specified at three levels: 0, 1 and 2. The attributes and the levels of each attribute were chosen carefully taking into consideration the relevance for key architectural design choices as well as the expected impact on preferences of residents. For example, parking and availability of communal spaces have significant implications both for the building design and the residents' preferences. Two attributes were present in all parts of the experiment: price (in order to be able to calculate the willingness-to-pay), and location. To compose the experiments we used a fractional factorial design (see Hensher et al., 2005).

In the estimation we pooled the two parts of the experiment – that with dwelling attributes and that with building attributes – together. Without the loss of generality the attributes that are missing (dwelling for the building part and building for the dwelling part) are assigned level 0. Effect coding was used to incorporate the attributes in the model.

Table 3. Stated choice experiment, attributes on the level of the dwelling

	Level 0	Level 1	Level 2
Size of the dwelling	$70m^2$	$90m^2$	$110m^2$
Garden or balcony	balcony $5m^2$	balcony $12m^2$	garden $12m^2$
Common garden bordering the building	no	yes, public garden	yes, private garden, only accessible for residents
Openness of the dwelling composition	closed kitchen, no doorway between living and sleeping rooms	open kitchen, doorway between living and sleeping rooms	open kitchen, no doorway between living and sleeping rooms
Location with respect to a larger city	in a larger city	in a small city, more than 15 min ride from a larger city	in a suburb of a larger city
Price	10% more expensive	same as the current dwelling	10% cheaper

Table 4. Stated choice experiment, attributes on the level of the building

	Level 0	Level 1	Level 2
Size building	more than 80 dwellings	20-80 dwellings	fewer than 20 dwellings
Entrance	outside gallery	small atrium	large atrium
Common space	no	yes, a meeting place or a recreational space for residents	yes, a café or a small supermarket
Parking	on-street parking	an outdoor parking place, residents only	an indoor garage
Location with respect to a larger city	in a larger city	in a small city, more than 15 min ride from a larger city	in a suburb of a larger city
Price	10% more expensive	same as the current dwelling	10% cheaper

4 Results of the choice experiment

4.1 Estimation results

The alternative dwellings offered in the choice experiment to the respondents differ in various respects from their current dwellings. Choosing for one of these alternatives implies in many cases downsizing in space, both within the house (living) and outside the house (garden). This downsizing may be compensated by senior-friendly facilities in the dwelling, a more comfortable and safe living environment and additional shared space (a common garden, a meeting place for the residents and other amenities within the building).

Around a half of the respondents (217 out of 437) expect a higher living satisfaction from at least one of the alternatives offered in the choice experiment, when compared to their current dwelling. To check for the robustness of our results, we estimate model (2) for the total sample as well as for the subsample of respondents who indicated to be attracted by at least one of the alternatives offered.

Table 5 reports the estimation results. Both models yield a reasonable fit with the pseudo R^2 of 11%. The coefficients are reported taking level 1 as reference and should be interpreted as a decrease/increase in utility from changing the level of an attribute from the reference to level 0 respectively 2.

Table 5. Estimation results choice experiment

		All respondents		Those attracted by the alternative dwellings	
		coeff	t-value	Coeff	t-value
Size					
Level 0	70m2	- 0.641***	(6.96)	- 0.446***	(3.31)
Level 1	90m2	Reference		Reference	
Level 2	110m2	0.311***	(3.42)	0.335**	(2.57)
Balcony/ garden					
Level 0	Balcony 5m2	-0.458***	(4.99)	-0.457***	(3.44)
Level 1	Balcony 12m2	Reference		Reference	
Level 2	Garden 12m2	0.245***	(2.67)	0.139	(1.06)
Garden next to building					
Level 0	No garden	-0.158*	(1.73)	-0.232*	(1.74)
Level 1	Yes, public garden	Reference		Reference	
Level 2	Yes, private garden, residents only	0.068	(0.74)	0.051	(0.38)
Openness dwelling					
Level 0	Open – 2	-0.072	(0.79)	- 0.001	(0.01)
Level 1	Closed	Reference		Reference	
Level 2	Open – 1	0.120	(1.32)	0.290**	(2.21)
Size building					
Level 0	>80 dwellings	- 0.532***	(5.77)	- 0.542***	(3.92)
Level 1	20-80 dwellings	Reference		Reference	
Level 2	<20 dwellings	0.423***	(4.66)	0.293**	(2.30)
Entrance					
Level 0	Outdoor gallery	-0.295***	(3.22)	-0.410***	(3.06)
Level 1	Indoor entrance, small atrium	Reference		Reference	
Level 2	Indoor entrance, large atrium	0.108	(1.19)	0.203	(1.51)
Common space					
Level 0	No common space	- 0.243**	(2.66)	- 0.467***	(3.48)
Level 1	Meeting space, residents only	Reference		Reference	
Level 2	Café or small supermarket	0.042	(0.47)	- 0.019	(0.14)
Parking					
Level 0	On-street parking	- 0.551***	(6.05)	- 0.589***	(4.48)
Level 1	Outdoor parking, residents only	Reference		Reference	
Level 2	Indoor garage	0.256**	(2.81)	0.201	(1.46)
Location					
Level 0	Within a larger city	-0.280***	(5.30)	- 0.260***	(3.44)
Level 1	Smaller city, more than 15 min drive from a larger city	Reference		Reference	
Level 2	Suburbs of a larger city	0.093*	(1.75)	0.132	(1.71)
Price					
Level 0	10% more expensive	- 0.284***	(5.36)	- 0.250***	(3.23)
Level 1	Equal to the current price	Reference		Reference	
Level 2	10% cheaper	0.094*	(1.77)	0.059	(0.78)
# respondents		437		217	

** Significant at 10 %; ** significant at 5 %; *** significant at 1%*

The resulting coefficients are mostly highly significant and have the expected signs. I.e. increasing the level of an attribute leads to an increase in utility and *vice versa*. Furthermore, the table suggests that the group of respondents who think that at least one offered alternative is more attractive than the current dwelling, does not significantly differ in their preferences from the average of the whole group.

Consumer toolbox and the best living concepts

We translate the results of the stated preference study into an easy to interpret consumer toolbox, see Figure 2 below. The toolbox contains the studied attributes of the dwelling and the building. The levels of the attributes are ordered by the values they have for the elderly according to the above analysis.

Figure 2. Consumer toolbox: best living concepts

	Size dwelling	Balcony /garden	Openness dwelling	Size building	Parking	Entrance	Common garden	Common space	Location
higher value/ utility	110 m2 (+16% value)	Ground floor, garden 12m2 (+13% value)	Open kitchen, no doorway living-sleeping	< 20 dwellings (+22% value)	Indoor parking garage (+14% value)	Large hall/atrium with lift	Yes, private, residents only	Yes, a small cafetaria or a supermarket	Suburbs of a larger city (+5% value)
reference dwelling	90 m2	No ground floor, balkony 12m2	Closed kitchen, no doorway living-sleeping	20-80 dwellings	Outdoor parking reserved for residents	Small hall with a lift	Yes, public garden	Yes, a recreation area/ a meeting place	Small city, more than 15 min driving to larger city
lower value/ utility	70 m2 (-34% value)	No ground floor, balkony 5m2 (-24% value)	Open kitchen, doorway living-sleeping	> 80 dwellings (-28% value)	Public parking on the street (-29% value)	Outdoor gallery (-16% value)	NO (-16% value)	NO (-13% value)	Larger city (-15% value)

The attribute levels of the reference dwelling are indicated yellow in the Figure. This dwelling can be described as:

- an apartment, elderly-accessible and equipped with amenities as: a lift in the building, an elevated toilet, broad doorways, etc.
- living space 90 m^2,
- balcony 12 m^2,
- closed kitchen and no doorway between the living and the sleeping rooms;
- medium large building of between 20 and 80 dwellings,
- public garden next to the building,
- common meeting space for the residents of the building,
- entrance through an indoor small atrium,
- outdoor parking space, residents only;
- located in a smaller city on a distance of more than 15 minutes' drive from a larger city;
- a price level of 225.000 euro.

In green are attribute levels that allow to increase the utility as compared to the reference dwelling. The corresponding value increase is measured in percentage of the dwelling value and is specified between parentheses. It is calculated as the willingness to pay (WTP) for a change in the level of the attribute, see equation (3). In red are attribute levels that decrease utility as compared to the reference dwelling, again with the value decrease specified.

The consumer toolbox offers clear trade-offs between improving and worsening the levels of certain attributes. Thus it allows to construct a variety of best living concepts that meet various financial, geographical and other restrictions. Consider, for instance, a situation in which an entrance through an outdoor gallery is desirable, due to technical or cost considerations. This reduces the living satisfaction of the elderly with 16%. Our toolbox allows to find out which other attributes can be improved to compensate for this loss. For example, a smaller building size or a larger size of the dwelling could do the job.

Let us consider now the trade-offs between specific attribute levels in more detail. An increase in the size of the dwelling from 90m^2 to 110 m^2 leads to 16% higher value (WTP, willingness-to-pay) for the elderly. A similar decrease in the size (from 90 m^2 to 70m^2) results in 34% lower WTP. For a reference dwelling with a value of 225.000 euro that implies an average squared meter price of 2.8 thousand euro/m^2, which is comparable with the m^2 apartment prices in the Netherlands in 2017. Furthermore, the results suggest that the marginal willingness to pay for extra space falls with the size of the dwelling.

Having a private outside space of a reasonable size is valued very high. A balcony of 12m^2 increases the living utility with more than 20% as compared to a balcony of 5m^2. This high valuation suggests that when designing the best senior dwelling a larger balcony than 12 m^2 needs to be considered as well. Availability of a garden of 12 m^2 instead of a balcony has a positive effect of 13%, but this effect disappears in the robustness check.

Looking at the valuation of the building characteristics, one can conclude that safety, social cohesion and comfort play a very important role for the elderly. For instance, the necessity to park on-street may imply a higher chance of a car robbery and a necessity to cruise for parking. It leads to a drop in the willingness-to-pay with almost 30%. An indoor garage, on the other hand, increases the value elderly attach to the dwelling with some 15%. An apartment building with more than 80 dwellings may imply a lower social cohesion, a higher chance that if something happens to a person, this will go unnoticed. This has a negative effect equal to almost 30%. A very small building with less than 20 apartments increases the WTP with more than 20%. An entrance via an outdoor gallery (lower transparency, less safety) has a negative impact of some 15%.

Another important aspect is a possibility of social contacts with neighbours. Availability of a common garden and a common space in the building increase the WTP with some 15% of the dwelling value each. There is no large difference between a public and a residents-only common garden, nor between different types of a common space within a building.

The location preferences suggest that the elderly make a trade-off between accessibility of amenities and facilities present in a large city, and the social cohesion of a smaller place. A suburb of a larger city combines the better of the two. Compared to a location in a smaller city at more than 15 minutes driving distance from a large city it yields a 5% higher value. The large city itself is least attractive, this location has a 15% lower value for the elderly than a smaller city.

5 Architectural design

In order to link measured preferences to design solutions, we transform the consumer toolbox into an architectural toolbox. We emphasize that there is no one-to-one correspondence between the preferences and the architectural solutions. Rather there are multiple ways in which the attributes can be implemented in the design. The architectural toolbox had to meet the requirement of flexibility, i.e.

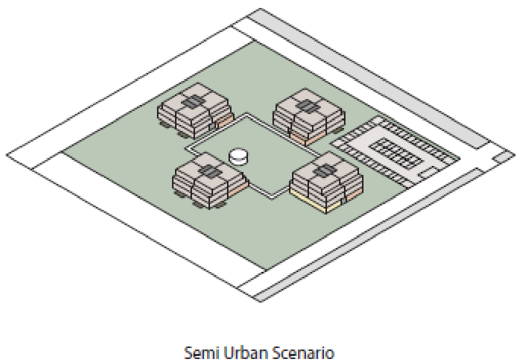
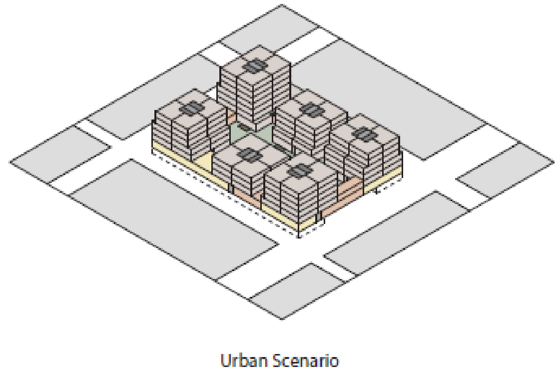
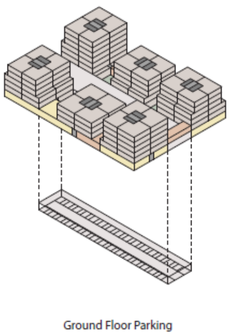
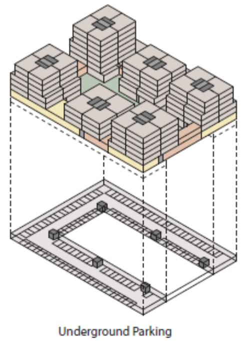
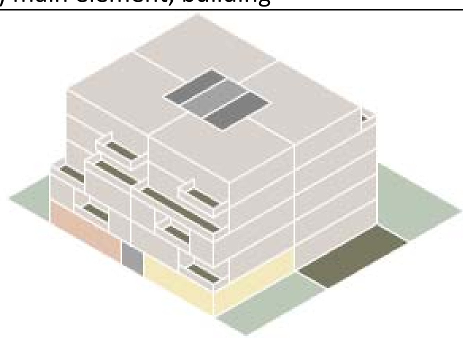
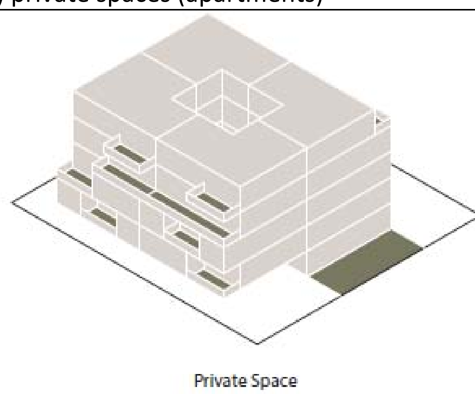
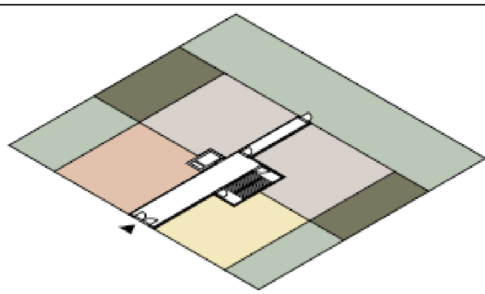
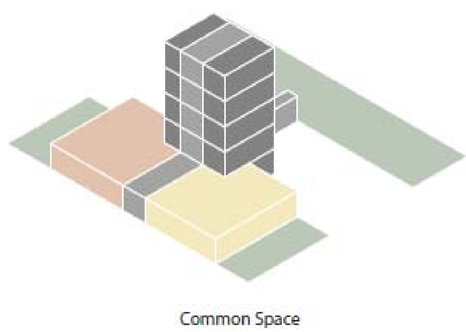
contain architectural elements that allow to compose different combinations from the consumer toolbox. Furthermore, we paid attention to enabling a social and communal way of living without compromising on privacy, and to ensuring accessibility and comfort for the elderly. Finally, solutions were developed for an urban and a semi-urban setting.

Figure 3 contains the elements of the architectural toolbox. The main element is the building, described in panels (e) to (h). A combination of several buildings forms a block (panels (a) to (d)). For presentation purposes, we start with the discussion of the block and then deal with the building.

Panels (a) and (b) illustrate two possible block compositions, left in a low density environment (semi-urban setting) and right in a high density environment (urban setting). Grouping several apartment buildings together in a block allows to share a common garden and a number of communal spaces and services. While communal spaces are mostly located on the ground floor, in the semi-urban setting it is also possible to create a separate building in the common garden, to increase the sense of community. The communal spaces in different buildings are connected to each other with a walking passage; they all can be reached from inside each building without walking outside.

In both settings, urban and semi-urban, measures are taken to protect privacy. First, every apartment building within the block has its own entrance directly from the street, its own lift and vertical circulation. In the semi-urban setting, the shared garden is located both, in the middle of the block and on the outside border, to increase the distance to the street. In the urban setting, enabling privacy presents a larger challenge and can be achieved by a number of measures: increase the distance between the building and the street by introducing a walking strip; locate the ground floor apartments 50 cm higher than the street level; locate communal spaces on the side facing the street, and apartments overlooking the garden.

Figure 4. Architectural toolbox

a) block, suburban setting	b) block, urban setting
	
(c) ground floor parking	d) underground parking
	
e) main element, building	f) private spaces (apartments)
	
g) ground floor building	h) communal spaces (lift, garden, shop, meeting place)
	

Panels (a), (c) and (d) illustrate three possible locations for parking. In panels (a) and (c), parking is realized on the ground level, respectively in a corner of the block and in the middle of the block. In the former solution, the parking place offers a direct entrance to the passage connecting different buildings, so that walking from the apartment to the parking is indoors. The latter solution makes more space available for other construction, but sacrifices the communal garden in the middle of the block. Panel (d) shows the most expensive solution: an underground parking.

Panel (e) zooms in at the building, which consists of four dwellings per floor, central core circulation with lift and stairs. The entrance leads to a large atrium (pane (f)) from where the stairs and the lift can be reached. The building allows different combinations of the attribute levels from the consumer toolbox. The size of the four dwellings can be easily adjusted between $90m^2$, $110m^2$ and $70m^2$. The number of floors can vary to adapt to different needs and urban settings. For instance, a five-floor building houses 20 dwellings and a ten-floor building houses 40 dwellings. Dwellings on higher floors are equipped with balconies; dwellings on the ground floor with a small garden.

Panels (g) and (h) zoom in at communal spaces within the building. Communal functions include an atrium, a lift, and other spaces such as residents-only meeting rooms and a restaurant, a small supermarket or a shop.

6 Discussion and conclusion

This paper applied a novel approach to designing best living concepts for a specific target group: senior homeowners. This approach combined the insights from two disciplines: social sciences and architecture. We first performed a stated choice experiment to retrieve the willingness to pay elderly have for a set of relevant attributes of the dwelling. The attributes with the highest valuation were combined into a consumer toolbox and consequently used as input for the architectural design. A flexible architectural toolbox was developed that allows to realize various combinations of the most valuable attributes.

Our study shows that combining a research into the residential preferences with the architectural design leads to important synergy effects. The consumer toolbox and the architectural toolbox we have developed, can be used to realise different concepts of senior housing that fit various practical restrictions and requirements. Financial limitations as well as specific characteristics of a location may make it impossible to realise the first-best living concept. The consumer toolbox yields insights into what attributes can be sacrificed with the smallest loss in the value of a dwelling for the seniors. The architectural toolbox offers construction elements that allow to adjust the design to a specific situation.

References

Abramson, M. and E.K. Andersson (2016). Changing Preferences with Ageing –Housing Choices and Housing Plans of Older People. Housing, Theory and Society 33: 217–241.

Abramsson, M., and E. Andersson (2012). "Residential Mobility Patterns of Elderly – Leaving the House for an Apartment." Housing Studies 27 (5): 582–604.

Angelini, V. and A. Laferrere (2012). Residential mobility of the European Elderly. CESifo Economic Studies 58: 544-569.

Bian, X. (2016). Leverage and Elderly Homeowners' Decisions to Downsize. Housing Studies 31: 20–41

Bohle, Ph., Rawlings-Way, O., Finn, J., Ang, J. and D. J. Kennedy (2014). Housing choice in retirement: community versus separation. Housing Studies, 29: 108-127.

Bonnet, C., Gobillon, L. and A. Laferrere (2010). The effect of widowhood on housing and location choices. Journal of Housing Economics 19: 94-108

Bonvalet, C., and J. Ogg. 2008. "The Housing Situation and Residential Strategies of Older People in France." Ageing and Society 28 (6): 753–777.

Cambell, N. (2015). Designing for social needs to support aging in place within continuing care retirement communities. J Housing and the Built Environ 30: 645–665.

Chen, Y. and S. S. Rosenthal (2008). Local amenities and life-cycle migration: Do people move for jobs or fun? Journal of Urban Economics 64: 519–537.

Coleman, T., Kearns, R.A. and J. Wiles (2016). Older adults' experiences of home maintenance issues and opportunities to maintain ageing in place. Housing Studies, 31(8), 964-983.

Costa-Font, J., Elivar, D. and Mascarillo-Miró, O. (2009). Ageing in place? Exploring elderly people's housing preferences in Spain. Urban Studies, 46(2), pp. 295-316.

Costa-Font, J. 2013. "Housing-related Well-being in Older People: The Impact of Environmental and Financial Influences." Urban Studies 50 (4): 657–673.

Darab, S., Hartman, Y. and L. Holdsworth (2018): What women want: single older women and their housing preferences, Housing Studies.

De Jong, P.A. and A.E. Brouwer (2012). Residential mobility of older adults in the Dutch housing market: do individual characteristics and housing attributes have an effect on mobility. European Spatial Research and Policy 19: 33-47

De Jong, P., Rouwendal, J., Van Hattum, P. and A. Brouwer (2018). 'The older adult' doesn't exist: using values to differentiate older adults in the Dutch housing market'. Housing Studies

Dorfman J.H. and A. M. Mandich (2016). Senior migration: spatial considerations of amenity and health access drivers. Journal of Regional Science 56: 96–133.

Eichholtz, P. and T. Lindenthal (2014). Demographics, human capital and the demand for housing. Journal of Housing Economics 26: 19-32.

Engelhardt, G.V. and N. Greenhalgh-Stanley (2010). Home health care and the housing and living arrangements of the elderly. Journal of Urban Economics 67: 226-238.

Eurostat (2017). People in the EU – population projections. Extracted on 26-06-2018 from:

http://ec.europa.eu/eurostat/statistics-explained/index.php/People_in_the_EU_-_population_projections

Feng, J., Tang, S. and X.Chuai (2018). The impact of neighbourhood environments on quality of life of elderly people: Evidence from Nanjing, China. Urban Studies 55: 2020-2039.

Garcia, I. and M. Rua (2017). ‘Our interests matter’: Puerto Rican older adults in the age of gentrification. Urban Studies 1-17.

Gobillon, L. and F-Ch. Wolff (2011). Housing and location choices of retiring households: evidence from France. Urban Studies 48(2): 331-347.

Graves, P.E. and D.M. Waldman (1991). Multimarket amenity compensation and the behavior of the elderly. American Economic Review 81: 1374-1381

Green, R.K. and H. Lee (2016). Age, demographics, and the demand for housing, revisited. Regional Science and Urban Economics 61: 86–98

Herbers, D.J. and C.H. Mulder (2016). Housing and subjective well-being of older adults in Europe. J Hous and the Built Environ.

Herbers, D. J., C. H. Mulder, and J. A. Mòdenes. 2014. “Moving Out of Homeownership in Later Life: The Influence of the Family and Housing Careers.” Housing Studies 29 (7): 910–936.

Hillcoat-Nallétamby, S., and J. Ogg. 2014. “Moving Beyond ‘Ageing in Place’: Older People’s Dislikes about Their Home and Neighbourhood Environments as a Motive for Wishing to Move.” Ageing and Society 34 (10): 1771–1796.

Hofman, E., Halman, J.I.M. and R.A. Ion (2006). Variation in housing design: identifying customer preferences. Housing Studies 21(6): 929–943.

Hoshino, T. (2011) Estimation and analysis of preference heterogeneity in residential choice behaviour, Urban Studies, 48(2), pp. 363–382.

Hu, H., Geertman, S. and P. Hooimeijer (2014). Green apartments in Nanjing China: do developers and planners understand the valuation by residents? Housing Studies, 29(1): 26-43.

Ibraimovic, T. and S. Hess (2017). A latent class model of residential choice behaviour and ethnic segregation preferences. Housing studies 1466-1810.

Ibraimovic, T. & Masiero, L. (2014) Do birds of a feather flock together? The impact of ethnic segregation preferences on neighbourhood choice, Urban Studies, 51(4), pp. 693–711.

Iersel, J. van, Leidelmeijer, K. and Buys, A. (2010). Senioren op de woningmarkt: nieuwe generaties, andere eisen en wensen (Dutch). Den Haag: Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer.

Kim, S. (2011). Intra-regional residential movement of the elderly: testing a suburban-to urban migration hypothesis, Annals of Regional Science, 46, pp. 1-17.

Kramer, C. and Pfaffenbach, C. (2009). Persistence preferred- on future residential (im)mobility among the generation 50plus. Erdkunde, 63 (2), pp. 161-172.

Kramer, C. and C. Pfaffenbach (2016). Should I stay or should I go? Housing preferences upon retirement in Germany. J Hous and the Built Environ 31: 239–256

Liu, Y., Dijst, M. and S. Geertman (2017). The subjective well-being of older adults in Shanghai: The role of residential environment and individual resources. Urban Studies 54: 1692–1714.

Morris, A. (2017). Housing tenure and the health of older Australians dependent on the age pension for their income. Housing studies, forthcoming.

Mosca, I., Van der Wees, Ph., Mot, E., Wammes, J.J.G. and P.P.T. Jeurissen (2017). Sustainability of Long-term Care: Puzzling Tasks Ahead for Policy-Makers. Int J Health Policy Manag. 6(4): 195–205.

Nagib W. and A. Williams (2016). Toward an autism-friendly home environment. Housing Studies, 32(2), 140-167,

Noordelijke Rekenkamer (2010). Eindrapport Blauwestad.

Önder, A.S. and H. Schlunk (2015). State Taxes, Tax Exemptions, and Elderly Migration. Journal of regional analysis and policy 45(1): 47-67.

Ong, R., Wood, G.A., Austen, S., Jefferson, Th. and M.E.A. Haffner (2015). Housing Equity Withdrawal in Australia: Prevalence, Patterns and Motivations in Mid-to-late Life Housing Studies 30: 1158–1181.

Painter, G. and K.O. Lee (2009). Housing tenure transitions of older households: Life cycle, demographic, and familial factors. Regional Science and Urban Economics 39: 749–760

Pope, N.D. and Kang, B. (2010). 'Residential Relocation in Later Life: A Comparison of Proactive and Reactive Moves', Journal of Housing For the Elderly, 24 (2), pp. 193-207.

Rouwendal, J. and F. Thomese (2013). Homeownership and long-term care. Housing Studies 28 (5): 746–763

Schaffar, A., Dimou, M. and M. El Mouhoub (2018). The determinants of elderly migration in France. Papers in Regional Science 2018: 1–22.

Takats, E. (2012). Aging and house prices. Journal of Housing Economics 21: 131–141

Tatsiramos, K. (2006). Residential mobility and housing adjustment of older households in Europe. Discussion Paper No. 2435, IZA, Bonn.

United Nations (2015). World population ageing, p.138. Extracted at: http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf

Wright, C.J., Zeeman, H. and J.A. Whitty (2017). Design principles in housing for people with complex physical and cognitive disability: towards an integrated framework for practice. J Hous and the Built Environ 32: 339–360.