A Business Case for Flexible Housing;
The feasibility of implementing flexibility measures in the housing market

Rob Geraedts\textsuperscript{1}, Joost Ruiterkamp\textsuperscript{2}
\textsuperscript{1}Delft University of Technology, Faculty of Architecture, r.p.geraedts@tudelft.nl
\textsuperscript{2}Delft University of Technology, Faculty of Architecture, joostruiterkamp@hotmail.com

ABSTRACT

Adaptive construction is already for decades on the agenda of the construction sector. The adaptive capacity of a building includes all properties and qualities that enable the building keeping its (economic feasible) functionality during the technical life cycle, under altered conditions and needs (Geraedts 2014). Meanwhile, the interest in flexible building has increased significantly from a broader perspective than ever before. This increased interest is caused by the growing awareness of the need for sustainability issues and related to that circular economy. The Dutch construction sector is responsible for 35% of the national waste production in Holland. This number emerges from a sector that accounts for 5,1% of the gross domestic product (Remøy 2013).

This paper reports about a follow-up study that was executed in collaboration with a Dutch building real estate developer (Ruiterkamp 2015). The purpose of this research was to develop a successful business case for flexible row house concept that could show the market under what conditions flexibility measures for future adaptations can be implemented. The main focus was on the financial feasibility of the concept through a life-cycle approach and the special conditions for success.

One of the main conclusions affirms that a long-lasting collaboration between the developer and the investor could result in a feasible business case if the developer stays involved after the delivery during the use phase of the dwellings. An important aspect is the degree and complexity of the possible future adjustments. For example it was financially more attractive to implement an extension at ground floor level for the flexible housing concept compared to the regular house brand dwelling of the developer involved.

Through many additional interviews this research was able to let the real estate market reflect about the business case of flexible row housing. All approached market parties defined the concept as customer-oriented, the business case successful and were highly interested in the concept.

KEYWORDS: Business Case, Flexible, Adaptive, Housing, Developer, Open Building

AUTHOR BIOGRAPHY: Prof. Rob Geraedts is co-founder and member of the international CIB Working Group W104 Open Building Implementation since 1996 and Associate Professor of Design & Construction Management at the Faculty of Architecture, Delft University of Technology, The Netherlands. His research field is Open Building, the adaptability of buildings and the transformation of vacant buildings into new functions, to meet the continuously changing individual user and market demands.

1. Introduction

The choice for the research subject of a flexible housing concept arises from three important aspects. The Dutch construction sector accounts for 35% of the national waste production in Holland. This number emerges from a sector that account for 5,1% of the gross domestic product (Remøy 2013). This inefficiency motivates for research to make the sector more efficient; flexibility can provide a solution. A changing demand and trends results in buildings which are already obsolete before they were taken into operation (De Jonge 2009). A flexible dwelling can be adjusted to the changing demand in the future. One of the trends that causes a
changing demand is the aging of the Dutch population. It is predicted that 20% of the Dutch population is 75 or older in 2040 (Van Belzen 2014). Demands will change due to this fact, but will also evaluate after the aging period is over.

2. Problem framing

2.1 Building real estate developer

The building real estate developer (from now on: developer) for this research - Heijmans Vastgoed - focuses on the development of a product and completes its task when the product is finished and can be handed over to the customer (Boterman 2014). Flexibility offers benefits during the use phase of the dwelling. The wish for a broader scope of Heijmans is in line with the need to utilize the advantages of flexibility during the use phase of the dwelling. The question is if this offers chances for a win-win situation for a business case with a long lasting collaboration between the developer and the investor? The basis of this idea is that a long lasting collaboration gives an extra incentive to make use of the taken flexibility measures when demands are changing.

2.2 Flexibility and the importance of taking into account the consumer requirements

Flexibility focuses on the easy way of making adjustments when the conditions for the building or the plot are changing. Building in a flexible way is characterised by Roders as a way of building what can be adjusted when the situation changes. In this way, a dwelling is able to answer the needs of the occupant what results into the extension of the usable life of the dwelling. This leads to an increase of sustainability because the building materials will have an increase in lifetime (Roders 2003).

The Durban paper ‘Adaptive Capacity of Buildings’ forms a basis for this research. It focuses on the adaptability in three ways. A distinction is made for organization flexibility, process flexibility and product flexibility (Geraedts 2014). Organization flexibility is focused on the end user who will adjust its lifestyle to its living environment instead of the other way around. This will not result in a living environment that satisfies the demand of the end user, but the end user will learn how to cope with the boundary conditions that its living environment is giving. Process flexibility focuses on the flexibility of the building process, the processes during the initial phase, the design phase and the construction phase of the project. Product flexibility is the actual degree of adaptability during the use phase of the dwelling. This research project is focused on product flexibility, the adaptability of a dwelling in the future. In figure 1 the different forms of flexibility from the ‘adaptive capacity’ report are showed.

![Diagram of adaptive capacity and flexibility types](image)

**Fig. 1.** Adaptive capacity, the types of flexibility related to the different life cycle phases at three different levels (Geraedts 2014)
The outcome of previous studies showed that the implementation of flexibility measures doesn’t always result in the completion of a meaningful flexible project (Shing 2001). Meaningful, in this case, is characterized as a project that actually uses the implemented flexibility measures during the use phase. In-depth target group research is needed to be able to foresee the actual requirements of the target group for the flexible concept (Geraedts 2011).

2.3 Dwelling type

Ground-dwellings are the most feasible when they are constructed as row-dwellings. Heijmans has much experience with row-dwellings because this type of dwelling is commonly used in the Netherlands. Row-dwellings will be the focus of this research project. The complete database from Heijmans has been used as a starting point for the right information about materialization, prices and measurements. Another focus of this research project is the rental sector. The main reason for this is the construction of a new business case for the flexible row-dwelling concept. The business case will consist of collaboration between the developer and the investor. Rent income will provide the returns for the joining parties so that a feasible business case can arise. Therefore this research focuses on the rental sector.

2.4 Target group

The geographical focus of the research will be the western part of the Netherlands (Randstad). This is caused by the expected shortage for housing in this area in the coming future. Because the middle income households of the private rental sector show a prolonged shortage, this research will focus on the target group with a middle income (Scanlon 2011). Also, from the target group analysis can be concluded that the age category is an important variable for the life-stage of the target group (Feijten 2005). For this research, the age categories will consist of the groups 18-29 years, 30-49 years, 50-64 years and 65 years or older.

2.5 Business case development

A business case is a recommendation for policymakers to choose for a certain direction for the organization. This is supported by the analysis of advantages, costs and risks compared to realistic alternatives (Gambles 2009). A business case focuses on the strategic advantages, indirect costs and organizational factors (Van Putten 2012). The business case in this research will consist of the following aspects (Gambles 2009):

- Actor analysis
- Organizational framework
- Company policy integration
- Financial framework, with a focus on a cost-benefit analysis
- Goals and performance framework
- Management platform

Overall this business case can be typed as feasible when the intended return is reached with a net present value of 0 for rent prices, which are in line with the market.

2.6 Problem definition

It is currently unknown under what conditions meaningful flexibility measures can be implemented in a flexible row-dwelling concept to ensure that the dwelling is adjustable for the different life-stages of the target group and whether this implementation delivers a feasible business case for a long-lasting collaboration between the developer and the investor. The objective of this research project is to construct an innovative row-dwelling concept that shows the market under what conditions flexibility measures can be implemented in dwellings. The focus is on the financial feasibility of the concept through a life-cycle costs approach in the development of a business case.
3. Research questions

The research project provides answers to the two main research questions:

- How can a new flexible row-dwelling concept be designed for the western part of the Netherlands?
- Does a long-lasting collaboration between the developer and the investor for this flexible row-dwelling concept result in a feasible business case?

The flexible row-dwelling concept is based on the existing dwelling of Heijmans called the Heijmans Huismerk dwelling (figure 2). During the design of the concept research has been carried out to the meaning of flexibility and which consumer requirements need to be taken into account. With the use of so called ‘practical reports’ flexible measures can be distinguished which will be connected to the consumer requirements and trends for the target group by the ‘flexibility triangle’. The flexibility triangle gives the flexibility requirements for the row-dwelling concept. The different constraints for the business case are elaborated with a focus on the company policy integration, the actors in the business case and the financial framework. With the use of these constraints the business case is tested for market potential in the client base of Heijmans. This resulted in meetings with different types of investors for row-dwellings in the Netherlands.

Fig. 2. Flexible row-dwelling concept is based on the existing Heijmans Huismerk (http://heijmans.nl/nl/nieuws/huismerk-huizen-leeswand-waalwijk-verkocht; 02-04-2015)

4. Creation of the flexible row-dwelling concept

Fig. 3. The flexibility triangle; the changing demand for flexibility measures, trends and the supply of flexibility measures (Ruiterkamp 2015)
The flexible row-dwelling concept is based on the standard Heijmans *Huismerk* dwelling. This dwelling is transformed into a flexible row-dwelling with the use of the constructed flexibility-triangle that makes a connection between dwelling functions, flexibility measures and trends. The flexibility-triangle can be found in figure 3.

The total amount of dwelling functions consists of general dwelling functions which are obtained from the research about activities in dwellings from the target group (Meesters 2006) and the flexible dwelling functions which are obtained from the adaptive capacity report (Hermans 2014). This results into the following dwelling functions for the flexible row-dwelling concept:

- Sleep function
- Residence function
- Eat function
- Universal function
- Outdoor function
- Personal care function
- Extension function
- Rearrange function
- Rejection function

Flexibility measures can be typed as the measures to implement in a dwelling to be able to adjust the dwelling to the changing demand. The flexibility measures are separated into spatial/functional measures and construction/technical measures (Geraedts 2014). The flexibility measures are obtained for national and international practical reports. Furthermore, the trend of aging is an important factor in the evolution of the housing sector. This is why trend became a third aspect in the flexibility-triangle.

### Table 1. Summary of the implemented flexibility measures of flexibility measures per dwelling function; not presented in the table are the design implementations for the spatial requirements

<table>
<thead>
<tr>
<th>Dwelling function</th>
<th>Implemented flexibility requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sleep function</td>
<td>Flexible walls (Bowall or MasterWall) Plinth system for wiring</td>
</tr>
<tr>
<td>2. Residence function</td>
<td>Flexible walls (Bowall or MasterWall) Plinth system for wiring</td>
</tr>
<tr>
<td>3. Eat function</td>
<td>Strategic empty floor spaces</td>
</tr>
<tr>
<td>4. Universal function</td>
<td>Flexible walls (Bowall or MasterWall) Plinth system for wiring</td>
</tr>
<tr>
<td>5. Personal care function</td>
<td>Threshold &lt;20mm rounded Flexible walls (Bowall or MasterWall) Accessible facilities shafts Possibilities for brackets/shower chair</td>
</tr>
<tr>
<td>7. Extension function</td>
<td>Extension capable foundation Preparation for dormer Demountable back facade Possibility for splitting facilities</td>
</tr>
<tr>
<td>8. Rearrange function</td>
<td>Possibility kitchen at first floor Box-in-box bathroom 2 Fontanels in construction floor</td>
</tr>
<tr>
<td>9. Rejection function</td>
<td>House separating floor House separating wall next to stairs House separating chairs Convecter heating instead of floor heating Possibility for splitting facilities</td>
</tr>
</tbody>
</table>

The development based on the flexibility requirements gives an incentive for the construction of two types of width sizes for the flexible row-dwelling concept:

- 5400 mm, strongly based on the standard dwelling, as well width as layout;
- 7500 mm, ideal for flexibility of rearrangements, but more expensive.

For both dwelling types a standard pre-investment is made to ensure the future adaptability of the dwelling. This pre-investment consists of the elements of Table 1 and will cost around € 11,000. Because of this investment, at least 14 different adjustments can be made during the use phase of the dwelling. These adjustments are called adaptability options and can be found in Table 2.
To be able to construct the flexible row-dwelling concept in the proper way, various preconditions need to be taken care of. The location gives the first precondition; it needs to be suitable for the different life-stages of the target group. Secondly the urban situation has to be suitable for the implementation of one of the width-types of the flexible row-dwelling concept. Thirdly the municipality has to be supportive for the creation of flexible dwellings with a possibility to adjust the dwelling to future demands. Adjustability has to be found in extensions of the dwelling, rearranging of the dwelling or rejection (part of) of the dwelling.

5. Creation of the business case

5.1 Actor analysis

The actor analysis leads to the relation between the main actors for the business case. For the flexible row-dwelling concept the three main actors are the developer, the investor and the end-user. The developer and investor have the most influence at the business case, although it has a major impact in day-to-day life for the end-user.

5.2 Scenario’s

The scenarios are approached from four different angles and are applied on the two different width types. Also they anticipate on trends and on the possible flexibility options of the dwellings. Furthermore, the fourth scenario is fully based on the life-stage approach obtained from the activities-in-dwellings-research (Meesters 2006). A short summary of the scenario can be found in table 3.

5.3 Preconditions

The business comes up from validated aspects but still preconditions need to be drawn. The financial precondition is that the business case needs a stable economic climate to create the results that the financial framework gives. The functional precondition is that the functional flexibility of the dwelling is limited to the

---

Table 2. 14 different adaptability options for the flexible row-dwelling concept

<table>
<thead>
<tr>
<th>Adaptability options during use phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptable inner walls</td>
</tr>
<tr>
<td>Extension at the back side of the house</td>
</tr>
<tr>
<td>Construction of a (bed)room</td>
</tr>
<tr>
<td>Bathroom ground floor</td>
</tr>
<tr>
<td>Extendable kitchen</td>
</tr>
<tr>
<td>Kitchen on first floor</td>
</tr>
<tr>
<td>Dwelling split (ground and first floor)</td>
</tr>
</tbody>
</table>

---

Table 3. 4 different scenarios for the business case

<table>
<thead>
<tr>
<th>Scenario 1: Home sweet home</th>
<th>Scenario 2: The divorce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Adjustment</td>
</tr>
<tr>
<td>Year 1</td>
<td>2 x power points</td>
</tr>
<tr>
<td>Year 6</td>
<td>Extra interior wall 18 m2</td>
</tr>
<tr>
<td>Year 15</td>
<td>Dormer for extra room</td>
</tr>
<tr>
<td>Year 22</td>
<td>Extension for extra living room space</td>
</tr>
<tr>
<td>Year 25</td>
<td>Change place interior wall (hobby)</td>
</tr>
<tr>
<td>Year 25</td>
<td>End of exploitation period</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario 3: Conscious older</th>
<th>Scenario 4: Life cycle according to Meesters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Adjustment</td>
</tr>
<tr>
<td>Year 6</td>
<td>Skylight for attic</td>
</tr>
<tr>
<td>Year 16</td>
<td>Dwelling split</td>
</tr>
<tr>
<td>Year 16</td>
<td>Elderly home on ground floor</td>
</tr>
<tr>
<td>Year 16</td>
<td>Bathroom/toilet for disabled</td>
</tr>
<tr>
<td>Year 20</td>
<td>Wiring adjustment through plint</td>
</tr>
<tr>
<td>Year 25</td>
<td>End of exploitation period</td>
</tr>
</tbody>
</table>
flexibility measures that are taken. There will not be an endless flexibility in the dwelling due to the considerations that had to be made. Furthermore, also the market potential has a precondition. The test for market potential remains to be called positive but changes in the market can have a big influence on the feasibility of the business case.

5.4 Company policy integration

The flexible row-dwelling concept has a relation with the current company policy of Heijmans. This relation can be found in the way the flexible row-dwelling concept broadens the scope of Heijmans. Broadening the scope is done by the long-lasting collaboration between the investor and Heijmans where Heijmans is responsible for the maintenance and the adjustments to the dwelling.

5.5 Management platform and goals

The management platform gives the steps to take at the start of executing the business case. These steps are similar to the steps that have to be taken for regular development projects; determine land positions, specific target-group analysis, attracting investors. Also, the business case comes with some risks. The main risk aspect can be found in the long-lasting collaboration with another commercial party, in this situation you’re dependent on the other company and dependent on their choices.

The five main goals of the business case are: future adaptability, counteract to the static character of dwellings, efficient use of building materials, financial feasibility and the extension of the total lifetime of the dwelling.

5.6 Financial framework

The cash flow models are based on the life-cycle cost approach. With these models the different scenarios have been calculated so that a comparison can be made between the two flexible width types of the concept and the standard Heijmans Huismerk dwelling. It can be concluded that it would more feasible to invest in the flexible row-dwelling concept when the adjustments are big and complex. Investments in these kind of possible adjustments are less expensive during the first construction phase than afterwards during the use phase.

5.7 Viability of the business case

The test of the concept with different experts in practice shows that the concept is structural/architectural viable; only the structural/architectural choices have an influence on the financial viability.

The financial framework is consulted with the market to test the market prices and the market potential. The test showed that different parties have a different way to approach an aspect like maintenance costs and from this can be concluded that the feasibility is also influenced by the assumptions that have been made by the sources. Overall can be concluded that all the scenarios attain the needed financial feasibility. The uncertainty still follows from the actual implementation of the flexibility options and the degree that the flexibility measures are used in the future.

5.8 Influence on financial feasibility of the business case

Some external factors can have influence on the financial feasibility but cannot just be expressed in euros. One of these factors is the GPR-Gebouw score, a score that tells something about the sustainability of a building in five sustainability themes; future value is one of them. Because of the increase of the future value, an aspect like the GPR-Gebouw score will increase and that will have a positive effect on the market value of the dwelling. Also, for example in Amsterdam, there is a possibility for a subsidy for adaptable houses.
6. Conclusions

The main research questions of this research were: How can a new flexible row-dwelling concept be designed for the western part of the Netherlands, and does a long-lasting collaboration between the developer and the investor for this flexible row-dwelling concept result in a feasible business case?

6.1 Design of flexible row-dwelling concept

The design of the flexible row-dwelling concept has been executed with the use of the flexibility triangle. The demand for a flexible dwelling will originate from the general demand and the flexibility demand for dwellings. Together this will result in the needed supply, the needed dwelling functions. The link for the flexibility triangle between dwelling functions, flexible measurements and trends result in the flexibility requirements. These requirements function as a guideline during the development of the flexible row-dwelling concept.

6.2 Feasibility of the business case

It can be concluded that a long-lasting collaboration between the developer and the investor will result in a feasible business case. An important aspect is the degree and complexity of the future adjustments. For example it is financially more attractive to implement an extension at the ground floor for the flexible row-dwelling concept compared to the regular Heijmans Huismerk dwelling. The implementation of for example a skylight will not result in a financially more attractive situation for the flexible row-dwelling concept. When the situation is approached from Heijmans point of view, the involvement in the use-phase of the dwellings will result in an increase of income for that specific project. This increase follows from the income of maintenance and the future adjustments.

6.3 Goals of the flexible row-dwelling concept

When the goals of the flexible row-dwelling concept are reached and when the dwelling actually gets a longer meaningful total lifespan, this will result in an increase of income for Heijmans for that specific project but does not have to result in a total benefit for Heijmans. The construction of dwellings is one of the main businesses of Heijmans. When the lifespan of houses will be increased, this could result in a decrease of houses that have to be built and that will have a negative effect on the main business of Heijmans.

6.4 The opinion of the market

Changes start with initiatives and people that can carry the load. This research was able to let the real estate market think about flexible row-dwellings. All market parties type the concept as customer-oriented. It can be concluded that market parties are interested in the concept. They see the added value of flexibility, only they are not sure of the way to implement it. The flexible row-dwelling concept doesn’t have to be the only suitable answer for this.

References


