# MANAGING METABOLISM

## enabling re-adaptive housing possibilities in the Netherlands

REAL ESTATE MANAGEMENT - HOUSING


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# MANAGING METABOLISM

## ENABLING RE-ADAPTIVE HOUSING POSSIBILITIES IN THE NETHERLANDS

A thesis submitted to Delft University of Technology for the degree of
Master of Science in Architecture, Urbanism, and Building Sciences

by

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P5 report

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# COLOPHON

## MSc Graduation thesis
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# PREFACE

As an alternative way of constructing new housing in the Netherlands, this research has been looking at re-adaptivity within housing possibilities. As this was something that wasn't found a lot about in academic papers, it is still quit a explorative research that touches the surface of possibilities. Although it was sometimes difficult for me, as I didn't really knew what direction to go, it also kept me very interested as I got to use different kind of research methods. I learned how to do proper literature review, how to do case studies, how to conduct interviews, how to analyse data, how to put out a survey, how to write conclusions and how to visualize important elements.

I genuinely enjoyed my whole study time (both at the Hogeschool Rotterdam for my BSc and TU Delft for my MSc). During writing this thesis, I especially learned how much I  don't know. Luckily that is what excites me. Writing a thesis has often been described as a report that summarizes the things you have been learning during your studies. However, I have experienced writing my thesis as a whole new learning experience on its own. Maybe I should write a thesis on that.

I would like to thank both my mentors Gerard van Bortel and Lidwine Spoormans from the TU Delft. It was genuinely a pleasure to work together on my thesis. I would like to thank you especially for giving me the freedom to explore through my research – as I'm aware that sometimes it was a bit.. vague. Also I would like to thank Linda van Dam from NEOO for both her supervision on my thesis, as well as mentoring me during my first experiences in real estate developing. You thought me a lot! For all my supervisors, Furthermore, I would like to show my graditude and thanks to the interviewees and critical panel members for their input and time. Lastly, I would like to thank my classmates, my friends and family for keeping me in a good mood. Hopefully you enjoy reading this research half as much as I enjoyed making it.

Shajwan Jabar
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# ABSTRACT

Currently there is a high demand for more housing dwellings, a change in housing compositions, mis-match between household profiles and their space and lastly a growing demand in sustainability, circularity and adaptivity. Re-adaptive housing prevents demolition, transformation to non-housing functions, is more sustainable and continuously meet the space demands from changing households. Yet, re-adaptive housing seems not be the norm of housing construction. The fundamental question is whether (re-)adaptive principles can be applied in practice along, what (dis) enables it and how re-adaptive housing can be managed.

Through researching the (re-)adaptive theories of Metabolism, Structuralism and Open Bouwen an own definition of re-adaptive is proposed as there is no definition of re-adaptivity yet. After the literature review, case studies are researched in the empirical study. Case studies are supplemented with interviews and a survey. As a result, enablers and barriers are allocated and addressed in terms of providing proposals to improve re-adaptive housing new construction in the Netherlands. For both the allocation and the addressing, a professional panel has been discussing these findings and shed a critical backlight from different actors within a project team.

The main four themes that came forward were 1) financial; 2) legal; 3)design and 4) governance.
Newly constructed re-adaptive housing in the Netherlands can be managed by a) first finding an investor who is willing to have a long-term vision for its financing to be paid back as re-adaptive housing shows a higher yield but over a longer time than usual housing construction; b) having the municipality and/or other larger legal bodies willing to make policy changes (or introduction) in  new flexibility in-use-policies with regards to the current building policies on a national level; c) offering a tenant contract with ownership over infill to the residents; d) providing the architect a very specific and clear brief/design assignment on re-adaptive architecture and e) setting up a different resident organisation with a more extensive communication between owner-resident and a continious management, even after the construction phase.

(Re-)adaptive housing  and above stated recommendations also lead to role changes of stakeholders as residents play a stronger role since they take partly a designing, financing and ownership role.  An additional stakeholder is the resident representative. Construction engineer and architect will have to work closer together. And the the owner/organisation will have to play a bigger role after construction as continuous guidance and management is needed.

Re-aaptive housing never re-visits the initation phase (when renovation or transformation is happening) but rather has the introduction of the 're-phase' which enablers (re-)adaptation of the housing unit. This phase is imbedded to such an extent that systems and information of what the possibilities are (within architectural space/design but also structural) are clear and set for residents. The operation phase (becoming more a loop) is longer due this re-phase, and also results in shorter life cycles and thus less need for maintenance. Lastly, the design phase is longer and the construction phase is shorter in comparison with regular housing.

It can be concluded that re-adaptivity is a process as its continuous / open ended, has a certain procedure to be followed (especially during the re-phase), doesn't have a definite duration, is event-driven and neverending. In order to enable re-adaptive housing in the Netherlands, re-adaptive housing should be seen, initiated and followed through as a process and not a project.

key words: adaptive housing, re-adaptive housing, metabolism, structuralism, open bouwen

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# 1. INTRODUCTION

The introduction will give an explaination of what led to the research of this thesis. Furthermore it elaborates on the research aim and research relevance.

# 1. INTRODUCTION

By 2034, the prognoses is a housing increase demand of 1.16 new homes (Groenemeijer et al., 2021). Additional new stock for the prognosed housing shortage can include replacing, renovating older dwellings (Asselbergs, & Spoormans, 2020), splitting dwellings or changing the use of the dwelling. This counted for almost 33.000 dwellings in 2021 (CBS, 2021a) and 25.000 in 2020 (CBS, 2021b). Besides the increase in housing demand,it is also expected by 2034 to have a different composition of shares between single-family housing and multi-family housing. Furthermore, there is a difference in family size and its m2: lots of people live either too big or too small than their needs (Stadszaken, 2020).

Besides, Geraerdts (2015) stated that there is an increase in demand for both flexibility and sustainability, together with a growing understanding of the importance of circular economy. According to Spoormans, Jonkman and Asselbergs (2020), adapdability plays an important role into this and is defined as the degree to which a structure can be modified to meet changing needs or a different purpose. Renewability and adaptability, having elements that allow flexibility and hence a wider range of interpretation, is more sustainable and makes continuous adaptation easier and less expensive. A building is more sustainable when it can keep its functional life cycle longer rather than becoming vacant, being demolished and/or require big renovations (Geraedts, 2016).

The topic of (re-)adaptive housing is relevant and worth investigating since it could provide a possible solution for the issues as stated above. As existing buildings can create new housing units through splitting, renovating and/or transformation, it prevents it for demolition or transformation to other functions. Knowledge about the implications and possibilities of flexible and adaptive housing has great importance for using these theories more often and releasing some pressure on the housing shortage along with preventing future mismatches between space supply and demand.

The possibilities of adaptive building and their general features has been studied and documented extensively and received their relative considerable attention in the building environment, in Japan with Metabolism and its Dutch counter parts Structuralism and Open bouwen. However when we look at an examples of buildings with principles on flexibility and adaptability, they do not function as expected. For example, Metabolism's the Nakagin Capsule Tower is now in heavy decay with lots of technical issues and a high vacancy rate waiting to be demolished (Magalhães, 2013; Ishida, 2017; Messynessy, 2016; Heilmeyer, 2021), Structuralism's Centraal Beheer Gebouw is also in decay and vacancy (Giele, 2021) and the Open Bouwen's Solids is also largely vacant (NUL20, 2013).

Previous research mainly concern themselves with the architectural side of adaptability, however the aspect of organisational management still needs further investigation. A large body of data concerning the practical outcomes, especially with regards to organisational and management concerns, of these adaptive building principles have not been reported. The question therefore remains how the theoretical implications can be implicated in practice. It's of interest not to only compare the (re-)adaptive theories and projects, but also draw lessons from these. Hence, additional research on the organisational and management aspect of adaptive housing projects is needed.

The purpose is to document the barriers and enablers of (re-)adaptive housing, making the aim of the thesis to propose organisational and management recommendations for newly re-adaptive housing construction in the Netherlands. This is done by literature review on metabolism, structuralism and open bouwen. This is followed by case studies, including interviews and a survey to complement the case studies. After proposing recommendations as a way to adress the barriers and enablers, this will also be discussed in a professional panel as well in order to validate the outcomes.

The remainder of this thesis is divided into five sections: the methodology, the literature review, the case studies including the interviews and surveys, the enablers and barriers with its recommendations including the critical panel.

Figure 1 shows the stated problems as in the introduction and how this leads to the reason for researching (re-)adaptivity in housing. The three theories together can be divided in both a architectural and organisational side and thus also its theoretical and practical side. Both sides can include barriers and enablers. The most interesting research point is how the theory and practice either crash or mutually work together well.

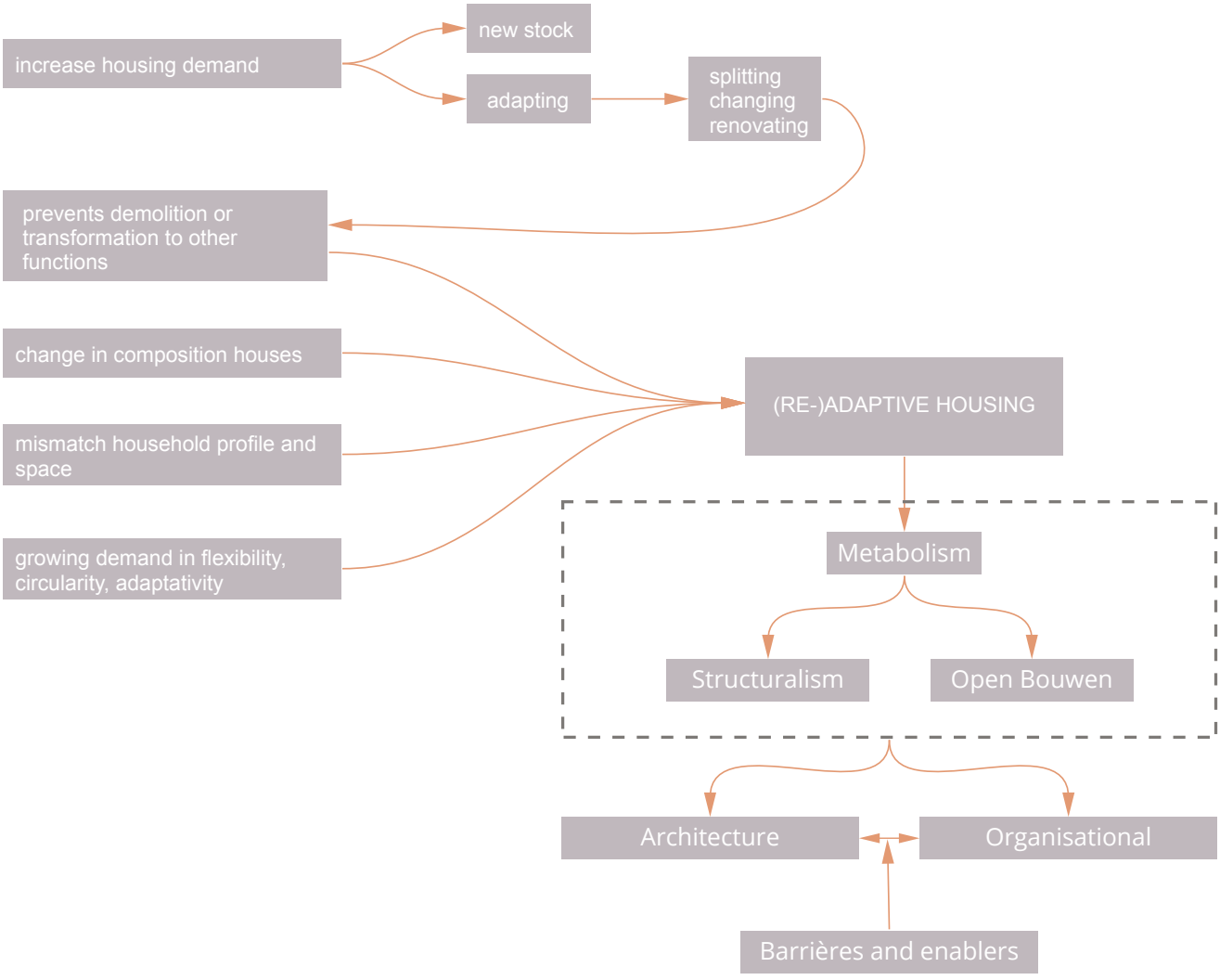



Figure 1: Research introduction (own illustration)

# 1.1 PROBLEM

## PROBLEM DESCRIPTION

According to prognoses of ABF Research, there will be a housing shortage of one million houses in the Netherlands by 2035 (Asselbergs & Spoormans, 2020). This can be as a result of result of changing housing preferences, immigration, ageing population and the relatively higher concentrations of housing demands in urban areas. Currently, 64% of the existing stock is single–family and the other 36% is multi–family. In 2035, this will be 51% single–family and 49% multi–family (Groenemeijer et al., 2021). This difference in ratios can be seen in figure 2 (2021) and figure 3 (2035). Also, based on the amount of starters looking for housing, home sharers aged 25 years old and up, the increase share of older children that live at home, the doubling of the amount of homeless people and the rising house pricing, it is expected that the total housing stock will increase with 12.4% by 2034, where 1.16 million homes are expected to be added and 168.000 will be withdrawn (Groenemeijer et al., 2021).

A quarter of a million of those houses has to be accounted for by newly constructed housing, the rest can also include replacing and renovating older dwellings. Existing buildings can therefore also create new buildings through splitting dwellings, renovate them to prevent demolition or transform of other function buildings (Jonkman, Asselbergs, & Spoormans, 2020).

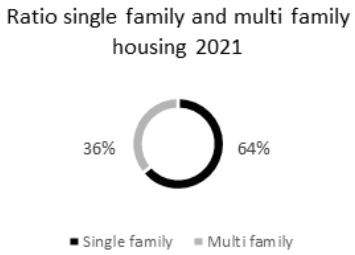



Figure 2: Ratio single family vs multi family housing in 2021 (Groenemeijer et. al, 2021)

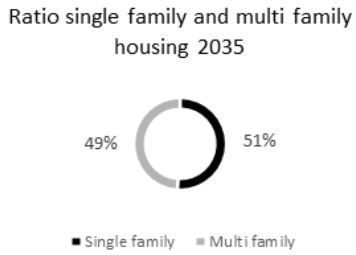



Figure 3: Ratio single family vs multi family housing in 2035 (Groenemeijer et al,m 2021)

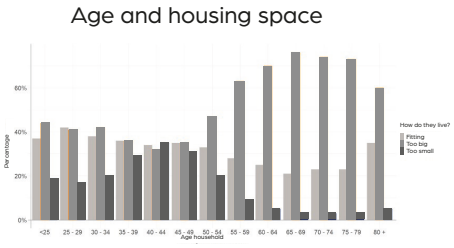



Figure 4: Ages resident and surplus of housing area (Stadszaken, 2020)

It's not only the prognoses of the population growth, but also the increase of the number and different types of households. As can be seen in figure 4, when living spaces are put against households, there is a peak in over–dwelling households in the age group over 50 and the age group of 35–50 years old live way too small. The age group over 50, the empty nesters, used to need this space for their family, however now the children left home and there is a surplus in space. Also, since the house often is largely repaid, the housing costs are relatively low (Stadszaken, 2020). People with too much space prefer keeping this than perhaps having a shortage in the future, elderly people who now live in a social rental rather stay than move with a significant price increase, empty nesters instinctively pay only little for their home as they have paid it off very often and moving to a new home is relatively more expensive (Stadszaken, 2020). But this does take space that other housholds would need.

To tackle these both the issue of housing shortage, new housing development can be constructed, current stock can be renovated and/or transformed into suitable housing dwellings.

Not only is new construction, renovation or transformation not always feasible, they also not or nihilistic provide a solution for the issue of mismatch between how people live and how they rather live, in terms of space. Also, it's assumed that people value the place they live in (social relationships and social capital), making moving to a different area less desirable and making (re–)adaptiveness of a house more a preference.

(Re–)adaptive housing could be a possible solution to these mentioned issues. Academically there is an increasing interest in adaptive constructions (involving the selected terminologies including retrofitting, renovation, rehabilitation, refurbishment, material reuse, building conversion and adaptive reuse) (Shahi et al., 2020). As can be seen in figure 5, this concerns a very high increase in papers published on building adaptation. strategies.

In practice we can see that in 2021 so far (from December 2020 to November 2021), the current housing stock counts for 9.202.409 dwellings, 79.727 (0,87%) of this number is newly constructed and 13.912 is demolished. What's most interesting, is that 33.209 (0,36%) of this current stock is accounted for additional new stock as a result of splitting, renovating or changing the use of the dwelling. 17.822 (0,19%) dwellings are withdrawn from the total housing stock as a result of merging or changing the use of dwellings (CBS, 2021a). In 2020, the

total housing stock was 7.891.785, with 70.080 (0,89%) newly constructed. Of the total stock, 24.695 (0,31%) accounted is as a result of splitting, renovating or changing the use of the dwelling and 16.415 (0,21%) have been withdrawn from this stock as a result of merging or changing the use of dwelling (CBS, 2021b).

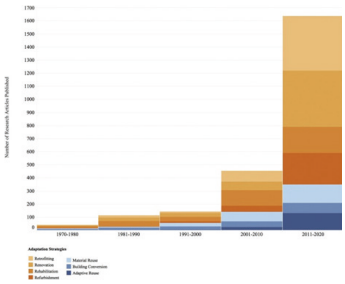


Figure 5: Published housing adaptivity papers (Shahi et al., 2020)

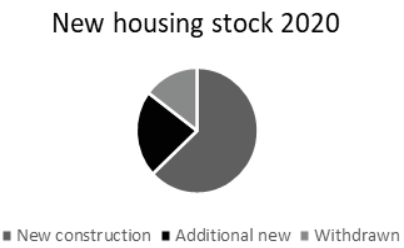



Figure 6: New housing stock due adaptivity in 2020 (own illustration, data from CBS, 2021b)

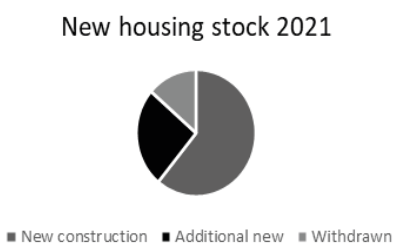



Figure 7: New housing stock due adaptivity in 2021 (own illustration, data from CBS 2021a)

Looking at these numbers, a relative big amount (0.36% in comparison to 0.87%) of additional housing stock comes adapting the dwelling (splitting, renovating or changing the use of the dwelling into housing, i.e. adapting the dwelling). Both figure 6 (for 2020) and figure 7 (for 2021) shows how much of the newly added stock concerns 'additional new', which includes the result of splitting, renovating or changing the use.

According to the market developments, there is also an increasing demand for both flexibility and sustainability, along with a growing understanding of the importance of circular economy (Geraedts, 2016).
'Re-using' buildings has great benefits in terms of sustainability as existing buildings hold great amounts of materials, energy and captured CO2. A building is more sustainable when it can keep its functional life cycle longer rather than becoming vacant, being demolished and/or require big renovations (Geraedts, 2016). All of these features are related to the building's renewability and adaptability, where certain characteristics might allow more flexibility and hence a wider range of alternative interpretations. This also makes continuous adaption easier and less expensive because buildings may be adapted to new uses with fewer significant changes. Because the demand for real estate is always changing, renewability and adaptability are equally vital. Demand-oriented development aid only in the short-term coordination of supply and demand. Also, supply takes multiple years to catch up with the demand as building projects usually take years (Spoormans, Jonkman and Asselbergs, 2020).

When thinking of incorporating (re-)adaptivity into its architecture, Metabolism is a great example of implementing these principles. Metabolism had seen buildings as regenerative rather than static, and its architects designed megastructures with both permanent and ephemeral components to allow them to develop over time (Kurokawa, 1977; Koolhaas et al., 2011). Structuralism and Open Bouwen are the Dutch counterparts to Metabolism with more or less similar principles. Figure 8 shows a initial overlap and differences between these theories. However when looking at examples of buildings with principles on flexibility and adaptability, they do not function as expected. It's interesting to note that some of these buildings that were designed with flexibility in mind, are either already being demolished or are up to being so. This can either be seen flawed in terms of flexibility relating to the design process, but not so much to reusability or because the building could be considered utterly flexible (van den Heuvel and Frausto, 2012). For example, Metabolism's the Nakagin Capsule Tower is now in heavy decay with lots of technical issues and a high vacancy rate waiting to be demolished (Magalhães, 2013; Ishida, 2017;Messynessy, 2016; Heilmeyer, 2021), Structuralism's Centraal Beheer Gebouw is also in decay and vacant (Giele, 2021) and the Open Bouwen's Solids also had vacancy (NUL20, 2013).

The combination of a current housing shortage and a mis-match of people their living needs and actual living space or financial size, leads to dwellings being newly build, renovated, transformed or demolished. In theory, flexible architectural principles such as metabolism, structuralism and Open Bouwen should offer a strong solution to adaptability of buildings and prevent such measures, however in practice this seems not the case.


Figure 8: Quick initial overview of Metabolism, Structuralism and Open Bouwen (own illustration)

# 1.2 RESEARCH AIM

Previous research has primarily focused on the architectural component of adaptability; however, the aspect of organizational management still need more research. There is a dearth of information on the practical outcomes of these adaptive construction principles, particularly in terms of organizational and management concerns.

The intention of this thesis is to research and explore in what way re-adaptive housin can be initiated and managed properly for these ideas to work out practically as housing in the Dutch context. It explores the possibilities within re-adaptive architectural principles and what the exact bottlenecks are, and offers a management proposal for new structures with (re-)adaptative principles. Metabolism is a starting point, and from there on similar concepts in the Netherlands will be looked at and further used in the research. With regards to Metabolism, there is not one specific theory that aligns completely. Therefore, two concepts will be used that together overlap metabolism its whole concept. These are Structuralism and Open Bouwen.

This thesis 'Managing Metabolism' researches if re-adaptive housing can function as a feasible project possibility for new construction housing stock, in terms of organisational and process related aspects. Existing Metabolism, Structuralist and Open Bouwen buildings will be researched through the in-depth research and analysis of the different barriers and enablers. (Re-)adaptive housing could prevents future mis-matches between housing demands and supply and minimizes the changes of big renovations, transformations, decaying and demolition.

The end objective will be a summary of the enablers and barrieres -with recommendations- of re-adaptive housing building, however priorities for further research through isolating key variables will also be established.

In order to reach this aim, the following research question has been formulated:

" In what way can (future) newly constructed re-adaptive housing in the Netherlands be managed? "

# 1.3 RELEVANCE

## ACADEMIC RELEVANCE

Not only is this thesis the interdisciplinary connecting link between architecture and management in the build environment, it fills the gap of research between theory and practice domains, of how the theory of (re-)adaptive building principles work out in practice. A deeper understanding of the enablers and barriers is researched. The academic addition of this thesis is not only the observation of, but also understanding the observations to also making new recommendations and proposals based on this from the tender phase till maintenance phase. Secondly, an own definition for 're-adaptivity' will be proposed. It also links the gap of research between Metabolism, Structuralism and Open Bouwen.

## SOCIETAL AND PRACTICAL RELEVANCE

Buildings are normative, meaning buildings are related to the way people live and behave and therefore the building and human behaviour are interrelated as they create a particular set of standards. A structure that is intended as a living creature to continuously support the lives of the individuals that live inside with principles of growth and transformation across time, has great potential to propose itself as a tool for social and behavioural change of inhabitants.

This research can lead developers, investors and the municipality into the decision of building re-adaptive housing. Building parties directly benefit from this as re-adaptive housing, possibly, leads to less need for transformation, big renovation, decay and even demolition of their properties. If there is a positive outcome, investors can build better re-adaptive housing and thus the inhabitants directly benefit from this. Now they live in a house that is fitted for their needs and also can be changed into their change of needs instead of having to move house when housing needs change. Secondly they can continue to build on to their social capital. If there is a negative outcome, which is also possible, further research can be built on specifically the negative outcomes - the barriers.. It could also be possible that the conclusion of this thesis that re-adaptivity in the housing branche for the Netherlands is not a feasible business case - in that case it's interesting to note what exactly makes it not possible.

# 2. METHODOLOGY

To start the research, the methodology underpins the overall approach in order to be able to answer the main research question. This chapter will include the research (sub) questions, the research framework to answer the research questions, how the research framework is set up per phase (including the used research methods, selection criteria and selections),  data plan and lastly the research objective.

# 2.1 RESEARCH QUESTIONS

## MAIN RESEARCH QUESTION

Based on the previous stated problem statements, the following main research question is formed:
''In what way can (future) newly constructed re-adaptive housing in the Netherlands be managed?''

In order to get to an answer to the main research questions, there are subquestions which are formulated below with a brief description. See the order and relationship between the subquestions in figure 9.

## SUBQUESTIONS

### SQ 1: What are principles and definitions for re-adaptive building?

The aim of this research question is to understand the principles of '(re-)adaptive' building and form a definition for 're-adaptivity'. This is done through a literature review. From this, a theoretical framework can be used and additioned further into the research as it is then clear what the definitions and important principles are of the chosen theories, making it clear what to look for and find out in the case studies and interviews. Metabolism is taken as an initial starting point and then is related back to the Dutch context by using its two very similar theories, Structuralism and Open Bouwen. These theories will be further researched on its origin, philosophy, key characteristics, rates of change (lifecycle elements), criticism and concluded with a proposed definition for each theory. Lastly, the three theories will be discussed together and will be concluded with a proposal for a definition of re-adaptivity.

### SQ 2: How do principles and definition of re-adaptivity manifest itself in projects?

Precedents will be analysed through a theoretical framework, that is based on what the most important key points are derived from SQ1. The aim of this is to get a better understanding of how theoretical ideas manifest itself into actual built projects.The Metabolism, Structuralism and Open Bouwen case studies include a long list of 10 case studies. These are to function as an overview of practices of the theory. There is one main case study, with secondary comparitive case studies.

### SQ 3: What are enablers and barriers regarding re-adaptivity in housing?

From the case studies enablers and barriers will be filtered on what is the most relevant to re-adaptive housing and not general housing construction. Then these will be branched out into key themes / elements such as financial, legal, design and governance.

### SQ 4 : How could barriers and enablers be addressed to improve re-adaptivity in housing?

Based on previous research questions, lessons can be learned and therefore recommendations can be formulated to enhance re-adaptive building for housing in the Netherlands. The enablers will be adressed by stated what the enablers are and perhaps how these can be enhanced. The barriers will be adressed by pointing out where the main knot of issues lie and a proposal will be recommended on how this can be tackled.

Both SQ3 and SQ4 will go through a critical backlight from professionals. This is done so the recommendations can be reflected, criticized, discussed and either left out or changed. By validating the outcome by professionals in the field of building development and management, the outcome is more practice-based and implementations are more clear. This results in the final recommendation.

# 2.2 TYPES OF STUDY

## INDUCTIVE

The research is inductive as it infers theoretical concepts (Metabolism, Structuralism, Open bouwen) and patterns (enablers, barriers) from observed data (literature review, case studies, interviews, survey expert panel). This thesis is both an exploratory in the sense of exploring the possibilities of (re-)adaptive housing, followed by explanatory research as in why it is feasible or not for the Dutch housing market.

## EXPLORATORY

As re-adaptive, housing in the Netherlands has not been studied or very ill defined, this thesis tests its feasibility. It explores the first steps of this becoming a possible housing solution with regards to re-adaptive building for the Dutch housing market. More extensive studies can be followed up.

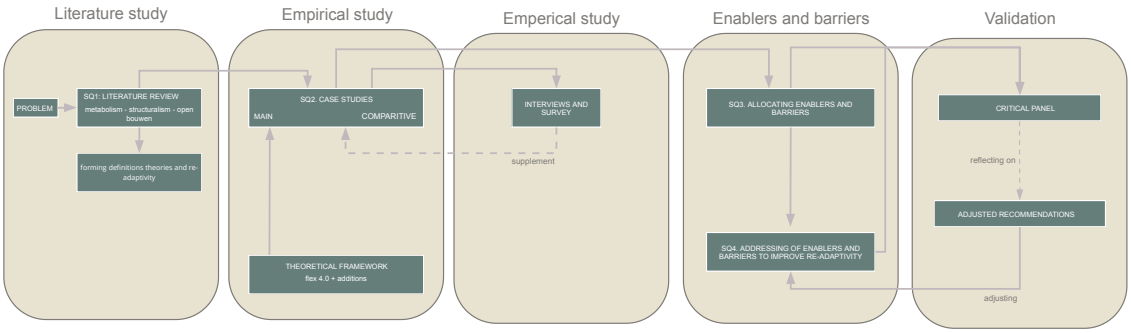
## EXPLAINATORY

As this thesis also seeks to explains the reason behind why re-adaptive housing barely can be seen in the Dutch housing market. It seeks to answer the 'why' and 'how': what where the issues? Why was this so? And how can these issues be minimized?'. By identifying the barriers and enablers, and their causal relationship the dots can be connected leading to an attempt of understanding the cause and effect of re-adaptive housing.

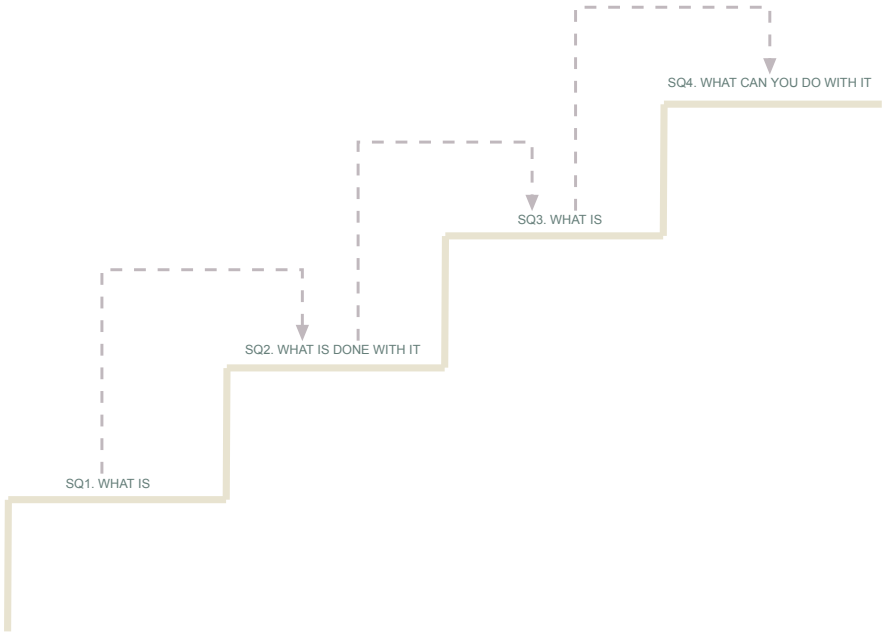
## QUALITATIVE RESEARCH

The case studies will lead into intensive knowledge about the small number of very well related projects. The case studies will show the process, how it was done and what the outcome has been leading to the barriers and enablers. The collection of information for these case studies, will be a range of data collection techniques such as literature review, interviews, books and a survey.

Relantionship research questions




Two step – research questions




Snowballing effect due addtions of research question

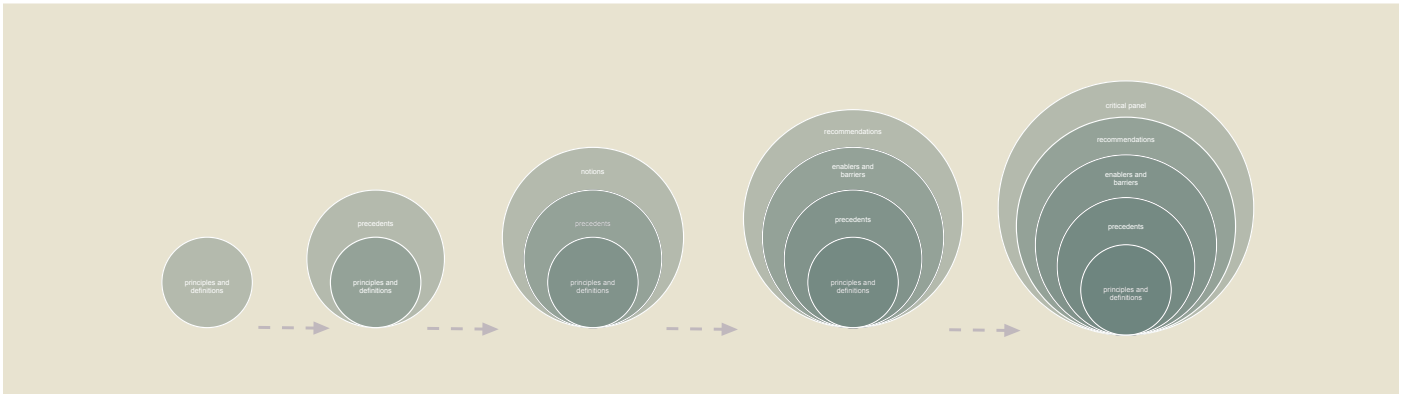



Figure 9: Order and relationship of subquestions (own illustration)

# In what way can (future) newly constructed adap

What are principles and definitions for re-adaptive building?

METABOLISM

relating to Dutch context

STRUCTURALISM & OB

LITERATURE REVIEW

Origin / Philosophy / Rates of change / Criticism / Definition

Defining re-adaptive

theory in practice

PHASE I - LITERATURE STUDY

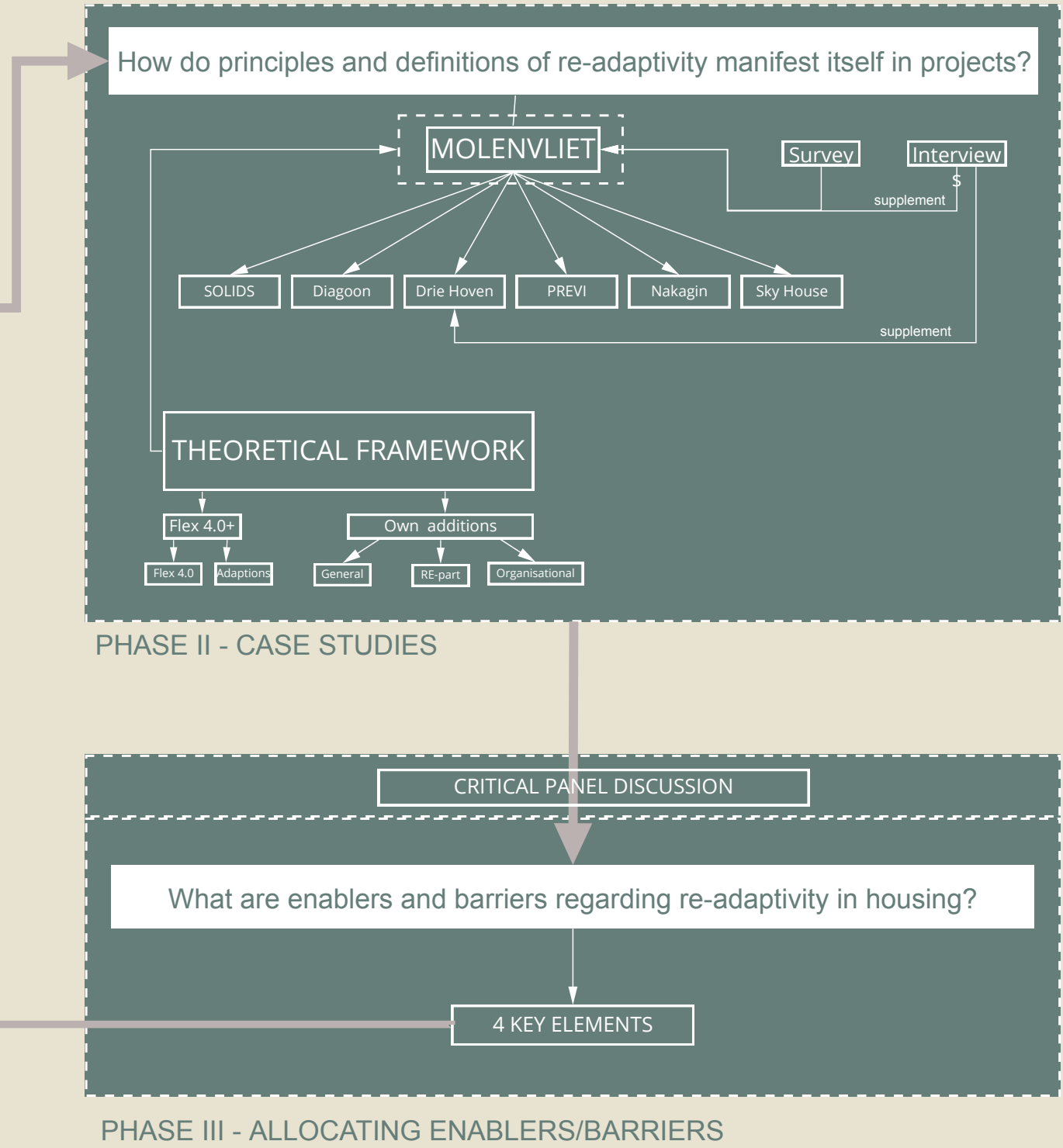
CRITICAL PANEL DISCUSSION

How could barriers and enablers be addressed
to improve re-adaptivity in housing?

RECOMMENDATIONS

PHASE III - ADRESSING ENABLERS/BARRIERS

# otivity ability housing in the Netherlands be managed?



## QUICK OVERVIEW DEFINITIONS

Before the research framework will be explained further, a quick overview of a possible re-adaptive definition will be explained as (re-)adaptivity is a term that comes back through out the paper from this point.
Note that re-adaptivity will be further elaborated on and defined during SQ1.
Adaptivity, adaptive re-use and re-adaptive are three very similar definitions. It's important to understand the fundamental difference between these definitions as 're-adaptive' will be further used in this research.

### ADAPTIVITY

Adaptivity is defined, based on definition used in the 'adaptief vermogen' paper by Rob Geraedts in which he uses adaptability definitions by R.B, Richard (from his strategies to generate individualised buildings) and T. Schuetze (from his 'Designing Extended Lifecycles') and from the definition in the report 'definition framework for building adaptation projects' by Sheida Shahi et. al (Sanchez & Haas, 2019; Sugden & Khirfan, 2017), (Bullen & Love, 2011; Conejos, Langston, & Smith, 2011; Langston et al., 2008; Larkham, 2002).

The definition of adaptability is as follows:
"Buildings with user-related transformation potential, that is easily adaptable to multiple functions and/ or changing requirement, where the building components are based on the historic – obsolete and derelict lifespan of the building with a minimum effort and loss of quality. Adaptable buildings are open to change and offer freedom of choice for the first users and the subsequent users. It considers the new requirements, socio-cultural demands and environmental regulations as it seeks to maximize reuse and retention of the existing structure. Adaptability goes along with the need for change, which is linked to the buildings element's lifecycles. Adaptability with regards to the structure, skin, system and space is taken into account"
Building components are easily adaptable to other functions, changing requirements and therefore open to change and offering freedom.

### ADAPTIVE RE-USE

Re-use, on building scale, links to renewing the use of a dwelling from its original function. Adaptive re-use then refers to enabling (adapting) dwellings to suiting new existence, conditions and functions once it is no longer suitable for its original function (Bullen and Love, 2011; Velthuis and Spennemann, 2007).
Adapting dwelling to a new existence, conditions and/or function.

### RE-ADAPTIVE

The difference between adaptive re-use and re-adaptive may be that adaptive re-use is more linear. The 'RE' in re-adaptive could be an important key aspect. It's not about adapting alone, but rather going back and forth in adapting as well. Re-adaptive is adaptability in a more circled way where A can change to B, but also to C and back to A. It's not just about adding and rejecting space, but also being able to do this multiple times. This is used as a possible definition now and will be further researched through out this thesis.
Adapting dwellings to new existence, conditions and/or functions, repeatedly and being able to return.

### RE-ADAPTABILITY

Adaptability, the ability to adapt then becomes re-adaptability: the ability to adapt back and forth, repeatedly. Re- adaptability can be dived into two parts: re-adapt and the abilitive. Re-adapt refers to the architecture side of the research and the ability to the management side. The ability, of the re-adaptive factors, is the to-be defined overarching main theme throughout the research. Questions such as what this ability exactly is, what it needs, what it stimulates and what it hinders are research components.

# 2.3 RESEARCH SET UP PER PHASE

## THREE PHASES

There are three phases in this research. The structure of the thesis follows along with the phasing structure. This can be seen in figure 10.

Phase I starts with literature review in order to understand the theories behind (re-) adaptive building. From this literature review on, a theoretical framework can be found and/or created so that case studies can be looked with this specific view on, which leads to the second phase. Phase II is to look at actual buildings build of the theories mentioned in phase I and how these work out in practice and therefore practical information is gained. Theory is being linked with the practice, and lessons can be learned from this. Before this can happen, a theoretical framework is chosen and/or created. This theoretical framework gives body to the case study research. From phase I and II, enablers and barrieres will come forward. These enablers and barrieres will be adressed. Through phase III both the enablers and barrieres, with their adression to enhance re-adaptivity, will be reflected on by a professional critical panel. Implications will be processed.

## 2.3.1 PHASE I : LITERATURE STUDY

The literature study is on Metabolism and its Dutch counterparts Structuralism and Open Bouwen. The theoretical framework will include each theory its origin, philosophy, key characteristics, rates of change, criticism and concluding it with a self proposed definition. The definitions between the theories are then being compared to understand in what they differ and in what they overlap leading to a proposal for a re-adaptivity definition.

Note that metabolism also includes elements that will not be The following elements will not be included further: Artificial land, ocean Cities, air cities and other urban development designs, so the focus is only on building scale. Also, the link between technology and humanity as discussed within metabolism, will not be taken into account. Lastly, Group Form will also not be taken into account because this relates more to expanding the building through making it a collective form of individual units rather than the flexibility and adaptability of it.
As sustainability is fundamentally a very important part of the reasoning behind this research, the amount and influence of sustainable materials and installations will not be further mentioned and taken into account. It is just stated that by building adaptive buildings, the building will be more sustainable. Exact numbers, other reasoning and influences will not be mentioned, as this research concerns itself with the management of adaptive elements.

Input for the literature study is from scientific articles, books, journal article, conference papers, documentaries, columns, archives, educational and scientific search engines such as the TU Delft online library, TU Delft repository, and ResearchGate.

## 2.3.2 PHASE II: CASE STUDIES

After the first phase, empirical study is done in additional to the literature studies. This is done to get a better understanding of how Metabolism,Structuralism and Open Bouwen function in practice so that lessons can be drawn from this. The case studies are of great importance for the research as literature doesn't provide much information. In phase III, interviews and a survey will be held as an enlargement of the case studies. Interviews are also part of case study gathering tools (Yazan, 2015). The case study includes a long list, a main case study and comparative case studies.

### SELECTION CRITERIA

The selection for the case studies is based up on what literature defines as metabolism buildings (Project-Japan, Metabolism in Architecture and Metabolism in Architecture), structuralist buildings (Structuralism in Dutch Architecture, Architectuur and Structuralisme and the Future of Structuralism), and Structure and Infill buildings (OpenBouwenCo, Book Open Bouwen and de Drager documentary).

#### Longlist

From here on, a selection of 10 case studies is made based on the decarmination as stated in SQ1 and other general criteria: no urban planning, no city-planning, based on the amount of available information, not choosing projects that have strong similar principles that are being used in a successor or more notable project that is of larger scale and/or more well-known, not projects that are design only, preferably also housing, no functions that are too difficult to relate to housing (such as theatres), no transformation projects, top-ups do.

Specific Metabolism criteria: no group form, not choosing projects that have too strong of a relation to artificial ground or prefab rather than adaptive elements, no portable capsules.

Specific Structuralism criteria: no sculptures, no projects that only focus on the aesthetics of numbers.

Specific Open Bouwen criteria: no focus on sustainability but this does however,interlink with the different lifecycles of elements and materials. This division between different lifecycles will be taken into account.

The 10 long list case studies function as a quick overview for idea forming of the theories. This can be found in Appendix 1.

### Main case study

The main case study, Molenvliet, is selected on its experimental nature, being a housing project, based in the Netherlands, that is still in use, a lot of in-depth information is able to gather, has done evaluations, to what extent it relates back to the definition of the theories and possibly its interconnection with the other theories, has many of the key characteristics of the suggested formed definition of re-adaptive and is possible to conduct interviews and/or surveys on.

### Comparative case studies

To highlight additional or alternative views, comparative case studies are 'hooked' on to the main case study. Case studies must be fundamentally comparative and hence similar in important aspects in order to be placed next to each other. The comparative case studies have overlap (similarities) with Molenvliet, allowing them to be compared. The primary goal of the comparative case studies is to identify differences in how adaptability is implemented in housing. It's fascinating to see where the parallels and differences exist, as well as what further lessons may be gleaned from this. The comparative case studies are chosen on the elements Molenvliet misses (such as polyvalence, core/capsule, direct growth of dwelling, direct social interaction, moving-nets).

#### SELECTION

Long list: See Appendix 1.
Main case study: Molenvliet
Comparative case studies: Solids (successor of Molenvliet with additional elements), Diagoon woningen (polyvalence), De Drie Hoven (central places and social interaction), PREVI (different rules and regulations), Nakagin Capsule Tower (capsule principle and common agreements) and Sky House (moving-nets).

#### ANALYSATION

Long list: will not be analysed further and is just to function as an extra overall view.

Main case study: for the main case study a theoretical framework is used, which is an adapted FLEX 4.0 will be used with own additions to this framework.

### FLEX 4.0

FLEX 4.0 is the result of several earlier versions of adaptive capacity assessment instruments and includes many flexibility key performance indicators. The instrument was developed through an extensive international literature surveys and professional consultations on adaptive capacity, sustainability and financial real estate business cases. (Geraedts, 2016). However, some changes have been made with regards to the original FLEX 4.0 (Geraedts, 2016) and the one used in this research. Some questions are taken out, rephrased, replaced due not being relevant enough to this research.

### Own additions

The own additions include a) general information b) aspects related to the RE-adaptivity and c) organisational aspecs. These aspects FLEX 4.0 did not include, as FLEX 4.0 is more architectural/technical related.
See 2 for the FLEX 4.0, with an explaination of the adjusted elements.

### Comparative case studies:

These studies are more explorative and have the following structure:
project information, key characteristics, evaluation/current context and ends with a summary and conclusion.

## 2.3.3 PHASE II: INTERVIEWS

To supplement the case studies, interviews are held.
This will be done through interviews with the architects of the case studies. For this, only the Dutch case studies will be used (Structuralism and Open Bouwen). This is because of relevance, since it is in the Dutch context and secondly it is more functional. The Japanese architects have been reached out to, however haven't given responses. The outcome of this research therefore is mostly related and applicable to the Netherlands. It could be applicable to other countries if these are relatable to the Netherlands in terms of housing culture, building strategies and policies.

### SELECTION CRITERIA

The architect of the main case study is Frans van der Werf. The architect of the Structuralist comparative case studies is Herman Hertzberger. These two architects are therefore interviewed because they were directly related in the projects and can supplement the case studies by validating certain research points and/or add elements.
Because of time, only the architect is interviewed because they are, usually, part of the process from beginning to end and therefore can also answer questions regarding initiation, construction and municipal starting points. The residents are not interviewed, however a resident survey has been set out.

### INTERVIEW STRUCTURE

#### Semi-structured

As the main purpose of the interviews is to draw lessons from the projects, the interviews are semi-structured, allowing for flexibility in the interview and resemble more an in depth conversation than asking for structural statements. The questions will be arranged from least difficult or general to more detailed and more difficult. This helps with slowly building confidence with the interviewee (Jacobs and Furgerson, 2012).

#### Opening and closing

The interview will start with a script, with critical details about the study along with a reminder on the informed consent. This will also help to alleviate any concerns that the participant might have about confidentiality (Jacobs and Furgerson, 2012).

The interview also closes with the script, where the interviewee will be remembered about contacting information when there may be need to have clarification information and/or additional remarks. The ending script also helps with letting the interviewee know how the research will further proceed and what they can expect from it afterwards (Jacobs and Furgerson, 2012).

#### Structure questions

Although the interviews allow flexibility, there still is a structure with certain topics to it to provide guidance and make sure same topics are discussed per different stakeholder. The questions in terms of enablers, barriers and thus lessons drawn are based on findings during the literature review and case studies. The interview questions are related to general information (initiation and such), re-adaptivity, how theory and practice overlap and/or clash, design-related aspects, cycle of change, organisational aspects and the intervention of the municipality.
See 3 for the semi-structured interview questions for both Frans van der Werf and Herman Hertzberger.
See 4 for the interview protocol.

### DATA COLLECTION

After contacting the interviewees, a date, time and manner of interview (face to face or videocall) will be set. During the interview, when given permission of the interviewee, the conversation will be recorded for transcribing reasons. The interview then will be transcribed.

### ANALYSATION

The interviews will be put in Atlas Ti and will be examined. This allows for a discovery of links between different elements and domains of a project. It might become difficult to find exact interconnection between the different projects and different actors with Atlas Ti. Therefore Atlas will be used to get a better understanding of the interview itself on its own. An attempt will be made to try to find whether the different interviews can be linked and show similarities and/or differences.
The used codes are the themes from the theoretical framework, so that information can quickly rightfully be placed in the case study. If certain quotations don't fit the codes, the most notable citations and useful informations will be remarked and summarized to see if there is a common theme. These returning themes will then be used in Atlas Ti as additional codes.

## 2.3.4 PHASE II: SURVEYS

Information of residents is derived through surveys instead  of the semi-structured interviews. This is because questions related to the residents are usually more directed and can also possibly be answered through multiple choice questions. Also, the number of residents are sustainably bigger than the number of other stakeholders per project. Therefore, in order to be able to validate certain aspects, the research needs more answers from this group simply because the group is bigger. In terms of time and availability, this is expected to be difficult leading the choice to be surveys with a possibility to follow-up with semi-structured interviews.

### DATA COLLECTION

Survey flyers will be made with a short explanation and QR code. These will be mailed to their frontdoor postbox.

### ANALYSATION

The surveys are conducted via Tripetto, which is an online site with a function to derive all responses into an excel sheet. From this excel sheet, a summarizing table will be made and further manually analysed on differences and overlaps between the residents.

## 2.3.5 PHASE III: ENABLERS AND BARRIERS

The insights and retrieved data from the literature study, empirical study, surveys and the interviews will be all set out to each other. An extensive barrier/enabler table per case study will be made and can be found in Appendix 5. This table is explorative as it mentions everything during the research. From this, a 'filter' will be held over, filtering out the 'regular' issues and focusing on two elements: the organisational matters in terms of re-adaptivity and the architectural matters in terms of re-adaptivity.  The enablers and barriers that are directly related to the re-adaptivity (with exclamation on the RE-aspect) and organisational matters, are prioritized. From these aspects on, to each critical notion a recommendation -on this critical notion- will be suggested.

By visualizing and setting out all the case study to all the key points from the case study interviews, it can be quickly analyzed which elements are common, which are specific to a project and which lack lots of data.
By slimming all the information from all the case studies into key statements, these key statements can be easily branched to certain themes. These themes again can be brances to four key points. From these four key points the enablers and barriers will be mentioned.

After having the barriers and enablers, these can be addressed in order to improve the re-adaptivity in housing. These recommendations are based on a) own input b) succesfull cases from the literature review and/or case studies. The critical panel will also be of input for both allocating the enablers and barriers and adressing these.

## 2.3.6 PHASE III: VALIDATION

The enablers and barriers with possible recommendations on these from phase III are the starting point for the expert panel discussion. The expert panels functions as a critical 'second-round'. In this round, professionals from the building environment can give their take on the (temporary) conclusions derived from this research. In this way, an extra critical layer gets added to the notions and measures to be taken for re-adaptive housing. After implementing the comments, the final proposal can be made and the main research question can be answered. The comments will be simultaneously implemented in the research output from the allocation and recommendation.

This is done in the form of a critical panel, as this can create interesting conversations and they can hook on each other's comments. If a critical panel wouldn't be possible due COVID-19 or planning issues, individual interviews are preffered. The critical panel can can vote for or against made statements, with stating their reasoning for it. Discussion is then very effective as there is a direct dialogue between the different stakeholders in a project, making the recommendations multi-layered.

### SELECTION CRITERIA

This diversity is needed in order to create a multi-perspective discussion on the recommendations. Therefore, the panel needs to include a developer (initiation, costs/profit), a project manager (organizing different aspects and stakeholders), an architect (building technology and design), a structural engineer (structural integrity), an installation advisor (installations) and a resident representative (needs and wishes of the user)

### SELECTION

From the project I have been allocated to during my internship, the critical panel is selected. This is done because they already know me and therefore are more willing to participate as well as this can smoothen the discussion. With regards to the resident representative: instead of a resident, Frank Bijdendijk, is selected to be a participant. He is a previous board member of Stadwonen and has been very actively involved with Solids and Open-Bouwen principles. A resident of one of the case studies is not preferred as they might not be able to follow the discussion between the other members well. Frank Bijdendijk can both understand building terms and thoughts, while also understanding a resident's point of view.

### DATA COLLECTION

There is a very high preference of having the discussion with the panel face to face in stead or videocall because discussing in a group on video call usually becomes difficult to follow and speak in practice. The max time frame is about an hour, not to burden the panel participants too much. With 6 panel experts, this gives them more or less 5-10 minutes per person speaking time. This means that the enablers and barriers with recommendations must be very clear and direct. Also, good preparations helps with keeping the panel within the time frame. Before the panel, a very short summary of the research and its outcome is send to each member. Also, every member is informed clearly about who the other members are, what the way of working is, what the expectations from them are, what my role will be and what they can expect the planning of the hour to be like.

### DATA ANALYSATION

Similar to the interviews, the discussion is recorded and transcribed. Furthermore, here also the transcription will be marked on interesting comments and outcomes. If participants (dis)agree, it will be stated why they (dis) agree. When participants have points of common (dis)agreements, and/or clashing (dis)agremeents, this also will be stated. Other discussion, which is expected to happen organically, will also be mentioned and linked to the best fitting enabler/barrier. If it doesn't fit any enabler/barrier, an additional enabler/barrier can be formed. From this on, the enablers and barriers with recommendations will be adjusted, left out, upgraded and/or validated.

# 2.4 RESEARCH OBJECTIVE

The research objective is answering the main research question:
''In what way can (future) newly constructed re-adaptive housing in the Netherlands be managed?''

This is done by finding the barriers and enablers for re-adaptive housing, with a focus on the RE-part in re-adaptivity and organisational aspects, so that these enabler/barriers can be adressed in order to improve re-adaptivity in Dutch new construction housing.

The research includes gaining an understanding of the context through literature review, exploring potential enablers and barriers through case studies in the empirical study, additional information through interviews and a survey, and validation through the critical panel. The objective is far less on technical or architectural possibilities with regards to re-adaptivity, but rather what this [re] could include, and how (re-)adaptive housing can be organised. These recommendations, by adressing the enablers/barriers, could offer a more streamlined proposal for building re-adaptive housing, ensuring more possibilities with regards to building these kinds of projects. The recommendations can also lead to new nodes that could be further explored. Re-adaptive housing can offer a solution for the housing shortage, match of household profile to spaces and sustainability requirements.

## RESEARCH OUTPUT

The research deliverable will be a list of recommendations (or notions of what needs further research) on how re-adaptivity housing in the Netherlands can be enhanced through strenghting the enablers and finding possible solutions for the barriers.

# 2.4 DATA PLAN

Data is obtained through literature study, empirical study, interviews and validations. Since the interviews and validation expert panel are based on stakeholders and professional's opinions and experiences, this information is sensitive and thus data protection and ethical considerations become extra important.

### DATA PROTECTION

Based on Wilkison et al. (2016), the FAIR (Findable, Accessible, Interoperable and Reusable) Guiding principles are handled:

**-Findable**

Published on the Technical University of Delft educational repository
link: https://repository.tudelft.nl
Uniquely identified by student number 5229960 on the name Shajwan Jabar

**-Accessible**

Data can be accessed freely on the open TU Delft repository. If original data is missing or website is out of air, information requirements can be inquired by email to: shajwanjabar@hotmail.com

**-Interoperable**

All information, including interviews, survey outcomes and panel discussions will be translated into English. Preferably these data findings will be conducted in English at the start in order to prevent translation mistakes.

Formal, accessible and broadly applicable language and vocabulary will be used

All data references can be found at the end of the thesis in the reference chapter. Here every resource is cited in APA-style.

**-Reusable**

The data meets domain-relevant community standards.

Particularities and/or limitations related to the data will be stated clearly.

The date and place of the interviews, surveys and expert panel discussions will be stated.

Whether it is raw or processed data will also be stated.

The transcription (raw data) of the interviews, surveys and expert panel discussion will not be directly attached to the thesis. These can be retrieved upon request through email on shajwanjabar@hotmail.com. However, some (parts of) data might not be shared upon request of participants.

Sensitive information will not be shared with third parties. Some information might be anonymized, blurred or (partly) left out in order to ensure confidentiality. This is upon request of the participants and will be stated when applicable.

# 3. LITERATURE REVIEW

The literature review discusses principles of (re-)adaptive theories: Metabolism, Structuralism and Open Bouwen. From this research, a proposed definition will be formed for each theory leading to forming a proposal for the definition of ‘re-adaptivity’. If it is clear what (re-)adaptivity is, then it can be clear what to look out for in the case studies. See figure 11.

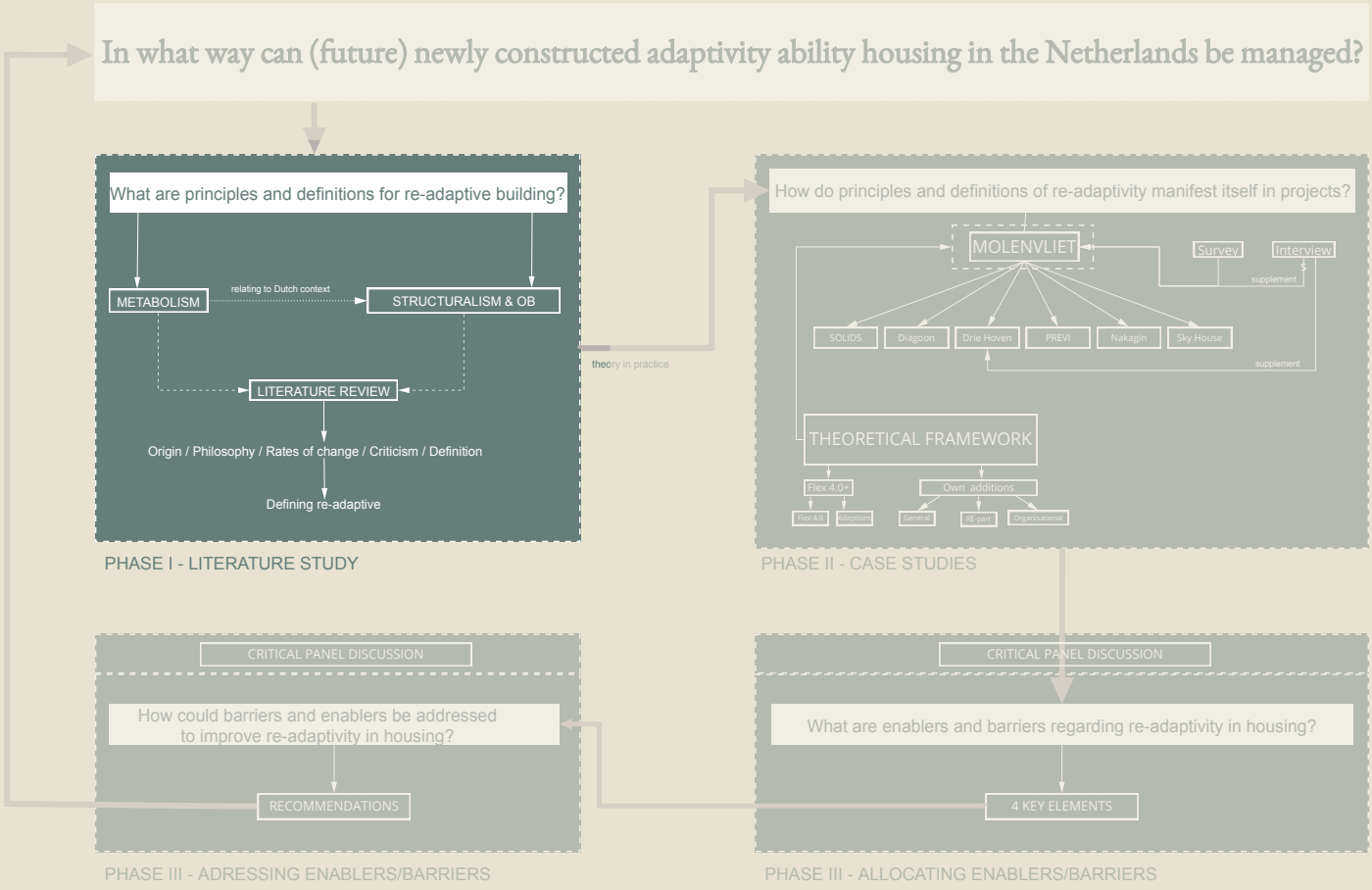



Figure 11: Research framework – phase I – literature review (own illustration)

# 3. FORMING DEFINITIONS

## SQ 1 - What are principles and definitions for re-adaptive building?

### Aim

The aim of this research question is to understand the principles of '(re-)adaptive' building in order to make a better definition of (re-)adaptive elements. The literature review can further be used once looking at the case studies as it shows what to look for/at in these case studies, and interviews.

### Content

The literature review is based on three theories: Metabolism, Structuralism and Open Bouwen. All three discuss the importance and the possibilities/principles of incorporating adaptive elements in their architecture.
As Metabolism discusses shrinkage, growth and (inter)changeability, this theory will be the initial starting point. This is then is related back to the Dutch context by using Structuralism and Open Bouwen, which are two Dutch theories that together overlap the principles of Metabolism as there is not one single Dutch theory that is equally similar to Metabolism. The definitions of the theories are then examined to see what they have in common and where they differ. These theories will be further researched on its origin, philosophy, key characteristics, rates of change (lifecycle elements), criticism, definitions and concluded with a summary and conclusion. Lastly, an own definition for re-adaptivity will be proposed.

### Sources

The literature study is done through sources from articles, books, journal article, conference papers, documentaries, columns, archives, educational and scientific search engines such as the TU Delft online library, TU Delft repository, and ResearchGate. Roughly there are three kinds of manners literature has been derived:

1. From books
Not all information is digitalized, therefor books were used as well.
As Metabolism and Structuralism are more elaborate theories, for both two books were used. Written by different writers and in substantially different release dates (old and more current). Open Bouwen is more straight forward and therefore only one book is used.
For metabolism this was 'Metabolism in Architecture' by Kisho Kurokawa. This book is directly written (1977) by one of the most active architect in Metabolism. Although this book both explains Metabolism and shows projects, it discusses only the work of one architect. A more recent book (2011) on Metabolism 'Project Japan: Metabolism Talks' by Rem Koolhaas et al., has also been used as this book explains Metabolism very much in its whole: it explains its history, the architects, the progress, has directly interviewed the architects, shows and explains many projects by the different architects as well. For Structuralism this was 'Structuralism in Dutch Architecture' (1992) by Wim van Heuvel and 'The Future of Structuralism' (2020) by Lidwine Spoormans. Both books were chosen because they both explain Structuralist principles and show the different projects.
For Open Bouwen 'De Dragers en de Mensen: Het einde van de massawoningbouw' (1961) by John Habraken is used, as it this is the Manifest of John Habraken himself, discussing Open Bouwen.

2. From the DOCOMOMO conference 2021 papers
Chapters from the DOCOMOMO (The 16th International Conference Proceedings DOCOMOMO: Inheritable Resilience - Sharing Values of Global Modernities). The following theme's, that were directly discussing metabolism, were mainly used: 3b PREVI The Metabolist first, last and only project; 8b Japanese Metabolist Architects work in Hawaii; 9a Metabolism from the perspective of humanism and contextualism; 9b How can our world we renewed; 9c Learnings from before and after metabolism

3. From databases
In order to also make the research more explorative and less biased, information from databases were also used by searching on direct relevant searching terms. The used databases were ResearchGate and the TU Delft Repository, with using the following search terms: Metabolism; metabolism buildings; kisho kurokawa; Structuralism; Herman Hertzberger; Structuralist building; Open Bouwen; John Habrakenl; structure and infill, adaptativity; adaptive re-use; readaptativty; flexible building; housing shortage Netherlands; modular building

This chapter starts with 3.1 Metabolism, followed by 3.2 Structuralism and 3.3 Open Bouwen. It ends with 3.4 conclusion of the three theories.

# 3.1 METABOLISM

It's important to note that the Metabolist theory is never intended to become an international style and establish standards around the globe, but rather should support the characteristics of its people, nation and region (Kurokawa, 1977).

## 3.1.1 ORIGIN

During the World Design Conference Tokyo, in 1960 a group of Japanese architects (Kenzo Tange, Kisho Kurokawa, Fumihiko Maki, Kiyonori Kikutake and critic Noboru Kawazoe) collectively contributing to this new school of thought whereas the philosophy is rooted in change (Kurokawa, 1977; Yi and Toledo, 2021). They had studied the politics of European avant-garde movements and were determined to fashion an 'ism' which would compete with those in the West (Kurokawa, 1977) for the reconstruction of their war-torn nation. Although being obviously influenced by CIAM, TeamX and the European Modern Movement, Metabolism advocated for adaptive building systems with a presumption of open-ended scenario's (Yi and Toledo, 2021). Moving away from the Modernist approach of planning complete cities, metabolism called for a pattern that can be followed consistently from current time to distant futures. The manifesto metabolism 1960, and its climax of collective built projects at the Expo 70 in Tokyo, pushed this new agenda out into the world (Hart,2021; Watanabe, 2021).

## 3.1.2 PHILOSOPHY

The Metabolist group proposed a new way of relationship between the human, nature and technology. This is translated to a concept of fixed systems with interchangeable parts, a variety and diversity between the parts and the whole and seeing cities as living organisms (Buzzone, 2021; Kurokawa, 1977).

## 3.1.3 KEY CHARACTERISTICS

### 1. Individuality of the user

The combination of the thought that technology would develop autonomously and the characteristics and feelings would get lost when architecture is anonymous, the Metabolist group aimed for systems whereby man maintains control over technology and prefabrication techniques restores the architectural spatial spaces to the individual human needs (Taro, 2018; Kurokawa, 1977). The average human is not considered a specialist, therefore the architect should reproduce mechanism of change that can reflect the different opinions and tastes of the people (Kurokawa, 1977).

### 2. Cycle of change

Through the comparison of buildings with energy processes through out life, it found its fundamental in the cycle of change, destruction after a life cycle ends, constant renewal and therefore eternal growth with no completed form (Taro, 2018; Kurokawa, 1977). As the biological term of metabolism also suggests, buildings and cities are ought to be designed to emulate organic propagations and adapting to its environment through multiple changes (Kurokawa, 1977). Organic expansion and replacement has roots in cyclical movement of decay, death and rebirth. Buddhist reincarnation has a direct connection of these change cycles (Kurokawa, 1977).

### 3.Core and cells

Metabolism buildings are build with the core and the individual cells. The individual cells can be (dis)placed individually and therefore can react to changes in the urban and societal context. The central core should be able to give the framework to these changes of the individual cells (Hayashi, 2021).

### 4.Re-newing rather than growing up through interchangeability

In a published article in the Japan Architect in 1967, Kurokawa writes that a Metabolic system should be developed in such a way that it promotes both destruction and growth that is necessary for humans, while also actively supressing unnecessary destruction and growth. In stead of rebuilding an entire space or building, spaces can be regenerated through inserting new elements while the existing living spaces gets preserved (Watanabe, 2021). Renewing was a more important possibility rather than growing up, making exchangeability more important than expandability. What's important to note is that with buildings with a conscious choice for interchangeability, create and urban monument that is both retrospective and prospective. The building has elements of the past while also having an ongoing cycle of looking and adapting to the future. It enables architecture to take on new and divergent tasks, establishing new meanings and serving as a direct link between past and present in a world of altering values (Mahen and Van Kluytenaar, 2021; Suzuki, 2021).

### 5. Use of prefab

In order to produce architectural buildings that are rich in its variety and individuality, metabolic architecture actually seeks the technique of prefabrication (Kurokawa, 1977). Other than this, no specific materials are used.

## 3.1.4 RATES OF CHANGE

Different rates of obsolescence are distinguished by metabolic theory, e.g. the wearing out of mechanical equipment is faster than that of structure. Their objective is to create a metropolis with such flexible connections that its components might grow, transform, and die while the core continued to live. The structure should be constituted of elements with a variety of durability lengths, so that it can still be destroyed when the shortest durability parts wear out (Kurokawa, 1977). Metabolism, as Kurokawa identified, has periods of change in the human's life. The 20–25 years old is the independent point, 50–60 years old the reproductive dysfunction point and 75–85 the life stop point. Time rhythms should be taken into account when designing architecture for each part of the urban structure – both the useful life material-wise and social wise. Living spaces have a metabolic rhythm of 20–30 years. Tools and equipment (household tools, automobiles) 1–5 years (Watanabe, 2021).

The cycle of metabolism is based on the (socially) durable years of the components.

A. EQUIPMENT (5 to 25 years)
The building facilities and installations. Such as water supply, drainages, electricity, gas and other spaces for pipe-laid facilities that are governed by technological progress.

B. DURABLE CONSUMER GOODS (5 to 25 years)
Such as the space for facilities, automobiles and products which are influenced by the rhythm of technological progress.

C. SERVICE (5 to 50 years)
The spaces that are occupied by service facilities that are needed in the daily life, such as the shops, business, entertainment, welfare, cultural, educational spaces etc. These are more flexible to change and growth

D. LIVING (10 – 125 years)
The most fundamental space in urban space and can be referred to as the 'master space'. It has a time-rea range of 10 to 125 years, with the time module of 25 years.

E. Association (25 – 625 years)
This includes spaces such as parks, open spaces, sidewalks etc.

F. Cultural facilities (125 – 3125 years)
Cultural assets, either natural or artificial. Things such as monumental spaces.

G. Nature (3125–400.000 years)
Nature space, the site.

## 3.1.5 CRITICISM

Almost all of the metabolism grand urban plans remained on paper. Although the built cases of Metabolist buildings have survived for around 50 years, there still is insufficient studies on their problems and values after the construction (Hayashi, 2021). Historian Cherie Wendelken, voicing the opinion of other Western critics, writes that metabolism project seem not to acknowledge rightfully the location and context (Hayashi, 2021). Metabolism can become redundant once demolition gets favoured over renovation, regardless of the ease (Taro, 2018). Furthermore, the core has been usually built by the government and developers, who unfortunately have rarely been expanded and maintained due budget shortage, physical constraints (expansions) and conflicts between owners of the individual spaces. Considering a decentralized core could be of interest (Hayashi, 2021).

## 3.1.6 DEFINITION

Even though metabolism seems to have a singular definition, when looking at metabolism projects it seems to be a lot more plural. For example, the four seminal essays in the metabolism manifesto include the oceans city, material and man, towards group form and space city. Projects include also different themes, from megastructures to very small living units, from elements of buildings that can be replaced to making the whole unit reportable, from living in the air to living on the ocean, the use and making of artificial land and the notion of group form. The proposed own definition of Metabolism is:

Metabolism is defined by its fundamental in the cycle of change, its constant renewal and anticipating future changes through making the (prefab) dwelling re-adaptive. Re-adaptiveinterchangeable. InterchangeabilityReRe-adaptive includes having a structure and different components that can (easily) grow, transform, be attached and removed from the larger structure. These different components have different life cycles on purpose.

# 3.2 STRUCTURALISM

Similar to Metabolism, Structuralism also applied life systems to fill a gap between the space and time, past and future (Wanatabe, 2021). Both share similar fundamentals such as the importance of flexibility and growth. Furthermore, structuralist buildings also incorporate urban spaces such as streets, squares and public/private spaces in their buildings (Van Heuvel, 1992).

## 3.2.1 ORIGIN

Structuralism in architecture came the 1960's, when Team X broke with CIAM (Moerman, 2019). Members of teamX: Aldo van Eyck, Jaap Bakema, Dick Apon, Gert Boon, Joop Hardy and Herman Hertzberger started with the magazine Forum in 1946. The first issue, tited 'The Story of Another Thought', expressed their anti-institutional and humanistic design mindset with a program that was based on restoration the relation between human and environment. In the 1970's these ideas found fertile breeding ground, leading to the birth of Structuralism (Somer,2020; Aldo van Eyck designs the Burgerweeshuis in 1960, that can bee seen as the first counter form of the ideas as written in Forum(Elshout, 2010; Heuvel, 1992). Team X, created during the preparations for the 10th CIAM congress in 1959, demonstrated against functionalism (Maminski, 2013; Heuvel, 1992). The housing shortage in post-war Netherlands was met to the dissatisfaction of Team X by monotonous new housing estates with porch flats of a maximum of four floors high in strip allotment. Team X argued that quantity should take priority of quality (Maminski, 2013; Elshout, 2010). TeamX sought ways to enrich these ideas with concepts such as growth, change, identity, the human scale and mobility (Somer,2020).

## 3.2.2 PHILOSOPHY

Structuralism finds its fundamentals in non-hierarchical spaces that have the possibility to be changeable and expandable in combination with the human scale – meeting the needs of people and their everyday life. The thought behind this is that the architecture should represent interaction, growth and adaptation (Spoormans, 2021).

## 3.2.3 KEY CHARACTERISTICS

### 1. Invariant, universal and collective grid structure

The collective structure can be seen in the repetitiveness of each block and a sequence of often uniform units (Soderqvist, 2011; Somer, 2020; Moerma, 2019; Elshout, 2010). After determining the cellsize, this cell got doubled, multiplied, mirrored and/or stacked (Moerman, 2019). This leads to non-hierarchic spaces and order which serves the democratic living, where all units were equal rather than having a 'main' and 'serving' space (Spoormans, 2021). In stead of designing per exact m2 and function, it is designed with these space units (Hertzberger, 2022). The repeating elements theoretically allow for flexibility and expandability, as the pattern could be continued (Moerman, 2019).

### 2.The binary pairs

Binary pairs are being stressed in structuralism and include things such as open/close, outside/inside, private/public, nature/culture, individual/collective (Soderqvist, 2011; Maminiski, 2013). With regards to materialization, for the interior raw concrete and brick are commonly used, normally used for outdoors, to blur borders. With this same intention, indoor streets and squares were created, thus making the building both in and out regardless where the spectator is (Soderqvist, 2011).

### 3.Visible construction

Instead of concealing the construction behind masonry, plaster or other materials and therefore only showing the large volume, the construction is un-finished. The construction shows the user how the building is built and what is structural. This gives the user insight and reference into the actual dimensions, giving a recognizable measure(Elshout, 2010; Van Heuvel, 1992).

### 4. Meeting spaces their interlinks between the repetitive structure

As people are central, mutual encounters and user relationship patterns are emphasized (Smit, 2018). Great importance is also attached to the individual recognizability of their own spaces. These individual interventions are possible in the transition areas from home to outdoor spaces. For instance, as Herman Herztberger used in his designs, balconies that make the user able to either withdraw themselves in a protected corner or contact their neighbours by communicating over the parapet (Elshout, 2010). Overlapping the structures with bridges, open spaces and/or streets lead to more possibilities of spatial relations and functions. These overlapping spaces can either function as a 'glue' to create bigger spaces or as a 'border' to divide smaller spaces. This makes the building more flexible as this one system has the possibility to house multiple functions and address the diversity of spatial requirements. To relate to the human scale, the non-hierarcihcal structures are connected by these type of spaces for meeting and social interactions and thus making these 'big buildings' into 'small

cities' (Somer, 2020). Street-like features are organized around the building as well, creating relationships between the cluster of buildings (Soderqvist, 2011).

5. Mixed-use

Before structuralism, the mixed-use of buildings rarely plated a role in new construction as the client often requested specifically designed spaces for set age groups. In pursuit of varied life, structuralism also looked for the urban integration of multiple land use (Elshout, 2010; Maminski, 2013).

6. Growth

The growing notion of structuralism is in its extendibility in the form of adding another multiplication of the existing urban structure and with that becoming part of the city. This growing structure can then be repeated endlessly, like a crystal duplicating itself (Spoormans, 2021; Van den Heuvel and Frausto, 2021). The smaller units together are read as a collective. Because of the smaller units being able to be read as a collective, it makes it easier for the design of the building to accept deviations and/or expansions and still be viewed the whole as an entity (van den Heuvel and Frausto, 2012). Structuralism also has an expression of 'unfinished' work – containing to some degree of in-built openness for possible future changes (Soderqvist, 2011).

7. Polyvalence

Polyvalence is designing elements to have multiple uses. To give rise to extra activities, somewhat larger covered areas at corridor juctions are designed. Elements such as low walls, column feets, stairs and/or deep window sills can also contribute to multifunctional use.

## 3.2.4 RATES OF CHANGE

The rates of change and/or specific layers aren't mentioned in literature. However, in some sense rates of change are taken into consideration with regards to flexibility in terms of the multiplication of units and over dimensioning.

## 3.2.5 CRITICISM

Visibility of construction can't be as applied anymore in current context as structuralism did as energy efficiency becomes a norm and thermal bridges arose in visible construction (Elshout, 2010). Also it's that exactly the reason of repetitive modules that can work retroactive as it limits the possibilities of irregular forms or higher ceilings. Furthermore, wayfinding can become an issue with the configuration of many similar modules. Despite the characteristics of being an open structure and flexibility for future growth or adaptation, many of the structuralism buildings now seem to have difficulties being adapted as such with programmatic possibilities along with other shortcomings such as the indoor climate (van den Heuvel and Frausto, 2012).
If 'structuralism' is only reserved for those buildings that are both open to influences of inside and outside, and can accommodate towards these, many labelled structuralist buildings are actually very rigid and inflexible (van den Heuvel and Frausto, 2012).

## 3.2.6 DEFINITION

Structuralism wasn't defined right from the beginning, but was developed and adapted to developments of the society through the years. It is clear that structuralism signifies changeability, however there are different interpretations of the exact manner of this. Extreme variants of flexible architecture is even sometimes regarded as structuralism (Soderqvist, 2011). There is a tendency to call everything Structuralist once it has a clear grid and resembles a woven texture. It is correct to state that Structuralism is concerned with the multiplication and configuration of units in terms of spatial, communicational and constructional matters. However, it is too superficial to label buildings structuralist based of this only (Lüchinger, 1981; Soderqvist, 2011). Looking at definitions from both van Eyck (Forum, 1960 p29) and Hertzberger (Forum, 1973) they both define structuralism as a multiplication of units, creating a larger whole and enriching diversity because of the interplay of the separate units. However, Hertzberger adds also the notion of the difference of the structure with a long-life cycle and its infill with a short life cycle and the importance of rules that enlarge the amount of free space (Hertzberger, 2017). Herman Hertzberger also mentions that flexible buildings can lead to neutral architecture that is eventually suitable for nothing. He rather mentions polyvalent buildings, meaning the building has a certain form that itself doesn't have to change in order to be suitable for different functions (Hertzberger, 1996).
The proposed own definition of Metabolism is:

Structuralism is defined by its flexibility that manifests itself through the uniform, multiplied and repetitive grid structure of small units. The small units can be combined, added or left out to make a the larger unit as an entity and whole. The area within the small units are free from large fixed walls. Overlapping units can either be linked with bridges, open spaces and/or 'inner' streets or can border units.

# 3.3 OPEN BOUWEN

Structuralist buildings can be divided in two variants: the one that is generic in their design and thus allows change, relating to the structure and infill as formulated by John Habraken, and the other that has a specifically infill and repetition of that, creating a hermetic system, 'the aesthetics of number', as formulated by Aldo van Eyck in 'het verhaal van andere gedachte' (Heuvel, 1992). The structure–infill is discussed in Open Bouwen.

## 3.3.1 ORIGIN

'De dragers en de mensen: het einde van massawoningen' (the structure and the infill: the end of mass dwellings) is a manifest by John Habraeken in 1961 as a reaction to the manner of building mass dwellings after the 2nd world war in the Netherlands during the reconstruction. According to John Habraken, the prefab-houses gave no room for individuality (Brinksma, 2017; Overdijk,2009). Residents would be unable to develop themselves in these mass housing as it makes the house an object of use and the residents just the user. Habraken furthermore argues that architects and urban planners are not suitable for designing housing as they have no affinity with the wishes of the future residents. Personal contribution can be taken into account through free composition (determining little as possible beforehand), renewable of environment (residents should be able to take possession and adapting possibilities of their living environment) and time (as it takes more than a single generation to enables societies that become one with their environment) (Brinksma, 2017). In his book he suggests dwellings with a division between the structure (the structural framework) and the infill (everything else), leading to individual freedom within a collective framework. The fixed structural framework is done by the architect and parties, while the infill is free of choice for the inhabitants (Schwarz and Luthi, 2013).

## 3.3.2 PHILOSOPHY

Habraken saw participation as a paternalistic term that implies that professionals decide how the world is made and the inhabitants only have the right to be part of this world and participate, while in reality it's the other way around. The question is more to what extent can and should the architect participate in the built environment in order to make it better. Architects believed that the future was made-able and that they should form the community of the future with their designed buildings and cities (Schwarz and Luthi, 2013).

## 3.3.3 KEY CHARACTERISTICS

### 1.Structure and infill

For the structure – infill principle, clear size agreements must be made as the structure is not just the structural skeleton but rather the 'carrier'. The carrier thus must be designed in such a way that residents are given all space to place their infill elements (Brinksma, 2017). The structure and infill should be strongly seperated.

### 2. Integrating end-users by separating common and individual interests

Open Bouwen gives the possibility of maintaining human dimension in larger construction volumes as Habraken also espresses the importance of having recognizable inner streets, corridors and squares (Overdijk,2009). Constructive elements are of common interest. Infill elements are of individual interest (Brinksma, 2017). Other communal spaces such as the entrances, corridors, stairwells, spaces for meetings etc. are the architect's responsibility. As the urban planner isn't concerned with the architecture realised in the city, they rather produce a framework in which the architect can work, the architect should take a similar position (Havik, 2017). Individuality also (can) result in individual facades and this can be a certain addition to the city's public domain, making it part of the architects responsibility (Havik, 2017). Although it seems paradoxical that by choosing a clear theme and starting point, and by repeating this, variety is created instead a monotone framework.

### 4.Different type of organization

Open Bouwen is also about the relationship between the designers, developers, builders and users (Overdijk,2009; Quanjel, 2015). A connection between the type of influence, the type of parties involved and the type of used time should be established. Inhabitants need to feel responsible for the buildings since it will make people value their living environment better and therefore take better care of it. This feeling of responsibility can be achieved by designing their house according to their individual wishes and needs. Integrating the end-users in the designing has consequences for the construction process as it requires a different set of organizing and responsibility decisions (Quanjel, 2015). Also, usually the floor plan is the first thing that is designed during housing construction and this is exactly what Habraken wanted to get rid of. This different design method aroused resistance, especially because of political and legal reasons as the 1092 Housing Act has led to professionalization of the social housing sector, leaving little room for individual influences (Overdijk,2009).

### 5.Different lifecycles of elements

Open Bouwen prioritizes extending the lifespan of buildings along with creating healthy communities. This is done through separating the elements that have different life cycles in order to increase flexibility and adaptability. In order to extend the lifespan of building to at least 150 years, the load bearing structure needs to

be separated from the rest of the building such as the façade and the infills systems for installations, inner walls and the façade infills. Furthermore these infills need to be adjustable and demountable. Infill is done through co-creation with the future users, engaging users already in the early stages of the projects and making them a stronger sense of belonging and ownership (Open Building Co, 2020).

## 3.3.4 RATES OF CHANGE

From the principles of Open Bouwen that John Habraken developed, OpenBuilding.co , a group of Dutch architects, engineers and developers, continue integrating these principles into their designs where they advocate the physical and decision-making division between structure and infill with their different life cycles (Open Building co, 2020). OpenBuildingCo continues with the Shearing Layers of Change (1994) of Steward Brand, where Steward Brand states that in order to give people buildings that can easily adapt to the changing requirements, the change of the 'faster' building layer should not be hindered by the 'slower' layer. The building has different layers with each a different lifespan (Brand, 1995; Open Building Co, 2020). He extends the four shearing classifications S's of Frank Duffy to six: Site, structure, skin, services, space plan and stuff.

### Site (infinite)

Important notes here are the property rights, the deed of divisions, the freedom of function assignment (zoning plan) and the centralised connection to utilities (Open Building Co, 2020).

### Structure (30–300 years)

The structure is the most persistent part of the building (Brand, 1995). The layout should be freely adjustable where disconnectable walls, open floors, bay widths and vertical connections become important factors to be taken into account in order to lengthen the structure's lifecycle (Open Building Co, 2020).

### Skin (20–50 years)

The skin is the outer layer of the building with a lifespan of 20 years according to Steward and 50 years to Open Building Co. The skin can more easily go out of style and could be replaced every 20 years to keep up with fashion and/or technology (Brand, 1995). The skin should be easily demountable, divisible and adaptable. By using a double skin there is freedom of layout, behind an uniform façade appearance (Open Building Co, 2020).

### System/services (7–25 years)

The system/services are the installations such as the HVAC and elevators. These simply wear (technically) out in 7–15 years according to Steward and 25 years according to Open Building Co.

### Space (3–30 years)

The space plan is the inside of the building that is directly property of the user, and has a life cycle of 15 years according to Open Building Co and 3–30 years according to Steward. It's important for it to be demountable and adjustable. It has the possibility of a phased investment, a collective purchase and customized manufacturing (Open Building Co, 2020).

### Stuff (1–7 years)

The stuff are the most easily changed elements in a building, these include things such as furniture and changes usually per season or trends. For Steward this can be from 1 day to 1 month and Open Building Co 7 years.

## 3.3.5 CRITICISM

The infill-structure principle is applied to the Solids, which seems to face inefficiency as the Solid on Ijburg is partly vacant. The chance that the initiator Stadgenoot or other developers/landlords will build more Solids is not unlikely as it seems that the concept is too risky, too expensive and possibly too unsuitable for the core tasks of the corporations (Platform 31, 2013).

## 3.3.6 DEFINITION

Although the definition of Open Building seems straightforward in definition, it's still important to understand that it's easy to confuse it with other types of flexible building. Buildings with modularity, 'infill' principles, differentiation of lifecycle elements and/or the use of a grid, are not perse Open Bouwen building. Perhaps the most important part of Open Bouwen, is the resident participation and influence on the decision-making.

An own definition of Open Building can be as a combination of all stated above and therefore defined by having a structure (structural framework) and an infill (anything else), enabling individual freedom within a fixed framework through separating decision-making levels. The different elements (structure and infill) have different life cycles. And there is a certain grid used with marges.

# 3.4 SUMMARY

Table 1 shows an overview and summary of the theories as discussed. All the discussed elements per theory can be seen in figure 12.

Table 1: Summary Metabolism – Structuralism – Open Bouwen (own table)

| | Metabolism | Structuralism | Open Bouwen |
|---|---|---|---|
| Origin | Reaction and re-interpretation of European modernism<br>World Design Conference and Metabolism manifesto. | Reaction to CIAM's modernist approach (bureacractic, inhumane and brutalist) to housing, creation of Team X and Forum magazines | Reaction to prefab and standardization : no room for individuality and lack of personal resident input |
| | Post-war | Post-war | Post war |
| Characteristics | Adaptive building growth<br>systems: fixed system with interchangeable parts of core and individual parts | Collective grid structure in which adaptivity in within the structure | Division between structure (fixed structural framework) and infill (everything else) |
| | Re-new rather than grow through interchangeability of building | Sequence uniform, equal units | Invidiual freedom in collective framework |
| | Relationship between human, nature and technology | Interconnection between units with street like features | The structure (common interest) is for the professional and the infill (individual interest) is the responsibility of the resident |
| | Individuality user | Binary pairs, blurring borders | Integrating end-users in design process |
| | Cycle of change, re-newal, growth with no complete form: open scenario's | Grid with modules, based on a small unit a 'cell' that can be multiplied, mirrored or stacked. | Different life cycle structure and infill |
| | | Social interaction and relationships with a focus on facilitating equality and liveability | |
| | | Human scale and visible construction | |
| | | Polyvalence | |
| | | Mixed use | |
| Criticism | Insufficient studies on their problems and values after construction. Core rarely gets expanded and maintained. | Visibility construction leads to cold bridges | Concept seem too risky, too expensive and possibly too unsuitable. |
| | Doesn't rightfully acknowledge the location and context | Limited possibilities of irregular forms or higher ceilings | |
| | Can become redundant once demolition gets favoured | Wayfinding can become an issue and programmatic issues | |

Zooming a bit deeper in the rates of change, it can be seen that Structuralism doesn't include different layers and their durability. Metabolism and Open Building.Co both do with more or less similair amount of years and similair layers. It must be noted however that the Structure-Infill principle of John Habraken does not include rates of change of different layers other than the different between long term structure and short term infill. See table 2.

Table 2 : Summary and comparison rates of change in building layers (own table)

| | Structuralism | Steward | Open Building.co | Metabolism |
|---|---|---|---|---|
| Site | N/D | Infinite | infinite | 3,125 – 400,000 years |
| Structure | N/D | 30–300 years | 200 years | 10 – 125 years |
| Skin | Skin = structure, so idem | 20 years | 50 years | N/D |
| System | N/D | 7–15 years | 25 years | 5–25 years |
| Space | N/D | 3–30 years | 15 years | N/D |
| Stuff | N/D | 1 day – 1 month | 7 years | 5–25 years |

In order to boil down the summary to the most important key elements of the principles and definitions of Metabolism, Structuralism and Open Bouwen, each research theme as in the literature review (initiation, philosophy, key characteristics, rates of change and criticism) has been summarized with one branch. This is done so that it can be very direct and clear what each theory stands for. See figure 13.

# 3.5 CONCLUSION

To understand how characteristics can be linked to each other within a theory, it's worth diving deeper in each proposed definition. Figure 14 visualizes the connection between each key characteristic and how these can be linked or branched out within the theory. As can be seen at first glance is that all theories have are all initiated as a reaction to the post-war architecture. All three theories have three branches: a) individuality b) urban context and in the middle and most important c) re-adaptivity. The purple dots show the direct similarities. All three theories are centered around the branch 'open-ended', however have different approaches towards this. All three mention individuality of the user and have an empathic tone on social common spaces such as squares and streets. The green dots show the similair principle, but these have been approached in diverse ways. All three in essence propose a similar concept: having both a fixed and changeable component. In metabolism this is the core and cells, in structuralism this is the grid and cell units and in Open Bouwen this is the structure and infill. However, there are some important fundamental differences. In Metabolism the focus is on interchangeability and renewal rather than growing, while in structuralism this is more focused on growth (the multiplication of the units) with flexibility within the units. Open Bouwen doesn't focus as much on growth but rather individualism within the design and process of the resident's housing. This is also the biggest difference between structuralism/metabolism with Open Bouwen: Open Bouwen focuses highly on incorporating the direct new user into the process by accompany the floor plans with the residents and offering change and not so much growth. The cycle of change comes back in in both Metabolism and Open Bouwen : more or less the same themes and accounted years. Structuralism doesn't specifically mentions the cycle of layers, but shared same thoughts roughly on a long cycle (the fixed structure) and the short cycle (the infill).
Although the universal collective grid structure is a key characteristic to only Structuralism, this can be seen back in Metabolism and Open Bouwen as well. In Open Bouwen this is less obvious, as it's the grid of the structural elements that is then copy pasted to the next house. In Metabolism this can be more directly seen such as in the Nakagin Capsule Tower, Takara Beautillion Expo 70, Nitto Food Cannery. Furthermore, Structuralism and Metabolism both the use of prefab. Structuralism and Metabolism are closer to each other, than they are to Open Bouwen. What's interesting that Metabolism has a similar project as 't Karregat with their 'open structure tents', where the inside is free of spatial layout. Diagoonwonigen (Structuralism), Molenvliet (Open-Bouwen) and PREVI (Metabolism) are the three projects that come very close to each other – however this is an exception rather than rule. Visually it can also be seen that one theory might be more branched and thus more complex than the other. Open Bouwen is a relatively simple and easy understanable figure while Structuralism has the most branches.

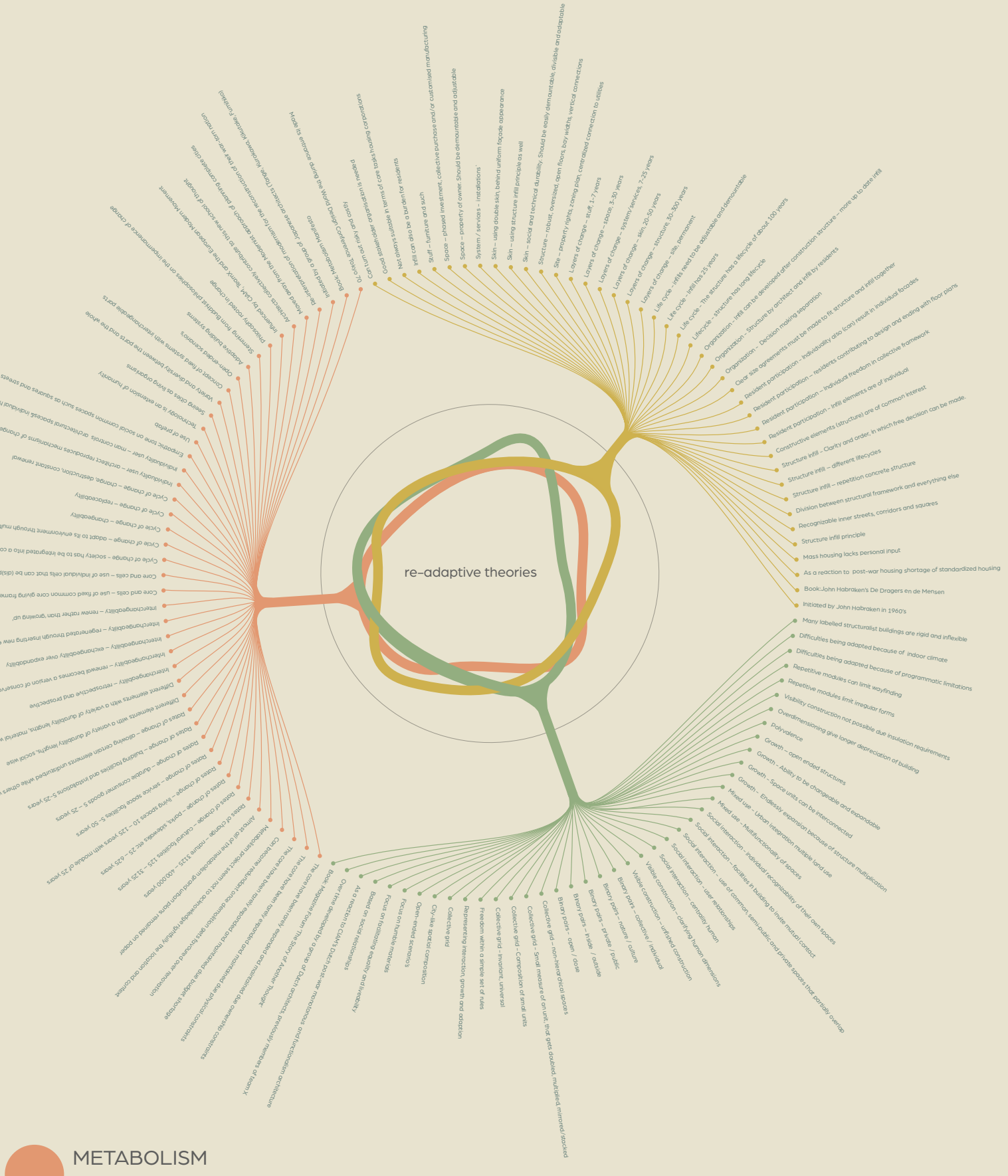
Perhaps the three theories are too different to melt them to one 'similair theory', but instead should be used as a combination of. Looking at the principles, Open Bouwen seems to be a simplified version of Structuralism and the Open Bouwen principles are already incorporated in Structuralism. The main difference is the resident participation in designing the floor plans. Although individuality seems the most strong in Open Bouwen, Structuralism has the heaviest branch. This is due to the fact that it incorporated inviduality in a 'softer' more philosophical way as it includes polyvalence, human dimensions and binary pairs.

Defining re-adaptive

As can be seen in figure 15 , fixed-change, open-ended, individualisty user and common spaces are reoccuring elements. Open-ended however is smaller in size since more an end-result of re-adaptivity rather than an element. Also, 'open-ended' is a vague term that is less concrete than the other elements. It can be seen that the key aspects of each theory are all very linked much to each other and there are only a very few very different elements. Initially, before the literature review took place the thought was that a) the three theories would overlap substantially enough for them to organically form one coherent theory and b) this being the definition of not only adaptive, but also re-adaptive. However, after the literature review we can see that a) the three theories differ more than they overlap and although they have similar fundamentals, their approach is different and that b) there is not a singular definition of adaptive and that c) re-adaptive is not defined at all. Therefore in an attempt to compose an definition of re-adaptive, as it's not defined in the literature review, an own definition is proposed. Re-adaptive can be defined by the combination of the definitions of Metabolism, Structuralism and Open Bouwen.

To take a position in this, a definition of re-adaptive is proposed:
Re-adaptive can be defined as the use of a structured grid system, marges related to this where interchangeability and expandability is possible through its core and/or multiplication. It has the possibility to add, remove or interconnect components of the building by using the structure and infill principle -and its differentiation of life cycles of the building layers - which also enablers the possibility for focus on personal individuality of the user with (possible) user participation. These elements give space for a dwelling to adapt (and re-adapt) to different functions and needs over time.

# (RE-) ADAPTIVE THEORIES



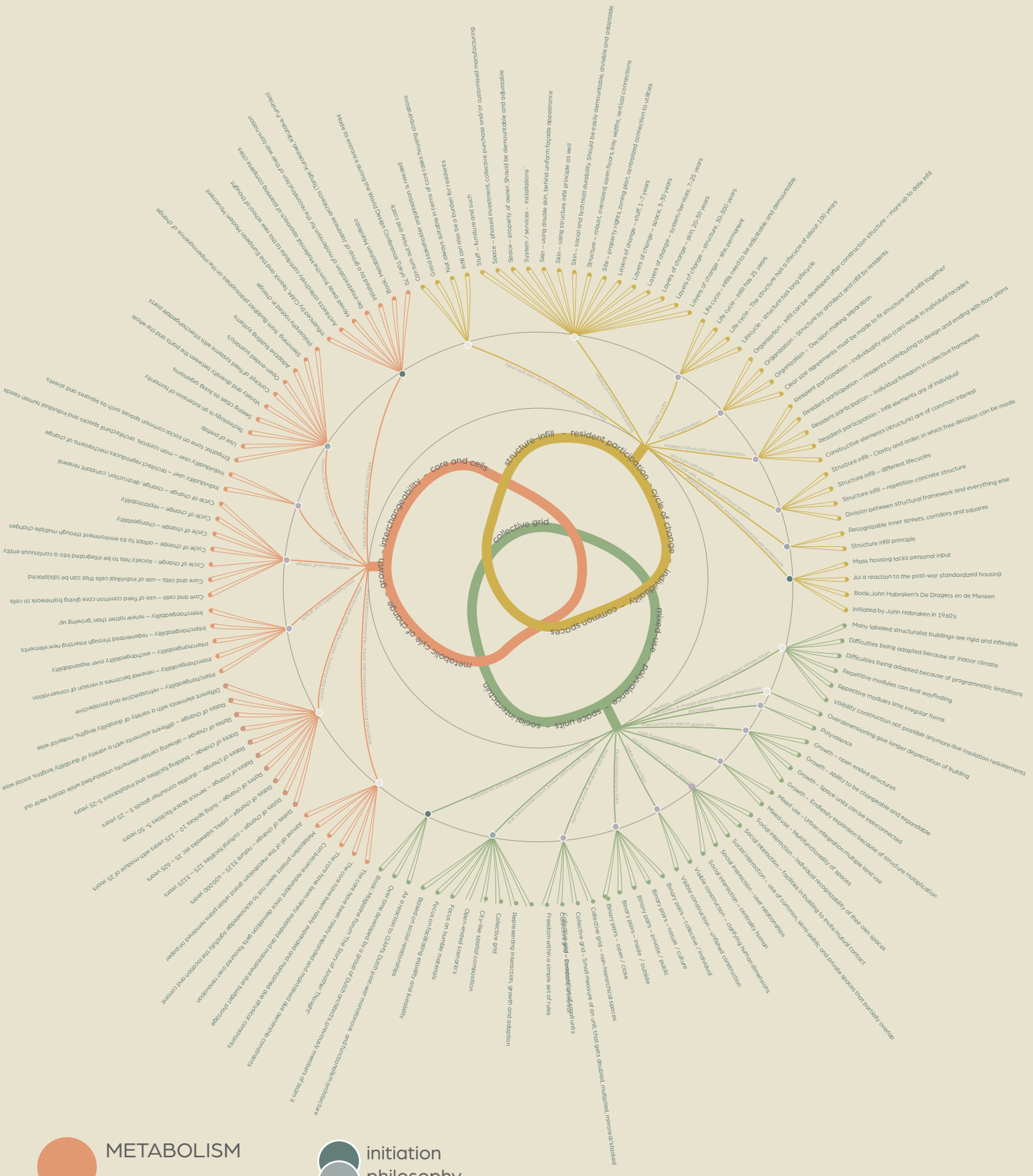

METABOLISM

OPEN BOUWEN

STRUCTURALISM

Figure 12: Overview principles each theory (own illustration)

# (RE-) ADAPTIVE THEORIES
# DEFINING DEFINITIONS




METABOLISM

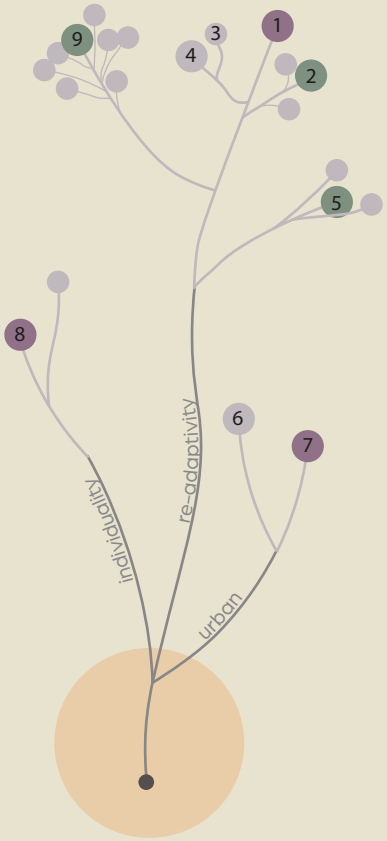
OPEN BOUWEN

STRUCTURALISM

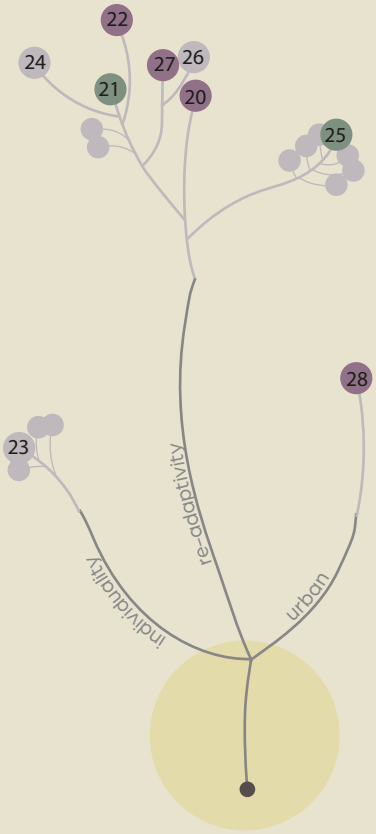
initiation
philosophy
key characteristics
rates of change
criticism

Figure 13: Overview principles each theory with key elements (own illustration)

## metabolism




## open bouwen





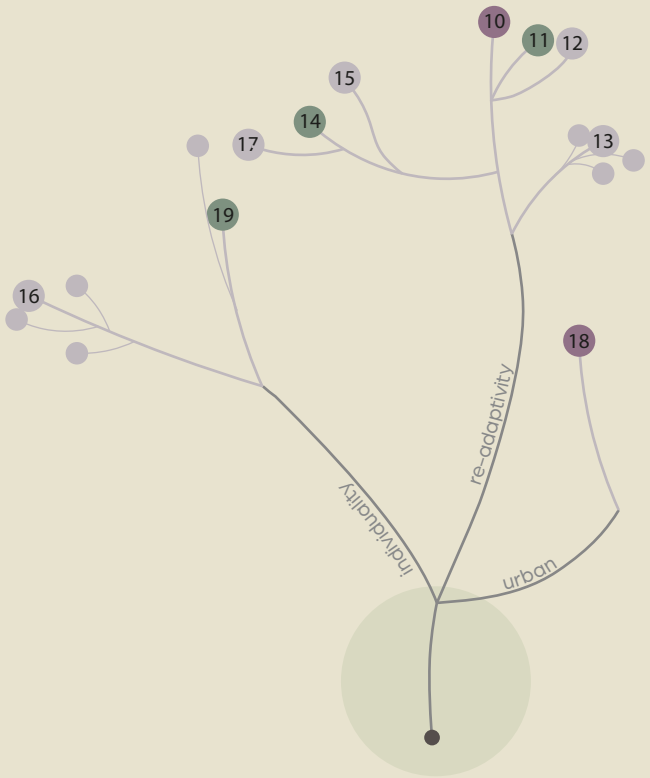

1 Open ended
2 Fixed and changing elements
–core and –cells
3 Renewal
4 Interchangeability
5 Adding or removing elements
–capsules –sky nets
6 City is an living organism
7 Common spaces (streets, squares etc.)
8 Individuality user –through created mechanism by architect
9 Metabolic rhythem cycle –installations
–consumer goods –service space –living space –traffic space
–cultural facilities –nature

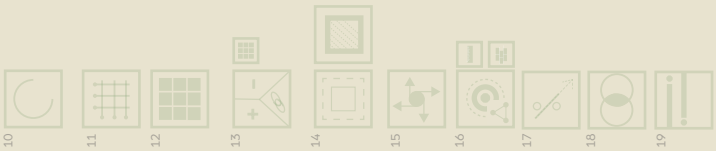
10 Open ended
11 Collective grid
12 Space units
13 Changing composition of space units –
interconnecting –adding – removing
14 Fixed and changing elements
–structure and inside
15 Polyvalence
16 Centrality human
–human dimensions –visible construction
–social interaction
17 Longer depreciation of structure
18 Common spaces (streets, squares etc.)
19 Individuality user
–collective/individual binary pair

Figure 14: Branching out elements per theory (own illustration)

# ID INTERCONNECTION

## structuralism




20 Open ended
21 Structure infill principel
-common/individual
-fixed/flexible
22 Grid, structure
23 Resident participation
-facade -floor plans -inifll
24 Decision making seperations
25 (Steward Brand's) lifecycle
-site -structure -skin -system -space -stuff
26 Adding or removing structure elements
27 Re allocation
28 Common spaces (streets, squares etc.)

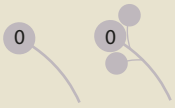
metabolism

structuralism

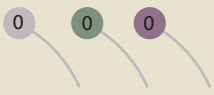
open bouwen

initiated as reaction to the post-war architecture

main branches
individuality
re-adaptivity
urban




characteristic with/without extra subbranch




applicable to 1 theory

applicable to multiple theo-ries/more or less similair

applicable to multiple theo-ries/the same

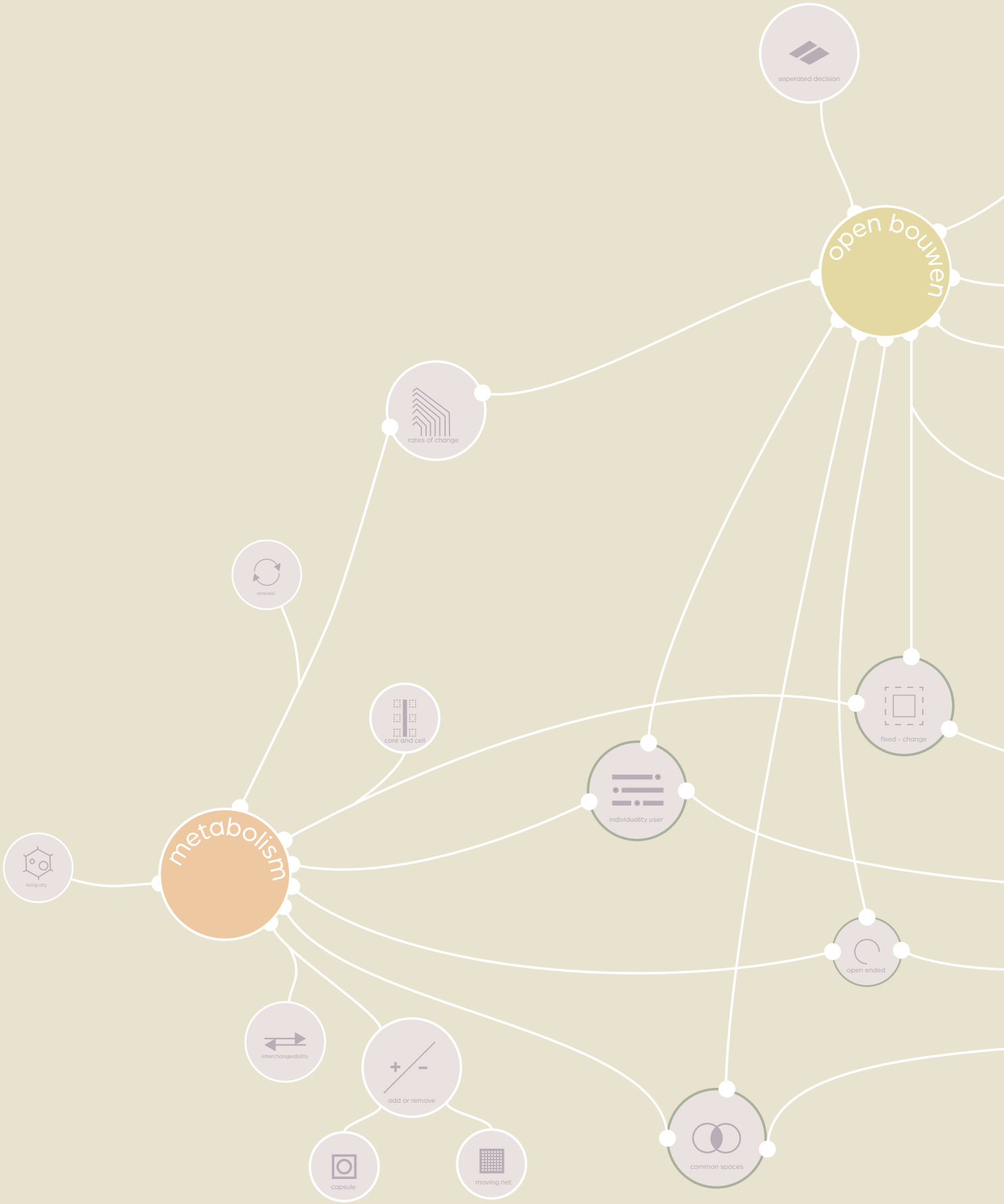
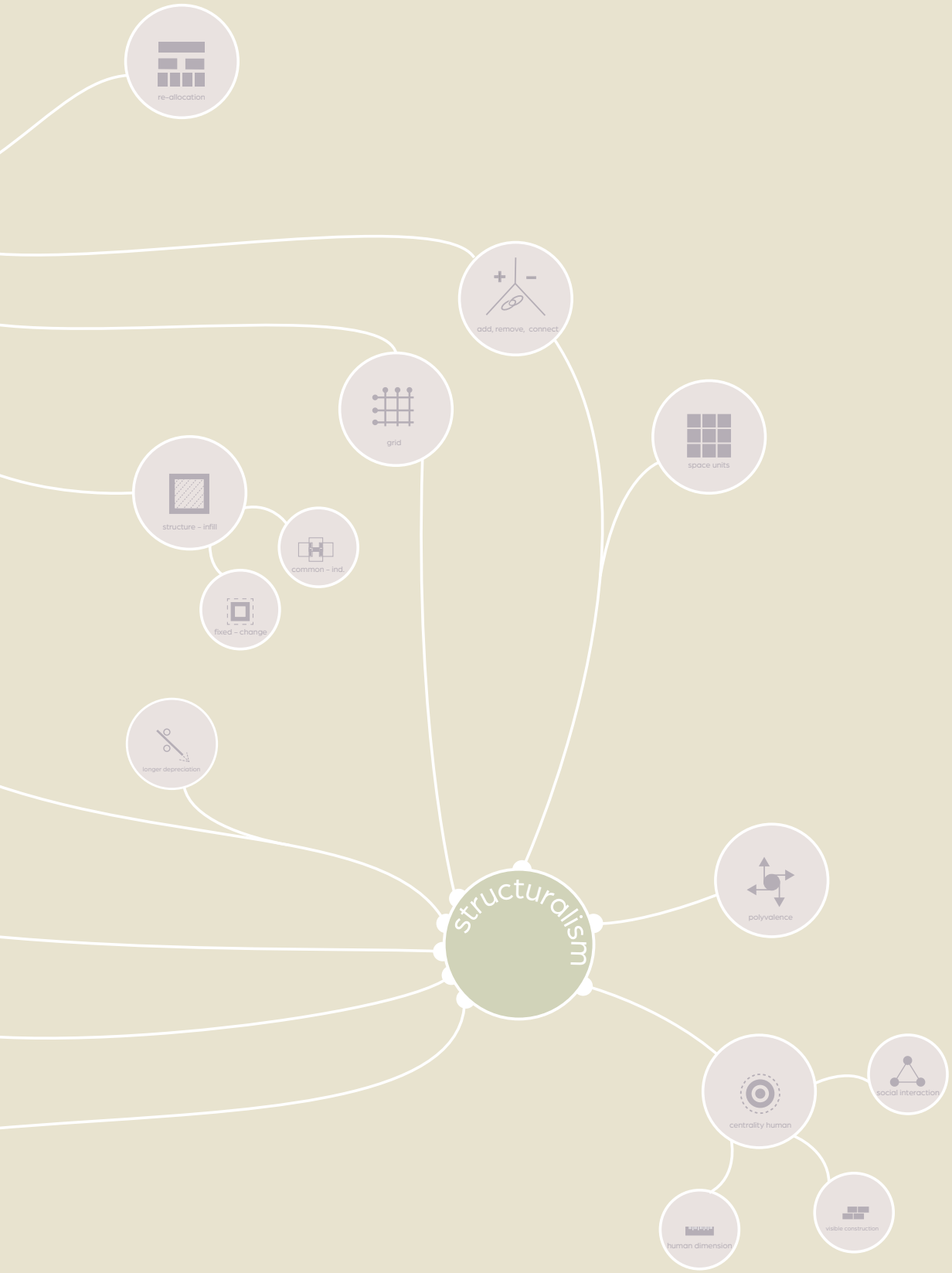



Figure 15: Attempt to defining re-adaptive (own illustration)

# RE-ADAPTIVE




- open ended
- renewable
- interchangeable
- fixed and flexible
- core and cells
- structure - infill
- living city
- common spaces
- polyvalence
- cycle of change
- depreciation structure
- centrality human
- human dimensions
- visible construction
- individual - collective
- resident participation
- seperate decisions
- re-allocation
- grid
- space units
- add, reject, connect
- add and reject
- capsule
- moving net
- theory
- linked to more theories
- linked to one theory
- link subelement

metabolism

structuralism

open-bouwen

# 4.THEORETICAL FRAMEWORK

Now that definitions for re-adaptivity have been proposed, case studies can be evaluated against this definition. Before that is done, it's important to know what exactly within these case studies will be researched. See figure 16.

The theoretical framework gives a framework in which the case studies can be investigated. Currently, there is no framework for re-adaptivity.
However there is one for adaptivity - FLEX 4.0. Therefore, FLEX 4.0 will be used. FLEX 4.0 will be adjusted slightly to filter out very specific elements.
Also, FLEX 4.0 doesn't touch on some elements as derived from the literature review. These will be added to the framework.

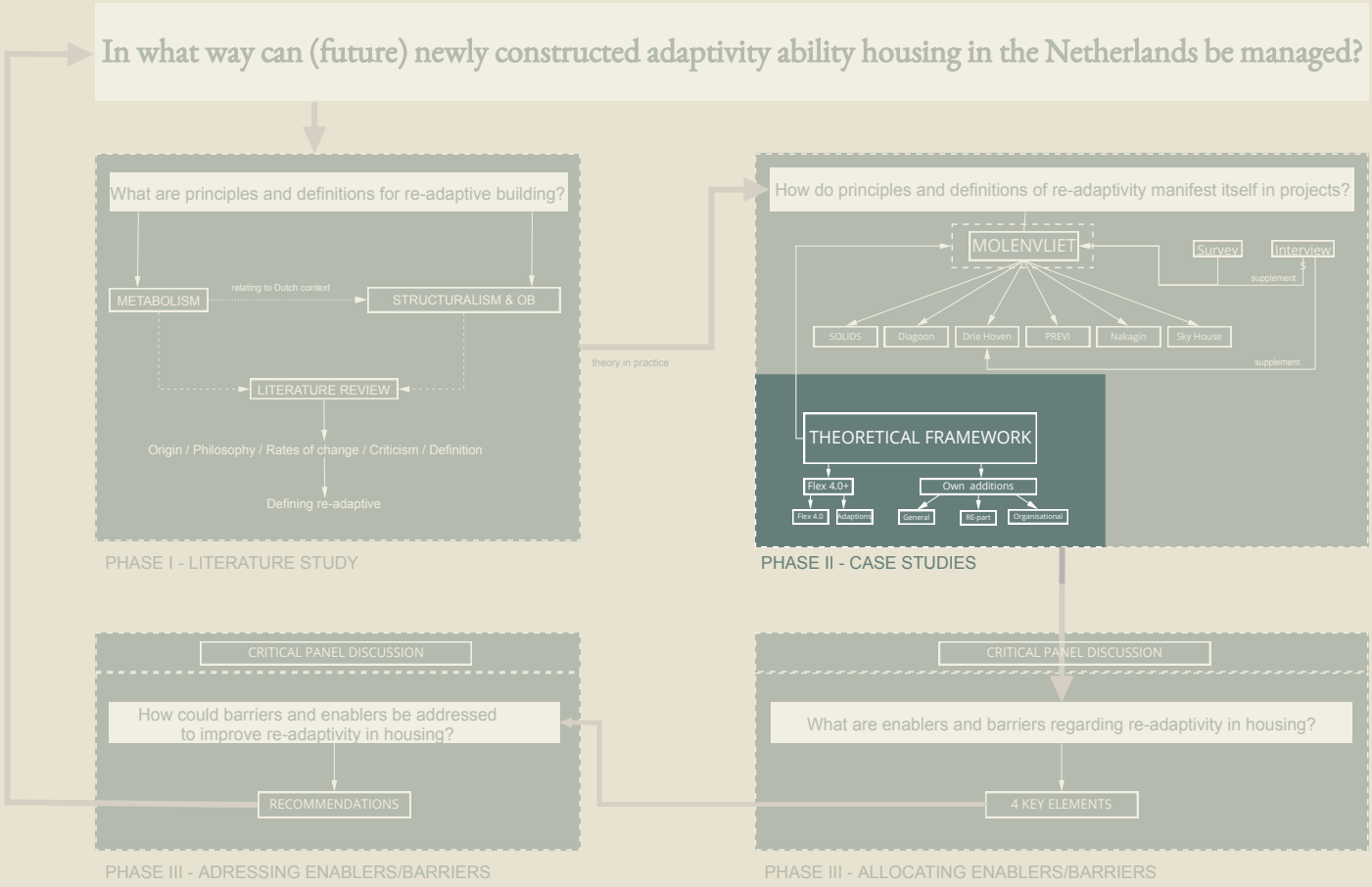



Figure 16: Research framework – phase II – theoretical framework (own illustration)

# 4. THEORETICAL FRAMEWORK

## SQ 2: How do principles and definitions of re-adaptivity manifest itself in projects?

AIM

In order to be able to answer SQ2, there is theoretical framework needed.
Now that the definition and key characteristics of each theory is explained, practice built cases can be analysed. To have a uniform and coherent analysation of each theory and their construction projects, a theoretical framework is needed. As re-adaptive is not a (strong) definition in literature yet, a framework for adaptivity will be used, as a basis. From which own elements, related to re-adaptativity and management, can be assed to this framework.

CONTENT

The content of this chapter is to introduce the theoretical framework that is used to analyse the main case study.

The fundamental idea behind FLEX 4.0 is the adaptive capacity of buildings, including their characteristics that enables the building to keep its functionality through the changing circumstances and requirements, during its technical life cycle and keeping it sustainable and profitable. However, FLEX 4.0 doesn't touch on some elements that arose during the literature review and forming of definition. Also regards to the 'management' part (things such as organisation and the building process, financing etc.) are not taken into account.

The theoretical framework therefore will consists of two parts:
A – The adjusted FLEX 4.0
B - Own additions.

SOURCES

The existing FLEX 4.0 by Rob Geraedts.
Literature review (previous chapter) and its proposed definitions of Metabolism, Structuralism, Open Bouwen and (re-)adaptivity.

This chapter starts with an introduction to the FLEX 4.0, then a mention and explanation of the adjusted elements. Lastly, as FLEX 4.0 doesn't include re-adaptive elements and organisational elements, an addition to the theoretical framework will also be discussed.

# 4.1 FLEX 4.0

## FLEX 4.0

The FLEX 4.0 is the latest version of earlier adaptive capacity assessment instruments by Geraerdts. The instrument was developed through an extensive international literature surveys on adaptive capacity, sustainability and financial real estate business cases. Along with this, a substantial number of professionals on both demand and supply side were consulted, leading to the updated version of the flexibility assessment instrument, the FLEX 4.0. It includes many flexibility key performance indicators and is partly based on the Support and Infill theory of John Habraken (Geraedts, 2016). FLEX 4.0 can be found in Appendix 2.

## ADJUSTMENTS

Questions that were too detailed have been taken out as this level of detail is not important for this research. It's important to note that this research is a first 'overview' of the possibilities rather than the exact numbers, such as the amount of capacity in kN and the fire resistance in minutes. These kind of more zoomed in analysis, can be later researched. Also questions that are dependable on the building size is also taken out. See table 3.

Table 3: Overview adjustments FLEX 4.0 to FLEX 4.0+ (own table)

| Concerning: | Issue | Solution |
|---|---|---|
| Layer site<br>Is about whether there is a surplus of space and if the location itself is capable of supporting multiple functions | But not about how the zoningsplan (bestemmingsplan) and the municipality can have an influence on this | Add new question:<br>2A. To what extent does the municipality have influence on the adaptability of a building? and<br>2B. What does the zoning plan says for this site and to what extent can this be changed? |
| 1. Does the site have a surplus of space and is the building located at the center? | Too specific Exact number too specific, take a more holistic view into account | Change into:<br>What does the area around it looks like?<br>How can the surrounding space (site) influence the building? How does the site level influence the building level? |
| 3.Does the building or user units have a surplus of the needed usable floor space? | Related mostly to structuralism – less related to Open Bouwen and metabolism | Still take into account, however be aware of this difference. |
| 4.What is the size of the usable floor surface? | Size of usable floor is dependable of the total size of building / units | Take out question |
| 5.Have positioning/measurement modular rules for constructions components been used? / 6.Has use been made of a horizontal zoning system, including intermediate margins? | Mostly related to Structuralism, to some extent to Metabolism. Less to Open Bouwen. | Still take into account, however be aware of this difference. |
| 7.Are sufficient stairs/elevators present in the building? | Dependable of type of building and size of building. | Take out and change into:<br>What are the horizontally and vertically moving elements (stairs, halls, lifts etc.) and how does this relate back to its adaptability of the building? |
| 9.How large is the load bearing capacity of the floors in the building? / 12. How many minutes is the fire resistance of the main load bearing construction? / 16. How is the thermal and acoustic insulation between the different storeys in the building?/ 19. How is the thermal and acoustic insulation quality of the façade of the building? / 21. Does the capacity of (the sources of) the facilities have a surplus capacity? | Too specific. | Take out |
| 27. Multifunctional building/units<br>Is the building capable to support different functions like offices, living, care and shops? | Answer to this more or less already is discussed in most of all the other questions –> whether certain performances support a rearrangement or transformation of functions, so the that the building can better meet the changing users' demand | Leave out. Not take this question into account. |

# 4.2 OWN ADDITIONS

FLEX 4.0 is more an tool to tests dwellings it adaptability in terms of architectural and building technical aspects. Although it's good and important to know what these things exactly are – what makes it technically and architecturally possible – the problem as stated before isn't necessarily this but rather the introduction of the re- aspect in re-adaptivity and the organisational part of it.
The re-part is important as an proposed definition of 're-adaptivity' is formed and this goes a step further than adaptivity. The organisational aspects are important as the research is especially about the link between theory and practice, with the practice mostly being with regards to organisational aspects of why (re-)adaptive housing is not a norm in Dutch housing construction.

## ADDITIONS

The FLEX 4.0+ doesn't touch on these elements and doesn't include a) general information about the project b)the re-part and c) organisational aspects.  Therefore these elements are added to an additional framework.

### General information

This is included by adding points in A and B (Origin/formation and an overview of the key characteristics.

### Organisational

This is included by adding points C till E (Process management, Decision-making, Financing).

### Re-part

This is included by adding points F and G (Rates of change and Opportunities to grow and shrink).

Furthermore points H and I are added. Point H (Criticism/ Evaluation) is added to make the theoretical framework less 'static' and fixed but rather to show the evaluation of the project to see what drawn lessons could be taken over time. Point I (Definition) is added to relate back to the definitions and theories as discussed in the literature review.

# 4.3 THEORETICAL FRAMEWORK

The framework therefore will consists of two parts:
A –  Own additions. See table 4 for the additions.
B – The total adjusted FLEX 4.0+. See table 5.

Table 4: Additions to FLEX 4.0+ (own table) - PART A (own table)

| | What's missing | Questions |
|---|---|---|
| A | Origin / formation | What was the initiative? Who took the initiative Why and for who was this build? |
| B | Overview of the key characteristics | What are the key characteristics of the building? |
| C | (Process)management | What was the tender phase, design phase, construction phase, maintenance phase like? What were uncommon ways of working, and/or difficulties during those phases? What turned out to be functional and what not? |
| D | Decision-making | What is de decision-making structure? What are the decision processes like? |
| E | Financing | How was the project financed? Was this sold or rent? Was it sold/rent quickly? Were there any selling points? |
| F | Rates of change / Life cycle | When dissecting the building, what are the different life cycles of the building elements? How are the layers of change (as discussed by Steward Brand) included in the project? |
| G | Opportunities to shrink or grow | What happens if you want to change (either interior-wise, exterior-wise, grow, shrink or just relocate areas) of the house? Once a resident want to grow their dwelling by extra rooms, how can this be met and what is the process behind this?  Once a resident want to shrink their dwelling by extra rooms, how can this be met and what is the process behind this? |
| H | Criticism / Evaluation | What is the criticism or  evaluation on the building, after completion and use? |
| I | Definition | How does the building relate to the proposed definitions made in the literature review? |

Table 5: Total FLEX 4.0+ (own table)

| Layer | Sub layer | Flexibility Performance | Assessment values | Remarks |
|---|---|---|---|---|
| 1.SITE | | 1.Surplus of site space<br>What does the area around it looks like?<br>How can the surrounding space (site) influence the building? | [more open and explorative'] | The more surplus space on site, the better the building can be expandable horizontally |
| | | 2.Multifunctional site/location<br>Is the location capable to support more functions, like offices, living, care and shops? | 1. Just one<br>2. Two functions<br>3. Three functions<br>4. >3 functions | The more a location around a building supports more different functions of the building, the more a building can easily be rearranged or transformed to other functions |
| | | 2A & B<br>To what extent does the municipality have influence on the adaptability of a building? | 1. Influence in terms of restricting it.<br>2. Doesn't take adaptability into account.<br>3. Promotes it, however not actively<br>4. Influence in terms of funding, zoningplan etc. Is in favor of. Not restricting. | The more a location around a building supports more different functions of the building, the more a building can easily be rearranged or transformed to other functions |
| | | | | |
| | | What does the zoning plan says for | 1. Very limited and rigid.<br>2. Very limited, however open for change<br>3. Is open to large variety, however not everything<br>4. Can be anything, no requirements | |
| 2. Structure | Measurement | 3.Available floor space of building<br>Does the building or user units have a surplus of the needed usable floor space? | 1. No, no surplus at all<br>2. 10–30%<br>3. 30–50%<br>4. >50% | The more surplus, the more easily it can be rearranged or transformed into other functions, the better the building can meet to changing user demands |
| | | 5. Measurement system<br>Have positioning/measurement modular rules for constructions components been used? | 1.No rules for modular coordination<br>2.<50% implemented<br>3.>50%<br>4.>90% | The more project independent, demountable and replaceable construction components have been implemented, the more easily a building can be rearranged/transformed to other functions |
| | | 6.Horizontal zone division/layout<br>Has use been made of a horizontal zoning system, including intermediate margins? | 1.No zoning system without margins<br>2.10–30% intermediate margins<br>3.30–50% intermediate margins<br>4.>50% intermediate margins | To more margins are used in the zoning system of the building, the more easily a building/unit can be rearranged/transformed to other functions |
| | | 7. Presence of stairs/elevators<br>What are the horizontally and vertically moving elements (stairs, halls, lifts etc.) and how does this relate back to its adaptability of the building? | [more open explorative] | The more stairs/elevators are available in the building, the more easily a building/units can be rearranged, rejected, extended or transformed to other functions |
| | | 8. Extension/reuse of<br>Is there a possibility to add new stairs/elevators to the building and reusing the existing ones? | 1. Not without drastic expensive measures<br>2.Can be accidently added and existing reused<br>3.Can be limited added and existing reused<br>4.Can be easily be added without drastic measures | The more stairs/elevators are available in the building, the more easily a building/units can be rearranged, rejected, extended or transformed to other functions |
| | Construction | 10.Shape of columns<br>How are the columns in the building shaped? | 1. Round shaped and/or have vertical different sizes<br>2.Octogonal shaped<br>3. Rectangular shaped<br>4. Square shaped | The less deviate from a square column, the better a building/units can be rearranged |
| | | 11.Positioning of facilities zones<br>Are facilities zones and vertical shafts located at central building level and/or local unit level? | 1. All located at central level<br>2. Located at central level and occasionally local level<br>3. Located at central level and limited at local level<br>4. Located at central level and at local level as well | The more facility zones/shafts are located at unit level, the easier a building can be rearranged, transformed to other functions |
| | | 13.Extendible building/units horizontally<br>Is it possible to expand the building horizontally for new extensions to the building/user unit? | 1. Not possible at all<br>2. Very limited possible, only at one side<br>3. Limited possible, at more sides<br>4. Easily possible, at all sides | The more a building/unit can be expanded, the easier a building can be rearranged or transformed to other functions or expanded, the better a building can meet the changing user demands. |
| | | 14.Extendinable building/units vertically<br>Is it possible to expand the building vertically, for adding new floors or a new basement? | 1. Not possible at all<br>2. Limited possible, only a few units<br>3. Possible after total rearrangement<br>4. Possible | The more of a building can be vertically expanded, the easier a building can be rearranged or transformed to other functions or expanded, the better a building can meet the changing user demands. |
| | | 15.Rejectable part of the building/unit<br>Is it possible to reject part of the building for selling/renting to third parties? | 1. Not possible at all<br>2. Possible to reject 10–30% of the building/units<br>3. Possible to reject 30–50% of the building/units<br>4. Possible to reject >50% of the building/units | The more a building can be vertically rejected, the easier a building can be rearranged or transformed to other functions or expanded, the better a building can meet the changing user demands. |

| | | | | |
|---|---|---|---|---|
| 3. Skin | Facade | 17.Dismountable façade<br>To what extend can façade components be dismantled in case of transformation? | 1. Components can't/hardly be dismantled without demolition<br>2. Small part can be dismantled (>20% < 50%)<br>3.Large part can be dismantled (>50 % < 90%)<br>4. All façade components are easily dismountable | The more façade components are easily dismountable, the more easily a building can be rearranged or transformed to other functions. |
| | | 18. Location/shape daylight<br>In what way are the façade/daylight openings positioned and shaped? | 1. Large closed surfaces<br>2. Small horizontal open surfaces<br>3.Large open surfaces, with different heigh sizes<br>4.Large continuous horizontal open surfaces, connections according to planning grid | The more regular open surfaces in the façade according to the planning grid, the better a building can meet changing demands in functions, quality and finishing of the building |
| 4. Facilities | Measures and Control | 20. Measure & control techniques<br>Is it possible to control/measure facilities on building level as well on user unit level? | 1.Takes place only at central building level<br>2.On central level and occasionally on unit level<br>3. On central level and limited on unit level<br>4. On central level and completely on unit level | The more possibilities for measurement and control of the facilities on unit level, the more easily units in a building can be rearranged or transformed to other functions |
| | Distribution | 22. Distribution facilities<br>Does the building have a specific distribution facility for hot/cold water, heating, cooling, gas? | 1. One for all different sources<br>2.For some of the different sources<br>3. For two of the different sources<br>4.No specific distribution | The less specific distribution equipment facilities have, the easier a building can be rearranged or transformed to other functions, the better a building can meet changing user demands |
| | | 23. Location sources facilities<br>What is the location of the central facility sources? | 1. Located at only one central location<br>2. Located at several locations<br>3. Located at a central location and decentred location<br>4. Located outside the building at city level (district heating) | The more facility sources are localized at decentred level, the easier a building can be rearranged or transformed to other functions, the better a building can meet changing user demands |
| | | 24. Disconnection of facility<br>Can the compoinents of the facilities be easily disconnected? | 1. Can't be disconnected or demounted<br>2. Hardly be disconnected or demounted<br>3. Partly be disconnected or demounted<br>4. Can be disconnected very easily and completely demountable | The more facility parts can be disconnected or demounted, the easier a building can be rearranged or transformed to other functions, to better it can meet changing user demands. |
| | | 25. Accessibility of facility<br>To what extend are facility components good accessible? | 1. Hardly or not accessible (eg concreted in)<br>2.Limited accessible (partly on support and infill level)<br>3. Good accessible (lot on infill level)<br>4. Very good, most components at infill level | The higher the accessibility of facilities components, the more easily units in a building can be rearranged or transformed to other functions, |
| | | 26. Independence of user units<br>In what way are the user units independent related to services as pantry, toilet facilities? | 1. No services available at user unit level<br>2. 1–2 services available<br>3. 2–4 services available<br>4. >4 services available | The more services are available at unit level, the more independent the units are opposite other units in the building, the more they meet individual user demands. |
| 5. Space | Technical | 28. Disconnectable, removable<br>To what extent are the user units in a building removable, relocatable? | 1. Is not removable, relocatable<br>2. Only relocatable with drastic expensive measures<br>3. Units are easy relocatable, constructed with demountable components<br>4. Easy relocatable, constructures with 2d/3d modules, transportable by road | The more the units consist of demountable and reusable components, the better the units are relocatable to another location in our outside the building |
| | | 29. Disconnectable, removable<br>To what extent are inner the walls in the building easily replaceable? | 1. not replaceable without drastic/expensive interventions<br>2. Not replaceable, but good destructible<br>3. Replaceable by dismantling and rebuilding at another location<br>3. Easily replaceable without radical/expensive interventions | The more inner walls can be easily replaced, the more easily a building can be rearranged or transformed to other functions, the better a building can meet to changing user demands |
| | | 30. Disconnectable connection detail<br>Which detailed construction is applied between the interior walls and support structure and façade? | 1. Penetrating connections<br>2. Wet connections (mortar, sealant, glue)<br>3. Bound connection elements<br>4. Unbound dismountable connections | The easier the connection of interior walls can be dismounted, the easier a building can be rearranged or transformed to other functions |
| | | 31. Possibility of suspended ceilings<br>Is it possible to apply suspended ceilings and to adapt these to the different user demands? | 1. Results in free floor height of <2.60 m<br>2. Results in floor height of 2.5 – 2.7 m<br>3. Results in floor height 2.7 – 2.8 m<br>4. Results in floor height of > 2.8m | The higher the free storey height, the better the building can meet the changing demands concerning functions, facilities, finishing and quality of the building |
| | | 32. Possibility of raised floors<br>Is it possible to apply raised floors and to adapt these to the different user demands? | 1. Results in free floor height of <2.60 m<br>2. Results in floor height of 2.5 – 2.7 m<br>3. Results in floor height 2.7 – 2.8 m<br>4. Results in floor height of > 2.8m | The higher the free storey height, the better the building can meet the changing demands concerning functions, facilities, finishing and quality of the building |

# 5. CASE STUDIES

Now that the theoretical framework is discussed, the case studies can be researched according to this framework. There is one main case study and multiple ‘smaller’ case studies. The case studies are also additioned with interviews and a survey. From the case studies, enablers and barriers can be noted. See figure 17.

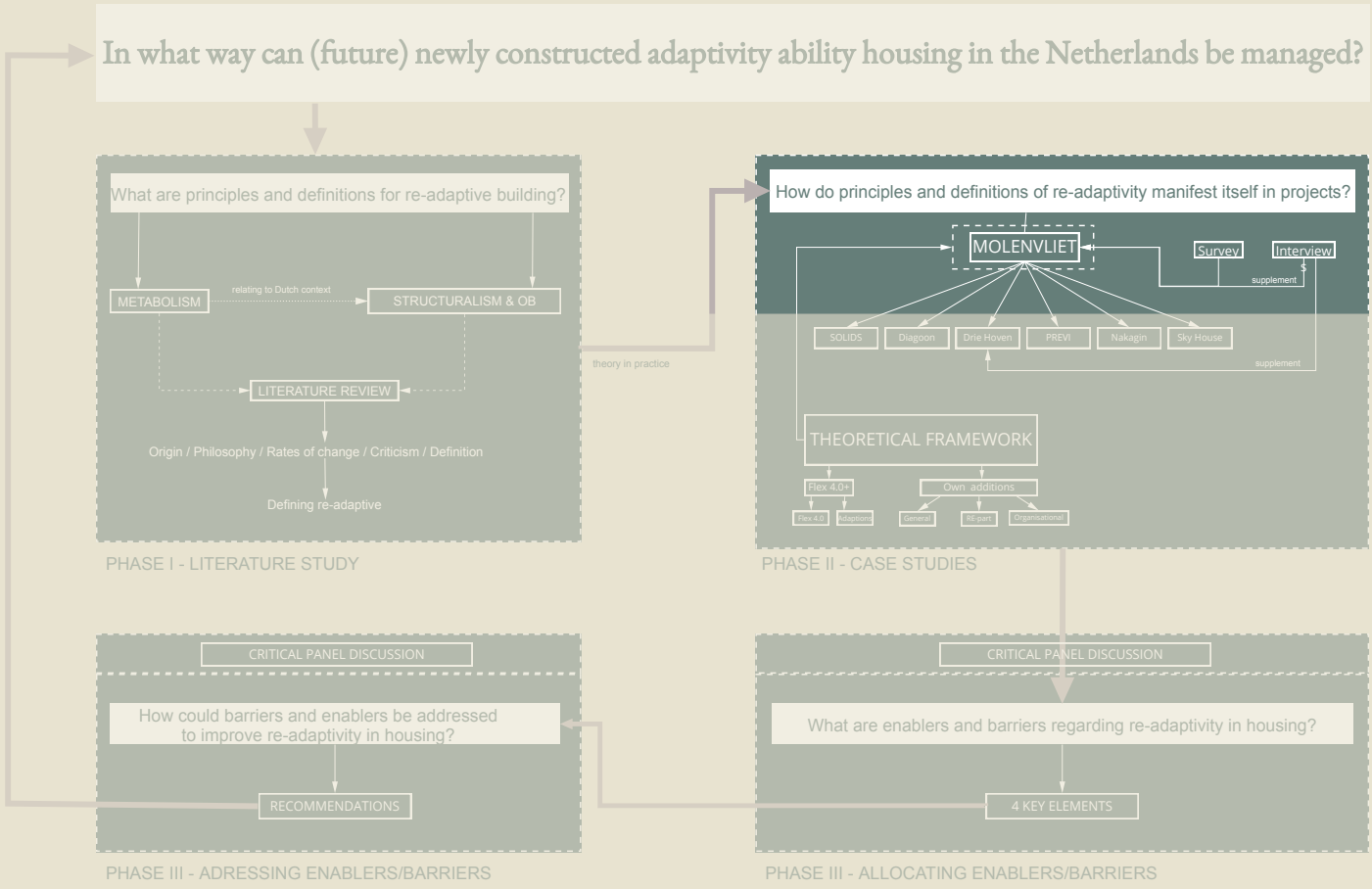



Figure 17: Research framework – phase II – case studies (own illustration)

1.

# 4. CASE STUDIES

## SQ 2: How do principles and definitions of re-adaptivity manifest itself in projects?

AIM:

Precedents will be analysed through the literature review and theoretical framework. The aim of this is to get a better understanding of how theoretical ideas manifest itself into actual built projects and to gain an understanding of different elements and their barriers and enablers. Not only to see how theory is put in practice, but especially where the differences lie. It proposes the use of unique or deviant situations to improve on current ideas, which could be a potentially useful approach of improving theories. Deviant or unusual situations are particularly intriguing using the method since they allow for the development or extension of ideas. The main objective is to refine, reconstruct or test the theories as stated in the theoretical framework (Small, 2009).

CONTENT:

This chapter includes the analysation of case studies according to the theoretical framework. The case studies are also supplemented with interviews from two related architects and a survey.
This case study part consists of two parts:

A : The main case study
The Molenvliet project is chosen for this because it is an experimental housing project (thus giving it extra ordinary possibilities), based in the Netherlands (in Dutch context and can be visited), still in use (giving the possibility to gain information from current residents and to evaluate it), and contact with the architect (ability to conduct an interview) and has other of the many characteristics of the theories such as: low rise high density, structure-infill, resident participation, use of grid and principles for adaptivity.
The main case study will be analysed as stated in chapter 3: the theoretical framework.

B: The comparative case studies
Although Molenvliet touches many surfaces of the theories in the literature review, it still misses some elements such as: polyvalence, core and capsule and direct growth of dwelling. Therefore some smaller, less elaborative, case studies are added. These are comparative case studies that 'hooked' on to the main case study, to show additional or different angles. To be able to place case studies next to each other, they must be fundamentally comparative and therefore similar in important aspects. The comparative case studies include an overlap with Molenvliet (similarities), so these can be compared to each other. The similarities are: build with the idea of adaptivity and within one of the three theories (Metabolism, Structuralism or Open Bouwen), has experimental characteristics (out of the ordinary) and it is a housing project. The main aim of the comparative case studies is to find the differences in terms of the way adaptability is incorporated in housing. It's interesting to see where the similarities and differences lie, and which extra teachings can be derived from this.

These studies are more explorative and have the following structure: project information, key characteristics, evaluation/current context and it also ends with a summary table of the enablers and barriers. Note that some comparative case studies might be a bit more elaborated than others, this is due the amount of information that can be found.

SOURCES:

A: MAIN CASE STUDY
Other than the architect's website (www.vdwerf.nl) and a short overview on OpenBouwen.Co, there wasn't much online substantial information about Molenvliet.

1. Books
Therefore two books have been used of the book series 'Experimenteren in woningbouw' (experimenting in housing) by the Ministerie van Volkshuisvesting en Ruimtelijke Ordening (ministry of on housing and urban planning) on the Molenvliet Papendrecht
1. Serie D nr. 22s : 'Samenvatting bewoners onderzoek' (summary resident research) by A. Gothink, 1979. This book is an evaluation and resident research.
2. Serie C nr. 3 : 'Project onderzoek' (project research) by J. Kapteijns, T. van Rooij and M. Monroy, 1978. This book is an explanation of the Molenvliet project.
Furthermore another book is also used that contains lots of project information on the plan development of Molenvliet. This book is
3. 'Dokumentatie bouwtechniek woningbouw Molenvliet te Papendrecht' (documentation building technology), 1979. Only chapter 4, written by F. van der Werf, of this book is used. Chapter 1 till 3 are related to another project. Chapter 5 is about architectural detailing and chapter 6 is about SAR 65, thus too detailled to use.

2. Interview
On march 8th 2022 an interview is held with the architect of Molenvliet: Frans van der Werf with a duration of 2 hours. This is done to gain additional insight and information from the architect. Also it's interesting to see how the architect looks back on Molenvliet after 45 years since completion.

The interview information is included in the case study and not a separate chapter. For the sent documents to the architect (informed consent, interview protocol, interview questions, explanation of research) see Appendix 3 and Appendix 4. The architect prepared the questions beforehand in a document, which he send later. This can be found in Appendix 6. During the interview, we discussed the questions and answers.

The transcript then got analysed with Atlas Ti, with the following codes, that are the same subheadings of the theoretical framework and thus the Molenvliet case study: Initiative / Structure & Infill – key characteristic / Resident participation – key characteristic / Residential environment – key characteristic / Grid – key characteristic / Tender – process management / Design phase – process management / Construction phase – process management / Operation phase – process management / Maintenance phase – process management / Decision making / Financing / Rates of change / Opportunities to grow and shrink / Evaluation. This is done so that interview information can be directly incorporated into the theoretical framework.

Furthermore, during the interview the architect also mentioned other case studies and just in general other stuff, other than the previously mentioned codes. Thus, two extra codes were used: 'comparitive case studies' and 'other'. The annotations with the same codes got put in an excel, where they got summarized and incorporated in the case study text.

3. Survey
A survey has been chosen over interviews as the expectation would be that people would faster fill in a quick survey than conduct an interview – especially when these people are not related to academics or the build environment. The limitations are however that it is reduced in length, in order to try to maintain a high(er) response rate.

The set out survey was not a selected survey, but rather to all the 122 residents. A flyer with a QR code has been printed and put in their physical mailbox. This is done because they e-mail addressed were not known and they would see the flyer the moment they open their door. On every flyer, also a small haribo candy bag was stapled, in the hopes that residents would respond more likely.

The amount of responses was 9 residents.
However those responses can not be considered reliable as generalization, of all residents. It has an inbuilt and uncounted for bias, as the small amount of respondents might have different attitudes than the non-respondents. The obtained inferences can't be adjusted in any way since there is nothing known about the non-respondents. Furthermore, no surveys have been set out to other project so even if the survey would obtain a 100% response rate, it might still be an atypical situation. So it's important to note that this is in extension of the evaluation of the Molenvliet project in the current context, and not a finding on its own.
See Appendix 7 for the flyer, the survey questionnaire and the survey data.

B: COMPARITIVE CASE STUDIES
1. Books
Structuralism: The same books as the literature review (Structuralism in Dutch Architecture and The Future of Structuralism), with the addition of Architectuur en Structuralisme by Herman Hertzberger (recommended by Herman Hertzberger before interview).
Metabolism: The same books as the literature review (Metabolism in Architecture and Project Japan:Metabolism Talks).

2. From the DOCOMOMO conference 2021 papers
Chapters from the DOCOMOMO (The 16th International Conference Proceedings DOCOMOMO: Inheritable Resilience - Sharing Values of Global Modernities). The following theme's were used: 3b PREVI The Metabolist first, last and only project; 9-b Metabolism Reconsidered: How Can Our World Be Renewed?- Re-reading Metabolism through the reuse projects of its legacy and 9-c Metabolism Reconsidered: Learnings from Before and After Metabolism.

3. Interview
For Structuralism, Herman Hertzberger got interviewed on April 5th 2022, with a duration of one hour. Herman Hertzberger is a very established architect within Structuralism and the architect of De Drie Hoven,

Studentenhousing Weesperstraat and de Diagoonwoningen.

The interview information is included in the case study and not a separate chapter. For the sent documents to the architect (informed consent, interview protocol, interview questions, explanation of research) see Appendix 3 and Appendix 4. During the interview, we discussed the questions and answers.

The transcript then got analysed with Atlas Ti, with the following codes: Barrier / City-like spatial organisation / De Drie Hoven / Diagoonwoningen / Enabler / Geometric floorplan / Polyvalentie / Re-adaptivity / Resident freedom / Resident participation / Shrink and Grow / Social interaction / Structure-infill

These were re-occuring themes. The annotations with the same codes got put in an excel, where they got summarized and incorporated in the case study text.

Furthermore, Certitudo Developers were also contacted to gain general information about redeveloping structuralist buildings as Certitudo is redeveloping Herman Hertzberger's Centraal Beheer Gebouw. However, they stated they can't provide further information as the project is in early stages.

For Metabolism, contact has been attempted with Kisho Kurokawa architects (in terms of the Nakagin Capsule Tower and the Sky House), however no response has been given. Also, contact has been tried to make with Tatsuyuki Maeda (Nakagin Capsule Building Preservation and Regeneration project), but he has given the information that the building will be demolished and a new building unrelated to the capsule tower will be built. The capsules will be removed and donated to museums or used as capsules to stay. That is all he could say for now.

4. Evaluation report
With regards to the Open Bouwen's case study Solids, the evaluation report of Platform31 'De Onbekende Toekomst Huisvesten' (housing the unknown future), 2013 is used. This independent evaluation – conducted by Inbo – was prepared with a lot of outside input. Stadgenoot (owner of Solids) carried out its own evaluation of the development of the concept. In addition, Inbo was commissioned by Stadgenoot and Platform31 (previously: Stuurgroep Experimenten Volkshuisvesting) to evaluate the experiences of the first tenants in Solid 11 and Solid 1 and 2. Finally, the preliminary results from both evaluations were also presented to a broad group of experts from the real estate world.

5. From databases
In order to also make the research more explorative and less biased, information from databases were also used by searching on direct relevant searching terms. The used databases were Google, Google scholar, ResearchGate and the TU Delft Repository, with using the following search terms: structuralism case study, structuralism housing, structuralism Netherlands, structuralism evaluation, De Drie Hoven, De Drie Hoven demolition, Weesperstraat housing Structuralism, Diagoonwoningen, Diagoon structuralism, PREVI metabolism, Nakagin Capsule Tower, Nakagin Capsule Tower case study, Nakagin Capsule Tower analyse, Nakagin Capsule Tower demolition, Sky House, Sky House Kikutake, Sky House Metabolism.

This chapter starts the main case study Molenvliet, followed by the Comparitive case studies in the following order: Open Bouwen (Solids), Structuralism (Diagoonwoningen, De Drie Hoven) and Metabolism (PREVI, Nakagin Capsule Tower and Sky House). Every case study ends with a conclusion.

# 5.1 MAIN CASE STUDY MOLENVLIET

First the main case study will be researched (and put next to the proposed definition of re-adaptive), followed later by the comparitive case studies.

# A. MOLENVLIET

This study has no further consideration of building physics aspects. The refined information with regards to detailing, grid rules and other specifics information can be for later studies.

## 1. ORIGIN

The Molenvliet houses are a result of a competition written by the municipality Papendrecht in 1929 to create a new neighbourhood in Papendrecht, for the inhabitants of Papendrecht (van der Werf, 1979). The municipality took the initiative and came up with experimental (social) housing to change the law in terms of the regulations surrounding construction matters. Frans van der Werf got commissioned for initially 80 dwellings, which got later more. The architect thought that the current housing situation was very forced and wanted to implement SAR principles, support and infill and user participation. He proposed a low rise high-density individual infill housing units for multiple types of different households, merged together throught courtyard structures. This resulted in 122 different types of housing units and the post-war uniformity of the housing mass construction was broken and freedom for residents was created (van der Werf, 1979).

## 2. KEY CHARACTERISTICS

The initial plan had divided houses ranging from 1 to 6 rooms, over 1 to 3 building layers and accessible through different zones (street, gallery, sidewalk, courtyard) in the total plan. The type of housing has many individual specialties such as retirement homes, sitting-bedrooms, disabled homes, open staircase in the dining kitchen, very large or small gardens, loggias on the sleeping floor, no garden or terrace, parents and children sleep on separate floors, largely live under cover) (Gothink, 1979; van der Werf, 1979).

The types of housing units (Kapteijns et. al, 1978):
For two layers:
a) one housing unit over two layers.
b) two housing units. The upper unit is attainable through an exterior stairwell or gallery. Lower unit attainable through front door on ground floor.
c) two housing units. The upper unit is attainable through an interior stairwell. Lower unit through front door on ground floor.

For three layers:
a) two housing units. The upper unit is attainable through a gallery and has a roof terrace.
b) three housing units. The upper unit is attainable through a gallery. The in-between unit is attainable through an exterior stairwell of the gallery and has a loggia, or through a interior stairwell.
The experimental characteristics of Molenvliet is 1) the resident participation, 2) the structure-infill principle, 3) the use of grid and 4) the residential environment (Gothink, 1979).

### 2.1 RESIDENT PARTICIPATION

In this project the decision-making process is phased and there is a possibility of participation of the residents during the plan preparation with regards to the infill (Gothink, 1979; van der Werf, 1979).
At SAR they had the idea that they should work with variation books, which is a book with basic-variants of floor plans with different sizes and different lay out variants. The architect disagreed, stating that its too abstract for the working class people that have no familiarity with reading floor plans and thus decided to have one-on-one conversations, consultation hours (van der Werf, 2022). The consultation hours ran as follow: The future residents came in with an empty floor plan. First they discussed where they'd like the front façade to be, followed by the stairwells, garden, terraces and pipe shafts. From here on, the architect asked them about their living habits and how they would wanted to live, where to sleep, whether they'd like open or closed spaces, what the children want, the amount of windows etc. Ideas then came loose and the residents could take their floor plan sketch home. A week later the residents came back after thinking about their sketch. The floor plans then got re-examined and possibly changed. Details (such as the future placement, exterior paintwork ,windows and door placements etc.) then also got discussed (Gothink, 1979; van der Werf, 1979).

#### Façade

There was also decision influence and participation on the facade, creating variety in the facade. The facade principle, vertical elements creating the frame, the structure. and the infill becomes either doors, closed doors, glass doors, fixed panel or a glass panel (van der Werf, 1979; van der Werf, 2022).

#### Restrictions

The carrier, the structure itself is a restriction of total freedom. Related the infill, piping ducts, sanitary installations, walls with or without windows and stairwells also caused some restriction. Furthermore, the SAR

10/20 grid was used, making it only possible to place walls every 30 cm. Also within the given window façade frames, it was possible to choose between solid panels or glass of a certain amount of chooses. The height of the parapet was fixed (van der Werf, 1979; van der Werf, 2022).

## 2.2 STRUCTURE AND INFILL

The structure is in essence very simple and every unit contains the exact same concrete disks, roofs and floors. The SAR principle had a transverse structure and a longitudinal structure. In Molenvliet, these got combined. The structure is exactly everywhere the same in elements and more or less also in form, the only difference is that at some places there is one layer less and there is 'half' a roofcap. This was done so that more sun could reach the courtyard. This skeleton can be 'filled' in with a large variety of types of houses and sizes. A timeless structure, the infill of which can change, vary and is subject to change. It integrates life in the street walls by individual expressions within a whole. The structure ensures coherence. Previously designing buildings were a series of pairs of types that were produced and multiply one after the other (Kapteijns et. al, 1978; van der Werf, 1979; van der Werf, 2022).

The facades offered a free layout as it, in essence, also has a structure and infill component. The structure is the frame consists of horizontal rails, in which different types of panels and thus the infill (either glass or closed, or a door) can be placed. The windows styles got screwed with a special profile onto the existing frame on construction site. Inner walls could then connect to facades at the location of a stile or closed panel (van der Werf, 1979; van der Werf, 2022).

### Structure

The structure and thus also 'common property' consist of the following elements (van der Werf, 1979).
1. Floors with holes for stairs and voids
2. Wall discs of 20x170 cm, on a grid size of 480x480, creating longitudinal and transverse directions.
3. Roof caps over 2 bays in the direction of the wall discs: they sometimes appear as transverse caps and sometimes as longitudinal caps. Inclination of 45 degrees creates large spaces in the hood, which can be used and classified again. A walkable loft has been created in the ridge as extra space for the upstairs apartments.
4. The windowframes of fillable facades in the longitudinal facades and in the transverse facades.
5. Roof terraces, as outdoor space for the upstairs apartments and the galleries with outside and inside stairs.
6. The pipe ducts of 60x60cm, in which all supply of energy and waste disposal is included (i.e. of gas, water, electricity, TV and telephone cables, exhaust fumes, ventilation and down pipe of the sewerage)

### Infill

The infill is designed to change easily and frequently per dwelling, which is an individual decision of the household (van der Werf, 1979; van der Werf, 2022).

### Allotment

The structural frame, the structure, is of the community and shared. The infill, is individually filled in by the resident. The structure is fixed and finished, but the house itself (the infill) is an open end (van der Werf, 1979).
In the supporting structure, possible subdivision solutions can be found by installing house-dividing walls, combined with holes for internal stairs in 2-storey houses. Allotment happens in 3 directions: below, above and next to each other. Each subdivision can respond to its own wishes (van der Werf, 1979). Dividing up the total construction is related to the required differentiation of housing sizes and possible integration of commercial spaces, locating storage areas on the ground floor and use of roof terraces, loggias and gardens (van der Werf, 1979). The house separating walls are of masonry in combination with plasterboard and acoustic material. This can easily be subdivided in the future, without the structure being modified. Possibilities in terms of renovation has therefore already been included (van der Werf, 1979).

## 2.3 GRID

This principle structure of structure-infill, only works if the fillable should be easy to change. It is important that there is a modular coordination, so that the infill fits in the structure (van der Werf, 2022).

The SAR 65 modular coordination of grid is based on a 1m-2m bandgrid which is used to make position agreements for carrier and built-in elements. The agreement is: material always ends in the 1m strip. Carrier material is always in the 2m strip. Installation material always in the 1m strip. Carrier element can therefore vary from 2 to 4 m. Installation from 0-1m. There is an exception to termination against the 1m band with regards to the stairwell (van der Werf, 1979).

Using the grid, the whole project, is also expandable by multiplying the units as the grid can easily be replicated. The monotone structure and its grid is the principle that makes it possible to expand (van der Werf, 2022).

### 2.4 RESIDENTIAL ENVIRONMENT

Molenvliet has a higher density in the centre and is tapering towards the edges. Attention is given to polarity such as public and private, with the aim to strengthen meeting and communication between residents (van der Werf, 1979). Courtyards ensure more encounters between residents. To create meaningful contacts and liveliness, the outside direct environment consists of garden courtyards or entrance courtyard, making every house lie between an entrance and garden courtyard. (Gothink, 1979). Interactions between residents are more interesting when they come from different types of families (large families, small families, single, etc.). Hence the suggestion to build all types of house sizes mixed together instead of 180 2-room houses. The low rise came from the argument that two flights of stairs is doable for most people, resulting in 3 layers and a hood (Gothink, 1979; van der Werf, 1979; van der Werf, 2022).

## 4. PROCESS MANAGEMENT

### 4.1 TENDER PHASE

The mayor of Papendrecht wanted to contribute something special to the development of housing, and the ministry had applied a designation to this experimentally. Through a competition, the architect was chosen (van der Werf, 2022).

### 4.2 DESIGN PHASE

What's most mentionable about the design process is a) the subsidy application and b) the resident participation.

#### Plan assessment and subsidy application

The assignment was 180 dwellings of 2 room-units at the time. The architect suggested doing multiple different sizes. During the design phase of the Molenvliet support structure has been parcelled into 109 units of different sizes, from 1 to 7 rooms. Because of the experimental nature, the plans allowed for the architect to submit the structure-infill plan. (Gothink, 1979; van der Werf, 1979; van der Werf, 2022). After it was approved, the architect was accompanied by a contractor and team (van der Werf, 2022).

Due to subsidy, all housing plans should be known before applying. Based on the floor plans, the accommodation unites per house are determined and subsidy is calculated. In this project however, the actual individual floor plans came a lot later than usual, and after subsidy was already determined. The subsidy then was determined based on test layouts, made for 67 types resulting in 108 homes with 466 V.E.'s. The fictional infill plans were used for the building permission, to show the capacity following the rules. The final floor plans were than assessed by the municipality, in particular in terms of the safety aspects (van der Werf, 1979). This took a lot of more time than had been foreseen. And it could not even be assumed that these were built. So the procedure is very time-consuming and people wonder whether it makes sense to test floor plans that are not realized after all (van der Werf, 1979). The ministry has approved the subsidy application based on these 466 V.E.'s, due the project being designated as 'Experimental Housing Plan' (van der Werf, 1979; van der Werf, 2022). It's important to note that this is an unusual way of working and therefore is not something that can be applicated to every project. Test-plans are also difficult with regard to calculations for the contractor which can only give a reasonable indication. More or less work can be applied, but can be far out of proportion. The solution may be to split this with a fixed contract sum for the carrier. And only determine the budget infill later when the house plans are known (van der Werf, 1979).

#### Resident participation

While graduating, the architect had already considered that people cannot build homes without resident participation. Furthermore, the architect had previously worked at the SAR with John Habraken, where a method has been developed for designing with a structure-infill principle. In addition to this, his design method has also been the use of patterns. Designing through patterns is, in short, in two parts. The first part asks what the need is, what do the residents want. The second part then wonders which form is suitable for this. Pattern working is therefore: first talking about people, in order to get something out of them. And then see which shape is suitable for that (van der Werf, 2022). At the SAR they thought that the use of variation booklets would be useful. Frans van der Werf suggested consultation hours in which the residents participate directly in the design phase, with regards to the floor plans and the façade layout (van der Werf, 2022).

#### Beta zone

A beta zone has been used in the design: the middle zone. This zone has the least amount of daylight (since the facade with windows is located on the other two sides), where many pipes and stairwells can be secured.

#### Facade

Structure-infill principle has also been used with the facades. The vertical frame elements are the same everywhere, and the interpretation in between has been discussed with the residents (van der Werf, 2022).

## 4.3 CONSTRUCTION PHASE

### Recruitment

This recruitment went through press releases and information evenings with both slides and models. The housing association provided the information on rent and subsidies. More than half of those who were present, registered. But only 1/3th  of them actually becamde residents (Gothink, 1979; van der Werf, 2022).

### Allocation

Homes are allocated by the municipality. In normal projects, tenants are assigned when construction is nearing completion. People were appointed in this project as soon as the first piles were driven, and sometimes even six months before completion. Involving people early also shows them that it is a realistic project and that it actually happening. But in the meantime anything can happen to a househol, which sometimes also caused residents to withdraw (van der Werf, 2022). The time difference between the construction of the first and last block is about 5 months. The housing allocation followed this schedule as well, resulting in allocating residents in house units late as possible during the construction process (van der Werf, 1979).

### Split housing units

During construction, another 14 large ground floor homes were split into 28 smaller homes, with an extra front door being added with an extra staircase to the upstairs apartments (van der Werf, 1979; van der Werf, 2022).

### Separation between structure and infill

To organize the work well, it's important to have a clear separation between carrier and installation. So the contractor builds the foundation, walls, roofs and facades. The rest is assembled in construction. This is can be referred to as wet construction and dry construction. Dry mounting also means that it can be disassembled. Separation of the carrier  and installation also offers contractors less risk. During construction, installers in particular can have difficulty with the large variation. This is mainly due to the fact that there are installations in the carrier as well as in the installation. During construction, the contractor kept track of how much the first home cost, and assumed that for the rest of the homes. The contracor found that the average costs didn't change that much and decided to fix an overall price (van der Werf, 2022).

## 4.4 OPERATION PHASE

In the first month there were some issues with regards to the finishing, which were solved within the first year. From the completion of the project on, there rarely is any vacancy. The building is still used as social housing (van der Werf, 1979).

Residents, in theory, can use their home for a longer period of time because of the demountability and thus change their layouts as desired during the user phase. The reparcelling would mean that there will be a change in house numbers, and that they may not always be logical. According to the architect, this is not a technical problem, but more of a people problem or habituation problem (van der Werf, 2022). Although it has been built with the idea of changeability, according to the law this is not even allowed. As a tenant, he/she must leave the house as he/she entered it. Which is very contradictory to the design principle, so a next occupant lives after the first occupant has been determined. The architect is aware of this and has also fed back this, with a view to changing tenant contracts (van der Werf, 2022).

### Current residents

This information –most important conclusions from survey– is from the survey set out in 2022 with 9 respondents. All the survey data can be found in the  7 and seen in figure 18.

Only one resident is an 'original' resident of the Molenvliet and therefore the only one who had resident participation in the floor plans. She is also the only one that specifically chose the house because of its experimental character. She mentions that the teamwork with the architect, amount of decision influence, and freedom of choice went well, furthermore she mentions no barriers or things that didn't go that well. She experiences her choices on the floor plan on both short term and long terms as very good. She does expect to move house on short term, as her house is now too big for her (and thus couldn't shrink with her needs).

A change in the household size is expected by four respondents, of which three singles expect to grow and one family to get smaller. The three singles also mention that they need more space/rooms. Most of the residents don't expect to move, 55%. 44% does expect to move on the short term because of the lack of needed space, and some also because of the neighbourhood. Furthermore, the most common reason to inhabit this house by the residents was mostly because of no specific reason, other than they just needed a home (55%), followed by the neighbourhood (33%).  Also, none of the respondents made any adjustments to their housing and also don't expect this to be the case in the future. When asked to rate the adaptability, growth/shrink possibilities

# MOLENVLIET RESIDENTS

## HOW IS THE (RE-)ADAPTIVENESS OF MOLENVLIET EXPERIENCED BY ITS RESIDENTS

A survey was conducted to all 122 housing units of Molenvliet project in Papendrecht designed by Frans van der Werf.

**9** RESPONDENTS

5 single women

1 single man

1 couple

1 parent with kid

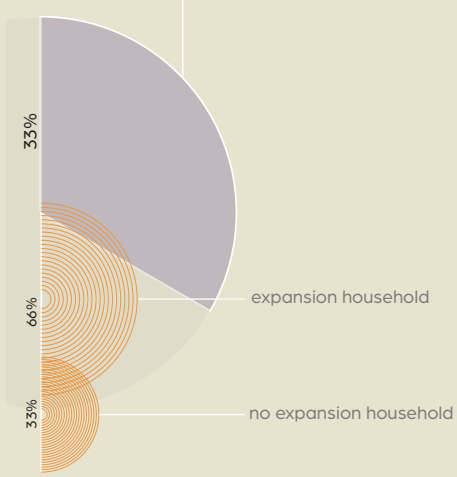
1 parents with kid

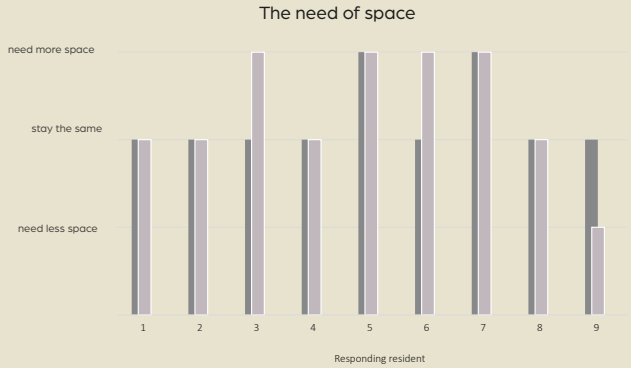
**7.4/10** An average of 7.4/10 was given to the overall housing satisfaction

**3.8/10** An average of 3.8/10 was given to the adaptability possibilities of the dwelling

**2.4/10** An average of 2.4/10 was given to the growth and shrink possibilities of the dwelling

### 33% needs more space

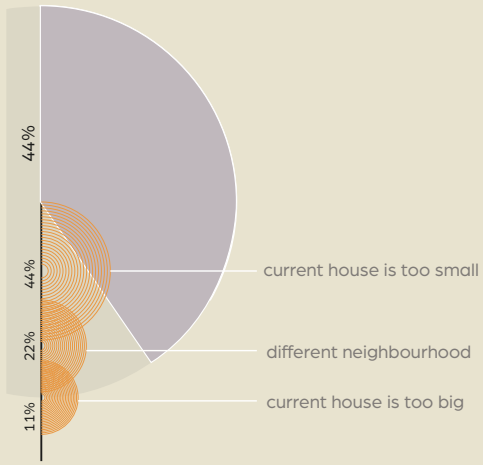


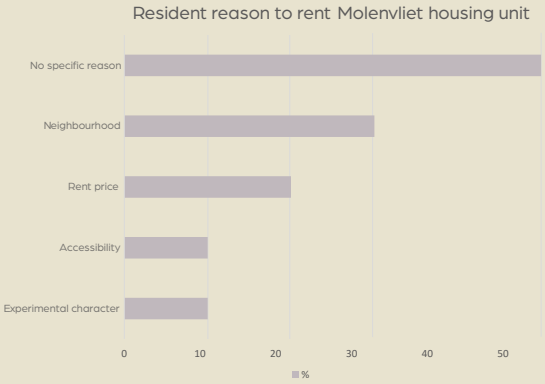




One knows very well what the experimental characteristic of Molenvliet entails. Five have heard of it and three have no idea.

AWARENESS

### 44% wants to move




Two have been making adjustments – these were very small adjustments.

MADE ADJUSTMENTS



No future adjustments are expected.

EXPECTED ADJUSTMENTS

### 11% is an original tenant


- Good team work with architect and freedom of choice
- Amount of decision influence was right and enough
- Experiences her own design on the short term as very good
- Experiences her own design on the long term as very good

The residents find mostly the diversity (mentioned five times) of the housing units the most outstanding characteristic of Molenvliet. Other mentioned characteristics are the possibility to design an own individual lay out (mentioned by the first tenant), the big roof terrace with enough privacy and enough space.

OUTSTANDING ELEMENTS

Residents do not move once their housing unit is too big for them due moving housing would be too much effort for them, the tight housing market and the preference to live bigger than needed.

MOVE HOUSING

Figure 18: Resident Molenvliet survey outcomes (own illustration)

and the satisfaction of their house,  the adaptability and growth/shrink possibilities  are rated very low while the overall satisfaction remains satisfactory.

There clearly is a big miscommunication and a gap of knowledge in the current residents. Some of them had no idea. Most of them have heard of the experimental character (flexibility possibilities and structure–infill), but never inquired more deeply themselves. This leads them to also not knowing the possibilities with regards to adaptivity. Even though there is a lack of information given to these residents, they still all –except for one– mention unusual characteristics of the project – such as the diversity of housing units.

What's interesting is to see that a building, such as Molenvliet, completely is oriented towards adaptivity, but shows no sign of adaptivity. The individuality and resident participation was beneficial for the first resident, however after that frozen in time for both first and secondary tenant. Molenvliet is not (re–)adaptive in practice.

### 4.5 MAINTENANCE PHASE

In terms of maintenance, the structure should last up to 100 years. Doors can be serviced every +/– 25 years. Furthermore, there is standard maintenance with all tenants' homes. The owner, the housing association, manages and maintains in principle the whole project as they rent it out to tenants (van der Werf, 2022).

What is remarkable is that all the different colors of the individual facade elements – determined by the residents – are now all painted a color red due to easier maintenance (van der Werf, 2022).

## 5. DECISION MAKING

### 5.1 STRUCTURE PLAN

SAR composed a schedule of decision making, made out of four levels that are based on the scale sized of the total design elements (Gothink, 1979; van der Werf, 1979). Each level has its own decision–makers who make decisions about the elaboration of that layer, which gives substance to the next layer (van der Werf, 2022). In each preceding phase, it is not more determined than necessary needed at that level. This is done by noting down agreements per level between the parties involved. Agreements per level remain the starting points for the next level (Gothink, 1979; van der Werf, 2022). Level 4 allows resident participation. The principle of infill and structure thus requires a different view than usual where the most important position in this regard is that the architect does not design houses, but an architectural structure in which anything is possible through the infill of this structure (Kapteijns et. al, 1979; van der Werf, 1979). These levels can be seen in Table 6.

Table 6: Levels of decision–making (own table)

| Level | Scale | Decision making |
|---|---|---|
| 1Zoning | Total plan of the district with its main elements sites with different characteris–tics, which are part of the zoning plan. | City council, council committee. |
| 2 Tissue | Plans in the 'building stains' of the outdoor spaces and building masses. elements of the immediate living environment, buildings, urban spaces and functions that come into it | City council, council committee. |
| 3 Support | Plans of the structure building elements (floors, walls etc.)<br>Support level: load–bearing walls, columns, floors, roofs | Housing association, technical advisors, the building team, |
| 4 Infill | Plans of the infill of the floor plans and façade infills.<br>Residential building elements | Architect In participation with the residents. |

### 5.2 LEVEL

In level 4 the resident participation has its influence on the last layer of the infill. See 'key charcacteristics – resident participation' for the process. The participation possibilities of the residents leads to a high degree of individuality . The participation is on the spatial infill of the floor plan within the structure and the facade elements with their colours. Although ultimately not incorporated, It was initially also planned for the residents to have a say about the final rent (which was supposed to be based on a basic amount of rent, adding into out according to the infill elements) and the spatial organisation of the outside common areas (Gothink, 1979).

## 6. FINANCING

A housing aossciation is in ownership of  the project and financed the project. The residents are renting (social rent) the housing units (van der Werf, 1979).

### 6.1 DEPRECIATION PERIOD

More financings is possible due the longer depreciation period. Structure life spand extension from 30 to 75–100 years is possible by means of the structure–infill principle. Housing differentiation in market changes, can be achieved easily due to the seperation of structue and infill (van der Werf, 2022).

### 6.2 RENT

All the housing dwellings are rented by tenants from the housing associations. With regard to renting or buying options, the preference is for renting as far as the architect is concerned. This has both a philosophical and functional approach. From a functional point of view, it is difficult to buy a home in such a project as the carrier is part of a larger whole. And so the floors and side walls are common with other. Philosophically speaking, when buying a house, also buying the land is what according to the architect should also be part of the community, like air, and should not be given ownership. The tenant adds his own value to the house by means of the infill. Value can therefore also vary per unit. In principle, the carrier is 80% of the construction cost, with the 20% being built-in. This 20% has a wide range of diversity. (van der Werf, 2022).

## 7. RATES OF CHANGE / LIFE CYCLE

### 7.1 LAYERS OF CHANGE

The layers as Steward Brand describes, and as the literature review also mentions, doesn't come back in this project. Not so much layers as Brand intended, but there is a certain separation between parts of the building.

### 7.2 LONGEVITY

There is, however, a longevity. Besides technical lifespans of elements wearing out, there is also a division of life cycles of different elements – just not as written out.  100 years is the minimum planning one should have to maintain a building, instead of the often used 30 year lifespan of a building. The support structure has been parceled out into dwelling units by dwelling separation walls. They are removable overtime when a collectivity of residents want to change the parcellation of the support structure, may be after 25 years or more. The infill is designed to change easily and frequently per dwelling, an individual decision of household. The subdivision of the structure extends the life of a building (van der Werf, 2022). For example, what does stand in the long term, and cannot be changed on a large scale, is the urban structure. This lasts for centuries, because neighborhoods, each with their own character, cannot be changed just like that. This is possible on a small scale, for example with regard to the placement of parking spaces (van der Werf, 2022).

## 8. OPPORTUNITIES TO SHRINK AND GROW

### 8.1 RE-PARCELLING

Shrink and grow can mainly be done in the building itself, because of the re-parcelling options. The building is subject to change, but on a smaller scale. This is possible because a support is changeable by re-parcellations and by flexible infill. This touches the interest of re-parcellation of the structure and re-distrubution of available space. This can be seen in the fact that the initial idea of the 6 bed-room house units were subdivided in smaller housing units (van der Werf, 2022). However, no (direct) growth or shrink per unit has been taken into account.

### 8.3 EXPANDING STRUCTURE

The structure itself is expandable on an urban scale, so that the grid can be continued and the house units can be multiplied. A structure is a complete whole, and can therefore in principle be expanded (van der Werf, 2022).

## 9. EVALUATION

As it was a first experiment, things were also done wrong. All renewing projects take time and effort. After Molenvliet, the architect realized 6 more Open Bouwen projects. According to the architect, many of the barriers are not a technical problem but purely a process and organizational problem (van der Werf, 2022).

#### Resident file

The total resident file in 1979 was 67%  married couples or cohabiting man and woman, 17% single men and 16% single woman. 62% had children living at home. The new residents scored their previous house on average a 6.3/10. On average, by far the most important reason to move out their previous house to this one, was because there were little alternatives. Residents score their house after the 1st year an average of 8, after the 3rd year not even a 7 (Gothink, 1979).

#### Amount of applications

Compared to normal new residential areas in Papendrecht, relatively fewer applications were received for this project. Reasons for this was too small demand for 6 room homes (they eventually split those big houses for smaller ones) and a relatively higher rent than other homes. In total, more than half dropped out who were the first to qualify for a home. It also regularly happened that residents who rejected a home during the 1st selection were allocated another home. Later selected residents were less satisfied, due to a smaller supply of course. At the end of the ride, a good number of potential residents, 68, still withdrew after the consultation hours, even just days before the completion. Reasons for this vary from the project design, the density of buildings, the project implementation, the relatively high rent or the specific home assigned to them. Many also found time to decide too short and information too insufficient (Gothink, 1979).

The floor plans that were discussed during the consultation hours could hardly or not at all be changed afterwards because of the built-in elements (Gothink, 1979).

In later projects, a lot less people dropped out because of a more streamlined process. For example, participation processes were better coordinated with the contractor, and the contractor himself also had a clearer separation between support and installation, making it easier to respond to changes. Housing associations also learned to set deadlines better and guide residents better. Digitalization is a big plus in the process, making it easier to implement the design process and changes (van der Werf, 2022).

### Not realised characteristics

Initially the plan included decision-making influence of the residents also on the outside environment and the rent. This both dropped as the municipality saw no functionality in this – it would become too messy. The amount of control over the façade was limited to a certain amount of alternatives (Gothink, 1979). Although the initial ideas not always got implemented in the project, no resident protested. This can be due a lack of correct information, not knowing any better, being happy already with the possibility to influence decision-making or this being their only possibility to move (Gothink, 1979).

### Finishing of the house

There were many complaints about the finishing of the house. Varying from cracks, doors that do not close properly, painting, electricity that goes out, incorrectly seated installations, drains, blockages, leaks and drafts, poor drainage etc. But also issues that are less easy to fix: houses that are too dark, storage areas that are too small, too little privacy in garden courtyards, gardens that are too small, living close together. A lot of defects got later fixed by the contractor.Gothink, 1979).

### Infill

Shower pipes are often the most difficult, because they are the lowest. A solution to this could be a 70 mm screed, which can be easily removed and pipes can be re-routed with a new pouring layer on top.Also the use of the beta zone, the middle zone in the depth of a house, is best suited for pipes as there are no windows there. It is therefore most convenient to place the bathroom, toilet or even kitchen in this middle zone. This beta zone could also be used for the stairwell in the future. The beta zone could in the future consist of prefab elements that are interchangeable. For example, the stairs can be placed on the other side or, if necessary, turned a quarter turn. Then the staircase is really built-in that can also be placed freely (Gothink, 1979).

### Stairwell or gallery

The preference is to use widened galleries for the front doors. Functionally this is useful in connection with a stretcher for example and moving house, but in this way a gallery can also become an outdoor space and/or offer more options with regard to allotments (Gothink, 1979).

### Simplicity

It is important to keep projects and possibilities close to realism. New techniques are of course always interesting, but can be too difficult to implement for residents. New techniques are also often very expensive, which can be at the expense of affordability (van der Werf, 2022)

### Participation on structure level

Individual future residents might have the right to 'influence' a support design by what we call 'participation' meetings, an information meeting that allows citizens to react on design propositions, so that designers and deciders might rethink ideas. It's not a decision-making meeting (van der Werf, 2022).

## 10. OTHER PROJECTS

During the interview with Frans van Der Werf, he also mentioned other projects and learnings from these.
In terms of initiators, they had always been municipalitie i.c.w. housing associations.

### Additional organisational elements

In projects after Molenvliet he informed the users better on forehand and they got more design tools such as full-scale models, furniture maps and a coached architect team.

Full-scale model
In built full-scale models residents could clamp in panels and could walk it through and change the floor plan.

Furniture map
This is a map with home furniture that residents could cut & place in their floor plan to get an idea of their layout.

Coached team
A team can be added that has coached the architect to conduct the consulation hours. Frank van der Werf coached and trained this team beforehand so that they could work quickly during the resident conversations.

Introduction of the computer
Building costs calculations became more precis as it became more systematically because floor plans could be quickly translated into costs and the residents could immediately see this during the conversation, and possibly change it. Using computer programs also was used for visual purposes on a screen with 3D projection Often the residents are not familiar with building plans, and 3D images appears to clarify spatial understanding.

Representatives
Community decisions that go further than an individual home layout can also be made. These bigger groups need a representative. The urban fabric must always have a representative because of its large scale. Once the carrier includes more than 200 homes, this also needs a representative, working together with a housing association or investor (van der Werf, 2022). Ideas can be generated and presented by the represenative committee so that then the residents can comment on these. After this, the committee looks back at the ideas and comes with a possible new proposal (van der Werf, 2022).

Persuading the client
Housing associations or investors might still doubt whether they wanted to continue with residents' participation. To motivate and convince them that it was not as complex as they thought, the architect once let them do it themselves. They were given an empty map during the weekend, to all come together again on Monday and look at each other's map. Here they commented on each other's floor plan and understood that resident participation is an important element after all. The board then decided to do it for the first 20 homes, and after this turned out to go smoothly, all homes were released (van der Werf, 2022).

Additional value
User participation and freedom of dwelling layout can become a major selling point. User participation requires extra costs for consultancy preparations and processing. In later projects, users got the choice to life in a standard (fictive) dwelling, or to pay of the consultancy price of two month rent in 5 years. Everybody choose the last option, representing a value among the residents (van der Werf, 2022).

Margins
Margins ('delta zones') can be used from the SAR principles. When a building with a support is designed, there is always a margin in which it can expand. This is the outdoor space that can eventually become (partly) indoor space. Expanding the structure is expensive, so reparcellation could offer a better solution for growth/shrink. This also includes all kinds of agreements about positioning and it's certainly not the case that everything has to be extensible as it has consequences for the neighbours and cohesion of the building (van der Werf, 2022).

Re-parcelling
Complete re-parcellation has been done in a other project after as te housing association wanted bigger housing units, since due to a market change. The property has been reparcelled from 3 homes to 2 and sometimes from 2 to 1 home. This was possible because of the structure-infill principle (van der Werf, 2022).

Resident pressure
What also proved was that because residents get involved, there is immediate pressure on the process. When 150 families are on top, they represent tremendous power (van der Werf, 2022).

Reducing infill
In order to reduce infill, it was also devised during another project to place light points perpendicular to where the window is. With regard to heating, use has also been made of underfloor heating with two fields at the facades so that both fields can be heated independently. If a room becomes smaller, then less underfloor heating is needed because the surface becomes smaller.

Discuss time
In Frank van der Werf's last project  people got more time to discuss and decide. The result was negative: the whole process became frustrated because users could not decide of the deadline.

## 11. FLEX 4.0+
The second part of the theoretical framework is the FLEX 4.0+. Table 7 shows the filled in FLEX 4.0+. The orange marked statements are the ones that are applicable to Molenvliet.

Table 7: filled in FLEX 4.0+ (own table)

| Layer | Sub layer | Flexibility Performance | Assessment values | Remarks |
|---|---|---|---|---|
| 1.SITE | | 1.Surplus of site space<br>What does the area around it looks like? How can the surrounding space (site) influence the building? | The direct area contains courtyards, gardens and traffic streets on both sides. This surplus can be used to build additional volumes – however this is at the expense of direct resident outdoor space and traffic streets. | The more surplus space on site, the better the building can be expandable horizontally |
| | | 2.Multifunctional site/location<br>Is the location capable to support more functions, like offices, living, care and shops? | 1. Just one<br>2. Two functions<br>3. Three functions<br>4. >3 functions<br><br>The project is located close to a large car road and public transport stops. The zoning-plan has some restrictions:<br>- It's housing specific, with also the possibility to place independent offices and practices; however mixed-living is not permitted on the first floor. Care facility, independent offices and practices (max gross surface of 100 m2, collectively max 500 m2) can only be placed on the ground floor and 1st floor. Home-bound professions or businesses, retail, services and offices can only be placed on ground floor with max 200 m2 per branch.<br>- There is an maximum height of 9m. This means there can't be an additional floor level constructed. | The more a location around a building supports more different functions of the building, the more a building can easily be rearranged or transformed to other functions |
| | | 2A & B<br>To what extent does the municipality have influence on the adaptability of a building? | 1. Influence in terms of restricting it.<br>2. Doesn't take adaptability into account.<br>3. Promotes it, however not actively<br>4. Influence in terms of funding, zoningplan etc. Is in favor of. Not restricting.<br><br>According to the structure vision of Papendrecht for 2020-2030 (Gemeente Papendrecht – CombiRaad – Woonkracht10, 2021), there is a contribution by accelerating new social housing construction and paying attention to quality aspects and commitment to insulation and energy transition. The focus is also on living with care, housing emergency seekers, temporary solutions and less conventional ways of housing. The structure vision doesn't mention (re-)adaptivity, however 'less conventional ways of housing' could implement that the municipality is open to such construction. | The more a location around a building supports more different functions of the building, the more a building can easily be rearranged or transformed to other functions |
| | | What does the zoning plan says for this site and to what extent can this be changed? [2B] | 1. Very limited and rigid.<br>2. Very limited, however open for change<br>3. Is open to large variety, however not everything<br>4. Can be anything, no requirements<br><br>See explanation above. | |

| Layer | Sub layer | Flexibility Performance | Assessment values | Remarks |
|---|---|---|---|---|
| 2. Structure | Measure-ment | 3.Available floor space of building<br>Does the building or user units have a surplus of the needed usable floor space? | 1. No, no surplus at all<br>2. 10–30%<br>3. 30–50%<br>4. >50% | The more surplus, the more easily it can be rearranged or transformed into other functions, the better the building can meet to changing user demands |
| | | 5. Measurement system<br>Have positioning/measu-rement modular rules for constructions components been used? | 1.No rules for modular coordination<br>2.<50% implemented<br>3.>50%<br>4.>90%<br>No data on % implementations however yes, there are rules for modular measurements and positioning (SAR). | The more project independent, demoun-table and replaceable construction components have been implemented, the more easily a building can be rearranged/ transformed to other functions |
| | | 6.Horizontal zone division/ layout<br>Has use been made of a hori-zontal zoning system, including intermediate margins? | 1.No zoning system without margins<br>2.10–30% intermediate margins<br>3.30–50% intermediate margins<br>4.>50% intermediate margins<br><br>No data on % margins however margins regarding measurements have been used (SAR67 margins). | To more margins are used in the zoning system of the building, the more easily a building/unit can be rearranged/transfor-med to other functions |
| | | 7. Presence of stairs/elevators<br>What are the horizontally and vertically moving elements (stairs, halls, lifts etc.) and how does this relate back to its adaptability of the building? | The horizontally moving elements are stairs, halls and lifts. The vertically moving elements are gardens, cour-tyards or halls.This is dependend on what kind of unit it is (positioned in which building layer and how many building layers the unit itself includes). | The more stairs/elevators are available in the building, the more easily a building/ units can be rearranged, rejected, ex-tended or transformed to other functions |
| | | 8. Extension/reuse of<br>Is there a possibility to add new stairs/elevators to the building and reusing the exis-ting ones? | 1. Not without drastic expensive measures<br>2.Can be accidently added and existing reused<br>3.Can be limited added and existing reused<br>4.Can be easily be added without drastic measures | The more stairs/elevators are available in the building, the more easily a building/ units can be rearranged, rejected, ex-tended or transformed to other functions |
| | Construc-tion | 10.Shape of columns<br>How are the columns in the building shaped? | 1. Round shaped and/or have vertical different sizes<br>2.Octogonal shaped<br>3. Rectangular shaped<br>4. Square shaped<br><br>There are no columns. | The less deviate from a square column, the better a building/units can be rearranged |
| | | 11.Positioning of facilities zones<br>Are facilities zones and vertical shafts located at central building level and/or local unit level? | 1. All located at central level<br>2. Located at central level and occasionally local level<br>3. Located at central level and limited at local level<br>4. Located at central level and at local level as well | The more facility zones/shafts are located at unit level, the easier a building can be rearranged, transformed to other functions |
| | | 13.Extendible building/units horizontally<br>Is it possible to expand the building horizontally for new extensions to the building/ user unit? | 1. Not possible at all<br>2. Very limited possible, only at one side<br>3. Limited possible, at more sides<br>4. Easily possible, at all sides | The more a building/unit can be expanded, the easier a building can be rearranged or transformed to other functions or expan-ded, the better a building can meet the changing user demands. |
| | | 14.Extendinable building/units vertically<br>Is it possible to expand the building vertically, for adding new floors or a new basement? | 1. Not possible at all<br>2. Limited possible, only a few units<br>3. Possible after total rearrangement<br>4. Possible | The more of a building can be vertically expanded, the easier a building can be rearranged or transformed to other functi-ons or expanded, the better a building can meet the changing user demands. |
| | | 15.Rejectable part of the building/unit<br>Is it possible to reject part of the building for selling/renting to third parties? | 1. Not possible at all<br>2. Possible to reject 10–30% of the building/units<br>3. Possible to reject 30–50% of the building/units<br>4. Possible to reject >50% of the building/units<br><br>The ground floor can be rejected i.c.m. with the possibi-lities given by the zoning plan. | The more a building can be vertically rejected, the easier a building can be rear-ranged or transformed to other functions or expanded, the better a building can meet the changing user demands. |
| 3. Skin | Facade | 17.Dismountable façade<br>To what extend can façade components be dismantled in case of transformation? | 1. Components can't/hardly be dismantled without demolition<br>2. Small part can be dismantled (>20% < 50%)<br>3.Large part can be dismantled (>50 % < 90%)<br>4. All façade components are easily dismountable | The more façade components are easily dismountable, the more easily a building can be rearranged or transformed to other functions. |
| | | 18. Location/shape daylight<br>In what way are the façade/ daylight openings positioned and shaped? | 1. Large closed surfaces<br>2. Small horizontal open surfaces<br>3.Large open surfaces, with different heigh sizes<br>4.Large continuous horizontal open surfaces, connecti-ons according to planning grid | The more regular open surfaces in the façade according to the planning grid, the better a building can meet changing demands in functions, quality and finishing of the building |

| Layer | Sub layer | Flexibility Performance | Assessment values | Remarks |
|---|---|---|---|---|
| 4. Facilities | Measu-res and Control | 20. Measure & control tech-niques<br>Is it possible to control/measu-re facilities on building level as well on user unit level? | 1.Takes place only at central building level<br>2.On central level and occasionally on unit level<br>3. On central level and limited on unit level<br>4. On central level and completely on unit level<br><br>On unit level – some shafts are shared however. | The more possibilities for measurement and control of the facilities on unit level, the more easily units in a building can be rearranged or transformed to other functions |
| | Distribution | 22. Distribution facilities<br>Does the building have a spe-cific distribution facility for hot/cold water, heating, cooling, gas? | 1. One for all different sources<br>2.For some of the different sources<br>3. For two of the different sources<br>4.No specific distribution | The less specific distribution equipment facilities have, the easier a building can be rearranged or transformed to other functions, the better a building can meet changing user demands |
| | | 23. Location sources facilities<br>What is the location of the cen-tral facility sources? | 1. Located at only one central location<br>2. Located at several locations<br>3. Located at a central location and decentred location<br>4. Located outside the building at city level (district heating) | The more facility sources are localized at decentred level, the easier a building can be rearranged or transformed to other functions, the better a building can meet changing user demands |
| | | 24. Disconnection of facility<br>Can the compoinents of the fa-cilities be easily disconnected? | 1. Can't be disconnected or demounted<br>2. Hardly be disconnected or demounted<br>3. Partly be disconnected or demounted<br>4. Can be disconnected very easily and completely demountable | The more facility parts can be disconnec-ted or demounted, the easier a building can be rearranged or transformed to other functions, to better it can meet changing user demands. |
| | | 25. Accessibility of facility<br>To what extend are facility components good accessible? | 1. Hardly or not accessible (eg concreted in)<br>2.Limited accessible (partly on support and infill level)<br>3. Good accessible (lot on infill level)<br>4. Very good, most components at infill level<br><br>Pipes are poured into the structure as well as in the infill. From the pipes that are poured into the concrete structure, installations can be branched on. | The higher the accessibility of facilities components, the more easily units in a building can be rearranged or transformed to other functions, |
| | | 26. Independence of user units<br>In what way are the user units independent related to servi-ces as pantry, toilet facilities? | 1. No services available at user unit level<br>2. 1–2 services available<br>3. 2–4 services available<br>4. >4 services available | The more services are available at unit level, the more independent the units are opposite other units in the building, the more they meet individual user demands. |
| 5. Space | Technical | 28. Disconnectable, removable<br>To what extent are the user units in a building removable, relocatable? | 1. Is not removable, relocatable<br>2. Only relocatable with drastic expensive measures<br>3. Units are easy relocatable, constructed with de-mountable components<br>4. Easy relocatable, constructures with 2d/3d modules, transportable by road | The more the units consist of demountable and reusable components, the better the units are relocatable to another location in our outside the building |
| | | 29. Disconnectable, removable<br>To what extent are inner the walls in the building easily replaceable? | 1. not replaceable without drastic/expensive interven-tions<br>2. Not replaceable, but good destructible<br>3. Replaceable by dismantling and rebuilding at ano-ther location<br>3. Easily replaceable without radical/expensive inter-ventions.<br><br>The house separating walls are of masonry in combina-tion with plasterboard and acoustic material. | The more inner walls can be easily replaced, the more easily a building can be rearranged or transformed to other functions, the better a building can meet to changing user demands |
| | | 30. Disconnectable connection detail<br>Which detailed construction is applied between the interior walls and support structure and façade? | 1. Penetrating connections<br>2. Wet connections (mortar, sealant, glue)<br>3. Bound connection elements<br>4. Unbound dismountable connections<br><br>The house separating walls are of masonry in combina-tion with plasterboard and acoustic material. Façade is not bearing. Also structure–infill principle. | The easier the connection of interior walls can be dismounted, the easier a building can be rearranged or transformed to other functions |
| | | 31. Possibility of suspended ceilings<br>Is it possible to apply sus-pended ceilings and to adapt these to the different user demands? | 1. Results in free floor height of <2.60 m<br>2. Results in floor height of 2.5 – 2.7 m<br>3. Results in floor height 2.7 – 2.8 m<br>4. Results in floor height of > 2.8m | The higher the free storey height, the better the building can meet the changing demands concerning functions, facilities, finishing and quality of the building |
| | | 32. Possibility of raised floors<br>Is it possible to apply raised floors and to adapt these to the different user demands? | 1. Results in free floor height of <2.60 m<br>2. Results in floor height of 2.5 – 2.7 m<br>3. Results in floor height 2.7 – 2.8 m<br>4. Results in floor height of > 2.8m | The higher the free storey height, the better the building can meet the changing demands concerning functions, facilities, finishing and quality of the building |

# 11. CONCLUSION

Molenvliet was an experimental housing project, focused on the structure-infill principle of John Habraken. By dividing the structure and infill, the building would be more adaptive in the sense that there is more open ended outcomes within the structure as the infill is not fixed. Along with this principle, Molenvliet incorporated resident participation giving the residents a direct say in their housing composition and floor lay-outs.
The total construction is divided in relationship to the required differentiation of the housing sizes, possible integration of working spaces, storage areas (ground floor), roof terraces, loggias, gardens etc. This creates a housing possibility for a large diversity of household profiles with different m2, housing units, types of accessibility (street, gallery, sidewalk, courtyard), outdoor spaces (garden, loggia, terrace). All within the same structure and merged together through courtyard structure.

Molenvliet will be first set out to the definitions as proposed during the literature review of Open Bouwen, Structuralism and Metabolism. Although Molenvliet is based on the principles of Open Bouwen, it is still interesting to see how possibly Molenvliet is relatable to Structuralism and/or Metabolism – especially since the proposed definition of re-adaptive is a combination of.

## DEFINITIONS

### Open bouwen

Molenvliet is an 'Open Building' as it has the structure-infill principle, enablers individual freedom within the fixed framework through the separation of decision making and a certain grid. It only lacks the use of delta zones.

### Structuralism

Molenvliet also has an uniform, multieplied and repetitive grid structure of small units which are combined to make a variety of housing units. Because of the structure-infill principle, Molenvliet is also free from fixed large walls and thus the areas within the fixed structure are open for change. Bridges, open spaces and/or 'inner'streets are included by the courtyards and gardens. It lacks fundamental Structuralism principles such as mixed-use and polyvalence.

### Metabolism

The definition of Metabolism stands a lot further from Molenvliet than Open Bouwen and Structuralism. Molenvliet lacks the fundamental of cycle of change, constant renewal possibilities, interchangeability (although the infill is interchangeable), growth and shrink possibilities. Molenvliet only overlaps with Metabolism in terms of being able to change over time, and having the structure being seperated from the infill.

### Re-adaptive

Molenvliet overlaps with the definition in terms of structured grid system, expandable through multiplication, structure-infill principle and personal individuality with user participation. However it lacks with (strongly focused) marges, interchangeability and possibility to add and remove components – exactly what makes adaptive, re-adaptive. Also, although differentiation of life cycles is incorporated in the difference of structure and infill, to be more re-adaptive this could be emphasized more.

## IN PRACTICE

Although re-adaptive is missing in the design, adaptivity comes strongly forward which would create space for adaptivity. However in practice, it can be seen that Molenvliet basically have been frozen in time. Although the project was based on adaptability, and also accommodates this, no measures of adaptability have actually been done. Re-adaptivity and adaptivity hangs together. A building can only be re-adaptive, once it is adaptive to begin with. For adaptivity, it can be stated that the building is indeed capable of adaptivity, however not defined and functioning as an adaptive building. Molenvliet is not capable of re-adaptivity as it doesn't or barely shows possibilities for (direct) growth, shrink and interchangeability other than re-parcelling. There could be a possible amount of reasoning for this.

The resident participation was of use for the first tenants, however the secondary tenants are now 'stuck' with the choices the first tenant made. This can also be seen in the façade of all the housing units, which were first all of different colours and now are all painted in one uniform colour red. Although it has been built with the idea of changeability, according to their tenant contract this is not even allowed. As a tenant, he/she must leave the house as he/she entered it. Which is very contradictory to the design principle.

Although it is mentioned that adaptivity of the housing is a good selling point to future resident, and residents are also willing to pay more for a consultancy with the architect, the question remains if how strongly this enhances adaptivity. First of all, resident participation isn't necessarily directed towards adaptivity. Resident participation could be a selling point for regular housing as well. Secondly, this resident participation is only

beneficial for the first renters. The individuality of the first renter, can become a burden of the next renter. This however doesn't mean that resident participation can't enhance adaptivity but this means additional measures should be incorporated. A first step is that the process of resident participation of the first tenant, should also be proposed to the next renter. Also, although resident participation and adaptivity is constantly mentioned in the literature review as something important and valuable to the resident, this is not the main reason of the residents for choosing this house. On average, for the first renters by far the most important reason to move out their previous house to this one, was because there were little alternatives. The secondary renters have a similar motive for inhabiting Molenvliet: the most common reason to inhabit this house by the residents was mostly because of no specific reason, other than they just needed a home (55%), followed by the neighbourhood (33%). So the question arises wether it really that desirable? Or is it thought it's desirable but residents see it as a plus rather than a first thing residents select on? It could also be a shortage of familiarity with adaptive housing, so it makes it more difficult for residents to understand the value of it.

Notable is also that Molenvliet was an experimental housing plan by the ministry to change laws in terms of regulations surrounding construction matters thus giving room for such a scaled structure–infill principle with resident participation. Because of the 'experimental' predicate, the project got not only extra subsidized but also exceptions were made with regards to he test layouts. This is not an usual route.

Moreover, as mentioned before, Molenvliet lacks possibilities to grow, shrink or have interchangeability.
The layers as Steward Brand describes, and as the literature review also mentions, doesn't come back in this project. It is mentioned however that there is a longer depreciation period of 100 years instead of 25 years. But with social housing dwellings, it's not unusual for dwellings to stand more than 25 years. When they do get demolished, it's often due insulation and sustainability requirements they do not meet rather than the structure itself. Furthermore, the question arises of how growth related to the urban context. There isn't much space to do so with the current Molenvliet location as it (might) take away too much from common traffic spaces and outdoor spaces. This also includes all kinds of agreements (e.g. the zoningplan) about positioning and it is not the case that the zoning plan allows more vertical and horizontal growth. This could mean that growth is a form of buying (or renting) too big, to make it possible in later stages to 'pull' those extra spaces. However this is not always financially possible for residents as income usually runs proportional to family expansion.

From the surveys it came forward that none of the respondents made any adjustments and also don't expect this to be the case in the future. When asked to rate the adaptability, growth/shrink possibilities and the satisfaction of their house, adaptability and growth/shrink possibilities are rated very low while the overall satisfaction still remains on average a 7.4. It makes sense that (re–)adaptability is rated low as Molenvliet doesn't function as one. Which could be a missed shot, since most of the respondents do expect a change in household size and change in housing needs. There clearly is a big miscommunication and a gap of knowledge in the current residents. Most of them have heard of the experimental character (flexibility possibilities and structure–infill), but never inquired more deeply themselves. This leads them to also not knowing the possibilities with regards to adaptivity. Although even when they would be aware, they still can't adapt anything to their dwellings with regards to current regulations such as the zoning plan, their housing contracts and beauty committee.

When looking at the architectural space and its room for (re–)adaptivity, FLEX 4.0+ can be looked at. The enablers, rated with 3–4 points, seem to be the realocateability; floor height; moveable and disconnectable walls; demountability elements; and facility zones with services that are located per unit . Molenvliet scores high points on flexibility within the structure. It scores low points (1–2) on matters on the site and extensitivty and thus growth. The FLEX 4.0+ shows that Molenvliet offers adaptivity within the structure in terms of architectural measures, however is not [re]–adaptive as it doesn't offer shrink. growth and seems to be having issues related to the zoning plan and municipality influence. Although it seems that the architectural space does give room for adaptivity, there is one main barrier in the architectural component – the fixed shafts and pipe ducts. In the Molenvliet there are fixed pipe ducts of 60x60 cm, in which all supplies (gas, water, electricity, TV and telephone cables, exhaust fumes, ventilation, down pipe of sewerage etc.) is included. First of all, the pipe dux and fuse box is fixed in every unit, pipes are partly collapsed in the structure and some pipes are in sight going from room to room.

It is clear that Molenvliet offers adaptivity in terms of its architectural principles, it does miss growth and shrink possibilities . Although the design seems to be able to be adaptive, it practice this hasn't been happening. Molenvliet, a project that is build around adaptivity has been extremely fixed and frozen in time since the first tenants.

# 5.2 COMPARITVE CASE STUDIES

Now that Molenvliet is researched, comparitive case studies will be hooked on. See figure 20.
The comparitive case studies are selected from the long list case studies, making sure that all thee theories and elements of their proposed definition are covered. See figure 19.

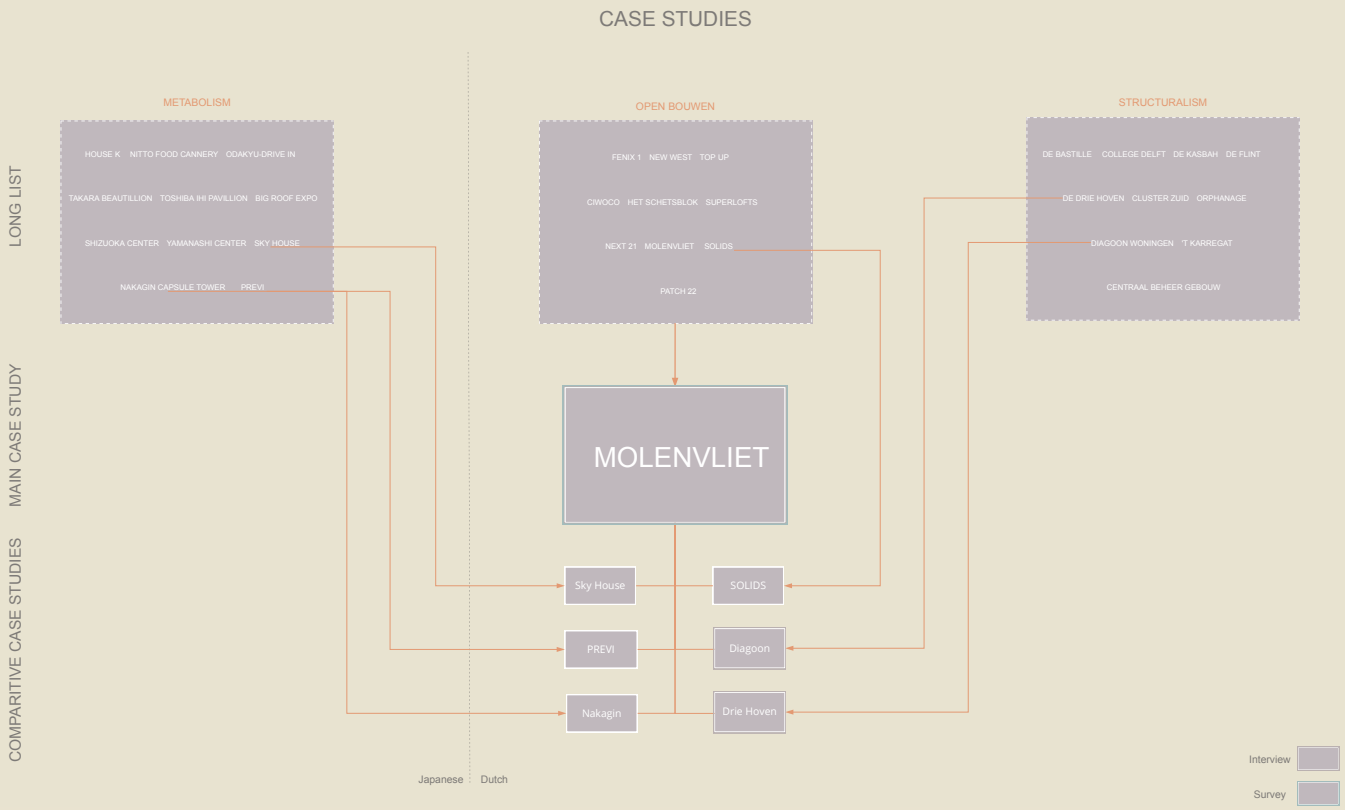



Figure 19: Selection comparitive case studies (own illustration)

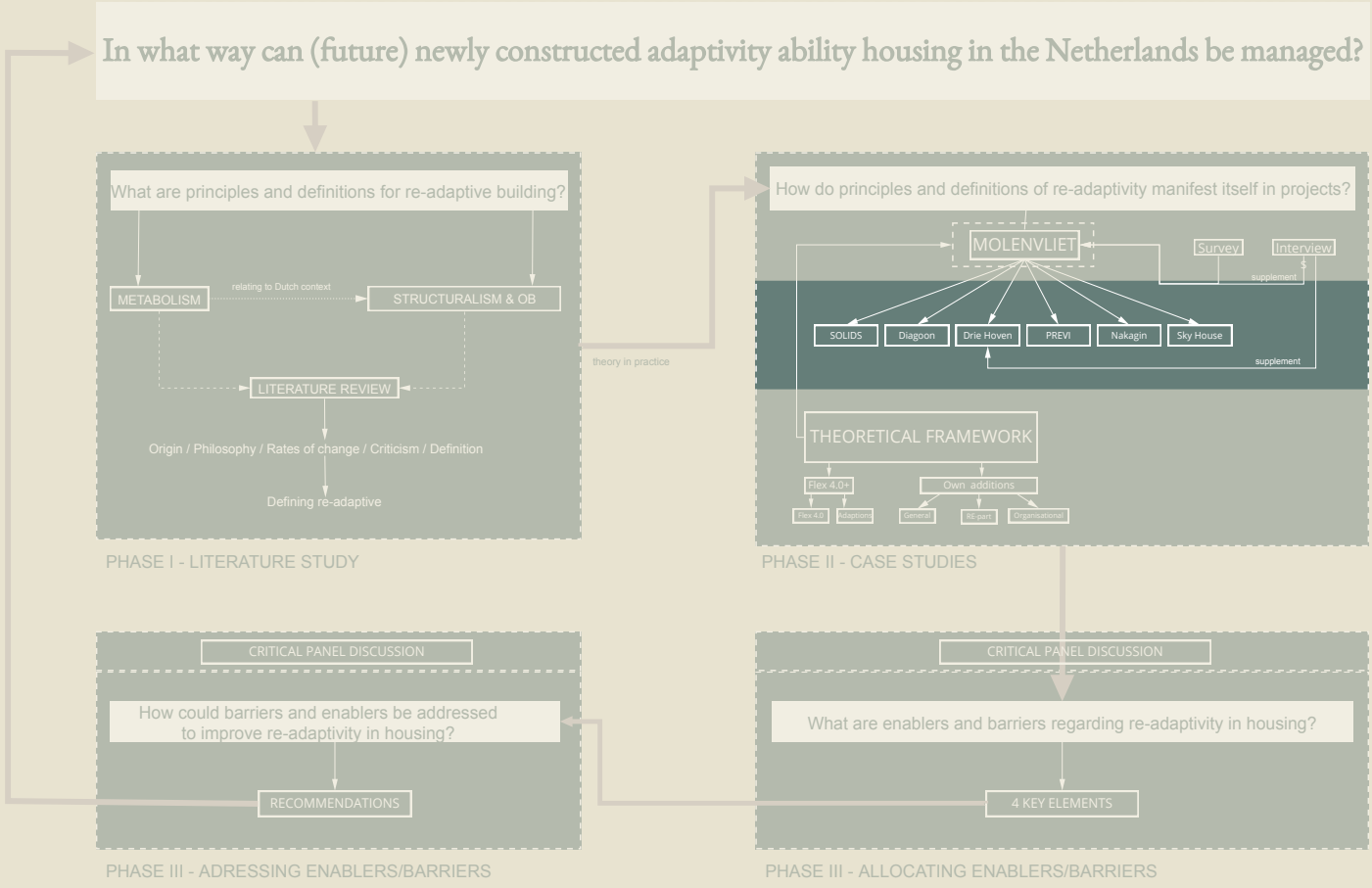



Figure 20: Research framework – phase II – case studies – comparitive (own illustration)

## Projects and relationship with Molenvliet and reason to incorporate in research

The following projects are incorporated as comparitive case studies and for the following reasons:

### Open Bouwen

#### Solids

The Solids is a large scale contemporary housing (and mixed-use) project with the structure-infill principles. It's like a successor of the Molenvliet, with additional elements, newer techniques, high rise and located in the inner city. Furthermore, in-depth evaluation has been done on the Solids.

### Structuralism

#### Diagoon woningen

Similair to the Molenvlliet, the Diagoon woningen are also experimental housing with structure-infill principles in both the spatial lay-out and façade elements.This project overlaps with structuralism and open t doesn't include resident participation, but shows the resident freedom in a very different way, namely the polyvalence of spaces.

#### De Drie Hovens

De Drie Hoven is also a housing project – although especially focused on elderly. The Drie Hoven is a good schoolbook example of structuralism with its geometric floorplan, mulitieplied and repetitive structures, the city-like spatial organisation and strong focus on social interactions. It ticks on lots of boxes of structuralist characteristics. Unlike Molenvliet, it doesn't include resident participation or direct resident freedom. It does have a strong focus on social interaction. Also, however still interesting in terms of the very like structuralism characteristics and especially because it got broken down and the reason behind it might be very important. As an extra example and sub-comparitive case study, the student housing in Weesperstraat is also mentioned, which shows another example of common spaces, polyvalence and mixed use. The student housing Weesperstraat can be found in Appendix 8.

### Metabolism

#### PREVI

PREVI is a good link between Metabolism and Open Bouwen. It is also experimental housing with a low rise high density for residents with a social income. No resident participation, however a lot of resident alteration. This didn't happen with Molenvliet, although it was anticipating it. So interesting because it shows possibilities without the (Dutch) regulations.

#### Nakagin Capsule Tower

It is interesting to see the structure-infill part in a different way: structure is the steel framework and infill the very uniform capsules. Unlike the individuality of Molenvliet, every capsule was the exact same. In stead of changing within the unit, the idea was the replace the whole unit. Resident organisation seemed to be a strong barrier. The Tower is about to be demolished, so interesting to see why. Also, the Nakagin will be shortly compared with Sky Building nr 3 that had similar principles as the Nakagin but instead actually did get redeveloped. The Sky Building nr 3 sub-comparitive case study can be found in Appendix 9.

#### Sky House

A metabolist example of Molenvliet can be the Sky House. The sky house can be regarded as a first built prototype of Metabolist proposals. It links both with the Nakagin (of placing and removing units) and Molenvliet (resident freedom to change spatial lay-out). What is especially interesting is that it also links with the Diagoon Woningen in terms of the possibility to grow the house. Also, the moving-nets are an interesting take that none of the projects (directly) include.

This chapter releates each comparitive case study with Molenvliet.
These are comparative case studies that 'hooked' on to the main case study, to show additional or different angles. To be able to place case studies next to each other, they must be fundamentally comparative and therefore similar in important aspects. The main aim of the comparative case studies is to find the differences in terms of the way adaptability is incorporated in housing. It's interesting to see where the similarities and differences lie, and which extra teachings can be derived from this. Note that some cases are a bit more elaborated than other. For the full comparitive case study research see Appendix 12. This is due to the amount of information that can be found. Followed by a conclusion of the comparitive case studies. Lastly, all the case studies (including Molenvliet) are put next to the proposed definition of re-adaptive.

## 1. Solids

The structure-infill principle, as also used in Molenvliet, is also incorporated in the Solids. However, different from Molenvliet, the structure (structural framework including collective pipe outlets, collective technical infrastructure and unit dividing walls) are in ownership of Stadgenoot. The infill is in ownership by the tenant. The tenant pays rent for on top of facilitating their own infill. The tenant can freely trade their install elements and propose a subsequent tenant. Due to the auction rent, the tenant can determines at his own discretion, expanse, amount of sqm, the use, the location within the building and the layout.

What is also similair to Molenvliet is the exceptional regulations in which the central government, the municipality and the city district, in collaboration with the necessary lawyers and other experts, made room for some exceptions to enable the necessary freedoms in terms of not needing to meet regulations with regards to the zoning plan, housing allocation, housing withdrawal and suitability criterium.

The third similairity with Molenvliet is that the adaptivity wasn't necessary the main selling point for residents. The Solids were largely marketed as adaptive, structure-infill, big accommodation capacity resident freedom of choice dwellings, however the most important factors for tenants were a) the location b) being able to have an influence through the auction and c) exemption from the regular housing rules. Furthermore the presence of private outdoor space seemed to be an important factor for tenants.

What came newly forward during the research on Solids is that the overdimesioning creates and both hinders flexibility. For instance, levels can't be vertically merged through an internal stair. Also overdimensioning creates a substantially larger sum of initiation costs and the question remains where the right balance lies between overdimensioning and costs-profit. The initiation costs of Solids are almost twice as high as regular new housing construction. The high costs are argued by the concept development and high pre-investment in the maximum accommodation capacity of the building. Of course the first Solids has a higher price since this includes concept development, marketing, communication and such. The learned lessons and accumulated knowledge from this, contributes to next Solids. However, a next Solids is not in sight anytime soon as the evaluation of the Solids states that the chance of Stadgenoot building more Solids is not great largely due the the concept being too risky and expensive.

Although important parameters are not known or likely to change strongly over time (such as actual life span, residual value, change of functions, rental incomes, vacancy, management and maintenance costs), the expectation is that there will be lower depreciation of investments, lower maintenance costs and higher yields because of 1) the high-quality materials (not so much related to re-adaptivity), 2) constructional measures for flexible future use (overdimensioning), 3) the infill creates lower maintenance complaints and lower mutation maintenance 4) lower risks of low rents and/or vacancy due the large accommodation capacity (both technical and planning-legal) and the substitution and negotiability of installation from departing tenant to new tenants. What was also very Solids-specific was the rental auction process. However this form of resident individuality again is only beneficial to the first tenants. Secondary renters are 'usual'/normal renters. On a good note, the auction resulted in higher rents, and residents were satisfied with the auction rent process.

Something that Molenvliet had no mention of, was the importance of the location. Reasons that there is vacancy in Ijburg is also largely due the less attractive location as the Solid at Ijburg becomes less attractive with its finishing level (infill investment), monthly payment, absence of own outdoor space and the cramped collective traffic space.

Unlike Molenvliet, Solid did show signs of adaptiveness. Namely, in later phases it was decided to create more Solid spaces. This needed additional front doors and so also additional traffic spaces. As a result however, narrow and unattractive collective traffic spaces were created.

## 2. Diagoon woningen

De Diagoon woningen has a similar structure-infill principle, however in a very different notion. The structure is the structural construction and the infill is the way of using the spaces within this framework.
The floors, kitchen and wet rooms are already determined, so with regards to the spatial layout there is ultimately little to no variation and freedom. In the light of adaptivity, it's more about the polyvalence - change of use- of the use in the fixed floor plans rather than the direct spatial change. The resident freedom lies in the use of space. Polyvalence of the dwelling is possible due the floors being layered in different heights and the possibility of each part of the floor being able to be separated as a separated room as well. The open vide from ground floor to roof creates a confluence of spaces. What is very similar to the Molenvliet is the façade design that has a certain schedule, in which the resident can decide which parts they want to have open or closed panels in.

Unlike Molenvliet and Solids, Diagoon does offer possibilities to add ons to the dwelling. Each house has its own garden, two roof terraces and a balcony above the entrance. This part under the entrance can be pulled to the house. Terraces can be enlarged and thus also a larger area below the terraces can be pulled to the house. At the roof levels rooms can be added too. Although Diagoon didn't have resident participation in the design phase like Molenvliet, it does however show direct signs of growing their spaces. All houses are different as several residents made use to expand their house, such as additional terraces to the kitchen and the carport being pulled by the house to enclose it. Shrink is not seen. Reason that Diagoon shows growth can be due to the full ownership of the dwelling, being land bound and all units being detached from each other.

## 3. De Drie Hoven

De Drie Hoven was a home for many eldery of different care needing levels. These considerations contributed to the concept of developing a single continuous structural framework based on the same modular unit to suit the requirements of the very varied and complex program. Columns, beams, and flooring are arranged in a predetermined and uniform order. Through the expression in patterns of the streets, squares and central encounter areas the building functions as a small city and the social interaction moments are prioritized. In terms of accessibility and amount of amenities, the complex also had to be conceived as an urban area rather than conglomerate of separate buildings.
Currently most of the project is demolished and the last tower will be too. A new senior-specific apartment mainly due cut down subsidies making Drie Hoven not financially vital anymore and that is seemed not overdimensioned enough and thus not meeting current requirements.

What comes most strong forward in de Drie Hoven, that seems to be not mentioned as strong in the other case studies is the social interaction. Social interaction, and its importance, is mentioned by Metabolism, Structuralism and Open Bouwen. For re-adaptive housing social interaction can be very important because social interaction leads to more mutual understanding. This can be especially important when housing units are adapting over time, since this can also have an influence of the living of the neighbour. Adding elements for social interaction can be difficult because it's not always possible to link it to a direct function and thus the financial profitability doesn't directly translate. This asks for a different approach. De Drie Hoven did this by adding public functions in a center square (De Drie Hoven) and the Weesperstraat by using the plinth. Adding such elements can help these social interactions while also being profitable for the public functions as they can expect a certain amount of users. These public functions however must be in interest of the residents. For instance, in the Solids, the public functions don't enhance social interaction as much since these are largely short-stay functions (hotels and such). In de Diagoon Woningen social interaction was tried to stimulate by not adding strong boundaries between entrance units. However, it turned out that residents themselves added hedges and fences.

In both the Drie Hoven resident freedom and/or re-adaptivity is not seen at all. There is an element of freedom, namely the polyvalence of common space (interieur) elements such as using certain plateau's as tables, chairs, etc. The fact that there is barely re-adaptivity can also be due to the very specific target groups. Both elderly and students are fixed in their household profile. De Drie Hoven is specifically only targeted at elderly and the Weesperstraat only at students. Once they outgrow this phase, these residents will move and thus adaptivity is also drastically less needed.

## 4. PREVI

The ability to respond to things is a key metabolic component, as the PREVI homes were also built to be open-ended and able to transcend generations. The structure is a platform for expansion and progressive adaptation to the family's needs throughout time, as evolution and subsequent adjustments were foreseen. This may still be observed 43 years later, as the residents have all drastically altered their homes.
The amount of changes and expansion weren't always as anticipated and planning and although the construction of the initial design was fundamentally supportive of this. Up to four more floors can be found in certain homes. Because the Metabolists utilized stricter seismic structural signals, the unrestricted expansion was allowed in a highly seismic zone. Even if it was not in favor of functionality or notably safety, it was somewhat flexible in allowing residents to grow in their dwellings. However it still isn't very safe since there is always a snapping point. This should have been informed to the residents beforehand.

There was no resident participation, but a lot of residents took own initiation to change/adapt their dwelling. This was all done without consultation. This could partly be due its culture, where people might prefer 'DIY' rather than hiring consultants and professional builders. What could be a stronger argument is the difference in the strictness of rules and regulations with regards to adapting existing buildings, and the requirements with regards to amount of sqm, dimensions, zoning plan, etc.

What is notable of PREVI –other than the high degree of adaptivity– is that it shows that households fluctuates not simply in terms of physical composition, but also in terms of social standing. The austere choice of finishing, which was the first building aspect to be contested by the residents, exemplifies this. This is something Metabolism overlooked. Molenvliet also had individuality in the facade (although this was a lot more subtle), but got uniformed by the housing corporation due to easier maintenance.

Lastly, rooms on the ground floor were also converted into shops that served the surrounding community by utilizing the façade as a storefront. Here we can see that if community serving public functions are not initially included in the project, the residents themselves will include it if the possibility is given to them. This again links back with building regulations, as in the Netherlands there is usually a strict zoning plan that includes or excludes public or retail functions.

## 5. The Nakagin Capsule Tower

The Nakagin Tower includes two towers with a plug–in system of high tension bolts. The 144 minimal housing units in the form of capsules are hooked to the two interconnected towers. This shows a fixed system (the towers) with interchangeable parts (the capsules).
To include the living space rhythm, the capsule units were supposed to be replaced every 20–30 years. After 50 years, no units have been replaced due the functional issue (of being unable to take out capsules horizontally) and an organisational issue (disagreement between tenants). The 25 year change was noted as a social one instead of technical one. But the question is who decides what the social changes are? Because if you look at regular rowhouses, some of them are 100 years old and have the same if not very similar lay out as newly constructed row houses. Now, the statement is not that this is perse correct, but it does make the question bigger of what exactly is then different every 25 years. Especially, when this means that all the capsules are all getting renewed with all the same new lay–out.

The idea of a steel tower structure, with capsule infills could be enhanced even more when the capsules themselves also have more flexibility and its own infill. The capsules are very rigid and fixed. All units were exactly the same and were all fixed. There was no space for resident freedom and/or adaptivity, other than residents having the possibility to purchase extra options (such as a telephone, tv, etc.).
Grow and shrink isn't much included. All units are separate and thus not connectable to each other either. Grow and shrink is in principle possible when removing or adding capsules. This is on a building level as a whole, and not on housing dwelling level. Because what makes the Sky Building a success, is the redevelopment of the project since the capsules were flexible within the capsule and the spatial lay–out could be changed.
There was no resident individuality, but rather everything was all the same and every unit was supposed to be changed as a whole.  Not replacing the capsules in combination with the poor maintenance results in conditions so severe that replacement of capsules is in large favour over renovation.

## 6. Sky House

The sky house can be regarded as a first built prototype of Metabolist proposals. It shows links with the Nakagin Capsule Tower as it also works with capsules and with Molenvliet/Solids in terms of structure–infill, and with Diagoon/PREVI as it shows direct signs of adapting and growth. The infill–structure principle can be seen in the permanent, open living space floats above the ground on long thin columns, surrounded by temporary other spaces. It is made up of a single square multi–functional space divided by discrete cupboard walls. Unlike all the other case studies, The Sky House actually does signs of growth and shrink through the move–nets.. Move nets are extensions of the main cell (large open area) that can be plugged into the floor, thereby turning the floor into a net on which a new cell –capsule– can be hung. This capsule can be for different functions. Initially, the ground level was unoccupied, but it was progressively filled with spaces thanks to move–nets. To be able to grow and shrink the dwelling can be due the fact that this is in ownership, it's a ground bound undetached dwelling and is located in Japan with possible different rules and regulation on such dwelling adjustments.. For a rental dwelling units that is located in the Netherlands and bordering on other units, it might be less likely for these adaptations to take place with regards to –especially– the moving nets. The question is what this would be mean for a tenant, especially with regards to the move nets. For instance, these could be added by the corporation resulting in a higher rent price. And when these are not needed anymore, the housing corporation could 'take them back' and lower the rent price again. Further research could be based on how moving nets can be (technically, spatially and organisationally) be incorporated into rental complex dwellings.

# 5.3 CASE STUDY CONCLUSION

### Molenvliet and Solids

The structure-infill principle as can be seen in both Molenvliet and Solids with Molenvliet also having resident participation with regards to designing the floor plan. Solids have a resident participation with regards to the auction (deciding their own sqm, place, composition etc.) and their ownership of the infill components.

The Molenvliet is basically frozen in time and nothing has changed ever since it was construced. Solids functions a lot more as adaptive than Molenvliet due its high accommodation capacity in terms of both allowable functions and overdimensioning. Also since the infill is in ownership of tenants, they are able to change this. With regards to the Solids, good evaluation needs more time. However, growth of places is not implemented in the project. Solids, like Molenvliet, has (yet) shown no signs of re-adaptiveness.

### Diagoon woningen

The resident freedom and adaptivity is approached so differently, that the question arises of which way provides more freedom and is more '(re)-adaptive' than the other.  De Diagoonwoningen has no resident participation but rather a notion of polyvalence of the fixed staggered floors making changes in the spatial lay out a lot more difficult and fixed, but providing a change of using the spaces. .

The Diagoonwoningen shows more direct signs of adaptiveness (through the extensions made) however this can also have to do with the ownership and the fact that these individual units (as opposed to Solids and Molenvliet were e.g. shafts are shared and/or units are directly placed next/under/above each other). Architecturally and structurally speaking, the Diagoonwoingen are a lot more fixed because of the staggered floors. Also, Diagoon woningen is also not re-adaptive.

### De Drie Hoven

Although Drie Hoven doesn't show any signs of adaptivity of re-adaptivity, de Drie Hoven does shows polyvalence and a strong focus on social interaction – two elements that are missing in previous case studies. Furthermore it explains possibilities of linking social interactions with a financial picture and since it's demolished, the importance of overdimensioning. Overdimensioning is stated in Solids, but De Drie Hoven validates that this is indeed an important aspect.

### PREVI

PREVI has no resident participation, and/or structure-infill elements but as the design was anticipated on open-end and growth. In terms of adapting the dwelling by resident initiation, the PREVI might be the most (re-)adaptive projects. This can however be due to ownership in combination with the building regulation differences and cultural differences (in many cultures it's more common to take own initiative in changing the house). PREVI also validates again the resident desire of having a mixed-use location.

### Nakagin Capsule Tower

The Nakagin Capsule Tower seems to be the project with the most philosphy of renewal and change – however never practicing any of it. This can be due that there is zero form of resident invididuality unlike Molenvliet, Solids, Diagoon woningen and PREVI. Also it doesn't show any polyvalence or social interaction spaces like De Drie Hoven. Change was rather to be made as a whole rather than individual. This however never happend either, partly due a technical issue and a flawed design. But this can be waived as currently there is enough technical knowledge on how to make such a structure were capsules can be easier taken out and a renovation plan was already proposed.  Organisational issues were  perhaps the real issue. All units could be replaced at the same time, but this needed a communal agreement and proved to be impossible as the unit owner's opinions were too different. Refurbishment of all the units needs, of course, 100% agreement. This also included communal spaces.

The 144 capsule-style minimum housing units are linked to the two interconnecting towers. This illustrates depicts a fixed system (the towers) with interchangeable pieces (the capsules). The capsule units were planned to be updated every 20-30 years to accommodate the living space rhythm. Due to a functional difficulty (the inability to remove capsules horizontally) and an organizational issue, no units have been replaced after 50 years (disagreement between tenants).
All of the units were identical and given no room for tenant independence and/or adaptability.
There was no resident individuality; instead, everything was the same, and each unit was designed to be changed as a whole. The capsules' life span was more of a social one than a mechanical one. Failure to replace capsules, along with poor maintenance, leads in situations so bad that demolition of the whole tower is preferable to renovation.

### Sky House

The Sky house, perhaps the most adaptive one, includes a structure-infill principle with moving-nets that have been (dis)placed and thus showing re-adaptivity. Resident participation was there however this was the architect's own dwelling. Also with regards to the moving-nets, this might also be possible due different rules and regulations regarding dwelling adaptation between Japan and the Netherlands and due to the Sky House being a detached groundbounded dwelling.

### Re-adaptivity

When we take back again the proposed definition of re-adaptive and set this out to the case studies, it can be seen that no case study is re-adaptive (according to the proposed definition of re-adaptivity). Sky House is the most re-adaptive and Nakagin the least. See table 8. As stated in the literature review, the most [re] elements in re-adaptivity actually came from the definition of Metabolism. The Nakagin Capsule Tower is one of the most 'school-book examples' of Metabolism, yet seems to not be very metabolic in that sense.

Table 8: Definition re-adaptivity to case studies (own table)

| | Grid | Marges | Interchan-geability | Add | Remove | Intercon-nect | Structu-re-infill | Resident individuality | Resident participation | Life cycles |
|---|---|---|---|---|---|---|---|---|---|---|
| Molenviet [5] | x | | | | | x | x | x | x | |
| Solids [6] | x | x | | | | x | x | x | x | |
| Diagoon [3] | | | | x | | | x | x | | |
| Drie Hoven [3] | x | | | | | x | x | | | |
| PREVI [4] | | x | | x | | | | x | x | |
| Nakagin [2] | x | | x | | | | | | | x |
| Sky House [8] | | x | x | x | x | x | x | x | x | |

Sky House seems to have elements of the previous case studies, but is the most adaptive and re-adaptive due mainly its introduction of moving nets i.c.w. the structure-infill principle. This can be due ownership and location None of them re-adaptive.

| | |
|---|---|
| Molenvliet | [structure-infill, resident participation, re-allocation, grid] |
| Solids | [overdimensioning, rental auction, ownership infill] |
| Diagoon | [growth, polyvalence] |
| Drie Hoven | [validates overdimensioning importance, mixed-use, grid] |
| PREVI | [resident individuality, open-ended design, resident freedom, mixed-use] |
| Nakagin | [structure-capsule, organizational issues common agreements] |
| Sky house | [structure-infill, moving nets, growth and shrink] |

# 6. ENABLERS AND BARRIERS

Now that theory and precedents are researched and also position is taken of both, enablers and barriers can be allocated. The enablers and barriers are focused on the possibility of re-adaptive housing.
After allocating these aspects, they can be adressed in order to enhance re-adaptivity housing. See figure 21.

Note that for both chapter 6 (allocation enablers/barriers) and 7 (addressing enablers/barriers) the critical panel outcomes are incorporated as this happend more simultaneously rather than chronologically.

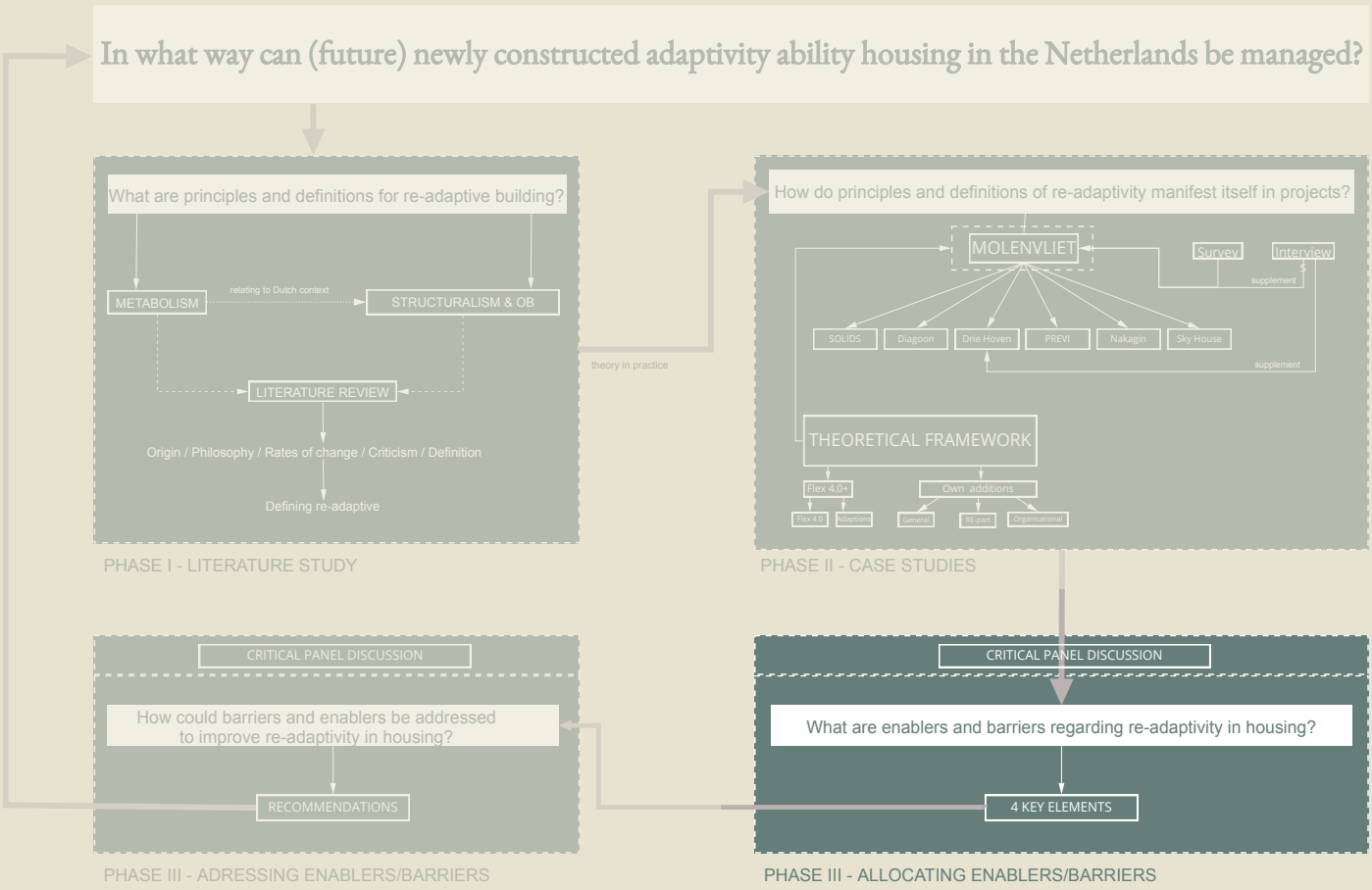



Figure 21: Research framework – phase III – enablers and barriers (own illustration)

# 6. ENABLERS AND BARRIERS

## SQ3: What are enablers and barriers regarding re-adaptivity in housing?

### Aim

Based on previous research questions, enablers and barriers and therefore recommendations can be formulated to possibly enhance re-adaptive building for housing in the Netherlands.

### Content

The insights and retrieved data from the literature study, empirical study, interviews and the survey. From the case studies espcially, the findings will be branched into themes, who again will be branched into main four key elements.

When studying the case studies, the question is what can be learned from them? What turned out to be elements that either strengthened or weakened the adaptability of the building? The barriers are important to know what the bottlenecks are and recommendations can be made for the barriers. . The enablers and barriers that are directly related to the re-adaptivity (with exclamation on the RE-aspect) and organisational matters, are prioritized. From these aspects on, each enabler/barrier can be adressed with a suggestion of recommendation to either enhance the enabler or provide a solution for the barrier.

First this chapter will elaborate on the case studies and theoretical framework, which leads to re-occuring themes. From these themes four key main branches are derived: financial, legal, design and governance aspects. Each main key branch will be then again zoomed in into, to filter the individual statements on this theme relating to re-adaptive housing in specific. Tables per key branch are first summarized to give an overview of the barrier and enablers, along with a notation of where this barrier or enabler comes from. After which, every key branch is further elaborated on.

### Sources

No additional information is searched or used, other than the lessons learned as derived from previous phases of this research and the critical panel. See next page elaboration of the critical panel.

This chapter starts with the critical panel outcome. This is dsicussed beforehand as the allocation and recommendation phase happend in line with the critical panel. After that, an explaination on how the four key branches are formed, followed by a further explaination of each key branch and its elements.

# CRITICAL PANEL

## Aim

Before proposing the final recommendations, the allocated enablers and barriers first will get through a critical backlight from professionals. Professionals from the building environment give their take on the (temporary) conclusions derived from the literature review and case studies. The purpose of the critical panel is to test the accuracy of the recommendations on the one hand, and to create a discussion on the other hand, to find out what the consequences or focus points are when implementing the recommendations. Each professional has a different background and a different type of organisation therefore creating a discussion from multiple perspectives. This will ultimately help to strengthen and, if needed, adapt the recommendations and final conclusions. By validating the outcome by professionals in the field of building development and management, the outcome is more practice-based.

## Content

The recommendations were formulated in the form of a proposition, meaning that they were not very detailed and debateable. This chapter will provide an summary overview of the critical panel and discussed points. The discussion points of each panel will be summarized. See Appendix 11 for the transcript of the full discussion.

## Sources

The critical notions and recommendation from phase III are the starting point for the expert panel discussion. The critical panel team consists of the following professionals:

| Function | Company | Name | Role |
|---|---|---|---|
| Project Manager | NEOO | Linda van Dam | Managing |
| Project Developer | NEOO | Arjen Seckel | Developing |
| Architect | N-Architecten | Arnold Riga | Designing |
| Construction Engineer | Zonneveld Ingenieurs | Pieter Slappedel | Engineering |
| Installation advisor | ILEX | Joop Hulst | Installation advising |
| Resident representative | Bijdendijk Consult - previous board member Stadwonen | Frank Bijdendijk | Housing corporation and resident representative |

The critical panel was held on 11-05-2022 through TEAMS since the panel members are located in different districts. To prevent cancellations, the timeframe was around an hour. In order to make optimal use of the hour, preperation documents were sent. Beforehand a short explanation of the research, proposed definitions as researched in the literature review, a critical panel report and the invitation were send. The critical panel report was a first initial report of the enablers and barriers based on the case studies. See Appendix 10. The invitation also included a short explanation of what the aim is of the critical panel, what my role will be, what their role will be/what is asked from them, a short planning of the hour and how the critical panel will be held. Furthermore, it was also stated which critical notions-recommendations would be most important for which professional. See Appendix 10 for the sent reports to the critical panel.

Initially the idea was to structurally go through every point. However, it was quickly clear that discussions happen more organically, therefore also a more organically approach was used by letting the discussion happen and intervening when it was time to go the a next statement. Recommendation points were linked together based on what the discussion at that point was. Furthermore, to prevent that only certain members spoke more than other, it was asked to the less speaking members what their thoughts were. The panel started with a quick and short repition of what was stated in the inventation, followed by an open question of what they think the biggest enabler and barrier is of re-adaptive housing. Secondly, the discussion started with the critical notion-recommendation points. The critical panel finished by a round of everybody stating what their overall conclusion was after the discussion.

## Summary of the critical panel's discussion

The discussion was based on the critical notions as sent before, which were in short the following notions:
1. Adaptivity not a selling point; 2. Resident participation; 3. Building rules and regulations; 4. Ownerhsip; 5. Social interaction; 6. Overdimensioning and growth; 7.Adaptivity possibilities; 8.RE-part in re-adaptivity and 9. Installations. See figure 22 for the most important conclusions/points from the critical panel memebers.

The construction engineer mentions that housing dwellings are mainly bought based on the location and less wether it's adaptive or not. In terms of structural construction, growth can be anticipated by calculating several floors in advance but these are expensive costs in advance however afterwards cheaper. With regards to cast concrete constructions, column strips can be made in closed walls. Furthermore he mentions that schools and offices are usually more adaptive than housing because of their higher free ceiling heights. Having high ceiling

heights for housing can sometimes lead to not being able to make an extra building layer. In terms of ceiling heights, especially housing is more difficult since installations are often casted in the floor and therefore new installations would either have to be placed above or below the floor. He concludes that construction-wise there are a lot of possibilities however costs is what it determines the most.

The installation advisor mentioned that it's more common to see flexibility in the form of function change where e.g. offices and schoolbuildings are changed into housing and not so much the other way around. Furthermore, he noted that installations are especially difficult in terms of (re-)adaptivity since residents share floors together in stacked construction. He stressed the importance of having shafts and fuse boxes being aligned above each other and the possibility of incorporating a core in every housing unit. Although installations will stay a knot for (re-)adaptivity, this centered core enables more possibilities as installations can be branched from four side.

The architect agreed with the installation advisor in terms of stacking shafts and fuse boxes with incorporating a core in each unit. Furthermore he sees possibilities in terms of resident participation but there is a high chance that investors don't want to incorporate this because of costs. He mentions that Program of Requirements are very strict, and therefore give no space for (re-)adaptivity. The architects gets assignments from the developer, which is mostly money driven. Sometimes he sees developers offering options of extensions and/or dormer windows, however these are related to onwer-occupied housing and this isn't seen in rental apartments. Although it rarely happens, sometimes the assignment does include designing the possibility to later connect apartments together by, for example, giving the option to make openings easily or connecting walls.

The project manager mentions that there is a different amount of interest and incentive for the different parties. Consultants and the developer do 'their trick' -based on a given assignment- and leave, while the investor is in it for the long term. The developer is making assignments based on the Program of Requirements that is given by the investor. Furthermore she mentions that social interaction can find place in shared spaces that can be exported separately. With regards to height, she agrees with the construction engineer that if on every floor the free height would be over dimensioned, it could save a whole building floor that can't be rented/sold. Furthermore she stated that it would be beneficial if municipalities could be more free and easy with their laws and regulations in terms of new construction. She ends that re-adaptive is also about giving up space, and raises the question on who is willing to do that – especially in this housing market.

The representor disagrees with the non-feasability as he has build Solids previously. He states that the Solids had higher returns that they have been calculated on the front end. Applying adaptivity capacities in building requires around 15-20% more expenditures but return comes higher with 30%. He agrees that adapvitiy is only possible with a long-term vision and a broad(er) zoning plan. He is aware that pension funds don't think about adaptability of dwellings and notes that the real estate world is very conservative and a change of mentality is needed. He also states that the highest valuation can be retrieved from housing in mixed-use areas.He furthermore agrees that re-adaptivity starts with the client and the investor should not think in initiation costs but returns – on the long term that being. The need for adaptivity exists only over time. Flexibility does not show itself very strongly in the initial view.

The developer notes that he is bound to a strict assignment from the investor where everything has to be brought back exactly to the building decree and optimization of gross floor cap vs net floor cap is very important. There are also strong other requirements such as sustainable building and gasless building, which leads to other things such as re-adaptivity to be taken out as the first requirement. He does sees possibilities in re-adaptivity in the terms that it's something over longer periods of time such as trends instead of smaller individual changes. For example from large to small units, in which the owner himself makes the choice to change the building layout based on changes in market demand. For him too, everything starts with the client and the client must be someone that is a long shareholder of the project. One might think that pension funds are in it for the long term, yet the pension funds give strict program of requirements with short term visions. Although he understands the importance of location and social interaction for (re-adaptive) housing, getting extra appreciation from this is difficult due to the 40/40/20 rule (Amsterdam), which in principle cannot be achieved with just the housing because then you are already at the maximum rent and never get extra appreciation for everything else. Extra appreciation -in terms of higher rents and higher yields- can then only be gotten from the 20% free sector. Social interaction spaces can be achieved by calculating this into service costs. In order to possibly convince investors of re-adaptive housing, good examples have to be cited or good plans could be made with the architect. Then it could be possible to ask for a higher investment. However this is very difficult due to the enormous pressure at the housing market at the moment.

The discussed points have been incorporated in both the allocation of the enablers and barriers, as well as the way to adress these.

# CRITICAL PANEL DISCUSSION

## DESIGN

### ARCHITECTURAL

resident participation and re-adaptive designing is possible

### STRUCTURAL

lots of possibilities

### INSTALLATIONS

difficult due shared floors possbilities with stacked shafts and fueseboxes in central core per unit

### COMMON SPACES

can be exported seperately or caluclated in service costs

## FUNCTION CHANGE

### SCHOOLS AND OFFICES

schools or offices seem to be more re-adaptive due high ceilings more common for a school or office to be adapted to housing than the other way around

higher ceiling heights can costs a building layer

## LOCATION

### VALUE ADDING

difficult to get the extra appreciation

## Different parties

Short incentive (consultants) and long term (investor)
short term vision and long term vision

## Investor should have longer term vision

COSTS

BRIEF

Resident representative

Developer

Project manager

Architect

Construction engineer

Installation advisor

Investor

Figure 22: Critical panel discussion (own figure)

# 6. ENABLERS AND BARRIERS

## SQ3: What are enablers and barriers regarding re-adaptivity in housing?

### Four themes

When the theoretical framework gets put an axis with all the previously mentioned case studies, each case study can be put next to each other in terms of the theoretical framework elements. In figure 23, the upper line shows the theoretical framework elements with perpendicular to that, all the mentioned information as is given in chapter 5. The horizontal axes here under are the case studies – Molenvliet, Other Projects, Solids, Diagoon woningen, De Drie Hoven, PREVI, Nakagin Capsule Tower and Sky House. Note that 'Other Projects' are the projects that Frank van der Werf additionally mentioned in the interview. The case studies and statements are either given a green, red or neutral bullet. Green shows that this statement is indeed applicable to the project, and red that this is not the case. A neutral bullet can either show that there is no data on this, or this is not relatable/linked. to the project.

Zooming out on all the case studies with this figure, there are certain gaps or densities noticeable. The first one is that some projects have more data/relevance to the theoretical framework than others. Eg. Molenvliet and Solids are the most elaborated. Most of the big gaps can be found in the resident valuation of their dwelling and financing aspects. These are mostly gaps due having no data on it. A first notion that can be made is that although the case studies 'more or less' are build on the same idealistic ideas of adaptivity, they all include and exclude certain elements. What's most applicable to most projects is the restriction by certain design elements, having a continuous structure, contractor build everything, having regular shaped openings, infill to be changed frequently and having installations controlled per unit. What has to most red bullets are resident participation elements and elements that restrict certain design elements and growth/shrink possibilities.
Resident valuation and financing information is largely missing, which could be a great importance for the conclusion. Design related elements are not only large in volume (amount of times mentioned) but also in applicability (amount of projects being able to give a green or red bullet). Growth/shrink is largely underexposed and the 're' in re-adaptivity seems to be missing.

The next step, is to branch each statements together to larger branches that have an overarching theme.
The following branches are being formed: rules & regulations / costs & profits / depreciation / ownership / shrink / growth / architectural / technical / overdimensioning / resident participation / resident opinion / resident organisation / social interaction.

These branches can again be formed together into bigger key-branches. For example, shrink / growth / architectural / technical / overdimensioning all has to do with the design aspect of (re-)adaptivity.
The following main branches are formed: financial, legal, design and governance.
Figure 26 shows these four key branches and their elements.

Each key branche can be traced back to individual statements explaining what this key branch entails. Each key branch has its barriers en ablers – these are derived from the case studies. All the case study information is 1) filtered to the key branch and 2) filtered to look specifically to elements that are related to the proposed definition of (re-)adaptive. These are: structured grid system, with marges related (overdimensioning), interchangeability, expandability, possibility of multiplication, add/remove/interconnect. structure-infill principle, differentiation of life-cycles, personal individuality of user and user participation.

Each key branch is summarized first with a table with its barrier and enabler. The numbers in the racket [number] explain where this enabler/barrier is derived from. See table 9, 10, 11 and 12.

| | | |
|---|---|---|
| [1] Molenvliet | [2] Solids | [3] Diagoon Woningen |
| [4] De Drie Hoven | [5] PREVI | [6] The Nakagin Capsule Tower |
| [7] Sky House | [8] Interview Frank vd Werf | [9] Interview Herman Hertzberger |
| [10] Survey | [11] Critical panel | [12] Own discretion |

After the overview, each element will be explained further. See figure 24 for all the barrier and enablers per key branch and its complexity.

## FINANCIAL

Table 9: Overview barriers and enablers – financial (own table)

| BARRIER | ENABLER |
|---|---|
| High initiation costs due overdimensioning [2] [9] [11], concept development [2] | High accommodation capacity [1] [2] [4] [5] [7] [8] [9] [11] |
| Selling point, evaluation high by residents is not necessary the re-adaptivity nature, but rather the context and location (mixed-use) [2] [11] | Infill in ownership tenant and thus lower depreciation investment, lower maintenance costs [2] [5] [7] [11] |
| Needs long term vision [9] [11] | Higher yield [11] |
| | Longer depreciation [1] [2] [4] [7] [8] [9] [11] |
| | Re-allocation possibilities [1] [2] [8] [9] [11] |
| | Rent in stead of sell – Also possible for starters to invest in their housing bit by bit as they rent structure and own infill. [2] [5] [11]<br>Also to prevent friction between individuals, umbrella ownership is of a third party [6] |
| | Rent auction can lead to higher rents [2] It must be said however, that in this very tight housing market, the maximum for social rent and mid segment rent can be asked anyway [x] |
| Social interaction and common spaces can't always be financed [9] [11] | Social interaction, common spaces, can be done through adding mixed-use in the dwelling [2] [4] [5] [9] [11], residents valuate higher too [2] [11]. Making not only the tenant want to pay more but also generate more income from the mixed-use activities that can be exploited [2] [5] [9] [11] |

## LEGAL

Table 10: Overview barriers and enablers – legal (own table)

| BARRIER | ENABLER |
|---|---|
| Experimental – (Re-)adaptive housing seems to be more and exceptional thing rather than a norm [1] [2] [3] [5] [6] [7] | With predicate experimental, exceptions are possible [1] [2] 5] |
| Building decree – rigid and strong requirments [5] [7] [8] [9] [11] | |
| Zoning plan – hold back adaptivity in terms of a fixed amount of housing units, with a pre-decided amount of size and the allowance of certain activities [x] [2] [1] [11] | |
| Beauty committee – how will the beauty committee react when the façade might change due the adaptivity and individual nature of the project? [x] | |
| Monumental – On the other hand, it also prevents change and adaptivity [9] | |
| Tenant contract – not in ownership [1] | Possibility to have (infill in) ownership [2] [3] [5] [7] |
| Tenant organisation – how to deal with communal decisions? [6] | |
| Permits for adaptivity [x] | |
| Ownership question: in ownership shows more adaptivity signs [2] [3] [5] [7], yet tenant is preferred in terms of financing and communal decisions [6] [11]. | |

## DESIGN

Table 11: Overview barriers and enablers – design (own table)

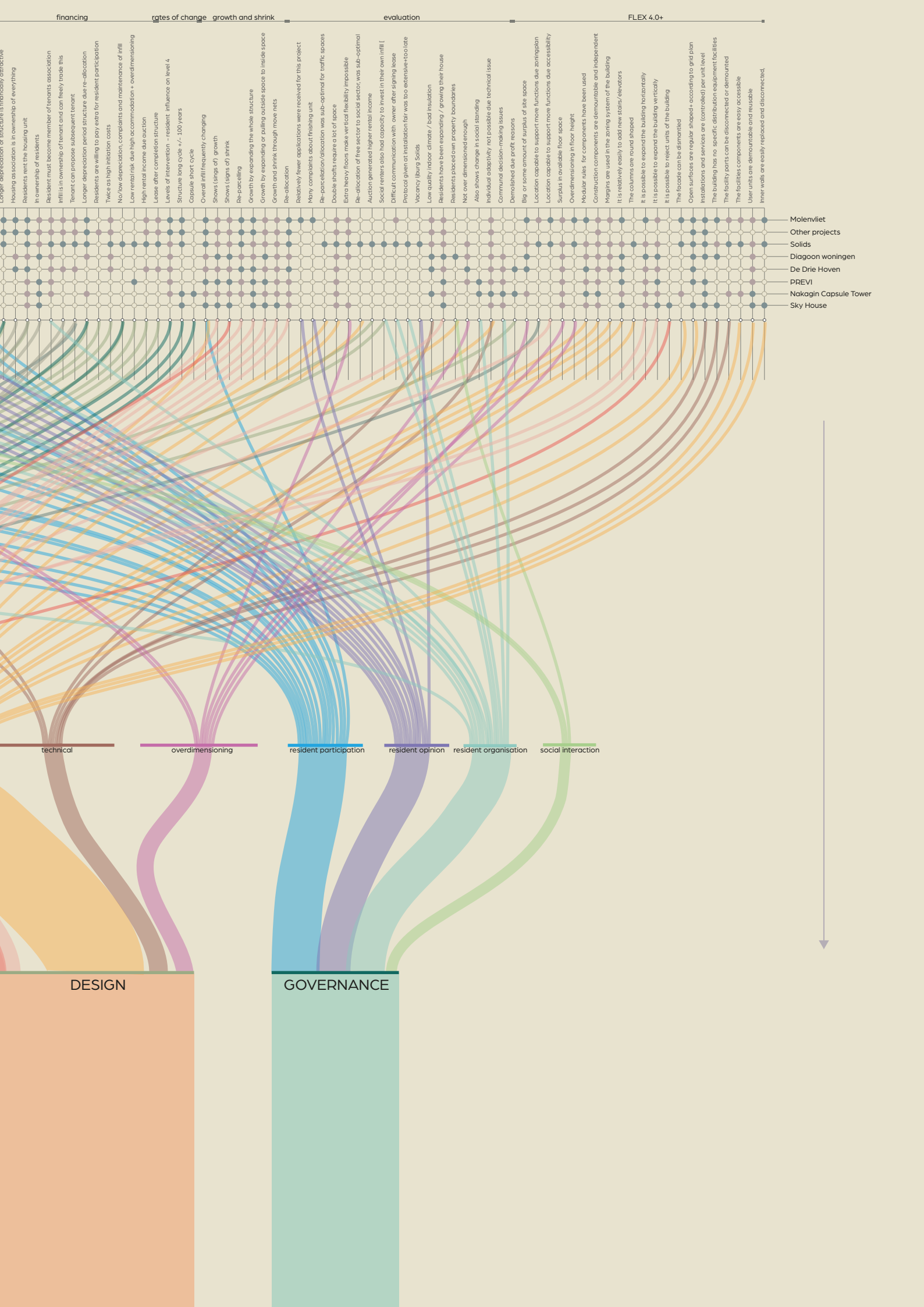
| BARRIER | ENABLER |
|---|---|
| | Adding common spaces for social interaction [1] [4] [8] [9] |
| Too much overdimensioning can form structural restrictions (e.g. no possibility of vertical connecti–ons) [2] [11] | Overdimensioning [2] [3] [5] [9] [11] |
| Most of the adaptivity freedom is restricted by the wet rooms and installations [1] [2] [3] [ | Structure–infill principle with modular coordination and dimensions [1] [2] [4] [6] [7] [8] [9] |
| | Segregating load bearing structure from the rest (façade, infill, installations etc.) [1] [2] [4] [6] [7] [8] [9] |
| | Infill easily adjustable and demountable. Should be freely done by residents. [1] [2] [3] [5] [7] [8] [9] |
| | Polyvalence [3] [4] |
| The individuality and resident participation for a first tenant can be beneficial, however can be frozen in time for both the first and secondary tenant [1] [8] [9] [10] | Resident participation is clearly appreciated [1] [2] |
| Re–parcelling per unit might be more difficult as this has direct consequences for the neighbour [x] | |
| Growth also means taken space somewhere else – vertically or horizontally. this does take away from common traffic spaces, gardens, outdoor spaces etc. [2] [3] [5] This has consequences for the neigh–bours, but also for the cohesion of the building [x] | |

## GOVERNANCE

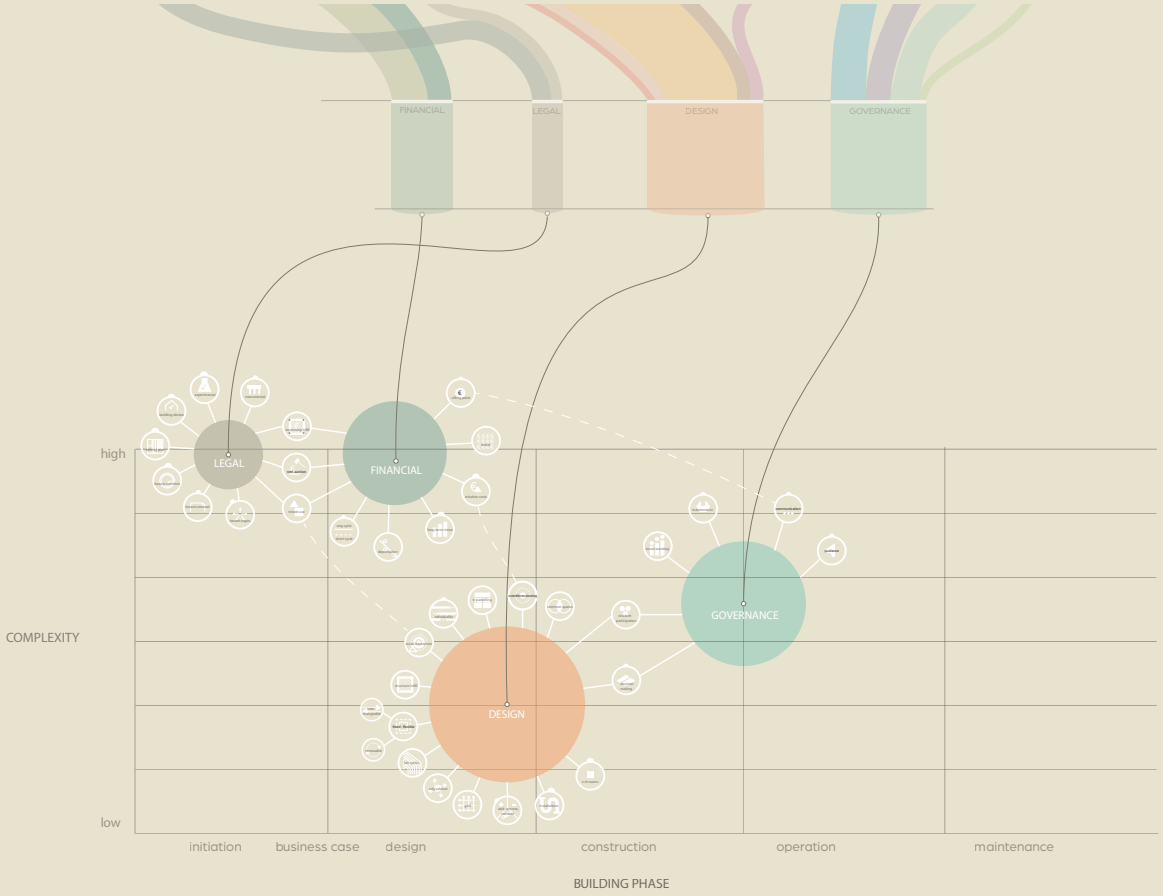
Table 12: Overview barriers and enablers – governance (own table)

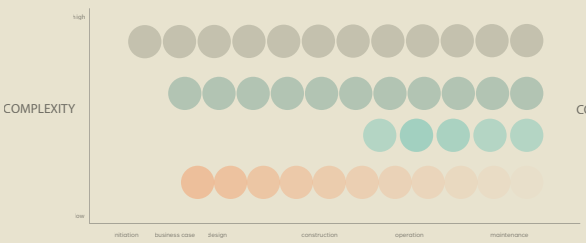
| BARRIER | ENABLER |
|---|---|
| Freedom should always be limited by a set of rules, otherwise it will devolve into chaos [8] [9] | Resident participation is very much valued and resi–dents are willing to invest in their own infill and/or to be a part of a tenant organisations [1] [2]. |
| Residents not satisfied with guidance / organisa–tion. [1] [2] Different organisation is required since (re–) adaptive housing is not a regular thing in the Netherlands, residents should be guided from start to finish – and further since there in essence is no 'finish' with open–ended housing construction [x]. | |
| By separating the structure–infill and commonual–in–dividual, there is a separation of maintenance as well which can lead to different varyties of maintenance [2] [5] [6] | |
| Once communal decisions have to be made, proces–ses can become very difficult and tangled [6]. The amount of communal decisions therefore should be minimized, and giving the building owner this positi–on of deciding on communal property. [x] | |

Figure 23: Case study key branches (own illustration)

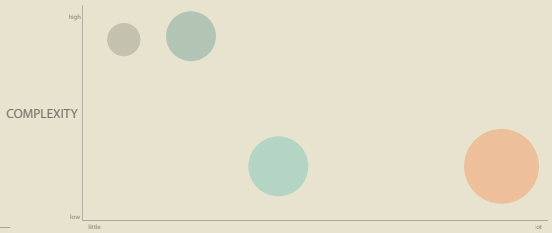

financing
rates of change
growth and shrink
evaluation
FLEX 4.0+
Longer depreciation or structure is financially attractive
Housing association is in ownership of everything
Residents rent the housing unit
In ownership of residents
Resident must become member of tenants association
Infill is in ownership of tenant and can freely trade this
Tenant can propose subsequent tenant
Longer depreciation period structure due re-allocation
Residents are willing to pay extra for resident participation
Twice as high initiation costs
No/low depreciation, complaints and maintenance of infill
Low rental risk due high accommodation + overdimensioning
High rental income due auction
Lease after completion structure
Levels of intervention - resident influence on level 4
Structure long cycle +/- 100 years
Capsule short cycle
Overall infill frequently changing
Shows (sings of) growth
Shows (signs of) shrink
Re-parcelling
Growth by expanding the whole structure
Growth by expanding or pulling outside space to inside space
Growth and shrink through move nets
Re-allocation
Relatively fewer applications were received for this project
Many complaints about finishing unit
Re-parcellation/allocation was sub-optimal for traffic spaces
Double shafts require a lot of space
Extra heavy floors make vertical flexibility impossible
Re-allocation of free sector to social sector, was sub-optimal
Auction generated higher rental income
Social renters also had capacity to invest in their own infill (
Difficult communication with owner after signing lease
Protocol given at installation fair was too extensive+too late
Vacancy (Burg Solids
Low quality indoor climate / bad insulation
Residents have been expanding / growing their house
Residents placed own property boundaries
Not over dimensioned enough
Also shows change in social standing
Individual adaptivity not possible due technical issue
Communal decision-making issues
Demolished due profit reasons
Big or some amount of surplus of site space
Location capable to support more functions due zoningplan
Location capable to support more functions due accessibility
Surplus in available floor space
Overdimensioning in floor height
Modular rules for components have been used
Construction components are demountable and independent
Margins are used in the zoning system of the building
It is relatively easily to add new stairs/elevators
The columns are round shaped
It is possible to expand the building horizontally
It is possible to expand the building vertically
It is possible to reject units of the building
The facade can be dismantled
Open surfaces are regular shaped+ according to grid plan
Installations and services are (controlled) per unit level
The building has no specific distribution equipment facilities
The facility parts can be disconnected or demounted
The facilities components are easy accessible
User units are demountable and reusable
Inner walls are easily replaced and disconnected.
Molenvliet
Other projects
Solids
Diagoon woningen
De Drie Hoven
PREVI
Nakagin Capsule Tower
Sky House
technical
overdimensioning
resident participation
resident opinion
resident organisation
social interaction
DESIGN
GOVERNANCE

# BARRIERS AND ENABLERS




PHASE RELEVANCE




AMOUNT OF FOUND INFORMAITON

LEGAL

FINANCIAL

GOVERNANCE

DESIGN


INTERNAL OR EXTERNAL INFLUENCEABLE

*Complexity
The term complexity used implicates the amount of actors involved, amount of risks related, the amount of commitment that is needed, the amount of information available on such matters, the amount of research that is done on this matter, the amount of difficulty it can take for this element to be changed or implemented.



The size of the circle shows the amount of lines derived from the case studies – the amount of times mentioned / incorporated / information. The bigger the cirlce, the more.



The first circle shows an enabler, the second circle with the bump shows a big barrier. The third circle with the smaller bump shows a small barrier.

Figure 24: Barriers and enablers (own illustration)

# 6.1 FINANCIAL

The financial key branch includes all the elements that are directly related to costs (initiation, depreciation, service) and profits (selling points, monthly rent) but also things such as who pays for what ownership, the lifecycles of certain elements and mixed-use with housing.

## High initiation costs

Initiation costs regarding building (re-)adaptive housing are substantially higher than usual such as in Solids. Solids was even twice as expensive as regular housing. This higher initiation costs includes not only architectural costs such as (mainly) overdimensioning but a large sum is also due the extra organisational (marketing, communication) and concept developing posts. Although important parameters such as actual life span, residual value, change of functions, rental incomes, vacancy, management and maintenance costs are unknown or unlikely to change significantly over time, the expectation is that there will be lower depreciation of investments, lower maintenance costs, and higher yields due to 1) high-quality materials (not so much related to re-adaptivity), 2) constructional measures for flexible future use (overdimensioning), 3) reduced risks of low rents and/or vacancy as a result of the huge accommodation capacity (both technical and planning-legal) and the substitution and negotiability of installation from exiting tenant to new renters.

## Selling point

What came forward in Molenvliet and Solids is that the adaptivity is not the most important factor for (first and secondary) tenants, but instead was the location, being able to have an influence through the auction, exemption from regular housing rules are and having little alternatives. This may have to do with unfamiliarity with re-adaptive housing. If something is unfamiliar, or little experience is known with it, it might just not be very telling and therefore appealing. However, when the option is given for resident participation and the notion of adaptivity, residents seem satisfied with it and are even willing to pay more for it (even when they are tenants).

## Depreciation

During interviews withthe architect and the critical panel, the importance of overdimensioning was a repeating discussion point. Solids, Diagoon Woningen and PREVI were overdimensioned while e.g. De Drie Hoven wasn't. The reason for the Drie Hoven's demolition was partly also because it was not overdimensioned enough. By over dimensioning the structure, the structure bids more future possibilities when the building needs to be adapted as it started with an maximum accommodation capacity. This makes the structure depreciate able over a longer period of time than usual, 100 years in stead of 25 years. This also means that there needs to be a clear division between the different life cycles of each element as the structure is there to stay over a very long cycle and the infill has to be changeable.

## Long term vision

The long-term vision came mostly forward during the critical panel. Re-adaptivity housing doesn't show its fruits right away as it about the adaptivity over time. This 'time' can be in a year (smaller change) to 10-50 years (family change). This asks not only a long term vision for the residents, but more importantly so from the initiator. Re-adaptivity also shows possibility in terms of re-allocation and re-distribution of space, giving the structure a longer depreciation term than usual. The initiator must understand that the higher initation costs will result in higher rendement, but these higher rendements are over a longer period of time than usual.

## Rental

Although in the case studies it can be seen that the most practiced adaptive dwellings are in ownership, the preference still is to rent out units in stead of selling hem. During the critical panel the members stated that the preference for re-adaptive housing goes to renting in stead of selling housing units. Re-adaptive housing becomes (financially) attractive -and therefore feasible- over a longer period than normal housing. Therefore the initiator needs to stay a stakeholder. Also, when re-adaptive buildings get sold, the question is what the direct incentive is for a buyer as they would have to pay more than a regular house. The issue with re-adaptivity is that it shows off its fruit after a while, making it difficult for (especially) starters to want to bring up a larger sum of money than usual for a re-adaptive house than other regular housing units.
A third reason is that (re-)adaptivity might lead to friction between neighbours when there all in ownership, while when they are tenants there is an overkoepelende third party that is in 'control and ownership'. The organisational issue of needing 100% agreements on decisions can lead to bad maintenance and eventually needing to demolish the building – this can be seen as in the Nakagin Capsule Tower.

An 'uplifting' factor to the higher initiation costs can be the rental auction. An example can be seen in Solids.
The tenant is given the opportunity to increase the bid price of their bid and maybe make new bids in each

round of the combinatorial auction, which has numerous rounds. This results in less thorough bidding, the bidder choosing a rental price that he believes is worth (partly in the context of other bids), and, on balance, a higher rental revenue is realized for the landlord. When the minimum rentals specified by Stadgenoot before to the auction are compared to the average prices offered, the auction generates higher rental income. In some cases, the average social rent/m2 is higher than that of the free sector in Solid 11. It must be said however, that it's expected –based on own assumptions– that in this very tight housing market, the maximum for social rent and mid segment rent can be asked anyway.

### Ownership infill

The structure–infill can also bid solutions to lowering (initiation) costs by making the tenant owner of their own infill, as can be seen mainly in Solids. Other case studies also have an ownership of infill (due to the fact these dwellings are in full ownership), however with Solids we see the ownership only in infill and not the structure. This then means that tenants pay rent over de structure (and perhaps other common spaces, service etc.) and the infill is for their own cheque.  Not only does this mean the building owner doesn't need to finance the infill, but also is not responsible for maintenance and/or other mutation with regards to the infill.

### Mixed-use

Social interaction and common spaces came back as important elements to be incorporated in both the literature review (defining definitions) as the resident evaluations of the case studies. It is multiple times mentioned that residents choose their housing based on the location and context. This came forward in the Molenvliet survey, Solids evaluation, interview with Herman Herztberger and the critical panel. A direct context that includes more than 'just housing' and other facilities, with also a possibility to socially interact, is perceived attractive. Re-adaptive housing can include mixed-use units as well, making not only the tenant want to pay more but also generate more income from the mixed-use activities that can be exploited.

## 6.2 LEGAL

According to the professionals, during both the interviews and critical panels, , it came forward that there is no technical issue but rather an organisational issue of the bureaucratic way of working. Before a developer can start by looking if a business case is possible in terms of financing, legal building rules and regulations can already restrict certain things such as dimensions, allowed activities, allowed amount of building layers, the appearance but also on a smaller scale the organisation of the tenants mutually and the organisation between tenant and owner.

### Experimental

(Re-)adaptive housing seems to be more and exceptional thing rather than a norm, especially due its building rules and regulations. Molenvliet, Solids, Diagoonwoningen and PREVI are labelled as experimental housing projects. This led to amongst other to a different way of subsiziding with test-layouts and serving exceptional regulations in terms of not needing to meet regulations with regards to suitability criteria, housing allocation and the zoning plan.

### Building decree

The barrier of building decree has been mentioned by the architects during the interview and the critical panel. The building decree is holding back adaptivity in terms of minimum requirements with sqm, certain % lightning, minimum certain dimensions and such. For example, the Sky House had moving nets. This wouldn't be possible with the Dutch building decree as it was probably considered unsafe (hanging construction), didn't have a step to the moving net, too little light, too narrow and a too low of a ceiling height.

### Zoning plan

The barrier of the zoning plan has also been mentioned during the interviews with the architects and the critical panel. The zoning plan can hold back adaptivity in terms of a fixed amount of housing units, with a pre-decided amount of size and the allowance of certain activities. Re-allocation, growth or shrink can become impossible when for instance the zoning plan only allows 1-bedroom units. Also the zoning plan can allow only housing and therefore not give space to mixed-use housing complexes.

### Beauty committee

An own addition to the building rules and regulations is the beauty committee. The beauty committee might accept the initial first architectural façade, volume and shape of the building. However how will the beauty committee react when the façade might change due the adaptivity and individual nature of the project? This is not only regards to the colour, but also volume and shape.

### Building permits
The PREVI demonstrates a less bureaucratic approach to building permits and rules and regulations (or, more accurately, the absence thereof). Where there was no resident input, but residents subsequently took a lot of initiative to change their own dwelling without consulting. This demonstrates that the strictness and fussiness of Dutch construction standards about modifying, adding, or deleting aspects of existing structures can be a significant impediment. Larger adaptation and especially with regards to adding and removing units (growth and shrink) needs permits obtained to do so. When larger adaptations are needed, it might be faster and less expensive to move homes rather than altering the current one.

### Tenant contract
Although many projects are built with the idea of changeability, according to regulations, this isn't even (extensionally) allowed. As a tenant, he/she must leave the house as he/she entered it. Which is very contradictory to the design principle, so a next occupant lives after the first occupant has been determined. In the Solids, this is done different by giving the infill in ownership and therefore freedom of adaptation. This can be mainly seen in Molenvliet.

### Ownership
The Diagoonwoningen, PREVI and Sky House are in ownership unlike the Solids (although the infill is in ownership) and Molenvliet, where the tenants pay monthly rent. This could also be the reason that they shows more of adaptiveness through the extensions and additions to the dwellings.
The Nakagin Capsule Tower is in ownership, yet doesn't show any adaptiveness. It seems that ownership leads to more adaptiveness when there are individual house dwellings that are in certain distance from each other. The issues with the Nakagin Capsule Tower were partly a technical issue, but this can be waived as currently there is enough technical knowledge on how to make such a structure were capsules can be easier taken out and a renovation plan was already proposed. Organisational issues were perhaps the real issue, especially because the capsules were in ownership. All units could be replaced at the same time, but this needed a communal 100% agreement and proved to be impossible as the unit owner's opinions were too different. This also included communal spaces. In apartment complex this seems to be more difficult, even in ownership, because ones decision for exterior changes influences the living of the other. Ownership shows more signs of practiced adaptivity, however rental is preferred in terms of financing but also communal decisions.

### Monumental
What was speficially mentioned during the interview with Herman Hertzberger was that monumental protection can be both an enabler and barrier. In a way, it prevents the building from being demolished and is preserved. On the other hand, it also prevents change and adaptivity. Buildings should however be adaptable in principle, and be able to move with times.

## 6.3 DESIGN
The architectural (and technical) design is different from regular housing as it should be able to anticipate change. Change can be adaptivity within the structure (room configuration eg) but also shrink and growth. Furthermore, this should mean that residents themselves can make such decisions and changes.

### Social interaction and common spaces
Stated by the architects and literature review, social interaction may be a crucial, though sometimes underestimated, aspect of re-adaptive housing. More mutual understanding and closer relationships result from social engagement. This is especially essential when housing units change over time, as this might have an impact on the way people live next door. People with mutual understanding are willing to accept more from one another and/or come easier to communal agreements. At the PREVI it can also be seen that, if community serving public functions are not initially included in the project, that the residents themselves will include it. This also links with the building regulations, giving room for this. Adding elements for social interaction can be difficult because it's not always possible to link it to a direct function and thus the financial profitability doesn't directly translate.

### Overdimensioning
Overdimensioning is needed as for instance, de Drie Hoven was demolished because their lack of. Also, in the Solids in Ijburg, after adding more Solid spaces in later phases, the additional front doors and traffic spaces resulted in narrow collective spaces. Overdimensioning to some extent would therefore have been necessary. However, overdimensioning too much leads to very high initiation costs, and also some structural restrictions (e.g. no possibility of vertical connections). The question is what aspects should be overdimensioned and how

much overdimensioned they should be. Also, how this can be financially justified in a market where every sqm counts?

## Structure – infill

The structure-infill principle can be most clear seen in Molenvliet, Solids and the Sky House. The structure-infill principle can provide flexibility and individuality within the common fixed structure.
Based on these case studies, as well as the interview with the architects and the literature review, clear size agreements must be formed for the structure – infill concept. This is because the structure is more than simply the structural skeleton, but also the 'carrier.' As a result, the carrier must be constructed in such a way that inhabitants have ample area to insert their infill elements. This structure-infill principle works only if the fillable is easily changeable. It is critical to have modular coordination so that dimensions match. The construction ensures that the infill fits inside the carrier. By having a clear grid with space units the structure keeps a certain repetitively and a module grid. This enables easier adding, rejecting or (inter)connected units. Also, by having a module, the infills can be easier fit to the structure. By having the structure-infill, elements are interchangeable and renewable.  The structure-infill principle can work for both the spatial lay out (floor plans) as well as the façade layouts, as can be seen with Molenvliet and the Diagoon Woningen.

## Life cycles

In line with the structure-infill principle, the minimum planning for building maintenance should be 100 years in stead of 30 years. Dwelling separation walls have divided the support structure into housing units. They are detachable over time if a group of inhabitants want to change the parcellation of the support system, which may occur after 25 years or more. The infill is intended to vary easily and frequently per dwelling, according on a family's preferences. Structure subdivision increases the longevity of a building. To increase the building's lifespan to at least 100 years, the load bearing structure must be segregated from the rest of the structure, including the façade and infills systems for installations, inner walls, and façade infills. These infills must also be adjustable and demountable. As a rough statement it could be stated that the structure has the longest lifecycle of about 100 years (or more), and the infill 25 years.

## Re-parcelling

Due to the structure-infill, and the flexible infill, the dwelling can be altered through re-parcellations. Available space can be re-distributed because of the separation between structure-infill. During the critical panel, the notion was that re-parcellation can take place on a larger scale. For example, when the whole building changes from 10 one-bed-room units to 5 two-bed-room units. Re-parcelling per unit might be more difficult as this has direct consequences for the neighbour.

## Polyvalence

Polyvalence is mentioned in the literature study about Structuralism and is mentioned by Herman Herztberger during the interview. Too much flexibility can lead to neutral architecture and eventually be suitable for nothing. Structuralist polyvalence uses building rather as a 'fixed' form that in itself doesn't change yet is suitable for a variety of functions. This is done by  contributing to a maximum amount of spatial conditions so that they can figure in every situation. In terms of adaptability, the polyvalence of use on each floor is more important than the direct spatial shift. So it's less about changing the floor pattern and more about changing how those set layouts are used. The independence of the resident is found in the utilization of space. Polyvalence is also a design possibility for (re-)adaptive housing.

## Adding (growth)

An own notion is that growth also means taking space somewhere else – this could be vertically or horizontally. Also the possibility of growth is nice in theory, how ever what does this mean for the urban design? There isn't always much space to do so. Keep in mind that this does take away from common traffic spaces, gardens, outdoor spaces etc. This also includes all kinds of agreements about positioning and it is certainly not the case that everything has to be extensible. This has consequences for the neighbours, but also for the cohesion of the building.

## Installations

Most of the adaptivity freedom is restricted by the wet rooms and installations due to the fact that the installations are collapsed in the structure, go through floors, have fixed cores with firebox's and shafts can't always be positioned everywhere. This can be seen in Molenvliet, Solids, Diagoon Woningen and the Sky House. This barrier of installations is also mentioned by both architects during the interview and in the critical panel.

## Resident participation

The structure–infill principle already creates a great frame for resident participation, as the infill can be freely done by residents. Direct resident participation can be seen in Molenvliet and Solids.

Adaptivity is a result of resident participation, however resident participation doesn't necessarily mean adaptivity though. The individuality and resident participation for a first tenant can be beneficial, however can be frozen in time for both the first and secondary tenant. Therefore, making it not (re–)adaptive. This can be see in Molenvliet. This means that first time renters and also secondary tenants need to be able to influence their dwelling over time and multiple times.

Resident participation is clearly appreciated. Even when they would have to pay extra money (or rent) over this as in Molenvliet, or have to finance their own infill as in Solids. The question is also to what level resident participation is preferred. For example, at the Solids the residents were satisfied with the amount of resident participation, however did prefer a less bare casco with already wet rooms being realized. Also the question is what the right balance is between fixed and flexible, restrictions and possibilities and tenant and landlord. The resident participation also means a separation in the decision–making process, giving the architect a different role than usual as they are not deciding on the floor plans and/or façade lay out but the resident is in co–speech.

# 6.4 GOVERNANCE

(Re–)adaptive housing asks for a different organisation and governance structure than regular housing as it concerns resident individuality, possible resident participation and adaptivity of architectural spaces.

## Guidance

With the structure–infill principle, (re–)adaptivity design possibilities and resident participation there needs to be a certain set of simple rooms in which freedom is possible. A set of rules is mentioned by both architects during the interviews. Freedom should always be limited by a set of rules, otherwise it will devolve into chaos.
Also, since (re–) adaptive housing is not a regular thing in the Netherlands, residents should be guided from start to finish – and further since there in essence is no 'finish' with open–ended housing construction. Residents of Solids would prefer better guidance, even after the moving in stage. This asks for a different type of resident organisation structure.

## Maintenance

By separating the structure–infill and commonual–individual, there should be clear agreements made about the maintenance responsibilities. Also, in order to keep the building as a whole on a similar maintenance level, there should be agreements made to specific time frames when maintenance is being done. The Nakagin Capsule Tower for example is an example where this was not the case, leading to bad maintenance and varying degrees of amount maintenance.

## Communal decisions

The structure–infill principle divides decision–making influence in which the resident also becomes a decision–maker. The decision–making structure should be very specific, clear and simple yet it should offer enough freedom for the individuals. Once communal decisions have to be made, processes can become very difficult and tangled. This can be seen in the Nakagin Capsule Tower, where revitalization of the building couldn't happen due the issue of having too many individual opinions. The amount of communal decisions therefore should be minimized, and giving the building owner this position of deciding on communal property.

# 6.5 COMPLEXITY

In figure 24, each key branch has a different size of circle. The size of the circle shows the amount of lines derived from the case studies – the amount of times mentioned / incorporated / information. The bigger the cirlce, the more it has been mentioned during this research. The circle with icons that have no bump are enablers. Those with a bump are barriers. The bigger the bump, the bigger the barrier.

Legal and financial are placed as high complexity recommendations, while design and governance are the least complex. Legal and financial are stated as more complex due to the most amount of barriers and the difficulties of incorporating the recommendations into practice.

The high complexity can also be due to the fact that financial and legal aspects start in earlier project phases and stay relevant through out the whole building phase. Financing stays important, especially since a long-term vision is needed. Legal aspects also stand ground through out the whole building lifecycle as the certain rules and regulation stay applicable. The design starts during the design phase and slowly becomes less important as this is done, built and then less design work is continued – other than the (re-)adaption of the current design. The governance starts slight before operation and fluctuates in importance throughout the building phases. In the beginning it's more relevant as the dwelling inhabits new tenants and a while the household will not change profile. Only after a certain amount of years, the household profile or social standing changes and the dwellings need to be (re-)adapted – this is when governance becomes important again and fades relevance again after a while until the process repeats itself.

Secondly, complexity may also be due to the amount (or lack of) information of especially legal and financial aspects as this master is less concerned with such aspects. Also, less research has been done on these aspects and is less mentioned by the theoretical framework. Financing- and legalparties were also not included in interviews and the critical panel. Design has the largest circle as it has the most derived information, and is the least complex. Legal is mentioned the least in the research and is the most complex. Furthermore, complexity might also be due to the fact that design and governance can be implemented within the project group. Financing is warranted by the developer and projectmanager (also within project team), but comes from the investor. Although the investor is initiating the project team, he/she isn't as involved with the project team and its process. The legal aspects are all 'in the hands' of legal bodies that stand external of the project team.

# 7. RECOMMEN-DATIONS

Now that the enablers/barriers are allocated, they can be adressed. By adressing the enablers/barriers, recommendations can be made to enhance re-adaptivity. This is the last step to answering the main research question. See figure 25.

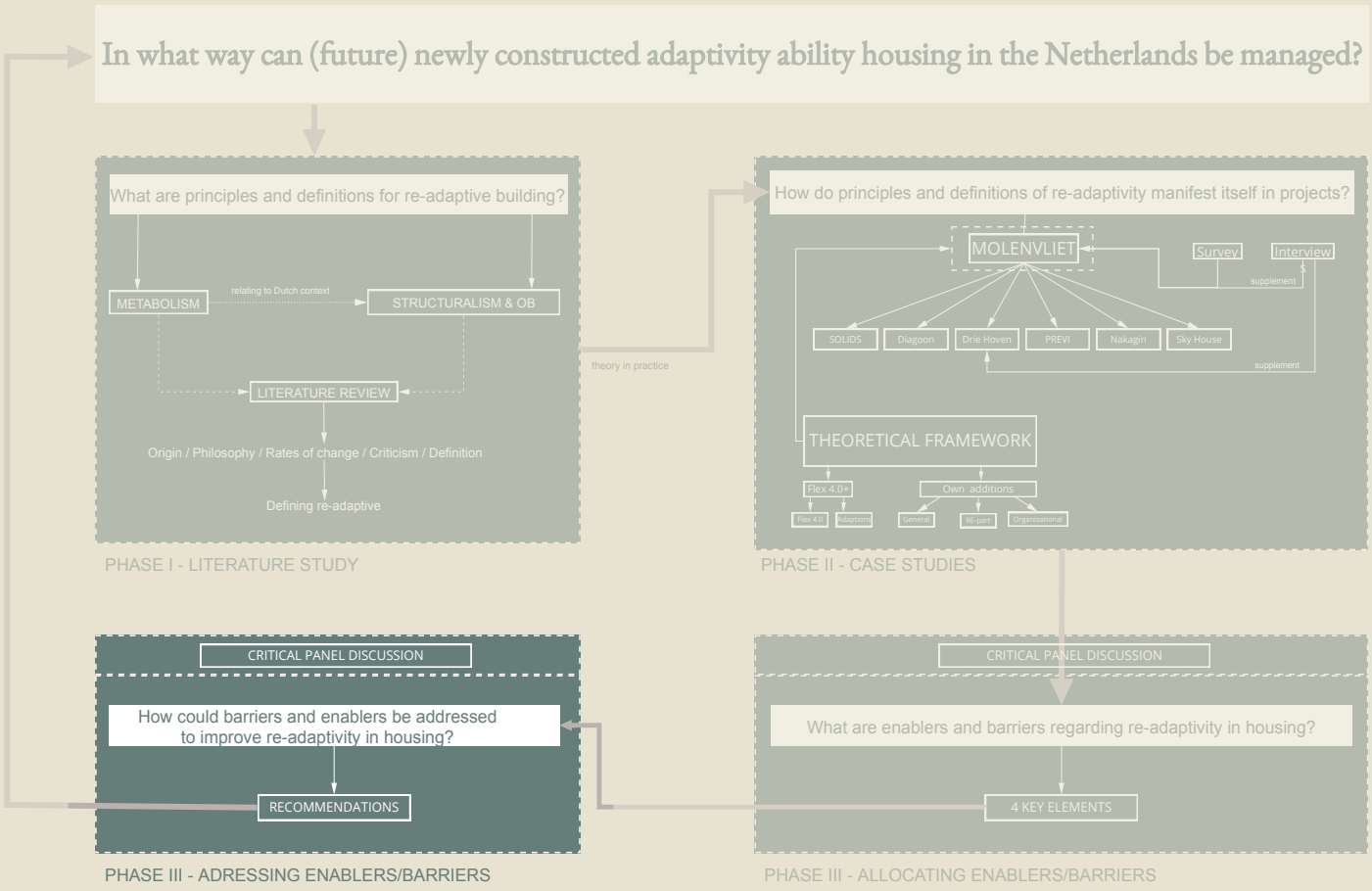



Figure 25: Research framework – phase III – recommendations (own illustration)

# 7. RECOMMENDATIONS

## SQ4: How could barriers and enablers be addressed to improve re-adaptivity in housing?

### Aim

The aim is to adress the enablers and barriers as allocated in the previous chapter. When adressing these, it can become clear what is possible and what is not possible to incorporate into a re-adaptive business case. For example, which aspects can be improvement and to which degree can this be implemented? What are the more complex issues?

### Content

First this chapter will adress the four main key branches: financial, legal, design and governance aspects. To each key branche -if possible- a recommendation will be proposed. Each key branch will also include information of how complex the allocated recommendations are. It will end with one conclusion to what it boils down to. Lastly, it will elaborate further on the likelyhood of the recommendations being possible / implementable.

### Sources

No additional information is searched or used, other than the lessons learned as derived from previous phases of this research and the critical panel.

This chapter starts with adressing each key branch and will end with the implementation possibilities of the stated recommendations.

# 7. ADDRESSING BARRIERS AND ENABLERS

How could barriers and enablers be addressed to improve re-adaptivity in housing?

# 7.1 FINANCIAL

As stated in the evaluation of the Solids, over time, the high initiation costs can be lowered per project as the initiation costs are partly high due concept developing. If there is a certain P.v.E. and process organisation, the initiation costs would lead less concept developing as a similar concept can be used.

Furthermore, the high initiation costs also include the overdimensioning of the structure. During the critical panel it was metioned that this results in +/- 20% higher structure costs. On the other hand, overdimensioning results in an higher accommodation capacity. Also, by the high accommodation capacity of the structure and the separation of structure-infill, the depreciation of the building can be taken into over a longer period of time (+/- 100 years in stead of 25 years).

As done in the Solids and by the strong separation of structure-infill, the resident can be given responsibility of their own infill resulting in the owner not needing to finance the infill, the maintenance of the infill, and not take into account the depreciation of the infill. Ownership is only over the infill, and not the total dwelling as for example in the Nakagin Capsule Tower, PREVI and Diagoon Woningen. During the critical panel it became clear that rent is a must over selling units as for the initiator the rendement of (re)-adaptive housing is after a longer period of time than regular housing and therefore needs to stay a longer stakeholder. To generate higher rents than usually a rent auction, as done in Solids, can be organised where residents bid directly against each other. An assumption is however that this should be taken with a grain of salt since currently the housing market is so tight, that a lot of residents are willing to pay maximum amounts of rent anyway.

As stated in the literature review, interview with Herman Hertzberger, PREVI, De Drie Hoven ,Solids and the critical panel, mixed-use is an important value-adding element in housing. By adding mixed-use in the dwelling a) As proposed during the critical panel, and can be seen in Solids & de Drie Hoven, businesses can be separately exploited by the owner b) leading to more common spaces and social interaction without 'loosing sqm' and c) become a selling point by creating a higher valuation of the dwelling since residents valuate dwellings with mixed-use substantially higher, as stated in the critical panel and Solids evaluation. The desire for mixed-use can also be seen in PREVI.

During the critical panel is became clear that the developer works with a certain budget that is given by the investor. Although it was also discussed that there is a higher initiation costs, there is also a higher yield over time, investors are still not willing to look over such a long period.
The financing barrier all boils down to the investor – this needs to be a investor that is willing to see the bigger picture and especially have a substantial longer term vision than usual.

See figure 26 and figure 27 for the adressing of the financial barriers and enablers.

# 7.2 LEGAL

Making recommendations for the legal aspects is less quickly applicable as this concerns a larger organisational body. First of all, experimental exceptions from certain building rules and regulations can be asked. For example, both Molenvliet and Solisd had experimental exceptions. Applicating for a 'experimental housing predicate', this could be done perhaps with the RE (growth and shrink)-component. However the assumption is that this can be applicated maybe the first couple of times (if possible), but this isn't something that is commonly done. After a while it doesn't become 'experimental' anymore and the experimental predicate is not assigned. Some possibility is seen in the structure-infill where there are test layouts applied for the infill part instead of a set fixed amount of floor plans with the exact infill, as this has been done with Molenvliet.

The building decree is very fixed and rigid giving it less possible gain. Currently, the building decree has its rules and regulations divided in new construction and renovation. (Re-)adaptive housing is something that lies between new construction and renovation. An own idea could be possible that the building decree would make new rules and regulations specifically assigned to (re-)adaptive housing. However, this might be too far-fatched as the implementation chance seems very small given the very small number of (re)adaptive housing construction to begin with.

Making agreements with the central government, the municipality and the city district, in collaboration with the necessary lawyers and other experts, can make room for zoning plan and suitability criterium. This is done with Solids. With regards to the zoning plan, this should allow more mixed-use functions. Also, the zoning plan could perhaps accept an extra building layer to be build than initially accepted, with the condition the building is overdimensioned. This could be an incentive for the initiator to indeed overdimension, without losing a possible building layer and therefore rental revenue. The overdimensioning and possibility of losing a floor came forward during the critical panel. For the municipality this could mean a more sustainable (durable) building and higher resident satisfactory evaluations. Secondly, the zoning plan should also give a certain amount of freedom in advance in terms of quanitiy units so that re-allocation/re-parcellation is also possible to implement.

Although it was not mentioned in the literature review, case studies or critical panel, the beauty committee might also be added to the list of legal barriers. As the shape, façade, and volume might change with (re-) adaptive housing, the beauty committee need to send approval of these possible changes beforehand. This could be done by applying also concept scenario's to the beauty committee which they can accept (or reject). For the concept scenario's, it's also very important to limit the residents within these scenario's. Freedom is always to a certain extent so agreements between tenant, owner and the beauty committee must be made about what exactly is permitted in terms of materialization, colours, volumes, shapes etc.

When there is too much ownership, communal decisions will need 100% agreements, which are rarely possible as can be seen in the Nakagin Capsule Tower. By basing the (re-)adaptive housing on tenant contracts, friction can be mitigated as there is an overarching party that is in ownership to the most extent. However, a certain amount of ownership is needed to make adaptivity possible for the tenants and thus the tenant contract needs to give space to the tenant to adapt their dwelling. In Molenvliet the residents had no ownership and therefore (re-)adaptivity couldn't be practiced. This means that there needs to be a separation in ownership where the tenant is in ownership of their infill, as is done with Solids.

With regards to monumental protection, the building should not try to become monumental or only be monumental for the structure. This idea is discussed during the interview with the Structuralist architect. This can be in discussion with the municipality. This is a side issue.

Lastly, when looking at PREVI it became clear that the amount of self-directed housing adaptions could be due to the different permit process. To streamline and shorten permit times, certain permits can be asked beforehand. Based on an own idea, the possibility to 'grow' (e.g. pull outdoor space to indoor) can be permitted long before it actually happens. Once a resident wants to grow their unit, it can be a lot faster done since the permit is already there. Also, in larger complexes this can be done in one go for (lets say) all 100 units in stead of 100 times separately over different time frames.

The legal aspects are complex. This is mainly due to the fact that these are done by larger decision-makers that are hierarchical and bureaucratic. Making a change in a legal rule or regulation, takes not only a lot of time but also is a big decision to make as it will influence many other projects as well. Also these parties are external to the project stakeholders, which makes it difficult.

See figure 26 and figure 27 for the adressing of the legal barriers and enablers.

# 7.3 DESIGN

By adding the structure-infill principle to (re-)adaptive housing, flexibility and invidiuality is created within a common fixed structure. This can mean adaptivity in both spatial lay outs as well as the façade. This does need a modular grid and the segregation of each building layer. The load bearing structure must be separated from the rest of the structure, including the façade and infills systems for installations, inner walls, and façade infills, to extend the building's lifespan. These infills must be adjustable and demountable as well. This can mainly be seen in Molenvliet, Solids and Sky House.

As in Molenvliet and Solids, this does ask for a different approach from the architect. The architect needs to keep in mind that they are designing a structure and not the infill. The architect design the structure, the shafts and the core. All the other will be done by the resident themselves. Frank van der Werf stated during the interview that this can be in co-speech with the same architect, by themselves or done by another architect. Before, the resident can design the infill themselves, it's important to keep a certain framework of rules and standardization, in which there is freedom provided. As explained by both architects during the interview and the case studies on Molenvliet and Solids, this is because total freedom is not possible because of the mutual coordination (between façade layout and/or colours, interior layout, wet spaces, shafts etc.) but also because of not hindering the neighbours living next door. Also, total freedom might lead to such situationships that it makes it difficult or impossible for a second tenant to adapt the first tenant's design choices. Thirdly, there is also an technical aspects of which the structure-infill principle only works if the fillable should be easy to change. It is important that there is a modular coordination, so that dimensions match. That the infill fits in the carrier, the structure. During the construction phase, the built-in elements have not only to be produced, delivered but also installed. Having many elements that are very similar but slightly different, can easily be overlooked. Therefore, the following standardization rules are proposed:

-Use of modules and grid coordination
Using the grid, the whole project, is also expandable by multiplying the units as the grid can easily be replicated. The use of a grid can be seen in Molenvliet, Solids, De Drie Hoven and the Nakagin Capsule Tower. The monotone structure and its grid is the principle that makes it possible to expand. By using a beta-, alfa- and delta zone (as proposed by SAR principles and mentioned by Frank van der Werf) freedom of design can be given a framework:

A . Fixed (beta zone):
By creating a betazone, it is clear what parts of the floor plan are less adaptive and what parts are more adaptive. This is a bit fixed as it already determines more or less the space for wet rooms. The betazone is middle part, in which most of the floor (stair and plumbing ) shafts can be located since it has the least natural daylight. With regards to the stairs, a prefab system can be made in which the stairs can be shafted within the betazone. Using the middle space for shafts, wet rooms and installations was also recommended during the critical panel.

B. Free zone (alfa zone)
Everything between the structure and seperate from the beta zone. This is all freely divisable.

C. Marge (delta zone):
Adding (growing) the unit to the outersides of the unit (so not merging units together, but adding on) should be possible by a certain pre-agreed marge. In an apartment complex, this could mean, giving the possibility for people to turn (parts of) their outdoor space/balcony into extra indoor spaces. By using the floor of your own balcony, and the 'roof' of the balcony floor of the level above you, this can be done. The balcony floors need to be extra structural strong for this. The surplus in space in this case is the outdoor space. This can be seen back in the Diagoon Woningen. Residents have to make sacrifices, not everything is possible. By having a communal outdoor space as well, residents at least will always have somewhat of an outdoor space. A certain zone that is taken into account before designing the structure which includes permissible future expansions, gives the possibility to later expand the dwelling. Standardized agreements on the maximum amount (m2) and direction (up, under, next) should be clearly made.

The possibilities for growth (and shrink) is further related to the points as discussed under Rules and Regulations (mainly beauty committee and zoning plan). Furthermore, the design needs to incorporate common spaces where residents can have social interaction (PREVI). This can be done by common gardens/open spaces (Molenvliet), which can be calculated in the service costs. Or this can be also done by exploiting the spaces to third parties. Adding public functions in a center square (De Drie Hoven) and the plinth (Weesperstraat) can help these social interactions while also being profitable for the public functions as they can expect a certain

amount of users. These public functions however must be in interest of the residents. For instance, in the Solids, the public functions don't enhance social interaction as much since these are largely short-stay functions (hotels and such). It's then important to only exploit it to businesses that indeed bring residents (or people in general) together. Things such as bars, café's, fitness, library's, cultural centres etc.

Additionally, to be able to be adaptive overdimensioning of structural elements but also traffic spaces should be taken into the design – as Solids shows that not enough traffic overdimensioning space can be a burden when adapting the building. Overdimensioning in height and traffic spaces are important, so these have to be extra wide. The wide traffic space can be combined with communal spaces. Overdimensioning in structural integrity is needed to a certain extent – making it possible to horizontally and vertically expand however still making vertically merging possible. This is a certain balance the architect and construction engineer can debate on together. Overdimensioning everything to the highest standars may not be needed. The high initiation costs of Solids are due to the overdimensioning of all floors. During the critical panel it was stated that it is less common for housing to be changed to other functions than the other way around. An exception is the plinth as this will including other functions due to the mixed-use preference.

Moreover, the design principle of polyvalence (such as in Diagoon woningen) can also be added to the design question in which the architect can create such architectural spaces that contribute to a large amount of spatial conditions so that functions can figure themselves in every situation.

Lastly, as it is mentioned in most case studies, the interviews and critical panel, installations and wet rooms should be clustered as much as possible. To begin with, a core with the shaft and fusebox  can be created in every unit where this core is all stacked vertically in the same line. This core finds its place in the beta zone since this is the place where there is the least amount of daylight and is in the middle and thus making it possible for the wet rooms to position in four directions. Also, a recommendation from Frank van der Werf is to use floor heating as pipes can be less in sight.

The design aspects are very easy to implement in terms of the design question, since such mechanisms and techniques already exist.

See figure 26 and figure 27 for the adressing of the design barriers and enablers.

# 7.4 GOVERNANCE

Guidance for the residents in terms of (re–)adaptive building and resident participation is very important to keep things running smoothly. Both first and secondary tenants need to stay involved, through out the whole process. The governance and organisation of this will be explained per phase:

– Allocation resident:
Adaptivity can be promoted with scenario imaging for example. Showing tenants very clearly what future options they have, with example floor plans and mock ups. Similair information events have been held for both Molenvliet and Solids.

Correct recruitment should happen a good time before however not too much before as people might change their preference over a longer time and withdraw as happend with Molenvliet. The auction and lease of spaces can be started after the (structure) building is (almost) completed, so that residents can see the qualities and possibilities of the building as is done with Solids. Also as done by solids its that by giving the possibility of the auction, tenants are able to determine their own location, dimensions, rental price etc. in competition with each other. Note that the rent auction is only applicable for the first time renters.

– Design:
The other set of simple rules are explained in the 'design'. These need to be communicated clearly with the resident in a textual and visual way. Like done in Molenvliet, resident participation for the infill can be done through consultant hours with residents, with a coached team of architects. Recommendations from Frans van der Werf for helping tools to help residents understand 'abstract floorplans' better can be quick 3D models, furniture maps, variety books and/or an 1:1 maquette.

– After construction:
The evaluation of Solids stated that guidance and supervision during moving in phase is also preferred. As the infill principle is relatively uncommon, an installation fair and protocol can be helping tools. Solids used these helping tools too. However, unlike the protocol of Solids, this protocol needs to be given before the auction, with simple understanding wording, examples and images. An own addition is that there should be a helpdesk where the residents can call to. It should be very clearly communicated what the exact possibilities are, how these can be achieved and who they need to contact.

Second renter:
All the case studies show possibilities for the first time tenant however not for secondary tenants. Consulant hour(s), guidance and supervision should also be given to secondary tenants.

Furthermore, in general very specific and clear agreements must be made on a) possibilities within design, b)possibilities with regards to growing and shrinking, c) ownership, d) maintenance responsibilities and e) communal decisions;
a – The possibilities with design can be read in 7.3.
b – The possibilities with regards to growing and shrinking, and that are directly related to the beauty committee and can be read back in 7.2.
c – Ownership needs to be clearly indicated, whereas the infill is in ownership of the tenant. See 7.1 and 7.2.
d – This includes who is responsible for what maintenance. Additionally, in order to keep the building as a whole on a similar maintenance level, there should be agreements made to specific time frames when maintenance is being done. Unlike the Nakagin Capsule Tower, where every unit has a different state of maintenance.
e – As earlier stated communal decisions should be minimized. An overarching organisation or person would be the main decision maker over communal property. It is assumed that this wouldn't be too restricting as the residents already have full ownership over their infill and the possibiliy to pull their outside space into inside space. Similar to Solids, it could be included in the tenant contract that all the tenants are automatically and compulsory a member of tenants' association. This could mitigate possible friction between residents. A tenant organisation should be set up by the housing association or owner.

The governance recommendations asks for a different approach however are not difficult to implement. It is however important to be very specific in the agreements. Further research could unfold what the agreements should be specifically.

See figure 26 and figure 27 for the adressing of the governance barriers and enablers.

# 7.5 MAIN RECOMMENDATIONS

Recommendations have been made based on the allocated barriers and enablers. All these recommendations have been distilled in order to come to a certain hierarchy of main- and secondary recommendations.

See figure 26. First the recommendations are grouped on its relevant key branch. Secondly, all key branches have been ordered to its relevant phase. All the recommendations than are set out to its key branch. Thirdly, on each recommendation, a weight is hanged depending on its complexity. Some recommendations are more complex and thus heavier to implement. Note that this weight is only an a rough estimation. Along with the weights, the related recommendations are clustered on theme. These themes are main aspects to the recommendations. From those main aspects, again one main recommendation has been formed of which the main aspects fall under. See figure 27. The main aspects are separated between being a barrier (B) and enabler (E) as even the main recommendations still have barriers (drawbacks) and enablers (benefits).

Financially there is a higher initiation costs, the higher yield weights it out. This higher yield however requires a long(er) term vision than usual. Thus the main recommendations for the financial aspect is finding a long term investor that is willing to have a longer term vision. Some legal aspects are internally implementable (such as the change of tenant contract), however most of them are determined by legal governmental bodies that are external of the project team and high in complexity. This makes it more difficult to implement such changes project per project. The main recommendation for the legal aspects is a change in building policies on a national level, enabling re-adaptivity. The design aspects are all techniques that already exist and have been used to some degree. Total freedom is not (yet) possible in terms of design because of the semi-fixed wet rooms and that growth also means taking up space else where. The main recommendation for the design aspects is to have a very specific and clear brief/design assignment on re-adaptive architecture. The governance aspects mostly requires a different organisation as the resident takes up a larger role in the process rather than just inhabiting the space. The main recommendation for the governance aspects is setting up a different resident organisation with a more extensive communication between owner and resident. The building needs a continious management.

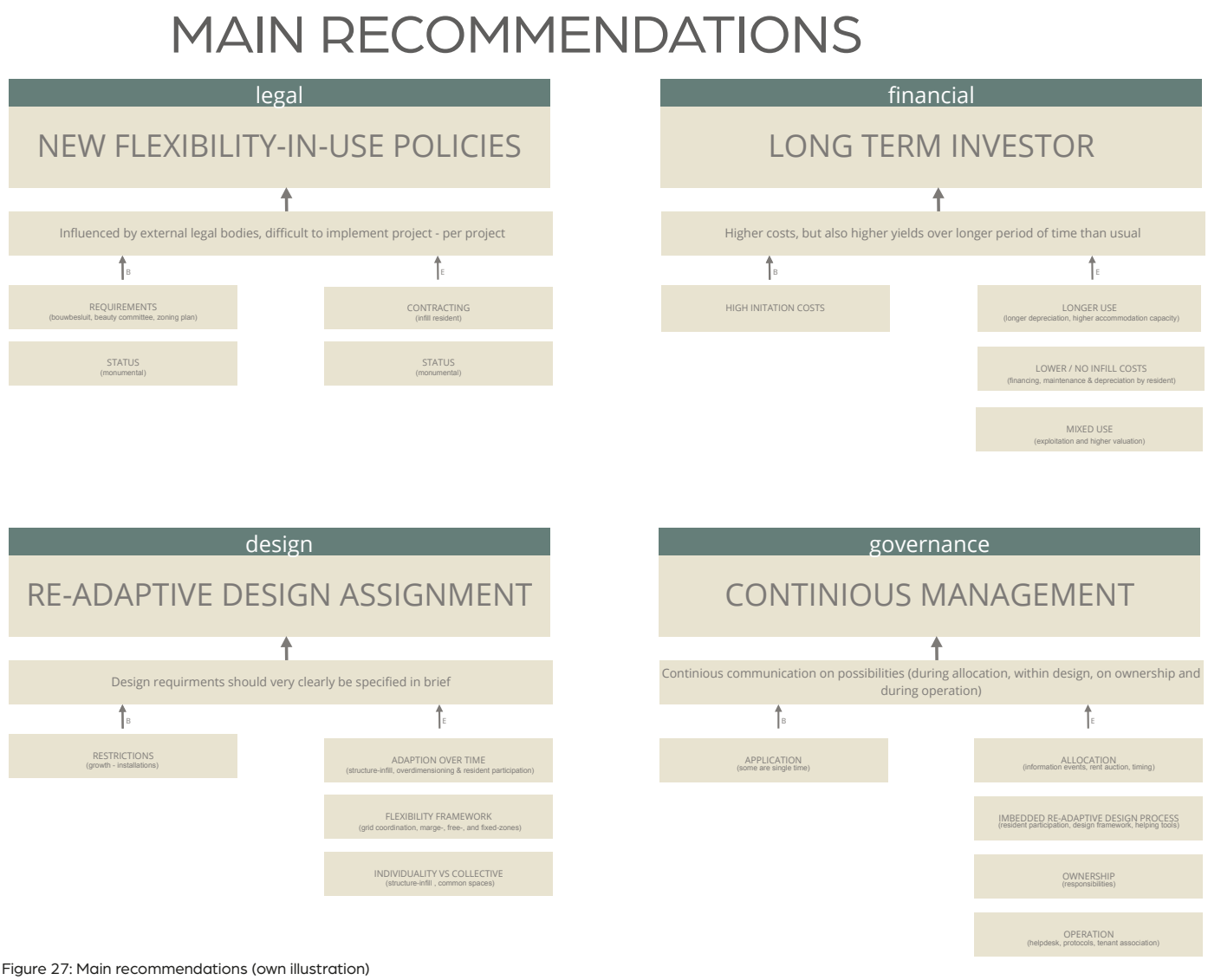



Figure 27: Main recommendations (own illustration)

# ADRESSING THE B

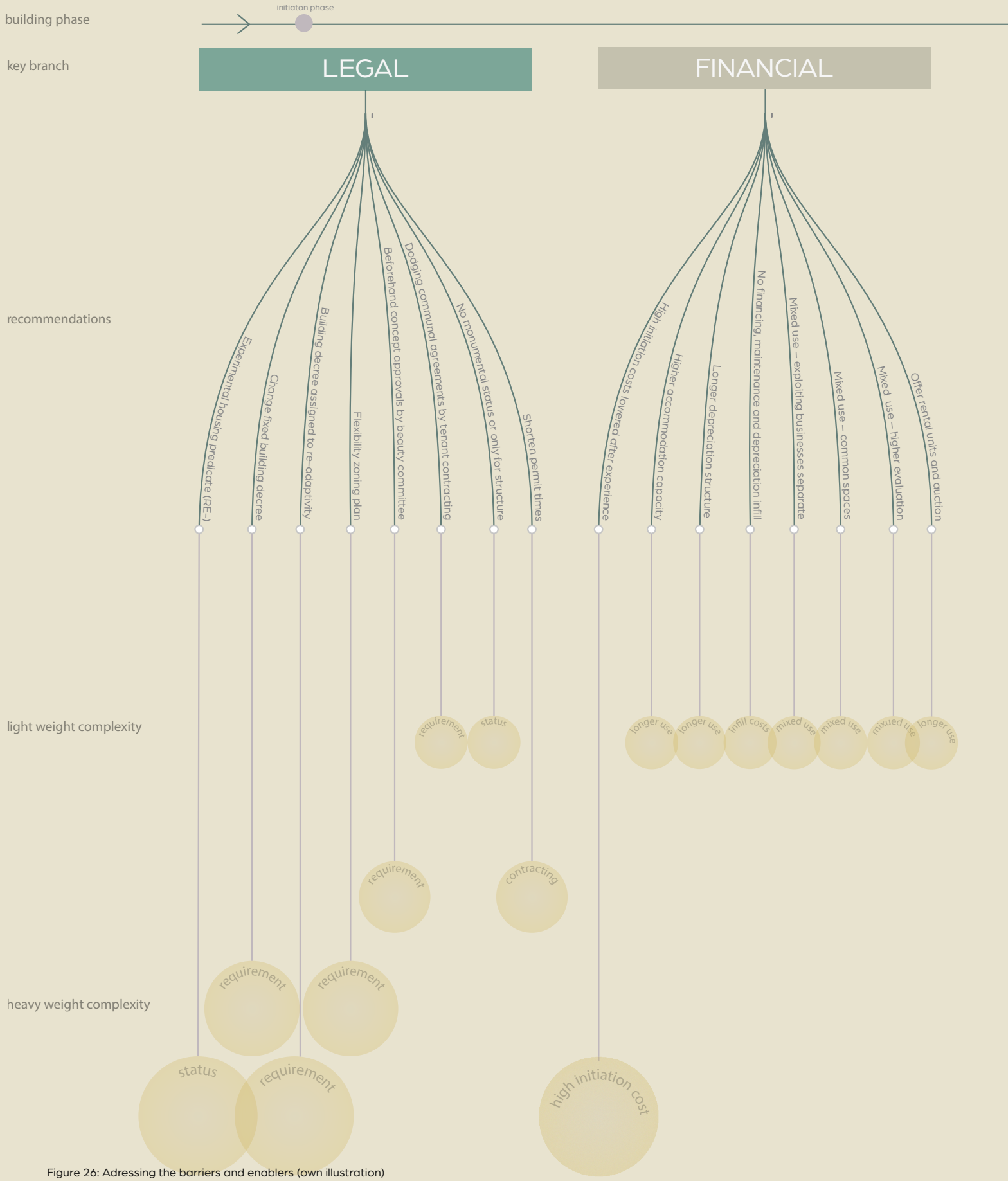
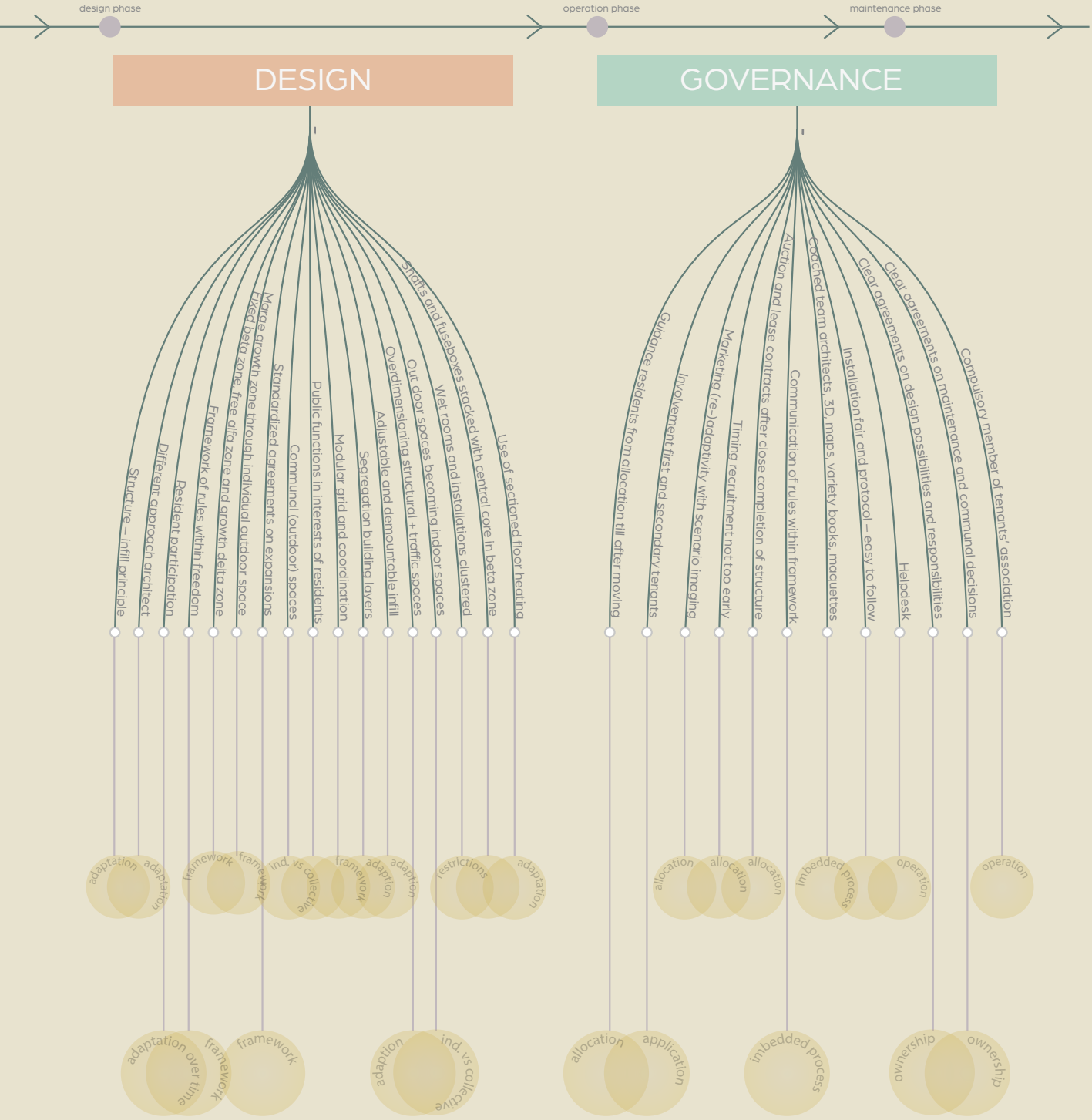



Figure 26: Adressing the barriers and enablers (own illustration)

# BARRIERS AND ENABLERS



# 7.6 IMPLEMENTATION

## COMPLEXITY

Each key branch its recommendation has a different level of complexity. The term complexity used implicates the amount of actors involved, amount of risks related, the amount of commitment that is needed, the amount of information available on such matters, the amount of research that is done on this matter, the amount of difficulty it can take for this element to be changed or implemented. The more complex a recommendation is, the more difficult it is to implement. Complexity is discussed on page 96.

## PROJECT INDIVIDUAL OR POLICY

The implementation possibilities and likelihood is also related to wether it can better be applicable per project or as a policy. Unlike the other key branches, legal recommendations are more difficult to apply project per project. It should rather be applied on a local/national level. This also makes it a more complex recommendation as it containts policy-making. Not only does this cost a lot of time, effort and money for the governmental bodies – but also the question of what their exact incentive could be is difficult to pinpoint. What this policy should exactly include is for further research.

## CHANGE IN BUILDING PHASES

(Re-)adaptive housing and its recommendations also lead to changes within the building phases. These changes are related to the a) role changes of the stakeholders b) the beginning and ending phase c) a new phase being introduced d) the length of each phase.

### Role changes of stakeholders

Resident participation leads to a designing role of the resident. This also means that the architect will be have to give this space to the resident. And in stead of designing the infill, the architect de-signs the structure (in co-operation with the structural engineer). The construction engineer and architect would also discuss the level of overdimensioning more than in other usual projects. Also, the architect takes a role of a 'coach' as they have to help the resident in terms of the infill design. Furthermore, the resident partly also becomes the investor and takes the role of investing in the infill from initial investor. The investor/owner now has no ownership over the infill but the structure and common spaces. This also means that the infill design (as previously mentioned), the financing role, the maintenance and depreciation of the infill is in responsibility of the resident. The roles (and responsibilities) of own-ership also changes as ownership now is shared between the investor and resident. As (re-)adaptive means that the total dwelling will be changing over time, the owner has to take a larger organisational role. Lastly, for re-adaptive housing, a resident representative is entering the process. This representative is not only to represent residents' needs and wishes -especially with large quantity residents- but also as an contacting point for the resident through out the process. This also means the project manager has an extra party to incorporate during the building team meetings.

### The beginning and ending phase

In regular housing projects, the initiation phase can be started again once there is a notion of transfor-mation or big renovation. After a certain amount of years, once the dwelling seems not to function properly for the function, the building gets adapted. Re-adaptivity is also about adaptation, however where this happens in the phase is the main differ aence. For normal dwellings, it starts at the initiation again where the owner/investors looks at the financial feasibility, followed by a (most likely) new pro-ject team including a developer, architect, project manager, construction engineer, contractor and other advisors. After a plan has been made, the next stop is the new construction. In re-adaptive housing, this initiation phase never gets revisited again. Rather this is somewhat incorporated in the 're-' phase.

### A new phase being introduced

What can be seen in figure 28, is that there is an additional phase. Along with the operation phase, the 're-' phase is operated. This 're-' phase is the phase in which the resident can re-adapt its housing unit. As re-adaptivity gives the possibility for the resident to change its dwellings, this also means that the operation (use) of their dwelling changes through out the phase. The white line is the operation, and the orange line is change (the re-adaptivity) of the dwelling. In this phase, the resident decides to change its dwelling. This can be growth, shrink or keeping the current size but with a different layout configuration. The possibilities and process of this should be maximal imbedded in the re-adaptivity housing process, so that there is little to no extra advisors needed in this phase. The resident should only let the owner know of the changes, in which the owner gives an approval or disapproval with reasoning on what is not approved. Systems and information of what the possibilities are (within architectural space/design but also structural) should be of such extent, that it's directly clear for the resident what they can do. After the owner approves, the resident is being linked to a fixed contractor. The preference is to have a fixed contractor in order to warranty building quality and smoothen

process. The fixed contractor is aware of the re-adaptivity possibilities and therefore can quicker come with a price and build according to the assignment.

### The length of the phases

Regular housing and re-adaptivity housing also require different durations of each phase.
In re-adaptive housing, the design phase is longer and the construction phase is shorter. This is because the resident is incorporated in the design phase. Also, unlike regular housing, the architect and construction engineer are required to work more close together. This could lead to more discussion and research time. The construction phase is shorter in re-adaptive housing as the contractor is only re-quired to construct the structure. The infill will be done by the residents, which somewhat overlaps with the operation phase. The operation phase itself is also longer than regular housing, as it's a loop since the resident can re-adapt the housing unit to changing needs. The loop starts again once there is a new resident – which also can endlessly re-adapt their dwelling. For regular housing, the resident moves to another dwelling. Or the dwelling gets transformed / renovated on a larger scale once the building has worn out. Re-adaptive housing doesn't require transformation as it continuously adapts to changing needs. It also doesn't need larger renovation as it continuously maintains the building along with the adaptations. Unlike regular housing, the maintenance phase isn't located at the end but rather continu-ously done in smaller scale through out the operation + re-adaptive phase. Adaptation comes with new elements, and therefore lifecycles become shorter and thus maintenance is aligned with re-adaptations.

## PROJECT OR PROCESS

Within the four main recommendations, term-related expressions are stated. See figure 28.
The new flexibility-in-use policies express the need of policies that safeguard the possibility to (re-)adapt the building. As re-adaptivity is open-ended, this means that the policies need to be also open and be flexible-in-use over a longer period of time. The long term investor speaks for itself. The re-adaptive assignment also states on a design that is re-adaptive and thus changeable over a long (or infinite) period of time. The continuous management asks for a management approach that has no end but rather is always present.

'Long', 'continuous', 'flexibility (in use)', and 're' are definitions that say something about the importance over a longer term or even a term that is rather open-ended and perhaps infinite. This conclusion about re-adaptivity and its link with 'long term', brings the research to the next conclusion. Re-adaptivity is not a project, but a process. A project (regular housing) has a beginning and an end while re-adaptive housing is the opposite that is flexible and has a longer term. The cycle of re-adaptivity is different, and is not a cycle of project but a cycle of process. The difference in a project and a process is that while the project is a temporary endeavor, which is undertaken to obtain an unique objective, the process is continuous. The process can also be referred to as a workflow as it flows from step to step, followed by a stated procedure. A project is scheduled, followed by a time constrained planning and thus also has a closure. A process doesn't have this definite duration, but is rather continuous and event-driven. A process is designed as neverending (Lousberg and Wamelink, 2007; Setti, 2010). Re-adaptivity is a process as its continuous, has a certain procedure to be followed, doesn't have a definite duration, is event-driven and neverending. This can also be seen in figure 27 that shows the change of phases. In this figure, normal housing has an arrow from the end to the beginning which shows a new initiation when renovating or transforming. This new initiation suggests a new project. With re-adaptive housing, the initiation phases doesn't get revisited and a new project is never initiated. Rather, is open-ended as the operation phase is continously re-newed as it operates along the re-phase. Re-adapting the housing unit is done through an imbedded workflow in a stated procedure. This cerrtain procedure is followed without a certain definite duration but is rather event-driven. The event in re-adaptive housing being a change of household, change of needs and wishes or change of social standing.

Re-adaptive housing projects have been not fully coming to fruitation in the Netherlands because, as the sentence itself states, re-adaptive housing has been seen as a project. Re-adaptive housing is open-ended, and thus a process. In order to enable re-adaptive housing in the Netherlands, re-adaptive housing should be initiated and followed through as a process.

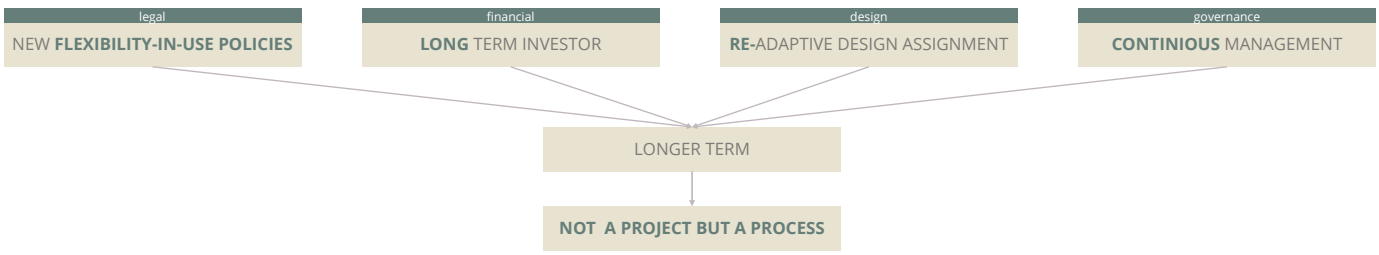



Figure 29: Main recommendations leading to main conclusion (own illustration)

# CHANGE IN ROLES AND

## TRADITIONAL HOUSING


Figure 27: Changes in stakeholder role (own illustration)

## RE-ADAPTIVE HOUSING

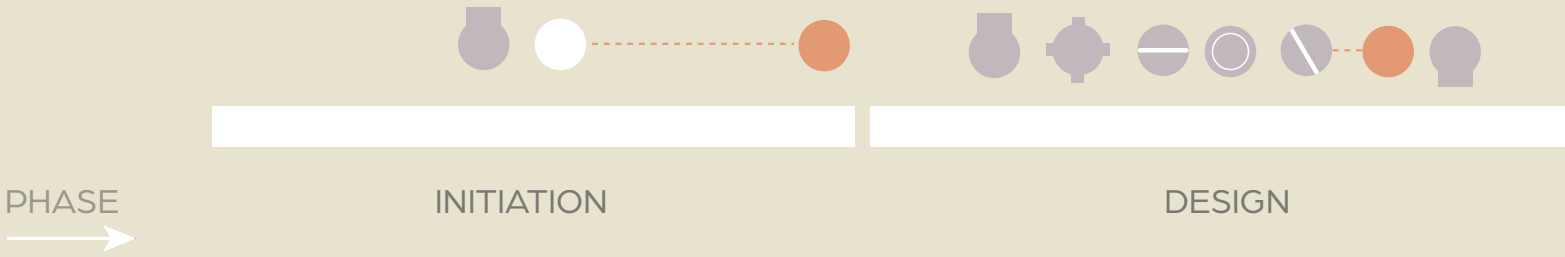
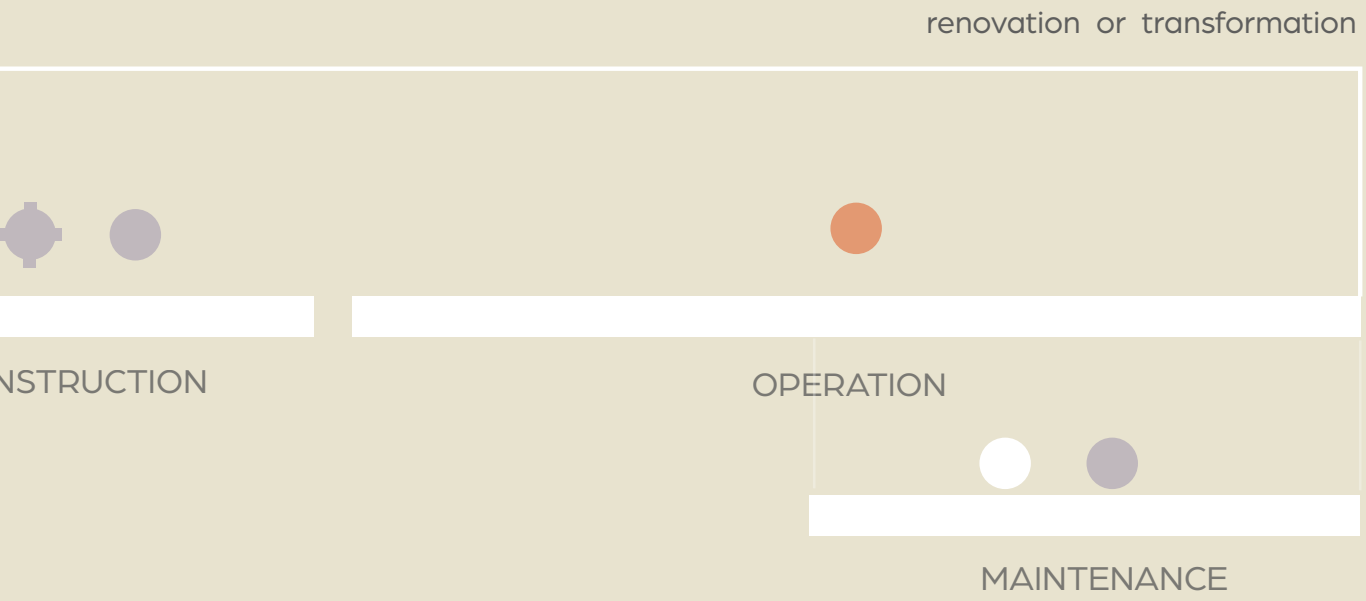
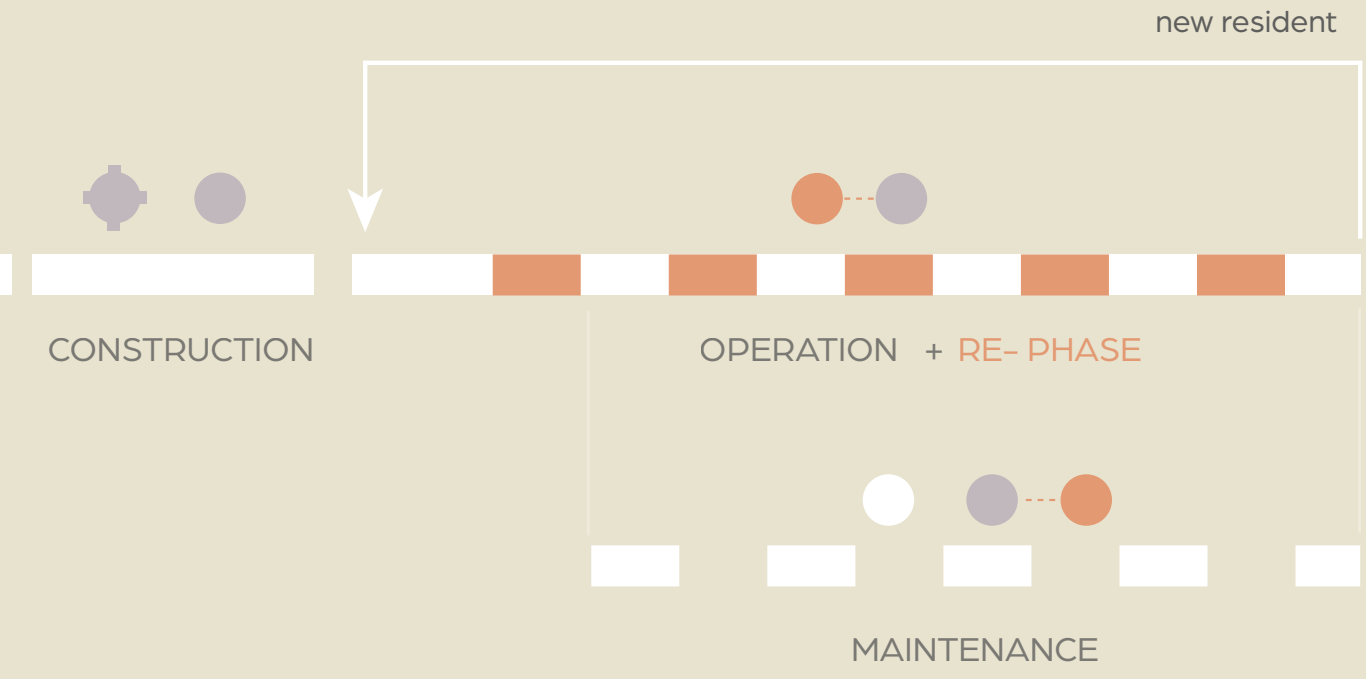



Figure 28: Changes in stakeholder role (own illustration)

# BUILDING PHASES




Architect Construction engineer Installation advisor Contractor Investor / owner Resident

# 8. CONCLUSION

Now that definitions are defined, theoretical framework is set, case studies are researched, enablers/barriers are allocated, and the enabler/barriers are adressed, the main research question can be answered.

# 8. CONCLUSION

## ''In what way can (future) newly constructed re-adaptive housing in the Netherlands be managed?''

The research objective is finding the barriers and enablers for re-adaptive housing, with the focus on the organisational aspects.

## What are principles and definitions for re-adaptive building?

As there is a lack of a singular definitions of the three theories, an own definition is proposed per theory based on the literature review.

Metabolism can be defined by its fundamental in the cycle of change, its constant renewal and anticipating future changes through making the (prefab) dwelling re-adaptive. Re-adaptive includes having a structure and different components that can (easily) grow, transform, be attached and removed from the larger structure. These different components have different life cycles on purpose.

Structuralism can be defined by its flexibility that manifests itself through the uniform, multiplied and repetitive grid structure of small units. The small units can be combined, added or left out to make a the larger unit as an entity and whole. The area within the small units are free from large fixed walls. Overlapping units can either be linked with bridges, open spaces and/or 'inner' streets or can border units.

Open Bouwen can be defined by having a structure (structural framework) and an infill (anything else), enabling individual freedom within a fixed framework through separating decision-making levels. The different elements (structure and infill) have different life cycles. And there is a certain grid used with marges.

The three theories have similar fundamentals, but a different approach. Re-adaptive can be characterized by combining the definitions of Metabolism, Structuralism, and Open Bouwen. As a result, in an attempt to build a definition of re-adaptive (which is not defined in the literature review) a new definition is proposed. The proposed formed definition is as follows: Re-adaptive can be defined as the use of a structured grid system, marges which are related to this, interchangeability, expandable through core and/or multiplication, the possibility to add and remove components of the building, the structure and infill principle and the focus on personal individuality of the user with user participation. These elements makes it possible for the dwelling to (re-)adapt to the changing needs and wishes.

The [re] in re-adaptive links to the possibilty to adapt 'back' as well and adapt multiple rounds. It's not only about adaptivity within the flexibility of the floor plans, but also about growth and shrink.

## How do these principles and definitions of re-adaptivity manifest itself in projects?

To find enablers and barriers of the proposed definition, the theory needs to be linked with the practice. Thus Molenvliet is used as a main case study. Molenvliet, was an experimental housing project based on John Habraken's structure-infill approach. By separating the structure and the infill, the building becomes more adaptable in the sense that there are more open-ended outcomes inside the structure because the infill is not fixed. Molenvliet introduced resident participation, allowing people a direct say in the composition of their dwellings and floor plans.

In terms of organized grid system, expandable by multiplication, structure-infill concept, and personal individuality with user interaction, Molenvliet overlaps with the definition of re-adaptive. However, it lacks (highly focused) marges, interchangeability, polyvalence, and the ability to add and delete components — precisely what distinguishes adaptive from re-adaptive. Therefore some smaller, less elaborative, 'comparative' case studies are 'hooked' on to the main case study, to show additional or different angles. The comparitive case studies are fundamentally comparative and similar (adaptivity fundamentals and within the elaborated theories, housing, experimental).

### Comparitive case studies

For Molenvliet and Solids both the structure-infill principle with resident participation (for molenvliet designing the floor plans, for solids the rent auction with ownership over infill) is incorporated. However with Molenvliet we can see that it's basically frozen in time and nothing has changed since the first tenant's decisions. For both Molenvliet and Solids expansion of places is not included in the design.

Diagoon Woningen and De Drie Hoven both didn't have resident participation. Diagoon woningen due to the notion of polyvalence in fixed spaces, and Drie Hoven's due its nature of elderly care needing housing but rather

focusing on social interactions. The fixedness of the Diagoon woningen does hold back adaptivity. Diagoon woningen does however offer growth by pulling outdoor spaces to the inside.

PREVI is an example of also having no resident participation but showing a lot of resident initation. This largely might be due to the less strict rules and regulations concerning adapting a dwelling.

Very different than all the stated above projects, the Nakagin Capsule Tower shows no signs of individuality and shows adaptivity through interchangeability where all the capsules were to be replaced over a certain time

Finally, The Sky House, possibly the most adaptable, incorporates a structure-infill approach with moving-nets, demonstrating re-adaptivity. Moving nets may also be possible because to differences in norms and regulations regarding housing adaption between Japan and the Netherlands.

## What are the enablers and barriers regarding re-adaptive housing?

The first point to note is that, while the case studies are all based on the same idealized ideals of adaptability, they all contain and exclude different features. The information on resident valuation and finance is mainly missing, which could have a significant impact on the decision. Design components are not only abundant in quantity, but also in applicability. The [RE] in re-adaptivity appears to be lacking, and growth/shrink is mainly underexposed.

Financial barriers are that there is a high initiation costs due to the overdimensioning and concept development, social interaction /common spaces can't always be financed, location seems to be more important to residents than the (re-)adaptive nature and that an investor is needed with a long(er) term vision than usual investors. The enablers are that on the other hand, overdimensioning does lead to a high accommodation capacity, re-allocation possibilities and a longer depreciation period. Furthermore, it 's possible to give the resident ownership to their infill, resulting in no infill maintenance, depreciation and investment for the investor. Thus lowering costs for the investor, but also giving the possibility for the resident to invest gradually in their housing. Furthermore, rent auction can lead to higher rents - this is mainly for the free sector as there are caps on social and middle segment housing. Furthermore, mixed-use can result to having social interaction/ common spaces, but still having these financed through seperate exploitation. Mixed-use locations are also higher valued by residents.

Legal has the most barriers as (re-)adaptive housing would need a lot of exceptions from regular building rules and regulations with regards to: a) the building decree -rigid requirments- b) zoning plan -fixed amount of building layers, building dimensions, amount of units, activities- c) beauty committee -facade and dimensions might re-adapt over time- d) monumental protection -might prevent change- e) building permits -might take too much effort and time to ask per household-. Furthermore, the tenant contract, communal decisions and (lack of) ownership can also be barriers. The enabler of giving the possibility of exceptions through a predicate experimental are less likely as this is an 'one-time solution'. Another enabler can be the possibility of giving the infill in ownership to the resident and thus giving room for practiced re-adaptivity.

Design barriers can be that too much overdimensioning can also lead to structural restrictions as certain connections can't be made. Furthermore, individuality of a first tenant could become a burden for a second tenant. Growth and re-parcellation can have a direct influence on neighbours. Especially growth as it takes away space somewhere else - this could be common traffic spaces and/or outdoor spaces. The largest barrier is the positioning of the installations and wet rooms as this is restricting for total (re-)adaptivity in the floor lay-outs. An enabler is that an structure-infill principle with modular coordination with easily adjustable and demountable infill can give individuality of spaces for the residents. This includes resident participation. By segregating load bearing structure for the other building elements, (re-)adaptivity becomes easier.

Governance has more barriers than enablers. Because (re-)adaptive housing is not common in the Netherlands, residents should be directed from start to finish – and further, because there is no 'ending' with open-ended housing development. Furthermore, there is a split of responsibilities as a result of the structure-infill and communal-individual, which might lead to various types of maintenance. Communal decisions can lead to complicated processes, therefore they can be a hindrance. An enabler is that resident participation is highly valued, and people are prepared to invest in their own infill and/or become involved with tenant organizations.

## How could barriers and enablers be addressed to improve re-adaptivity in housing?

### FINANCIAL

The high initiation costs are due to overdimensioning and concept developing. Over time this can be lowered per project. Initiation costs can be further lowered by giving residents ownership and responsibility over their own infill. This means that the investor doesn't need to finance the infill, maintain the infill and take its depreciation into account. Furthermore, by including mixed-use in the dwelling, the owner can a) separately exploit businesses or add in service costs, b) create more common spaces and social interaction without 'losing sqm,' and c) become a selling point by creating a higher valuation of the dwelling because residents value mixed-use dwellings significantly higher. To anticipate future changes and giving the possibility of re-adaptiveness, overdimension should be included. Lastly, rent is preferable to selling units since, for the initiator, the rendement of (re)adaptive housing occurs after a longer period of time than conventional housing and hence requires a longer stakeholder. A rent auction can be organized to generate higher rents than usual.

### LEGAL

Legal recommendations can be split between a) external to the project, rules and regulations that are set by legal governmental bodies and b) internal to the project in which the building team has direct influence on.

External

It could be possible that the building decree will include new norms and regulations for (re-)adaptive housing, as it is positioned between new construction and renovation. However, this may be overly optimistic considering the modest number of (re)adaptive housing projects. Furthermore, making agreements with the central government, municipality, and city district, in partnership with the requisite lawyers and other professionals, can allow for zoning plan and suitability criterion. This could allow for more mixed-use development or the construction of an extra building layer than was previously permitted, with the caveat that the building is overdimensioned. This could be an incentive for the initiator to overdimension in order to avoid losing a possible building layer and thus rental revenue. The zoning plan also should provide room for some flexibility in terms of quantity units in advance, so that re-allocation/re-parcellation can be implemented. Because the shape, façade, and volume of (re-)adaptive housing may change, the beauty committee must send approval of any potential alterations ahead of time. Agreements must be reached between the renter, the owner, and the beauty committee regarding what is and is not permissible in terms of materialization, colors, volumes and shapes. In terms of monumental protection, the structure should not attempt to become monumental or should only be monumental for the structure. Most legal aspects are externally done by governmental bodies, and thus is difficult to apply project per project. This would need legal measures on larger (national) level and thus policy.

Internal

In order to prevent cases of needing 100% communal decision agreements, re-adaptive housing is based on tenant contracts in which the infill is in ownership so that individual adaptivity within infill is possible. Common spaces and the structure is still in ownership of the housing association/owner.

### DESIGN

By incorporating the structure-infill principle to (re-)adaptive housing, flexibility and invidiuality is created.
The architect design the structure, the shafts and the core. All the other will be done by the resident themselves – this can be in co-speech with an architect or by themselves. It's important to keep a certain framework of rules and standardization, in which there is freedom provided. A modular grid coordination and the segregation of each building layer is needed where the infills must be adjustable and demountable easily. The following three zones should be implemented – the fixed beta zone for the shafts and installations, the free alfa zone, the marged delta zone in which possible growth is taken into the margins by the possibility to pull outdoor space to the inside. Standardized agreements on the maximum amount (m2) and direction (up, under, next) should be clearly made. Furthermore, the design needs to incorporate common spaces, within interest of residents, where residents can have social interaction. Additionally, structural elements, traffic spaces and ceiling heights should be overdimensioned. Overdimensioning in structural integrity is needed to a certain extent – making it possible to horizontally and vertically expand however still making vertically merging possible. Lastly, wet rooms and installations can be clustered as much as possible. A core with the shaft and fuse box can be created in the beta zone on every unit where this core is all stacked vertically in the same line.

### GOVERNANCE

Guidance for residents in terms of (re-)adaptive building and resident participation is critical to keeping things functioning smoothly. Both the primary and secondary tenants must remain involved throughout the process. Furthermore, very specific and clear agreements must be made on a) possibilities within design, b)possibilities with regards to growing and shrinking, c) ownership, d) maintenance responsibilities and e) communal decisions

– Allocation resident:
Correct recruitment and auction timing is after finishing the structural body of the dwelling.

– Design:
Resident involvement in the infill can be accomplished through consultant hours with residents and a coached team of architects. 3D models, furniture maps, variety catalogs, and/or a 1:1 maquette can all assist tenants grasp 'abstract floorplans' better.

– After construction:
Because the infill principle is uncommon, an installation fair and protocol can be useful tools. The procedure must be presented before to the auction, with simple to grasp text, examples, and graphics. There should also be a helpline that residents can contact. It should be stated very clearly what the actual possibilities are, how they can be realized, and who they should contact.

## ''In what way can (future) newly constructed re-adaptive housing in the Netherlands be managed?''

### Initiation phase [FINANCIAL AND LEGAL]

Although financially there is a higher initiation cost, there is also a higher yield over a longer period of time. The higher yield is due to the longer use (longer depreciation and higher accommodation capacity). There is also no infill costs as the infill is in ownership of the resident (no financing, maintenance and depreciation costs for the investor). Also by implementing mixed-use to the dwelling, more financial exploitation is possible and also results in a higher building valuation. The main recommendations for the financial aspect is finding a long term investor that is willing to finance higher initiation costs and take more rendement over a longer period of time . The investor therefore needs a substantial longer term vision than usual.

Some legal aspects are internally implementable (such as the change of tenant contract), however most of them are determined by legal governmental bodies that are external of the project team and high in complexity. Current requirements (bouwbesluit, beauty committee and zoning plan) could counteract to practiced re-adaptivity. The status (monumental) could both be an enabler and barrier as monumental status does preserve the building. However, a building with principles of re-adaptivity should be allowed to change as well. Other than a change in tenant contracting (giving the tenant ownership to their infill), legal aspects should be addressed on a larger scale and thus on a national level. Making a modification to legal building regulations not only might take a long time, but it is also a huge choice that will affect many other projects. The main recommendation for the legal aspects is a change (or introduction) in new flexibility in-use-policies with regards to the current building policies on a national level.

### Design and construction phase [DESIGN]

Design has the least amounts of barriers and its aspects are very easy to implement in terms of the design question, since such mechanisms and techniques already exist. The design should give space for adaptation over time (through structure-infill, overdimensioning and resident participation) with a set flexibility framework (grid coordination, marge-, free- and fixed-zones). Furthermore, re-adaptive design needs individual and collective spaces (structure-infill and common spaces). Restrictions in the design are (only) the growth possibilities (meaning taking place somewhere else) and installations.
The main recommendation for the design aspects is to have a very specific and clear brief/design assignment on re-adaptive architecture.

### Operation, re- and maintenance phase [GOVERNANCE]

The governance aspects mostly requires a different organisation as the resident takes up a larger role in the process. An additional organisational elements is during the allocation (additional information events, different allocation timing than with regular housing, rent auction). The re-adaptivity should be made possible through an embedded re-adaptive design process (resident participation, design framework and helping tools). Management is also needed within ownership seperation (and thus different responsibilities), and the operation phase (helpdesk, protocols, tenant association).
The main recommendation for the governance aspects is setting up a different resident organisation with a more extensive communication between owner-resident and a continious management, even after the construction phase.

When implementing these recommendations, the building phases and stakeholder roles shift.
As the residents becomes partly owner (ownership), designer (free infill design), investor (investing in own infill), the architect and investor need to give parts of their role to the resident. The construction engineer and the architect will be working closer together on the structure of the building.  Furthermore, a resident representative is being introduced as an additional stakeholder – an extra party that the project manager has to take into account. Lastly, the owner/organisation will have to play a bigger role after construction as continuous guidance and management is needed.

Re-aaptive housing never re-visits the initation phase (when renovation or transformation is happening) but rather has the introduction of the 're-phase'. This re-phase is parallel with the operation phase, and includes the (re-)adaptations being made to the housing unit. This phase is imbedded in such an extent that systems and information of what the possibilities are (within architectural space/design but also structural) are clear and set for residents. After a formal approval, the resident can be linked to a fixed contractor. The fixed contractor is familiar with the buildings re-adaptivity and warranties similar building qualities between the different units.

Re-adaptive housing also will have a longer (infinite loop) of operation phase, while for normal housing the dwelling wears out after a certain time. Maintenance begins earlier with re-adaptive housing since with re-adaptivity there comes renewal (shorter life cycles) and thus maintenance. The design phase is longer in re-adaptive housing as the resident is incorporated in the design phase and the architect needs extra discussion time with the construction engineering as the structure gets overdimensioned and future anticipative. Lastly, the construction phase is shorter as contractor only build the structure and common spaces while the residents builds the infill which flows towards the operation phase.

From the main recommendations and the changes in the build phases, it can be concluded that re-adaptivity is a process and not a project. Re-adaptivity is a process as its continuous / open ended, has a certain procedure to be followed (especially during the re-phase), doesn't have a definite duration, is event-driven and neverending. Re-adapting the housing unit is done through an imbedded workflow in a stated procedure. This certain procedure is followed without a certain definite duration but is rather event-driven. The event in re-adaptive housing being a change of household, change of needs and wishes or change of social standing. This is unlike a project that is a temporary endeavor, which is undertaken to obtain an unique objective with a constrained planning and thus closure. With a housing project, once the needs and wishes of a resident change, they usually move to a different project (different housing dwelling).

This research can be ended with the conclusion of re-adaptive housing never fully coming to fruitation in the Netherlands because it has been seen as a project. In order to enable re-adaptive housing in the Netherlands, re-adaptive housing should be seen, initiated and followed through as a process.

# 9. DISCUSSION

To valuate the conclusion, the discussion section will elaborate on the context of the research and limitations. Furthermore, recommendations for further research will be made.

# 9. DISCUSSION AND LIMITATIONS

To support the conclusion, this thesis discussion provides explanations and interpretations of the research findings in the context of re-adaptive housing, examines its consequences, states the research limits, and lastly offers recommendations.
Per research phase it is tried to be as clear and transparent as possible so that when another researcher follows the same steps, the same findings would be observed. However, the data has not been contextualized with previous research and theories and the significance of new results have not been evaluated. The discussion furthermore can have alternative explanations of why certain conclusions have been formed. In order to provide an accurate picture of the credibility of the conclusions, limitations are being explained as well. This will be done per research question.

## What are principles and definitions for re-adaptive building?

For defining re-adaptive building, three theories have been selected as a starting point: Metabolism, Structuralism and Open Bouwen. The research initiated from Metabolism and its fundamentals, where Structuralism and Open Bouwen were also taken into account in order to bring it to the Dutch context. When the research could have been initiated by a different theory, the outcome of re-adaptive building could also be different as perhaps two different Dutch theories would be used instead of Structuralism and Open Bouwen.

Also, this research focused itself on the Dutch context with regards to not only the two Dutch theories, but also the case studies, interviews and critical panel. It could be possible re-adaptive would be a very different (proposed) definition if the research would focus on a different country.
Also, re-adaptivity is not so much discussed in academic papers and it seems that its definition has not been clearly formed. This led to the decision to propose an own definition of re-adaptivity. Not only is this based on the three theories as mentioned before (and therefore very focused on only three possible theories), but also an own standing that has been taken. Since the research continues from this re-adaptivity definition, the focus has been on the key characteristics of this proposed definition. A different definition proposal could have lead to very different outcomes as the focus might lie on different elements.

Lastly, also during the definition forming of re-adaptivity not every characteristic is as clear as the other. For example, things such as 'open-ended', 'replaceable' and 'individuality user' do show the overall philosophy behind re-adaptivity, but are very difficult to make specific and concrete. For example, open-ended could mean open-ended in free infill, or in growth, or in nihilistic limitations with regards to financing or legal aspects. Individuality user could mean ownership over infill, but could also mean just having different sizes units in a whole dwelling. Also terms as polyvalence have been used in the definitions. Polyvalence is a difficult term to really pin point what this exactly means in terms of designing.

## How do these principles and definitions of re-adaptivity manifest itself in projects?

### Theoretical framework

The theoretical framework used for the case studies was FLEX 4.0. This framework was a framework focused on adaptivity, but still was chosen since there were not frameworks on re-adaptivity. Also, this framework didn't include organisational aspects. Therefore, the framework as been additional with such elements. This led however to the framework being split in two parts. The FLEX part is very clear and offers statements of which the case study can be linked to. The additional part are more open and elaborative aspects. This makes the framework not very cohesive and more of two separated frameworks rather than one.

### Cases studies

Principles and definitions of re-adaptivity can be seen in the selected case studies. A selection of different case studies could have led to very different outcomes. The focus might be a lot on Open Bouwen as the main case study is Molenvliet, which is a project mainly based on the structure-infill principle of Open Bouwen. This case study was chosen due the most amount of information findable, being in the Netherlands, still functioning as housing and being able to conduct an interview with the architect. If, for example, the Nakagin Capsule Tower had the same amount of information and interview possibilities, it could have been possible that this would become a main case study and therefore outcomes would be more directly linked with Metabolism and the capsule principle.
In terms of the amount of information, the comparitive case studies didn't always have the same amount information availability degree. Perhaps more information, and interviews could lead to more and different insights.

### Interviews

Interviews have been conducted wit two architect – Frans van der Werf (Molenvliet) and Herman Hertzberger (De Drie Hoven and Diagoon Woningen). The interviews were very relevant to the case studies and research theme, however other architects might have had different views and opinions such as the architect for the Solids or the Metabolist architects. An attempt was made to interview Kisho Kurokawa's architectural firm (since Kisho Kurokawa has passed away himself) who designed the Nakagin Capsule Tower, however no answer has been given. Also, an attempt has been made to contact Tatsuyuki Maeda to gain more information about the redevelopment of the Nakagin Capsule Tower and to gain contacting information about its investor. However, Tatsuyuki Maeda couldn't provide more information.

For the sake of time, however, only the architect is interviewed, as they are usually part of the process from beginning to end and can therefore answer questions about initiation, construction and municipal principles. This could have led to more input on the architectural aspect of re-adaptivity. If instead, more developers would have been interviewed, this could lead to more focus and insight on initiation, business cases and concept development. Or if only the municipality would have been interviewed, the focus could perhaps be very linked to for example zoning plans.

### Survey

Lastly, residents of Molenvliet didn't get interviewed but rather a survey has been posted to them. This is done so that the chance would be higher of residents willing to participate.The limitations are however that it is reduced in length, in order to try to maintain a high(er) response rate.  The survey was distributed to all 122 residents rather than a selected group. A QR code flyer has been printed and placed in their physical mailbox. This is done since their e-mail address is unknown and they will see the flyer as soon as they open their door. A small haribo candy bag was fastened to each flyer in the hopes that residents would reply more likely. There were 9 answers from residents. This number could be low due to the fact that some of the postboxes of the first floor units were collectively on the ground floor and residents might not check it too often. Also, it could be due to the fact that there were also elderly living in Molenvliet that are not familiar with QR codes. It could be possible for a next time to ring everybody door with a very short introduction and then handing the flyer. This might led to people filling in the survey quicker.

The responses can not be considered reliable as generalization, of all residents. It has an inbuilt and uncounted for bias, as the small amount of respondents might have different attitudes than the non-respondents. The obtained inferences can't be adjusted in any way since there is nothing known about the non-respondents. Furthermore, no surveys have been set out to other project so even if the survey would obtain a 100% response rate, it might still be an atypical situation. So it's important to note that this is in extension of the evaluation of the Molenvliet project in the current context.

## What are enablers and barriers regarding re-adaptivity in housing?

The enablers and barriers are based on a) the selected case studies and b) based on the theoretical framework. Therefore, different case studies could lead to different insights and a different theoretical framework could lead to different key points. The key points are based off the theoretical framework statement information and branched off to certain themes. Some of these themes have no data. Furthermore, there is no weight per statement attached. This leads to the fact that e.g. design is very elaborated and legal is very small in comparison with design. This has to do with the framework that is mostly design focused and less legal and financial related. This can be due to the fact that the theoretical framework lacks more research points, or that re-adaptivity housing research often focuses on architectural matters rather than organisational elements.

The smaller branch units (legal and financial) are the smallest due being mentioned the least, however the most complex and heavy. Design contains a lot of information and is mentioned often, and therefore easy to implement. Governance is not so much mentioned, however the implementation isn't too difficult. Legal and financial are both small and heavy weight. This may be due to:

- Logically, the more written about something, the more thought has gone into it. Legal and financial matters have not been researched and written about enough.
- A lot of thought has already gone into legal / financial issues, but this has not been researched enough.
- It seems to be very complex due to the fact that financial issues and legality is not very much within the MBE/ Architecture field of study.
- It could also be very complex due to the fact that legality is an external organisation and is not within a project team such as the developer and advisors are.
- It's complexity can also be due to the fact that no interviews have been done with relevant people in these branches such as investors and legal municipality workers.

## How could barriers and enablers be addressed to improve re-adaptivity in housing?

Barriers and enablers are being addressed for improvements based on what could be seen in the case studies (what have they done and can be used as an improvement for the overall re-adaptivity question) and what has been said during the critical panel. Again, different case studies could lead to different improvement. The critical panel included a developer, project manager, architect, structural engineer, installation advisor and resident representative. The diversity of the group created a multi-perspective discussion which was very interesting. However the critical panel did miss an investor and municipality or legal body.Furthermore, the resident representative has been building Solids in the past and therefore ofcourse has a more positive attitude towards re-adaptive building.

Initially the idea was to structurally go through every point. However, it was quickly clear that discussions happen more organically, therefore also a more organically approach was used by letting the discussion happen and intervening when certain members either speak too long or loose focus. Recommendation points were linked together based on what the discussion on that point was. Furthermore, the prevent that only certain members spoke more than other, it was asked to the less speaking members what their thoughts were. There was also only one hour planned for the whole discussion, so this meant that points had to be clearly discussed. This was explained to them previous in the e-mail. Also the discussion points were emailed to them before with a clear explanation of what the expectation from them was, what the researches role in this panel was, and what the planning for the hour would be. This resulted in the panel members already clearly knowing what to say and not losing time on 'thinking and understanding'.

What came forward in the discussion was that in principle everybody had no issues whatso ever with building re-adaptive housing, but they were being held back by the investor. And the investor was the one that was not included in the critical panel!

Lastly, the conclusion that it re-adaptive housing is a project and not a process is definetly

## Further research recommendations

This research has been a first step towards re-adaptivity housing possibilities in terms of the organisation issue. This research is a explorative research, which led to some interesting points that can be further explored and unfolded. The smaller elements can be further researched and dived in deeper.

- Re-adaptive definition
  It would be very interesting to further define 're-adaptive' as this is a first attempt to a possible definition of re-adaptive. It would be of value to question, criticize and expand this definition.
- Supplement theoretical framework
  The theoretical framework can be further expanded with the proposed improvement points as discussed in the last research question. The used theoretical framework consisted of FLEX 4.0 with statements in which case studies could check boxes. The addition to the framework were more open questions. Based on the improvement points, these could be formed into statements and also be included in the FLEX 4.0, making it a coherent framework with 'check boxes' and scores.
- Additional interviews
  Interviews with investors and legal organisation bodies can lead to a lot of new insights.
- Financial
  Additional research can be done on why a longer term vision is not common for investors. What exactly holds investors back if they could gain a higher rendement?
- Legal
  Additional research can be done related to all the rules and regulations that can be an enabler and barrier to re-adaptive housing. For now, the rules and regulations element has been very superficially examined. In this research it was only mentioned that 'policy needs to change', however it wasn't specified any further what exact changes need to be in that policy and how this could be implemented. Further research could specify what new policies exactly need to include and how these policies can be implemented.
- Governance
  It was concluded it demands a different type of organisation structure with some leading elements such as communicating and incorporating the resident more. Further research on this can be what 'continious manegement' exactly entails and how an organisation can do this.
- Process
  The research started with an initial idea of housing projects and ended that it's a process in stead. Re-doing this research or doing new research with the view of a process, could lead to new insights. It's also worth researching how a process usually is done in terms of housing.

# 10. REFLECTION

To reflect back on the thesis and process, chapter 10 includes reflection on the research topic, reflection on the results and reflection on feedback given by mentors.

# 1. Reflection on research

## 1.1 Relation graduation topic and MBE track

Researching adaptive housing possibilities in the Netherlands is directly applicable to the Real Estate Housing studio. As it concerns the management and organisational aspects, it relates to the Management in the Built Environment track. Furthermore, as it also includes the link with architecture, it links back to the master programme as a larger whole rather than just the MBE track.

## 1.2 Relevance

Academic relevance

In the built environment, there is an academic domain mismatch, specifically in architecture and management. This thesis not only serves as an interdisciplinary connecting link between architecture and management in the built environment, but it also bridges the research gap between theory and practice domains, demonstrating how the theory of (re-)adaptive building principles works in practice. It is being explored to gain a better knowledge of the facilitators and barriers. Re-adaptivity will also be defined. It also bridges the research gap between Metabolism, Structuralism, and Open Bouwen. Furthermore, the interviews and surveys will provide insight and new information on the attitudes of multi-stakeholders, such as developers, residents, and advisers, on this type of housing project.

Societal and practical relevance

This research can lead to building professionals into deciding building re-adaptive housing. Building parties directly benefit from this, possibly, leads to less need for transformation, big renovation, decay and even demolition of their properties. Further research can be built on specifically the more complex issues such as the financial and legal aspects.

# 2. Reflection on results of research

## 2.1 Choice of methods

The methods have not been changed after the P2. I look back with satisfaction of the used methods as I think they all have been completing each other using multiple angles (both theoretical and practical), and make a logical order in use as well What was not expected before hand was that visualisation in a way also became a research method. Before, to me, visualisation was something that would only be done afterwards as an 'extra' thing to make the research paper more easthecially pleasing. However, after I spend the last weeks before P4 visualizing the research outcomes I started to understand my own research a lot better. It also resulted in new insights that not necesiarrly came as a surprise, but did clear up a lot of vagueness. Looking back, I should have made (strong) visualisations a lot more early in the process. I think this would have benefitted the research a lot.

## 2.2 Process

After the P2, some research questions have been changed multiple times due new insights of the research.

### Literature review

Firstly, materialization as important key characteristic was part of the literature review. During the research this seemed not to be such a relevant characteristic. An important difference result during the literature review was the formation of my own definition of re-adaptive. In the P2 is was expected the re-adaptive definition to be something similar to the three theories, as it was expected for all three to have many overlaps. Although they do have overlaps, they have fundamental differences as well. This led to a different formation of (proposed) definition of re-adaptive and therefore also a higher focus on the [RE] part of re-adaptive. Initially planned, it was not taken into account to propose an own definition for re-adaptivity. It was to my surprise that this was not defined yet. This also led to changes in the theoretical framework as well.

### Theoretical framework

The theoretical framework was before only an adjusted FLEX 4.0. After the proposed definition of 're-adaptive', the theoretical framework got supplemented with 1) general project information 2) organisational/ management aspect and 3)The 're' part in re-adaptive. As stated in the discussion, the theoretical framework has a lot of influence of the research outcomes and might be the reason the outcome is so architectural driven. Perhaps I could spend more time looking for a different framework that is more focused on organisational matters and just take the architectural aspects as a given that is possible. Looking back, most my conclusions came forward from my own additional framework and less so much from the FLEX 4.0. If the FLEX 4.0 was not used in this research, more or less the same conclusions still would have been made.

### Case studies

With regards to the case studies, the selection, the amount of case studies and the analyse framework also changed in comparison with the P2 plan. First, the plan was to have 3 short listed case studies per theory, 9 in total. This seemed not reachable within the time frame. Also, it was a better idea to do one case study very extensively and later have a couple 'smaller' (less extensive) comparative case studies. Even when the comparative case studies were chosen, these were also changed through out the process. Two comparative case studies have been taken out eventually. Even after the P4 the comparitive case studies have been moved from main report to the Appendix. This was due readability. The most important conclusions from the comparitive cases studies were only put in the main report.

### Interviews

In the P2 plan the plan was to conduct interview to the related architects/developers/contractors of the short listed Dutch case studies. Since there weren't 'short-listed' case studies anymore, but rather only 1 main case study, this part also expired.

Only two interviews have been conducted. One with the architect of the main case study, and the other of the architect of the other Dutch comparative case study. An interview with the Solids, as planned in the P2, seemed not necessary anymore as it 1) became a comparative case study and 2) the evaluation by Stadwonen was elaborative enough. An interview with Herman Hertzberger, the architect of 3 of the Structuralist case studies, was conducted. With regards to metabolism, the architects were contacted however no response was received.

With regards to the main case study, it seemed not necessary anymore to conduct interviews with the initiator, developer or contractor since the needed information was already gathered through evaluation books and the interview with the architect.

Also, according to the P2 the plan was to first do case studies, then interviews as a kind of 'validation and discussion' of the case study, with the possibility to add new information to it. In practice, this happened more simultaneously. The interviews were more in addition of the case study and directly incorporated rather than being a separate later chapter.

### Interview questions

The questions as in the P2 were a good guideline, however got more specific during the actual interviews. The interviews themselves also were more like an dialogue rather than 'question-answer' and therefore sometimes on the spot questions were also asked, or questions were left out as they were earlier discussed.

### Analyzing the interviews

A PEST/SWOT (as planned in the P2) wasn't used anymore to analyse the interviews, but was analysed through codes as the theoretical framework and theme's that came forward (more explorative).

### Survey

A survey has been set out to the, total 122, current inhabitants of Molenvliet. The survey was printed, with a small bag of haribo's as a thank you attached, and put in their mailboxes each. This was done over e-mailing, as 1) the mail addresses of the residents weren't known and 2) the postbox get's checked immediately after someone comes home, so the response rate could be higher.
The survey flyer shortly introduces the research, the aim, how long it takes and the QR code. The survey was set out on march 7th and was analysed on march 30th. Of the 122 set out surveys, 9 people have responded. This is a response rate of 7.4%.

A higher response rate could perhaps be achieved by knocking on every door, and give a short pitch to each of them. Also, a lot of the the surveys were put in the mailboxes on the ground floor and not through the smaller mailbox on their door (those who live on the first floor). It could be that some people never or rarely check their mailbox on the ground floor. Also, it could be that there is a high density of elderly living, that don't know how to use a QR code.

### Enablers and barriers

The initial plan was to order and categorize all the enablers and barriers that were derived from the case studies, in a SWOT/PEST table. Looking back, this didn't make much sense or at least didn't have a strong argumentation. The plan changed into: 1) put all the enablers and barriers together 2) place similar themed enablers/barriers together and theme these 3) This is the overall larger enabler and barrier table that can be found in Appendix 5. 4) Filter these to what's most relevant for the RE part in re-adaptive and/or un-ordinary organisational aspects. 5) Categorize these as the theoretical framework (not the FLEX 4.0 part, but

the additional own part). This again changed when I started visualizing the research outcomes. When I made a framework of the case studies put against the case study outcomes themselves, red and green dots could be added to each statement. This gave a very quick and clear overview of all the case study pages. It also showed very quickly where the gaps were in terms of relevance and/or information. Every statement (=case study content) then could be branched into a certain amount of themes (sub branches). By visualizing this, it became very clear what was linked to what. I did this by printing out every statement and cutting each one with scissors, and then manually put each piece of paper together that were within a certain theme. Sub branches could then be merged to the key branches. When I did this, it also became very quickly clear what key branches had the most information. By further visualizing these with icons, texts, and putting them in other graphs new information again arose. Things I wouldn't normally even think of, became interesting finds.
Even after my P4, I still made changes to the barriers and enablers. I saw that I have issues with understanding main issues and side issues. My recommendations have been changed into more specific main recommendations with the underlying principles. Also during my P4 I got the feedback if I thought about the difference in building phases and stakeholder roles. I did, however not extensively. When I did incorporate this result of my conclusions, a lot of new insights came forward. While I did this, it was clear that a certain element seemed to come back: a process. From this, the researched got an extra layer of conclusion. On top of the main recommendation conclusions, the conclusion came that re-adaptivity is not a project but a process. This was something very new and unexpected for me – as I was so used to project thinking.

### Critical panel

The critical panel initially only included an architect, developer and project manager. However, during the case study themes related to installation, structure and construction came forward. Therefore, an installation advisor, structural engineer and contractor were added to the critical panel. As this panel as it would be, would be very technical driven, the resident interests could be fade too much. As a resident (assuming they are not related to the build environment) might be too confused about the used terms and rate of discussion in the critical panel, a representative is chosen. For this, Frank Bijdenwijk is chosen as a resident representative as he is a advocate of resident freedom, participation and adaptive housing.

The critical panel input was based on a previous critical notions document I have made based on the case studies. These critical notions were based on my own perspective of which elements would be most critical to discuss. This was done before the visualization and thus done before new additional insights came forward. However, this critical panel still more or less discussed the most important parts of the enablers and barriers. For a next time, it would have been a lot better to (again) have the visualisations a lot earlier, so this could also be used in the critical panel.

## 2.3 P2 anticipated risks

None of the risks were actually a problem during the research. However, it was still good to anticipate.

The first risks was that there couldn't not be enough information about the selected case studies. This was firstly prevented by beforehand having the case studies also selected on the amount of information available, with a back up of case studies on the long list. And eventually adapting the theoretical framework (as flex 4.0+ was extensive and leaving out parts wouldn't necessarily result in a too superficial analysation). As there now is only one main case study, the one main case study partly got chosen on the amount of information available. Also, the interview with the architect containted a lot of information.

The second risk that may occur is that the interviewee's are not willing to participate. This was also prevented by having multiple options and a 'buffer-list' of possible interviewee's. If all stakeholders of the short listed case studies wouldn't want to participate, then stakeholders from a project from the long-listed case study would be contacted. Once they agreed to participate, this project will be turned into a short-listed case study i.e. more extensively researched and then interviewed about. If it turned out, that no stakeholders from the whole list (short listed and long listed) wouldn't want to participate, then extern professionals in the same field would be interviewed. The questions that relate directly to the case studies then would have to be changed into more discussion-like and opinion based questions.
The two architects were willing to participate. The Japanese architects didn't respond. The representative of the Nakagin Preservation Group did respond, with some information about the demolishing plans but couldn't give out any more information. This however didn't become a big issue as the Metabolism case studies are 1) comparative and 2) older interviews from the architects could be found. Furthermore, Certitudo developers was contacted about the redevelopment of Centraal Beheer Gebouw. They however also couldn't provide more information. This wasn't a big issue as an interview about the CBH was more informative rather than necessary.

The third risk is having not enough participants for the professional panel. To prevent this, the search for a panel would need to happen as soon as possible. When having a internship, employees from this company could be used. If this is not possible either, then faculty teachers at the TU Delft could be contacted. During my internship, I worked on a project of which I could reach out to the all the functions working on it too. The only 'extern' expert was Frank Bijdendijk – who was also very easy to contact. I called him and asked if he wanted to participate, followed by an email with the TEAMS link.

# 3. Reflection upon feedback given by mentors

The feedback was largely to bring more focus in the research and to bring more structure/readable in the research. I agreed, so it was more easy to understand what they meant. I tried to incorporate feedback as soon as possible as comments in the paper, and then go through them. I just to have a lot of tables through out the process. In this the feedback was a lot to take out the tables (or put them in the appendix) and really come to the core of what those tables tell.  Also, because there is a lot of text, it was not always as easy to follow where the research is going. The feedback was to visualize and add in pages that show where the research is at now. I also tried to make the report more readable by only keeping the most important information in the report, and putting everything else in the Appendix. Visualisation helped me personally to understand my research better, however I am aware that it might be confusing (at first) for a first time reader. That's why I tried to make my visualisations more readable. Also, I tried to explain the figures in my report with words.

Overall in the process, I think the most common reoccuring feedback was that I have issues with seperating subinformation and the main information. To me, everything seems important. This makes the research too scattered. Looking back, perhaps I could have focused on only one element within re-adaptive housing. For example, only the financial aspect or only the organisational aspect. But still I'm content with my research as it's a very explorative research by nature and next thesis writers could focus on one of the aspects more.

The supervisors didn't bring answers when given feedback, but rather let me know what needed improvement. As I was in the research process, it can be difficult to oversee what you are missing. Especially if you are not aware of the fact that there is something missing. After being aware of whatever is missing (done by the supervisors), then the next step becomes doing something with this missing element which then again is finetuned.

Especially between P4 and P5 the given feedback by my mentors was to make the research more followable and understandable for people that didn't were part of my research process. Especially with regards to the presentation, as some illustrations might be overwhelming and not quickly understandable. It's important to have a good, coherent and followable story. I tried to do this narrowing down my paper, with only the most important findings. Between P4 and P5 I managed to narrow it down to 36 pages less than before. Also, I tried to make a hierarchy in the main important conclusions and supportive sub-conclusions. Lastly, after P4 I still did some extra additions to the thesis based on feedback given at the P4. This included adding the notion of role changes of stakeholders, the notion of policy change in stead of project-per-project implementation and the making more clear where certain barriers/enablers/recommendations come from. Even my final conclusion (re-adaptivity being a process and not a project) was made in the last couple of weeks.

All in all, I really think I have learned a lot. Not about my subject, but about general researching skills as well. I think I have been making process every week and I have been improving myself also with every presentation. I look back to a very usefull learning experience.

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# 12. APPENDIX

# APPENDIX


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# 1. Long list

## 1.1 METABOLISM

| CASE STUDY LIST METABOLISM | | | | |
|---|---|---|---|---|
| Project | Year | Function | Characteristics | Current status |
| **Nakagin Capsule Tower<br>Kisho Kurokawa<br>Tokyo** | 1972 | Housing | Two cores with plugged-in capsules.<br>30% bought by companies for overlays of its employees, 30% families who use this as an extension to their own house eg study room etc. , 20% bachelors and the other 20% miscellaneous.<br>Capsules individually and independently cantilevered to shaft, so removing should could be done without disturbing the other capsules. Shows the plug-in capsules best, very 'typical' example, media coverage, a lot of information, about to be demolished, shows a lot of things that went wrong | About to be demolished |
| **Sky House**<br><br>**Move-net for Sky House<br>Kikutake** | 1958<br><br>1962 | Housing | Hanging moving-nets under house to add more space and detach them when it's no longer needed. Shows continuous growth, still standing, smaller scale, dwelling scale | Still standing, housing(ArchEyes, 2020) |
| **Yamanashi Press and Broadcasting Center<br>Tange** | 1964 | Broadcasting center | Communication shafts (joint cores). These cores provide future growth, which happens in 1974. Shows growth over years, still standing. A good overlap between structuralism and metabolism as this building is also discussed in literature as a structuralist building. | In 2013 renovated<br>In 2016 additional measures for earthquake resistance(SOSburtalism, n/d) |
| Capsule Summer House K<br>Kiso Kurokawa | 1972 | Housing | Four capsules with standardized dimensions, same as nakagin capsule tower. Intention to change the configuration of the capsules over time. Is like a 'smaller' version of nakagin tower. | Still standing, mainly because the designer, owner and landowner were all the same person, there is no development around the site and the small scale of the building. |
| Nitto Food Cannery<br>Kurokawa | 1963 | Restaurant | Single unit. Plan was for more. Interesting structure. Eight squares where the corner trusses have extruding steel flaps, so they are ready to plug in a new square/module whenever it is wished. Interesting structure, therefore worth the mention. However not enough information to be found about it and it concerns a restaurant typology. | N/D |
| Odakyu Drive-in<br>Kurokawa | 1969 | Roadstyle diner | First Metabolist building with changeable elements. Combining space frame and capsules. Structural space frame with the use of prefab extension joints. Interesting structure, therefore worth the mention. However not enough information to be found about it and it concerns a restaurant typology. | N/D |
| Shizuoka Press and Broadcasting Center<br>Tange | 1967 | Broadcasting center | Single core with office spaces attached to the cure. | Still standing<br>Newspaper publisher(Merin, 2013) |
| Takara Beautillion Expo 70<br>Kurokawa | 1970 | Expo | Cubic structural frame made out of curved crosses, where capsules can be plugged in. Future growth is facilitated with extrusions, as if it is caught in the process. Similar to Odakyu drive in. Was part of the Expo '70 – more a prototype and conceptual. | Dismantled after expo |
| Toshiba IHI Pavilion Expo 70<br>Kurokawa | 1970 | Expo | Interesting principle, although it is very conceptual.<br>Structural space framework consist tetrahedral units, foreseeing expansion and erasure. Able to make unlimited amount of new forms because of the possibility of growth in fourteen directions. Was part of the Expo '70 – more a prototype and conceptual. | Dismantled after expo |
| Big roof expo '70<br><br>Mid-air (Awazu)<br>Golgi-structure (Maki)<br>Capsule (Kurokawa) | 1970 | Expo | Extremely large frame of 292 meters long and 30 meters high, making huge plaza underneath with hanged elements<br>-Egg like capsule of glass<br>-Framework with installed capsules<br>-Residential capsules<br>Was part of the Expo '70 – more a prototype and conceptual. | Dismantled after expo |

| CASE STUDY LIST METABOLISM – NOT FURTHER USED IN RESEARCH | | | |
|---|---|---|---|
| Project | Year | Function | Characteristics and why not explanations why not taken into account for research |
| Box-type apartments Kurokawa | 1962 | Housing | Four types of capsules in framework and residents can configurate this according to their needs and wishes. Design only and similair idea in Nakagin Capsule Tower, which is already being used. |
| Pumpkin house Ekuan | 1964 | Housing | Capsules swivel around core. Not much in-depth information. Design only. |
| Tortoise house | 1967 | Housing | Not much in-depth information. Interesting framework however.<br>Repeatable orthogonal units, creating the space frame that facilitates future growth. This similar principle can be seen in the Nitto Food Cannery and the Odakyu drive-in, which are already being used. |
| Device Plaza icw Main Gate expo '70 Ekuan | 1969 | Plaza | Relates more to artificial ground and prefab, rather than really re-adaptability and. Maybe, re-adaptive in a sense that it can be placed over any growing city, similar to structuralism. |
| Phone booth Ekuan | 1953 | Phone booth NTT | Just one capsule on its own. |
| Tonogaya Apartmens Kikutake | 1956 | Housing | Shoe boxes outside of each window are the prototypes of the capsules used in the move-net, which is already being used. |
| Plastic Ski Lodge | 1962 | Housing | Portable capsule – not much related to this research |
| Yadokari Hermit Crab Capsule Ekuan | 1969 | Housing | Portable capsule - not much related to this research |
| Moving Capsule Kurokawa | 1970 | Housing | Portable capsule - not much related to this research |
| Mushroom house (K Residence) Kisho Kurokawa<br><br>Central lodge | 1960<br><br>1967 | Housing | First (and only) build mushroom house. Interesting form of the building – sprout from the ground, views focused towards to ground. Not much related to re-adaptivity and/or flexibility. |
| World Health Organization | 1960 | WHO headquarter | A-frame with creating levels of artificial ground. Interior plaza to enforce communication both visually and mentally Related to city – creation artificial ground, not re-adaptability. Also design only. |
| Kodomo-no-kuni Kikutake | 1967 | Summer school | Related to creating and building on artificial ground with creating diamond-shaped buildings. Similarity with structuralism, however no mention of flexibility / re-adaptability. |
| Main gate expo '70 Otaka | 1970 | Elevated plaza | Artificial ground connecting south and main expo site. |
| Sony Tower Kurokawa | 1976 | Showroom and offices | Pipes, elevators and the stairs can be seen in the exterior of the building. Capsules function as the conventional office and showroom space. Same capsules used as in Nakagin Capsule Tower. In 2006 building is demolished. Similar principles as the broadcasting centers, which are being used. |
| Marunouchi Project Isozaki | 1963 | Housing | Structure hovering over existing buildings. New structure is tetrahedrons stacked. Design only. |
| Um Al-Kanhazeer Kurokawa | 1975 | Conference hall, hotel, casino, sports, shopping | Build-up method with attached units (capsules) for the bath units. Attached from outside. Design only. |
| Big Box Seibu Kurokawa | 1974 | Multi Shopping, restaurant, bowling, sauna, sports etc. | Black box with capsules attached. Capsules hold functions of stairways, toilets and piping.<br>Wall structure with no columns, free interior alterations possible. Similar to the Yamanashi and Shizuoka Press and Broadcasting centers, which are being used in stead. |
| Koito Building Kurokawa | 1974 | Office | Capsules are used here for an office building. The capsules for the bath units and air-conditioning units were prepared at a factory and attached to the building. Similar to the Yamanashi and Shizuoka Press and Broadcasting centers, which are being used in stead. |
| Expo Tower Kurokawa | 1970 | Expo | Denuded realization of the Tower-shaped community designs from 1958. Core is a space frame with capsules being attached to it. Similar to his work at Big roof expo 70. |

As this research focuses on the building-level and not city planning/urban planning, naturally the following cases will not be taken into account as well: Linear City (Kurokawa), Wall City (Kurokawa), Argricultural City (Kurokawa), Sakaide Artificial Ground (Otaka), Stratiform Structure Module (Kikutake), Yamagata Hawaii Dreamland (Kurokawa), Mina (Muna) Pilgrim City (Tange and Ekuan), Marine City (Kikutake), Ocean City (Kikutake), Disaster Prevention City (Kikutake), Floating City Kasumigaura (Kurokawa), Shallow Sea-Type Community (Kikutake), Marine City (Kikutake), Ocean City (Kikutake), Floating Factory Metabonat (Kurokawa), Marine City Hawaii (Kikutake)l, Aquapolis Okinwa Ocean Expo 75 (Kikutake), KIC (Kikutake), IT Aquapolis (Kikutake), Capsule Village (Kurokawa), Office buildings city mega structure (Tange and Isozaki), City in the Air Sinjuku (Isozaki), Ikebukuro plan (Kikutake), Tjsukiji Plan (Tange), Helix City (Kurokawa), Tetra Project (Kikutake), Clusters in the Air (Isozaki), Dwelling City (Ekuan), Tree-shaped community (Kikutake), Golgi-structure (Maki), Tower shaped community (Kikutake)

Furthermore, group form was also a part of metabolism. These buildings are also not included: Shinjuku Project (Maki and Otaka), K-Project (Maki) and Hillside Terrace (Maki).

## 1.2 STRUCTURALISM

| CASE STUDIES STRUCTURALISM | | | | |
|---|---|---|---|---|
| Project | Year | Function | Characteristics | Current status |
| **Centraal Beheer Gebouw 116**<br>Herman Hertzberger<br>Amsterdam<br>(Heuvel, 1992) | 1972 | Office | Concrete<br>Geometric floorplan. multiplied and repetitive structure<br>Spreading structure<br>Open structure inside<br>'City-like'/labyrinth<br>Shows structuralism in a very 'typical' way. Very well known and document example. | Decaying<br>Waiting for re-use (Van den Bergen, 2007; Giele, 2021; architectuur.org, n/d) |
| **'T Karregat 134**<br>Frank van Klingeren<br>Eindhoven<br>(Heuvel, 1992) | 1973 | Multi-use<br>Supermarket, primary schools, sports hall, small shops and community centre. | Large structural steel, continuous roof with free spaces (no partitioning walls) underneath, leaving it up to the users.(Archdaily, 2016)<br>Interlink between structuralism and metabolism (Odakyu Drive-in / Big roof expo) | Multi-use cultural center<br>School / day-care centre / community facilities<br>Renovated(Niesten, 1973; Archdaily, 2016) |
| **Diagoon woningen 112**<br>Herman Hertzberger<br>Delft<br>(Heuvel, 1992) | 1971 | Housing | Structural framework with slit levels around vide and two fixed cores, giving the inhabitant freedom of individual spatial design (Knudsen, 2015)<br>Example of structure and infill (drager en inbouw)(Von der Nahmer, 2019) | Housing(Knudsen, 2015; Von der Nahmer, 2019) |
| **De drie Hoven 144**<br>Herman Hertzberger<br>Amsterdam<br>(Heuvel, 1992) | 1974 | Housing for elderly who are physically and mentally challenged | Geometric floorplan. multiplied and repetitive structure<br>Open structure inside<br>'City-like'/labyrinth<br>(Polygoonjournaal, 1975; Hidden Architecture, 2016; housing our mature elders, 2018)<br>Both aesthetics of numbers and flexibility within building in terms of combining units. Also, two towers were demolished: so interesting: why?<br>Interlink between structuralism and open bouwen | 2 of the 3 towers demolished<br>Some units have been combined to make a larger apartment.<br>(housing our mature elders, 2018; Iersel, 2018) |
| Cluster Zuid / Faculteit of Arts 190<br>Joop van Stijgt<br>Leiden<br>(Heuvel, 1992) | 1982 | University | Structuralist dimensioning<br>Clear grid of mushroom-shaped concrete columns<br>Concrete (De Zwarte Hond, no date)<br>Less relevant because of function, less focus on adaptability | University<br>Renovated by Zwarte Hond (start 2021)(De Zwarte Hond, no date) |
| Orphanage<br>Aldo van Eyck<br>Amsterdam<br>(Heuvel, 1992) | 1960 | Orphanage | Concrete<br>Geometric -orthogonal grid- floorplan. multiplied and repetitive structure<br>Open structure inside<br>'City-like'/labyrinth<br>The 'first' structuralist building<br>Breaking down hierarchy of spaces<br>Spreading structure<br>(Fracalossi, 2019; Haan, n/d; WikiArquitectura, n/d)<br>Although first structuralist building with structuralist characteristics, spaces and sizes are very specifically designed – lacks flexibility component. | Office<br>Partly exhibition/museum<br>Three specifically children's designed spaces were kept in memory of.<br>National monument(Iersel, 2018; Van der Vliet, 2018; Haan, n/d; WikiArquitectura, n/d) |
| De Flint 166<br>Onno Greiner<br>Amesfoort<br>(Heuvel, 1992) | 1977 | Theatre | Geometric floorplan. multiplied and repetitive structure(Prins *et al.*, 2016)<br>Less relevant because of function, big theatre space. Also, more aesthetics of number, not so much including the flexibility in terms of walls etc. | Theatre(Flint, n/d)<br><br>Partly burnt down, new addition (1994)(Prins *et al.*, 2016; GGH, n/d) |
| De Kasbah 126<br>Piet Blom<br>Amesfoort<br>(Heuvel, 1992) | 1973 | Housing | Building density is 4 times higher than an usual neighbourhood(Bussink, 2021)<br>Very structuralist building in sense of 'aesthetics of number', less focus on flexibility within the housing building itself. | Housing(Bussink, 2021)<br>Gemeentelijk monument (architectuur.org, 2013) |

| | | | | |
|---|---|---|---|---|
| College Delft<br>Hendriks, Campman and Tennekes (Heuvel, 1992) | 1977 | College | Cross shaped building. Cruciform connected in a way so that each of them is a module removed from another. Moveable walls making it flexible.<br>Less relevant because of function and scale. | N/D |
| De Bastille University of Twente<br>Piet Blom | 1969 | Center campus | Basic structure that should be easily extendable in the future. Building able to be build in different phases.<br>Less relevant because of function, no mention perse of flexibility of space and rooms. | Renovation by Mei Architects in 2004, now restaurant and offices.(Mei architects and planners, n/d) |

| CASE STUDY LIST STRUCTURALISM – NOT FURTHER USED IN RESEARCH | | |
|---|---|---|
| Project | Function | Characteristics and why not explanations why not taken into account for research |
| Prix de Rome / Joop van Stigt / 1962 | Children's village | Only design |
| Chapel for 'Kerk en de Wereld' / Aldo van Eyck /1964 | Chapel | Only design |
| Town Hall / Herman Hertzberger / 1966<br>Town Hall / Herman Hertzberger with Leo Heijdenrijk, Gert Boon and Jan Verhoeven / 1968<br><br>Town Hall / Leo van Heijdenrijk / 1977 | Town hall Valkenswaard<br>Town Hall Amsterdam<br><br>Town Hall Lelystad | Only design<br>Only design<br><br>Only design |
| Church-building / Leo Heijdenrijk / 1968 | Church - building | Only design |
| Student restaurant / Piet Blom / 1964 | Temporary student restaurant for U/T | Converted farmhouse |
| Staff canteen / Joop van Stigt / 1964 | Staff canteen for U/T | Similar use of repetitive grid and material use with other projects that are of larger scale, to housing-related and/or more well-known. |
| Sculpture pavilion / Aldo van Eyck / 1966 | Sculpture pavilion for Sonsbeek | Sculpture |
| The Zilveren Schor / Onno Greiner / 1967 | Meeting centre for Dutch youth | Similar use of repetitive grid and material use with other projects that are of larger scale, to housing-related and/or more well-known. |
| Temporary Town hall / Joop van Stigt / 1968 | Temporary Town hall | Similar use of repetitive grid and material use with other projects that are of larger scale, to housing-related and/or more well-known. |
| Applied Mathematics and Computing Centre / Leo van Heijdenrijk and Jos Mol / 1973 | Education - Applied Mathematics and Computing Centre for U/T | Maintaining landscape character was a key factor. Structuralism comes in as using 'building blocks' by building in different phases with it, making it into an extensions phase by phase. |
| Social services and Dwellings / Abe Bonnema / 1975 | Offices | Prefab concrete skeleton and standardization – not enough to be considered |
| Library / Wim Davidse / 1976 | Library | Very similar to Central Beheer gebouw in terms of spatial, voids and material use for skeleton CBH is on a larger scale |
| Huburtushuis / Aldo van Eyck / 1978 | Centre for single parents in need of temporary shelter | Concrete skeleton is strongly manipulated and subordinate to spatial wishes |
| Muziekcentrum / Herman Hertzberger / 1979 | Music centre | Difficult to relate to housing because of very different function (big music hall) |
| PEN offices / Abe Bonnema / 1982 | Offices | Six buildings linked by bridges with prefab construction and repetitive grid.. ? Just not enough |
| Amsterdam Academic Medical Centre / Duintjer, Kramer and Van Willegen with D. van Mourik / 1983 | Teaching hospital | Phasing design, making parts of the building simple and continuable altered able when in use and possible to extent in future. Not a textbook example. Function to unrelatable to housing. |
| Minestry of Education and Science / Flip Rosdorff / 1984 | Offices | Repetitive blocks. Octogonal towers. Concrete structure. No mention of flexibility or growth. |
| Estec / Aldo and Hannie van Eyck / 1989 | Service building and offices of Estec | Towers linked with others buildings that have irregular floor plans. Partly also steel structure with different measures, depending on load. |
| Ministry of Social Affairs and Employment / Herman Hertzberger / 1990 | Offices | Ministry building – difficult to obtain certain information |
| Kubus Woningen / Piet Blom / 1984 | Housing | Similair to Kasbah, but just a lot more difficulty in terms of shape (making it less flexible). |
| Willibrordus Church / Afrikahuis<br>Joop van Stigt / 1968 | Multifunctional Church/pastorate/housing for personnel/garden halls | Strong geometric floorplan of five linked octagons, concrete(Stigt et al., 2014). It's a very simplified version of other cases. |
| Pastor van Ars Church / Aldo van Eyck / 1963 | Church | |

## 1.3 OPEN BOUWEN

| CASE STUDIES OPEN BOUWEN | | | | |
|---|---|---|---|---|
| Project info | Year | Function | Characteristics | Current status |
| **PATCH 22**<br>Frantzen et al.<br>Amsterdam<br>(Hannema, 2016; Frantzen et al, 2017; Open Building Co, 2020) | 2016 | Housing<br>Office<br>Parking | Hollow floors and removable top floor<br>Lack of shafts in the apartments<br>Having the piping and cabling taken horizontally to central shaft in core<br>Agreements for a fixed ground lease<br>Flexible positioning of functions within building<br>Devision walls between dwellings can be easily removed or added making dividing or merging dwellings possible<br>Gross heights of 4m<br>Escape routing regulations for both housing and offices applied<br>New kind of land-lease contract with Amsterdam, in terms of future alternative use | Housing |
| **Molenvliet**<br>Rotterdam<br>Frans van der Werf<br>(van Hoogstraten, 2011; Council on open building, 2021a) | 1977 | Housing | First experiment of the theory<br>Drager (hoofdstructuur), met fictieve plattegronden en fictieve huizen<br>Structural framework if uniform cast-in place concrete.<br>Co-creation with future residents and architect for spatial floor plans and infill. Resulting in different façade composition per dwelling | Housing |
| **Solids** 1&2<br>Ijburg / Amsterdam<br>Baumschlager Eberle<br><br>Solids 11<br>Oud West / Amsterdam<br>Tony Fretton<br><br>(Vastgoed journaal, 2009; ArchDaily, 2012; Mensink, 2013; NUL20, 2013) | 2011 | Mixed use, including housing | Structural framework (structure) with infill<br>Without predetermined destination<br>Renters are free to use space as they wish<br>Expected lifecycle is 200 years<br>However expectations didn't come true, and might be regarded as a 'failure'. Very well evaluated.<br><br>Habraken also calls this a example of Open Bouwen | Mixed use, including housing |
| **NEXT 21**<br>Yositika UTIDA, Shu-Koh-Sha Architectural and Urban Design Studio<br>Osaka, Japan<br>(Zuidema, 2015; Kendall, 2016; Council on open building, 2021b) | 1993 | Housing | Systemized construction<br>Variety of units, designed by 13 different architects<br>Freely designed within set of rules for positioning elements<br>Utility distribution is under raised floors and above ceiling<br>Natural greenery with wildlife habitat<br>Sustainability: treating waste and drainage on site, minimizing compound burden of building, energy efficient,<br>Structural framework, façade, interior and mechanical systems are independent of each other with each an own life cycle.<br>large-scale renovations have been carried out, such us dividing one unit into two. Every seven years a new phase starts – with new users and approaches to developments | Housing |
| SuperLofts<br>Marc Koehler Architects<br>2019 / 2022 / 2017 / 2022 / 2016 / 2021<br>(Open Building Co, 2020) | Delft, Utrecht, Almere, Amsterdam (rent), Amsterdam (buy) and Groningen | Housing | Flexible and open framework that can be adapted to changing use cycles.<br>Prefabricated modular concrete framework (support) is one unit, with different units stacked to create larger framework.<br>Building system (infill) can be updated in independent cycles: support structure used endlessly, facades updated every 25 years, HVAC systems every 10 years and interior every 5 years.<br>Gradual investments for buyers who can grow into their space<br>Sustainability: systems can be reused or recycled independently, smart façade integrated energy saving. | Housing |
| Het Schetsblok<br>ANA Architects<br>Amsterdam<br>(Open Building Co, 2020) | 2017 | Housing<br>Parking<br>Storage boxes | Inhabitants were integrated in design decision making with also separate tenders for infill<br>Customized and adaptable dwellings<br>Structure can adapt over time<br>Flexibility offered – but requires extensive work (re-installment installations and insulation)<br>Splitting or adding number of dwellings is possible through renewed deed of division.<br>Short façade element life cycle because of anticipated adaptation | Housing |
| CiWoCo<br>GAAGA Architects<br>Amsterdam<br>(Open Building Co, 2020) | 2018 | Housing<br>Offices | Flex zones in apartments, which are up to the inhabitants what they do with it<br>Light, non-load bearing inner and dwelling-separating walls used.<br>Making it easy to combine dwellings and/or rooms. | Housing<br>Offices |

| | | | | |
|---|---|---|---|---|
| | | | Installations not poured into the structural framework, but in the lowered ceilings and retaining walls. | |
| TOP UP<br>Frantz et. Al<br>Amsterdam<br>(Open Building Co, 2020) | 2019 | Housing | Building materials can be re-used<br>Function of building can change.<br>Individual lofts can be combined to make larger appartments. Loft keep their apartmentrights and can later be split off.<br>Spaces in dwellings have freedom of layout. | Housing |
| NEW WEST<br>Olaf Gipser<br>(Open Building Co, 2020) | 2020 | Housing<br>Commercial<br>Parking | Social cohesion<br>Open building principles of infill and structure<br>Half of units are generic double heigh casco<br>Two/thirds have custom designed layouts with co-creation with the future residents<br>One third is rental | same |
| Fenix 1<br>Mei Architects & Planners<br>Rotterdam(Helleman, 2019; Open Building Co, 2020; Mei architects and planners, 2021) | 2019 | Housing,<br>Offices<br>Commercial<br>hotel<br>Theater<br>Sports<br>Parking | Steel table construction frame for new conctrete construction placed over existing loods from 1992<br>With co-creating with buyers in terms of size and sometimes with the use of a vide one dwelling is over two building layers.<br>The minimum loft is 40 m2 of living space and 11 meters of balcony. This loft can be enlarged with extra m2, whereby the increase is by leaps and bounds of 20 m2 of living space and a spacious 5 m2 balcony.<br>Lots of media coverage and many awards | same |

| CASE STUDY LIST OPEN BOUWEN – NOT FURTHER USED IN RESEARCH | | |
|---|---|---|
| Name / architect / year | Function | Characteristics and why not used further in research |
| Juf Nienke<br>SeARCH / RAU / DS<br>nvt | Housing<br>Retail<br>Parking | Prefabricated timber stacked or paired to create larger framework<br>All modules are demountable so building is able to adapt to future needs however:<br>Not build |
| MaMa One<br>Marc Koehler Architects<br>nvt | Housing | Idem as Juf Nienke (timber modules with flexibility inside dwelling and possibility to add/remove, however not build) |
| Object ONE<br>Space&Matter<br><br>nvt | Housing<br>Public spaces | Structural framework to municipal grid with basic connections, stack of units<br>Not all plots need to be housing so there is room left for outdoor space and/or future extensions, offering flexibility. Plot passport: rules of play about the (im)possibilities of the plots. Not build. |
| Silodam<br>MVRDV<br>2003<br>(Frearson, 2015; Sundermann, 2016; MVRDV, n/d) | Housing<br>Offices<br>Commercial<br>Public | Variety of dwellings with different typologies, increasing the individuality and leading to smaller communities of subcultures together, however not much re-adaptativity/flexibility |
| Frame<br>Koschuch Architects<br>2019<br>(Pintos, 2019) | Housing<br>Office<br>Commercial | Volumetrically of a geometric ensemble and all sided raster = all round flexibility, however not much more. |
| Het Bosbad<br>GAAGA<br>2019 (*Wonen in de weelde, de rust en de ruimte van Bosbad Eindhoven*, 2021; *Het Bosbad, Eindhoven — GAAGA*, n/d) | Housing | Very high focus on sustainability (Biodiversity, natural materials, circular materials, limited energy demands, natural materials), not so much on re-adaptivity |
| Lunetten<br>1981<br>Frans van der Werf<br>(den Boer, 2020) | Housing | Drager and inbouw (structure and infill) principle and co-creation with future residents and architect for spatial floor plans and infill. Very similar to Molenvliet. Molenvliet is chosen instead because it can be marked as the first real project of the theory. |
| Stories<br>OLAF Architects<br>2021<br>(Heutink, 2021; Olaf Gipser architects, 2021; Weessies, 2021) | Housing<br>Commercial<br>Parking | CPO project, Circulair material use. Steel, concrete, CLT wood<br>Future residents had direct influence and were part of decision making -> freedom of choice for floor plans<br>Interesting part is more about the use of timber for high rise building, rather than the freedom of choice of floor plans, which is also already mentioned in the other used projects. |
| De Hoofden(Era Contour, 2015)<br>2015<br>Marc Koehler et al. | Housing<br>Mix-use | Collective self build prject (CPO) S**tructural framework of 5 m high, floors and walls can be placed per preference.** Façade is collectively decided of the inhabitant groups. Not much about re-adaptivity. |
| BlackJack<br>BNB Architects & BO6 Architects<br>2016<br>(Raaij, 2017; BO6 architects, n/d) | Housing<br>Offices<br>Hotel<br>Commercial | Variety in dwelling, co-creating with future residents. From 45 – 200 m2, studio's to maisonettes. Units can be added per 50 m2.<br>Façade has a grid of 2.4 meter with different façade elements. Based on function, façade element can be chosen to be open, closed, in between etc.<br>Column structural casco -> flexibility in facade and spatial floor plans<br>Use of CPO. Similair to PATCH22 and Top up. |

# 2. FLEX 4.0

| Layer | Sub layer | Flexibility Performance | Assessment values | Remarks |
|---|---|---|---|---|
| 1.SITE | | 1.Surplus of site space<br>Does the site have a surplus of space and is the building located at the center? | 1. No surplus at all<br>2. 10-30%<br>3. 30-50%<br>4. >50% | The more surplus space on site, the better the building can be expandable horizontally |
| | | 2.Multifunctional site/location<br>Is the location capable to support more functions, like offices, living, care and shops? | 1. Just one<br>2. Two functions<br>3. Three functions<br>4. >3 functions | The more a location around a building supports more different functions of the building, the more a building can easily be rearranged or transformed to other functions |
| | | 2A & B<br>To what extent does the municipality have influence on the adaptability of a building? [2A]<br><br>What does the zoning plan says for this site and to what extent can this be changed? [2B] | 1. Influence in terms of restricting it.<br>2. Doesn't take adaptability into account.<br>3. Promotes it, however not actively<br>4. Influence in terms of funding, zoningplan etc. Is in favor of. Not restricting.<br><br>1. Very limited and rigid.<br>2. Very limited, however open for change<br>3. Is open to large variety, however not everything<br>4. Can be anything, no requirements | The more a location around a building supports more different functions of the building, the more a building can easily be rearranged or transformed to other functions |
| 2. Structure | Measurement | 3.Available floor space of building<br>Does the building or user units have a surplus of the needed usable floor space? | 1. No, no surplus at all<br>2. 10-30%<br>3. 30-50%<br>4. >50% | The more surplus, the more easily it can be rearranged or transformed into other functions, the better the building can meet to changing user demands |
| | | 4. Size of floor buildings<br>What is the size of the usable floor surface? | 1. <400 m2<br>2. 400-600 m2<br>3. 600-1000 m2<br>4 >1000 m2 | The larger the usable floor surface, the more easily units in a building can be rearranged or transformed to other functions |
| | | 5. Measurement system<br>Have positioning/measurement modular rules for constructions components been used? | 1.No rules for modular coordination<br>2.<50% implemented<br>3.>50%<br>4.>90% | The more project independent, demountable and replaceable construction components have been implemented, the more easily a building can be rearranged/transformed to other functions |
| | | 6.Horizontal zone division/layout<br>Has use been made of a horizontal zoning system, including intermediate margins? | 1.No zoning system without margins<br>2.10-30% intermediate margins<br>3.30-50% intermediate margins<br>4.>50% intermediate margins | To more margins are used in the zoning system of the building, the more easily a building/unit can be rearranged/transformed to other functions |
| | | 7. Presence of stairs/elevators<br>Are sufficient stairs/elevators present in the building? | 1.Only one decentred located<br>2.One central located<br>3.Different wings, with each central core<br>4.One central and several decentred per wing | The more stairs/elevators are available in the building, the more easily a building/units can be rearranged, rejected, extended or transformed to other functions |
| | | 8. Extension/reuse of<br>Is there a possibility to add new stairs/elevators to the building and reusing the existing ones? | 1. Not without drastic expensive measures<br>2.Can be accidently added and existing reused<br>3.Can be limited added and existing reused<br>4.Can be easily be added without drastic measures | The more stairs/elevators are available in the building, the more easily a building/units can be rearranged, rejected, extended or transformed to other functions |
| | | | | |
| | Construction | 9.Surplus of load bearing capacity<br>How large is the load bearing capacity of the floors in the building? | 1. <3 kN/m2<br>2. 3-3.5 kN/m2<br>3. 3.5-4 kN/m2<br>4. >4 kN/m2 and several areas > 8 kN/m2 | The larger the load bearing capacity, the easier a building can be rearranged, transformed to other functions, or vertical extended, the better a building can meet to changing user demands. |
| | | 10.Shape of columns<br>How are the columns in the building shaped? | 1. Round shaped and/or have vertical different sizes<br>2.Octogonal shaped<br>3. Rectangular shaped<br>4. Square shaped | The less deviate from a square column, the better a building/units can be rearranged |
| | | 11.Positioning of facilities zones<br>Are facilities zones and vertical shafts located at central building level and/or local unit level? | 1. All located at central level<br>2. Located at central level and occasionally local level<br>3. Located at central level and limited at local level<br>4. Located at central level and at local level as well | The more facility zones/shafts are located at unit level, the easier a building can be rearranged, transformed to other functions |
| | | 12.Fire resistance main bearing<br>How many minutes is the fire resistance of the main load bearing construction? | 1. 30 minutes<br>2. 60 minutes<br>3. 90 minutes<br>4. 120 minutes | The higher the fire resistance of load bearing construction, the easier a building can be rearranged/transformed to other functions, |
| | | 13.Extendible building/units horizontally<br>Is it possible to expand the building horizontally for new extensions to the building/user unit? | 1. Not possible at all<br>2. Very limited possible, only at one side<br>3. Limited possible, at more sides<br>4. Easily possible, at all sides | The more a building/unit can be expanded, the easier a building can be rearranged or transformed to other functions or expanded, the better a building can meet the changing user demands. |
| | | 14.Extendinable building/units vertically<br>Is it possible to expand the building vertically, for adding new floors or a new basement? | 1. Not possible at all<br>2. Limited possible, only a few units<br>3. Possible after total rearrangement<br>4. Possible | The more of a building can be vertically expanded, the easier a building can be rearranged or transformed to other functions or expanded, the better a building can meet the changing user demands. |
| | | 15.Rejectable part of the building/unit<br>Is it possible to reject part of the building for selling/renting to third parties? | 1. Not possible at all<br>2. Possible to reject 10-30% of the building/units<br>3. Possible to reject 30-50% of the building/units<br>4. Possible to reject >50% of the building/units | The more a building can be vertically rejected, the easier a building can be rearranged or transformed to other functions or expanded, the better a building can meet the changing user demands. |
| | | 16. Insulation between stories/units<br>How is the thermal and acoustic insulation between the different storeys in the building? | 1. Insulation does not meet current demands of offices<br>2. Meets current demand of offices<br>3. Meets current demands for housing and care too<br>4. Meets 10% above current demands for all functions | The better the thermal and acoustic insulation between different storeys the easier a building can be rearranged or transformed to other functions or expanded, the better a building can meet the changing user demands. |

| | | | | |
|---|---|---|---|---|
| 3. Skin | Facade | 17.Dismountable façade<br>To what extend can façade components be dismantled in case of transformation? | 1. Components can't/hardly be dismantled without demolition<br>2. Small part can be dismantled (>20% < 50%)<br>3.Large part can be dismantled (>50 % < 90%)<br>4. All façade components are easily dismountable | The more façade components are easily dismountable, the more easily a building can be rearranged or transformed to other functions. |
| | | 18. Location/shape daylight<br>In what way are the façade/daylight openings positioned and shaped? | 1. Large closed surfaces<br>2. Small horizontal open surfaces<br>3.Large open surfaces, with different heigh sizes<br>4.Large continuous horizontal open surfaces, connections according to planning grid | The more regular open surfaces in the façade according to the planning grid, the better a building can meet changing demands in functions, quality and finishing of the building |
| | | 19. Insulation of façade<br>How is the thermal and acoustic insulation quality of the façade of the building? | 1. Does not meet current demands for offices<br>2. Meets current demands for offices<br>3. Also meets current demands for housing and care<br>4. Meets 10% above current demands for all functions | The better thermal and acoustic insulation of the façade, the easier a building can be rearranged or transformed to other functions, to better it can meet changing user demands. |
| | | | | |
| 4. Facilities | Measures and Control | 20. Measure & control techniques<br>Is it possible to control/measure facilities on building level as well on user unit level? | 1.Takes place only at central building level<br>2.On central level and occasionally on unit level<br>3. On central level and limited on unit level<br>4. On central level and completely on unit level | The more possibilities for measurement and control of the facilities on unit level, the more easily units in a building can be rearranged or transformed to other functions |
| | Dimensions | 21.Surplus capacity of facilities<br>Does the capacity of (the sources of) the facilities have a surplus capacity? | 1. No surplus at all<br>2. 10-30%<br>3. 30-50%<br>4. >50% | The more surplus capacity of the facilities, the easier a building can be rearranged or transformed to other functions, to better it can meet changing user demands. |
| | Distribution | 22. Distribution facilities<br>Does the building have a specific distribution facility for hot/cold water, heating, cooling, gas? | 1. One for all different sources<br>2.For some of the different sources<br>3. For two of the different sources<br>4.No specific distribution | The less specific distribution equipment facilities have, the easier a building can be rearranged or transformed to other functions, the better a building can meet changing user demands |
| | | 23. Location sources facilities<br>What is the location of the central facility sources? | 1. Located at only one central location<br>2. Located at several locations<br>3. Located at a central location and decentred location<br>4. Located outside the building at city level (district heating) | The more facility sources are localized at decentred level, the easier a building can be rearranged or transformed to other functions, the better a building can meet changing user demands |
| | | 24. Disconnection of facility<br>Can the compoinents of the facilities be easily disconnected? | 1. Can't be disconnected or demounted<br>2. Hardly be disconnected or demounted<br>3. Partly be disconnected or demounted<br>4. Can be disconnected very easily and completely demountable | The more facility parts can be disconnected or demounted, the easier a building can be rearranged or transformed to other functions, to better it can meet changing user demands. |
| | | 25. Accessibility of facility<br>To what extend are facility components good accessible? | 1. Hardly or not accessible (eg concreted in)<br>2.Limited accessible (partly on support and infill level)<br>3. Good accessible (lot on infill level)<br>4. Very good, most components at infill level | The higher the accessibility of facilities components, the more easily units in a building can be rearranged or transformed to other functions, |
| | | 26. Independence of user units<br>In what way are the user units independent related to services as pantry, toilet facilities? | 1. No services available at user unit level<br>2. 1-2 services available<br>3. 2-4 services available<br>4. >4 services available | The more services are available at unit level, the more independent the units are opposite other units in the building, the more they meet individual user demands. |
| | | | | |
| 5. Space | Functional | 27. Multifunctional building/units<br>Is the building capable to support different functions like offices, living, care and shops? | 1. Support only one function<br>2. Supports 2 functions<br>3. Supports 3 functions<br>4. Supports >3 functions | The more a building supports different functions of a building, the more easily a building can be rearranged or transformed to other functions. |
| | Technical | 28. Disconnectable, removable<br>To what extent are the user units in a building removable, relocatable? | 1. Is not removable, relocatable<br>2. Only relocatable with drastic expensive measures<br>3. Units are easy relocatable, constructured with demountable components<br>4. Easy relocatable, constructures with 2d/3d modules, transportable by road | The more the units consist of demountable and reusable components, the better the units are relocatable to another location in our outside the building |
| | | 29. Disconnectable, removable<br>To what extent are inner the walls in the building easily replaceable? | 1. not replaceable without drastic/expensive interventions<br>2. Not replaceable, but good destructible<br>3. Replaceable by dismantling and rebuilding at another location<br>3. Easily replaceable without radical/expensive interventions | The more inner walls can be easily replaced, the more easily a building can be rearranged or transformed to other functions, the better a building can meet to changing user demands |
| | | 30. Disconnectable connection detail<br>Which detailed construction is applied between the interior walls and support structure and façade? | 1. Penetrating connections<br>2. Wet connections (mortar, sealant, glue)<br>3. Bound connection elements<br>4. Unbound dismountable connections | The easier the connection of interior walls can be dismounted, the easier a building can be rearranged or transformed to other functions |
| | | 31. Possibility of suspended ceilings<br>Is it possible to apply suspended ceilings and to adapt these to the different user demands? | 1. Results in free floor height of <2.60 m<br>2. Results in floor height of 2.5 – 2.7 m<br>3. Results in floor height 2.7 – 2.8 m<br>4. Results in floor height of > 2.8m | The higher the free storey height, the better the building can meet the changing demands concerning functions, facilities, finishing and quality of the building |
| | | 32. Possibility of raised floors<br>Is it possible to apply raised floors and to adapt these to the different user demands? | 1. Results in free floor height of <2.60 m<br>2. Results in floor height of 2.5 – 2.7 m<br>3. Results in floor height 2.7 – 2.8 m<br>4. Results in floor height of > 2.8m | The higher the free storey height, the better the building can meet the changing demands concerning functions, facilities, finishing and quality of the building |

# 3. Interview questions Frans van der Werf

**Design**

Q1. What were your main and least objectives and desires for the project?

Q2. Future residents had a decision-making influence on the infill level. What are your thoughts on having them also some kind of decision-making influence on the structure level?

Q3. When looking at the layers of change, as discussed by Steward Brand. Did you take this into account as well? What are the elements in this building that are designed to be changed over time, if they are? How should these be replaced, in how many years and why?

Q4. In what way can the building be dismantled if needed? Or what and how are element that are designed for dismantling?

Q5. During the project, what were things that turned out to be different in practice (during the design phase – during construction – after project delivery) than you expected it to be? What was the expectation and what was the outcome? Why was there a difference? How would you do this the next time. What are some things that work out in the design, but just not in practice?

Q6. What are the things you would have done differently if you could do the project over (overall / especially related to adaptability / at that moment vs now)?

Q7. What are general the biggest difficulties and barriers? How do you think these could be solved?

Q8. Having multiple individuals, leads to having a difference in the façade. How can you make sure this still becomes coherent, or perhaps that is not important at all? What does this mean for the street design?

Q9. Bathrooms, in terms of tiles and plumbing, can be a bottleneck when looking at the possibilities of changing the infill. How do you see this being solved?

Q10. Molenvliet offers personalization of living spaces, however doesn't take into account the changing of the household profiles. The wishes and needs of the, then, future residents were taken into account in terms of floor plans, facades and decision-making. However, how does this relate to the next upcoming resident? What are your thoughts on growing and shrinking space? How could this be integrated in design?

**Municipality**

Q11. How does the municipality intervene and has an effect (either positive or negative) of such projects? How would you like to be supported by the municipality? What are the most important laws, legislations and regulations you have to take into account with adaptive housing?

**Organisational**

Q12. The floor plans weren't fixed and rather fictive floor plans were used. What does this say on the

process and organisation in terms of building costs (calculating the costs, but also does it require extra costs for the architect etc.), the planning and the municipality?

Q13.One of the main recommendations seem to be giving the residents more time and the two consulting hours weren't sufficient enough. Could it a possible way of tackling this be to provide some kind of manual beforehand?

Q14. At the end, a large amount of potential buyers dropped out. Some of them even right before the delivery phase. Reasons of this include the building density, the implementation of the project, the designated house to them, the high rent and/or the short decision time. For 38% of the housing units it was the case that their floor plans couldn't (or nihilistic could) be changed, regards to ordering the building elements. The other consultancy hours were more to inform them about the already set design. These residents also had higher moving-out tendency. The municipality assigned people to houses (empty floor plans( in stead of first finding the right people and then assigning a (empty floorplan) house to them.  How would this influence your work differently?

Q15. Almost none of the participants would be willing to repeat this kind of project. Organisational wise this takes a lot of time and effort. What are your thoughts on this? How could this be more streamlined?

Q16. With what other actor you have the most and least connections with? Why? How are you related? What between you and them clashes? Why and how can this be solved? What goes best between you and them? How come?

**Other**

Q17. Molenvliet was  experimental housing construction. Did you further developed these principles into other projects? Can you tell me more about this?

# 3. Interview questions Herman Hertzberger

**General**
1. What were (overall, in general) your main and least objectives for your projects?

**Re-adaptivity**
2. How important and relevant do you think (re-) adaptive housing is for the current and future housing context in the Netherlands?

3. What are your thoughts on growing and shrinking space? How can change (grow/shrink) be integrated in the design?

4. What are general the biggest enablers and barriers looking at (re-)adaptability? How do you think these could be solved?

**Theory - practice**
5. During the projects, what were things that turned out to be different in practice (during the design phase – during construction – after project delivery) than you expected it to be? What was the expectation and what was the outcome? Why was there a difference? How would you do this the next time? What are some things that work out in the design, but just not in practice(overall / especially related to adaptability / at that moment vs now)?

6. What is the reason that the Ministerie van Sociale Zaken en Werkgelegenheid is being demolished, since according to the design it should be able to adapt to other functions? Why is the developer not in alignment with the architect?

7. What was the reason that two of the three towers of the De Drie Hovens was demolished? Could this be anticipated and prevented in the future?

**Design**
8. Bathrooms, in terms of tiles and plumbing, can be a bottleneck when looking at the possibilities of (re)adaptivity? How do you see this being solved?

9. What are your thoughts on resident participation (having a direct say in design elements)?

10. Having multiple individuals, leads to having a difference in the façade. How can you make sure this still becomes coherent, or perhaps that is not important at all? What does this mean for the street design?

**Cycle of change**
11. When looking at the layers of change, as discussed by Steward Brand: Did you take this into account as well? What are the elements in this building that are designed to be changed over time, if they are? How should these be replaced, in how many years and why?
In what way can the building be dismantled if needed? Or what and how are element that are designed for dismantling?

**Municipality**
13. How does the municipality intervene and has an effect (either positive or negative) of such projects? How would you like to be supported by the municipality? What are the most important laws, legislations and regulations you have to take into account with adaptive housing?

# 4. Interview protocols

## INTERVIEW PROTOCOL

Shajwan Jabar – Frans van der Werf

**Algemene informatie**

Geïnterviewde: Frans van der Werf

Functie: [Functie]
Organisatie: [Bedrijf/organisatie]

Interviewer: Shajwan Jabar
Functie: Master student 'Management in the Built Environment'
Organisatie: Technische Universiteit Delft

Datum: 08-03-2022

**Onderwerpen en opmerkingen**
Het gesprek zal de volgende onderdelen behandelen:

( ) 0: Achtergrond van de geïnterviewde en project
( ) 1: Interview vragen
( ) 2: Open discussie
( ) 3: Overige opmerkingen

Tijdens het gesprek zijn de volgende documenten verkregen of ingezien:

_____

**INFORMED CONSENT**

Dear Frans van der Werf,

As a solution to the high housing shortage in the Netherlands, adaptive housing is being researched. Current housing stock and its increase relatively holds a fair share of additional new stock as a result of adapting buildings either through splitting, renovating or changing the use of the dwelling or combination. Furthermore, there is a difference in family size and its m2, lots of people live either too big or too small than their needs. The needed room space also differentiates over the years. As there also is an increase in demand for flexibility, sustainability, circular economy, renewability and adaptability in housing, the topic of adaptive housing is relevant and worth investigating since it could provide a possible solution and forms a significant part of the issues as stated above. As existing buildings can create new housing through splitting, renovating and/or transformation, it prevents it for demolition or transformation to other functions.

Knowledge about the implications and possibilities of flexible and adaptive housing has great importance for using these theories more often and releasing some pressure on the housing shortage along with preventing future mismatches between space supply and demand. Previous research mainly concern themselves with the architectural side of adaptability, however the aspect of organizational management still needs further investigation. This thesis concerns itself with drawing lessons from adaptive building principles (Metabolism, Structuralism and Open Bouwen), to provide recommendations for new adaptive housing construction in the Netherlands mainly focusing on the organizational and management side to it. The possibilities of adaptive and flexible building and their general features has been studied and documented extensively and received their relative considerable attention in the building environment, in Japan with Metabolism and its Dutch counter parts Structuralism and Open Bouwen. The Molenvliet project has been part of my research and therefore your conceptions would be of great value. In the interview, you will be asked about specific questions on the Molenvliet project.

The interview will be held by 'Management in the Build Environment' master student Shajwan Jabar, the researcher of the thesis. The thesis is being guided by Lidwine Spoormans and Gerard van Bortel, both teachers at the TU Delft BK Faculty.

The interview itself will take about an hour. And, if consented, will be audio recorded for later transcription.

Please note, that you will be asked again in during the interview about your participation consent and whether you agree for audio recording. You are freely able to state that you don't want to participate, at any time given. An explanation is not required. Furthermore, you are free to dismiss any question asked.

When agreed to participate to the interview, please fill in and sign this letter and retour a PDF copy. A copy with the interviewer's signature then will be send back to you. Your information will be handled truthfully.

When you have any questions and/or remarks, don't hesitate to contact:

Shajwan Jabar / shajwanjabar@hotmail.com / 0684676075

When agreed to participate, please fill in the statement below.
Kind regards,
Shajwan Jabar

INFORMED CONSENT FORM

To be filled in by interviewee [Frans van der Werf] and interviewer [Shajwan Jabar]

I, Frans van der Werf, declare that I have been beforehand informed about the research its objective, method and purpose. Any questions I had, were answered clearly and satisfactorily.

Any interview questions that I did not want to answer, I have stated and those questions will be taken out of the interview. I am aware of the right that I don't need reasoning for this.

I am aware that audio material will be collected, transcribed and used exclusively for this research.

I am aware of the right to withdraw participation or not answer all questions, without stating the reason, at any given time.

This form has been read by me, and I agree to the participation of this interview for the research.

Audio transcription can be shared to third parties afterwards, when asked [ YES ] [ NO ]

Transcription summary can be shared to third parties afterwards, when asked [ YES ] [ NO ]

I'd like a copy of the transcription [ YES ] [ NO ]

I'd like a copy of the transcription summary [ YES ] [ NO ]

I'd like a copy of the thesis [ YES ] [ NO ]

Place:
Date: 08-03-2022

Name participant (first and lastname, in blockletters]
Signature participant:

'I have informed the participant about the research and declare I will be prepared to answer any questions related to the research'

Place: Delft, the Netherlands

Date: 08-03-2022

Name interviewer: Shajwan Jabar

Signature interviewer:

# Interview protocol

Shajwan Jabar

**Algemene informatie**

Geïnterviewde: Herman Hertzberger

Functie: Architect
Organisatie: AHH

Interviewer: Shajwan Jabar
Functie: Master student ‘Management in the Built Environment’, TU Delft

Datum: 5 april 2022

**Onderwerpen en opmerkingen**

Het gesprek zal de volgende onderdelen behandelen:

( ) 0: Achtergrond van de geïnterviewde en project
( ) 1: Interview vragen
( ) 2: Open discussie
( ) 3: Overige opmerkingen

Tijdens het gesprek zijn de volgende documenten verkregen of ingezien:

_____

## INFORMED CONSENT

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Current housing stock and its increase relatively holds a fair share of additional new stock as a result of adapting buildings either through splitting, renovating or changing the use of the dwelling or combination. Furthermore, there is a difference in family size and its m2, lots of people live either too big or too small than their needs. The needed room space also differentiates over the years.

As there also is an increase in demand for flexibility, sustainability, circular economy, renewability and adaptability in housing, the topic of adaptive housing is relevant and worth investigating since it could provide a possible solution and forms a significant part of the issues as stated above. As existing buildings can create new housing through splitting, renovating and/or transformation, it prevents it for demolition or transformation to other functions.

Knowledge about the implications and possibilities of flexible and adaptive housing has great importance for using these theories more often and releasing some pressure on the housing shortage along with preventing future mismatches between space supply and demand.

Previous research mainly concern themselves with the architectural side of adaptability, however the aspect of organizational management still needs further investigation. This thesis concerns itself with drawing lessons from adaptive buildings (metabolism, structuralist or open bouwen), to provide recommendations for new adaptive housing construction in the Netherlands mainly focusing on the organizational and management side to it.

The possibilities of adaptive and flexible building and their general features has been studied and documented extensively and received their relative considerable attention in the building environment, in Japan with Metabolism and its Dutch counter parts Structuralism and Open bouwen. The [insert name project] has been part of my research and therefore your conceptions would be of great value. In the interview, you will be asked about specific questions on the [insert project name].

The interview will be held by ‘Management in the Build Environment’ master student Shajwan Jabar, the researcher of the thesis. The thesis is being guided by Lidwine Spoormans and Gerard van Bortel, both teachers at the TU Delft BK Faculty.

The interview itself will take about an hour. And, if consented, will be audio recorded for later transcription.

Please note, that you will be asked again in during the interview about your participation consent and whether you agree for audio recording. You are freely able to state that you don’t want to participate, at any time given. An explanation is not required. Furthermore, you are free to dismiss any question asked.

When agreed to participate to the interview, please fill in and sign this letter. Your information will be handled truthfully.

When you have any questions and/or remarks, don’t hesitate to contact:

Shajwan Jabar
shajwanjabar@hotmail.com

0684676075

When agreed to participate, please fill in the statement below.

Kind regards,

Shajwan Jabar

## INFORMED CONSENT

To be filled in by interviewee [Herman Hertzberger] and interviewer [Shajwan Jabar]

I, [Herman Hertzberger], declare that I have been beforehand informed about the research its objective, method and purpose. Any questions I had, were answered clearly and satisfactorily.

Any interview questions that I did not want to answer, I have stated and those questions will be taken out of the interview. I am aware of the right that I don't need reasoning for this.

I am aware that audio material will be collected, transcribed and used exclusively for this research.

I am aware of the right to withdraw participation or not answer all questions, without stating the reason, at any given time.

This form has been read by me, and I agree to the participation of this interview for the research.

Audio transcription can be shared to third parties afterwards, when asked [ YES ] [ NO ]

Transcription summary can be shared to third parties afterwards, when asked [ YES ] [ NO ]

I'd like a copy of the transcription [ YES ] [ NO ]

I'd like a copy of the transcription summary [ YES ] [ NO ]

I'd like a copy of the thesis [ YES ] [ NO ]

Place: Amsterdam

Date: 5 april 2022

Name participant (first and lastname, in blockletters]

Signature participant:

'I have informed the participant about the research and declare I will be prepared to answer any questions related to the research'

Place: Delft, the Netherlands

Date:

Name interviewer: Shajwan Jabar

Signature interviewer:

# 5. Enablers/barriers tables per case study

## 5.1 Molenvliet

| | Enabler | Barrier |
|---|---|---|
| Experimental | Possibility to determine subsidy based on test layouts. | The ministry determined it as 'Experimental Housing Plan', gives the possibility of this kind of project (test layouts), however is not usual |
| Adaptability (layout) | The interior walls are of prefab elements that are clamped between the floor and ceiling, making it possible to change the layout. | The tiling in the bathroom and toilet is one of the main obstacle. |
| | The house separating walls are of masonry in combination with plasterboard and acoustic material. Façade is not bearing. Also structure-infill principle. Inner walls relatively easy replaceable, and disconnectable connection between façade – inner wall – construction. Thus building can easily be rearranged or transformed to other functions. | Sanitary facilities depend on the placement of the wooden rails of the inner walls. Because heavier elements can be attached there |
| | Other than stairwells and corridors, there are no shared services. The more services are available at unit level, the more independent the units are opposite other units in the building, the more they meet individual user demands. | Height parapets are fixed in the facade. Some therefore have a parapets in their living room, that is too high. |
| | The floor height is 2.7m, giving possibilities to apply raised floors / suspended ceilings, being able to meet changing demands with regards to functions, facilities, finishings etc. | Little attention was paid to mutual coordination of the housing layout (parapet and facade layout) and the colour combination of the exterior of the homes. However, there was a pallet of colours resident could choose from. So that could also mean coordination. |
| | The facades offered a free layout as it, in essence, also has a structure and infill component | Within the given window façade frames, it was possible to choose between solid panels or glass of a certain amount of options. |
| | During construction, another 14 large ground floor homes were split into 28 smaller homes, with an extra front door being added with a staircase to the upstairs apartments. That is a form of flexibility and reallocation in the work. | The more stairs/elevators are available in the building, the more easily a building/units can be rearranged, rejected, extended or transformed to other functions. Because of the large diversity in typologies, some have stairs, others don't. some have multiple stairs, other don't. etc. Also, drastic measures are needed if one gets removed, replaced or added. |
| | | The entrance, front door, to house is fixed |
| Adaptability (plumbing) | Electricity can be connected at ceiling and floor height with movable plinth gutters for light points, pull switches and sockets. | The pipe ducts with the fuse box and the stairwells are fixed in every unit. |
| | Connection to sewerage and ventilation possible on 3 sides because the pipe shaft has a detachable panel. | The electricity is partly collapsed in the load-bearing wall disks |
| | Pipe duct is always in combination with the fuse box and central heating boiler. Pipes in the duct are placed diagonally so that there was a lot of freedom to leave the duct before the pipes, and it is also possible to make connections to the pipes from outside. Connection options and venting are not hindered. | Each house has a separate heating system. Pipes along the ceiling to radiators from central heating per home. Installing a central heating system has led to many sightlines, often in living rooms and bedrooms. It would have been better to also make a fundamental distinction between structure pipes (collapsed from duct to facades) and built-in pipes with radiators where necessary. |
| | | Pipes for central heating gas and water are also mounted on inner walls from the central pipe connector. |
| | | Distribution equipment facilities are pretty specific. The less specific distribution equipment facilities have, the easier a building can be rearranged or transformed to other functions, the better a building can meet changing user demands |
| | | The need to locate wet cells as close as possible to the pipe shaft since the pipes cannot be concealed, but run visibly through the room |
| | | acing the fuse box on the pipe duct is not so convenient, because in some houses the fuse box is directly accessible from the kitchen or living room. Fuse box must be able to be placed in all rooms except the wet cells and sleeping quarters, for the sake of freedom. |
| | | Fixed space for shaft. Some shaft are shared between onder en boven woning. Dependant on each other. The more possibilities for measurement and control of the facilities on unit level, the more easily units in a building can be rearranged or transformed to other functions |
| Execution | It was a first timer, and the people involved believed in it. | The many types of interior corners, various connections, terraces and loggias creates extra complexity of the process. Better standardization of building components would have simplified the process. Manufacturing built-in elements is not difficult, but organizing production, delivery and installation is. Changes to built-in elements also cost money. Many elements are very similar but still slightly different, such as holes in stairs, pipe ducts holes (which seem to have the same location but sometimes just 30 cm apart), concrete/wooden facade elements and placements. General complaint from the exporter that such a system was lacking. Small deviations are easily overlooked. |
| Team | | There was no preliminary study done of the floor plans nor was there any experience with public participation. The complexity of the construction process led to some participants reporting sick and even being fired. The housing association was assigned a contractor by the municipality with whom they had no experience with. All participants hardly had any experience with resident participation. Delay has mostly to do with the procedures issues and in combination with technical complexity. |

| | | |
|---|---|---|
| Grid | Keeps a structure | The SAR 10/20 grid was used, making it only possible to place walls every 30 cm and sometimes resulted in dimensional deviations.<br>The unit of measure structure/carrier (SAR grid), is determining of the width and depth of the living space |
| Municipality/legal influence | The land was already available to the municipality, housing association appeared to be prepared for an assignment on the recommendation of the municipality, so transfer of land from municipality to building association was no problem. In terms of finances, extra subsidy was possible in the context of experimental construction. Permits were also easier because it went through the municipality, as the municipality took the initiative themselves. | Although it has been built with the idea of changeability, according to the law this is not even allowed. As a tenant, he/she must leave the house as he/she entered it. Which is very contradictory to the design principle, so a next occupant lives after the first occupant has been determined. The architect is aware of this and has also fed back this, with a view to changing the law and rules |
| | | Zoning plan restrictions |
| Housing allocation | People can be allocated to the house, size and rentscale they wish. | Not all homes are easy to rent out. Some cancelled 5 times. Especially with regard to the 6-room homes. Rent was relatively too high in the beginning, so many residents were not eligible. The rent dropped after the division of the 6-room houses. But that happened later, then the question of whether she registered or not already had another home. Resulting also in a (too) late allocation of housing and a large number of changes in housing allocation (68 cancellations and shifts in housing allocations). Those who did not participate in resident participation, also higher willingness to move. The mutations in resident population, led to more time spent on extra consultation hours.<br>The time difference between the construction of the first and last block is about 5 months. The housing allocation followed this schedule as well, resulting in allocating residents in house units late as possible during the construction process. |
| Resident matters<br>User participation | There is a high interest from residents in this type of participation. Residents clearly indicate that they are in favour of a repeat project and participation, but with improved situations. | As the resident participation is positive for the current resident, the specific layout may be unacceptable for the next tenant. |
| | User participation and freedom of dwelling layout will become a major selling point as it's valued by the users. | The most common reason to inhabit this house by the residents was mostly because of no specific reason, other than they just needed a home, followed by the neighbourhood. Selling point only for first time renters.<br><br>There clearly is a big miscommunication and a gap of knowledge in the current residents. Some of them had no idea. Most of them have heard of the experimental character (flexibility possibilities and structure-infill), but never inquired more deeply themselves. This leads them to also not knowing the possibilities with regards to the adaptability, although they can't even adapt anything with regards to the regulations. |
| | Decisions can be made collectively and bigger ones can be made through representatives. | Time constraints of the participants (more than 1 week people went to the information evening, and only 2 office hours of 45 minutes, and the 2nd office hour was already final. After office hours, residents could no longer change the final drawings. |
| | | |
| Life span | 100 years is the minimum planning one should have to maintain a building, instead of the often used 30 year lifespan of a building. The support structure has been parceled out into dwelling units by dwelling separation walls. They are removable overtime when a collectivity of residents want to change the parcellation of the support structure, may be after 25 years or more. | |
| Finance | | From a functional point of view, it is difficult to buy a home in such a project as the carrier is part of a larger whole. And so the floors and side walls are common with other. |
| Opportunities to shrink and grow, change in function | Shrink and grow can mainly be done in the building itself, because of the reparcelling options. There are, however, some growth opportunities, whereby the load-bearing capacities of, for example, the foundation have been considered in advance. Margins are used from the SAR. When a building with a support is designed, there is always a margin in which to expand if necessary.This is the outdoor space that can eventually become (partly) indoor space later on. | Not per unit however<br><br>This also includes all kinds of agreements about positioning and it is certainly not the case that everything has to be extensible. This has consequences for the neighbours, but also for the cohesion of the building. |
| | The structure itself is expandable on an urban scale, so that the grid can be continued and the house units can be multiplied. A structure is a complete whole, and can therefore in principle be expanded. The more surplus space on site, the better the building can be expandable horizontally | Nice in theory, how ever what does this mean for the urban design? There isn't much space to do so. Keep in mind that this does take away from common traffic spaces, gardens, outdoor spaces etc. |
| | Located close to the inner city, making the location around the building support more than a housing function, and thus can easily be rearranged/transformed to other functions. | Zoningplan has restrictions. Also no to low surplus of space: The more surplus, the more easily it can be rearranged or transformed into other functions, the better the building can meet to changing user demands |

## 5.2 Other cases mentioned by Frans vd Werf during interview

| | Enabler | Barrier |
|---|---|---|
| Residents matters / user participation | Representatives can represent the residents and principles, once groups get bigger. This way, decisions can be made from the community that go further than an individual home layout. | |
| | Full-scale model (clamping in panels), 3D models on screen and furniture map. | |
| | Team of coached architects to conduct the consultancy hours. | |
| | To give residents the choice whether they wanted a standard layout without extra costs, or the option to come to a free layout with the architect against a payment of 2 months' rent, with a payment term of three year. | However too much discuss time leads into the whole process becoming frustrated because users could not decide of the deadline. |
| Execution | To motivate and convince the client that it's not as complex as they might think, the architect would let them do it themselves and give the option to do it phased. | |
| Adaptability (layout) | Use of underfloor heating with two fields at the facades so that both fields can be heated independently. If a room becomes smaller, then less underfloor heating is needed because the surface becomes smaller. | |

# 5.3 Solids

| | Enabler | Barrier |
|---|---|---|
| Resident matters / user participation | The infill is owned by the tenant, who determines at his own discretion, expanse, amount of sqm, the use, the location within the building and the layout. The tenant can freely trade these install elements and propose a subsequent tenant. | The most important factors for tentants were the location (and the confidence of return on investment due this), being able to have an influence through the auction, the exemption from the regular housing rules for social tenants and the operators of the hotels/shortstay facility and the intended, but ultimately only partially realized, small-scale mix of functions in the building. And not, as expected, the maximum freedom of choice, or the separation of ownership between structure-infill and the big accommodation capacity. |
| | Built-in housing costs range from €5,000 (social rented housing in Solid 1 and 2) to almost €200,000 (free sector housing in Solid 11. A striking observation is that social renters have also been able to invest in their build-in; sometimes limited, sometimes considerable. | However, most tenants mentioned that, despite the satisfaction with the infill process and the result, they would have preferred a less bare casco. Certain basic facilities, such as a wet room, they would have liked to see already realized by Stadswonen. |
| | the overall rating of a building is largely determined by the presence of private outdoor space, a good transition between private and public (such as galleries and glass entrance of Solid 11 or the arcade of Solid 12) | or, on the contrary, by the absence of private outdoor space and less successful transitions between private and public (such as entrances and corridors of Solid 12). |
| | The first lease of the spaces started after the building was completed, so that tenants were able to fully understand the qualities and possibilities of the building. | |
| Municipality / legal influence | The central government, the municipality and the city district, in collaboration with the necessary lawyers and other experts, made room within the current legislations for some exceptions to enable the necessary freedoms (housing allocation, housing withdrawel, suitability criterium, onderhuur, bestemmingsvrijheid) | The central government, the municipality and the city district, in collaboration with the necessary lawyers and other experts, made room within the current legislations for some exceptions to enable the necessary freedoms. Not usual, but possible. |
| Adaptability (layout) | Based on the largest function (meeting functions), the floor conditions (structural, acoustic, isolation value), the installations capacity, shaft space, entrances and vluchtwegen are dimensioned. | Levels can't be vertically merged through an internal stair. |
| | the floorheight has a minimum of 3m (bovenkant ruwe vloer tot ruw plafond) and for the ground floor this is even minimal 4.5. This makes it possible for the levelfloors to place and maintain installations, floors, ceilings, cables and pipes | In later phases of the design process at Solid 12, the decision was made to create more Solid spaces, which necessitated additional front doors and thus additional traffic space against the concrete cores. This produced a sub-optimal result by creating narrow, unattractive and above all cluttered collective traffic spaces.<br><br>The extra heavy floors make vertical flexibility impossible (due to bearing capacity). Also, the slope between the structural floor and the second floor is too low to allow for sewer connections at all points in the space. |
| Finance | Against these higher initiation costs, the expectation is that the Solids will provide lower maintenance costs and higher yields, due to:<br>– No depreciation of the investment and lower maintenance costs of the structure (casco) because of the high-quality materials and the constructional measures (flexibility and overdimensioning) that have been taken to facilitate flexible use in the future.<br>– No complaints maintenance on the infill because these are the property of the tenant.<br>– Low mutation maintenance because in most cases the infill is traded and mutation maintenance will only take place if the infill is left behind by the departing tenant and it has to be removed by Stadgenoot.<br>– Low rental risk due to the accommodation capacity.<br>– Higher rental income due to the auction.<br>– Low risk of frictional and structural vacancy due to the substitution and negotiability of the installation from the departing tenant to the new tenant, as well as the (constructiontechnical and planning-legal) accommodation capacity. | The initiation costs of Solids are almost twice as high as regular new housing construction. The high costs are argumented by the concept development and sustainability, but more importantly are due to high pre-investment in the maximum accomondation capacatiy of the building. |
| | When the minimum rents, as determined by Stadgenoot prior to the auction, are compared to the average prices bid, the auction generated higher rental income. In some situations, the average social rent/m² turns out to be higher than that for the free sector in Solid 11 | |
| Housing allocation | At the auction the tenants, in competition with others, were able to able to determine the location, dimensions, filling in of their desired hull space and the rental price. The tenants look back on the auction with satisfaction and accept the fact that the auction has increased their rents | A difficult communication between tenants and Stadgenoot from the move-in stage on. |
| | Intense marketing and communication for tenant recruitment | An installation fair had been organized, in which an extensive protocol was presented. The moment at which this protocol was presented (after the auction) as well as the size (over 40 pages) and the level of detail led to considerable criticism and lack of understanding among tenants |
| | | Also, the moment of signing the lease would have been preferable after the construction period. Now it had to be signed before the construction period, while for most tenants the installation started later. In the meantime tenants have had to pay rent. |
| Adaptability (plumbing) | All cables, pipelines, pipes and channels are distributed vertically, and as much as possible decentrally, in shafts so that many connection points can be created. Vertical distribution leads not needing technical installation matters in floors and walls | The shafts require a lot of space at the expense of rentable floor area and spatial perception, have a cost-prohibitive construction and the catering facilities do have enough with the capacity of such a decentralized shaft for their ventilation. They need a central shaft adjacent to the core, which limited their freedom of subdivision to the core of Solid 11. The decentralized shafts are always located in the Solid spaces, which makes management and maintenance more complex because one always has to enter a private space. |
| | To make it possible to install facilities in the floor at any desired location in the room, the top of the bare construction floor floors is lower than the floor at the access point. | |
| Opportunities to grow, shrink or change in function | The high-quality appearance and maximum accommodation capacity, is best placed in a a metropolitan setting, either within or on certain edges of the A10. | The Solid on IJburg turned out to be in a less attractive location, which means that there is also vacancy. Reasons are:<br>- In the current difficult market situation, the Solid in its current finishing level and monthly payments only seems attractive in an environment where pressure on the real estate market is and remains high, where tenants are therefore prepared to invest (more) in their housing have the confidence in these investments. IJburg is not such a location (yet).<br>- The absence of its own outdoor space and the design of the collective traffic space, which is regarded as cramped and unclear. |

## 5.4 Diagoon woningen

| | Enabler | Barrier |
|---|---|---|
| Experimental | Experimental housing | Experimental housing, not usual. |
| Adaptability (layout) | Layered floors on different heights with the possibility to have any desired function. Each part of the floor can separately be a room too. | The floors are already determined and ultimately has little variation and change to make in the spatial layout. In addition, the placement of the kitchen and bathroom in the design is fixed in advance. |
| | Floor-to-ceiling windows, with a division in three layers of windows, are installed per floor at the front and rear façade. In each layer surfaces can be filled with glass, rotating parts or panels. The facades will have a characteristic appearance as long as it is filled in symmetrically. | There are however two permanent cores, the stairs and wet |
| | Continuity in a spatial sense is created due the central void, that occupies the full height of the house, and the constellation of the staggered floors. | The combination of bad insulation, the openness of the void and the glass roof leads the house into needing a lot of heating energy. |
| Adaptability (plumbing) | | Wet rooms are fixed |
| Execution | | |
| Team | | |
| Grid | | |
| Municipality / legal influence | | |
| Housing allocation | | |
| Resident matters / user participation | Polyvalence: defined as not just being for a singular use or within a singular context, but making things that is not within an established order, not just for particular purposes but are rather still open and can be used in different ways. It is up to the people themselves how they use the polyvalent elements in certain situations. | After a year of construction, residents placed hedges, boxes and/or fences as property boundaries ; division between units is desired |
| Life span | | |
| Opportunity to grow, shrink or change function | As private outdoor spaces, each house has a garden, two roof terraces and a balcony above the entrance, which can be pulled to the house. The roof level rooms can also be added.<br><br>Several residents have made use of the possibilities to expand the house. All houses are therefore different on the inside and outside. Terraces added to kitchen by various neighbours. | |

## 5.5 De Drie Hoven

| | Enabler | Barrier |
|---|---|---|
| Experimental | | |
| Adaptability (layout) | | It is not spacious enough for regular and electric wheelchairs, bedridden residents and hoists use to help people in/out of bed. The corridors, doors, elevators and bathrooms are simply not wide and specious enough for the current requirements. Also, the ceilings are too low. |
| Adaptability (plumbing) | | The Drie Hoven is not energy-efficient and technologically prepard for (future) innovations. |
| | | The Drie Hoven doesn't meet the current indoor climate quality requirements and fire safety requirements. |
| Execution | | |
| Team | | |
| Grid | A single continues structural structure based on the same modular unit enables to meet different requirements of a varied and complex program. | |
| Municipality / legal influence | De Drie Hoven was subsidized by the state. | De Drie Hoven was subsidized by the state. After a round of reflection, subsidies got cut down and the project came into the hands of a project developer that saw no possibility in exploiting this building without the subsidies. |
| Housing allocation | | |
| Resident matters / user participation | Through the expression in patterns of the streets, squares and central encounter areas the building functions as a small city and thus enlarging the social interaction moments. The inner big square included a big shop, laudnromat, billiard room library and terrace. From this square center, there were multiple wings with a wing for independent housing, care housing and more intensive housing. All the residents from each wing could come together at the center, which functioned as a kind of village meeting square. This promoted social interaction and hold off isolation and loneliness | Renovation creates a lot of nuisance for the residents as they have to move twice ,to the temporary location and back to the renovated building |
| Life span | | Demolished except for one tower; which is about to be demolished as well. |
| Opportunity to grow, shrink or change function | | |

## 5.6 PREVI

| | Enabler | Barrier |
|---|---|---|
| Experimental | | |
| Adaptability (layout) | Although change and expansion was anticipated, the exact way and form was not always as anticipated and planned. However this wasn't a big issue as the initial design and construction was fundamentally supportive of this | Householders not only change physically in terms of family composition, but there is also a social standing. This can be seen in the austere choice of finishes that was the first building element that was challenged by the residents. This is what metabolism failed to consider. The original architecture has almost disappeared under the floors, loggias, and layers of glass and plaster that were later added, and the in-between spaces are now the only visible element, remaining largely untouched by the constant accumulation of built mass |
| Adaptability (plumbing) | | |
| Execution | | |
| Team | | |
| Grid | | |
| Municipality / legal influence | | |
| Housing allocation | | |
| Resident matters / user participation | | |
| Life span | | |
| Opportunity to grow, shrink or change function | Space expansion and progressive adjustment to fit family needs and in appearance were consequent changes in the PREVI houses, just as it was anticipated | It was somewhat very permissive in allowing the residents to grow in their homes even though it was not in favour of functionality and especially safety. Evidence of a certain snapping point of adaptability can be seen in the one (out of 17) house that has been demolished and this one has been rebuild with a seven story building. |
| | After 43 years after its construction, house owners took their own ownership in changing their house and adding sequential additions, without consultation. Some houses have up to four additional floors. The unregulated expansion was permitted in a highly seismic zone because the Metabolist's used stricter seismic structural indications | Maki, one of the architects, is nonchalant about the additional floors being build however, although the PREVI houses were build with the Japanese eathquak proofe-ness, is still concerned with the structural integrity |

## 5.7 The Nakagin Capsule Tower

| | Enabler | Barrier |
|---|---|---|
| Experimental | | |
| Adaptability (layout) | The central core includes the main circulation, with the modular apartments being repeated on the two sides of this core. Each unit appears as a plugged in capsule, and sticks out the main volume. | The upper part is fixed with four bolts, only point of connection between structure and capsules, to the tower itself. The vertical gap between each capsule is around 30 cm, which is too narrow and makes it impossible to detach the capsules from the brackets. For capsules to be removed, every capsule above it should be removed too Structurally the capsules can't be taken out horizontally as the underside of each capsule is fixed to brackets. These brackters extent from the tower core |
| | From the exterior each unit is distinguishable, however from the interior multiple units could able to form one single residential unit | Extreme small bathroom<br>Capsules don't facilitate any cooking devices and has permanently sealed windows. |
| | A building's structure recovery was allowed through an re-use project. Main saviour in the salvation of the building, is the dynamicity of its capsule system that gave the possibility to establish new functions. The capsules on the 6$^{th}$ till 14$^{th}$ floor have been re-arranged to single units, to correspondent with the central corridor. | |
| Adaptability (plumbing) | | Fixed systems<br>-Other plumbing problems regarding hot water, drainage, leaks, air conditioning. Also, as water pipes run through each units, it makes it logistically difficult. |
| Execution | Capsules were prefabricated and transported by truck, lifted by crane on site and attached to the two towers, making it possible to construct fast | |
| Team | | |
| Grid | | |
| Municipality / legal influence | | |
| Housing allocation | | |
| Financing | | Also -the buildable potential of the site where its located doesn't get exploited enough, as it is also on leased land. Land prices are high in Ginza and it would be more profitable to build another building with a more efficient surface area-to-volume-ratio. |
| Resident matters / user participation | | It could be possible, and efficient, to replace all the units at the same time. Making a communal decision like this proved to be impossible as the opinions and states of repair of the unit (owners) are too different. Refurbishment needs 100% agreement, of all 140 individual owners, as it not includes just individual capsules but also communal spaces. This human complexity was not included in the metabolism vision |
| Life span | Note that life span of the capsules not so much a mechanical one, but more a social one. | Although the idea was to replace the units every 25 years, in 50 years still no unit has been replaced. The reason behind this is a functional issue (unable to take out capsules horizontally) and organisational (disagreements between tenants). |

| | | |
|---|---|---|
| Opportunity to grow, shrink or change function | | Not replacing the capsules in combination with the poor maintenance results in conditions so severe that replacement of capsules is in large favour over renovation |
| OTHER | | Conservation and Metabolist buildings might clash however, since metabolism is based on ideas of growth and change while conservation (as World Heritage rules) is the buildings its sustained or enhanced 'conditions of integrity and/or authenticity at the time of inscription' |
| | | -Capsules are rusting on the outside.<br>-Structure's earthquake resistance is not sufficient. |

## 5.8 Sky House

| | Enabler | Barrier |
|---|---|---|
| Experimental | | |
| Adaptability (layout) | As defined by Kikutake for the movable and replaceable units of the kitchen, bathroom, and WC. | |
| | This floor has an open plan with an exterior balcony. The exterior walls slide open, allowing access to the surrounding balcony. The interior walls are moveable and adaptable to the number of people occupying a certain space | |
| | | |
| Adaptability (plumbing) | Indicating expandability, the plumbing comportments are located on two sides of the building. | |
| Execution | | |
| Team | | |
| Grid | | |
| Municipality / legal influence | | |
| Housing allocation | | |
| Financing | | |
| Resident matters / user participation | | |
| Life span | | |
| Opportunity to grow, shrink or change function | Indicating expandability, the plumbing comportments are located on two sides of the building. | |
| | Possible expansions are also suggested by incorporation of the 'move-nets' | |
| OTHER | | |
| | | |

# 6. Frans vd Werf Additional document

This document was send by Frans van der Werf. Before the interview, he typed out his answers in short beforehand.

**Design**

**Q1. What were your main and least objectives and desires for the project?**

My main objectives:
1. To experience the SAR principles and methods by the development of an urban tissue of courtyards , streets and allies for low rise high density housing concept as an alternative for my Award winning project 1970 partly high rise, saving 2/3th of the district area for green purposes.

2. To experience the SAR principles and methods by designing a simple support structure within such an low rise high density urban tissue by the integration of transversal and longitudinal structures around courtyards.

3. After the housing corporation ''Papendrecht'' commissioned me the architectural design of 80 dwellings I wanted to experience the design, the execution of a support/infill project and the full user participation.

**Q2. Future residents had a decision-making influence on the infill level. What are your thoughts on having them also some kind of decision-making influence on the structure level?**

1. Individual future residents might have the right to 'influence' a support design by what we call 'inspraak' meetings, an information meeting that allows citizens to react on design propositions, so that designers and deciders might rethink ideas. It is not an decision making meeting.
2. Representants of a collectively of -future, involved- residents might very well participate in the decision making. For instance by writing 'patterns' of the desired support structure. See our 'Meander' project in Zwolle.

**Q3. When looking at the layers of change, as discussed by Steward Brand. Did you take this into account as well? What are the elements in this building that are designed to be changed over time, if they are? How should these be replaced, in how many years and why?**

1. Brands layers of change as I understand are very different, because only based on building components and their lifetime. Open buildings levels are 'levels of intervention', levels of design and decision making, based on: Who decides on what, where. It allows levels op participation, Public: Urban Tissue, Collective: Support and Private: Infill. OB has a site on each level, that we call 'domain', and also elements and spatial plans. Urban Tissues and Support both are 'structures', infill able structures! A major OB principle, made for change also, but in a overall vision of decision making. Lifetime of building components depends on techniques, not on decision making.

2. The support structure has been parceled out into dwelling units by dwelling separation walls. They are removable overtime when a collectivity of residents want to change the parcellation of the support structure, may be after 25 years or more. Like in our 'Keyenburg' project in Rotterdam
3. The infill is designed to change easily and frequently per dwelling, an individual decision of household.

**Q4. In what way can the building be dismantled if needed? Or what and how are element that are designed for dismantling?**

1. The principle is: A support structure is not designed to be dismantled, but has to be solid for more than 100 or 200 years! The writing off of our 'Pelgromhof' support in Zevenaar has been accepted on 75 years instead of 35 years, an amazing difference of investment.
2. This is possible because a support is changeable by re-parcellations and by flexible infill. The very economic sustainable character of support structures.

**Q5. During the project, what were things that turned out to be different in practice (during the design phase – during construction – after project delivery) than you expected it to be? What was the expectation and what was the outcome? Why was there a difference? How would you do this the next time. What are some things that work out in the design, but just not in practice?**

1. During the design phase of the Molenvliet support structure has been parcelled into 109 units of different sizes, from 1 to 7 rooms. During the construction, 14 large units have been split into small ones, offering after this re-parcellation a final number of 123. Great satisfaction to the housing association.
2. The project would have been successful if each dwelling could have a different infill according to the user wishes. During the design came out that infill part could also be ready for change over time,
3. Dwelling separations by brick walls between concrete piers are expensive. In our later projects they have been replaced by support walls with 'fontanels', iron free parts of walls to be opened or closer later on, to allow (re)parcellation.
4. In 1975 there was no experience or infill market! Infill electric, piping and heating systems and controls have been improvised, but more cleverly simplified applied in our later projects, like the Pelgromhof in Zevenaar.

**Q6. What are the things you would have done differently if you could do the project over (overall / especially related to adaptability / at that moment vs now)?**

1. My new study '' Transformation of Slums'' is based on the same support structure and urban tissue idea. Now I would design very long related galleries, balconies on the galleries, roofs for sun energy, water storage and roof gardening.
2. I would design a special floor system of the beta-zones of supports in order to apply simple piping systems but also flexible stair holes!

**Q7. What are general the biggest difficulties and barriers? How do you think these could be solved?**

1. Biggest barriers are not technically but mentally. In the buyers' market developers are not interested in re-parcellation or to offer freedom to users other than secondary topics like

finishings and some prefab choices. Nevertheless user participation and freedom of dwelling layout will become a major selling point.
2. Housing associations are more and more interested in managing their property on long term, but are holding back to users freedom and the building costs, a mistake. My seven OB projects are all realized in social rent housing for Housing Corporations. They are by definition interested in the long term value and management of the support.
3. Architects are not used to design structures. They could discover the richness, beauty and fulfilment of creating infill able structures that offer so much freedom to users.
4. Builders think it is complicated, but it is the contrary. Building support structure is a real building activity. Infill is assembling! Very different knowledge and profession.

**Q8. Having multiple individuals, leads to having a difference in the façade. How can you make sure this still becomes coherent, or perhaps that is not important at all? What does this mean for the street design?**

1. The architectural variations of infill within a façade structure is the most interesting aspect of Open building. It integrates life in the street walls by individual expressions within a whole. See the Molenvliet facades with the original colours!

**Q9. Bathrooms, in terms of tiles and plumbing, can be a bottleneck when looking at the possibilities of changing the infill. How do you see this being solved?**

1. The optimal cost/quality solution I discovered is 7 cm screed floor on the construction floor. Bathrooms are not changing frequently. The main question is the possibility to change infill without damaging the support structure.
2. I see new infill systems arise now and in the future. Molenvliet was a pilot to discover many questions to work out.

**Q10. Molenvliet offers personalization of living spaces, however doesn't take into account the changing of the household profiles. The wishes and needs of the, then, future residents were taken into account in terms of floor plans, facades and decision-making. However, how does this relate to the next upcoming resident? What are your thoughts on growing and shrinking space? How could this be integrated in design?**

1. This touches the interest of re-parcellation of the structure. The re-distribution of available space is interesting, not the extensions or shrinking of private space. Therefore I see a support as a collective good, not as a series of individual goods. What is collective should be shared in common, what is private managed individually.
2. Re-parcellation allows the option of larger or smaller units. Practiced in Keyenburg.

**Municipality**
**Q11. How does the municipality intervene and has an effect (either positive or negative) of such projects? How would you like to be supported by the municipality? What are the most important laws, legislations and regulations you have to take into account with adaptive housing?**

1. The municipality should decide on the urban tissue. In the Molenvliet project the interwoven outdoor spaces courtyards, streets and allies

2. They should control the normal application of the building rules in the support design and execution.
3. They have no say on the infill within the different dwellings. Here a housing association could control on safety.

**Organisational**

**Q12. The floor plans weren't fixed and rather fictive floor plans were used. What does this say on the process and organisation in terms of building costs (calculating the costs, but also does it require extra costs for the architect etc.), the planning and the municipality?**

1. The fictive infill plans were used for the building permission, to show the capacity following the rules. Not for users.
2. The builder used the fictive plans to estimate the building costs. After the first infill after the user consultation hours, the builder found the average costs did not change much and decided to fix an overall price.
3. User participation require extra costs for consultancy preparations and processing. I accepted it in this first project. In later projects, users got the choice to life in a standard (fictive) dwelling, or to pay of the consultancy price of two month rent in 5 years. Everybody choose the last option.

**Q13.One of the main recommendations seem to be giving the residents more time and the two consulting hours weren't sufficient enough. Could it a possible way of tackling this be to provide some kind of manual beforehand?**

1. In our last project, Meander in Zwolle, people got more time to discuss and decide. The result was negative: the whole process became frustrated because users could not decide of the deadline!
2. In projects after Molenvliet we informed the users better on forehand and they got not only an empty dwelling but also a paper with all kind of furniture on scale and between the two sessions they all tried out their infill layout in a true scale model and discuss the layout walking in the model and change the sketch.

**Q14. At the end, a large amount of potential buyers dropped out. Some of them even right before the delivery phase. Reasons of this include the building density, the implementation of the project, the designated house to them, the high rent and/or the short decision time. For 38% of the housing units it was the case that their floor plans couldn't (or nihilistic could) be changed, regards to ordering the building elements. The other consultancy hours were more to inform them about the already set design. These residents also had higher moving-out tendency. The municipality assigned people to houses (empty floor plans( in stead of first finding the right people and then assigning a (empty floorplan) house to them. How would this influence your work differently?**

1. Molenvliet was the first support infill project in the Netherlands! No experience, no examples! The assignment of the dwellings to the people was completely new and difficult because so many different parcelled forms of dwellings had to be assigned in each building phase. After all, they did wonderful work and inspired all the following OB projects.
2. A real experimental project, we learned a lot!

**Q15. Almost none of the participants would be willing to repeat this kind of project. Organisational wise this takes a lot of time and effort. What are your thoughts on this? How could this be more streamlined?**

1. After Molenvliet we realized 6 more OB projects, 5 in the Netherlands!
2. All renewing projects take time and effort. All participants spent much more time and energy than normal. Mostly with great satisfaction to have participated to an evolution towards a better world.
3. It will be streamlined by more and more experience through applications.

**Q16. With what other actor you have the most and least connections with? Why? How are you related? What between you and them clashes? Why and how can this be solved? What goes best between you and them? How come?**

1. I had the best connections with the users. I admired and supported always the housing corporations and builders who took the risks!

**Other**

**Q17. Molenvliet was experimental housing construction. Did you further developed these principles into other projects? Can you tell me more about this?**

1. Yes, see my website: www.vdwerf.nl

# 7. Survey

7.1 Flyer

## ONDERZOEK NAAR AANPASBARE EN TOEKOMSTBESTENDIGE WONINGEN

Hi! Mijn naam is Shajwan en ben momenteel bezig met mijn master scriptie aan de Technische Universiteit Delft waarbij ik mijn onderzoek doe naar 'Re-adaptive housing'. Ik zou heel graag uw mening ook horen!


Deze vragenlijst gaat over **uw ervaringen en beoordelingen** van uw huidige woning en is volkomen **anoniem**. Het duurt tussen de **2 en 5 minuten**. Het helpt het onderzoek naar **wat mensen zelf** echt willen enorm! U kunt bovenstaande **QR code scannen**.

Het is een deel onderzoek over de **evaluatie** van de experimentiele Molenvliet woningen en hoe de **bewonersparticipatie** en **aanpasbaarheid** van woningen in de toekomst beter kan.

Het volledige onderzoek gaat over 're-adaptive housing' en de mogelijkheid hiernaar. Het re-adaptief huizen bouwen in Nederland kan eventueel een oplossing bieden voor de marktkrapte wanneer men langer in zijn woning kan blijven wonen en deze woning meekrimpt of meegroeit met de wensen van de bewoners. Het onderzoek kan u terugvinden eind deze zomer op de TU Delft Repository onder de naam: Shajwan Jabar.

# 7.2 Questions

**Hoe ziet het huidige huishouden eruit?**

- [ ] Twee ouders
- [ ] Een ouder (vader of moeder)
- [ ] Kind(eren) tussen 0-5 jaar
- [ ] Kind(eren) tussen 5-12 jaar
- [ ] Kind(eren) tussen 12-18 jaar
- [ ] Kind(eren) van 20+
- [ ] Alleenstaande vrouw
- [ ] Alleenstaande man
- [ ] Koppel zonder kinderen

↓ Volgende

**Verwacht u dat uw huishoudengrootte veranderd op korte termijn (0-5 jaar)?**

- [ ] Ja: wordt groter
- [ ] Nee
- [ ] Ja: wordt kleiner

↓ Volgende

**Verwacht u dat uw huishouden op lange termijn veranderd (5-10 jaar)?**

- [ ] Ja: wordt groter
- [ ] Nee
- [ ] Ja: wordt kleiner

↓ Volgende

**Wat was uw voornaamste reden voor het huren van deze woning?**

- [ ] Huurprijs
- [ ] Geen specifieke redenen, anders dat ik gewoon een woning nodig had
- [ ] Fijne wijk
- [ ] Bereikbaarheid
- [ ] Mogelijkheden tot het veranderen van mijn woning naar wens
- [ ] Experimentiele woningbouw karakter

↓ Volgende

**Wat is er volgens u anders aan de Molenvliet woningen dan aan reguliere woningbouw?**

↓ Volgende

**Bent u zich bewust van het experimentiele achtergrond van uw woning? (dat het flexible mogelijkheden heeft met betrekking tot de structuur en invulling)**

- [ ] Ik heb er wel van gehoord, alleen nooit dieper op ingeinformeerd
- [ ] Ik weet niet zo goed wat dit inhoud
- [ ] Ik ben mij hier erg goed van bewust
- [ ] Ik had geen idee

↓ Volgende

**Bent u de eerste bewoner of was er verhuurder voor u?**

- Ik ben de eerste huurder geweest en heb mee-ontworpen aan de plattegrond met de architect.
- Ik ben de eerste huurder, en heb de woning toegewezen gekregen.
- Er zijn huurders voor mij geweest.

**Als u een 1e huurder bent en hebt mee ontworpen:**
**Wat vond u goed en minder goed gaan aan dit process?**

↓ Volgende

**Als u een 1e huurder bent en hebt mee ontworpen: hoe heeft u uw eigen ontwerp ervaren op korte termijn (0-5 jaar)?**

↓ Volgende

**Als u een 1e huurder bent en hebt mee ontworpen: Hoe heeft u dit ervaren op langere termijn? (na 5 jaar)**

↓ Volgende

**Als u een 1e huurder bent en hebt mee ontworpen:**
**Had u achteraf liever dat u een plattegrond kreeg van de architect zonder uw eigen ingeving?**

- Ik had liever meer inspraak gehad
- De hoeveel inspraak was genoeg
- Ik had graag alsnog inspraak gehad, maar meer geleid door de architect
- Neutraal
- Ik had liever dat de architect het volledig in handen nam (geen inspraak)

**Heeft u op het moment genoeg aan uw ruimtes?**

- [ ] Nee: meer slaapkamers nodig
- [ ] Nee: grotere woonkamer of keuken nodig
- [ ] Nee: extra kamer nodig (niet tbv slaapkamer)
- [ ] Ja
- [ ] Ik heb een (slaap)kamer te veel
- [ ] Ik heb een of meerdere (slaap)kamers te veel

↓ Volgende

**Als u meer ruimtes nodig heeft, waarom?**

↓ Volgende

**Als u verwacht te verhuizen op korte termijn (<5 jaar), waarom?**

- [ ] Huidige woning is te klein
- [ ] Huidige woning is te groot
- [ ] Andere wijk
- [ ] Ik verwacht niet te verhuizen
- [ ] Huidige woning heeft teveel reparaties nodig
- [ ] Ruimtes niet geschikt voor fysieke behoeftes
- [ ] Ik zoek iets dichterbij werk/school/vrienden/familie
- [ ] Ik wil apart wonen van de huidige gezinssamenstelling

↓ Volgende

**Als u meer ruimte heeft dan nodig hebt, waarom verhuist u niet kleiner?**

- [ ] Te hecht aan de wijk
- [ ] Lastig een woning te vinden in deze markt, dus blijf liever waar ik woon
- [ ] Verhuizen is teveel gedoe
- [ ] Ik vind het wel fijn om ruimer te wonen

↓ Volgende

**Heeft u in het verleden uw woning aangepast? Zo ja, wat en waarom?**

↓ Volgende

**Verwacht u ook aanpassingen aan uw woning te doen? Welke aanpassing en waarom?**

↓ Volgende

**In hoeverre ervaart u de aanpasbaarheid van u woning?**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|

**Kunt u dit nader toelichten?**

↓ Volgende

**In hoeverre ervaart u de mogelijkheid tot groeien en krimpen in uw woning?**

0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10

**Kunt u dit nader toelichten?**

↓ Volgende

**In hoeverre bent u tevreden over uw woning (niet uw wijk, omgeving, tuin, beschikbaarheid etc.)**

0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10

**Wilt u nog dingen kwijt?**

↓ Volgende

# 7.3 Survey outcome

| Respondent | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | General |
|---|---|---|---|---|---|---|---|---|---|---|
| Current household | Single woman | One parent with child(ren) between 12-18 | Single woman | Single woman | Single women | Couple without children | Single man | Single woman | Two parents with child(ren) between 12-18 years | 67% singles<br>11% couple<br>22% family |
| Expectations for household size adjustments in short term | No | No | No | No | Yes, to get bigger | No | Yes, to get bigger | No | No | Only two singles expect to get a bigger household in short term (22%) |
| Expectations for household size adjustments in long term | No | No | Yes, to get bigger | No | Yes, to get bigger | Yes, to get bigger | Yes, to get bigger | No | Yes, to get smaller | 3 singles expect to get bigger, and one family to get smaller (44%) |
| Main reason to rent this house | Experimental character of the project | Nice neighbourhood | Rent price<br>No specific reason, other than I just needed a house | Nice neighbourhood | No specific reason, other than I just needed a house | No specific reason, other than I just need a house | Rent price, nice neighbourhood, accessibility | No specific reason, other than I just need a house | No specific reason, other than I just need a house | Experimental character: 11%<br>Accessibility: 11%<br>Rent: 22%<br>Neighbourhood: 33%<br>No specific reason: 55% |
| What makes Molenvliet different than usual housing? | De persoonlijke indeling die mogelijk was, het experimentele karakter. | Lekker groot en ook een groot dakterras en toch veel privacy | I dont know | Unique | - | Alle huizen lijken anders dan de anderen in dezelfde straat | Sommige zijn echt raar ingedeeld | Dat alle woningen anders zijn. | De veelzijdigheid van het soort woningen. | Diversity |
| Consicousness of the experimental background (flexibility possibilities and structure-infill) | Erg goed bewust van | Ik heb er wel van gehoord, alleen nooit dieper op ingeinformeerd | I had no idea | I've heard of it, but nooit dieper op geinformeerd | I don't know what this entails<br>I had no idea | I had no idea | I've heard of it, but nooit dieper op geinformeerd | I've heard of it, but nooit dieper op geinformeerd | I've heard of it, but nooit dieper op geinformeerd | Knows well: 1<br>No idea:3<br>Heard of it, but never inquired more deeply: 5 |
| First renter or secondary renter | Ik ben de eerste huurder geweest en heb mee-ontworpen aan de plattegrond met de architect. | Er zijn huurders voor mij geweest. | Er zijn huurders voor mij geweest. | Er zijn huurders voor mij geweest. | Er zijn huurders voor mij geweest. | Er zijn huurders voor mij geweest. | Er zijn huurders voor mij geweest. | Er zijn huurders voor mij geweest. | Er zijn huurders voor mij geweest. | Only 1 person that is a first time renter and influenced layout |
| If first renter and helped design floor plan: things that went well and less good | Goed: samenwerking met architect en de vrijheid van keuze.<br>Fout: niet van toepassing. | - | - | - | - | - | De ruimte van de woning, minder goed slechte muren is gipsplaat toilet alleen beneden . | - | - | Good team work with architect and freedom of choice. |
| If first renter and helped design floor plan: how you experienced your own design on short term | Very good | - | - | - | - | - | - | - | - | Experiences her own design on the short term as very good |
| If first renter and helped design floor plan: how you experienced your own design on long term | Still fine | - | - | - | - | - | - | - | - | And still does. |
| If first renter and helped design floor plan: preference regarding amount of influence on design | Amount of influence was enough | - | - | - | - | - | - | - | - | To her, the amount of decision influence was right and enough. |
| Amount of spaces / room | Enough | Enough | No, need more | Enough | Need more bedrooms, a bigger living | Need a bigger livingroom or | Enough | Enough | Enough | 66% enough space<br>33% need more rooms |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | bedroo ms | | room or kitchen and an extra room | kitchen and an extra room | | | | |
| Why would more spaces be needed for | - | - | Slaapka mer is erg klein | Walking closet werkrui mte | Ik zou graag samen willen gaan wonen en beginnen aan kinderen in de toekomst. In dit huis is dit niet mogelijk. | Door het intrekken van vriendin en dus meer spullen is de woning te klein. | - | - | - | Because one bedroom is too small and because of household size expansion. |
| If expected to move on short term: why? | Current house is too big Different neighbourh ood | I don't expect to move on the short term | Current house is too small Differen t neighbo urhood | I don't expect to move on the short term | Current house is too small | House too small | I don't expect to move on the short term | I don't expect to move on the short term | I don't expect to move on the short term | Don't expect to move: 55% 44% expects to move on short term because of the house being too small, 22% because of the neighbourhood First lady, because her house is too big. |
| If you have more space than needed, why not move smaller? | - | - | - | Verhuiz en is teveel gedoe | - | - | Verhuizen is teveel gedoe | Ik vind het wel fijn om ruimer te wonen | Lastig een woning te vinden in deze markt, dus blijf liever waar ik woon | The others woouldnt move house when their house it too big because of moving being too much of an effort, enjoy having extra space and because of the right housing market. |
| Most Have adjustments be made to your dwelling, which and why? | Ja,maar vooral ter verbetering van het woongenot. | Ik heb de hele binnenkant netjes gemaakt, muren gestuct enz. Dit was erg veroudert en nummert blij | No | No | - | No | - | - | No | Only 2 made adjustments: these were small however, such as, plastering walls. |
| Expectations to make adjustments, which one and why | No | No | - | Badkam er ik ben 60+ me douche om in te staan is verhoog d is te hoog voor mij en te gevaarlij k moet aangepa st worden | - | Nee ik verwacht binnen enkele jaren te verhuizen | - | - | No | No (big) adjustments are expected to be made |
| Rate of adaptaibility of housing<br><br>Explanation | 7<br><br>- | 5<br><br>Geen behoefte om aan te passen, een lift zou wel noodzakelijk zijn. Of een schuur per woning, nu delen we een schuur en met een scooter en elektrische fiets is dit niet handig. De buren slopen (onbewust) je spullen. | - | 10<br><br>Badkam er vervang en | 4 | 0<br><br>Ik ben me niet bewust van woning aanpasbaarhei d | 7 | - | 0<br><br>Ik zou niet weten wat kan en mag | Ranges very broadly from 10 to 0.<br>10<br>7<br>7<br>5<br>4<br>0<br>0<br><br>The low ratings are largely due not knowing what the possibilities are.<br><br>The 10 might be a mistake, as the explanation is 'changing bathroom'. So this is taken out. |
| Rate of growth and shrink possibilities<br><br>Explanation | 7<br><br>- | 0 | - | 10<br><br>Badkam er vervang en | - | 0<br><br>Niet bekend met de mogelijkheden | 5 | - | 0<br><br>Ik zou niet weten wat kan en mag | 7<br>5<br>0<br>0<br>0 |
| Rate of satisfaction house | 9 | 10 | - | 8 | 3 | 6 | 7 | 7 | 9 | 10<br>9<br>9<br>8<br>7<br>7<br>6<br>3<br><br>7.4 gemiddeld |
| Any thing else you want to say | Multiple neighbours | Ik hoop niet dat deze wijk weggaat of dat er andere woningen voor in de plaats komen :( ik woon hier super fijn en hoop ook niet dat dit het doel is | - | Mijn badkam er mag echt naar gekeken worden gelijkvlo ers makenn | - | - | - | Zou beter onderhouden moeten worden | - | |
| | karinrobbe n@hotmail. com | 0615074993 | - | Everts_ michi@ hotmail. com | | - | - | - | - | |

| Respondent | General |
|---|---|
| Current household | 67% singles<br>11% couple<br>22% family |
| Expectations for household size adjustments in short term | Only two singles expect to get a bigger household in short term (22%) |
| Expectations for household size adjustments in long term | 3 singles expect to get bigger, and one family to get smaller (44%) |
| Main reason to rent this house | Experimental character: 11%<br>Accessibility: 11%<br>Rent: 22%<br>Neighbourhood: 33%<br>No specific reason: 55% |
| What makes Molenvliet different than usual housing? | Diversity |
| Consicousness of the experimental background (flexibility possibilities and structure-infill) | Knows well: 1<br>No idea:3<br>Heard of it, but never inquired more deeply: 5 |
| First renter or secondary renter | Only 1 person that is a first time renter and influenced layout |
| If first renter and helped design floor plan:<br>things that went well and less good | Good team work with architect and freedom of choice. |
| If first renter and helped design floor plan:<br>how you experienced your own design on short term | Experiences her own design on the short term as very good |
| If first renter and helped design floor plan:<br>how you experienced your own design on long term | And still does. |
| If first renter and helped design floor plan:<br>preference regarding amount of influence on design | To her, the amount of decision influence was right and enough. |
| Amount of spaces / room | 66% enough space<br>33% need more rooms |
| Why would more spaces be needed for | Because one bedroom is too small and because of household size expansion. |
| If expected to move on short term: why? | Don't expect to move: 55%<br>44% expects to move on short term because of the house being too small,<br>22% because of the neighbourhood<br>First lady, because her house is too big. |
| If you have more space than needed, why not move smaller? | The others woouldnt move house when their house it too big because of moving being too much of an effort, enjoy having extra space and because of the right housing market. |
| Most Have adjustments be made to your dwelling, which and why? | Only 2 made adjustments: these were small however, such as, plastering walls. |
| Expectations to make adjustments, which one and why | No (big) adjustments are expected to be made |
| Rate of adaptaibility of housing | Ranges very broadly from 10 to 0. (1x10, 2x7, 1x5, 1x4, 2x0)<br>The low ratings are largely due not knowing what the possibilities are.<br>The 10 might be a mistake, as the explanation is 'changing bathroom'. So this is taken out. |
| Rate of growth and shrink possibilities | 1x7, 1x5, 3x0 |
| Rate of satisfaction house | 1x10, 2x9, 1x8, 2x7, 1x6, 1x3<br>7.4 gemiddeld |

# 8. Case Weesperstraat

## Studenthousing Weesperstraat

**General project information**

Project: Studenthuizen Weesperstraat
Architect: Herman Hertzberger
Year:
Location: Amsterdam

## Key characteristics

250 studentwoningen, waarvan 8 ook student-echtpaar woningen.
all units have their own front door, front door and letterbox. regard as residential houses, located at the communal stairwell. communal laundry room, toilets and storage rooms, lunch.
The ground floor is occupied with facilities such as bookstore, café, asva center (meeting room and central room offices) and is made separate from the living areas since these are public functions. These functions can therefore also count on the concentration of people (approximately 250 student residents).

**Structural in sight**

The facades are not load-bearing because of the self-supporting concrete skeleton. The load bearing beams not only have their load-bearing function but are also planes that connect other planes in order to make the structural idea of the building clear and in sight (GoedWonen, 1966).

**Polarities**

The building has many orientation marks due its strong use of polarities. It has alternations of high and low spaces, contrasts between dark and light spaces, connections with inside-outside (GoedWonen, 1966).

**Inside – outside**

To continue the environment and make a less abrupt boundary between inside-outside/public-private, the building is on columns. Penetrating into the living area, one enters successively: gallery under the building, outside staircase, terrace, enclosed porch, hall, stair and lift house, porch, front door of the living unit, corridor to which the rooms open (GoedWonen, 1966).

On the 4$^{th}$ floor there is also a gallery street. The residential units located there, prompted the creation of this street in the lunchtime. Residential street without traffic, not only to reach the front door but is also a real extension of the living space to the outside: common area where you can sit in front of your house. The reason for this was that the fourth floor was on the building line of the old surrounding buildings and Hertzberger thought that old and new should 'meet' at that height (GoedWonen, 1966).

**Social interaction and multifunctionality**

To enhance social interactions, the central point in the corridor is a telephone niche so it can also serve as a reason to hangout.  For more sightlines and open views, the staircase that connects the two dining areas  has a larger platform than would be necessary, and at such a heigh that both above and below allow optimal social exchange. The parapets are made with the expectation that they will be interpreted as a table, bench, or step, the hidden intentions of the architect to articulate each part in such a way that the most varied exchange pattern can arise. Loggia’s are not just for garbage

cans, but of such dimensions that one can also eat and sleep here or be a place of plants, a sandbox etc.

Also the concrete lightning block, that are positioned low so that residents aren't hindered by this, are multifunctional as they can be used as a table, bench, workbench etc. Also the concrete wall with square holes in the Open House on the 4th floor's roof, is multifunctional as it can function as the squares function as storage spaces (GoedWonen, 1966).

## Evaluation / current context

Still student housing

## Enablers and barriers

| | Enabler | Barrier |
|---|---|---|
| Experimental | - | - |
| Adaptability (layout) | The facades are not load-bearing because of the self-supporting concrete skeleton. | Fixed spaces of wetrooms. Other untis only have a shared bathroom and kitchen |
| Adaptability (plumbing) | | Fixed spaces of wetrooms. |
| Execution | | |
| Team | | |
| Grid | | |
| Municipality / legal influence | | |
| Housing allocation | | |
| Resident matters / user participation | | |
| Life span | | |
| Opportunity to grow, shrink or change function | | |
| OTHER | The load bearing beams not only have their load-bearing function but are also planes that connect other planes in order to make the structural idea of the building clear and in sight | |
| | To continue the environment and make a less abrupt boundary between inside-outside/public-private, the building is on columns. Penetrating into the living area, one enters successively: gallery under the building, outside staircase, terrace, enclosed porch, hall, stair and lift house, porch, front door of the living unit, corridor to which the rooms open<br>The building has many orientation marks due its strong use of polarities. It has alternations of high and low spaces, contrasts between dark and light spaces, connections with inside-outside | |
| | Businesses in the plinth, giving directly a large crowd | |
| | To enhance social interactions, the central point in the corridor is a telephone niche.The parapets are made with the expectation that they will be interpreted as a table, bench, or step. Loggia's are not just for garbage cans, but of such dimensions that one can also eat and sleep here or be a place of plants, a sandbox etc. | |

# 9. Sky Building nr 3

**SKY BUILDING NR3**

**General project information:**

Project: Sky building  nr 3
Architect: Yoyi Watanbe
Year: 1972
Location: Higashi Shinjuku - Tokyo

**Relationship with Molenvliet:**

Another example of metabolist's principle of fixed core with attached capsule can be the Sky House, designed by Yoji Watanabe Although he did not belong to the Metabolism group, this project shows not only strong relations to it but also shows a successful redevelopment (Buzzone, 2021).

**Key characteristics:**

**Core with units branching off**

By borrowing principles from prefab and the industrialisation of the modern movement, the architect used mostly steel, concrete and the basic idea of having a 14 story concrete frame core with 115 units branching off. The central core includes the main circulation, with the modular apartments being repeated on the two sides of this core. Each unit appears as a plugged in capsule, and sticks out the main volume.

These units, capsules, have all equal access to natural lightning (Buzzone, 2021). The idea of cylindrical infrastructure trunks with branching of spaces, can also be seen in the Shizuoka Press and Broadcasting Centre (singular trunk with offices cantilevering off) and the Yamanashi Press can Broadcasting Centre (multiple trunks also connected through bridges) (Hart, 2021).

**Different unit sizes and lifestyles**

From the exterior each unit is distinguishable, however from the interior multiple units form one single residential unit. On the floors, multiple units form a total of 4 housing per building layer with an exception at the 13$^{th}$ and 14$^{th}$ floor. Here, 4 units are combined to one large single residence. The 15$^{th}$ floor is a terrace (Buzzone, 2021). Furthermore, different lifestyles were also combined in the building as the capsules on the east side are presented with tatami flooring and the capsules on the west side are presented with an ordinary type of flooring (Buzzone, 2021).

**Building in current context / evaluation:**

Renewal

Between the periods of the 1990s and 2000s, the building was in abandonment. It wasn't until 2010 that protection and repair actions were taken. A building's structure recovery was allowed through an re-use project (Buzzone, 2021). Main saviour in the salvation of the building, is the dynamicity of its capsule system that gave the possibility to establish new functions (Buzzone, 2021).

New function

Currently the building  is a mixed use of offices, SOHO (small office home office), social apartments, and purposed floors for entertainment and cultural activities. Now the basement still has its own original flooring. The first two floors are in almost the original asset with the 2$^{nd}$ floor being preserved of its previous appearance of exposed concrete and atelier functions. The 3rd till 5$^{th}$ floor

are used as offices, to make this happen some vertical elements were removed. The capsules on the 6th till 14th floor have been re-arranged to single units, to correspondent with the central corridor. The 6th till 8th floor include SOHO, the 9th floor a wide dining and living space at service of the complex and the 10th till 14th floor social apartments (Buzzone, 2021). All spaces are for lease and not sale.

New standards
In order to adapt to the building its current standards, a seismic retrofit system has also been applied. Also some other interior and exterior interventions oriented towards energy savings, such as thermal and acoustic insulation, applied to the interior stone wool (Buzzone, 2021).

## Enablers and barriers

| | Enabler | Barrier |
|---|---|---|
| | The central core includes the main circulation, with the modular apartments being repeated on the two sides of this core. Each unit appears as a plugged in capsule, and sticks out the main volume. | In order to adapt to the building its current standards, a seismic retrofit system has also been applied. Also some other interior and exterior interventions oriented towards energy savings, such as thermal and acoustic insulation, applied to the interior stone wool |
| | From the exterior each unit is distinguishable, however from the interior multiple units form one single residential unit | Had long time of abandonment |
| | A building's structure recovery was allowed through an re-use project (Buzzone, 2021). Main saviour in the salvation of the building, is the dynamicity of its capsule system that gave the possibility to establish new functions (Buzzone, 2021).<br>The capsules on the 6th till 14th floor have been re-arranged to single units, to correspondent with the central corridor. | |

# 10. Critical panel send pieces

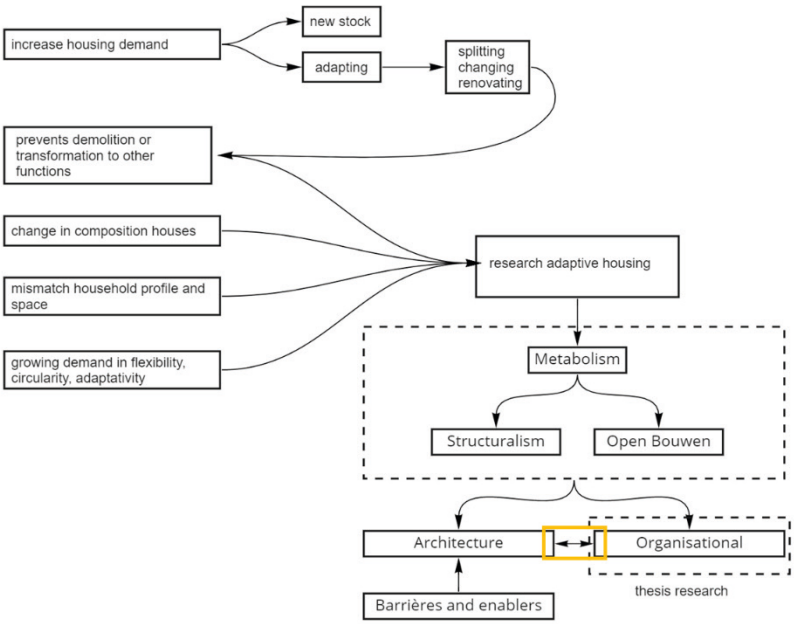
## 10.1 Explanation research

**Uitleg onderzoek**

Als oplossing voor het hoge woningtekort in Nederland wordt onderzoek gedaan naar aanpassingswoningen.

In de huidige woningvoorraad en de toename daarvan zit relatief veel extra nieuwbouw als gevolg van het aanpassen van gebouwen, hetzij door splitsing, renovatie of wijziging van het gebruik van de woning of een combinatie daarvan. Bovendien is er een verschil in gezinsgrootte en de m2 daarvan, veel mensen wonen ofwel te groot ofwel te klein dan zij nodig hebben. Ook de benodigde ruimte verschilt in de loop der jaren.

Aangezien er ook een toenemende vraag is naar flexibiliteit, duurzaamheid, circulaire economie, hernieuwbaarheid en aanpasbaarheid in huisvesting, is het onderwerp van aanpasbare huisvesting relevant en het onderzoeken waard aangezien het een mogelijke oplossing zou kunnen bieden en een belangrijk deel uitmaakt van de problemen zoals hierboven vermeld. Omdat bestaande gebouwen door splitsing, renovatie en/of transformatie nieuwe huisvesting kunnen creëren, wordt sloop of transformatie naar andere functies voorkomen.



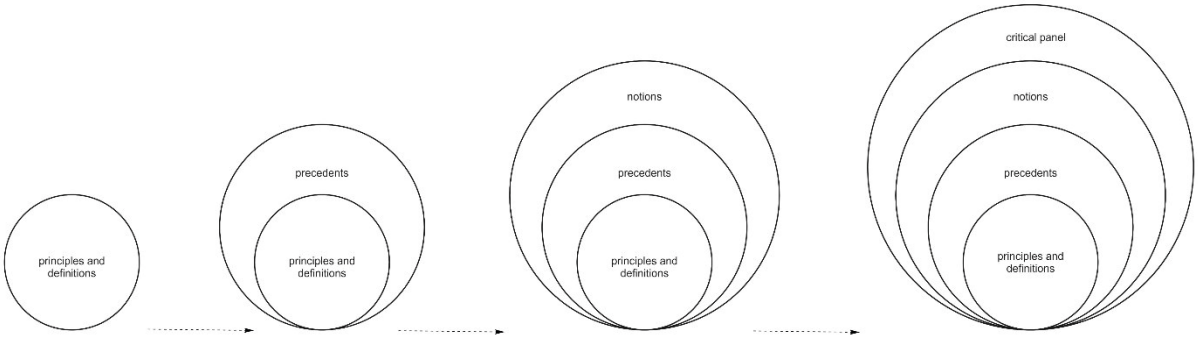

Figuur 1: Onderzoek aanleiding

Kennis over de implicaties en mogelijkheden van flexibele en adaptieve huisvesting is van groot belang om deze theorieën vaker toe te passen, de woningnood enigszins te verlichten en toekomstige mismatches tussen vraag en aanbod van ruimte te voorkomen.

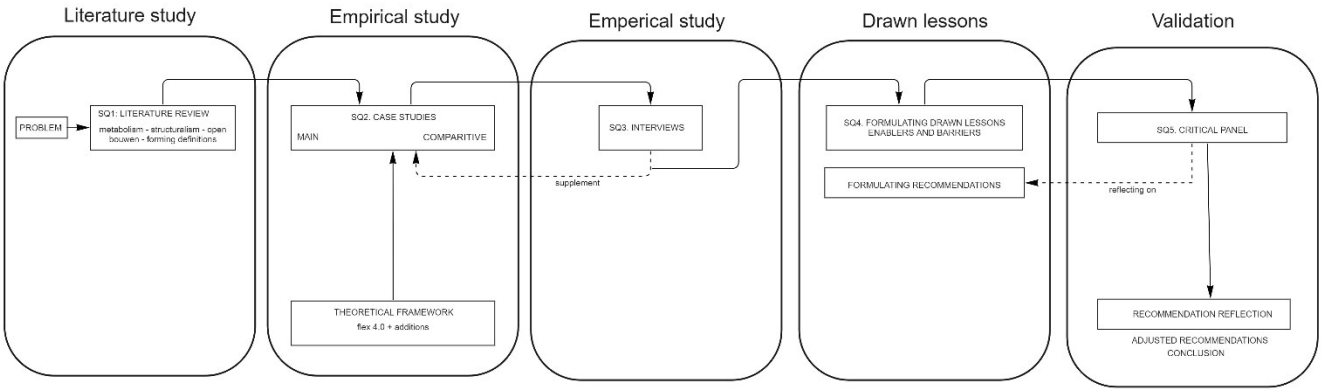
Eerder onderzoek richtte zich vooral op de architectonische kant van aanpasbaarheid, maar het aspect van organisatorisch management behoeft nog nader onderzoek. Deze dissertatie richt zich op het trekken van lessen uit adaptieve gebouwen (metabolisme, structuralisme of open bouwen), om aanbevelingen te doen voor nieuwe adaptieve woningbouw in Nederland, met name gericht op de organisatorische en management kant ervan.

De mogelijkheden van adaptief en flexibel bouwen en hun algemene kenmerken zijn uitgebreid bestudeerd en gedocumenteerd en hebben hun relatieve grote aandacht gekregen in de bouwwereld, in Japan met Metabolisme en zijn Nederlandse tegenhangers Structuralisme en Open bouwen.

Het onderzoek is gedaan door eerst een literatuur studie te doen naar de theorien en dit aan te vullen met case studies. Om zo een link te maken tussen theorie en praktijk. De case studies zijn aangevuld met interviews om er meer kijk op te krijgen. Vanuit de case studies zijn er kritische punten voort gekomen, waaruit recommandaties (om adaptief wonen 'bouwbaar' te maken) worden gemaakt. In de laatste fase van het onderzoek, worden deze recommandaties besproken. Dit is de fase waarin we nu zitten.



Figuur 2: Opbouw informatie verzameling



Figuur 3: Opbouw onderzoek

**BEGRIPPENLIJST**

**METABOLISME**
Fundamenteel in de **cyclus van verandering**, de voortdurende **vernieuwing** en het anticiperen op toekomstige veranderingen door de (prefab) woning re-adaptief te maken. Heraanpasbaar betekent een structuur en verschillende componenten die (gemakkelijk) kunnen groeien, transformeren, worden bevestigd en verwijderd uit de grotere structuur. Deze verschillende componenten hebben doelbewust een verschillende levenscyclus.

**STRUCTURALISME**
Flexibiliteit die tot uiting komt in de uniforme, vermenigvuldigde en zich **herhalende rasterstructuur** van kleine eenheden. De kleine eenheden kunnen worden gecombineerd, toegevoegd of weggelaten om een grotere eenheid als een eenheid en geheel te maken. De ruimte binnen de kleine eenheden is vrij van grote vaste wanden. Overlappende eenheden kunnen worden verbonden met bruggen, open ruimten en/of 'binnen'straten of kunnen eenheden begrenzen

**OPEN BOUWEN**
Open Bouwen wordt gedefinieerd door het hebben van een **structuur** (constructie) en een **invulling** (al het andere), waardoor individuele vrijheid binnen een vast kader mogelijk wordt. De verschillende elementen (structuur en invulling) hebben verschillende levenscycli.

### Het definiëren van re-adaptive (eigen voorgestelde definitie)
Re-adaptive kan worden gedefinieerd als het gebruik van een gestructureerd rastersysteem, marges die hiermee samenhangen, uitwisselbaarheid, uitbreidbaar door kern en/of vermeerdering, het structuur- en invulprincipe en de focus op persoonlijke individualiteit van de gebruiker met (mogelijke) gebruikersparticipatie. Deze elementen geven ruimte aan een woning om zich in de loop van de tijd aan te passen (en opnieuw aan te passen) aan verschillende functies en behoeften.

## 10.2 Critical panel content

Of the case studies, a number of important issues were emerged as they came forward multiple times and have to do specifically with (re-)adaptivity and organisational aspects. Technical and design related issues have been largely taken out.

In black the critical notion (the barrier). In blue the recommendation (‘solution’).

### Critical notions
**1. Adaptivity not a selling point**
What came forward in Molenvliet and Solids is that the adaptivity is not the most important factor for (first and secondary) tenants, but instead was the location, being able to have an influence through the auction, exemption from regular housing rules are and having little alternatives.

This may have to do with unfamiliarity with re-adaptive housing. If something is unfamiliar, or little experience is known with it, it might just not be very telling and therefore appealing.
However, when the option is given for resident participation and the notion of adaptivity, residents seem satisfied with it and are even willing to pay more for it (even when they are tenants).

So adaptivity can be promoted with scenario imaging for example. Showing tenants very clearly what future options they have, with example floor plans and mock ups.
However, this is only possible when the other critical notions are possible as well. This is a 'solution' that you add to the last step. You can of course only give examples, when it is also actually possible to implement these.

**2. Resident participation**

There are two counter-arguments to the assumption that this has much to do with adaptability. For instance, resident engagement isn't always about adaptability, but rather about freedom of choice. Participation by residents could also be a selling feature for conventional dwellings. Second, only the first renters benefit from this resident participation. The following renters will have to put up with the layout, sqm, and unit composition that the original renters chose. This isn't to say that resident engagement can't help with adaptivity; it can. However, this necessitates the inclusion of extra measures.

Both first and secondary tenants need to stay involved, through out the whole process.

Design:
Consultant hours with residents, with a coached team of architects. Helping tools to help residents understand 'abstract floorplans' better can be quick 3D models, furniture maps, variety books and/or an 1:1 maquette.

Allocation:
Correct recruitment should happen a good time before however not too much before as people might change their preference over a longer time and withdraw. The auction and lease of spaces can be started after the (structure) building is (almost) completed, so that residents can see the qualities and possibilities of the building.

By giving the possibility of the auction, tenants are able to determine their own location, dimensions, rental price etc. in competition with each other.

This is only applicable for the first time renters.

After construction:
Guidance and supervision during moving in phase is also preferred. As the infill principle is relatively uncommon, an installation fair and protocol can be helping tools. The protocol needs to be given before the auction, with simple understanding wording, examples and images. Also there should be a helpdesk where the residents can call to. It should be very clearly communicated what the exact possibilities are, how these can be achieved and who they need to contact.

Second renter:
This consultant hour(s), guidance and supervision should also be given to secondary tenants.

**3. Rules and regulations**

Molenvliet, Diagoon woningen and PREVI were experimental housing projects. De Drie Hoven got subsidized by the government and Solids has exceptional regulations in terms of not needing to meet regulations with regards to the zoning plan, housing allocation, housing withdrawal and suitability criterium. Most projects came into being through extra-ordinary circumstances.
During the interview with both Frans van der Werf and Herman Hertzberger came the issue forward of being 'pushed back' by the building rules and regulations considering the zoning plan (the amount of housing units permissible, the possibility to mix it with other functions), housing allocation rules, tenant contracts (eg. a renter should leave the dwelling as they entered it – however this leaves no room for adaptivity), welstand commission (in terms of the building its exterior and thus façade choices and changes) and the building decree (minimal heights, widths etc.).

Although it has been built with the idea of changeability, according to above stated regulations, this isn't even (extensionally) allowed. As a tenant, he/she must leave the house as he/she entered it. Which is very

contradictory to the design principle, so a next occupant lives after the first occupant has been determined. As a house owner, you are still restricted by the zoning plan, welstandscommissie and/or building decree – and then not even speaking on the amount of permits that must first be obtained to do so. This makes it sometimes faster and financially easier to move housing instead of adapting the current one.

Furthermore, what can both be a barrier and enabler is monumental protection. In a way, it prevents the building from being demolished and is preserved. On the other hand, it also prevents change and adaptivity. Buildings should however be adaptable in principle, and be able to move with times.

During the interviews, it came forward that there is no technical issue but rather an organisational issue of the bureaucratic way of working.

A less bureaucratic way of building permits, and rules and regulations (or better to say, lack of) can be seen in the PREVI. Where there was no resident participation but the residents eventually took a lot of initiation to adapt their own dwelling, without consultation. This can show that the strictness and fussiness of Dutch building regulations regarding changing, adding or removing elements of existing buildings can be a big barrier.

The Building Decree is very fixed, however the zoning plans, housing allocation rules and the welstandscommissie are discussable and do have some space for alternatives.

Making recommendations for this point is less quickly applicable as this concerns a larger organisational body. Some possibilities could be
A) applicating for a 'experimental housing predicate', this could be done perhaps with the RE-component. However this can be applicated maybe the first couple of times (if possible), but this isn't something that is commonly done.
B) Making agreements with the central government, the municipality and the city district, in collaboration with the necessary lawyers and other experts, to make room for zoning plan and suitability criterium.
C) No monumental status.
D) Give tenants more room to practice adaptability. This can be achieved by more guidance and supervision of the landlord.
C) Also, in order to streamline and shorten the permit time, certain permits can be asked beforehand. For example, the possibility to 'grow' (e.g. pull outdoor space to indoor) can be permitted long before it actually happens. Once a resident wants to grow their unit, it can be a lot faster done since the permit is already there. Also, in larger complexes this can be done in one go for (lets say) all 100 units in stead of 100 times separately over different time frames.

But it should be emphasized that this is an aspect that definitely needs a larger and more comprehensive study. For now, it is good to state it and be aware of this barrier.

**4. Ownership**
The Diagoonwoningen, PREVI and Sky House are in ownership unlike the Solids (although the infill is in ownership) and Molenvliet, where the tenants pay monthly rent. This could also be the reason that they shows more of adaptiveness through the extensions and additions to the dwellings.
The Nakagin Capsule Tower is in ownership, yet doesn't show any adaptiveness. It seems that ownership leads to more adaptiveness when there are individual house dwellings that are in certain distance from each other. The issues with the Nakagin Capsule Tower were partly a technical issue, but this can be waived as currently there is enough technical knowledge on how to make such a structure were capsules can be easier taken out and a renovation plan was already proposed. Organisational issues were perhaps the real issue, especially because the capsules were in ownership. All units could be replaced at the same time, but this needed a communal 100% agreement and proved to be impossible as the unit owner's opinions were too different. This also included communal spaces.

In apartment complex this seems to be more difficult, even in ownership, because ones decision for exterior changes influences the living of the other.

For homes located somewhere on the hey, re-adaptive building will not be a problem organizationally. Also, for reasonably inner-city homes, with detached houses, this will not be a problem organizationally (apart from construction issues and the rules and regulations as stated before). When it becomes urban, it quickly becomes densely built-up housing units. Rental units are then preferred in order to prevent major friction between residents. When renting, then there is always an umbrella party that keeps things up, runs smoothly, switches gears, and guides the resident in that. Also by including in the contract that all the tenants are automatically and compulsory a member of tenants' association, it streamlines communal agreements.

This does require even more landlord involvement. Because they will be involved more often with the tenant and may have to create a separate department for this.

**5. Social interactions**

Social interaction may be a crucial, though sometimes underestimated, aspect of re-adaptive housing. More mutual understanding and closer relationships result from social engagement. This is especially essential when housing units change over time, as this might have an impact on the way people live next door. People with mutual understanding are willing to accept more from one another and/or come easier to communal agreements. At the PREVI it can also be seen that, if community serving public functions are not initially included in the project, that the residents themselves will include it. This also links with the building regulations, giving room for this.

Adding elements for social interaction can be difficult because it's not always possible to link it to a direct function and thus the financial profitability doesn't directly translate.

Adding public functions in a center square (De Drie Hoven) and the plinth (Weesperstraat) can help these social interactions while also being profitable for the public functions as they can expect a certain amount of users. These public functions however must be in interest of the residents. For instance, in the Solids, the public functions don't enhance social interaction as much since these are largely short-stay functions (hotels and such). Also 'resident-only common spaces' could be added, and this could be calculated in the service costs.

->How add common spaces in profit calculations?

**6. Overdimensioning and growth**

Overdimensioning is needed as for instance, de Drie Hoven was demolished because their lack of. Also, in the Solids in Ijburg, after adding more Solid spaces in later phases, the additional front doors and traffic spaces resulted in narrow collective spaces. Overdimensioning to some extent would therefore have been necessary. However, overdimensioning too much leads to very high initiation costs, and also some structural restrictions (e.g. no possibility of vertical connections). The question is what aspects should be overdimensioned and how much overdimensioned they should be. Also, how this can be financially justified in a market where every sqm counts?

Also the possibility of growth is nice in theory, how ever what does this mean for the urban design? There isn't much space to do so. Keep in mind that this does take away from common traffic spaces, gardens, outdoor spaces etc. This also includes all kinds of agreements about positioning and it is certainly not the case that everything has to be extensible. This has consequences for the neighbours, but also for the cohesion of the building. Welstandcomissie and the  Zoningplan has restrictions.

Structurally and spatially overdimensioning

It is not needed to overdimension for the largest function, just keeping the housing function is fine (also keeping the option to vertically merge), with exception for the plinth. Overdimensioning in height only by 200 mm, the change that could be excepted as the Building Decree 2004 had a minimal height of 2.4m, and 2006 2.6m. The jump of 200mm would lead to a new height of 2.8m. Overdimensioning in traffic spaces seems important, so these have to be extra wide. The wide traffic space can be combined with communal spaces.

Perhaps it could be possible to make certain structural additional investments 'for the half', or only partly, and do the rest when it is actually needed? ← is this possible?

Growth
Adding (growing) the unit to the outersides of the unit (so not merging units together, but adding on) should be possible by a certain pre-agreed marge. In an apartment complex, this could mean, giving the possibility for people to turn (parts of) their outdoor space/balcony into extra indoor spaces. By using the floor of your own balcony, and the 'roof' of the balcony floor of the level above you, this can be done. This is similar to the Diagoon woningen. The balcony floors need to be extra structural strong for this. The surplus in space in this case is the outdoor space. Residents have to make sacrifices, not everything is possible. By having a communal outdoor space as well, residents at least will always have somewhat of an outdoor space. The possibilities for growth (and shrink) is further related to the points as discussed under Rules and Regulations (mainly welcoming committee and zoning plan).

**7. Adaptivity possibilities**
Also, although the infill process and result is satisfactionary for the tenant, they do preferred a less bare casco with certain facilities (eg wet room) already being realized by Stadswonen. Also the question is what the right balance is between fixed and flexible, restrictions and possibilities and tenant and landlord.

**Rules within freedom**
First of all, it's important to keep a certain framework of rules and standardization, in which there is freedom provided.
-Total freedom is not possible because of the mutual coordination (between façade layout and/or colours, interior layout, wet spaces, shafts etc.) but also because of not hindering the neighbours living next door.
-Organisational aspect of second time renters, can be replied.
-Technical aspect – The structure-infill principle only works if the fillable should be easy to change. It is important that there is a modular coordination, so that dimensions match. That the infill fits in the carrier, the structure.
-Execution during construction phase. The built-in elements have not only to be produced, delivered but also installed. Having many elements that are very similar but slightly different, can easily be overlooked.

**Standardization:**
*-Use of modules and grid coordination*
Using the grid, the whole project, is also expandable by multiplying the units as the grid can easily be replicated. The monotone structure and its grid is the principle that makes it possible to expand:

*A . Fixed (beta zone):*
By creating a betazone, it is clear what parts of the floor plan are less adaptive and what parts are more adaptive. The betazone is middle part, in which most of the floor (stair and plumbing ) shafts can be located. With regards to the stairs, a prefab system can be made in which the stairs can be shafted within the betazone. This is a bit fixed as it already determines more or less the space for wet rooms, however it's not very likely anyway that someone wants their toilet by the window.

B. *Free* zone (alfa zone?)
Everything between the structure and seperate from the beta zone. This is all freely divisable.

*C. Marge (delta zone):*
A certain zone that is taken into account before designing the structure which includes permissible future expansions, gives the possibility to later expand the dwelling. Standardized agreements on the maximum amount (m2) and direction (up, under, next) should be clearly made.

**8. The RE part**
It's difficult to obtain a good recommendation with regards to the RE part of re-adaptivity since there is barely any practiced adaptivity to begin with, let alone re-adaptivity. The only re-adaptivity that can be seen is in the Sky House when moving nets are placed and removed.

It's good to take a step back and first figure out the enablers and barriers of adaptivity, and how this can be put into practice. Re-adaptivity is a successor of adaptivity and thus adaptivity first needs to be possible.

**9. Installation**
The fixed shafts and collapsed in structure pipe ducts came strongly forward as barriers.

Pipes can be less in sight by using floor heating in stead of radiators (for heating). With a focus on gasless housing, only the water/electricity/ventilation pipes need a solution.
Water pipes can be more or less fixed as there most likely will be placed in the beta zone.
Electricity and ventilation pipes..? I don't know..

Furthermore, the pipe duct shafts and fuse box need to be separated from each other so that the fuse box is able to be placed in all rooms (except wet cells). Preferably the shafts are placed either outside the living units or in the beta zone.

OVERVIEW

| Cases tudy | Molenvliet | Solids | Diagoon | De Drie Hoven | PREVI | Nakagin Capsule Tower | Sky House |
|---|---|---|---|---|---|---|---|
| | Experimental housing | Exceptional regulations | Experimental housing | Subsidized | Experimental housing | - | - |
| Adaptivity princple | Resident participation (floor plans)<br><br>Structure-infill | Resident participation (auction)<br><br>Structure-infill | No resident participation<br><br>Polyvalence | No resident participation<br><br>single continuous structural framework based on the same modular unit to suit the requirements of the very varied and complex program | No resident participation but high resident initiation<br><br>The structure is a platform for expansion and progressive adaptation to the family's needs throughout time, | Capsules, to be replaced every 25 years. | Resident participation (architect's own house)<br><br>Structure-infill<br><br>Adapting over time |
| Signs of growth or adaption | No | No | Yes | No | Yes | No | Yes |
| Ownership | Rent | Rent / owner (infill) | Owner | Rent | Owner | Owner | Owner |

**What form of re-adaptivity ?**

The case study shows different types of adaptivity.

**Molenvliet and Solids**
The structure-infill principle as can be seen in both Molenvliet and Solids with Molenvliet also having resident participation with regards to designing the floor plan. Solids have a resident participation with regards to the auction (deciding their own sqm, place, composition etc.) and their ownership of the infill components.
- The Molenvliet is basically frozen in time and nothing has changed ever since it was construced. So it's nice that it's designed and constructed with the thought of adaptivity, however what use is it if it doesn't function as one. With regards to the Solids, good evaluation needs more time. However, growth of places is not implemented in the project.

**Diagoon woningen**
De Diagoonwoningen has no resident participation but rather a notion of polyvalence of the fixed staggered floors making changes in the spatial lay out a lot more difficult and fixed, but providing a change of *using* the spaces.
- The staggered floors with the vide might be *too* fixed, rooms can't be pulled together for instance. It does however show growth: pulled outdoor spaces to the inside.

**PREVI**
PREVI has no resident participation, and/or structure-infill elements but as the design was anticipated on open-end and growth. PREVI shows the most amount of resident initiation.
- This largely might be due to the less strict rules and regulations concerning adapting a dwelling. Also the structural integrity has been close call.

**Nakagin Capsule Tower**
The Nakagin Capsule Tower shows adaptivity more through interchangeability, of replacing all the capsules after 25 years.
- Question of where the residents stay while their unit is being replaced is in this specific case not a big issue as these were initially all second housing units. However, if this would be applicated to normal housing, then all temporary housing all the residents might be an extra barrier. Also the structure should allow for bigger or smaller capsules being placed and/or to merge capsules together.

**Sky House**
The Sky house, perhaps the most adaptive one, includes a structure-infill principle with moving-nets and thus showing re-adaptivity.
-Resident participation was there however this was the architect's own dwelling. Also with regards to the moving-nets, this might also be possible due different rules and regulations regarding dwelling adaptation between Japan and the Netherlands. Also, the Sky House was a detached house.

### Combining
It could be that making a combination of the stated above principles would create a coherent adaptive principle: A structure-infill unit with polyvalence elements, the ability to add/remove 'moving-nets' in the form of capsules and with resident participation in terms of spatial lay-out and auction.

## 10.3 Critical panel e-mail

Hi allen!

Wat fijn dat jullie allemaal mee willen doen aan de critical panel voor mijn afstuderen.

Kort uitleg over mijn onderzoek(sopzet) zit in de bijlage. Het is handig om dit even snel door te bladeren. De TEAMS uitnodiging is verzonden.

**Wat we gaan doen**
Tijdens het onderzoek zijn er een aantal kritische noties uitgekomen, die een barrière kunnen vormen voor het verwezenlijken van (re-)adaptief woningbouwen.
Deze notities, met daarbij aanhangende recommandaties, gaan wij bespreken.

**Mijn rol**
Voornamelijk naar jullie luisteren en het gesprek leiden. Ik zal geen (tot weinig) inhoudelijke toevoegingen hebben.

**Jullie rol**
Jullie mening (en het liefst zoveel kritiek 😊) op mijn conclusies/recommandaties. Het is erg handig als jullie vooraf het document 'critical panel stukken' doornemen en er alvast een beetje over

nadenken.
Het zou erg fijn zijn als jullie hier bijvoorbeeld ook comments aanhangen in het document en later opsturen.

**Planning**
Aangezien we slechts een uur hebben, zullen we aan elk punt 5 minuten besteden. De overige 15 minuten zijn voor de voorstellingsronde, de 1e* vraag en afsluiting.
*De 1e vraag is een open vraag: ''Wat zijn volgens jou de grootste stimulator en barriere voor re-adaptief bouwen?''. Neem deze vraag zo vrij mogelijk op.

**Hoe we te werk gaan**
Kan iedereen vooraf op drie papiertjes duidelijk schrijven E, O, N. E=eens. O=oneens. N=neutraal.
1) De noties en recommandaties worden benoemd.
2) Iedereen laat op de webcam zijn papiertje zien (of ze het dus eens, oneens, of neutraal zijn). Gelieve neutraal zo min mogelijk te gebruiken, ookal heeft het niet direct met jouw eigen expertise te maken.
3) Ik benoem of hij/zij het e.e.a. wilt toelichten en of er eventueel iemand anders daar (extra) commentaar op heeft.

Het is bijvoorbeeld goed als de volgende personen voornamelijk kijken naar de volgende punten:
Arjen [1] [3] [4] [5]
Linda [2] [4]
Richard [3] [6] [7]
Arnold [5] [6] [7]
Joop [6] [9]
Pieter [6] [7]
Frank [1] [2] [3] [4]

Het is zo best schools en niet zo interactief, maar helaas kan het even niet anders i.v.m. de tijd en het aantal punten.

**Verder;**

Tijdens het gesprek zal ik jullie vragen of ik toestemming heb om het TEAMS gesprek op te nemen voor nadere transcripties. Ook vraag ik jullie of ik jullie mag benoemen in de scriptie. Helemaal prima als er partijen zijn die dit liever niet hebben.

Tot woensdag!

Met vriendelijke groet,

**Shajwan Jabar**

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# 11. Critical panel transcription

SJ: Ik begin wel gewoon met het uitleggen van het onderzoek voor het geval dat jullie het nog niet helemaal hebben doorgelezen. Ik doe in het kort mijn onderzoek over het re-adaptief bouwen. En dan voornamelijk kijken naar het organisatorische en het management deel. De ontwikkeling daarvan, wat er een beetje goed en verkeerd gaat. Dus niet perse het architectuur gedeelte en de technische aspecten daarvan. Dan hebben we een aantal definities die ik heel kort ga toelichten zodat we een beter beeld hebben van waar we het over hebben. Dan ben ik begonnen met drie theorieën: Metabolisme, Structuralisme en Open Bouwen. Daarin zitten allemaal principes van veranderingen en het anticiperen van toekomstige veranderingen. Daar zitten dus allemaal verschillende soorten vormen tussen. Blijkbaar is er wel een definitie van adaptief bouwen, maar in de literatuur en de stukken die ik heb gelezen is re-adaptief nog geen definitie. Daarbij heb ik een voorstelling van een definitie, dat het gedefinieerd kan worden als een combinatie van de theorieën die ik eerder heb onderzocht. Zoals de uitwisselbaarheid, uitbaarbaar, veranderbaarheid, structure-ifnill principe dat je een structuur hebt, met alles daarbinnen met een infill dat continu kan veranderen. En die elementen samen zouden dan de ruimte geven om in de loop van de tijd de woningen te kunnen aanpassen aan de hand van de behoeftes van de bewoners en daarmee een betere levensduurloop durig zijn. Dat was in het kort het onderzoek. Dan begin ik met een open vraag, en die mag je zo breed nemen als je wilt. Wat is voor jullie echt de grootste enablers en barriers, dus wat bevordert het en wat houdt het tegen, met het re-adaptief bouwen? Dan begin ik bij Joop. Joop, wil jij het kort hebben over wat het eerst bij jou in het opkomt?

JH: Gaat het over woningen of bouw algemeen?

SJ: Echt specifiek woning bouw.

AJ: Installaties denk ik, voor Joop.

JH: Dat mag ook. Wat ik een beetje mis in die stukken, ik zie over dimensionering en groei. Alleen het stuk flexibiliteit en ombouwen naar andere gebruiksmogelijkheden mis ik. Want vandaag de dag, wordt dat ook meer noodzakelijk. Want je ontwerpt iets, en dat kan best wezen dat dat over 15 of 20 jaar een andere gebruiksfunctie krijgt.  Dan neem ik het voorbeeld van scholen, er worden op het moment heel veel scholen gebouwd. Er worden in scholen  al veel voorzieningen getroffen om later kantoren of woningen te maken. Of het overdimensionering is, of flexibilieit, dat laat ik in het midden.

SJ: Wat is voor jou bijvoorbeeld iets dat het re-adaptief bouwen moeilijk maakt?
JH: Dat is juist een uitdaging.

SJ: Ja, dat wel. Maar we moeten wel opzoek gaan naar iets, waar we goed op moeten letten.

JH: Wat daarbij belangrijk is, voor mij dan he ,technisch. De schachten, bij voorkeur boven elkaar. Dat klinkt heel vreemd, maar het komt heel vaak voor dat ze niet boven elkaar zitten. Dat geld ook voor meterkasten. In gestapelde woningen, moeten die ook boven elkaar zitten. Anders komt het nutsbedrijf er gewoon niet binnen. Dat is een eerste vereiste. Een aandachtspunt is met name de ventilatie, wat een plicht aan het worden is. Wat nog wel eens vergeten wordt. De alternatieve

energie-opwekking. Daar mag je verstaan onder wat je wilt. Daar zijn de geleerde in Nederland er ook niet over eens. Maar er moet in ieder geval gas in.
SJ: Ja, dat in ieder geval inderdaad. Dan gaan we door naar Arjen. Aan wat voor punten denk jij aan?

AJ: De meeste woningbouw projecten die ik gezien heb, zijn vaak extreem scherp aan de wind. Om een project haalbaar te krijgen, ga je ongelofelijk optimaliseren op bruto vloeroppervlak vs netto vloeroppervlak, de bouwhoogte terug brengen tot precies bouwbesluit. Dat maakt wat je niet doet wat Joop zegt, dat je heel weinig flexibiliteit creëert. Omdat je gewoon overal, je moet overal aan het scherpste wind paren om een project haalbaar te krijgen. Dat komt door de hele sterke eisen die er zijn he, van klimaat adaptief bouwen en gas loos bouwen. De eisen worden extreem opgestapeld over waar een project aan moet voldoen. En re-adaptief bouwen zit niet in dat eisen pakket. Dus is dat het eerste wat je eruit snijd, om een project nog haalbaar te krijgen. Het mooiste zou zijn dat je een woning bouwt, en je maakt hem niet exact bouwbesluit hoogte maar 50 cm hoger. Want dan kan je er later een kantoor of iets anders van maken. Hetzelfde geldt als je een woning in de toekomst groter zou willen maken, bijvoorbeeld nu maken we kleine hokjes met wanden van bekisting. Dat is niet handig als je later die woningen zou willen door breken. Maar goed, als je het niet doet, zouden die woningen niet haalbaar zijn.

SJ: Want Frank, hoe denk jij daar over?

FB: Ik ben er helemaal niet mee eens. Ik heb zelf Solids gebouwd, met een enorme overwaarde. Die is toen verhuurd met precenten rendenement hoger en opleverde dan aan de voorkant gecalculeerd. Dus de beperkingen die mensen voelen, dat vind ik zonde. Dat je je daardoor laat lijden. Dat is ook korte termijn denken. Adaptiviteit gaat over de lange termijn, dus niet over 5 jaar maar over 25 tot 50 jaar. Ik was dus verhuurde van ruimte, ik heb een Solid gebouwd.En die kon niet alleen woningen bevatten maar ook allerlei andere dingen, dus in het bestemmingsplan stond dat alles mocht eigenlijk behalve bordelen en coffeeshops. nou, dus daar hebben we opgerekend, dat daar op langere termijn renderend. als je niet op lange termijn kan denken, omdat je op korte termijn moet denken, omdat je teveel kwijt moet nu vandaag tegen een bepaalde marktprijs. Ja dat houd adaptiviteit op een enorme manier tegen.

SJ: Hoe kijk daar tegen aan Linda?

LD: Ik denk dat dat heel erg zit in de verschillende belangen die de verschillende partijen hebben. Want ik kan Frank hierin heel goed volgen, want als je ontwikkelaar bent, dan zit je daar alleen voor je project. om je trucje te doen en dan ben je weg. En dat is hetzelfde als met de meeste adviseurs die aan tafel zitten. Joop is weg, Arnold is weg, Pieter is weg. Dus waar zit de incentive in voor ons om dat dan te doen?

AJ: Maar Linda, wij verkopen projecten aan pensioenfondsen. Die er voor de super lange termijn in zouden moeten zitten. Maar die dat absoluut niet doen. Althans, ik zou heel graag willen dat die zich opstellen zoals Frank dat doet. Maar die hebben een heel strict P.v.E waar je aan moet voldoen en die kijken helemaal niet naar de lange termijn van kan ik over 20 jaar van deze hokken van 50 meter nog weer een woning van 100 meter maken, of kan ik er iets anders mee.

FB: Dat is natuurlijk een van de problemen. Dat korte termijn denken van het hele vastgoed wereld, kijk die pensioenfondsen die zitten als volgt in elkaar. Die hebben geldschieters, dat zijn aandeel houders. En die aandeelhouders zijn leden van het vakbond. En die hebben geleerd van een of andere makelaar dat er drie soorten vastgoed bestaan. Namelijk, retail, kantoren en woningen. Ik zeg maar even wat. Dus die zeggen, nou dat gaan we dan even maken. Gaan we retail, kantoren of woningen maken? Zo denken die mensen. Die denken helemaal niet aanpasbaarheid en aanpassingsvermogen. Totaal niet. Dus een zekere opvoed probleem wat wij hebben met z'n alle, om

die vastgoed wereld anders  te laten denken. Kijk als je logisch denkt, is op lange termijn, zoals ik probeer. Dan heb ik gelijk. Dan heb ik gewoon gelijk. En ik kan je vertellen, ik zit nog steeds in die wereld. Ik heb pensioenfondsen altijd weten te overtuigen van dit gelijk. Ik weet niet of je van het woord impact weleens hebt gehoord? Dat gaat over investeren in niet alleen korte termijn waarde zoals direct rendement en indirect rendement, maar over lange termijn. Maar op langere termijn. Dat heeft met veranderlijke mentaliteit in de wereld. Je moet er wel iets voor doen. Maar ja, als je zegt, ik kan niks doen want mijn klant die is de baas hier en ik die zegt wat hij wilt. Ja, dan komen we nergens. Dat snap ik ook. Die vastgoed  wereld is zo conservatief als wat. Dat snap ik hoor, dat begrijp ik helemaal.

AJ: Frank. Als we een appartement complex nemen, want dat is vaak he als je het hebt over re-adaptief bouwen voor woningen. Hoeveel procent meer moet je uitgeven aan een gebouw om dat zodanig aanpasbaar te maken dat je later vrij gemakkelijk woningen kunt samenvoegen, splitsen..

FB: Ik denk zoiets, 15 a 20 procent. He, maar dat rendement is 30% hoger snap je. Op lange termijn. Bij Solid, kijk. Shajwan zegt ja wacht even jongens adaptiviteit is helemaal niet belangrijk want de markt is zo sterk. Niemand vraagt er om en iedereen, als tie maar wat heeft is tie al blij. Dan denk ik, ja dat klopt. 2022 is dat zo. Ik heb ook tijden meegemaakt dat dat andersom was. Dat er zelfs in Amsterdam leegstand was. Dus het is niet zo dat een markt heel stabiel is. Er kan nog van alles en nog wat gebeuren. Solids, die kan zich aanpassen. Stel, dan kan het kantoren worden, dan kan het een kroeg worden. Dan kan het van alles worden. Nou, dus voor een belegger is dat super interessant. Die heeft nooit van zijn leven leegstand, die kan het gebouw altijd opnieuw gebruiken, telkens wat anders maar voor wat het beste rendement geeft op dat moment. Dus als je op lange termijn niet kunt denken omdat je dat niet gewend bent, ja dan komt er niks terecht van ook.

JH: Frank, mag ik daar even iets aanvullen. Ik maak allerlei ontwikkelingen mee, bijvoorbeeld scholen die omgebouwd moeten kunnen worden naar woningen. En dan wordt er in het ontwerp rekening meegehouden dat een bepaalde stramienmaat in zit, zodat er later woningen in gemaakt kunnen worden. Ik maak op dit moment ook mee dat de utiliet wordt gerealiseerd, gerealiseerd dat er misschien over 20 jaar woningen in moeten. Zo maak ik het wel mee, maar vanuit woningen naar een andere functie is heel lastig. Dat heeft ook met de verdiepingshoogte van de woning te maken. Dat past gewoon bijna niks anders is. Ik maak wel mee van utiliteit of andere vormen naar woningen toe, en het ook voorbereiden zodat het ook nog eens tweede of derde leven kan krijgen. Maar woningen naar een kantoor of school of iets dergelijks, ja dat maak je niet mee. Omdat de woningen gewoon een beperkte hoogte heeft.

AR: Joop, ik denk dat je daar wel een punt hebt. Ik denk dat de ontwikkelaars die woningen bouwen, die willen ook geen kantoren. Dus die bouwen ook alleen voor woningen. Wat wij ook zien, want ik herken het verhaal van Arjen en Linda, wij hebben echt P.v.E's die zo strak zijn qua kosten enzovoorts, daar heb je geen mogelijkheden. Wat we wel zien, we hebben laatst gedaan, is dat je bijvoorbeeld appartementen aan elkaar kunt verbinden. Bijvoorbeeld dat twee kleinere units later een grotere unit kan worden. En dan maken wij wel bijvoorbeeld mogelijkheden dat je achteraf heel makkelijk sparingen kan maken. Dus de moeilijkheid en beperking om het later aan te passen, is dan voornamelijk constructie. Dus dat je voldoende hebt om een optopping te maken of dat je voldoende constructie hebt om zonder constructieve veranderingen bijvoorbeeld een wand kunt maken zodat je vaker kunt koppelen.

FB: Ik zou zeggen, ik zou helemaal geen wanden maken. Ik zou alleen maar kolommen maken. Schietbouw is anti-adaptiviteit. Dat is gewoon het tegenovergesteld van aanpasbaar bouwen. Dat is beperkend. Joop die zegt, corporaties willen niks anders dan woningen bouwen, die weten niet beter. Ik heb ooit eens onderzoek gedaan naar waar wordt nou de hoogste waarde betaald voor woningen? Nou, je kunt op je klompen natellen het was, we hebben allerlei verbanden ontdenkt, het

meest in het oog lopende verbanden is dat multifunctionaliteit -gemengde gebieden-, veel hogere waarde hebben dan ongemengde gebieden. Dus de westelijke tuinsteden, slotermeer, daar werd heel veel minder betaald voor precies dezelfde woning met dezelfde huur als een woning in Amsterdam zuid of in het centrum. Nou, als je dan kijkt wat is daar nou anders. Dan is dat vooral functiemening. Dus dan is het ook voor een coorporatie van belang, dat die gebouwen neer zet die ook een andere functie kunnen gaan krijgen want kennelijk is dat bevoordelijk voor de kwaliteit en de prijs. Dat is kortzichtig, een corporatie kan zeggen dat de minister het niet toestaat. Die zitten dan met een staart tussen hun benen, dat snap ik ook wel. Maar zo moet je niet denken natuurlijk als je op lange termijn investeert in vastgoed, 50-100 jaar.

SJ: Ik denk dat we een goeie discussie zijn begonnen en dat iedereen een beetje heeft gezien waar iedereen zit. Laten we vanwege de tijd snel naar de kritische notities gaan, waarbij de eerste wel heel goed aansluit bij wat je eigenlijk net benoemd. Wat dus of dat adaptiviteit wel of geen verkoopargument is. Want het blijkt dus, over het algemeen wanneer mensen de kans krijgen zijn ze er wel blij mee en tevreden mee, en willen zij er best meer voor betalen. Ook al zijn het huurwoningen. Maar, dat in eerste instantie niet op adapvitieit af gaan maar eerder op de huur of inderdaad de functiemenging zoals je net benoemd. Denken jullie dat dit ligt aan het feit dat mensen niet beter weten, en het niet zoveel zeggend is. Of omdat  mensen er gewoon oprecht geen behoefte aan hebben?

FB: Die behoefte bestaat pas in de loop van der tijd. Dat is het probleem. Aanpassingsvermogen wordt pas intereassant na verloop van tijd. Als je gezinssamenstelling veranderd, hey dan kunnen we die woning aanpassen. Maar dat is nog niet op het moment dat je die woning koopt of huurt. Dus het is vooral vind ik, at de verhuurder moet bedenken. Het is zijn belang. Ik wil er van uit gaan dat de verhuurder er tientallen jaren verbonden blijft.

PS: Ik zeg, aan de ene kant koop je een huis op locatie. Waar wil je wonen? Ik heb toevallig een huis wat wel bepaalde kenmerken heeft om uit te breiden. Ik heb de optie om op te toppen en ik heb een optie om ook uit te breiden verticaal. En dat waren inderdaad, uiteindelijk wel punten die mij dat huis deden kopen maar dat was niet het primaire argument om het huis te kopen. Want ik was al blij dat ik een huis kon kopen in deze markt. Ik ben er achteraf wel blij mee, ook al staan de prijzen momenteel zo gigantiscsh hoog dat ik het toch niet kan betalen. Maar goed, dat is een ander probleem.

AR: Ja, je merkt wel bij de ontwikkelaars van gewone woningbouw -dus geen appartementen maar grondgebonden-, dat ze graag wel opties willen bieden zoals een dakkapelletje of een aanbouwtje. Dus daar gebeurd het wel. Met appartementen eigenlijk niet.

JH: Dan wordt het ook lastig, appartementen.

AR: Ja, maar dan zou je wel kunnen denken over wat ik net vertelde. Van dat je kunt samenvoegen, dat soort zaken. Maar die vraag krijgen we niet zo vaak. Bij gewone woningbouw op vaste grond komt dat vaker voor.

SJ: En dan Arnold, nu je toch aan het woord bent kunnen we denk ik heel goed naar het tweede punt gaan. Het tweede punt is eigenlijk over inspraak van de bewoners. Dat kan gedaan worden aan de hand van dat je echt samen plattegronden gaat maken met bewoners aan de hand van een architectsteam dat daarop gecoacht is om zo die directe inspraak te geven. Maar dat kan dus ook door middel van een veiling, wat Frank bijvoorbeeld heeft gedaan met de Solids. Wat trouwens misschien goed om te horen voor Arjen, is dat de veiling ook heeft geresulteerd in hogere huurprijzen omdat mensen zo de kans kregen om met elkaar te concurreren. Het bleek ook dat sommige sociale huurwoningen zelfs meer huur opbrengsten leverden dan vrije huur sector

woningen. Want Arnold, hoe kijk jij hier tegen aan? Denk jij dat dit iets is wat toepasbaar zou kunnen zijn?

AR: Ik denk het wel, maar ik denk dat grotere coorporaties of investeerders dit niet echt doen of willen. Dat zal waarschijnlijk vanwege de prijs en kosten zijn. Omdat die al onder druk staan. Dat is wat ik merk. Ik denk dat het gewoon lastig is. Misschien kan Arjen of Linda daar wat meer over zeggen.

SJ: Arjen, kan jij daar wat over kwijt?

AS: Ik heb er geen ervaring mee moet ik bekennen maar ik denk zelf dat die re-adaptiviteit meer zit in over langere periodes zaken wijzigen dan dat je nou zegt ik maak een gebouw, en ohja ik doe even de appartement van de buurman erbij want ik ben mijn gezinssamenstelling aan het weizigen. Ik denk dat meer zit in trends die over de tijd veranderen. Dat je bijvoorbeeld van groot naar klein, of van klein weer naar groot gaat. Dat het meer zit in de eigenaar zelf die een keuze maakt om een bepaalde indeling om van het woongebouw te maken en die na verloop van tijd weer besluit om die indeling weer aan te passen omdat hij ziet dat de marktvraag veranderd.

SJ: Dan gaan we door naar het derde punt, want denk ik wel een hele interessante is. Die gaat over de regels en voorschriften. Tijdens interviews met een aantal architecten kwam continu eigenlijk wel heel duidelijk naar voren, dat over het algemeen gezien de regel en wetgeving wel de grootste barriere is. Dus welstandscomissie, bouwbesluit, de bestemmingsplan.. En dat vaak de projecten die wel zijn uitgevoerd met adaptief en re-adaptief, hele uitzonderlijke projecten waren. Die waren of predikaat experimentiele woningbouw of die hadden zoals bij Solids een bijzondere uitzondering op veel regels. Dus het zou niet iets zijn wat heel gemakkelijk continu zou kunnen gebeuren. Hoe denk jij daar over Frank?

FB: Je hebt daar gelijk in. Waar je steeds tegen aan loopt is het conservatisme van die hele bouwwereld en die hele regelgeving daar om heen. En het korte termijn denken. Ik hoor net Arnold iets van zei, die het had over stichtingskosten. Kijk, als je investeerder bent van woningen moet je niet denken in termen van stichtingskosten maar in termen van rendement. Het verband tussen de lange termijn inkomsten en uitgaven die je nu doet. Dus zolang de stichtingskosten en korte termijn denken, denken we in regelgeving met iemand bovenin die wat heeft bedacht. Dan kom je nergens. Omdat dus de momentale vraag naar adaptiviteit zeer gevakt is, die ontstaat pas in de loop van de tijd. Dat is geen mechanisme dat zorgt dat er een doorbraak komt, dan moet je zorgen dat de belegger of de coorporatie hebben die er heel anders over denkt. Zoals ik dat was destijds. Ik ben gewoon naar de gemeente gestapt met, ik heb een totaal anders iets. Een radicaal experiment. We gaan het allemaal anders doen. Dat vonden ze leuk. Dat alles anders was. Niet een klein stukje, artikel die en die. Nee, alles anders. Dan krijg je iemand wel mee als je dat doet. En ook de voordelen daarvan bekend maakt. Dat is vrij goed gelukt destijds.

AR: Frank, ik merk ook dat een aannemer vaak best wel veel te zeggen heeft in de bouwkosten en hoe je het dus uitvoert. Bijvoorbeeld bij een project, zijn we 1 cm extra ruimte voor boven de 2.6m eis, okal wil je het anders. Het wordt gewoon opgelegd aan ons, op basis van stichtingskosten.

FB: Dat is dat korte termijn weer.

AJ: Alles begint bij de opdrachtgever. Dat moet bij zo'n process een partij zijn die niet alleen opdrachtgever is maar die ook langer termijn aandeelhouder wordt van een project. Anders krijg je dat nooit rond.

FB: Helemaal juist. Het begint helemaal niet bij de architect. En het is ook helemaal niet moeilijk om te maken. Maar je moet een opdracht gever hebben die er voor voelt. Dat is helemaal waar. Dus het onderzoek, Shajwan, moet je richten op opdrachtgevers en niet op architecten.

SJ: Het onderzoek is ook niet gericht op architecten. Het is begonnen vanuit de theorie inderdaad, wat is er mogelijk en wat kan er. En blijkbaar, is dat ook helemaal niet het probleem. Het is ook helemaal geen technisch probleem. Het is meer gewoon een mensen probleem, om het zo kort te zeggen. Maar wat je nu net benoemt, met een aandeelhouder voor een langere termijn - houd dat dan ook meteen in huurwoningen dat daar de voorkeur naar uit gaat dan koopwoningen? Want als je het koopt, dan verkoop je het. Dan heb je de winst behaald en ben je weer uit het proces. En als je het verhuurt, blijf je als initiatiefnemer langer in het proces en heb je er op langere termijn meer baat bij. Klopt dat?

AJ: Ja, tenminste ik zie niet in waarom een invidiuele koper van een woning in een appartementgebouw dat toevallig met kolommen is gebouwd i.p.v. gestorte wanden, omdat je dan in de toekomst je appartement kan samenvoegen met de buren. Ik zie niet in, dat iemand daar, die 20 of 30% bouwkosten voor gaat betalen. Dan is de enige andere variabele, is dat de grondprijs veel lager is omdat de gemeente of diegene die de grond verkoopt bereid is om die investering op zich te nemen. Maar ik moet eerst nog de gemeente ontdekken die bereid is dat te doen.

SJ: Nee, duidelijk. Ik denk dat iedereen daar ook wel grotendeels mee eens is. Als we naar punt 5 gaan, met de sociale interactie. Als je dus inderdaad dus huurders hebt, en die met elkaar samen wonen in een complex, en zodra er een verandering in het gebouw komt -kan zowel een gevel zijn, als indeling, of een gang dat toch smaller wordt- iedereen heeft daar natuurljk een mening over. Wat je daar mee wel een beetje mee kan doen, is zorgen dat mensen beter met elkaar zijn. Dat er meer sociale interactie is, want dan zijn mensen over het algemeen ook eerder geneigd om te accepteren dat iemand bijvoorbeeld een kleine uitbouw heeft waardoor jouw achtertuin of jouw terras iets minder zon heeft. Of dat kwam in ieder geval tijdens de literatuur review, case studies en interviews heel erg naar voren. Dat blijkbaar sociale interacties en common spaces heel erg belangrijk zijn. Alleen daar heb je wel weer de keerzijde dat je daar niet een directe functie aan kan hangen en dus ook niet direct kan mee berekenen in de winst. Arjen misschien?

AJ: Ik zie bijvoorbeeld bij Amvest die rekenen, die maken hele kleine hokjes. Dan maken ze daar op de begane grond en eerste verdieping hele grote gezamelijke ruimtes bij. En dat vertaald zich wel in opbrengsten uiteindelijk want iemand is meer bereid meer huur te betalen voor een kleiner hokje als hij daarnaast een soort gezamelijke huiskamer heeft dan als hij alleen dat kleine hokje heeft. Dus als je uiteindelijk zo'n gebouw, als blijkt dat 30-40m2 niet meer genoeg is en je wilt daar die hokken gaan samenvoegen en de gezamelijke ruimte opofferen en daar gewoon woningen van maken, dan kan dat op zo'n manier. Maar als je kijkt hoe zij rekenen, dan kan je dat doen over 30 of 40 jaar. Maar niet na 10 jaar.

FB: Mag ik daar ook een opmerking over maken? Als je dus kijkt naar de manier waarop mensen komen tot waardering van hun woning, dan gaat het over twee onderwerpen. Ik heb heel veel huurders gesproken. Twee onderwerpen. Het ene is de woning zelf, en de andere is de woonomgeving. Dus de context. Daar waar binnen de woning is neer gezet. En als je daar op kijkt, door goede algemeen bruikbare ruimte rondom die woning maakt, de context verbeterd. Dan wordt de woning zelf meer waard. Dat is heel logisch. Dus als ik een woning verkoop in Geuzeveld in een minder gewenste context dan in een woning in Amsterdam centrum, die in hoge dichtheid is gebouwd maar de omgeving is zo aantrekkelijk. Dus het principe van omgevings beinvloeding is ook natuurlijk weer op langer termijn een belangrijker principe.

AJ: Ja, waarbij dan wel weer geld dat zolang de 40/40/20 regel wordt gehanteerd, dat principe bijna niet omgaat omdat je dan alleen met de woning zelf al aan de maximale huur zit en je dus nooit extra waardering gaat krijgen voor al het andere wat je doet. Dat kan je dan alleen uit die 20% vrije sector woningen halen.

FB: Daar heb je gelijk in. Dat moet dan inderdaad komen op de verkoopprijzen van de koopwoningen, de vrije markt. Maar in middeldure huur, kun je spelen hoor. Kun je ook een beetje met de huur, er is flexibilieit laat ik het zo zeggen.

JH: We hebben ook andere mogelijkheden he. Ik ben op dit moment bezig met een werk bezig in Den Haag. Daar gaan we drie kantoren ombouwen naar iets van 350 woningen. De begane grond en de 1e verdieping zijn algemene ruimtes. In een van die ruimtes komt een fitness, de andere ruimte krijgt een bijeenkomst ruimte waar mensen een borreltje kunnen bedenken en wat kunnen eten. Maar die worden apart ge-exporteerd. En dan worden de kosten niet toeverdeeld aan de woningen, maar gewoon eigen exportatie. Dan werkt het ook.

SJ: Ja. Want, wat wilde jij zeggen Pieter?

PS: Ja, wat je dus omschrijft, inderdaad kleine ruimtes. En dan een gezamelijke ruimte, dat doet mij denken aan mijn tijd dat ik studeerde. Dan heb je een kamertje. Ik kan me voorstellen dat als je ouder wordt, dat je dan zegt joh ik ga dat gezamelijke toe-eigenen. Dan is die buitenruimte of gezamelijke ruimtes zeker wel efficient om te benutten.

LD: Je hebt natuurlijk ook, in Rotterdam, staan er een aantal gebouwen waar je dan een soort van derde kamer hebt die je dan als je logees hebt, die kan je dan gewoon afhuren. Die wordt dan wel bekostigt om de manier waarop Joop aangeeft. Dus daar zijn in wel mogelijkheden.

SJ: Oke, want Pieter. Want dan kunnen we gelijk door naar punt 6 wat erg gaat over overdimensionering en groei wat voor het structurele ook wel erg belangrijk is. Want je dus overdimensioneren zoals bij Solids erg is gedaan. Dus vooraf alles eigenlijk te groot maken. Te hoog, in principe gewoon te ruim en te sterk zodat het later nog van allerlei functies ruimte kan bieden. Maar daarvoor heb je natuurlijk wel in de vooraf fase, van die hoge initieringskosten. Zit daar ergens iets tussenin met constructie? Zou je bijvoorbeeld iets voor de helft kunnen doen?

PS: Je kan in zekere maten vooraf wat doen in de constructie. Je kan rekenen op 6 bouwlagen en uitvoeren op 3 bouwlagen. Dan heb je de optie om het op te toppen met drie bouwlagen. Dat zijn vaak wel dure kosten, maar die zijn uiteindelijk wel altijd goedkoper dan het achteraf te doen. Want als dan de fundering dan versterken moet, is het vaak not done. Dat geldt tevens ook voor horizontale uitbreidingen. We hebben het net over gietbouw gehad met dichte wanden, maar we hebben ook wel eens meegemaakt dat we dan in die wanden kolomstroken maken. Dat je dan sterke kolomstroken hebt, zodat je later sparingen kan maken in de wand. Dan heb je nooit last van een uitbreiding. Als je stekkenbakken opneemt in wanden, dat zijn wapeningen die je kan uitvouwen,  waar je later weer wanden aan kunt opnemen. Dat zijn allemaal voorbeelden om het toch uit te breiden. Alleen mijn ervaringen is wel, dat het vaak op papier wel heel mooi staat en mooi is uitgewerkt, en dus ook is gemaakt. Maar dat in de praktijk toch veelal toch anders loopt dan verwacht. Dus je moet wel een heel erg duidelijke visie hebben. Want bijvoorbeeld scholen, zijn dus uitermate geschikt als woningen. Kantoren ook. Wat ook veel gebeurd. Die hebben toch vaak hoge ruimte en kan je veelal ook ongestraft vloeren al gebruiken voor woningen. En vaak ook nog, als het een gebouw is van 3-4 verdiepingen, kan je heel vaak een extra etage op zetten. Onder bepaalde voorwaarde. Dat zijn vaak eigenschappen die dat soort gebouwen al in zich hebben en voor woningen kom ik dat zelf minder tegen. Ik probeer wel een beetje altijd de opdrachtgever te informeren van joh ik zou persoonlijk wel wat meer.. dat zijn dan vaak wel iets meer kosten omdat er

meer wapening in je constructie komt. Maar ja, dat is dan nog wel te verkopen. Maar ook wel een beetje per ontwikkelaar. Maar als je vaak oplevert dan komt de vraag van kan ik daar ook een koeling op zetten. Dan denk ik, ja dat had ik toen al aangegeven. Dat belemmert je alleen jezelf mee. Dus ik merk dat mensen daar wel meer, oke doe maar. Dan kost het vaak 5 euro per m2 extra. Maar dat gebeurd zeker wel, overdimensionering en groei. Met name als je woningen gaat transformeren naar andere woningen, dan zijn vaak de installaties die vaak verouderd zijn. Achteraf kan je vaak installaties niet meer in de vloer leggen. Dan moet je dan vaak onder de constructie aanleggen, of er boven. Dan ga je vaak plat met je constructiehoogte. Maar ook, als je hogere verdiepingshoogtes gaat maken, kan het net een etage schelen. Dan is het toch weer de opdrachtgever en de kosten die dat belemmeren.

SJ: Heeft iemand daar een opmerking op?

FB: Ik wil hier een dingetje over zeggen. Dat is dat adaptief bouwen, iets bij voorbedoeling gebeurd. Ik woon hier op de Amsterdamse grachten, ik zie niet anders dan aannemers die een auto neer zetten om de gebouwen aan te passen aan die eisen en die gebouwen zelf bestaan inmiddels 350 jaar. Het uiterlijk is niet zo veranderd, maar het innerlijk voortdurend. Het is niks geens bijzonders, adaptief bouwen. Het is waar, hoge verdiepingen bieden heel veel mogelijkheden om goedkoop aan te passen. Flexbiliteit is niks anders dan goedkoop kunnen veranderd. Als het duur veranderen wordt, omdat je alles moet slopen, dan heb je er niet veel aan. Het is niets bijzonders, het is iets wat voortdurend overal ter wereld gebeurd.

SJ: Ja. Als we naar punt 7 gaan met de aanpasingsmogelijkheden. Dan praten we een beetje over in hoeverre je die mogelijkheid geeft. In hoeverre moet iets aanpasbaar kunnen zijn. Dit is misschien een goeie vraag voor Arnold, als hij er op wilt reageren. Want, waar zie jij een beetje de balans tussen de aanpasbaarheid en de bewoner wel zijn eigen ding te kunnen laten doen tussen bepaalde grenzen natuurlijk. En wat zijn die grenzen dan.

AR: Dat is een lastige. In principe ben ik er eigenlijk voor dat je het altijd goed moet kunnen aan passen. We krijgen natuurlijk veel meer met een samenleving te maken, ouderen die langer thuis kunnen wonen, mensen die langer in hun huis blijven wonen, gezin die zijn samenstelling aanpast, ook meer singles in de wereld. Ik denk eigenlijk dat je veel zou kunnen moeten aanpassen, ik denk dat je veel rekening mee moet houden. MAar wat de juiste balans is, weet ik niet. Voor mijn gevoel is het gewoon heel erg geld gedreven. Als ik een balans zou moeten benoemen, zou ik zeggen dat een ontwikkelaar of aannemer het zo aanpasbaar mogelijk moet maken, dat je kunt zeggen ja door hele simpele ingrepen kun je het aanpassen waardoor de kosten niet zo heel hoog zijn. Zoals wat Pieter zegt. Als je kolommen bouwt enzovoorts, hoeft het niet zozeer meer te kosten en kan je het makkelijk aan passen. Van te voren is er een beperking op het budget altijd. Zo kun je wel hoog en laag springen, maar het wordt gewoon niet gedaan. Dat is gewoon lastig. het enige wat je kunt doen, is door een bepaalde flexibiliteit in te bouwen maar niet echt al heel veel rekening houden met heel veel dingen. Want het geld is er gewoon voor niet. Of het wordt je gewoon beperkt.

SJ: Linda, hoe kijk jij daar tegen aan?

LD: Ik zat te denken. Je kan het best bijvoorbeeld, dat je blokjes er constant in zet en eruit haalt. Je hebt daar wel tegenwoordig concepten in zeg maar, dat ikea niet alleen de bank bied maar iets grotere stellen zijn zoals een natte cel wat je erin en eruit kan halen.

JH: Dat is al gelijk een lastige.

LD: Ja, dan moet je wel gelijk de goeie aansluitpunten hebben toch? Dat zal ik ook al door te denken inderdaad. Dus dan moet ieder huis in Nederland de zelfde aansluitpunten hebben.

JH: En het geld met name voor gestapelde bouw. Je zit direct op de verdieping van een ander. Op het moment dat je met een afvoer naar beneden moet, je kan moeilijk de vloer doorboren en zeggen alsjeblieft buurman. In je flexibiliteit ben je heel erg beperkt. Je mag geen waterleiding reserve aanbrengen, dan krijg je dood water, dat mag niet meer. Vroeger kon je nog eens aansluiting ergens doen, maar dat is nu vanwege de voorschriften verboden. Afvoer kan je ook niet doen, want dat gaat niet best ruiken in een appartement. Dus je raakt heel snel beperkt met je natte cel, om daar flexibiliteit in te maken. Het enige wat je steeds meer ziet, is dat om de kern heen, dat de woning een eigen kern krijgt met een techniek ruimte. En daar om heen, bepaalde flexibiliteit qua inrichting met badkamer en keuken. Dat het omgewisseld kan worden, maar dan zitten de voorzieningen niet met de vloer, maar gaat voornamelijk naar de wanden toe omdat er een techniekruimte in het midden staat. Dus dan krijg je wel een stukje flexibiliteit, maar die blijft allemaal beperkt tot die kern.

SJ: Misschien is het inderdaad ook niet heel erg, misschien is dat gewoon de beperking van een natte cel. Dat dat in het midden ligt, dichtbij de kern. Dat dat gewoon een beperking is, en dat je dat ook een soort van moet accepteren wellicht.

JH: Ik ben bezig in Eindhoven. Daar worden op dit moment ook woningen gemaakt en daar zijn we aan het kijken van we maken een technische kern. En aan alle vier de kanten van die technische kern moet je een eventueel een badkamer of keuken moeten kunnen maken. Zodat die mensen een vrij grote flexibiliteit krijgen van waar zit de slaapkamer, waar zit de woonkamer, waar zit de keuken. Dan wordt het in principe als casco, met natte kern verhuurd of verkocht.

SJ: Ja. Want het laatste kritische punt ging ook wel heel erg over de installaties maar ik denk dat we daar grotendeels ook wel overheen zijn gegaan met de informatie. Want heb jij nog belangrijke aanvullende punten met betrekking tot specifiek installaties of algemeen na het horen van alles vandaag?

JH: Ja kijk, de meterkasten bepaal je eigenlijk niet zelf. Die worden bepaald door het NUTS bedrijf. Die moeten maximaal 3m vanaf de voordeur zitten. Dat is een keuze, dat kan niet anders. De schachten, als we gaan stapelen, die moeten boven elkaar zitten. Daar moet de architect soms nog wel eens aan wennen. Ja, dat water en afvoer. Dat begint steeds meer met de voorschriften een probleem te worden. Er zitten wel wat aandachtspunten vandaag te dag in.

SJ: Dat is algemeen of al helemaal gericht naar re-adaptief?

JH: Ja, dat is algemeen eigenlijk. Daar kom je niet onderuit. Kijk ventilatiebuizen, als die in beton zitten moeten die ingestort worden. Want die willen we niet zien, en in een verlaagd plafond daar hebben we de financiele ruimte niet voor. En als het niet ingestort kan worden, gaat de verdiepingshoogte omhoog. Dan gaat de ontwikkelaar ook beginnen, daar heb ik de centjes niet voor. Dat is toch het geen waar je continu tegen aan loopt. Het moet zo flexibel mogelijk zijn, er mag flexibiliteit zijn maar het mag geen geld kosten.

SJ: En, Arnold, hoe kijk jij daar tegen aan?

AR: Het zelfde als Joop. Kijk, ik denk qua installaties technisch kom je het verst als je voldoende types hebt zodat je achteraf altijd nog iets in het plafond kan leggen. En de schachten op de goede plek. Op een centrale plek. En net iets meer ruimte, dan kun je altijd nog over het plafond langs en dan kan er nog een extra leiding door de schacht heen. Installatie technisch zit er verder niet zo heel veel andere mogelijkheden in. Wat we hadden gedaan, met het toekomstig samenvoegen van die appartementen, hebben we gekeken of we de natte cellen en de sanitair en keuken of het allemaal op de zelfde soort plek terecht kan komen. Zodat je de leidingen kan hergebruiken, of in iedergeval

schachten hebt waar je leidingen doorheen kan zetten. Maar als je beperkt wordt in de hoogte, wat ook met deze bouw is. Dan heb ik nog 1cm over om flexibel te zijn, ja dat gaat niet anders. In die zin, zou het installatie technisch ideaal zijn om voldoende verdiepingshoogte te hebben en de leidingschachten voldoende groot en op de goede plek.

SJ: Pieter, heb jij na alles gehoord te hebben vandaag. Wat is een beetje jouw conslusie van de dag?

PS: Uiteindelijk de prijs bepaald. Daar loop je telkens tegen aan. Dat is zo'n zonde. Daar is echt wel meer uit te halen. Al zou je alleen maar de vloeren meer geschikt maken, dan heb je de ruimte om naderhand sparingen te maken, dan kun je herverdelen, dat is eigenlijk het meest belangrijkste. En dan in combinatie met een wat hogere verdiepingshoogte. Dan heb je al zoveel meer mogelijkheden. De kosten vallen dan wel mee. Naarmate je hoger gaat, kan het net wel weer een laag schelen. En dat zijn toch wel weer duurdere woningen. Maar dan moeten diegene die dat betalen daar van wel het belangen van in zien. En mensen kijken toch vaak wel naar het belangen van de portemonnee en niet het belang van de gene na je. Mij heb je hoor, ik betaal de rekening niet.

SJ: En Linda?

LD: Misschien is sowieso een conclusie wel de kosten. Het help ook als gemeentes wat makkelijker, de staat uiteindelijk, is in de wet en regelgeving. Als oplossing wat Pieter ook zegt, een aantal bouwlagen bepaald in plaats van de hoogte. Want uiteindelijk als je telkens een kleine hoogte bij doet, scheelt je dat misschien een woonlaag dat je niet kan verkopen of verhuren. Dat is mijn conclusie.

SJ: Frank, hoe kijk jij daar tegen op?

FB: Ik heb in het begin al een conclusie getrokken dat wij in een vastgoed wereld leven die heel erg op de korte termijn is gericht. We maken een P.v.E. en als krimpfolie maken we daar een gebouw om heen. Terwijl je natuurlijk ruimte nodig hebt, zoals verdiepingshoogte, om die flexibiliteit in de toekomst goed te maken. Het vervelende is ook dat die vraag naar flexibiliteit ook in het beginzicht zich zo weinig krachtig laat voelen. Maar ik ben verhuurder geweest, ik ben veel bij mijn huurders over de vloer gekomen, en ik kan je vertellen dat we hebben onderzocht dat in al onze woningen jaarlijks 10% werdt verbouwdt ook door de huurders. Uiteindelijk is die vraag naar flexibilieit en verbouwingsmogelijkheden op een eenvoudige manier, is heel groot. Die 10% van al onze woningen werd elk jaar verbouwd door de huurder. Maar dat komt niet tot uiting in de aanvangssituatie, dus daar zit een probleem. Het moet op een ander niveau worden opgeslot. Dat wordt niet opgelost door het technici, technisch is het helemaal niet moeilijk. Daar zit helemaal het probleem ook niet. Dat schachten boven elkaar moeten liggen, 1 en 1 is twee. Maar die 30cm hogere verdiepingshoogte is een geweldige winst, alleen niet op korte termijn.

SJ: Ik denk dat we het dan heel mooi kunnen afsluiten met Arjen, de ontwikkelaar. Grotendeels hoor je het kostenplaatje, wat wel heel erg logisch is want je werkt natuurlijk wel voor een belegger of investeerder.  Hoe zou jij dan, alsnog, toch meer uit het budget kunnen halen? Hoe zou jij diegene kunnen overhalen?

AJ: Dat is denk ik door goede voorbeelden aan te halen, en dan met de architect samen te kijken naar plattegrond weizigingen die nog mogelijk zijn na oplevering. Sparingen aangeven, dat als je nog bepaalde sparingen maakt, en nu tijdelijk dichtzet en dan wel weer kan openen, dat je dan een flexibeler gebouw oplevert. En daar dan ook meer geld voor vragen, want uiteindelijk draait het daar om. Je moet die investeerder overtuigen van de lange termijn success van zo'n ontwikkeling. Ik denk dat het grote nadeel is, er zit natuurlijk een korte termijns visie bij die investeerders en dat komt natuurlijk ook. Er ligt een enorme druk op die woningmarkt, al jaren lang. Ik denk dat bijna niemand

de periode van grote leegstand bij woningen heeft meegemaakt. Begin jaren 80 heb je dat misschien gehad. Maar iedereen die daarna is komen werken, die kent dat niet meer. Die is dan ook minder geneigd daar rekening mee te houden. Dat het ook wel eens de andere kant op kan gaan. Bij kantoren weten we het allemaal, daar hebben we een paar goede verliezers gehad. De helft van de kantoren zijn ondertussen omgekapt naar woningen of platgegooid. Bij winkels hebben we die crisis nu met z'n alle.

LD: Dan is ook nog de vraag, je kan adaptief bouwen. Dan is het wel vaak ruimte toevoegen, maar is het ook ruimte afgeven. Ik hoor Frank net zeggen dat hij in een mooi grachtenpand in Amsterdam woont. In hoeverre gaat een Frank dan ook ruimte afstaan omdat iemand zoals Sha, net op de markt komt en in Amsterdam wilt wonen, daar ook een woon ruimte heeft. In dat opzicht zou je hem ook nog moeten beschouwen.

SJ: Ja, het is inderdaad meer ruimte nemen, groeien. Maar ook inderdaad ruimte afgeven en krimpen. Dat heb ik nu een beetje achterwege gelaten omdat het adaptieve eigenlijk nog niet helemaal goed tot zijn recht komt en re-adaptief eigenlijk een soort opvolger is van adaptief. Maar heel erg dat afstaan van ruimtes, is een heel onderzoek op zich. Maar wel heel goed dat je dat benoemd. Nou, we hebben nog een minuut. Laten we nog heel kort iedereen af gaan. Joop, heb jij nog aanvullingen?

JH: Ik heb een paar aandachtspuntjes erin staan, die zal ik jou zo wel even mailen.

SJ: Helemaal prima. Arnold?

AR: Ik denk dat het goed is dat we het met z'n alle beter bespreekbaar maken. Ik denk dat dat de eerste stap is.

SJ: Arjen?

AS: Nee, dankjewel.

SJ: Frank?

FB: Nee hoor, dankjewel. Ik heb jou al geschreven ook al he.

SJ: En Linda, had jij nog punten?

LD: Nee

SJ: Oke top. Nou, harstikke bedankt allemaal voor jullie tijd en moeite. Ik hoop dat ik er wat moois van kan maken.

# 12. Comparative case studies

## 1. SOLIDS

### 1.GENERAL PROJECT INFORMATION

Projectname: Solids
Location: Amsterdam
Solids 11: Eerste Constantijn Huygensstraat in Amsterdam Oud West – built on an underground park
Solds 1+2: Ijburglaan – Shops in the plinth and psychiatric clinic
Initiator: Het Oosten (Now Stadgenoot) – Housing corporation

### 2. KEY CHARACTERISTICS

The solids project includes two building: Solid 11 and Solid 1+2 (will be now mentioned as solids12) Solid 11 is an U-shaped building of 7 floors with a collective courtyard. Access is through a gallery with 2 cores on either side of this courtyard. The floors have a central shaft (for the ventilation o the parking garage, and connection possibilities for catering functions) and decentralized shafts (for the individual gas, water, electricity etc.). Solids 12 has 8 floors and is accessible through 2 entrances on the side of the building, both of which lead to the core. Both have an WKO storage system.

The solids also includes business spaces. These will not be further taken into account as the focus is only on the housing functions.

#### 1. STRUCTURE INFILL

The architects didn't design the floor plans and a fixed program of requirement but took the structural framework (the structure) as the starting point for their design. During the construction, there was a strict separation between structural work (structure) and infill, as the Open Bouwen principle is.

The structure is in ownership of Stadgenoot and represents the collective value. This structure includes all the structural elements (columns, cores, floors etc.), the façade, the roof, all shafts, all collective ontsluitingen (entrance, stairwells, galleries, lifts, halls etc.), all collective parts of the technical infrastructure in the shafts (warmth-cold installations, electricity, ventilation etc), the installations for the NUTS (warmt/cold, electricity and water). The tenant can branch on this collective basic utilities. When subdividing the structure into multiple housing units, the unit dividing walls are also part of the structure. On the other hand, the infill (all the other) is owned by the tenant, who determines at his own discretion, expanse, amount of sqm, the use, the location within the building and the layout. The tenant can freely trade these install elements and propose a subsequent tenant.

#### 2. EXCEPTIONAL REGULATORY LAWS

The central government, the municipality and the city district, in collaboration with the necessary lawyers and other experts, made room within the current legislations for some exceptions to enable the necessary freedoms.  Stadsregio Amsterdam made it possible for Stadgenoot to temporarily not need to meet the rules with regards to housing allocation, housing withdrawal and the suitability criterium. Furthermore, onderhuur is permissible, with veto rights to Stadgenoot.
Municipality Amsterdam decided that the leasehold –at an average occupancy of the complexes over a period of five years is used as a benchmark – making it possible for the leasehold to go up or down. As much zoning freedom as possible is created with the city districts, subject to conditions.
Maximum freedom for tenant

On every floor, the tenants can choose from almost all kinds of functions with self-dividable units. Some functions are not allowed because these could cause too much nuisance or are too offensive. There are some restriction:
-a minimum of 15% of the area is for social housing rent, approx. 60 m2 per unit
-for free sector rent, the unit is minimum 96 m2.
-for businesses, the unit is at least 60 m2.
-levels can't be vertically merged through an internal stair.

### 3. MAXIMUM EXPLOITATION RESULTS FOR STADGENOOT

The initiation costs of Solids are almost twice as high as regular new housing construction. The high costs are argued by the concept development and sustainability, but more importantly are due to high pre-investment in the maximum accommodation capacity of the building.
Against these higher initiation costs, the expectation is that the Solids will provide lower maintenance costs and higher yields, due to:
– No depreciation of the investment and lower maintenance costs of the structure (casco) because of the high-quality materials and the constructional measures (flexibility and overdimensioning) that have been taken to facilitate flexible use in the future.
– No complaints maintenance on the infill because these are the property of the tenant.
– Low mutation maintenance because in most cases the infill is traded and mutation maintenance will only take place if the infill is left behind by the departing tenant and it has to be removed by Stadgenoot.
– Low rental risk due to the accommodation capacity.
– Higher rental income due to the auction.
– Low risk of frictional and structural vacancy due to the substitution and negotiability of the installation from the departing tenant to the new tenant, as well as the (construction-technical and planning-legal) accommodation capacity.

### 4. MAXIMUM ACCOMMODATION CAPACITY

There is a maximum accommodation capacity due the Exceptional regulatory laws, the structure-infill principle, and the overdimensioning. Based on the largest function (meeting functions), the floor conditions (structural, acoustic, isolation value), the installations capacity, shaft space, entrances and escape routes are dimensioned.
All cables, pipelines, pipes and channels are distributed vertically, and as much as possible decentral, in shafts so that many connection points can be created. Vertical distribution leads not needing technical installation matters in floors and walls  To make it possible to install facilities in the floor at any desired location in the room, the top of the bare construction floor floors is  lower than the floor at the access point. Furthermore, the floor height has a minimum of 3m (top of raw floor to raw ceiling)

and for the ground floor this is even minimal 4.5. This makes it possible for the level floors to place and maintain installations, floors, ceilings, cables and pipes

### 5. AUCTION RENTAL PROCESS

All the tenants received the same lease contract, which consists of an object-related (lot and rent) part and a subject-related (infill and use of lot) part. The agreement includes that every tenant automatically, and compulsory, becomes a member of the tenants' association.
– Rental process after delivery.
The first lease of the spaces started after the building was completed, so that tenants were able to fully understand the qualities and possibilities of the building.

### Rental process

At the auction the tenants, in competition with others, were able to able to determine the location, dimensions, filling in of their desired hull space and the rental price.
In the combinatorial auction with its several rounds, in each round the tenant is given the opportunity to increase the bid price of their bid and possibly also to make new bids. This results in biddings being less careful, the bidder chooses a rental price that he thinks is worth (partly in the context of other bidders) and, on balance, a higher rental income is realized for the landlord.
After each bidding round, the computer system calculates an allocation from all the different bids, based on the highest total rental income for Stadgenoot. The allocation was then anonymized and the popularity of the lots was shown graphically. After this, the tenants could place another bid with a minimum increase of € 0.50/$m^2$. The Solid spaces did not necessarily go to the highest bidders, because various factors played a role in the allocation. When there were more possible allocations after a bidding round, the computer program selected an allocation at random. Disadvantages are that it is not completely clear to calculate what the optimal allocation is and that this makes it more complicated for the bidder to follow why he is or is not 'winning'.

## 3.EVALUATION / CRITICISM

### 1. Vacancy

The Solid in West was rented out in one go. Thanks to Solids, hotels and a short-stay facility have been able to establish themselves in this area as according to the regular regulations, this would not have been possible. The Solid on IJburg turned out to be in a less attractive location, which means that there is also vacancy. Reasons are:
- In the current difficult market situation, the Solid in its current finishing level and monthly payments only seems attractive in an environment where pressure on the real estate market is and remains high, where tenants are therefore prepared to invest (more) in their housing have the confidence in these investments. IJburg is not such a location (yet).
- The absence of its own outdoor space and the design of the collective traffic space, which is regarded as cramped and unclear.

### Auction and rental price

The tenants look back on the auction with satisfaction and accept the fact that the auction has increased their rents. The downside some interested people have decided against participating in the auction due to the price-increasing effect and the uncertainty about the location within the building.

### Choice of tenants

The most important factors for tenants were the location (and the confidence of return on investment due this), being able to have an influence through the auction, the exemption from the regular housing rules for social tenants and the operators of the hotels/short stay facility and the intended, but ultimately only partially realized, small-scale mix of functions in the building. And not, as expected, the maximum freedom of choice, or the separation of ownership between structure-infill and the big accommodation capacity.
To tenants, the broad zoning freedom is perceived as attractive, but with an infill that is inconsistent with the presence of several large hotels and especially hotel guests who have little connection to the building.
Furthermore, the overall rating of a building is largely determined by the presence of private outdoor space, a good transition between private and public (such as galleries and glass entrance of Solid 11 or the arcade of Solid 12) or, on the contrary, by the absence of private outdoor space and less successful transitions between private and public (such as entrances and corridors of Solid 12).

### Separation structure-infill

The separation structure-infill has allowed tenants to furnish their house according to their own wishes, for some other tenants it has been experienced as a burden rather than a pleasure. The fact that the infill is marketable by the tenant has helped determine for most tenants what and how they have furnished their space. Thus, there is clear anticipation of possible sale, although at the same time most tenants indicate that they do not expect to move soon. However, most tenants mentioned that, despite the satisfaction with the infill process and the result, they would have preferred a less bare casco. Certain basic facilities, such as a wet room, they would have liked to see already realized by Stadswonen.

### Collective traffic spaces

In later phases of the design process at Solid 12, the decision was made to create more Solid spaces, which necessitated additional front doors and thus additional traffic space against the concrete cores. This produced a sub-optimal result by creating narrow, unattractive and above all cluttered collective traffic spaces.

### Shafts

In Solid 11 there are ten decentralized double shafts with one shaft for living and one shaft for working. In Solids 21, there are two shafts per core where up to four Solid rooms can be provided with installations. The shafts require a lot of space at the expense of rentable floor area and spatial perception, have a cost-prohibitive construction and the catering facilities do have enough with the capacity of such a decentralized shaft for their ventilation. They need a central shaft adjacent to the core, which limited their freedom of subdivision to the core of Solid 11. The decentralized shafts are always located in the Solid spaces, which makes management and maintenance more complex because one always has to enter a private space.
For both solids, the construction of double shafts stems from requirements of utility companies.

### Structural floors

The extra heavy floors make vertical flexibility impossible (due to bearing capacity). Also, the slope between the structural floor and the second floor is too low to allow for sewer connections at all points in the space.

### Social rent and vacancy

Initially it was decided to concentrate the Solid spaces of solids 12 for social rent on the 4th, 5th and 6th floor. Due to the market situation, the spaces for free sector have not been rented out enough leading Stadsgenoot to decide, a year after completion, to make the vacant Solid spaces suitable for social rental. However when adjusting the minimum plot size to 60 $m^2$ for social rental the large floor area in combination with the two cores proved restrictive. Installations had to be moved and an extra corridor had to be built around the core.

### Rental prices

When the minimum rents, as determined by Stadgenoot prior to the auction, are compared to the average prices bid, the auction generated higher rental income. In some situations, the average social rent/$m^2$ turns out to be higher than that for the free sector in Solid 11

### Infill costs

Built-in housing costs range from €5,000 (social rented housing in Solid 1 and 2) to almost €200,000 (free sector housing in Solid 11). A striking observation is that social renters have also been able to invest in their build-in; sometimes limited, sometimes considerable.

### Tenant recruitment

For some tenants, Stadgenoot's intensive marketing and communication efforts until the signing of the leases contrasted with the difficult communication between tenants and Stadgenoot from the move-in stage on. Even in this phase, the experiment should have continued to be shared, according to the tenants. An installation fair had been organized, in which an extensive protocol was presented. The moment at which this protocol was presented (after the auction) as well as the size (over 40 pages) and the level of detail led to considerable criticism and lack of understanding among tenants. Also, the moment of signing the lease would have been preferable after the construction period. Now it had to be signed before the construction period, while for most tenants the installation started later. In the meantime tenants have had to pay rent.

### Costs

Solid 12 results in a positive result of almost 1.5 million and Solid 11 in a negative result of about 1.6 million. If the value of the land on which Solid 11 was built were included in the calculation of the business value, Solid 11 would also result in a positive result. A number of parameters are not yet known (life span, residual value, change of function and expected rental income, market prices, vacancy, management and maintenance costs) or are likely to change (strongly) over time. On balance, Stadgenoot states that it paid a high price for the first Solids, since the costs also include concept developments, marketing, communication etc. Experience however will contribute to building similar complexes better and more cheaply in the future.

### Chance of doing it again

The chance that initiator Stadgenoot will build more Solids is not great. The concept is too risky, too expensive and possibly too little in line with the core tasks of corporations. A Solid Light variant (e.g. lighter and cheaper structural shell, a semi-detached shell) or a Solid Reuse variant (transforming existing vacant real estate into multifunctional spaces) has more chance of success.

# 2. DIAGOON WONINGEN

## 1. GENERAL PROJECT INFORMATION

Project: Diagoon woningen
Architect: Herman Hertzberger
Year: 1974
Location: Amsterdam

## 2. KEY CHARACTERISTICS

The Diagoon houses were an experimental housing project of 8 housing units located in Delft (Von der Nahmer, 2019).

### 1. Structure – infill

The common idea of dividing living areas and sleeping areas is in practice unusable, when looking at (re-)adaptivity. In the Diagoonwoningen the spatial units are connecting so they can also be seen as one whole space, where you can make large and small rooms out of it making it possible to follow a whole cycle of life. The facade is designed in such a way that is has a schedule in it and the residents can decide which parts within this schedule they want to have closed or open. It is important to always have a certain set of rules, in which freedom is possible (Hertzberger, 2022).

The structure-infill principle is here used by providing a semi-finished product, the structural framework, which then can be finished off, expanded and completed by the residents. They can do this so based on their own functional and emotional needs and wishes. The half product, the semi-unfinishedness, can also be seen in the private outdoor spaces. Here these outdoor spaces, adjacent to the entrance and carport, are covered with ordinary pavement stones to make it look like it's part of the public street. Also, no (or minimal to merely suggest by a footing of concrete blocks) dividing lines and/or fences were included between adjacent gardens and terraces to stimulate social interactions (Hertzberger, 2016; Knudsen, 2015; Von der Nahmer, 2019).

### 2. Resident freedom

To give the residents more control over their house, the house stages different spatial and functional initial conditions. It is not a neutral structure. There are however two permanent cores, the stairs and wet areas. Around these cores, the floors are of different heights, staggered by half a floor. These floors can have any desired function such as sleeping, living, eating etc. Each part of the floor can be separated as a room. Continuity in a spatial sense is created due the central void, that occupies the full height of the house, and the constellation of the staggered floors. Residents are given the opportunity to think for themselves about their housing activities and behavior, and to come up with housing solutions as a result of this (Von der Nahmer, 2019).

Floor-to-ceiling windows, with a division in three layers of windows, are installed per floor at the front and rear façade. In each layer surfaces can be filled with glass, rotating parts or panels (Hertzberger, 2016; Knudsen, 2015). The facades will have a characteristic appearance as long as it is filled in

symmetrically (Hertzberger, 2016). As private outdoor spaces, each house has a garden, two roof terraces and a balcony above the entrance, which can be pulled to the house. In most diagoon housing, the carport is pulled to the house by enclosing the carport (Knudsen, 2015). Expansion is possible due, for example, enlargen the terrace and thus cover a larger area at the entrance below which can be added to the house if desired. The terrace at the rear can also been added to the kitchen. At the roof level rooms can also be added (Knudsen, 2015).

### 3. Polyvalence

The Diagoon house is basically one vertically and horizontally articulated space, next to a central living area, with a variety of sites. Each site, floor, is interpretable individually for different uses. This makes polyvalence into practice, as it shows the suitability of generating pertinent solutions per each new situation.

Rather than leaving out as much as possible, polyvalence contributes to a maximum amount of spatial conditions that can figure into every situation and lend them to new uses (Hertzberger, 2016). Polyvalence is defined as not just being for a singular use or within a singular context, but making things that is not within an established order, not just for particular purposes but are rather still open and can be used in different ways. In stead of making things like a programmed device (programmed to a certain opreation and purpose), it should be made more like an instrument (although it plays noted, the player can compose freely with these notes). The architect, once put a block in the middle of a school in a provocative and fundamental way. What was then seen, was that children used this block for multiple uses: working on it, performing on it, putting food during lunch etc (Hertzberger, 2022).

## 3. EVALUATION / CURRENT CONTEXT

One unit is acts also as a inhabited museum since it still has most of its original elements including a metal drawbridge to the loft, the metal landing, builtin closets and the sitplaces around the central loft (Von der Nahmer, 2019). A survey from 1978 shows that the residents are still enthusiastic and appreciative of the openness of the houses (Knudsen, 2021). Also, several residents have made use of the possibilities to expand the house. All houses are therefore different on the inside and outside. Terraces added to kitchen by various neighbours (Knudsen, 2015). Furthermore, the notion of not having (strong) divisions turned out to be less popular amongst residents. After a year of construction, residents placed hedges, boxes and/or fences as property boundaries (Von der Nahmer, 2019). To the other units, some changes have been made such as removing a partition wall, renewing the woodwork of the windows, balustrades, stairs and closets (Knudsen, 2015). Lastly, the combination of bad insulation, the openness of the void and the glass roof leads the house into needing a lot of heating energy (Knudsen, 2015).

# 3. DE DRIE HOVENS

## 1. GENERAL PROJECT INFORMATION

Project: De Drie Hovens
Architect: Herman Hertzberger
Year: 1971
Location: Amsterdam

## 2. KEY CHARACTERISTICS

The Drie Hoven is an complex of Housing for physically or mentally challenged elderly who are physically and mentally challenged. It contains 55 units for couples, 190 single-person units and a nursing home (Polygoonjournaal, 1975). The aim was to create such an environment that would give maximum possibilities for social interactions. (Hidden Architecture, 2016)

### Geometric floorplan. multiplied and repetitive structure

To meet the requirements of the highly varied and complex program, these considerations led to the notion of establishing a single continues structural structure based on the same modular unit (Hidden Architecture, 2016). Columns, beams and floors are incorporated in a fixed and consistent module and order. Because of this order, the building actually allows a great amount of use space freedom, in both wide-ranging programs and anticipating future expansions. (Polygoonjournaal, 1975; housing our mature elders, 2018).

### City like

Through the expression in patterns of the streets, squares and central encounter areas the building functions as a small city and thus enlarging the social interaction moments. In terms of accessibility and amount of amenities, the complex also had to be conceived as an urban area rather than conglomerate of separate buildings (Polygoonjournaal, 1975; Hidden Architecture, 2016; housing our mature elders, 2018). This can be seen back in the articulation of the four buildings being situated in a pinwheel set up, around a central 'village green' building that was serving as a civic heart. The corridors, in the buildings, were the streets with different alcoves and informal sitting and meeting areas along the route (housing our mature elders, 2018).
Because of the two different sections (nursing home and independent units) the aim was to include maximum interchangeability so that residents can be moved from section dependent on their condition (Hidden Architecture, 2016).

### Social interaction

In architecture, looking at re-adaptivity, there seems way too much emphasis on individuality. And not on, trying to do something together. To try to make things so that it also improves social contacts is one of the main objectives of Herman Hertzberger. So in all those galleries, which could be made an extension of, people could sit together. People who sit individually are always bothered by the others. The other person's kitchen smells, his music, his things bother them. That's because they don't have contact with each other. If they do, then they say 'oh he's making his delicious dish again that he taught

me last week' or 'he's making that music again that I also like so much. Social interaction leads to more mutual understanding'. Currently there is individual housing (as most of the projects), but also some collective housing initiations where they share things such as a kitchen. Herman Herztberger looks for something different than these two, that is something in between which is difficult because, once again, the financial profitability doesn't directly translate (Hertzberger, 2022).
At the Drie Hoven there was a big town square that included a big shop, laudnromat, billiard room library and terrace. From this square center, there were multiple wings with a wing for independent housing, care housing and more intensive housing. All the residents from each wing could come together at the center, which functioned as a kind of village meeting square. This promoted social interaction and hold off isolation and loneliness (Hertzberger, 2022).

## STUDENTHOUSING WEESPERSTRAAT

The geometric floorplan, city-like spatial lay out and priority of social interaction can also be seen at the student housing dwelling at the Weesperstraat.
Unlike functioning for care-needing elderly, this dwelling is for students. Each unit has its own front door and is located at a communal stairwell. There is a communal laundrey room, toilets, storage rooms, lunchrooms. Unlike the Drie Hoven, it's not the center, but the ground floor that is occupied with public functions. Such as a bookstore, café, meeting rooms, room offies etc. These functions can therefore also count on the concentration of people (approximately 250 student residents).
Additional information on the Weesperstraat studenthousing can be found in Appendix 9.

To continue the environment and make a less abrupt boundary between inside-outside/public-private, the building is on columns. On the 4th floor there is also a gallery street. Residential street without traffic, not only to reach the front door but is also a real extension of the living space to the outside: common area where you can sit in front of your house. This is also to enhance social interaction. Other ways this is done is through a central point in the corridor is a telephone niche, large platforms on the staircase that connects two dining areas, parapets and lightning blocks at a height that enhances to be used as a table/bench or step. The hidden intentions of the architect to articulate each part in such a way that the most varied exchange pattern can arise. Loggia's are not just for garbage cans, but of such dimensions that one can also eat and sleep here or be a place of plants, a sandbox etc.

## 3. EVALUATION / CURRENT CONTEXT

De Drie Hoven was subsidized by the state. After a round of reflection, subsidies got cut down and the project came into the hands of a project developer that saw no possibility in exploiting this building without the subsidies. Many care homes had to downsize or close down due the removal of financing low care seniors and the increase of home care service reliance. The residents got an individual subsidy, which thet could finance their individual apartment: however without the social and personal interactions. This led to many residents moving to another facility or returned home, reducing drastically the community component of the Drie Hoven (Hartveld, 2020; Hertzberger, 2022). A subsidy system can both give birth and kill certain projects.

Currently only one tower is remained, the other three towers including the village green have been demolished. The land of these buildings is sold and being redeveloped into senior-specific apartments. The last tower is slated for demolition soon (housing our mature elders, 2018), currently it is inhabited by students (Hartveld, 2020; Hertzberger, 2022). The building is owned by Woonzorg, and as renovation wouldn't be vital enough, they decided to demolish and build a new building (Hartveld, 2020). Major renovation would be needed, and even then it might not be an optimal building for nursing activities.

Secondly, renovation creates a lot of nuisance for the residents as they have to move twice ,to the temporary location and back to the renovated building (Amstelring, 2019). Although sometimes buildings can be converted into nursing homes, the Drie Hoven can't as it's too difficult to make it suitable for the increasing demands and requirements for care functions (Amstelring, 2019; Hartveld, 2020). It lacks on the following points (Amstelring, 2019):

-It is not spacious enough for regular and electric wheelchairs, bedridden residents and hoists use to help people in/out of bed. The corridors, doors, elevators and bathrooms are simply not wide and specious enough for the current requirements. Also, the ceilings are too low.

-The Drie Hoven doesn't meet the current indoor climate quality requirements and fire safety requirements.

-The Drie Hoven is not energy-efficient and technologically prepard for (future) innovations.

-It contains a lot of asbestos.

# 4. PREVI

## 1. GENERAL PROJECT INFORMATION

Project: PREVI houses
Architects: Kiyonori Kikutake, Noraiki Kurokawa and Fumihiko Maki.
Location: Lima
Year: 1969

## 2. KEY CHARACTERISTICS

### Low rise high density social income

The PREVI project abandons elements such as machine aesthetic and high-rise imagery, but rather focuses on human scale and a pedestrian orientated environment. The PREVI houses were not intended to invent new radical housing types but rather to demonstrate the combination of low rise with high density and social income housing , integrating small courtyards and expandability as well (Yi & Toledo, 2021; Mateo et al., 2016).

### Open-ended, growing house concept

The houses are arranged in a linear classic row house fashion with a base rectilinear unit that is composed of two unequally wide bars. The wide bar is a single story with a central courtyard and the narrower bar has a double story. An important metabolism factor is the ability of responding to things, as the PREVI houses also were designed to be open-ended and being able to span generation (Yi & Toledo, 2021). As evolution and subsequent changes were anticipated, the building is a platform for expansion and gradual adaptation to the family needs over time. This can be seen 43 years later, as the inhabitants have each radically transformer their dwellings (Mateo et al., 2016).

## 3. EVALUATION / CURRENT CONTEXT

Space expansion and progressive adjustment to fit family needs and in appearance were consequent changes in the PREVI houses, just as it was anticipated. This also means that each house differences from the other one, reflecting the different family identities. PREVI's renovation portrays a vibrant and diverse neighborhood, rather than one that is uniform (Mateo et al., 2016).

Although change and expansion was anticipated, the exact way and form was not always as anticipated and planned. However this wasn't a big issue as the initial design and construction was fundamentally supportive of this (Mateo et al., 2016)

### Structure – functional changes

The structure didn't also get preserved as much as residents didn't hesitate to add new building layers. After 43 years after its construction, house owners took their own ownership in changing their house and adding sequential additions, without consultation. Some houses have up to four additional floors. The unregulated expansion was permitted in a highly seismic zone because the Metabolist's used stricter seismic structural indications (Yi & Toledo, 2021). Maki, one of the architects, is nonchalant about the additional floors being build however, although the PREVI houses were build with the Japanese eathquak proofe-ness, is still concerned with the structural integrity (Yi & Toledo, 2021). It

was somewhat very permissive in allowing the residents to grow in their homes even though it was not in favour of functionality and especially safety (Yi & Toledo, 2021). Evidence of a certain snapping point of adaptability can be seen in the one (out of 17) house that has been demolished and this one has been rebuild with a seven story building (Yi & Toledo, 2021).

### Social standing

Householders not only change physically in terms of family composition, but there is also a social standing. This can be seen in the austere choice of finishes that was the first building element that was challenged by the residents. This is what metabolism failed to consider. The original architecture has almost disappeared under the floors, loggias, and layers of glass and plaster that were later added, and the in-between spaces are now the only visible element, remaining largely untouched by the constant accumulation of built mass (Yi & Toledo, 2021). As the facades were also used as storefront, rooms were turned into shops serving to the outside community (Yi & Toledo, 2021).

# 5. NAKAGIN CAPSULE TOWER

## 1. GENERAL PROJECT INFORMATION

Project: Nakagin Capsule Tower
Architect: Kisho Kurokawa
Location: Ginza (Tokyo)
Year: 1972

## 3. KEY CHARACTERISTICS

### Fixed – interchangeable

The Nakagin Tower (now referred as TNT) includes two towers of 13 floors and 11 floors. With a plug-in system of high tension bolts, the 144 minimal housing units in the form of capsules are hooked to the two interconnected towers. This shows a fixed system (the towers) with interchangeable parts (the capsules) (Buzzone, 2021; Maeda & Yoshida, 2021).

### Capsules

A single capsule external dimensions are 2.5x4 and has a round window of 130cm in diameter (Yusuke, 2021). It includes traditional aspects as well as modulating in tatami for a surface of 1x5 (bathroom 1/3), large marumado (the round window that is tradionally Japanese) and furnishing fixed structure, satifying most daily needs (Buzzone, 2021). These measurements are based on the maximal size of an object that was legally transportable on the road in Japan. Capsules were prefabricated and transported by truck, lifted by crane on site and attached to the two towers, making it possible to construct fast (Buezzone, 2021).

### Minimal living space

It was pitched originally to a prosaic demographic of hard working salarymen that needed to be centrally located in their work environment (Russell, 2020) thus the units were a minimal and alternative individual living space. Interior has built-in storage including integrated devices such as the bathroom, desk, refrigirator (no kitchen!), air conditioning and lightning. Buyers had the possibility to purchase options such as telephone, tv, digital clock, audio system and electronic calculators (Maeda & Yoshida, 2021). A kitchen and laundry facilities were not included as the occupancy was directed towards non-permanence. Room cleaning and laundry was a concierge provided service. There also was a staff of 'capsule ladies' on site to provide secretary services (Maeda & Yoshida, 2021; Tasker 2021).

### Cycle of change

Kurokawa stated that architecture should adapt to the metabolic rhythm of humans, which consists of 3 period points: 1) The independent point, once one is 20-25 years old. 2) The reproductive dysfunction point, once on is between 50-60 years old and the 3) Life stop point, once one is 75-85 years old. Also elements of the building have different lifecycles, and must be correctly taken into consideration with regards to the useful life (both material-wise and social life) of each part of the urban structure. With this in mind, two main structures were designed with 140 capsules attached to it. As the living space has a rhythm and a metabolic cycle of 20-30 years, the capsule units should be replaced in 20-30 years (Buzzone, 2021; Watanabe, 2021). Note that life span of the capsules not so much a mechanical one, but more a social one.

## 3. EVALUATION / CURRENT CONTEXT

Although the idea was to replace the units every 25 years, in 50 years still no unit has been replaced. The reason behind this is a functional issue (unable to take out capsules horizontally) and organisational (disagreements between tenants).

### Functional issue

The upper part is fixed with four bolts, only point of connection between structure and capsules, to the tower itself. The vertical gap between each capsule is around 30 cm, which is too narrow and makes it impossible to detach the capsules from the brackets. For capsules to be removed, every capsule above it should be removed too Structurally the capsules can't be taken out horizontally as the underside of each capsule is fixed to brackets. These brackters extent from the tower core (Maeda & Yoshida, 2021).

### Organisational issue

It could be possible, and efficient, to replace all the units at the same time. Making a communal decision like this proved to be impossible as the opinions and states of repair of the unit (owners) are too different. Refurbishment needs 100% agreement, of all 140 individual owners, as it not includes just individual capsules but also communal spaces. This human complexity was not included in the metabolism vision (Buzzone, 2021; Tasker, 2021). An example is when Kurokawa also came with a renovation plan of replacing the current capsules with larger ones, however this plan never was realised as it didn't meet enough approval of the tenants. Since then, no overall maintenance and renewal has been done leading to gradual abandonment. (Buzzone, 2021)

### Poor maintenance

Not replacing the capsules in combination with the poor maintenance results in conditions so severe that replacement of capsules is in large favour over renovation (Russell, 2020). Poor maintenance can be a result from a combination of the economic slowdown due the oil crisis in 1973 and the speculative bubble burst in the 1990's (Buzzone, 2021). The building related issues with TNC are currently:

-Capsules are rusting on the outside (Russell, 2020).
-Structure's earthquake resistance is not sufficient (Russell, 2020).
-Other plumbing problems regarding hot water, drainage, leaks, air conditioning (Russell, 2020). Also, as water pipes run through each units, it makes it logistically difficult (Tasker, 2021).
-Full of asbestos (Russell, 2020).
-Capsules don't facilitate any cooking devices and has permanently sealed windows.
-Extreme small bathroom (Tasker, 2021).

### Redevelopment

The Nakagin Group (which owned 17 capsules, the street-level store, offices on the second floor, and the plot on which the building stands) was in talk with a foreign real estate company that is interested in buying the NCT and redeveloping it. This foreign company supports replacement of capsules including the needed renovation work. They were also considering registering the NCT as a World Heritage Side or Tangible Cultural Property (Russell, 2020). The Nakagin group sold all proprietary rights to the CTB CK company, an investment group. The company pushed forward to purchase the capsules and, as of 1st November 2020, they have acquired 80% or more of the voting rights and are trying to complete this purchase in order to demolish the building (Maeda & Yoshida, 2021; Watanabe, 2021; Yusuke, 2021; Russell). However it was saved by an unlikely saviour: the global financial crisis leading to bankruptcy of the company that was planned to do the demolition work (Buzzone, 2021; Russell, 2020 ; Yusuke, 2021).

Currently, 20 capsules are used as residence, 40 as offices, 40 as second homes and the remaining 40 are un-used because of their extreme state of despair making it unusable (Watanabe, 2021; Russell, 2020). Owning now 15 units, Tatsuyuki Maeda formed the Nakagin group: 'Nakagin Capsule Tower Building Preservation and Regeneration Project' in 2014 (Buzzone, 2021; Maeda & Yoshida, 2021).

The preservation renovation group replaced tenants instead of capsules but got interrupted with the sale of the remaining capsules to the landowner by the management association (Buzzone, 2021). Over the past two years, the Nakagin Capsule Tower Preservation and Restoration Project has considered several measures, such as a plan to renew capsules, a renovation plan, leaving some part of the capsule tower or buildings intact, or the construction of a mini-capsule tower (Maeda & Yoshida, 2021). Conservation and Metabolist buildings might clash however, since metabolism is based on ideas of growth and change while conservation (as World Heritage rules) is the buildings its sustained or enhanced 'conditions of integrity and/or authenticity at the time of inscription' (Russell, 2020). Also the buildable potential of the site where its located doesn't get exploited enough, as it is also on leased land. Land prices are high in Ginza and it would be more profitable to build another building with a more efficient surface area-to-volume-ratio. (Buzzone, 2021;Maeda & Yoshida, 2021)

## Sky building nr 3

A redeveloped precedents, that is similar to the Nakagin Capsule Tower is the Sky Building number 3 (1972). By borrowing principles from prefab and the industrialisation of the modern movement, the architect Yoji Watanabe, used mostly steel, concrete and the basic idea of having a 14 story concrete frame core with 115 units branching off. The central core includes the main circulation, with the modular apartments being repeated on the two sides of this core. Each unit appears as a plugged in capsule, and sticks out the main volume. These units, capsules, have all equal access to natural lightning (Buzzone, 2021). The idea of cylindrical infrastructure trunks with branching of spaces, can also be seen in the Shizuoka Press and Broadcasting Centre (singular trunk with offices cantilevering off) and the Yamanashi Press can Broadcasting Centre (multiple trunks also connected through bridges) (Hart, 2021).

Different from the Nakagin Capsule Tower, is that from the interior multiple units form one single residential unit. On the floors, multiple units form a total of 4 housing per building layer with an exception at the 13th and 14th floor. Here, 4 units are combined to one large single residence. The 15th floor is a terrace (Buzzone, 2021). Also, unlike the Nakagin Capsule Tower, the Sky Building got renewed. Between the periods of the 1990s and 2000s, the building was in abandonment. It wasn't until 2010 that protection and repair actions were taken. A building's structure recovery was allowed through an re-use project (Buzzone, 2021). Main saviour in the salvation of the building, is the dynamicity of its capsule system that gave the possibility to establish new functions (Buzzone, 2021). Currently the building is a mixed use of offices, SOHO (small office home office), social apartments, and purposed floors for entertainment and cultural activities. The first two floors are in almost the original asset with the 2nd floor being preserved of its previous appearance of exposed concrete and atelier functions. The 3rd till 5th floor are used as offices, to make this happen some vertical elements were removed. The capsules on the 6th till 14th floor have been re-arranged to single units, to correspondent with the central corridor. The 6th till 8th floor include SOHO, the 9th floor a wide dining and living space at service of the complex and the 10th till 14th floor social apartments (Buzzone, 2021). All spaces are for lease and not sale. In order to adapt to the building its current standards, a seismic retrofit system has also been applied. Also some other interior and exterior interventions oriented towards energy

savings, such as thermal and acoustic insulation, applied to the interior stone wool (Buzzone, 2021). See Appendix 9 for more information of Sky Building nr 3.

# 6. SKY HOUSE

## 1. GENERAL PROJECT INFORMATION

Project: Sky House
Architect: Kiyonori Kikutake
Year: 1958
Location: Tokyo

## 2. KEY CHARACTERISTICS

### Multi-functional space

The house has a permanent, open living space that is floating above the ground on long thin columns, surrounded by temporary other spaces such as the children's rooms and the kitchen. Sky House is an example of the flexibility that Kikutake embraced throughout his design. It consists of square single multi-functional space, only partitioned with an isolated cupboard wall.

### Movenets

As defined by Kikutake for the movable and replaceable units of the kitchen, bathroom, and WC. Its structure is four pillars on four edges of the 10x10m square, supporting a relatively thin pitched roof plate and thick floor slab that contains all pipes and electricity connections (Tempel, 1969). This floor has an open plan with an exterior balcony. The exterior walls slide open, allowing access to the surrounding balcony. The interior walls are moveable and adaptable to the number of people occupying a certain space. The kitchen and toilets are moveable (Harris, 2014; Hidden Architecture, 2015; ArchEyes, 2020).

### Expandability

Indicating expandability, the plumbing comportments are located on two sides of the building.
Possible expansions are also suggested by incorporation of the 'move-nets'. Move nets are an extension of the main cell (the large open space), that can bee plugged into the floor and thus making the floor a net in which a new cell -capsule- can be hanged upon. This capsule can function as a bathroom, storage space, children's room. Initially, the ground floor is empty and gradually got occupied with spaces through move-nets (Harris, 2014; Hidden Architecture, 2015; ArchEyes, 2020). The first move-net was a bedroom, hanged from the concrete slab. The idea behind this was that once the children required their own room, the house could grow in form as it was specifically designed for change and adaption. Once the bedroom was not needed anymore, it got removed. During the 1980's, the ground floor became completely occupied and therefore connected with its terrain (Harris, 2014; Hidden Architecture, 2015; ArchEyes, 2020).

## 3. EVALUATION / CURRENT CONTEXT

Over the years, the Sky House has proven its adaptability. In 1968 multiple moving nets were added, in 1977 the moving nets were detached and other additional volumes were added. In 1985, these volumes were removed and again other larger volumes were added (ArchEyes, 2020). Currently, the sky house is still in use as a residential house (Triphobo, 2022).