Vertical building extensions

A strategic assessment framework for Housing Associations in the Netherlands

P2 report

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Abstract

This research investigates the strategic assessment of vertical building extensions as a viable solution for housing associations in the Netherlands. The study aims to explore decision-making frameworks, adaptive reuse strategies, and the factors influencing the success of vertical extension projects. Through a combination of literature review, qualitative interviews with key stakeholders, and case studies of existing projects, the research seeks to identify best practices, barriers, and opportunities in the implementation of vertical extensions, particularly in the context of housing associations. The findings will contribute to a deeper understanding of how housing associations can effectively address housing shortages while maximizing the potential of existing urban spaces.

Keywords: Vertical Extensions, Housing Associations, Decision-Making Frameworks, Adaptive Reuse, Case Studies

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1. Research Context

The housing shortage in the overheated housing market in the Netherlands is growing. According to ABF Research, by July 2024, the statistical shortage had risen to 400,500 homes, which is 4.9% of the total national housing stock. It is expected that the number of households will also continue to increase in all Dutch municipalities. ABF states that, due to the rising demand for housing, 232,000 new homes are immediately needed to meet the demand (ABF Research, 2024).

In the fall of 2024, the government presented plans to reduce the housing shortage. The government's ambition is to build 100,000 homes per year. The cabinet wants to build homes more efficiently and quickly, taking measures to stimulate this. The government has allocated €5 billion for affordable housing construction through 2029 (Rijksoverheid, 2024).

To move towards concrete implementation and solutions for these plans, the Minister organized a Housing Summit in the fall of 2024, with the participation of the national government, local governments, housing corporations, and market parties to make agreements. A new annual incentive package for affordable housing construction was also announced (VRO, 2024). During this summit, National Performance Agreements 2025-2035 were signed between the cabinet, Aedes, and VNG, which include additional measures to accelerate the construction pace by corporations as quickly as possible. The goal is to increase the annual realization of social rental homes from 18,000 to 30,000 by 2029. The parties agreed that housing corporations and municipalities will actively work to optimize the use of existing buildings and their surroundings to meet the housing demand. "This can be achieved through vertical extensions, transformations, the placement of flexible homes, splitting homes, or other modifications that create new living spaces"(VRO, 2025). At the same time, the agreements emphasize the importance of maintaining a good balance between intensifying the use of existing buildings and preserving liveability.

In addition to the housing challenge, achieving the Paris climate goals also demands the construction sector's attention. The built environment is responsible for 35% of global energy consumption and 38% of greenhouse gas emissions (United Nations Environment Program, 2020) A shift toward a more circular economy can help reduce these emissions. Preserving and reusing existing buildings, rather than demolishing and replacing them, is one of the most effective ways to apply circular economy principles (Gillott et al., 2022). This approach ensures that materials are preserved in their most valuable state for as long as possible. Vertical extensions involve modifying an existing building by adding additional floors. This not only prevents material waste but also creates new usable space while limiting the environmental impact of new construction (Gillott et al., 2022). This is where the housing challenge and adaptive reuse intersect.

Architects argue that many post-war neighborhoods offer ample space to expand existing buildings, which could help address the housing challenge. A significant portion of this space is located around properties owned by housing associations (KAW, 2020). However, opinions differ on whether the available rooftop space truly has the potential for vertical extensions by building owners.

Based on a quantitative analysis, Stec Groep estimates a potential addition of 100,000 homes through vertical extensions across the Netherlands (Geuting & Wevers, 2024). WoningbouwersNL is more critical of project feasibility and sees a potential of 15,000 to 28,000 homes (WoningbouwersNL, 2024). The Economic Institute for Construction (EIB) identifies significant technical potential but expects that financial, societal, and regulatory barriers will limit the actual addition to 2,250 to 3,000 homes per year through vertical extensions (EIB, 2024). Current experiences with project development appear to significantly impact the technical feasibility.

Stec further concludes from interviews that there is a lack of clear and publicly accessible examples of long-term profitability. Building owners often have a less precise understanding of the financial benefits of densification. As a result, the required short-term investment carries more weight in the decision-making process on whether or not to pursue vertical extensions (Geuting & Wevers, 2024).

Existing research on vertical extensions in the scientific literature often approaches the topic as a technical issue (Amer et al., 2017, 2019; Floerke et al., 2014; Gillott et al., 2022; Julistiono et al., 2023, 2023; Sundling et al., 2019; Wijnants et al., 2019). Sundling (2018) delves deeper into the development process for vertical extension projects (Sundling, 2018). However, there is a lack of research evaluating vertical extensions as a real estate activity within the existing portfolio strategy of housing associations.

In the Dutch context, the link between the policy-driven decision at the portfolio management level and the actual investment decision at the asset management level appears to be a weak point for housing associations (Nieboer, 2011). This underscores the importance of an integrated decision-making framework for vertical extensions.

2. Research Design

2.1. Problem statement and research aim

Although vertical extensions can be considered a form of adaptive reuse with the potential to contribute to addressing the housing challenge, housing associations remain cautious, and the theoretical potential has yet to translate into an increase in vertical extension projects. Studies have attempted to understand the technical complexity by identifying barriers and opportunities that could facilitate the development process. However, these studies do not incorporate the decision-making framework of building owners, such as housing associations. The key to integrating success factors into the decision-making processes of housing associations is still missing.

This research focuses on developing a decision-making framework to support housing associations in making informed investment decisions regarding vertical extensions. The goal is to enable the successful implementation of vertical extension projects while contributing to both the housing challenge and adaptive reuse.

2.2. Relevance

Although vertical extensions are actively encouraged at national, provincial, and sometimes municipal levels, practical implementation remains challenging. Progress lags behind the estimated potential, indicating a need for concrete tools and insights to successfully realize vertical extension projects (Stec, 2024)

Social Relevance
The housing shortage in the Netherlands is one of the most pressing societal challenges, with a shortfall of over 400,000 homes as of mid-2024. Developing an approach to vertical extension of existing buildings can help alleviate pressure on the housing market, particularly concerning the shortage of affordable housing. Additionally, vertical extension contributes to creating more sustainable urban environments. Optimizing the use of existing spaces can prevent further urban sprawl and potentially preserve green areas, contributing to more sustainable and livable cities.

Professional Relevance
For housing associations, which play a vital role in addressing the housing crisis, this research provides insights about decision-making and internal assessing of investments in addition to the latest report about vertical extension (Stec, 2024). It directly contributes to the field of portfolio and asset management and supports housing associations in making well-founded investment decisions.

Scientific Relevance
Scientifically, this research fills a gap in the academic literature on vertical extension of existing buildings, particularly in the context of housing associations. It offers new perspectives on adaptive reuse, building renovation, and the policy and financial frameworks that support these processes. The study contributes to broader academic discussions on sustainable urban development, solutions to the housing crisis, and the reuse of post-war buildings. Additionally, by developing an evaluation framework,

the research provides a valuable tool for future researchers and professionals to further study and implement vertical extension projects.
Within the Dutch context, there is a lack of academic literature on vertical extension by housing associations. While exploratory studies have been conducted by governments and private organizations (EIB, 2024; Geuting et al., 2023; KAW, 2020; Stec, 2024; WoningbouwersNL, 2024) and several master's theses have focused on vertical extension (Beun de, 2023; Bor, 2023; Wong, 2024; Zwanink, 2017), an in-depth analysis from the perspective of decision making of housing associations is missing. This research specifically examines the evaluation of vertical extension projects by housing associations, incorporating lessons learned from both completed and uncompleted cases. This focus highlights the scientific and practical significance of the study.

2.3. Target audience

This research primarily focuses on all housing associations in the Netherlands that own buildings in post-war neighborhoods. Where possible, the study will be conducted in collaboration with larger organizations of housing associations, making these associations not only the primary target group but also the direct recipients of the insights and recommendations resulting from this research. Housing associations such as SOR Rotterdam are actively involved in exploring the potential of vertical extensions as a solution to the housing shortage and improving urban livability.

Additionally, other partners of the associations, such as municipal governments, architects, and construction companies, play role in the execution of vertical extension projects. In coordination with the involved associations, the findings can be shared with these stakeholders. The outcomes of this research can help disseminate knowledge and strengthen decision-making processes related to vertical extensions, enabling them to contribute on a larger scale to addressing the housing shortage in the country.

2.4. Research questions

Main Research Question:

What does an effective decision-making framework for vertical extension projects look like that enables housing associations to successfully contribute to better utilization of the existing building stock in the Netherlands?

Purpose: To develop a practical decision-making framework that supports housing associations in making informed investment decisions about vertical extension projects. Also to contribute to the housing challenge through vertical extensions of existing buildings while helping housing associations achieve their strategic objectives by promoting adaptive reuse.

Subquestions:

1. How can vertical extension contribute to better utilization of the existing building stock?
   Purpose: Identify the possibilities and benefits of vertical extension for better utilization of the existing building stock.
   Method: A literature review.

2. How do housing associations make decisions on projects, and what evaluation frameworks influence these decisions?
   Purpose: Map out the process and factors that determine housing associations' decision-making for investment projects. Understand how internal and external evaluation frameworks influence investment decisions and identify challenges or opportunities in this context.
   Method: A literature review and interviews.

3. How are vertical extension projects currently evaluated by housing associations?
   Purpose: Analyze the current approaches, criteria, and methods housing associations use to assess vertical extension projects. Identify strengths and weaknesses in the existing approach as a basis for improving the decision-making framework.
   Method: Cross-case analysis and interviews.

4. What barriers and opportunities do housing associations identify for vertical extension projects?
   Purpose: Determine the key obstacles and opportunities in developing vertical extension projects. Understand how housing associations can overcome barriers and maximize opportunities to successfully implement projects.
   Method: Literature review, cross case analysis and interviews.

5. How should the decision-making framework for housing associations be designed to realize successful vertical extension projects?
   Purpose: Develop an integrated decision-making framework that aligns with the strategic and operational goals of housing associations. Provide a practical tool to help housing associations make informed decisions and implement successful vertical extension projects.
   Method: Expert meetings.

2.5. Research elements

This research distinguishes itself through the integration of various components that collectively form the foundation of the study, as visually represented in Figure 1. The first element involves a literature review on vertical extension projects and their potential to optimize the existing building stock in the Netherlands (sphere 1). The second element focuses on housing associations, examining how they make decisions and the evaluation frameworks that guide those decisions (sphere 2). The intersection of these two areas encapsulates the practical challenges and opportunities that housing associations encounter in implementing vertical extension projects. This intersection of spheres forms the core of this research.

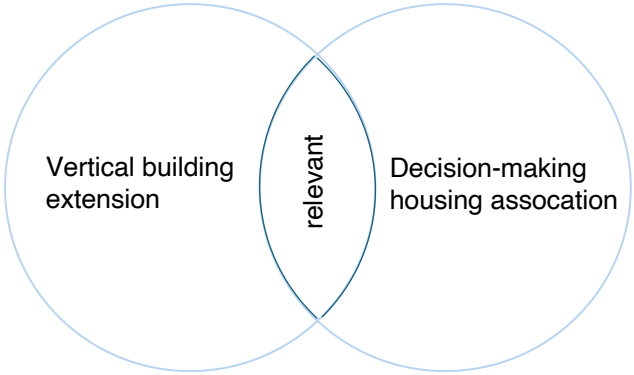


Figure 1: Research elements (own work)

The conceptual framework of this research is illustrated in Figure 2. It focuses on the role of vertical extensions in optimizing the existing building stock, with particular emphasis on the barriers and opportunities as strategic considerations within housing associations. These considerations are influenced by a complex set of factors, including financial constraints, regulations, and organizational capacities. The evaluation framework being developed helps to understand under which specific conditions vertical extension projects are most feasible. Further elaboration of the conceptual framework is presented in the following sections of this report.

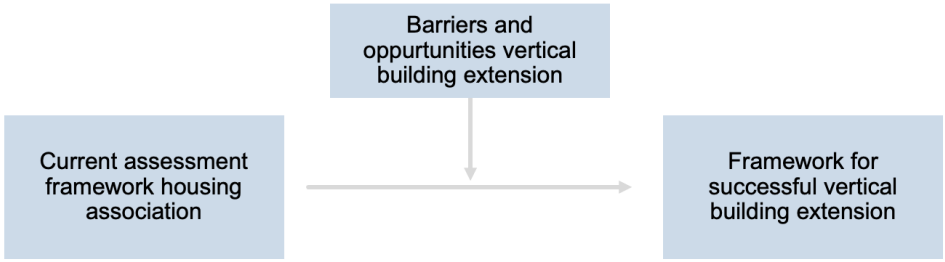


Figure 2: Conceptual model (own work)

2.6. Research methods

2.6.1. Qualitative research

This research uses a qualitative research methodology, which is suitable for exploring the complexity and dynamics of vertical extension projects and the decision-making processes within housing associations. According to (Bryman, 2012), qualitative research methods are particularly effective in examining how stakeholders make decisions and how specific contextual factors influence those decisions. This approach is appropriate for this study, as the goal is to understand how housing associations evaluate and implement vertical extension projects, a process influenced by multiple factors such as financial considerations, organizational structure, and external regulations. The applied qualitative methods include literature review, case studies, semi-structured interviews, and expert meetings. These methods enable the research to gain a deep understanding of both the theoretical and practical aspects of vertical extensions in the context of housing associations.

The first phase of the research will involve a literature review to gather theoretical insights on vertical extension, adaptive reuse, and decision-making frameworks. This phase will provide a foundation for understanding the key concepts and variables involved in the study. Additionally, a document analysis of existing reports, policy documents, and guidelines from housing associations will help establish the current framework for evaluating vertical extension projects.

In the next phase, qualitative interviews will be conducted with key stakeholders within housing associations, including project managers, asset managers, and financial experts. These interviews will provide practical insights into the decision-making processes and the factors influencing the success or failure of vertical extension projects. The interviews will be semi-structured, allowing for flexibility while ensuring that specific areas of interest are addressed.

A case study approach will also be applied to analyze specific vertical extension projects, both successful and less successful, to extract valuable lessons and best practices. By examining real-world examples, this research will identify the factors that contributed to the success or failure of projects, as well as the barriers and opportunities that housing associations encountered during implementation.

Finally, the research will be concluded with an expert meeting, in which the developed decision-making framework will be validated and refined based on feedback from professionals with extensive experience in the field. The expert meeting will provide strategic and practical input that ensures the framework is both relevant and applicable to housing associations.

2.6.2. Research methods

Literature review

The research will begin with desk research, which consists of a literature review to uncover existing knowledge on vertical extension projects and decision-making within housing associations. Introducing a new decision-making framework for vertical extension projects requires a thorough understanding of the existing knowledge and trends in this area. The aim of this literature review is to gain insight into three key aspects: the role of vertical extension in optimizing the building stock, the decision-making processes within housing associations, and the success factors of vertical extension projects. The outcomes of this desk research will serve as a foundation for the subsequent phases of the study.

Document analysis

Relevant documents, such as policy reports and guidelines from housing associations, are analyzed to understand the current framework for vertical extension and decision-making. The document analysis highlights the financial, organizational, and regulatory considerations housing associations encounter. This provides valuable context for developing practical steps for vertical extension projects.

Cross-Case analysis

The cross-case analysis examines specific vertical extension projects from housing associations to understand how they address technical, financial, and organizational challenges. It focuses on both successful and less successful projects. The case study provides practical lessons and insights that can assist housing associations in the implementation of their own vertical extension projects.

By studying multiple cases in different circumstances, a cross-case analysis contributes to strengthening theories by showing where these hold up or fail (Bryman, 2012).
There are four selection criteria for choosing the case studies that will be examined in the cross-case analysis:

- The project must have been recently completed or is expected to be completed by 2025 at the latest.
- Sufficient documentation must be available, and possibly additional information that can be found online.
- All projects must be located in the Netherlands so that the context can be well understood.
- The case studies will be selected using purposive sampling. This means that the cases are not chosen randomly, but are strategically selected to ensure their relevance to the research question (Bryman, 2012).

Interviews

Semi-structured interviews are an effective way to gain deeper insights into the complex dynamics of specific projects and processes. Groat and Wang (2013) argue that it is often more useful to thoroughly investigate the detailed aspects of one case, rather than superficially analyzing a large number of cases (Groat & Wang, 2013). In this research, the second phase of the empirical study focuses on conducting in-depth interviews with key individuals from 2-3 selected cases, which were chosen earlier based on the cross-case analysis. Topics covered during the interviews will include:

- Evaluation criteria for vertical extension projects
    - What specific factors are considered when evaluating vertical extension projects?
- Decision-making processes
    - How are decisions made regarding the feasibility and execution of vertical extension projects within the housing association?
- Organizational challenges
    - What organizational obstacles do housing associations encounter when implementing vertical extension projects?
- Financial considerations
    - How is the financial feasibility assessed, and what financing models are considered for vertical extension projects?
- Collaboration with external parties
    - What role do external partners, such as architects, contractors, or municipalities, play in the execution of vertical extension projects?
- Opportunities and benefits of vertical extensions
    - What do housing associations see as the key benefits of vertical extensions for the existing building stock?
- Barriers to vertical extension projects
    - What are the biggest barriers that housing associations encounter when realizing vertical extension projects?
- Lessons from previous projects
    - What are the main lessons learned from previous vertical extension projects, and how are these applied in new projects?
- Strategic goals of housing associations
    - How do vertical extension projects fit into the broader strategic goals of the housing association?

Expertpanel

An expert meeting with involved housing associations will be organized to gather detailed insights and specific expertise from people with extensive experience on the subject. The focus will be on obtaining substantive and strategic feedback on the decision-making framework.

The goals of organizing this expert panel are:

- To verify the results and the identified barriers and opportunities from the empirical phase;
- To verify the design of the decision-making framework;
- To expand and/or adjust the process model so that it better aligns with practice;
- To test the model as a representative of the research findings.

The expert panel is considered an effective method for validation and feedback, which is necessary to create a decision-making framework that is usable in practice. For a successful session, it is important to involve as many disciplines or types of stakeholders from the vertical extension project process as possible, such as initiators/clients, developers, financiers/investors, consultants, and project/process managers (at least one participant from each type of discipline).

The advantage of organizing an expert panel is that the chairperson can guide the discussion toward a consensus or final judgment, and it is possible to discuss complex issues thanks to the variety of backgrounds of the participants (Slocum, 2003).

Sub-question	Literature review	Document analysis	Interviews	Case-study	Expert-panel
1.How can vertical extensions contribute to better utilizing the existing building stock?	X				
2.How do housing associations make decisions on projects, and which evaluation frameworks influence these decisions?	X	X			
3.How are vertical extension projects currently assessed by housing associations?		X	X	X	
4.What barriers and opportunities do housing associations identify for vertical extension projects?	X	X	X	X	
5.How should the assessment framework for housing associations be designed to enable successful vertical extension projects?			X	X	X

Table 1 Visual summary of the method(s) per sub-question

Internship
This research is linked to a graduation internship at Van der Bouw, a construction management and consultancy firm. Van der Bouw maintains extensive contacts with housing associations across the Netherlands, providing access to a wide network for interviews, cases and valuable insights. In addition, the provinces offer a quickscan through Van der Bouw, which helps housing associations explore the feasibility of roof extension projects. This (financial) incentive encourages housing associations to consider vertical extensions as a solution to the housing shortage, thus providing a relevant context for the research.

2.6.3. Ethical considerations and dataplan

The data management plan describes how the data in this research will be collected, processed, stored, and shared. The primary goal is to ensure the privacy of the participants and to manage the data securely. The following types of data will be collected during the research:

- Recordings of interviews
- Codings of success factors
- Reports and recordings of the expert panel
- Documentation of case studies

All recordings and data involving human participation will be collected only after obtaining consent from the participant. The collected data will be handled with care, and the anonymity of the participants will be guaranteed.
The researcher is responsible for managing the data, including interview recordings, codings, expert panel notes, and case study documentation. After the research is completed, the researcher will ensure the secure storage of the data on an external hard drive and a separate storage drive. The final research output, the thesis, will be publicly accessible in a repository. All raw data, such as documentation and additionl information, will be permanently deleted and made untraceable after processing.

Participants will always be informed in advance about the goals of the different parts of the research. They have the right to refuse questions that make them uncomfortable or conflict with their ethical beliefs or privacy. Furthermore, their data will be anonymized to avoid ethical issues after publication. Prior to publication, all participants will be informed about the processing of their data, such as their interview, case study, or the role they played.
In cases where the research is conducted within a corporate environment, such as during an internship, sensitive company information may appear in the thesis. In such cases, measures will be taken to ensure that this information is not shared with third parties and is presented in a way that does not allow the company to be identified. The data management plan will be re-evaluated before the completion of the thesis and adjusted if necessary.

2.7. Research outputs

2.7.1. Goals and objectives

The primary goal of this research is to develop an integrated decision-making framework that supports housing associations in making informed investment decisions about vertical extension projects. This framework should help housing associations successfully implement vertical extension projects while contributing to solving the housing shortage in the Netherlands.

The specific objectives are:

- Mapping decision-making processes: Investigating how housing associations currently make decisions about vertical extension projects and which internal and external evaluation frameworks influence their choices.
- Evaluating current assessment methods**:** Analyzing existing practices for assessing vertical extension projects, identifying strengths and weaknesses to improve the decision-making process.
- Identifying barriers and opportunities: Identifying the main challenges and opportunities for housing associations in implementing vertical extension projects and finding ways to overcome these obstacles.
- Developing an integrated decision-making framework: Creating a structured, practical tool that helps housing associations assess the feasibility of vertical extension projects based on strategic and operational objectives.

2.7.2. Deliverables (including datasets)

The expected deliverables are:

- Comprehensive literature review: A report detailing the benefits, limitations, and case studies of vertical extension, both in the Netherlands and internationally.
- Decision-making framework for housing associations: A detailed, practical framework tailored to the needs of housing corporations, enabling them to make informed decisions about vertical extension projects.
- Case study report: A collection of case studies documenting both successful and unsuccessful vertical extension projects, offering valuable lessons.
- Interview data: Data collected from interviews with key stakeholders, such as portfolio and asset managers from housing corporations, policymakers, and experts in the field.
- Expert validation sessions: The results of expert meetings in which the proposed decision-making framework is tested and validated by stakeholders in the housing sector.

2.7.3. Dissemination and target audiences

- Primary audience
    - Housing corporations in the Netherlands, particularly those owning property in post-war neighborhoods. The insights from this research will help them assess the feasibility of vertical extension projects.

- Secondary audience
    - Local, regional, and national governments, especially policymakers involved in housing and urban development.
    - Academic researchers and students interested in sustainable urban development, adaptive reuse, and the housing crisis.

- Dissemination channels
    - Report: final report will be shared with housing corporations, governmental agencies, and academic institutions.
    - Workshops or presentations: Where possible, workshops and presentations will be held with key stakeholders, including housing corporations, municipalities, and relevant organizations such as Aedes, to present findings and the decision-making framework.

2.8. Research Plan

2.8.1. Tasks

The research consists of the following main activities:

No.	Task	Description
1	Literature review on vertical extension and adaptive reuse	Collecting information on the benefits, limitations, and existing examples of vertical extension.
2	Literature review on decision-making processes of Housing Corporations	Investigating how housing corporations make decisions about vertical extension projects and which internal and external evaluation frameworks influence their choices.
3	Case study analysis of completed and uncompleted vertical extension projects	Analyzing successful and failed vertical extension projects to identify strengths and weaknesses.
4	Interviews with housing corporations and policymakers	Gathering practical insights into the barriers and opportunities in vertical extension projects from the perspectives of housing corporations and policymakers.
5	Development of an Integrated Decision-Making Framework	Creating a structured decision-making framework for housing corporations to assess vertical extension projects.
6	Validation of the Decision-Making Framework through Expert Meetings	Testing the decision-making framework with experts and stakeholders in the housing sector to refine and validate it.
7	Reporting	Writing and presenting the research results in the form of a final report and publications.

Table 2 Taks of the graduation plan

2.8.2. Milestones

To achieve realization, the research process includes the following milestones:

Milestone 1: Completion of the literature review
The literature review should be completed, with a detailed analysis of the benefits, limitations, and examples of vertical extension in other countries.

Milestone 2: Completion of interviews with housing corporations and policymakers

The collection of input from portfolio and asset managers, policymakers, and experts should be completed, ensuring a full understanding of decision-making processes.

Milestone 3: Completion of the case study analysis
The analysis of completed and uncompleted vertical extension projects should be finished.

Milestone 4: Completion of the design of the decision-making framework
A first version of the decision-making framework should be ready and prepared for expert validation.

Milestone 5: Validation of the decision-making framework
The decision-making framework must be validated by experts and stakeholders in the housing sector.

Milestone 6: Completion of reporting and dissemination
The final report and publications should be completed and shared with the target audiences.

2.8.3. Interdependencies between tasks and milestones

The literature review (Task 1) forms the basis for the subsequent tasks, such as the case study analysis (Task 3) and interviews with housing corporations (Task 4). It must be completed first before other tasks can be carried out.

The decision-making processes of housing corporations (Task 2) and the case study analysis (Task 3) can be conducted in parallel, but the results from the interviews are necessary for developing the decision-making framework (Task 5).

The case study analysis (Task 3) and interviews (Task 4) must provide the key input for designing the decision-making framework (Task 5), which will form the basis for validation (Milestone 5).

Validation of the decision-making framework (Task 6) depends on the completion of the framework design (Milestone 4). Feedback from the experts during validation must be processed before the reporting (Task 7) can begin.

Reporting (Task 7) can only be completed after the validation process (Milestone 5) and the integration of feedback.

3 Literature study

3.1. Vertical extension

This paragraph defines vertical extension, explores the circularity concept of better utilizing the existing stock, and highlights the approach to vertical extension from existing research. The goal is to answer the first sub-question: How can vertical extension contribute to better utilizing the existing building stock in the Netherlands?

3.1.1. Vertical extension as adaptive reuse

Vertical extension is closely linked to the concept of adaptive reuse, which is defined by Holden (2018) as the repurposing and adaptation of existing buildings for new functions. This approach emphasizes the importance of preserving the existing built environment while simultaneously addressing the changing needs of society. Holden (2018) states that adding new structures to the roofs of existing buildings not only extends the lifespan of the original building but also reduces the ecological footprint of the construction sector. This is particularly relevant in urban areas where space is scarce and the pressure to create new housing is increasing.

Furthermore, vertical extension as a form of adaptive reuse offers the opportunity to explore innovative architectural solutions that enhance the aesthetic and functional value of urban environments. Holden (2018) points out that this approach allows cities to maintain their historical and cultural identity while simultaneously responding to modern demands for sustainability and efficiency. By combining old and new elements, vertical extension can contribute to dynamic urban development that promotes both social cohesion and economic vitality, which is essential for creating resilient cities in the future (Holden, 2018).

The *Circulair Renoveren* handbook emphasizes the importance of reusing existing structures as a crucial aspect of circular renovation and provides housing corporations with tools and strategies for this (Van Stijn & Stolker, 2021). By optimizing and renovating existing buildings, housing corporations can reduce the ecological impact of the construction sector and extend the lifespan of these buildings. This aligns with the need to integrate circular solutions into renovation practice, with a focus on preserving materials and minimizing waste (Van Stijn & Stolker, 2021). In addition to environmental gains, Stolker & Stijn identify several opportunities for housing corporations in a circular approach:

- Extending the lifespan of homes (allowing for longer exploitation) and increasing the value of homes.
- Stimulating climate neutrality and accelerating the energy transition.
- Making housing more affordable and comfortable for residents.
- "Picking low-hanging fruit": In practice, often more is possible for the same cost than expected.
- Capitalizing on the circular momentum and gaining practical experience that increases circular knowledge and sparks further innovation.
- Exploring new forms of collaboration and forming long-term partnerships.
- Taking on a societal leadership role.
- Building more flexibility into the housing stock to respond to future changes in tenant housing preferences.
- Gaining more control over your future by managing your own innovation processes.
- Securing raw materials (cost & availability).

Although the handbook does not specifically address the concept of "vertical extension," it does provide a framework for repurposing and adapting existing structures, which can contribute to more sustainable and efficient urban development.

3.1.2. Vertical extension and energy-efficient renovation

In a study by Sundling (2018), the financial and environmental feasibility of various building renovation concepts from the 1970s in Gothenburg was explored. The results of this study showed that the combination of an energy-efficient renovation with a vertical extension (roof extension) yielded the highest return on investment and the lowest environmental impact compared to other renovation concepts, such as minimalist or code-compliant approaches. The concept of a low-energy renovation combined with a vertical extension not only improved the building's energy efficiency but also promoted

financial feasibility by adding more homes without expanding the available urban space further (Sundling et al., 2019).

These findings highlight the benefits of vertical extensions as a solution to both the housing shortage and sustainability goals. Vertical extensions not only provide additional housing space in high-demand areas but can also contribute to reducing energy dependence and environmental impact, as it is often possible to retain and upgrade the existing structure (Sundling, 2019). This creates a key synergy between the need to achieve sustainability and the need to increase the housing stock without further urban sprawl. Sundling's study (2019) emphasizes the importance of an integrated approach to renovation, combining energy efficiency with urban densification, which can contribute to more sustainable and resilient cities in the long term.

Combining vertical extensions with sustainability measures, such as energy-efficient renovations, thus presents a promising strategy to meet the growing demand for housing while simultaneously reducing the ecological footprint and strengthening the urban environment. This approach is particularly relevant for addressing the challenges associated with aging housing stock and limited available space in densely populated urban areas and can therefore be a significant reason for housing corporations to consider vertical extensions.

Gohardani et al. (2015) also highlight the crucial importance of early decision-making in the renovation process. They argue that to implement energy-saving measures effectively, a strategic approach in the early stages of the project is essential. During the pre-planning and planning phases, key decisions need to be made about integrating energy-saving measures into planned renovations, with the involvement of energy experts being crucial. This process ensures that energy-saving measures are not merely considered later in the renovation but are integrated into the planning from the start. The success of this approach is evident in the case studies, where energy-saving measures were actually implemented as part of major renovations due to early investment in the evaluation and approval of such measures (Gohardani et al., 2015).

3.1.3. Vertical extensions and the development process

In Sundling (2018), a development process for vertical extensions of buildings is presented, based on four case studies in Sweden. This process consists of seven essential steps that are necessary for the successful implementation of vertical extensions. The seven steps are:

1. Opportunities for Vertical Extension:

This step involves identifying opportunities for vertical extension, considering factors such as housing demand, location, and the construction capacity of the existing building. A high demand for housing in a specific area, for instance, can strengthen the need for a vertical extension, especially when the existing structure offers sufficient potential for expansion (Sundling, 2018).

2. Strategies for Implementation:

The second step involves determining the implementation strategy. Evaluating the load-bearing capacity of the structural foundations is crucial to assess whether the existing construction can handle the additional weight of a vertical extension. This can result in three outcomes: no reinforcement required, reinforcement needed, or no feasible reinforcement possible (Sundling, 2018).

3. Detailed Planning Process:

In this step, a detailed plan for the extension is developed, addressing all technical aspects of the renovation. This includes the design and structural adjustments necessary for the vertical extension, ensuring compliance with relevant regulations (Sundling, 2018).

4. Concept Development:

This step focuses on developing the concept for the extension, where design choices and functional requirements are determined. This process must ensure that the extension integrates well with the existing building and meets the future residents' needs (Sundling, 2018).

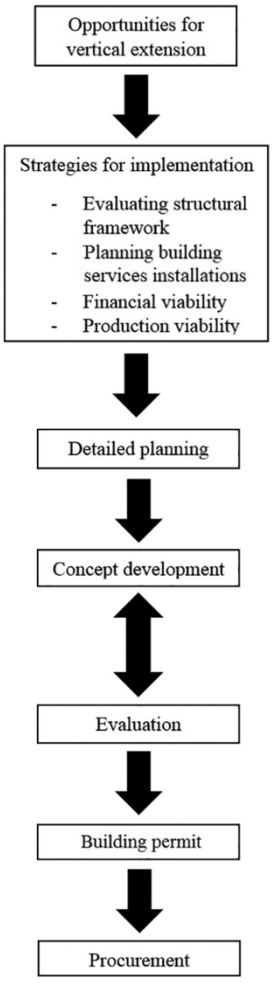


Figure 3. Sundling (2018)

5. Evaluation:

The evaluation involves assessing the feasibility of the extension based on various criteria, such as market demand, costs, and environmental impact. This helps validate the project and provides a basis for decision-making on whether to continue the process (Sundling, 2018).

6. Building Permit:

Obtaining the necessary building permit is a critical step in the development process. This involves getting approval from local authorities to ensure that the extension complies with zoning plans and building codes (Sundling, 2018).

7. Procurement:

The final step concerns procurement, where contracts for construction are awarded. This process is vital for actually realizing the vertical extension and involves selecting contractors and defining the project scope (Sundling, 2018).

These seven steps form the framework for successfully implementing vertical extensions, with each step needing careful planning and execution to make the project financially and technically feasible. The development process presented by Sundling (2018) provides insights into the complex factors involved in the decision to vertically extend a building, emphasizing the importance of detailed planning, evaluation, and permits.

3.1.4. Vertical extensions and the decision-making process for municipalities

The decision-making process for vertical extensions, particularly in the context of urban densification, involves multiple stages, as demonstrated in the methodology developed by Amer et al. (2017). Vertical extension refers to adding additional stories to existing buildings, a solution that can address growing housing demands in urban areas without expanding city boundaries. This approach to densification requires a structured, multidisciplinary decision-making process that engages various stakeholders at the municipal level, including urban planners, architects, engineers, and local residents.

Amer et al. (2017) propose a three-phase workflow to guide the decision-making process for vertical extensions. The first phase, *urban and policy configurations*, involves assessing the primary need for densification based on urban policies, population forecasts, and the regulatory framework established by the municipality. Municipal decision-makers must consider factors such as population growth, urbanization strategies, and the potential for transforming existing buildings through vertical extension. Additionally, urban heritage regulations can pose constraints, as listed heritage buildings may be restricted from modifications or face minimal intervention (Amer et al., 2017). This phase sets the foundation for understanding whether vertical extension is a viable solution and what urban configurations allow for such developments.

The second phase, *engineering configurations*, focuses on evaluating the structural capacity of the buildings within the identified urban area. In this phase, available data, often obtained from Geographic Information Systems (GIS), are used to assess the type of building structure and foundation, which are essential in determining if the building can accommodate additional floors. Depending on the existing building's structural integrity, the extension may require reinforcement or may be deemed unfeasible. The accuracy of this analysis depends on the availability of detailed structural data, and it provides an initial estimation of the building's ability to support vertical extensions (Amer et al., 2017).

The third phase, *architectural configurations*, involves a detailed architectural assessment where planners, architects, engineers, and residents work together to finalize the design and ensure the feasibility of the vertical extension. This phase incorporates precise measurements and analysis to confirm the building's ability to handle the additional load, including the effects on plumbing, sanitation, and other utilities. This detailed evaluation is crucial for securing approval from municipal authorities and initiating the actual construction process. Once all the necessary architectural and structural adjustments are addressed, a final decision is made on the extent of the vertical extension that can be implemented (Amer et al., 2017).

The methodology developed by Amer et al. (2017) not only emphasizes the technical and architectural feasibility of vertical extensions but also highlights the role of urban planners in making informed decisions that align with the municipality's sustainable development goals. It also underscores the need for a collaborative approach, where all relevant stakeholders are involved throughout the process. Moreover, the methodology offers valuable insights for municipalities looking to adopt vertical extensions as part of their urban densification strategies.

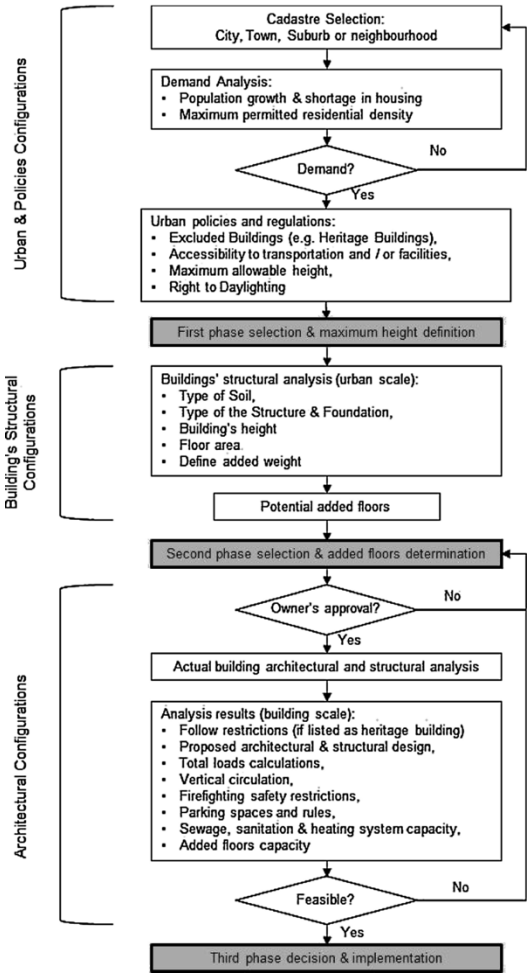


Figure 4. Amer, et al. (2017)

3.1.5. Drivers, barriers and enablers

According to Gillot et al. (2022), identifying drivers and barriers plays a key role in realizing vertical extensions and sustainable construction practices. For example, Sundling's (2019) research identified some important enablers, such as the presence of reserve structural capacity, stakeholder involvement and collaboration, and early evaluation of options. Although Sundling mentioned these enablers, no specific approach was presented to realize these conditions, highlighting the need for further research (Sundling et al., 2019). (Gillott et al., 2022) built on this work and examined the main enablers for vertical extensions, considering real-world case studies with the entire construction sector as the target population.

Category	Drivers	Barriers	Enablers
Economic	- Primary drivers are economic: desire to increase asset value at a reduced cost. - Possible savings in land costs, reduced material requirements, and shorter project timelines compared to new build projects. - 32/50 respondents believe material costs will be lower for vertical extensions. - Embodied carbon savings seen as secondary benefit.	Uncertain business case due to variations in building form, condition, and extension suitability. - Commercial risk due to upfront investment (e.g., site investigations, structural appraisal) with no guarantee of extension feasibility. - Clients may opt for new builds instead of vertical extensions due to risk aversion.	No specific economic enablers

Technical	- Vertical extensions are seen as feasible due to potential reserve structural capacity in existing buildings. - Some engineers believe additional capacity (20–30%) can be found in most structures. - Engineers generally agree that vertical extensions are possible with suitable appraisal and investigation.	Structural capacity: engineers recognize the need for structural strengthening if additional capacity is not available. - Structural appraisal is a specialized skill, leading to a division of experience between engineers who understand existing buildings and those relying on outdated methods. - Lack of original design information often requires costly structural investigations. - Spatial constraints like restrictive structural grids, floor-to-ceiling heights, and insufficient core/riser space for services. - Site access and operational challenges in buildings with ongoing use.	- Enhanced education for engineers on structural appraisal and adaptive reuse. - More tools, guidance, and training for vertical extension design. - Design tools to help engineers address vertical extension challenges. - Engineers encouraged to understand adaptive reuse and its role in combating climate change.
Cultural	- Corporate inertia and resistance to innovation in the construction sector hinder vertical extensions. - Initial resistance to new ideas and techniques can result in delays and added investment, but typically recouped later in project stages	- Resistance to innovation due to the conservative nature of the construction sector. - Difficulty in getting stakeholders "on board" with extension schemes	- The formation of long-term partnerships is considered a key enabler for adoption. - Less emphasis on CSR or personal moral obligations in driving vertical extensions.
Legal	- VAT for new builds is zero-rated in the UK, while VAT for structural alterations is 5–20%. This tax regime discourages refurbishment and vertical extensions.	- Tax regimes act as a barrier, making new builds more financially favorable over refurbishment projects. - Planning permission for vertical extensions can be challenging, with potential delays and additional costs. - Planning process can be lengthier and more onerous, leading to uncertainty.	- No specific legal enablers mentioned in the provided text.

Table 3. Gillot et al. (2022)

3.1.6. Conclusion

Vertical expansion offers a promising solution to the housing shortage and sustainability goals in the Netherlands. By utilizing existing buildings and adding extra floors, it aligns with the circular economy and reduces the ecological footprint. Research shows that combining rooftop extensions with energy-efficient renovations not only improves energy performance but also enhances financial feasibility. Although housing corporations have not received much attention in existing research, the combination of vertical expansion and sustainability provides valuable insights for their challenges. An integrated approach with early planning and collaboration is essential for success.

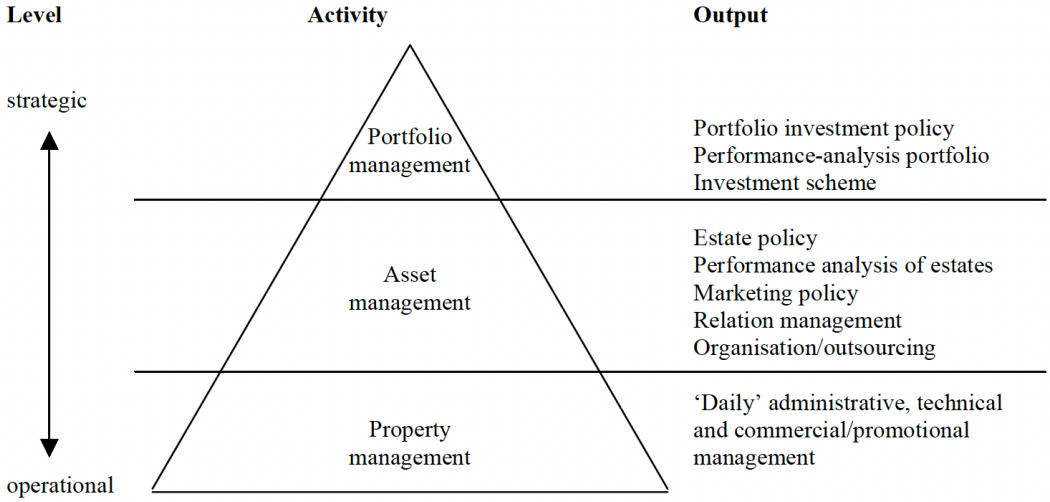
3.2. Decision-making housing associations

By incorporating vertical expansion into the portfolio strategy, the question arises as to how the feasibility of real estate activities is assessed. This paragraph delves into the extent to which processes have been standardized. This provides an answer to the sub-question: What does the evaluation framework for new developments look like for housing corporations, and what assessment frameworks underlie this?

3.2.1. Process of decision-making

In the literature on decision-making by housing corporations, strategic asset management has become increasingly important, especially after the policy changes in the 1980s and 1990s that strengthened market orientation in the social rental sector (Gruis & Nieboer, 2004). Social landlords had to adapt to a dynamic market and gain more freedom in their policies, which forced them to manage their housing portfolios more strategically. Gruis and Nieboer (2004) define strategic asset management as the process by which housing corporations anticipate market developments and develop long-term strategies to align their housing stock with changing demand. This decision-making process requires a systematic and market-oriented approach, where social landlords no longer consider their housing stock as static property, but as a dynamic asset that must be continuously adjusted.

Figure 1: Organisational levels of real estate management

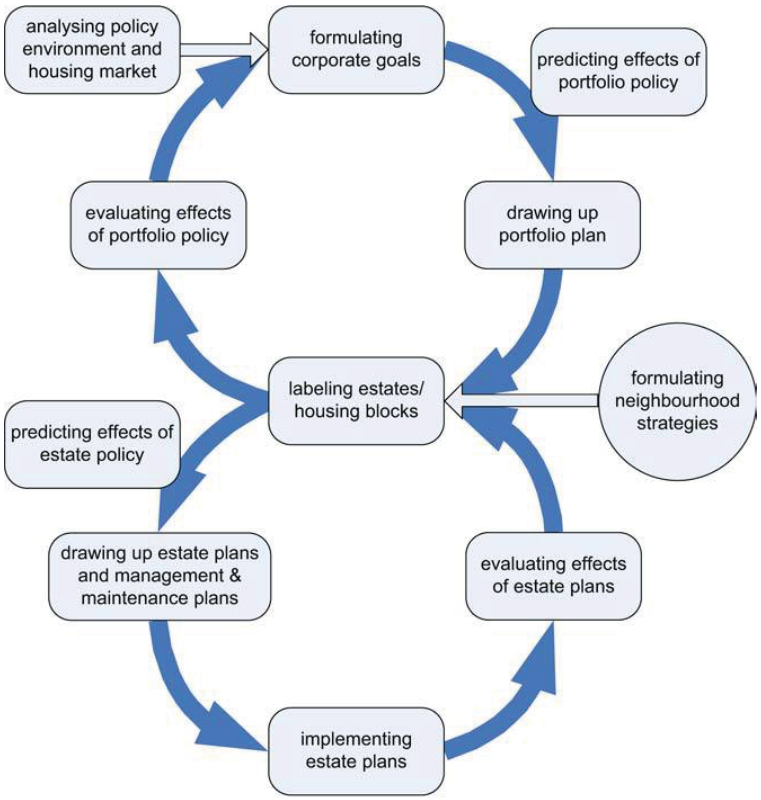


Source: Miles *et al.* (1996).

The decision-making process within strategic asset management follows a sequence of analyzing the current situation, formulating policy options, evaluating these options, and developing a final strategy for the housing portfolio. Gruis and Nieboer (2004) emphasize that the use of strategic planning models, such as Kotler's model, helps housing corporations make informed choices when developing long-term policies. This increases the effectiveness and efficiency of decision-making, which is crucial for housing corporations that must navigate between social policies and financial sustainability.

In the Dutch non-profit housing sector, models have been developed to structure and systematize decision-making regarding investments in the housing stock (Nieboer, 2011). An example of this is the planning process model by Van Os (2007).

Nieboer (2010) examined the feasibility of strategic business planning models for the non-profit housing sector by reflecting them with housing corporations. Case studies were conducted with six Dutch non-profit landlords. The finding is that the influence of portfolio policy on investment choices at the property level is modest. The models being used appear to be unsuccessful in their impact on actual investments: the models assume that policy can be implemented vertically and top-down, while in practice, the policy is shaped by other strategies, beliefs, and motives within the organization.



Source: Van Os (2007, p. 25) (own translation)

3.2.2. Criteria voor investment decisions

Gruis and Nijboer (2004) discuss various criteria that are important for decision-making regarding investments in the housing stock of housing corporations. One important aspect is the application of strategic business models, such as the use of portfolio analysis, in which the market position of the housing stock and the future outlook of the housing market are analyzed. Investments are determined not only by financial considerations, such as the economic feasibility of the project, but also by the technical quality of the homes and the market demand for specific types of housing. In addition, corporations must take into account government policies and the requirements of stakeholders, such as tenants and local governments. This process must be systematic and market-oriented, with investment choices and the management of the housing stock aligned with expected developments in the housing market and the social objectives of the corporations (Gruis & Nieboer, 2004).

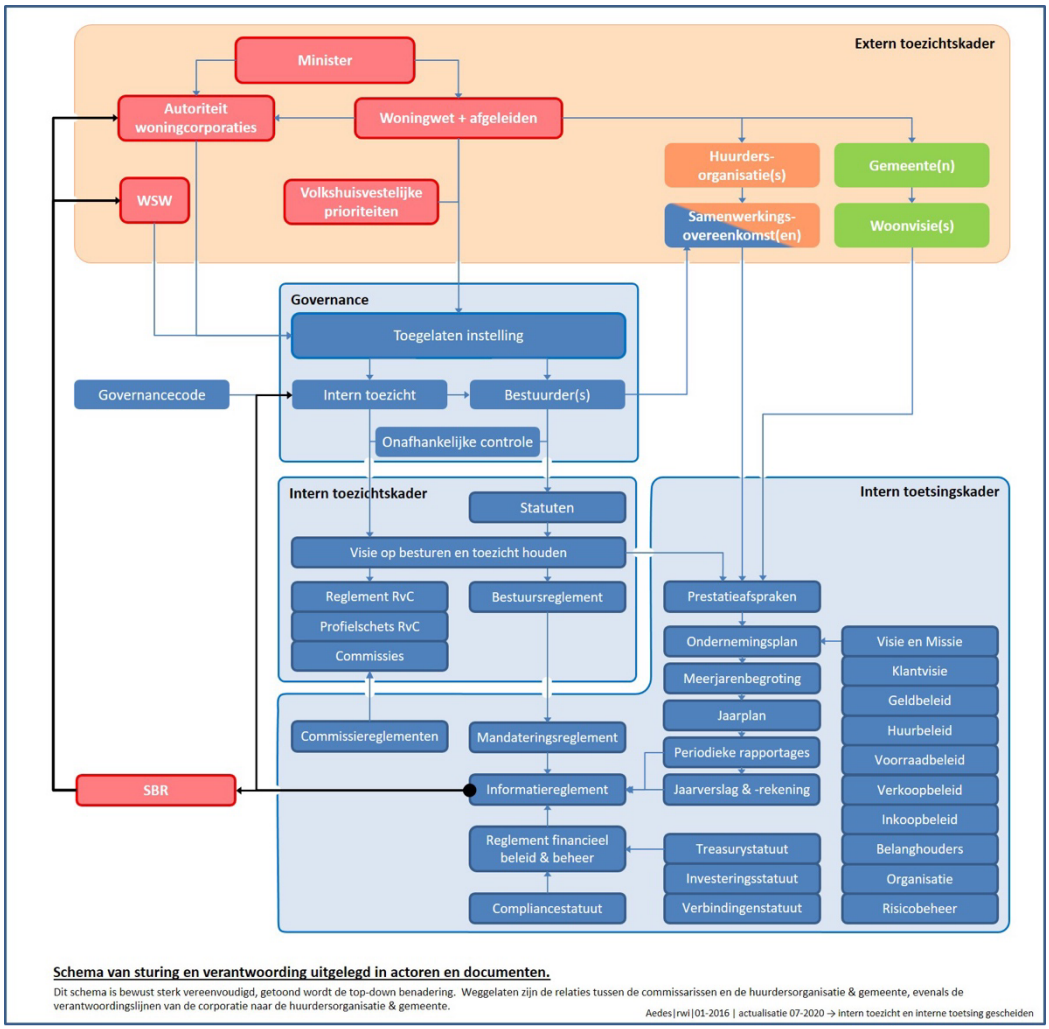
Table I: Decision factors in strategic housing management of housing association De Combinatie, Rotterdam

Housing association De Combinatie (11,000 homes in the city of Rotterdam) has used the following seven predefined categories of factors that it regards as crucial in the formulation of its strategic housing management:	
1	housing market (surpluses and shortages, market expectations);
2	lettability (turnover rate, vacancy, difficulty of reletting);
3	tenant involvement and tenant preferences;
4	policy environment (government regulations, agreements with other parties, neighbourhood development plans);
5	estate characteristics (technical condition, equipment, location);
6	portfolio mix (present composition of the housing stock, regarding size, target group, technical quality);
7	costs and revenues (discounted cash flow, market value).

Note: Sustainability has not been defined as a decision factor, but will be taken into account in the near future.

3.2.3. Context with external factors

The Steering and Accountability framework from Aedes, the industry association of housing corporations, is used within the sector as a framework for clarity (Hardy & Bruil, 2021). Broadly, the framework provides a top-down view of the external framework involved, including the Housing Act, the position of the Housing Corporation Authority, the WSW, and the link to municipal politics. Through blue highlighting, it becomes clear what the internal governance, supervision, and assessment frameworks of individual housing corporations entail (Aedes, 2016 update 2020). Real estate activities are included in this framework under the Multi-year Budget, Annual Plan, and Business Plan, based on mission, vision, customer vision, and more. By submitting a proposal to the municipality's Housing Vision, corporations and municipalities periodically agree on performance agreements regarding new real estate activities, such as rooftop expansions (Hardy & Bruil, 2021).



Strategic Portfolio Policy

The strategic portfolio policy translates the mission and vision into a forward-looking alignment of the real estate portfolio with societal goals. This policy addresses, among other things, the development of target groups, the desired composition of the housing stock, and investment programs (such as rooftop expansions). The policy is assessed by the Housing Corporation Authority (AW) and the Social Housing Guarantee Fund (WSW) and serves as a basis for investment proposals presented to the Supervisory Board (RvC)(Hardy & Bruil, 2021).

Financial continuity

The decisions made by a housing corporation regarding new investments are also dependent on the financial capacity of the corporation. For the financial continuity of the corporation, a quantitative framework with ratios and thresholds is applied, established by AW/WSW, including ICR, LTV, and solvency. This assessment focuses on three components: liquidity, equity, and coverage/collateral.

Tabel 2: Ratio's en grenswaarden

Ratio	DAEB	Niet-DAEB	Enkelvoudig/ geconsolideerd
ICR	1,4	1,8	1,4
LTV	85%	75%	85%
Solvabiliteit	15%	40%	15%
Dekkingsratio	70%	70%	70%
Onderpandratio (WSW)	n.v.t.	n.v.t.	70%

The score on these ratios is taken into account when making decisions about new investments, as the data required for the assessment of the ratios includes: (Hardy & Bruil, 2021)

- Cash flow statement: actual + 5-year forecast;
- Balance sheet (based on market value of real estate): actual + 5-year forecast;
- Market value of loans: actual (no forecast);
- Policy value of real estate: actual + 5-year forecast.
  The cash flow statement represents how the corporation aligns its vision of the social task, portfolio strategy, and real estate activities.

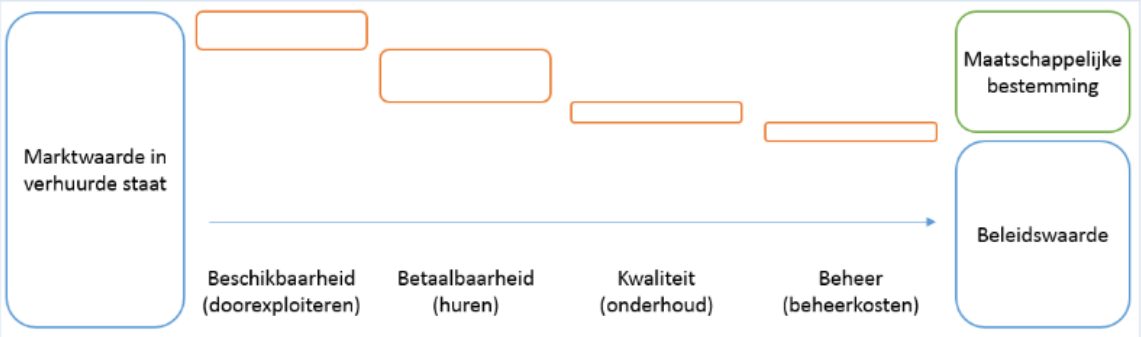
Valuation methodology for market value and policy Value

Valuing real estate based on market value is insufficient for assessment by AW/WSW, as the net cash flow for housing corporations is lower than the market-conform cash flow. The policy value is determined based on the market value. The following general principles apply to the market value valuation method used by housing corporations:

1. All real estate-related market-conform cash flows
2. Over a 15-year period
3. Plus a residual value in 15 years
4. Discounted to the present (DCF method)
5. Where the final value is the highest of either selling or continuing to operate

To derive the policy value from the market value, four components can be distinguished that give context to the societal purpose of part of the market value (Fakton, 2024):

- Availability: Structural sale of homes is not possible due to agreements on the size of the social housing stock with municipalities. The property is valued based on continued operation.
- Affordability: The maximum rent is capped. The housing corporation's rent policy is the basis, fitting the target group and applicable laws and regulations.
- Quality: Maintenance policy aimed at long-term sustainability. Typically, this cost is higher than in the market value.
- Management: Managing the social housing stock incurs additional costs beyond regular management expenses.



From market value to policy value (Fakton, 2024)

Assessment Framework for Portfolio Strategy
In addition to financial continuity, the assessment framework of AW/WSW also evaluates the business model of housing corporations. Regarding the business model, a distinction is made between the strategic level and the tactical level. At the strategic level, the portfolio strategy is assessed annually based on the corporation's policy documents and a discussion. The rationale behind this is that a sound strategy limits the risk of asset leakage or the inefficient allocation of resources. At the tactical/operational level, it is assessed whether the strategic objectives have been logically translated. This should be included in a transition program that, on one hand, concretely and measurably describes the portfolio goals and the balance between societal contribution and financial effects.

3.2.4. Challenges
The literature discusses various challenges in investment decision-making by housing corporations. Nieboer (2011) states that portfolio management plays little role in investment decisions at the neighborhood level, leading to a lack of systematic methods for investments. Housing corporations often determine investments without fixed standards for costs, quality levels, and choices such as demolition or renovation, except for sales policies. However, this does not mean decisions are unfounded, but rather that they are often based on a neighborhood-focused approach rather than an overarching portfolio policy (Nieboer, 2011). Overmeeren (2011) emphasizes that housing corporations use elements from various planning models, with a focus on rational and collaborative models. (Overmeeren, 2011). Furthermore, Nieboer(2017) note that housing corporations often implement sustainability measures in small steps, partly due to limited investment frameworks that define project sizes and budget allocation. General decision criteria, such as the lifespan of building elements and the market position of homes, play an important role in this. Despite the desire to make progress in sustainability, there is often resistance to early depreciation and additional investment arrangements. In-depth energy renovations are still not widely applied in practice (Nieboer, 2017)

3.2.5. Innovation
According to Lamberts et al. (2021), innovation plays a crucial role in the transition of housing corporations to sustainable business models, especially in renovations. Housing corporations need innovation to reduce renovation costs and achieve their social objectives, such as providing affordable housing. Unlike commercial companies, which often require innovation for competitive advantage, innovation in housing corporations focuses on achieving sustainable renovations within available financial resources. Collaboration between housing corporations proves to be of great importance, as it offers the opportunity to learn from one another, create economies of scale, and develop sustainable procurement and supply chain strategies. Despite this, various barriers to innovation are identified, such as the conservative attitude of the construction sector, rising construction costs, administrative burdens, and limited acceptance of sustainable solutions by tenants. These factors complicate the adoption of innovative, sustainable technologies, emphasizing that innovation in housing corporations is not only dependent on technological progress but also on collaboration within the sector and involving tenants in the sustainability process (Lambrechts et al., 2021).

Conclusion

In conclusion, it can be stated that the decision-making framework for new real estate developments in housing corporations is strongly influenced by both internal and external factors. The process of strategic portfolio management plays a crucial role, with corporations systematically analyzing market developments and applying strategic planning models to make informed choices. This decision-making process is not only financially driven but also takes into account the technical quality of the homes, market demand, and the preferences of stakeholders. While financing and the assessment of policy value play an important role, the success of the decision-making framework is also determined by the degree of standardization of processes and the implementation of strategic planning models. However, in practice, there often appears to be a discrepancy between theoretical models and actual investment choices, which are sometimes more focused on local conditions and tailored approaches than on overarching strategies.

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