Rooftop Extension

A strategic decision-making framework for Housing Associations in the Netherlands

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Acknowledgments

Throughout the research, I have been inspired by the insights of many professionals from the sector who shared their knowledge and experience through interviews and case studies. The contributions of these experts were essential in refining the research focus and validating the findings. I am therefore grateful to the interviewees, the case partners, and the expert panel for their openness and constructive feedback, which enriched the process.

This report is intended not only to provide housing associations with theoretical insights but also practical guidance for making investment decisions related to rooftop extensions. The decision-making framework presented in this report aims to be a comprehensive tool that structures not only financial feasibility but also societal, technical, and strategic considerations. I hope that the findings from this research contribute to the broader discussion on circular housing construction and that this report makes a valuable contribution to developing rooftop extension projects that create both societal and housing value.

With gratitude and appreciation for my supervisors Hans Wamelink and Peter Boelhouwer, who have followed this process and provided feedback, I look back on a rewarding and challenging period.

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Abstract

This study explores how rooftop extension projects can be evaluated more systematically, paying specific attention to their strategic, technical, financial, and societal implications within portfolio-based investment decisions. In a context of mounting housing shortages and spatial constraints in Dutch cities, innovative densification strategies are becoming increasingly important. Rooftop extensions, adding extra layers to existing buildings, are often regarded as promising because they add dwellings without additional land take and align with circular ambitions. In practice, however, housing associations still treat such projects largely as incidental initiatives, assessed with generic tools originally designed for new-build or large-scale renovation.

The research combines a literature review on adaptive reuse and investment structures with five case studies. For each case, two interviews were conducted, one at a strategic level and one at an operational level, and the conceptual assessment framework was validated by an expert panel. The findings show that decision-making on better use of the existing stock is evolving in some associations. Risk perceptions, such as technical uncertainties, planning constraints, or construction in occupied buildings, are examples of identified barriers. At the same time, the cases illustrate that rooftop extensions can support integrated renovation, enhance neighborhood livability, and increase typological diversity.

To help housing associations assess these projects more systematically and enables to argue investment decisions more robustly, an evaluation framework was developed with three components:

- Knock-out criteria, such as critical project mass;
- Opportunity valuation, for aspects such as circularity and housing differentiation;
- Key considerations relating to risks and policy alignment.

The study concludes that further professionalization is needed to embed rooftop extensions firmly within development and investment strategies. This requires explicit integration into portfolio policies, greater attention to societal value, early coordination with municipalities, and ongoing internal knowledge development. Standardizing design and permitting procedures can facilitate wider applicability and scaling.

Keywords: Rooftop Extension, Housing Associations, Decision-making Framework, Adaptive Reuse

Content

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1. Introduction

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 associations, 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 coaltion, Aedes, and VNG, which include additional measures to accelerate the construction pace by associations 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 associations 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 rooftop extensions, transformations, the placement of flexible homes, splitting homes, or other modifications that create new living spaces"(VRO, 2025).

Although the performance agreements came under pressure in April 2025 due to unilateral changes in the agreements by the Dutch government (Bos, 2025), the previously signed performance agreements emphasize the importance of maintaining a good balance between intensifying the use of existing buildings and preserving livability.

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. Rooftop 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 rooftop extensions by building owners. Based on a quantitative analysis, Stec Groep estimates a potential addition of 100,000 homes through rooftop 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 rooftop 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 rooftop extensions (Geuting & Wevers, 2024).

Existing research on rooftop 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 rooftop extension projects (Sundling, 2018). However, there is a lack of research evaluating the value of rooftop extensions as a real estate activity within the existing portfolio strategy of housing associations.

Although rooftop 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 rooftop extension projects (Stec, 2024). This research

addresses this blind spot: it provides insight into how housing associations assess rooftop extension projects, where decision-making stalls, and what is needed to make well-founded and feasible investment decisions.

1.1 Problem statement and research aim

Although rooftop 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 rooftop 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 an assessment framework to support housing associations in making informed investment decisions regarding rooftop extensions. The goal is to enable the successful implementation of rooftop extension projects while contributing to both the housing challenge and adaptive reuse.

1.2 Research questions

The central research question for this study is:

How can housing associations effectively assess the value of rooftop extensions as a strategy to expand within the existing building stock?

To answer the main question, the following subquestions are answered:
Sub question 1: How can rooftop extension contribute to better utilization of the existing building stock?
With the aim of gaining insight into the possibilities and advantages of rooftop extensions for the more efficient use of existing buildings by conducting a literature review.

Sub question 2: How do housing associations make decisions on projects in general, and what evaluation methods influence these decisions?
With the aim of gaining insight into the decision-making process of housing associations and the factors that determine investment choices by conducting a literature review.

Sub question 3: How are rooftop extension projects currently evaluated by housing associations?
With the aim of analyzing how housing associations currently evaluate rooftop extension projects by conducting multiple case studies and interviews.

Sub question 4: What barriers and opportunities do housing associations identify for rooftop extension projects?
With the aim of gaining insight into the main obstacles and opportunities in the development of rooftop extension projects and how housing associations can overcome barriers and leverage opportunities for successful implementation by conducting multiple case studies and interviews.

Sub question 5: How should the decision-making framework for housing associations be structured to support well-informed investment decisions on rooftop extension projects?
With the aim of developing an assessment framework that can serve as a practical tool for substantiating investment decisions regarding rooftop extension projects by having housing associations provide feedback in an expert panel.

1.3 Target audience

The main target group for this research consists of housing associations in the Netherlands that are exploring rooftop extensions as a method to better utilize the existing housing stock. This includes both smaller and larger housing associations, which are crucial stakeholders in the implementation of such initiatives. The research is particularly relevant for housing associations looking for ways to structure decision-making in a way that aligns with the unique nature of rooftop extension projects, while also recognizing the benefits these initiatives offer. Municipalities, architects, construction companies, and other stakeholders involved in urban development will also be valuable recipients of this research, as they play an essential in the successful realization of rooftop extension projects and require broad collaboration.

1.4 Relevance

The urgency to expand the housing stock in the Netherlands is greater than ever: the current shortage of over 400,000 homes calls for rapid, space-efficient, and sustainable solutions. Rooftop extension projects offer a promising contribution to this challenge. Therefore, this research provides not only academic added value but also direct practical relevance for all parties committed to affordable, high-quality, and future-proof housing.

Housing associations play the most important role in delivering affordable housing. This study provides them with an integrated assessment framework that enables them to evaluate rooftop extensions in terms of financial feasibility, social impact, technical feasibility, and strategic portfolio goals. The framework helps to shift rooftop development from an incidental approach to a structural component of investment policy, allowing associations to make well-considered decisions about when and under what conditions rooftop extensions constitute a sound investment.

By aligning with national performance agreements, such as increasing housing production and raising the annual realization of social rental homes, this research supports housing associations and municipalities in fulfilling their shared housing development agenda. Moreover, the framework stimulates proactive cooperation with municipalities by identifying opportunities and barriers to accelerate permitting procedures.

The report highlights the role of rooftop extensions as a circular method: it extends the lifespan of existing buildings, minimizes material use, and contributes to the reduction of CO_2 emissions in the built environment. By incorporating these opportunities into investment decisions, projects are created that not only add homes but also contribute to broader sustainability goals.

1.5 Research elements

This research distinguishes itself through the integration of various components that collectively form the foundation of the study, as illustrated in Figure 1. The first element involves a literature review on rooftop extension projects and their potential to optimize the existing housing stock in the Netherlands (circle 1). The second element focuses on housing associations and examines how they make decisions and which evaluation methods influence that decision-making (circle 2). The intersection of these two domains represents the point from which the practical challenges and opportunities faced by housing associations in realizing rooftop extension projects are explored.

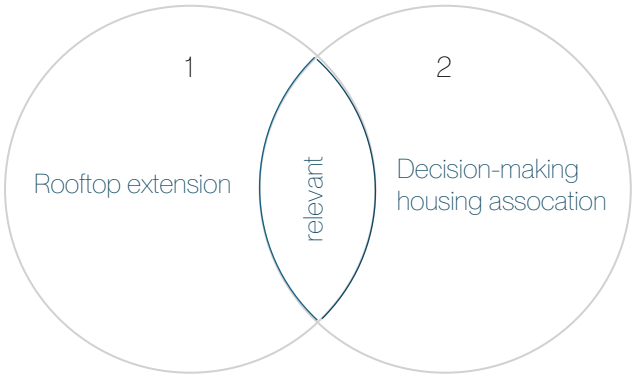


Figure 1: Research elements (own work)

The conceptual model of this research is illustrated in Figure 2. It focuses on the role of rooftop 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 criteria being developed helps to understand under which specific conditions rooftop extension projects are most feasible.

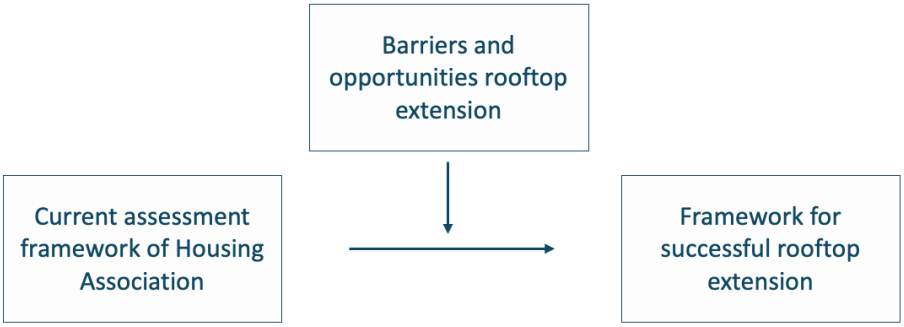


Figure 2: Conceptual model (own work)

1.6 Research methods

The theoretical basis is formed by the literature review on two central themes as shown in Figure 1. This literature review, based on academic and professional sources, serves as the foundation for the empirical research phase.

In addition, semi-structured interviews were conducted with project participants from the five case studies. This method was chosen because it offers depth in understanding the underlying considerations within the decision-making process and the barriers and opportunities that housing associations encounter in rooftop extension projects.

To conclude the empirical research, an expert panel was organized in which professionals from the field provided feedback on the developed decision-making framework. This panel consisted of representatives from various areas of expertise involved in decision-making. The expert panel thus served as a validation step and a means to enrich the developed framework with practical knowledge (Slocum, 2003).

The collected practical findings were then tested against the previously established theoretical basis, focusing on decision-making within housing associations. Based on this analysis, the conclusions provide an answer to the central research question, the limitations of the research, recommendations for future research, and recommendations for the housing sector. The methodology of the research is schematically shown in Figure 3.

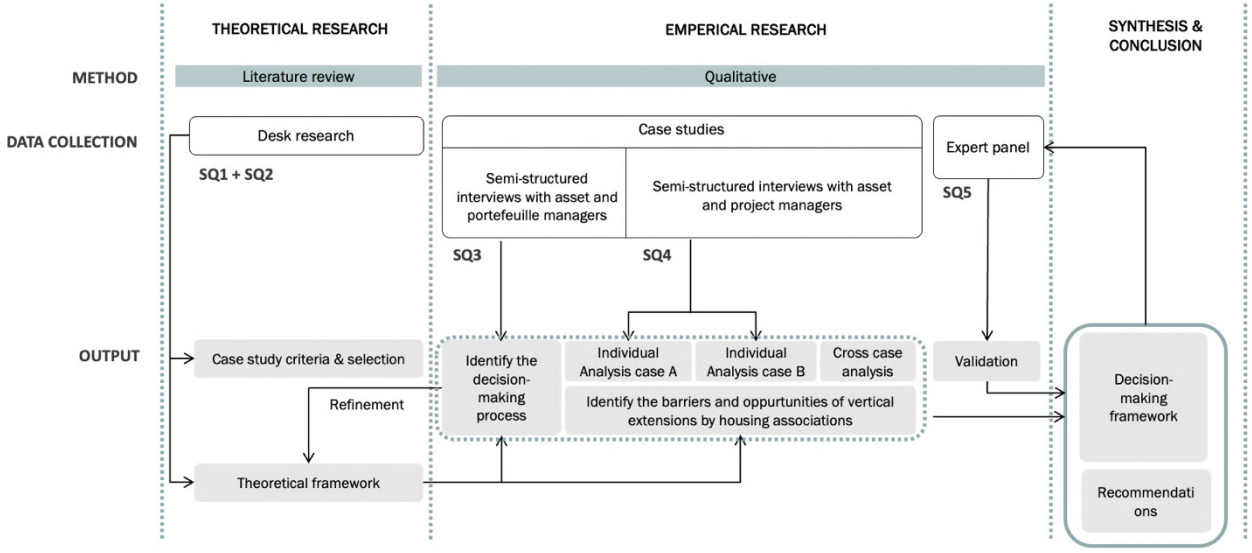


Figure 3: Research methods used

Coding and Table-Based Analysis

All interviews were transcribed and anonymized. The finalized transcripts were analyzed using a combination of coding and structured table-based interpretation. Two complementary methods were employed:

- ATLAS.ti: Professional software for qualitative data analysis
- Excel-based thematic tables: Developed using researcher judgment

These approaches helped to extract as much insight as possible from the semi-structured interviews. The analysis was guided by the central research question and sub-questions, resulting in the development of the following set of thematic categories:

#	Theme	#	Theme
1	Organizational Structure	10	Innovation & collaboration
2	Decision-making process	11	Motivation
3	Current decision-making framework	12	Current decision-making
4	Municipality and regulations	13	New decision-making framework
5	Technical challenges	14	Target groups
6	Risk analysis	15	Livability
7	Sustainability	16	Planning
8	Economic aspects	17	Barriers
9	Stopped projects	18	Opportunities

Table 1. Interview coding themes

Selection of Housing Associations

Each selected housing association had made, or was in the process of making, an investment decision regarding a rooftop extension. While no definitive data exists on the number of associations actively pursuing such projects, the selected cases represent a diverse cross-section of development phases and organizational approaches.

Analytical coherence

The analytical process followed a clear and coherent structure:

1. Definition of main and sub-questions
2. Development of the theoretical background
3. Formulation of an interview guide based on both
4. Execution of interviews with two roles per association
5. Transcription and anonymization of interviews
6. Thematic coding and analysis using software and structured tables

1.7 Reading guide

The literature review served as the theoretical basis and starting point for formulating relevant themes and constructing the interview guide. These themes provided direction for the case selection and offered structure to the interviews conducted with asset managers, development managers, and portfolio managers from five housing associations. Therefore, the results of the case studies (Chapter 3) are presented using the same themes as those discussed in the literature review (Chapter 2), enabling a direct and structured comparison (Chapter 4).

2

2. Literature study

The structure of the literature review offers a clear perspective on the various dimensions relevant to investment decisions regarding rooftop extension projects within housing associations. By using this structure as a starting point, a consistent and analytically grounded approach is established.

1. Motivation for rooftop extensions (2.1/2.2): Rooftop extensions as a means to preserve existing buildings, reduce the ecological footprint, and as a solution for sustainable renovation to achieve financial feasibility.
2. The development process (2.1.3): The sequential steps and preconditions for the successful realization of rooftop extension projects, from opportunity exploration to procurement.
3. Collaboration with municipalities (2.1.4): Three phases,, policy, structural and architectural configurations, form a structured, multidisciplinary collaboration between municipalities, designers, engineers, and residents for rooftop projects.
4. Drivers & barriers (2.1.5): Drivers, barriers, and enabling conditions as identified in the literature.
5. Decision-making process within the housing association (2.2.1): The structure of real estate management and the role of strategic and tactical levels in steering investments. Substantive and procedural criteria that underlie investment decisions.
6. Financial assessment (2.2.2): The financial indicators, evaluation models, and policy values that guide investment decisions.
7. Challenges in decision-making (2.2.3): Investment decisions in housing associations are often influenced by local, neighborhood-specific considerations and limited investment methodologies.
8. The role of innovation (2.2.4): The role of innovation in accelerating sustainability and facilitating rooftop extension projects.

The selection of these eight themes is based on a combination of insights from academic literature, practice-oriented publications, and relevant policy documents. The focus was on identifying themes that, on the one hand, frequently recur in existing studies on rooftop extensions, sustainable renovation, and investment decisions, and on the other hand, align with the central question of how housing associations assess the value of rooftop extension projects. Together, the themes cover both the project-based and strategic dimensions of decision-making, thus providing a comprehensive framework to systematically analyze the experiences, considerations, and challenges of housing associations.

The aim of the literature review is to provide context and gather input for the empirical part of this research. The results in Chapter 3 are also structured around the eight central themes that emerge from the literature review.

2.1 Rooftop extension

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

2.1.1 Rooftop extension as adaptive reuse

Rooftop 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, rooftop extension as a form of adaptive reuse offers the opportunity to explore innovative architectural solutions that improve 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, rooftop 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 handbook Circular Renovation emphasizes the importance of reusing existing structures as a crucial aspect of circular renovation and provides housing associations with tools and strategies for this (Van Stijn & Stolker, 2021). By optimizing and renovating existing buildings, housing associations 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 associations 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 "rooftop extension", it does provide directions for repurposing and adapting existing structures, which can contribute to more sustainable and efficient urban development.

2.1.2 Rooftop extension and energy-efficient renovation

A logical continuation of positioning rooftop extensions as a form of adaptive reuse is the exploration of how this intervention can be combined with renovation strategies. Sundling (2018) emphasizes that the combination of rooftop extensions with energy-efficient renovation is particularly relevant for property owners: it not only increases the number of housing units without additional land use, but also delivers environmental and financial benefits. In his study of renovation concepts from the 1970s in Gothenburg, he demonstrates that combining low-energy renovation with rooftop extension yielded the highest return on investment and the lowest environmental impact, compared to other strategies such as minimal or standard-compliant renovations (Sundling et al., 2019). This integrated approach improved both the energy performance of the building and financial feasibility, as more homes could be added without occupying new land.

These findings highlights that rooftop extension projects not only help alleviate housing shortages but can also serve as a catalyst for sustainability. They make use of existing structures, reduce demolition, and limit material use thus aligning with circular and climate-sensitive policy goals (Sundling, 2019). In densely populated urban areas where space is scarce and the housing stock is aging, this integrated approach represents a promising strategy.

Gohardani et al. (2015) emphasizes that the success of energy-efficient renovation largely depends on early-stage decision-making. They argue that a strategic approach at the beginning of the project is essential for effectively integrating energy-saving measures. In the pre-design and planning phases, important decisions must be made about incorporating energy-saving measures into the renovation plan, with the involvement of energy experts being indispensable. This process prevents energy measures from being treated merely as late additions and instead integrates them into the initial planning. The success of this approach is evident in case studies where energy measures were effectively implemented as part of large-scale renovations, thanks to early investment in the assessment and approval of such measures (Gohardani et al., 2015).

From this perspective, it is useful to explore at an early stage in rooftop extension projects whether and how sustainability, for example in the form of insulation, district heating, or building services engineering, can be combined with the physical expansion. In doing so, rooftop extensions can serve as a catalyst for broader renovation and sustainability efforts.

2.1.3 Rooftop extensions and the development process

In addition to the strategic combination of rooftop extensions with energy-efficient renovation, as discussed in the previous paragraph, it is equally important to consider the procedural approach required for the successful realization of rooftop extension projects. Realizing a rooftop extension involves not only technical and financial considerations but also requires a careful and phased development process.

In this context, the development process established by Sundling (2018) offers a valuable structure. Based on four case studies in Sweden, he defines seven consecutive steps that can support building owners in systematically planning rooftop extension projects.

1. Opportunities for rooftop extension

This step involves identifying opportunities for rooftop 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 rooftop extension, especially when the existing structure offers sufficient potential for expansion.

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 rooftop extension. This can result in three outcomes: no reinforcement required, reinforcement needed, or no feasible reinforcement possible.

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 rooftop extension, ensuring compliance with relevant regulations.

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.

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.

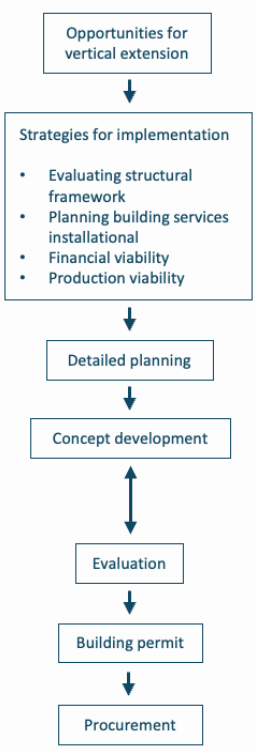


Figure 4. Sundling (2018)

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.

7. Procurement

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

These seven steps form the structure for successfully implementing rooftop 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.

2.1.4 Rooftop extensions and the decision-making process for municipalities

Whereas Sundling (2018) primarily describes the development process within the context of the executing party, such as housing associations, the method proposed by Amer et al. (2017) provides additional insight into the role of municipal actors in the development and decision-making process surrounding rooftop extension projects.

The decision-making process for rooftop extensions, particularly in the context of urban densification, consists of multiple phases, as described in the method by Amer et al. (2017). According to Amer et al., rooftop extension requires a structured, multidisciplinary decision-making process involving 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 rooftop extensions. The first phase, urban and policy configurations, involves assessing the primary need for densification based on urban policies, population forecasts, and the regulatory background established by the municipality. Municipal decision-makers must consider factors such as population growth, urbanization strategies, and the potential for transforming existing buildings through rooftop 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 rooftop 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 rooftop 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 rooftop 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 rooftop 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 rooftop extensions but also emphasizes the role of urban planners in making informed decisions that align with the municipality's sustainable development goals. The authors further emphasize the importance of collaboration among all stakeholders throughout the entire process. The method offers valuable tools for municipalities that wish to adopt rooftop extensions as part of their densification strategy.

The conditions set at the municipal level, such as planning space, permits, and aesthetic requirements, thus form direct preconditions for the internal decision-making process of housing associations. By gaining insight into this external field of influence, housing associations can better interpret the opportunities and barriers for rooftop extension projects within the broader system in which they operate.

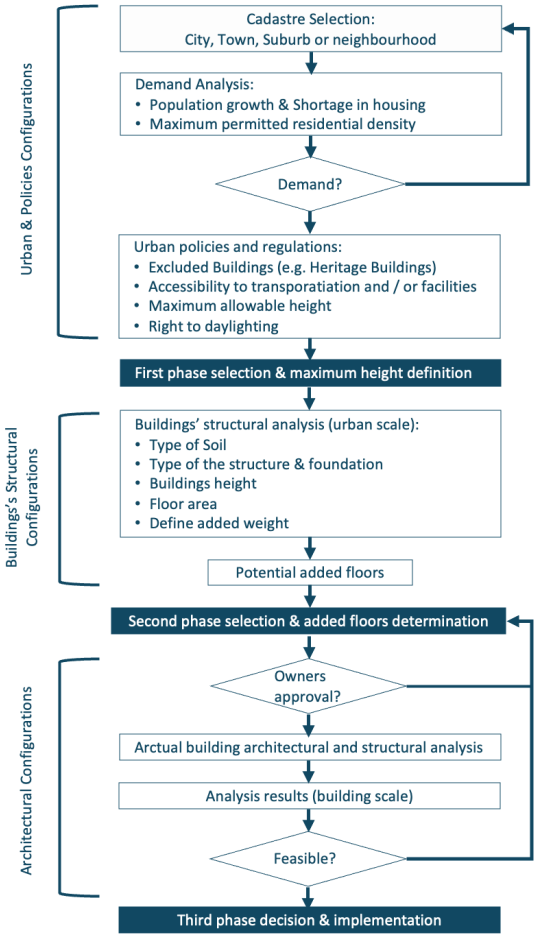


Figure 5. Amer, et al.

2.1.5 Drivers, barriers and enablers

After discussing the development process of rooftop extension projects at the level of housing associations and municipalities, it is valuable to also take a broader perspective on the factors that influence the realization of such projects in practice. While Sundling (2018) and Amer et al. (2017) provide insight into procedural and governance-related aspects, Gillott et al. (2022) map out the more comprehensive structural preconditions that arise from practical experience within the construction sector. Through a sector-wide study, they identify drivers, barriers, and enabling factors that are crucial to the successful implementation of rooftop extensions. This analysis is relevant for housing associations, as they function as both clients and risk-bearers and are dependent on this broader context.

According to Gillot et al. (2022), identifying drivers and barriers is important by realizing rooftop 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, indicating the need for further research (Sundling et al., 2019) (Gillott et al., 2022) built on this work and examined the main enablers for rooftop 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 rooftop extensions.	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 rooftop extensions due to risk aversion.	No specific economic enablers

	- Embodied carbon savings seen as secondary benefit.		
Technical	- Rooftop 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 rooftop 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 rooftop extension design. - Design tools to help engineers address rooftop 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 rooftop 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 an enabler for adoption. - Less emphasis on CSR or personal moral obligations in driving rooftop 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 rooftop extensions.	- Tax regimes act as a barrier, making new builds more financially favorable over refurbishment projects. - Planning permission for rooftop 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.

Table 2. Gillot et al. (2022)

The study by Gillott et al. (2022) illustrates how rooftop extension projects are shaped by complex interdependencies across the construction sector. Their research exposes cross-cutting economic, technical, cultural, and legal factors that can either hinder or facilitate implementation. Although not specifically focused on housing associations, these systemic insights are important for understanding the external context in which associations must operate. As clients and initiators, housing associations are dependent on the functioning of broader sectoral dynamics, including engineering expertise, contractor practices, planning systems, and innovation readiness. These findings therefore provide an important reference point for interpreting the barriers and opportunities that housing associations may face, as explored further in the empirical part of this study.

2.1.6 Conclusion

Rooftop extension emerges from the literature as a promising strategy to improve the utilization of the existing building stock in the Netherlands. As a form of adaptive reuse, it contributes to extending building lifespans, reducing demolition, preserving materials, and achieving circular and climate-related policy goals. Particularly when combined with energy-efficient renovation, rooftop extensions enable the addition of housing units without using new land, offering both environmental and financial benefits for housing associations. However, the realization of such projects requires more than just strategic intent. As Sundling (2018) and Amer et al. (2017) show, it also demands a structured, phased development process, clear municipal frameworks, and active collaboration with urban stakeholders. Moreover, the broader construction sector context, as mapped out by Gillott et al. (2022), reveals that economic uncertainty, technical complexity, sectoral conservatism, and legal obstacles often impede progress. Although housing associations are not always central in these studies, their role as initiators and clients makes them directly dependent on these systemic conditions. In sum, rooftop extensions offer significant potential for densification and sustainability, but their success is contingent on integration with renovation strategies, strong institutional alignment, and mitigation of barriers throughout the value chain.

2.2 Decision-making housing associations

After examining the potential of rooftop extensions in terms of adaptive reuse, circular benefits, municipal frameworks, and sector-wide challenges, this section shifts focus to the internal decision-making processes of housing associations. Since rooftop extensions often fall outside the scope of standard development paths such as renovation or new construction, it is crucial to understand how housing associations determine the feasibility of such non-conventional projects.

By incorporating rooftop extensions into the portfolio strategy, the question arises of how the feasibility of real estate activities is assessed. This paragraph addresses the extent to which these internal processes are standardized and governed by evaluation methods. It provides an answer to the sub-question: How do housing associations make decisions on projects in general, and what evaluation methods influence these decisions?

2.2.1 Process of decision-making

The strategic deployment of rooftop extension projects, as discussed in the previous sections, requires insight into how housing associations make internal investment decisions. Rooftop extensions are not standalone interventions; they are tied to broader strategic choices about the future of the housing stock. The question is how this type of project fits within the existing decision-making structures of housing associations, and which evaluation frameworks underpin them.

Since the policy reforms of the 1980s and 1990s, which reinforced market orientation in the social rental sector, housing associations have been compelled to manage their real estate portfolios more strategically (Gruis & Nieboer, 2004). Strategic asset management is central to this process: a systematic approach in which associations anticipate market developments, formulate long-term strategies, and continuously align their assets with changing societal and spatial demands. It involves recognizing the asset not as static property, but as a dynamic strategic resource.

Within this process, Gruis and Nieboer (2004) identify four phases: analyzing the current situation, formulating policy options, evaluating those options, and ultimately developing a strategy. Strategic planning models are used to underpin decisions and introduce consistency into policy. These models are crucial for housing associations seeking to balance social objectives with financial viability. In the Dutch non-profit rental sector, models have been developed to structure and systematize investment decision-making for the housing stock (Nieboer, 2011). One example is the planning process model by Van Os (2007).

Nevertheless, Nieboer's (2011) research shows that the impact of these strategic models on project-level investments is limited in practice. In case studies of six housing associations, he observes that decision-making is often less top-down than assumed. Investment decisions are shaped in interaction with internal beliefs, preferences, and local dynamics. While planning models provide structure, they appear only partially directive in actual decisions (Nieboer, 2011).

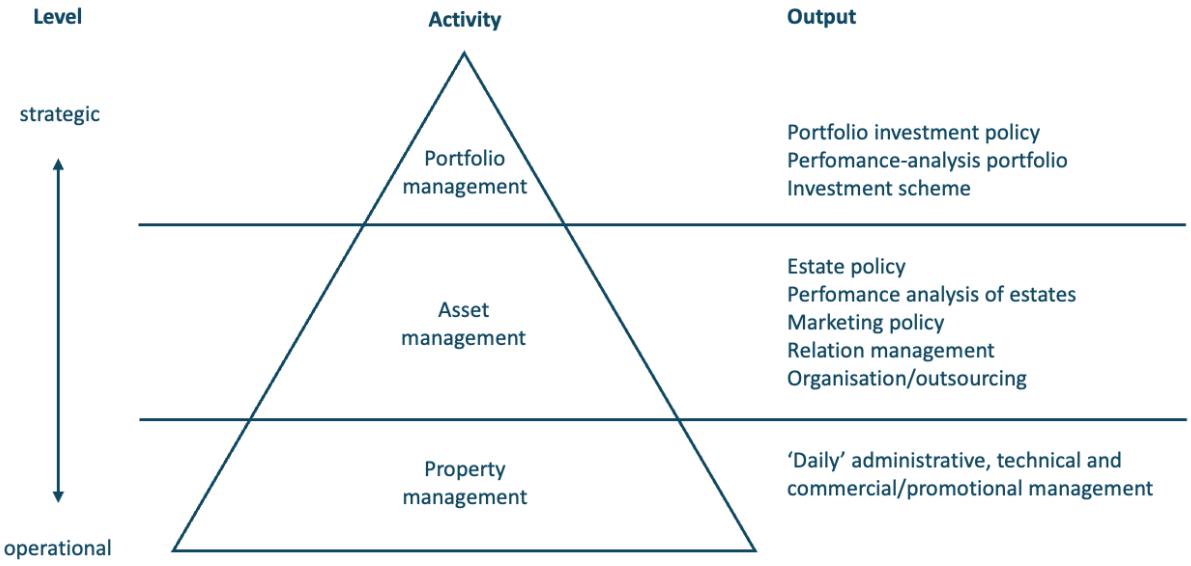


Figure 6. Organizational levels of real estate management (Miles et al., 1996)

Regarding the substantive criteria underlying investment considerations, Gruis and Nieboer (2004) indicate that these are situated at the intersection of financial, technical, and societal values. Associations assess not only the economic feasibility of a project but also the technical quality of their stock and the demand for specific housing types. External frameworks such as government policy and the expectations of tenants and municipalities also play a role. The decision-making process is thus complex: structured through portfolio strategies, but also influenced by local implementation practices.

This dynamic is particularly relevant to rooftop extensions. These projects diverge from standard development paths such as renovation or new construction and require the integration of multiple evaluation dimensions: existing property, sustainability, spatial potential, and societal added value. The extent to which such considerations are embedded within strategic frameworks largely determines whether rooftop projects even surface on the radar of investment committees.

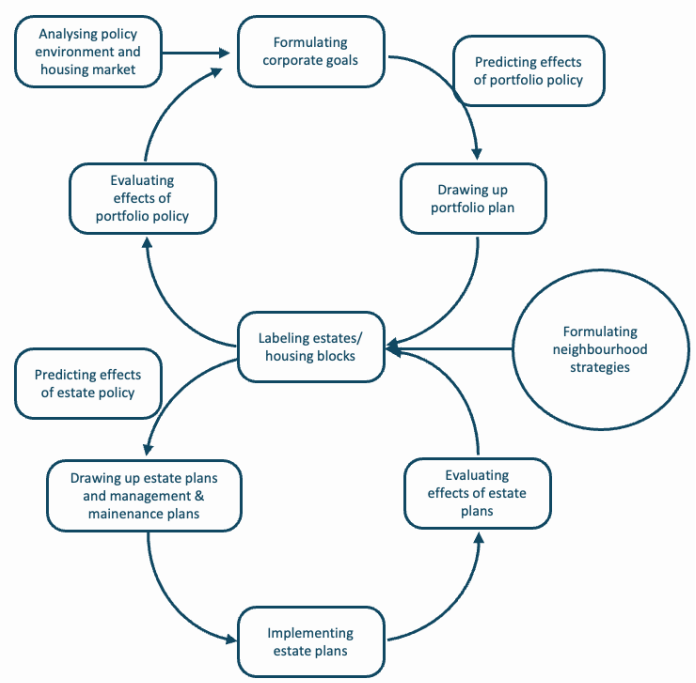


Figure 7. Formulating corporate goals (Van Os, 2007)

This literature shows that while housing associations possess structures for strategic asset management and policy formation, the translation of these into actual project decisions is complex and context-dependent. This forms a crucial background for the empirical part of the research, which explores how rooftop extensions, as hybrid and non-standard interventions, are evaluated and positioned within existing decision-making processes. The empirical section therefore investigates the extent to which such considerations actually play a role in practice and how housing associations address the positioning and assessment of rooftop projects within their existing decision-making structure.

2.2.2 Financial assessment

Financial feasibility is a determinant in the decision-making process of housing associations. To justify investments while safeguarding financial continuity, associations rely on structured evaluation frameworks. A central instrument in this regard is the investment statute, which provides concrete guidelines for assessing the financial viability of projects. Before delving into the workings of this statute, it is important to outline the policy and institutional context in which financial evaluations take place.

Policy and institutional context

Housing associations operate within a complex network of external actors, including the Ministry of the Interior (BZK), the Authority for Housing Associations (AW), the Social Housing Guarantee Fund (WSW), and municipal governments. Each of these actors influences the conditions under which investment decisions are made, based on their respective roles. Internally, associations ensure sound governance, accountability, and oversight through standardized documents such as the multi-year budget, the annual plan, and the business plan. These documents link concrete real estate initiatives to broader organizational goals in terms of mission, vision, and societal value.

An external component in this process is collaboration with municipalities. Through the municipal Housing Vision, performance agreements are made regarding the contribution of housing associations to local housing tasks (Hardy & Bruil, 2021). Rooftop extension projects can play an explicit role here, for example, in the context of densification, affordability, or sustainability.

Strategic portfolio policy

Within this context, the strategic portfolio policy translates an association's mission and vision into a desired direction for its real estate portfolio. This policy outlines choices regarding target groups, stock development, and investment

priorities, including projects such as rooftop extensions. It serves as the substantive basis for investment proposals submitted to the Supervisory Board (RvC) for approval (Hardy & Bruil, 2021).

Investment statutes

Based on the portfolio policy, investment proposals are further developed and assessed using the investment statute (Kornegoor et al.,, 2024).. This statute defines how projects are financially evaluated and serves as a guide for assessing the feasibility of the overall investment program. Within this framework, so-called model investments are used as benchmarks for project-level assessment. The model investment statute provides clear guidelines for various types of real estate projects, such as new construction, renovations, transformations, and divestments. The assessment focuses on three main criteria:

- Market compliance of construction costs, evaluated based on internal or external estimates or tender results;
- Ratio between vacancy value and policy value relative to construction costs, as a measure of financial robustness;
- Direct return and internal rate of return (IRR), as an indicator of the project's financial attractiveness.

Integration of societal value

The model investment statute offers a framework that makes it possible to incorporate not only financial feasibility but also broader societal objectives into the investment assessment. By translating strategic goals into measurable indicators, the model provides the tools to account for aspects such as affordability, sustainability, and livability, including in projects like rooftop extensions. While this potential exists within the structure of the statute, it does not imply that such integration is already common practice. Rather, the model presents an opportunity for housing associations to systematically align their investment decisions with wider policy ambitions.

Provision for justified deviations

The model statute also allows for situations in which deviations from the standard development process are desirable or necessary. Associations may deviate from the standard procedure, provided that the alternative approach is well substantiated and consistent with long-term strategies. The conditions for such deviations can be explicitly stated within the statute, thereby safeguarding transparency and accountability.

2.2.3 Challenges

Although frameworks such as the model investment statute provide clear criteria for linking financial feasibility with social objectives, investment decisions in practice are not without challenges. The literature discusses various difficulties in investment decision-making by housing associations. Nieboer (2011) noted at the time that portfolio steering played little role in investment decisions at the neighborhood level, resulting in a lack of systematic methods for investments. Housing associations would often make investment decisions without fixed standards for costs, quality levels, or choices such as demolition or renovation, with the exception of sales policy. This does not mean that decisions are unfounded, but rather that they are often based on an area-oriented approach instead of overarching portfolio-based policy (Nieboer, 2011).

Overmeeren (2011) emphasizes that housing associations use elements from different planning models, with a focus on rational and collaborative models. In addition, Nieboer (2017) observes that housing associations often implement sustainability measures step by step, partly due to limited investment methods that determine project size and budget allocation. General decision criteria, such as the lifespan of building components and the market position of homes, play an important role. Despite the desire to advance sustainability, there is often resistance to early depreciation and additional investment agreements. Deep energy renovations are still only marginally applied in practice (Nieboer, 2017).

These challenges demonstrate that decision-making within housing associations is strongly influenced by local circumstances, institutional constraints, and risk-averse behavior. This can limit the integration of sustainability and innovation. Therefore, the next paragraph explores the extent to which innovation is used as a means to enhance feasibility and accelerate progress in rooftop extension projects.

2.2.4 Innovation

In light of these structural and procedural limitations, innovation emerges as a potential lever to overcome current bottlenecks in investment decision-making and sustainable project realization. According to Lamberts et al. (2021), innovation plays a crucial role in the transition of housing associations to sustainable business models, especially in renovations. Housing associations 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 associations focuses on achieving sustainable renovations within available financial resources. Collaboration between housing associations 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 associations 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).

2.2.5 Conclusion

Financial figures such as construction costs, returns, and policy values are important, but are increasingly complemented by social objectives, such as affordability, sustainability, and livability. At the same time, fragmented planning processes, the absence of a standardized approach, and cautious behavior within organizations can lead to decision-making that does not always proceed smoothly.

In this context, innovation can help make projects more feasible and sustainable, that collaboration within the sector is strengthened and tenants are actively involved. Altogether, this shows that decisions within housing associations are not purely technical or financial, but involve a balance between ambition, feasibility, and social responsibility.

3

3. Results

This chapter presents the results of the multiple case study and builds on the theoretical framework presented in Chapter 2. The eight central themes identified in the literature review provide the analytical basis for organizing and interpreting the empirical findings from the multiple case study. This thematic consistency ensures a clear connection between theoretical insights and real-world experiences of housing associations:

1. Motivation for rooftop extensions (2.1/2.2): Rooftop extensions as a way to preserve existing buildings, reduce the ecological footprint, and as a solution for sustainable renovation to achieve financial feasibility.
2. The development process (2.1.3.): The sequential steps and conditions for the successful realization of rooftop extension projects, from opportunity exploration to tendering.
3. Municipal collaboration (2.1.4.): Three phases, policy, technical, and architectural configuration, a structured, multidisciplinary collaboration between municipalities, designers, engineers, and residents for rooftop extensions.
4. Drivers & barriers (2.1.5.): Drivers, barriers, and enablers as identified in the literature.
5. Decision-making process within the housing association (2.2.1.): The structure of property management and the role of strategic and tactical levels in steering investments. Substantive and procedural criteria underlying investment decisions.
6. Financial Assessment (2.2.2.): The financial metrics, assessment models, and policy values that guide investment decisions.
7. Challenges in decision-making (2.2.3.): Investment decisions in housing associations are often driven by local, neighborhood-specific considerations and limited investment methods.
8. Role of innovation (2.2.4.): The role of innovation in accelerating sustainability and facilitating rooftop extension projects.

The results are presented per case, with each case study described in a separate subsection (Sections 3.1–3.5). Within each subsection, the findings are summarized in tabular form, following the same thematic order. This approach combines project-specific depth with thematic consistency, enabling both detailed insight and comparison across cases.

3.1 Case 1

Project Type	Complete renovation including rooftop extension
Number of dwellings	34 rooftop extension dwellings, total of 182
Demolition and renovation	July 2021 – November 2023
Rooftop extension construction	Timber frame construction, partly prefabricated, with limited steel structures for spans
Characteristics	
CO_2 reduction	Approx. 1500 tons by preserving the building's structural shell
Circular reuse	Including roof insulation, sanitary fittings, fire hose reels, and recycled demolition wood for the extension
New installations	Energy-efficient, partly all-electric, solar panels, collective heating

Motivation for rooftop extension	The trigger for the project was the poor technical condition of the building and livability issues. Issues with installations, elevators, noise, moisture, and high energy costs made renovation necessary. The rooftop extension emerged from the desire to make the renovation financially viable: adding extra dwellings was essential to close the business case. The decision to add stories was also influenced by design-related considerations, such as the need to relocate the main entrance without losing any housing units. Additionally, political pressure to address the complex and improve livability played a role. In this case, the housing association saw rooftop extension as a functional tool to combine renovation and densification, in line with broader sustainability goals related to circularity.
The development process	After weighing several scenarios, including demolition/new construction and prefab, timber frame construction was chosen on top of the existing structure. Planning and technical detailing required close coordination with internal teams and external partners, including the municipality. By relocating residents beforehand, the entire process could be carried out integrally. The existing renovation frameworks were applied for financial assessment. The permit procedure required intensive coordination but ultimately led to political cooperation, thanks in part to short lines of communication with the permit department.
Municipal collaboration	Staff turnover led to successors being insufficiently informed about the project's progress, which delayed development. The permit procedure required much coordination but ultimately led to political cooperation, partly due to the close working relationship with the permit department. Although cooperation with the municipality was good, the process revealed that administrative capacity and continuity are crucial factors affecting the pace and consistency of decision-making.
Drivers & barriers	Social opportunity In this case, rooftop extension is explicitly seen not only as a way to add housing but also to strengthen the social dynamics of the neighborhood. By introducing other housing types, such as mid-income rental units, more diversity emerged in the resident population, giving the neighborhood a qualitative boost. Rooftop extension also provided an opportunity to renovate existing parts of the building, including the plinth, public space, and

	entrances. In consultation with the municipality, parking norms were relaxed to preserve green space. Technical barrier Unexpected complications arose during execution. A clear example was the discovery of outdated sewer lines, which had to be completely replaced. These technical risks were underestimated at the start of the project, leading to delays and increased costs. Economic driver Adding dwellings proved essential to close the business case. Additional rental income enabled investments in elevators and renovation. Reusing buildings is also considered financially more attractive than demolition and new construction, provided the technical condition of the building allows for it. The housing association emphasized the importance of strategically using maintenance budgets and portfolio funds, for example by aligning investments with long-term planning and rent increases. Economic barrier At the same time, the housing association faces internal financial constraints, such as borrowing capacity and strict budgeting. In another project, the status of "protected cityscape" led to a negative recommendation from the aesthetics committee, even though adding at least two stories was necessary for financial feasibility. As a result, the plan ultimately proved unviable.
Decision-making process	Rooftop extension projects at the studied housing association are still assessed under the regular investment framework for new construction. A thematic plus-and-minus scoring system is used, but this is considered relatively subjective. Topics such as sustainability and circularity are taken into account but do not carry enough weight to be prioritized without additional urgency.
Financial Assessment	Rooftop extension projects are assessed using the existing investment framework, in which the Internal Rate of Return (IRR) plays a central role. This is notable given the distinctive nature and complexity of rooftop extensions compared to conventional new-build projects. These projects must also compete with other investment priorities, meaning promising proposals are not automatically approved.
Challenges in decision-making	The timing of decision-making and securing internal support prove to be critical factors. Projects without technical or policy-driven urgency are easily postponed.
Role of innovation	The project is considered a showcase for the housing association in terms of innovation, although this was not one of the motivations. The role of innovation in construction methods or process design is only addressed marginally.

Table 3. Findings Case 1 (own work)

3.2 Case 2

Project Type	Rooftop extension on a transformation complex
Number of dwellings	33 rooftop apartments (70 m² each)
Demolition and realization	2024-2025
Rooftop construction	Timber frame construction on a steel frame structure
<u>Characteristics</u>	
Building Type	Retail plinth with former office floors → previously transformed into housing
Collaboration	Contractor from the previous transformation selected for execution
Target Group	Middle-income households, mid-market segment
New installations	Connected to district heating, with 4 solar panels per apartment

Motivation for rooftop extension	In this case, the rooftop extension was explicitly linked to a strategic densification goal: adding housing within the existing urban boundaries. This ambition aligned with broader objectives of the housing association to expand the housing supply without using new land. The earlier transformation of the complex from office to residential use took place several years earlier. Due to unfamiliarity with rooftop extensions, the projects were carried out separately, and the rooftop extension was postponed.
The development process	The development process was deliberately streamlined by choosing a turnkey delivery with a trusted contractor. This allowed the project to move directly from design to execution, without separate decision-making phases or tendering rounds. The housing association cited the combination of regional property responsibility with an in-house development company (BV) as a helpful factor: this structure provided scope for control, speed, and flexibility in complex projects.
Municipal collaboration	The case shows that complex municipal procedures can lead housing associations to scale back their plans. For example, only one additional floor was added due to the risk of delay. The central location proved promising thanks to existing parking facilities at shopping centers. The municipality did not impose additional parking requirements.
Drivers & barriers	Social Drivers The rooftop extension was also used by the housing association to more effectively promote tenant flow and diversification. The project helped expand the mid-income rental segment. Social Barriers Construction in occupied buildings led to tensions. Experiences during the project made the housing association more cautious about carrying out projects in occupied buildings due to the disturbances experienced by residents. Technical Barriers The inner-city context posed logistical limitations. Material transport and hoisting of prefab elements were not feasible due to lack of space. In this case, full prefab units simply could not be applied. Additionally, the existing roof turned out to be fragile: perforations for anchoring and installations caused

	leaks that only became visible after completion. Respondents indicated that these risks had initially been underestimated. Economic Barriers Financially, the project turned out to be less robust than initially expected. The assumption that rooftop extension would be a cost-efficient solution did not hold. Rising construction costs, limited economies of scale, and unforeseen expenses strained the business case. Prefab solutions or lightweight structures were sometimes even more expensive than conventional methods. Moreover, elements such as elevators and steel structures required significant investments, placing a heavy burden on the budget.
Decision-making process	Rooftop extension projects are not a separate category in this housing association's decision-making. Projects are financially assessed using standard metrics such as the Internal Rate of Return (IRR), without accounting for the specific nature of rooftop projects.
Financial Assessment	The project was assessed using the existing investment framework, with focus on return criteria such as the IRR. Rooftop extension projects are evaluated financially in the same way as conventional new construction, despite their distinct nature and complexity.
Challenges in decision-making	Elsewhere in the portfolio, the potential for rooftop extension on a complex was negatively assessed due to the quality of the building's structure. Combined with the poor energy performance of the existing building, the project required such large investments that rooftop extension was no longer financially attractive.
Role of innovation	Although housing associations consider standardization and prefabrication to be promising strategies for efficiency and cost control, these can sometimes conflict with the physical and logistical realities of urban locations. Narrow streets, limited site access, and the need for customized work on existing buildings often complicate or limit the applicability of standardized solutions.

Table 4. Findings Case 2 (own work)

3.3 Case 3

Project Type	Rooftop extension on a transformation complex
Number of dwellings	20 rooftop apartments (70 m² each)
Demolition and realization	2025 – ongoing
Rooftop construction	Lightweight prefab steel frame construction
Characteristics	
Construction period	Estimated at 20 weeks
Phasing	Previous purchase and renovation of the serviced apartment complex, except for roof replacement
Logistics	All construction activities organized externally (outside the building), while the building remains occupied.

Motivation for rooftop extension	The trigger for the rooftop extension project was the purchase of a largely vacant former serviced apartment complex, located on an available site. In this context, rooftop extension was considered a logical next step, particularly due to the opportunity to combine it with the renovation and transformation of the existing building. To avoid rental losses immediately after the acquisition, the renovation was carried out first and the rooftop extension was postponed. Although circularity was not the primary driver of the rooftop extension, the housing association still considered the project a valuable circular intervention. The preservation and expansion of the existing property are recognized as a societal benefit.
The development process	Within the sector, there is a general expectation that rooftop extension projects can be realized faster than conventional new construction, partly due to the use of prefab building systems. In theory, this would lead to shorter lead times. However, in practice, realization often still takes years. In this case, progress was delayed due to a prolonged process with the municipality, which tempered the initial expectations.
Municipal collaboration	Although municipalities often encourage rooftop extension in policy documents and vision statements, practical implementation remains difficult. According to respondents, municipal departments often lack specific knowledge, urgency, and political will to actively support rooftop projects. This results in slow and cumbersome procedures.
Drivers & barriers	Social Barriers Adding housing in a densely built context encountered resistance from local residents, particularly due to concerns about privacy, sunlight, and noise disturbance. In addition, the physical impact of construction work—such as vibrations, drilling into existing structures, and prolonged disturbance—was explicitly mentioned as a risk factor that requires careful coordination with residents. Technical Opportunities In this case, the renovation was used as a strategic moment to do technical interventions. By carefully analyzing the structural condition of the building, it was possible to directly determine whether rooftop extension was technically feasible. Lightweight prefab elements were used to reduce implementation obstacles. The use of individual installations per rooftop unit creates room for

	sustainable solutions, such as heat pumps and all-electric systems. This enabled a high energy performance, independent of existing infrastructure. Economic Barriers Financial feasibility turned out to be fragile. Delays led to indexation, which threw previously balanced business cases off track. This undermined project progress and jeopardized viability.
Decision-making process	As in previous cases, rooftop projects at this housing association are not yet a formal part of regular investment assessments. However, the organization uses a so-called "three-chamber model," in which each project is evaluated from the social, financial, and real estate perspectives. This structure supports an internally well-founded decision-making process but also requires solid justification for each project proposal. The association is also developing a decision-making framework to better utilize the existing building stock. Although the project resulted from a promising acquisition, it was not assessed within a options study. Decisions were made project-specifically, with a focus on financial feasibility and aligned with performance agreements.
Financial Assessment	Standard investment criteria remain the leading factor, with the Internal Rate of Return (IRR) as the metric. This creates tension because rooftop projects, due to their specific complexity and different risk profile, do not always fit these frameworks. If a proposal lacks sufficient substantiation regarding risks or returns, it can be returned for revision. In this case, the project was even temporarily halted because the revised plans no longer met the financial requirements. The combination of frustration over delays and uncertainty about feasibility led to a temporary suspension.
Challenges in decision-making	The project experienced significant delays due to personnel changes and limited municipal capacity, leading to stagnation in the permitting process and reevaluation within the housing association. This external dependency required extensive coordination and created uncertainty in the planning process. In addition, the association chose to phase the project by carrying out the renovation first. The rooftop extension was postponed to reduce risks such as rental loss, complaints, or technical complications. This demonstrates that risk aversion and manageability play a major role in decision-making about rooftop extensions.
Role of innovation	Innovation was not explicitly mentioned as a starting point, but the housing association does consider the project a valuable learning opportunity for future renovation and rooftop extension projects.

Table 5. Findings Case 3 (own work)

3.4 Case 4

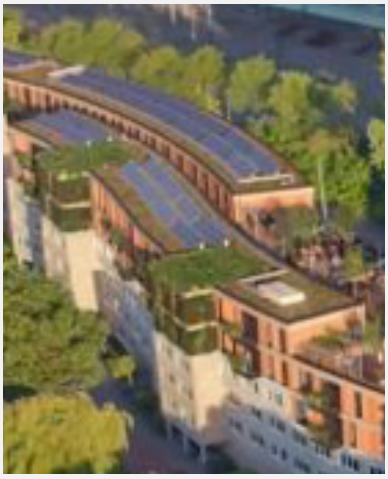
Project Type	Rooftop extension
Number of dwellings	9 buildings, 11 rooftop apartments per building
Demolition and realization	In preparation, estimated at two months
Rooftop construction	Prefabricated wooden modules with standardization per unit Installed on an intermediate layer, after structural reinforcement
Characteristics	
Execution	Pilot project, with the aim of scaling up a repeatable concept

Motivation for rooftop extension	The project was set up as a pilot with the aim of gaining experience with rooftop extensions as a development strategy. For the housing association, it is not only an investment in housing but also a learning process to explore the potential of rooftop extensions as a structural instrument. The broader value of rooftop extension as a circular construction method is recognized and aligns with the sector's sustainability goals.
The development process	This case shows a housing association looking for ways to adapt its assessment methods for rooftop projects. Instead of a traditional project-based approach, in which each project is developed individually, a more product-oriented approach is being pursued. In doing so, housing associations align themselves with existing building concepts from market parties. This working method promises more predictability and speed but simultaneously requires internal process adjustments. In particular, preparing for the serial application of standard modules demands a more efficient setup of decision-making and execution.
Municipal collaboration	The case shows that existing spatial procedures are often insufficiently aligned with the characteristics of rooftop projects. Ambiguity from the municipality about the nature of the project, whether it is new construction or not, eventually led to it being reviewed as regular new construction, resulting in additional requirements such as acoustic studies and longer permit procedures. Interviews reveal that scale is important: smaller rooftop projects receive less priority from municipalities than large-scale densification initiatives. However, early involvement is preferred by the municipality. More broadly, cooperation with municipalities is described as a process of "joint exploration," where willingness exists, but pace, approach, and expectations are not always aligned.
Drivers & barriers	Social Barriers Because residents do not directly benefit from the rooftop extension, the housing association expects that creating support will be challenging. Coupling it with renovation would only increase the inconvenience for residents, which is why the association is considering separating the two. Technical Barriers Despite earlier estimates, structural analysis showed that the existing building's load-bearing capacity was limited. Expensive structural reinforcements are needed, which puts financial feasibility under pressure.

	Economic Opportunities The housing association sees the importance of standardization and scale. By using modular building systems, the association aims to reduce costs and streamline processes, with the expectation of scaling up from a pilot to broader application. Cooperation with market parties is cited as a critical success factor. Instead of traditional client-contractor relationships, the association opts for open dialogue with builders, comparing and optimizing business cases.
Decision-making process	At this housing association, rooftop extension is part of the standard investment assessment process. Projects are evaluated individually. However, there is a growing awareness within the organization that rooftop projects deserve a structural place in the evaluation framework, although this is still in development.
Financial Assessment	Rooftop projects are assessed using the existing investment framework, with the Internal Rate of Return (IRR) as the core criterion. This creates tension, as these projects differ significantly from regular new construction in terms of risk, planning, and execution. Nevertheless, they are evaluated within the same framework, which limits opportunities for deviant yet promising projects.
Challenges in decision-making	In contrast to classic new construction, where design and execution are integrated, rooftop projects require customized work on existing buildings. The technical complexity, existing conditions, and uncertainties in the environment make the process less manageable. This leads to an increased risk profile, both during preparation and implementation.
Role of innovation	Standardization and prefabrication are seen by the housing association as tools to increase efficiency and achieve favorable pricing agreements. However, they also note the tension between speed and quality: standardization can come at the expense of the adaptability of modular concepts to the association's requirements for maintenance.

Table 6. Findings Case 4 (own work)

3.5 Case 5



Project Type	Rooftop extension
Number of dwellings	230 rooftop apartments, total of 528 apartments
Demolition and realization	In preparation, project decision has been made
Rooftop construction	Not specified
<u>Characteristics</u>	
Target group	Student housing (24-50m2 gross floor area)
Zoning plan	Project falls within the maximum permitted building height

Motivation for rooftop extension	The housing association has set itself an ambitious goal: to add 5,000 extra homes within the existing real estate stock. Rooftop extensions are considered one of the strategic tools to achieve this goal, partly due to the limited availability of expansion space in the city.
The development process	The development process deviates from traditional approaches. Instead of first appointing an architect and then organizing a tender based on their design, the association aligns with existing market concepts from modular builders. The building concept serves as the starting point, after which the builder handles the permit process and further design elaboration. This reversed approach enables faster decision-making but also requires the housing association to adjust its selection and decision-making processes accordingly.
Municipal collaboration	In addition to legal and procedural obstacles, financial factors also complicate collaboration with the municipality. For instance, an additional land price is demanded when adding building volumes, even in cases of full land ownership. This places significant pressure on the business case. Proactive support is also experienced from the municipality through the appointment of a rooftop coordinator. This role acts as an intermediary between initiators and the municipality.
Drivers & barriers	Social Drivers The rooftop extension contributes to physical accessibility and user comfort, for example by adding elevators and improving bicycle storage. The ground floor is also redeveloped to create more vibrancy and functionality for both new and existing residents. Social Barriers In this case, it became clear that the design of the plinth and surrounding area is crucial. In large-scale extensions, where hundreds of homes are added, significant pressure is placed on public space, bicycle storage, and waste systems. Without additional measures, this leads to tension and reduced livability. Economic Drivers The choice for compact housing types, such as student units, contributes to financial feasibility due to low construction costs per unit combined with high

	occupancy rates. The association sees the number of units per building as promising. However, scale advantages from placing modular units on multiple buildings are not expected. Economic Barriers Municipal conditions, such as leasehold clauses or agreements on additional compensation, even in cases of full land ownership, lead to significant cost increases at an early stage of the project.
Decision-making process	Investments are assessed according to the 'people-bricks-money' principle, which shows similarities with the three-room model. Rooftop projects are not yet a standard part of regular investment assessments. They are evaluated on a project basis, separate from broader decision-making systems.
Financial Assessment	Rooftop projects at this housing association, as in earlier cases, are not yet a standard part of regular investment assessments. They are assessed individually, often outside broader strategic portfolio objectives. The financial assessment is strongly leading. Performance criteria such as the Internal Rate of Return (IRR) form the core of the decision-making process. As a result, rooftop projects often have to compete with other investment options within the annual budget, limiting their chances of success, even when they are compelling in content.
Challenges in decision-making	Another case illustrates how a rooftop proposal within an ongoing renovation project was halted due to the high cost per dwelling. The contractor had proposed adding extra floors, but calculations showed that the costs were significantly higher than those for regular new construction. The project was therefore not continued. This illustrates how market prices, combined with high quality or location requirements, can make rooftop extensions financially unfeasible.
Role of innovation	Due to the spread within the portfolio of suitable complexes and the variety of building types, the association is often forced to approach rooftop projects as stand-alone cases. This makes it more difficult to leverage economies of scale. Sustainable technologies such as district heating are, for example, financially unattractive if the association is developing ahead of the broader area.

Table 7. Findings Case 5 (own work)

The cases are numbered and are referred to by these designations in the text. In Appendix B, the table with respondents is displayed.

4

4. Discussion

This chapter discusses the results of the case study in relation to the theoretical framework outlined in Chapter 2. For each theme, similarities and differences between theory and practice are reflected upon, with the aim of achieving an integrated understanding of decision-making about rooftop extension projects within housing associations.

4.1 Motivations for Rooftop Extensions

While theory positions rooftop extensions as a form of adaptive reuse with circular value, such as life span extension, sustainability, and resource conservation, the case studies show that this is rarely an explicit motivation for housing associations. Projects are mostly initiated due to practical necessity, strategic densification, or organizational goals, such as adding housing. Nonetheless, circular benefits like avoiding demolition and combining renovation with expansion are acknowledged as valuable side effects. Rooftop extensions thus become implicitly part of broader sustainability strategies, even when lacking explicit policy anchoring.

Although literature emphasizes that combining energy-efficient renovation with rooftop extension is the most financially and ecologically viable approach (Sundling et al., 2019), in practice these efforts are often separated due to project complexity or internal decision-making processes. The acknowledgment by associations that "a combination would have been better" underlines recognition of the potential of integrated sustainability.

Van Stijn & Stolker (2021) view circular renovation as a strategic opportunity to create flexibility in housing stock. In that light, rooftop extensions not only add homes but also help align the housing supply with demographic developments or policy objectives. In some cases, targeting specific tenant groups is desirable to prevent neighborhood homogenization.

4.2 Municipal collaboration

Although theory suggests municipalities should apply a carefully phased decision-making process to tackle densification challenges such as rooftop extensions in an integrated and multidisciplinary way (Amer et al., 2017), the case studies show this is far from current practice. In all cases studied, clear municipal policies were lacking, and projects faced slow decision-making, inconsistent involvement, and regulatory uncertainty. For instance, it is unclear whether rooftop extensions are treated as new construction or renovation in permit procedures. Many municipalities are still exploring the topic, and concrete policy tools for rooftop projects are often absent. However, early coordination, appropriate project scale, and specific support, such as a municipal coordinator for rooftop extension projects, were found to contribute to smoother processes.

4.3 The development process

Based on Sundling (2018) and the case study results regarding development processes for rooftop projects, it can be concluded that there are clear similarities between theoretical development steps and practice within housing associations, but also differences in implementation and organizational context.

Sundling's seven steps, from opportunity identification to tendering, are reflected to varying degrees in the cases. The step of identifying opportunities is clearly present in projects where associations strategically selected sites with high demand and sufficient load-bearing capacity. The implementation strategy (step 2), however, is highly context-dependent. Use of turnkey models or prefab systems supports steps three and four (planning and concept development) and is often tailored to the organization's structure, such as an in-house development company. These internal benefits are underrepresented in Sundling's model but appear in practice to accelerate, streamline, and scale up projects.

Moreover, the cases show that Sundling's fifth step, feasibility study, is an ongoing iterative process in practice, with business cases being repeatedly recalculated. In two cases, long permit procedures (step 6) and slow internal decision-making hindered progress, as they altered the underlying business case. In reality, the process is neither linear nor continuous, but rather iterative and fragmented.

Finally, step 7, tendering, is not always the final step, but sometimes occurs early in the process through conceptual tenders in which builders offer modular systems that define the entire process. This highlights that rooftop project development is not just technical or legal, but also a learning process in terms of organization and collaboration.

4.4 Drivers & barriers

Literature (Gillot et al., 2022; Sundling et al., 2019) describes rooftop extensions as a promising strategy for urban densification, with economic, technical, cultural, and legal advantages and challenges. The case studies confirm these to an extent but also add nuance. Economic benefits, like increased property value and savings on land, are important motivators, but are often overshadowed by technical complexity, unexpected costs, and slow, unclear permitting procedures. Prefab and modular systems promise acceleration but are not always applicable or suitable. The business case is vulnerable to risks such as leaks, load-bearing issues, or land lease arrangements. However, the cases demonstrate that collaboration, standardization, and process alignment can help mitigate these barriers. Success appears to depend more on clear regulations, risk management, knowledge sharing, and integrated planning than on technology or design.

The cases also show that rooftop extensions offer opportunities for broader quality improvements. For instance, the addition of elevators improves accessibility, which in turn increases resident support. Activation of the plinth and ground floor is also mentioned as an important theme. Additional housing creates vibrancy and enhances functions like retail or community spaces. Sometimes rooftop projects are used to address blind façades or underused storage areas and improve building aesthetics. Resident interests require good communication and participation, especially in inhabited buildings, to build support and avoid resistance. Housing associations also reflect on the future-proofing of rooftop concepts, seeking repeatable, standardized solutions that meet future standards like BENG or bio-based construction. This shift enables scalability and strategic value, rooftop extensions as products rather than one-off projects.

4.5 Decision-making housing associations

Although some housing associations are experimenting with integrating rooftop extensions into broader investment frameworks, decision-making around rooftop projects and densification is clearly still in transition. The theory of strategic real estate management (e.g., Gruis & Nieboer, 2004; Nieboer, 2010) emphasizes the importance of systematic and integrated decision-making, treating real estate as a dynamic capital asset. In practice, however, rooftop projects are often treated as isolated pilots, indicating limited structural embedding of rooftop development within portfolio policies. Decisions are mostly made on a project-by-project basis, using existing evaluation frameworks designed for new construction or renovation. Some associations are experimenting with broader evaluation frameworks in which, in addition to financial feasibility, social value is explicitly considered. They are exploring how better utilization of the existing stock can be appropriately assessed as a full-fledged development strategy. All of this underline the need for a dedicated evaluation framework for rooftop extension projects.

4.6 Financial assessment

The financial assessment of rooftop extension projects holds a central role within housing associations and is generally based on indicators such as the Internal Rate of Return (IRR) and direct yield (Hardy & Bruil, 2021). The case studies show that rooftop extensions can be financially viable if adequate risk management is in place to keep costs within budget. They also reveal that such projects can have societal added value, prompting some associations to experiment with broader evaluation frameworks. A few housing associations are exploring how to more explicitly include the benefits of better utilizing the existing stock, such as adding housing units or improving livability, alongside standard financial indicators.

Some associations indicate they are willing to weigh societal outcomes, like adding affordable housing or activating the ground floor, more heavily than direct project yield. Other factors influencing decisions include the avoidance of demolition-related depreciation, value appreciation of existing assets due to rooftop extension, diversification of rental income, and alignment with maintenance planning. Additionally, the use of proven modular construction concepts is seen as positive for the business case due to predictability and cost control.

Although financial assessments are closely tied to strategic and societal considerations, these elements are rarely integrated explicitly into formal investment frameworks. Notably, none of the respondents mentioned external incentives, such as subsidies, in their decision-making process.

4.7 Challenges in decision-making

The interviews partially confirm the challenges described in the literature concerning investment decisions within housing associations, though differences exist. As Nieboer (2011) noted, systematic portfolio strategies tend to play a minor role in neighborhood-focused investments, which also applies to rooftop extensions. Projects frequently

stall due to context-specific barriers such as heritage regulations, technical constraints, or an unfavorable cost-benefit ratio. Limited municipal capacity, unpredictable processes, and market-driven price developments further increase the risk profile of rooftop projects. Consistent with Nieboer (2017), tight budgets lead to a cautious stance towards such developments. The cumulative effect of these factors underscores that successful decision-making not only requires technical and financial reasoning but also political courage, clear frameworks, and policy embedding of new development approaches.

4.8 Role of innovations

The role of innovation in rooftop extension projects is perceived variably by housing associations. In theory, innovation offers opportunities to reduce renovation costs and achieve societal goals (Lambrechts et al., 2021). In practice, physical and organizational factors often act as barriers. Although prefab systems and modular bathrooms are considered efficient, concerns exist about long-term sustainability and maintenance. Moreover, economies of scale are limited due to significant variation among buildings and the rarity of repeatable conditions. Integration with sustainable infrastructure, such as district heating, entails high initial costs, making innovation less appealing.

Nevertheless, the case studies show that rooftop extension projects can drive industrial innovation, provided that scale and context are suitable. The transition from 'project to product', as mentioned by associations, illustrates that innovation must be embedded not only technically but also organizationally.

These thematic insights form the basis for the assessment framework that is presented in the next chapter. This framework offers a structured method to better substantiate investment decisions regarding rooftop extensions.

5

5. The Framework

5.1 Introduction

This chapter outlines the assessment framework developed based on the findings from the literature in Chapter 2 and case studies as discussed in Chapter 3. The framework is specifically tailored to rooftop extensions as a development strategy and does not compare them to alternative development options, in line with the research's focus. Its goal is to provide investment committees with a structured tool to identify and evaluate the added value of rooftop projects.

The framework was developed through an iterative process involving multiple design phases, reflection moments, and validation steps. Initially, a checklist based on themes from the literature review was created to structure relevant decision-making aspects for rooftop projects. However, it soon became clear that investment committees tend to operate using a go/no-go logic rather than a flexible checklist. This insight led to the idea of not only listing criteria but allowing them to be scored. However, assigning weights would require too much subjective interpretation by the researcher without a solid academic basis. Therefore, the framework allows for weighted scoring to be customized by each housing association, depending on context and priorities.

Based on interviews with housing association professionals, a selection was made of criteria repeatedly identified as decisive. These were classified as knock-out criteria, prerequisites that must be met before a project can be considered seriously. Additionally, a second set of criteria was developed to score a project's potential. These are indicative rather than decisive. Finally, a supplementary checklist of other relevant aspects was compiled. These factors influence decision-making but are not critical to investment approval. This structure enables both hard conditions and softer considerations to be assessed in an integrated manner.

To validate and refine the framework, an expert panel of housing association representatives was convened. Valuable feedback was received on the formulation of the criteria. Participants stressed that the framework should reflect the perspective of the investment committee: the committee does not complete the framework themselves but reviews a pre-filled proposal. This requires objective and transparent criteria. The panel also suggested adding the knock-out criterion "critical mass", reflecting the idea that the number of additional units must justify the investment in time, capacity, and resources. Experts noted that the threshold for this varies by organization, indicating the importance of allowing for customizable weighting.

5.2 Criteria

The selection of criteria is directly derived from practical experiences in the five case studies and the thematic analysis in Chapter 4. That analysis revealed that existing frameworks, often tailored to conventional new construction, fail to fully address the specific characteristics, risks, and opportunities of rooftop projects. This framework aims to close that gap by explicitly identifying and structuring relevant criteria.

Knock-out criteria: essential prerequisites

These criteria were identified across multiple cases as decisive for whether a rooftop project was pursued:

Knock-out criteria	Explanation
Alignment with portfolio strategy	Projects aligned with strategic goals (e.g., housing diversification, sustainability, urban densification) were more likely to be prioritized.
Structural capacity	Insufficient load-bearing capacity of existing structures was a direct barrier in several cases, with necessary reinforcements often rendering projects financially unfeasible.
Business case viability	Multiple cases showed that without additional rental income or investment funds, the business case could not be closed.
Critical mass	The expert panel confirmed that the number of units added is a determining factor in justifying the commitment of resources. This was explicitly added as a new knock-out criterion.

Table 8. Knock-out criteria (own work)

Opportunity assessment: thematic evaluation

The remaining criteria are grouped into five recurring dimensions:

Opportunities	Explanation
Social	Criteria such as housing diversification, accessibility, activation of ground-floor areas, and circular construction reflect ambitions present in many cases, though rarely weighted explicitly in investment decisions. These aspects contribute to stakeholder support, future-proofing, and broader impact.
Technical	Opportunities to align with maintenance or renovation cycles, and the applicability of prefab/modular systems, emerged in several cases. Anticipating future standards (e.g., BENG) was also cited as a strategic advantage.
Legal	Legal feasibility and predictability of permitting processes were risk factors in all cases. Bureaucratic turnover, ambiguous policy frameworks, or classification of projects as new construction led to major delays.
Financial	Beyond the IRR, the handling of non-profitable components, value appreciation of existing assets, and the availability of subsidies were found to influence investment decisions. These elements are often missing from formal frameworks but can positively impact feasibility.

Table 9. Opportunities (own work)

Contextual factors: weighted considerations

This category contains aspects that are not directly measurable as criteria but emerged as influential in decision-making across multiple cases. Flexibility in the housing stock and technical risk management were noted as contributors to robust decision-making. Early coordination with public officials and municipal spatial strategies were essential in avoiding process delays. Suggestions such as balancing portfolios and deviating from standard return requirements in light of social value were offered as alternative forms of accountability.

5.3 Decision-making Framework for Rooftop extensions

The framework not only identifies risks but emphasizes the unique opportunities of rooftop projects. By evaluating strategic, social, technical, legal, and financial factors in an integrated way, a balanced understanding of a project's added value is achieved.

The framework consists of three main components: knock-out criteria, opportunity scoring, and contextual attention points, each with its own set of questions. Knock-out criteria are decisive for proceeding with a project. For each opportunity criterion, the question is asked whether it is met (1 = yes, 0 = no). The binary score indicates whether the criterion satisfies a baseline condition. A weighting factor indicates how important the criterion is within the context of the specific project or the strategic agenda of the housing association. The total score indicates both the feasibility and added value of the rooftop project. Associations can assign weights or designate certain criteria as go/no-go factors.

A high total score suggests a project is not only feasible but also makes a significant contribution to the organization's goals, such as increasing the supply of affordable housing, improving sustainability, or strengthening neighborhoods. A lower score does not necessarily imply rejection, but rather signals the need for further research, redesign, or additional measures.

The framework encourages stakeholders to evaluate rooftop projects not merely through a risk lens, but as promising interventions. These may improve livability, enable densification without using more land, or combine circularity and renovation in innovative ways. It helps ensure that such qualities are explicitly recognized and integrated into investment decisions.

Decision-making framework for Rooftop Extension Projects

Project Name -
Version
Target group: Investment Committee Housing Association

Advice: GO/ NO GO

Knock-out criteria

Dimension	Criterion	Explanations	Meets / Does not meet	Example
Strategic	Compatibility with portfolio strategy	Does the project align with strategic policy goals?	Meets	*The existing stock is utilized and modernized*
	Structural capacity of the existing building	Is the building's structure suitable for vertical extension without (or with minimal) structural adjustments?	Does not meet	*1-floor extension is possible without structural adjustments*
	Feasibility of the business case	Is the project financially feasible within the financial frameworks (IRR) of the housing corporation?	Meets	*Minimum IRR of 3.4% applies*
	Critical mass	Does the project provide sufficient housing to meet required capacity?	Meets	*≥ 25 homes*

Opportunity Valuation

Dimension	Criterion	Explanations	Score 1 = Yes 0 = No N.A.	Weight	Score X Weight	Example
Social	Housing differentiation and target group expansion	Does the project contribute to a broader range of housing types or attracting different target groups?	1			*Increases differentiation in both price levels and tenants*
	Accessibility improvement	Does the project improve accessibility of the existing building?	0			*A lift is added to the building*
	Activation of the ground floor	Is the extension the trigger to restructure the ground floor or add more functional space?	N.A.			*Garage boxes transformed into meeting space*
	Resident interests in inhabited state	Do current residents benefit from the project, and is disruption compensated?				*All work is organized outside the building*
	Circular construction principles and demountability	Is the building system designed with circularity or demountability in mind?				*Preservation avoids demolition and new foundation work → savings in CO_2, materials, and costs.*
Technical	Compatibility with renovation or maintenance	Is the extension combined with planned renovation or energy improvement?				*Renovation has already taken place*
	Integrative technical improvement	Does the project lead to broader technical improvements (e.g., lifts, installations)?				*New lifts added to the building*
	Prefabricated/modular construction	Is prefabricated or modular construction used?				*Prefab improves construction speed and reduces disruption*
	Preparation for future requirements	Is the extension designed with future regulations in mind?				*(e.g., MPG, GWP)?*
Legal & Regulatory	Legal feasibility	Can the project be executed within the current legal and planning frameworks, or is there flexibility via the 'kruimel' procedure?				*An environmental permit must be obtained, the 'kruimel' procedure offers no opportunity*
	Permitting and coordination	Is there clear and timely coordination with the municipality and welfare authority?				*Municipality encourages the project, and there is bi-weekly coordination*
Financial	Explanation of unprofitable part	Is an unprofitable part justifiable based on social benefits?				*The score for the "Social" dimension is positive.*
	Subsidy opportunities	Are there unused subsidies that could increase the IRR?				*SFT scheme and SDE+ subsidies have been applied for*
	Value increase of existing property	Is there an increase in the value of existing homes due to the extension that can be included in the business case?				*No additional budget is reserved for extra architectural quality*
	Ground lease as a cost factor	Is the project fully owned?				*Additional conditions apply*

Key considerations

Dimension	Point of Attention	Explanations	Relevant / Not Relevant	
	Flexibility in housing stock	Does the project contribute to meeting the changing housing needs of tenants?	Relevant	
	Technical risk management	Have risks for execution, leakage, or disruption been assessed and mitigated?	Not Relevant	
	Early administrative and political coordination	Is the municipality involved early in the process, both at the administrative and political level?		
	Utilizing municipal scaling strategies	Is the project aligned with municipal strategies to develop multiple buildings at once?		
	Cost versus savings on land	Are the savings on land costs compared to the extra costs for roof construction and preparation?		
	Compensating through portfolio management	Is there room in the portfolio to compensate for financial shortfalls in the extension project?		
	Deviating from return requirements due to societal value	Is there a reason to deviate from the minimum IRR due to demonstrable societal impact?		

Conclusion		**Meets knock-out criteria**	**Yes**			***Go / No Go***
		Score	**1**			***Score of 14 points***

Figure 8: Decision-making Framework Investment Committees Housing Association (own work)

6

6. Conclusion & Recommendations

6.1 Conclusions

This research aimed to answer the following central question:

How can housing associations effectively assess the value of rooftop extensions as a strategy to expand within the existing building stock?

The findings show that a structured assessment framework can support housing associations in evaluating rooftop projects effectively. This framework combines strategic knock-out criteria (such as structural capacity and IRR), specific opportunity criteria that highlight the unique potential of rooftop additions (e.g., ground-floor activation, circularity, and scale), and contextual considerations that clarify risk management, feasibility, and policy alignment. The developed framework enables housing associations to systematically evaluate the added value of rooftop extensions in relation to other development strategies.

To explore how rooftop projects are assessed in practice, the following sub-questions were answered:

SQ1. How can rooftop extensions contribute to better use of the existing housing stock?
Rooftop extensions utilize existing buildings to add housing units without consuming new land. This supports densification, extends building lifespans, retains material value (circularity), and fosters diversity in otherwise homogeneous neighborhoods. It enhances the exploitable value of housing associations' assets and aligns with adaptive reuse and sustainable construction principles.

SQ2. How do housing associations make decisions about projects, and what assessment methods influence these decisions?
Decisions are generally driven by financial metrics (IRR, cash flow, policy value) and policy objectives (portfolio strategies, performance agreements). The extent to which associations experiment with tailored decision-making frameworks for reusing existing stock varies, as does the inclusion of social impact. Case studies show that rooftop projects are often judged using standard new construction frameworks, which do not adequately capture their unique risks and opportunities (e.g., occupied buildings, modular construction, or scale benefits).

SQ3. How are rooftop projects currently assessed by housing associations?
Rooftop projects are frequently evaluated within existing renovation or new construction frameworks. Only one of five cases applied a specific societal framework for densification. Challenges include fragmented business cases (e.g., separating renovation and extension), limited attention to social value, and ad hoc decision-making. As a result, comparisons are limited, and choices often lack sufficient justification.

SQ4. What barriers and opportunities do housing associations see in rooftop projects?
Rooftop extension is viewed as a promising strategy to expand housing within existing stock. Opportunities include using available rooftops in strategic locations, diversifying housing supply, and integrating expansion with sustainability goals. By avoiding new foundations and reusing structures, rooftop projects can contribute to circular goals and CO_2 reduction. Prefab and modular construction methods offer potential for faster delivery, cost control, and replicability. At the same time, several prerequisites determine success. Without sufficient structural capacity, a viable business case, or critical mass (e.g., fewer than 20–25 units), projects are often not feasible. Legal barriers such as extended permitting or leasehold complications, as well as construction in occupied buildings, also pose challenges. However, the cases show these barriers can largely be mitigated through early municipal coordination, smart phasing, or combining with renovations. If embedded in a strategic portfolio and supported by a sound business case, rooftop projects can evolve into a full-fledged investment category.

SQ5. How should an assessment framework be structured to support investment decisions on rooftop projects?
The developed assessment framework includes three components: knock-out criteria, opportunity scoring, and contextual attention points. Knock-out criteria quickly determine feasibility based on strategic alignment, structural integrity, IRR, and scale. Opportunity scoring evaluates added values, such as circular design, ground-floor activation, and prefab potential. Contextual aspects highlight risks and policy issues such as legal procedures or design flexibility. The framework is grounded in literature, case analysis, and validated by an expert panel. With the

addition of rooftop-specific criteria, the framework is distinctive and usable in investment committees, enabling housing associations to make better-informed decisions about rooftop extensions.

6.2 Limitations of the research

Although this research offers valuable insights into the decision-making processes surrounding rooftop extension projects within Dutch housing associations, there are several important limitations that influence the interpretation and scope of the findings.

First, decision-making within housing associations often appears highly context-dependent. This makes it difficult to draw conclusions that are broadly generalizable across the sector. Moreover, the insights gained from the expert panel were partly shaped by the positions of the participants, causing certain perspectives, such as those related to financing or implementation, to be more prominently represented than others.

In addition, the availability of financial data and long-term evaluations was limited. While the qualitative interviews and case analyses provided a rich understanding of the underlying considerations, it was not possible to systematically assess to what extent the intended returns or societal outcomes were actually achieved. This limits the ability to conduct a comprehensive economic evaluation of rooftop projects.

It should also be noted that the research was conducted within a specific policy context in the Netherlands. Policy frameworks, market conditions, and municipal procedures are subject to change over time and can vary significantly between municipalities. As a result, the findings are highly context-dependent and may not be directly applicable to other (inter)national settings.

Finally, the research focused primarily on housing associations. Although the perspectives of other stakeholders, such as municipalities and construction firms, were indirectly included through the expert panel, the study offers only limited insight into the interaction between parties. A broader multi-stakeholder approach could have provided a more comprehensive understanding.

This research offers valuable insights into the decision-making processes within housing associations regarding rooftop extension projects, but it also has limitations that affect the generalizability and depth of the findings.

6.3 Recommendations for future research

Based on the findings of this research, several relevant directions for future research can be identified. These may contribute to further substantiating and refining decision-making processes concerning rooftop extension projects, and to embedding rooftop development more structurally in the development practices of housing associations.

A first opportunity lies in conducting long-term studies on completed rooftop extension projects. By following projects over several years, insights can be gained into financial performance, resident satisfaction, management challenges, and spatial integration. Such studies would support a more realistic understanding of the long-term returns and risks of rooftop projects.

A second direction involves comparative research into alternative densification strategies. By systematically comparing rooftop extensions with strategies such as demolition/reconstruction, infill development, or large-scale renovation, the relative strengths, weaknesses, and investment conditions of rooftop extensions can be better identified. Scenario analyses can help housing associations make more evidence-based investment decisions.

Moreover, collaboration between housing associations and municipalities continues to be a critical factor for successful implementation. Policy frameworks and ambiguity surrounding permitting procedures often determine the feasibility of rooftop projects. Future research could examine how different forms of coordination, mutual trust, and shared ownership between institutional actors contribute to smoother processes. Particular attention could be given to procedural arrangements, joint spatial planning tools, and area-based coalitions.

An important additional theme concerns the impact of policy coherence on investment certainty. As highlighted in the reflection, tension often arises when national ambitions, such as those articulated in the National Performance Agreements, conflict with local planning constraints, including design guidelines or restrictive zoning ordinances. Exploring how consistency between national and local policy frameworks affects trust and willingness to invest may yield valuable insights for future policy alignment.

In parallel, there is a need to examine the scaling potential of standardized rooftop solutions. In practice, standardization and replicability are helpfull to reduce project costs and accelerating approval procedures. Future studies could focus on how typologies like prefabricated rooftop modules can be scaled effectively and what implications this has for design flexibility, procurement strategies, policy frameworks, and tenant involvement.

Finally, future research should also pay attention to the role of internal behaviour and decision-making dynamics within housing associations. In addition to institutional and procedural barriers, the willingness to adopt rooftop extension projects may also be influenced by openness to innovation, leadership styles, professional

convictions, and perceptions of risk. Investigating how these internal factors affect the adoption of innovative densification strategies could provide valuable insights into why certain rooftop projects are implemented while others stall, despite their technical and strategic potential.

6.4 Recommendations for practice

The findings of this study show that the full potential of rooftop-extension projects can be realised only when housing associations stop treating them as one-off opportunities and regard them instead as fully fledged strategic development options. Achieving this calls for structural adjustments in both policy and practice.

A first step is to embed rooftop development explicitly in portfolio strategies and investment-decision frameworks. At present, rooftop projects are still assessed with generic tools designed for new-build or large-scale renovation, so specific opportunities and risks, such as economies of scale, technical constraints, or societal added value, often remain underexposed. The assessment framework developed in this research offers a practical tool for systematically and substantively integrating these unique characteristics into decision-making.

Societal value is likewise an under-represented dimension in investment decisions. Aspects such as CO_2 reduction or the diversification of target groups are seldom weighed in a structured way. By incorporating these factors into project evaluations, housing associations can better honour the broader public interest many rooftop projects represent.

Intensifying collaboration with municipalities is also essential. Local authorities set the spatial and procedural conditions for rooftop projects through zoning plans, design requirements, and permitting procedures. Early alignment on rooftop opportunities within environmental visions or area programmes, combined with formal agreements on fast-track procedures for standardised solutions, can help remove existing bottlenecks.

Effective realisation of rooftop projects further requires consistency between national and local policy. This study shows that tensions arise when national ambitions, such as those embedded in the National Performance Agreements, clash with local planning restrictions, including stringent design frameworks, uncertainty about permit assessment criteria, or rigid zoning plans. Clear alignment across policy levels increases housing associations' confidence and can lead to greater investment certainty.

Besides external coordination, internal change capacity is equally crucial. Housing associations are advised to invest in innovation-oriented thinking and internal knowledge-sharing so that rooftop projects are no longer seen as exceptional but as a mainstream development strategy.

Finally, there is considerable potential in further developing and applying standardised rooftop solutions. In practice, standardisation and repeatability help control costs, improve scalability, and accelerate permitting. Working with municipalities, housing associations can craft policies that accommodate repeatable design principles while safeguarding local spatial quality and resident involvement.

7

7. Reflection

7.1 Social relevance and core message

This research demonstrates that the perceived complexity of rooftop extension projects within housing associations is often relative. In practice, many of the commonly cited barriers, whether social, technical, legal, or financial, are challenging but manageable, provided that effective collaboration with stakeholders is established. Especially when such collaboration is initiated early and structured carefully, many of the typical obstacles that would otherwise lead to a negative investment assessment can be avoided.

The central challenge of rooftop development, therefore, does not primarily lie in the execution phase, but in how projects are prepared, aligned, and evaluated. The developed assessment framework contributes to this by clarifying which criteria are critical for a well-substantiated decision. By incorporating the framework into the evaluation process, e.g., regarding ownership status, programmatic compatibility, and policy urgency, there is room to substantiate projects more thoroughly, even when they deviate from standard new-build logic.

The value of this study lies not only in its practically applicable assessment framework but also in the broader insight it provides into how housing associations can more effectively navigate the complex decision-making challenges associated with urban densification. Against the backdrop of an increasingly urgent housing shortage, spatial pressure in cities, climate ambitions, and the reuse of existing buildings, it is becoming more important for housing associations to systematically include inner-city densification options like rooftop extensions in their investment policies. The relevance of the developed framework lies in its ability to help associations shift from an ad hoc and project-based approach to a more systematic and policy-driven strategy.

More broadly, this research shows that rooftop extensions need not be the exception in investment policy, nor do they require a fundamentally different decision-making process, provided the specific conditions associated with this type of intervention are properly accounted for.

The core message of this thesis is that rooftop extensions do not primarily require more resources, but rather a shift in perspective: not if, but when, and under what conditions they constitute a sound investment. This perspective empowers housing associations to contribute more quickly, intelligently, and socially effectively to the task of making better use of the existing housing stock and alleviating the housing shortage in the Netherlands.

7.2 Academic reflection

Relation to master track and program

My graduation project aligns with the Management in the Built Environment (MBE) master track, as it focuses on strategic real estate management and decision-making within housing associations. The topic, rooftop extension as a densification strategy, connects themes such as asset management, portfolio steering, sustainability, and collaboration with internal and external stakeholders. Within the MBE program, courses such as Design & Construction Management, Real Estate Management, and Urban Development Management have equipped me with the theoretical and methodological foundation to analyze investment challenges at the building, portfolio, and area levels. My thesis thus contributes to the overarching MSc AUBS program, which focuses on integrated solutions for the built environment.

Mutual influence between research and recommendations

The decision-making framework developed in this project directly emerged from insights gained during the case studies, particularly the lack of specific evaluation structures for rooftop extensions. At the same time, the research was shaped by the need to prioritize practical applicability. The expert panel discussion, in which feedback from the field was incorporated, led to several iterations of the framework. This resulted in a cyclical process in which theory and practice mutually reinforced each other, and the final product evolved into a usable tool for investment decision-making.

Assessment of approach and methodology

The chosen research approach, a combination of literature review, multiple case study analysis, and validation through an expert panel, fits within a qualitative, exploratory research design. This approach enabled me to gather both strategic and operational insights. By using ATLAS.ti, I was able to code systematically and identify patterns, which enhanced the analytical depth of the study. The method proved highly suitable for exploring complex decision-making processes.

Academic value

Academically, this research fills a gap in the existing literature by approaching rooftop extension as an investment consideration. Societally, it addresses urgent challenges such as urban densification, circular construction, and the creation of a future-proof housing stock. Ethical considerations were taken into account by conducting interviews with informed consent and processing all data anonymously, in accordance with TU Delft guidelines. (see Appendix H: Data Management Plan).

Transferability of results

The framework was developed with transferability as a core principle. By using generic criteria and a modular structure, it is broadly applicable across various policy contexts within housing associations. The combination of fixed assessment components and room for customization makes it both flexible and adaptable. Validation by practitioners increases the likelihood that it will be adopted in real-world decision-making processes.

Relation to existing decision-making structures

My framework positions itself as a complement to existing internal structures, such as the investment statute or three-room models commonly used by housing associations. While those structures are often applied in later project phases, my framework helps make strategic and societal value visible at an earlier stage. It is aimed at professionals in the preparatory phase of project development and thus functions as a bridge between strategic policy and concrete investment decisions.

Balancing short- and long-term value

The framework explicitly addresses the tension between short-term feasibility (such as return on investment or technical viability) and long-term societal value. By including sub-criteria such as CO_2 reduction, functional mixing, and improved accessibility, the strategic value of a project becomes more visible. This encourages housing associations to look beyond purely financial criteria, especially in projects with high potential but limited initial returns.

R

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Appendix A Interview Protocol

The interview protocol is available upon request from the researcher.

Appendix B Consent Forms

The consent forms are available upon request from the researcher.

Appendix C - Case Selection

Component	Value
1. Research question	SQ3. How are rooftop extension projects currently evaluated by housing associations? And SQ4. What barriers and opportunities do housing associations identify for rooftop extension projects? To answer the final question: SQ5. How should the decision-making framework for housing associations be designed to realize successful rooftop extension projects?
2. Definition of the research case	The study focuses on rooftop extension projects undertaken by housing associations in the Netherlands, particularly in post-war neighborhoods, assessing their decision-making processes and evaluation frameworks.
3. Case unit / unit of analysis	The unit of analysis is housing associations that own and manage buildings within post-war neighborhoods and are involved in rooftop extension projects.
4. Contextual boundaries	The research is limited to the context of housing associations in the Netherlands, specifically targeting post-war neighborhoods and the organizational, financial, and regulatory factors influencing rooftop extensions.
5. Theoretical prepositions	Rooftop extension projects can be effective strategies for housing associations to mitigate housing shortages, influenced by financial constraints, decision-making processes, and regulatory frameworks.
6. Criteria for case selection	The cases are selected based on - housing associations actively engaged in rooftop extension projects, - including those that have completed or initiated such projects variatie in projectgrootte en gebouwtype variatie in corporatiegrootte
7. Data collection methods	The study employs qualitative research methods including document review, semi-structured interviews with stakeholders from housing associations and municipal governments, case studies of completed and uncompleted projects, and expert panel discussions.
8. Logic of linking data to theory	The analysis connects empirical data from interviews and case studies to theoretical frameworks on decision-making in housing associations, enabling the identification of barriers and opportunities in rooftop extension projects.
9. Criteria for interpreting the findings	Findings are interpreted based on their relevance to existing literature, applicability to practical frameworks for housing associations, and their potential to inform policy and decision-making related to rooftop extensions.

Appendix D Expert Panel protocol

The expert panel protocol is available upon request from the researcher.

Appendix E Developing Decision-making Framework

The development story is available upon request from the researcher.

Appendix F Transcript Interview

The interview transcripts are available upon request from the researcher.

Appendix G Transcript Expert Panel

The interview transcripts are available upon request from the researcher.

Appendix H Data Management Plan

The data management plan is available upon request from the researcher.