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Sustainable Renovation Practices in Decision-Making for Multi-Family Buildings

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Highlights

What are the main findings?

- An overview of sustainable renovation practices in Sweden's multi-family buildings was provided.
- Energy use and investment costs are key evaluation methods.

What is the implication of the main finding?

- Standardized decision-making tools are needed.
- Findings highlight areas for improvement in current practices.

Abstract: Energy-efficient renovation of the existing building stock is essential for achieving the ambitious sustainability goals set by the European Commission for 2030. However, implementing sustainable renovation has proven challenging, as numerous studies have concluded. Multi-family buildings are a significant part of Sweden's building stock and require renovations to meet energy efficiency standards. This study aims to provide an overview of sustainable renovation practices in Sweden's multi-family buildings. A semi-open structured questionnaire was developed to examine the adoption of these practices, with data collected from 11 housing companies. The responses reveal that Swedish housing companies are well aware of the three key aspects of sustainability and actively consider them in their renovation projects. Notably, specific energy use and investment costs are the most commonly used methods for evaluating the environmental and economic aspects, respectively. However, there is a lack of a common method for assessing the social aspects of renovation projects. Additionally, this study highlights the need for standardized decision-making tools in multi-family building renovations.

Keywords: multi-family buildings; renovation projects; sustainable renovation; decision-making tool; social sustainability

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1. Introduction

In its Climate Target Plan 2030, the European Commission has proposed an ambitious goal to cut greenhouse gas emissions by at least 55% by 2030 compared to 1990 [1]. Recognizing the essential role of the building sector, responsible for approximately 40% of the EU's energy consumption and 36% of greenhouse gas emissions from energy [2], energy efficiency emerges as a crucial component of this initiative. To achieve the 55% emission reduction target, the EU must prioritize substantial reductions in buildings' greenhouse gas emissions by 60%, their final energy consumption by 14%, and energy consumption for

heating and cooling by 18% by 2030 [3]. The scale of the challenge becomes obvious when considering that over 220 million building units, representing 85% of the EU's building stock, were constructed before 2001. An estimated 85–95% of these existing buildings are expected to last until 2050, yet many lack energy efficiency, relying on fossil fuels, outdated technologies, and wasteful appliances [4]. The urgency for the EU to focus on making buildings more energy-efficient and less carbon-intensive over their full life cycle is imminent. Deep renovations, capable of reducing energy consumption by at least 60%, are carried out in only 0.2% of the building stock annually across the EU. In some regions, energy renovation rates are virtually absent, and at this pace, achieving net-zero carbon emissions from the building sector would require centuries [5].

Over the past three decades, sustainability has emerged as a crucial focal point in the socio-economic development of global society. In 1987, the Brundtland Commission, convened by the United Nations General Assembly, introduced for the first time the concept of "sustainable development", which "meets the needs of the present without compromising the ability of future generations to meet their own needs" [6]. Thus "sustainable renovation" should align with the principles of sustainable development. The European Commission's 2019 recommendations on building renovation stress the importance of integrating environmental, economic, and social factors into the renovation process to ensure a holistic and sustainable approach [7].

The concept of the "three pillars" of sustainability is widely recognized [8]. However, it is essential to note that this is just one among numerous definitions [9,10], with over 300 others identified [11]. The ongoing discourse surrounding the concept revolves around the necessity for criteria that facilitate sustainability assessments of systems [12].

Approximately 20% of Swedish dwellings were constructed between 1965 and 1974, during a period known as the 'Million Homes Program' (MHP), which resulted in the development of 1,005,578 housing units [13]. Notably, nearly one-third of the country's multi-family buildings were built during this era. As these apartments now approach 50 years of age, several hundred thousand units require extensive renovation [14]. Sweden's energy policy is firmly committed to balancing ecological sustainability, competitiveness, and energy security, in alignment with EU legislation. A key national goal is to achieve net-zero emissions by 2045, with a target of reducing emissions by at least 85% compared to 1990 levels [15]. Additionally, there is a sub-goal to improve energy efficiency by 50% by 2030, relative to 2005 [16]. Although Sweden ranks among the most advanced countries in energy efficiency [17], Swedish authorities recognize the need to raise their ambitions, especially in advancing sustainable renovation practices. Due to the high initial costs of deep renovations, the question of renovation versus demolition has been explored by Bragadin et al. [18]. Their study found that deep renovation significantly reduces the overall environmental impact compared to new construction and demolition, which generate large amounts of waste and material mass.

An analysis of the state of the art conducted by Moschetti et al. [19] found that most research on sustainability analysis for energy renovation projects focuses on individual or aggregated sustainability aspects, rather than addressing all three aspects. Consequently, comprehensive evaluations that incorporate environmental, economic, and social criteria are lacking in this field. A systematic literature review of 44 comparative studies examining methodological approaches for assessing renovation found that the environmental aspect is the most studied, followed by cost analysis. However, social aspects are often overlooked [20].

Numerous studies highlight obstacles to achieving sustainable renovations. Results from a questionnaire survey of 341 citizens in Trondheim city, Norway, confirm economic issues as the main barrier for sustainable building renovation [21]. Thuvander et al. [22]

identified a need for enhanced tools to support integrated decision-making in sustainable renovation, while Cattano et al. [23] noted that unforeseen conditions during renovations often disrupt costs and schedules, presenting a significant barrier. Renovation measures are frequently evaluated based on short-term investment payback rather than life-cycle costs [24].

Renovating existing buildings is particularly challenging, as design constraints from decades-old decisions limit available options. Fahlstedt et al. [25] reached this conclusion through an analysis of 54 scientific articles published between 2005 and 2022. Attia et al.'s study [26] explored societal and technical barriers to building renovation in Southern Europe, uncovering challenges beyond economic constraints, such as limited understanding of sustainable renovation requirements and communication gaps with researchers.

Lind [27] concluded that while sustainable renovation is achievable, it often encounters conflicts among different sustainability aspects. For instance, prioritizing environmental aspects can increase costs and rents, creating social challenges. As a result, few property owners comprehensively address all sustainability dimensions in renovation projects. Multiple studies suggest that an emphasis on economic and financial concerns often diminishes attention to other sustainability aspects [28,29]. Given the complexity of these issues, no single renovation concept can provide a perfect solution; instead, stakeholders must work toward a viable compromise, as noted in a study from Sweden [30].

Conflicts arise not only between sustainability goals but also among stakeholders, including housing companies, society, and tenants [5,31]. Greater coordination efforts in renovation projects increase complexity and implementation costs, reducing stakeholder participation and raising conflict risks [32].

A study on apartment building renovations in Sweden [30] concluded that decision-making is challenging, requiring a thorough evaluation of renovation concepts across multiple dimensions, many with complex, 'wicked' characteristics. Another study from Sweden [33] found that sustainability and social responsibility are becoming more prominent in both public sector agendas and private renovation strategies. This trend has also shifted renovations from extensive toward more tenant-adapted incremental renovations. Surveys show that tenants value renovation choices that allow them to control costs and living standards. Balancing economic feasibility with social sustainability is crucial, especially in economically disadvantaged areas with significant renovation needs. While prioritizing tenants may reduce profitability, public housing companies must remain financially viable under Swedish regulations [34].

Several studies propose recommendations to address the sustainable renovation dilemma. Häkkinen and Belloni [35] stress the importance of raising client awareness about sustainable building benefits, while Olsson et al. [36] advocates for government subsidies, incentives, or new business models to promote sustainability in the built environment. A Norwegian study [37] suggests that varied financial support could help mitigate the economic challenges tied to sustainable renovation.

The initiation of sustainable renovation often hinges on individual decision-making, balancing anticipated benefits and costs. A sustainable business model describes how an organization creates value across economic, social, cultural, or other contexts sustainably. Many industries now use this type of model to address economic, environmental, and social goals simultaneously. However, the extent of the adoption and progress of sustainable business models varies across sectors [38]. A vital step toward advancing sustainable business models is the systematic application of quantitative sustainability analyses [19].

Novelty and Aim

Sweden has introduced regulations to promote sustainability, such as the Climate Declaration and the Primary Energy Number, as mandatory requirements for new buildings. However, these regulations currently exclude existing buildings if they are not undergoing deep renovation and the renovation can be done without a build permit, highlighting a significant gap in policy and practice for sustainable renovations.

Despite the rise in sustainable development initiatives, a recent review study [39] on sustainable renovation highlighted the decrease in the number of research studies, especially since 2020, and identified a specific lack of recent studies on sustainable renovation practices in Sweden. There is a research gap in recent studies exploring how sustainability is integrated into the renovation of multi-family buildings, particularly from the perspective of housing companies, the primary decision-makers in this process. Key questions include: What do housing companies define as "sustainable renovation"? and What types of analyses or assessment tools are used to evaluate the environmental, economic, and social aspects of renovation of multi-family buildings? Addressing these questions is essential for advancing sustainable renovation practices and aligning them with broader sustainability goals. By understanding current practices, areas for improvement can be identified, enabling the building industry to better contribute to ecological, economic, and social sustainability in renovation projects and foster a more sustainable future.

This study aims to provide a view on sustainable renovation practices in multi-family buildings across Sweden. The objective is to examine how both private and public housing companies integrate sustainability into their renovation projects by investigating their understanding of sustainability and assessment methods. Moreover, the study examines which aspects—economic, environmental, or social—are prioritized. The findings will highlight areas for improvement in current practices, ultimately contributing to the advancement of sustainable renovation in Sweden.

2. Methods

To fulfill the aim of this study, a semi-open questionnaire was developed as the primary research method [40]. The reason behind this choice was to balance structured data collection with the flexibility to capture deeper insights. This approach allows for quantitative comparisons across responses while also providing room for qualitative elaboration, enabling respondents to express their perspectives more freely. Given the complexity of sustainability in renovation projects, a fully structured questionnaire might limit nuanced responses, while an entirely open-ended format could make it difficult to identify trends. The semi-open format ensured a systematic yet adaptable exploration of how sustainability is applied in multi-family building renovations, accommodating variations in company practices and decision-making processes.

This questionnaire synthesized insights from existing studies and the expertise of the research team to provide an understanding of the current status of building renovation projects. Building on the existing literature, this study identifies sustainability evaluation aspects and summarizes methods for assessing environmental, economic, and social aspects. Additionally, the most crucial factors involved in implementing sustainable renovations of multi-family buildings in Sweden are pinpointed.

The specific questions to be investigated included the following:

1. How do Swedish housing companies perceive the idea of sustainability within the framework of renovating multi-family buildings?
2. What methods dominate when it comes to assessing and measuring various aspects of sustainability during the renovation of multi-family buildings in Sweden?

3. From the perspective of housing companies, what are the most important factors and considerations in terms of sustainability when undertaking renovation projects for multi-family buildings in Sweden?

The questionnaire consisted of the following sections, each designed to analyze different aspects.

2.1. Information About the Housing Company

In the first part of the questionnaire, information about the housing companies was gathered, including whether they operate in the private or public sector and their company size. As a result, the first two questions were as follows:

1. What is the kind of company (private/public)?
2. The most suitable option regarding size of your company:
    - Employs fewer than 50 people and has an annual turnover or a balance sheet total not exceeding 100 million SEK.
    - Employs fewer than 250 people and has an annual turnover not exceeding 500 million SEK or a balance sheet total not exceeding 430 million SEK per year.
    - Exceeds the values specified above.

2.2. Definitions of Sustainable Renovation

Numerous studies indicate a lack of understanding among housing owners/companies—who are the decision-makers in this context—regarding the definition of sustainable renovation [35,36]. Despite varying definitions, sustainability is generally understood to encompass three key aspects: economic, environmental, and social [41,42]. However, there is a growing recognition of the need to expand the scope of sustainability assessments in renovation projects. Some researchers advocate for the inclusion of additional dimensions beyond the traditional three pillars. For instance, Mickaityte et al. [43] and Kohler and Hassler [44] propose incorporating a cultural aspect into the sustainability framework. Additionally, Lind et al. [27], D'Oca et al. [45] and Jiménez-Pulido et al. [46] emphasize the importance of including a "technical" aspect as a fourth dimension in the understanding of sustainability. Others argue that criteria such as safety should also be integrated into the definition of sustainable renovation [47].

As a result of these ongoing discussions, the following question regarding the definition of sustainable renovation was posed:

3. Please describe how you perceive the term "sustainable renovation".

2.3. Criteria and Sub-Criteria for Assessing Different Aspects of Sustainable Renovation

This section of the designed questionnaire investigated the most common sub-criteria used to assess the sustainable renovation of multi-family buildings, focusing on environmental, economic, and social aspects. The selected sub-criteria were derived from various studies in the field, ensuring a comprehensive approach to evaluating sustainability.

For the environmental aspect, several key factors were considered. Life cycle greenhouse gas (GHG) emissions related to building renovation are a primary focus [19]. In addition, important metrics such as CO_{2e} emissions, renewable energy production, and overall energy consumption are included in the assessment [48]. Energy performance is a critical consideration for energy-efficient refurbishment and is highlighted in numerous review studies [49,50]. The Life Cycle Assessment (LCA) method serves as an effective tool for quantifying the environmental performance of buildings [51].

Turning to the economic dimension, investment costs play a significant role in sustainability assessments [18]. Both operational costs and initial investment costs are commonly used metrics, as noted in Nielsen et al.'s review [52,53]. Additionally, the net present

value (NPV) is identified as the most widely used economic assessment metric in renovation projects [50]. Other considerations include construction costs, the added value of the building post-renovation, operational, and maintenance cost savings, and insurance and compensation system [54]. Furthermore, a study examining the attitudes of Swedish real estate and property owners towards Life Cycle Costing (LCC) revealed a positive inclination to utilize LCC in renovation projects [55].

Among the three pillars of sustainability, social sustainability is often the least clearly defined [56,57]. While many studies employ a combined method of LCA and LCC to evaluate the sustainability of renovation projects, social aspects are frequently overlooked [50,58,59]. Social impacts have only been addressed in a limited number of studies [60], and none of the reviewed papers conducted a life cycle social assessment, as highlighted in a review study [50]. According to Nielsen et al.'s review [52], Indoor Environmental Quality (IEQ) and thermal comfort are the most commonly used assessment tools for evaluating social aspects of sustainable renovation. Other important sub-criteria for assessing the social dimension in the renovation of multi-family buildings include enhancing the building's value after renovation, considering occupants' experiences during construction, and ensuring reasonable rent levels [48,61]. Additionally, the impacts on occupants' health and comfort are critical factors to consider in the assessment process [62].

Based on this, the following questions (4 to 7) summarized the sub-criteria under each aspect:

4. What is the primary method your company uses to assess ecological sustainability aspects in renovation projects? (Choose one option)
    - Specific energy consumption (combined heating and electricity)
    - Primary energy according to BBR (Swedish building regulations)
    - Life cycle analysis (with a focus on greenhouse gas emissions)
    - None
    - Other
5. What is the primary method your company uses to assess economic sustainability aspects in renovation projects? (Choose one option)
    - Investment costs (material and labor costs)
    - Energy costs
    - Maintenance costs
    - Life cycle cost
    - Payback period
    - Net present value calculation
    - None
    - Other
6. What ways/method(s) does your company use to assess social aspects in renovation projects?

2.4. Decision-Making Tools

Decision support tools for building renovation play a crucial role in assisting professional building owners in setting sustainability goals and ensuring their achievement throughout the design process. This applies whether renovating a single building or selecting renovation actions within a building portfolio [52]. Research on the barriers to building renovation in Denmark identified a significant obstacle: the lack of simple and comprehensive tools to aid stakeholders in prioritization and decision-making during the early stages of renovation projects [48].

To address this gap, several studies have developed innovative tools to facilitate sustainable building renovation. For instance, dynamic life-cycle analysis tools [63] provide advanced simulations of renovation scenarios over a building's lifespan, enabling stakeholders to evaluate long-term environmental and economic impacts. These tools help in assessing energy consumption, resource use, and cost implications, thereby supporting more informed decision-making. Adaptive BIM (Building Information Modeling) tools [64] allow for a collaborative and integrated design process by visualizing building performance data during renovation. In addition, decision support systems [65] consolidate various data inputs—ranging from financial projections to environmental assessments—into a unified platform. This integration aids decision-makers in weighing trade-offs between different renovation strategies, ultimately optimizing both economic and sustainability outcomes. Sustainability certification systems [46] offer standardized frameworks to ensure that renovation projects meet established sustainability criteria. These certification systems not only benchmark project performance against industry standards but also enhance transparency and accountability in the renovation process.

Based on these insights, the following question was included in the questionnaire:

7. Please describe which decision support tools your organization uses to make decisions in renovation projects, such as certification systems, consultants, building regulations, local regulations, and energy calculation programs.

2.5. The Most Important Criteria and Sub-Criteria for Sustainable Renovation

This section of the questionnaire was designed to identify the primary criteria for sustainable renovation from the perspective of building owners, as well as the most significant sub-criteria within these categories. To achieve this, a total of 30 distinct sub-criteria were selected, with 10 falling under each of the environmental, economic, and social criteria. Building owners were requested to select the seven most important sub-criteria when undertaking sustainable renovation projects. This approach not only provides insight into the key parameters utilized in real renovation efforts but also offers valuable perspectives on the critical aspects of sustainability as perceived by building owners, without directly posing such inquiries.

8. Select seven keywords that you consider to be the most important for achieving sustainability in the renovation of multi-family buildings.
    1. Reduced specific energy use.
    2. Indoor air quality.
    3. Reduced district heating usage.
    4. Low material and labor costs.
    5. Achieving nearly zero-energy level (NZEB goals).
    6. Reduced greenhouse gas emissions.
    7. Thermal comfort.
    8. Reduced primary energy use.
    9. Low life cycle cost.
    10. Sound insulation.
    11. Environmentally friendly renovation materials.
    12. Low electricity costs.
    13. Daylighting.
    14. Renewable energy sources.
    15. Balcony/patio/playground.
    16. Expected living quality.
    17. Safety and security.
    18. Eligibility for grants.

19. Housing costs before and after renovation.
20. Low maintenance costs.
21. Community spaces, e.g., party room or hobby room.
22. Low annual heating costs/district heating costs.
23. Comfort of the tenants during the renovation period.
24. Low annual energy costs.
25. Property value appreciation.
26. Minimizing peak power demand.
27. Rent increase after renovation.
28. Insurance conditions.
29. Reduced electricity usage.
30. Reduced domestic hot water usage.

3. Data Collection

The questionnaire was distributed to selected decision-makers at 11 housing companies within the Swedish multi-family housing sector. The initial distribution took place during a workshop hosted by the Swedish Energy Agency, which focused on sustainability in renovation projects.

The second distribution channel was ByggDialog Dalarna [66], an industry association for the construction and real estate sector in Dalarna, Sweden, which promotes sustainability in construction.

Responses were obtained through direct contact, as the researchers personally reached out to selected decision-makers from housing companies across different regions in Sweden. The selected private and public companies are geographically distributed across northern, central, and southern Sweden. The questionnaire was sent to them, with researchers providing guidance, and the decision-makers confirmed that their responses were based on their expertise in renovating multi-family buildings.

4. Results

Responses were collected from 11 housing companies, comprising five private and six public entities. Among these, five were categorized as small businesses, four as medium-sized, and two as large corporations (see Figure 1).

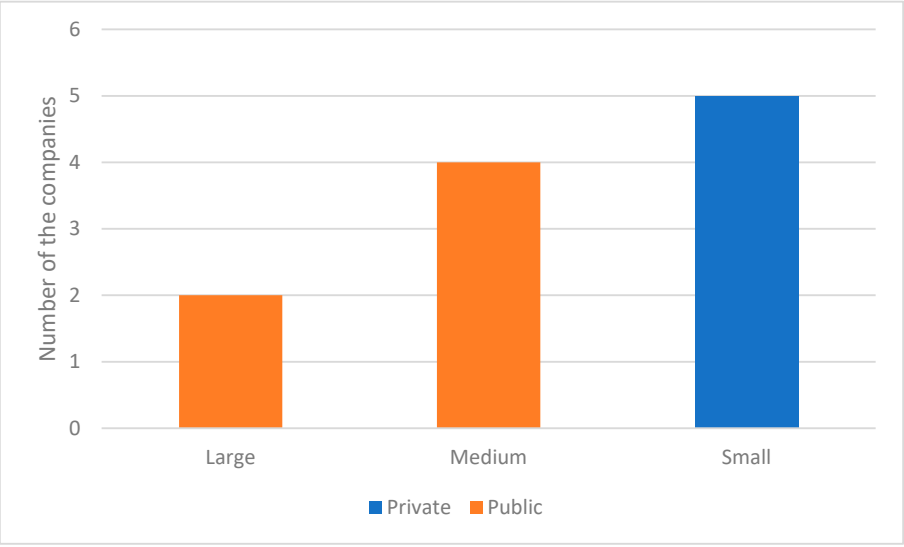

Figure 1. Overview of the companies participating in this study, categorized by size and type.

4.1. Sustainability Aspects and Assessment Methods

The housing companies included three aspects of sustainability—economic, environmental, and social—in their definition of sustainable renovation, affirming the importance of considering all these criteria. Notably, no additional criteria/aspects were mentioned or defined by the housing companies.

The results of the methods used to assess environmental aspects are illustrated in Figure 2. Among the surveyed housing companies, the majority rely on specific energy consumption metrics as their primary method for evaluating environmental sustainability. Notably, only two public companies incorporate Life Cycle Assessment (LCA) into their environmental evaluations, and just one company assesses primary energy in alignment with BBR (Swedish Building Regulations) standards, in which primary energy reflects on the use of energy resources.

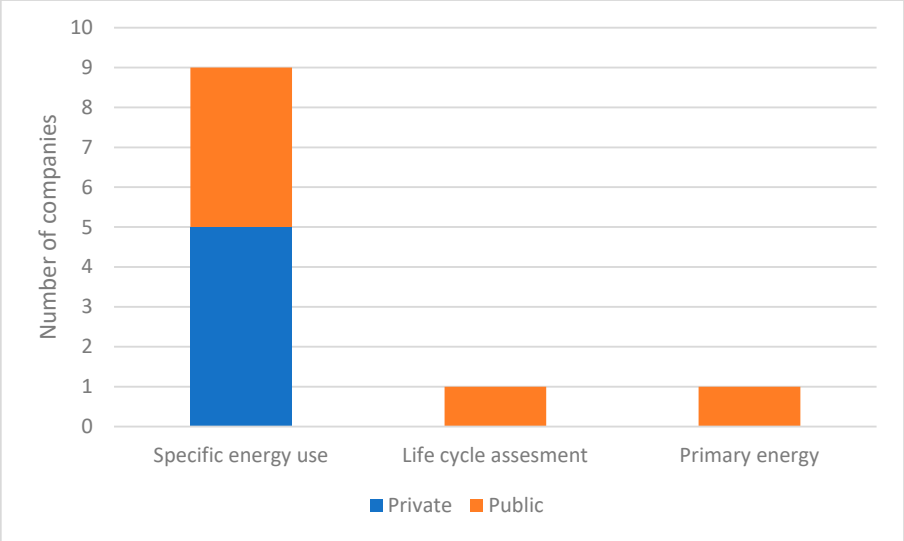

Figure 2. Methods used to assess the environmental aspect in the renovation of multi-family buildings.

The methods used to assess the economic aspects of sustainable renovation are displayed in Figure 3. Among the surveyed housing companies, investment cost emerges as the most frequently used metric for economic assessment. Following this, energy costs and life cycle costs are each utilized by two companies. Maintenance costs are considered by only one company, indicating limited attention to ongoing operational expenses.

For the social aspect, the majority of the companies reported incorporating social considerations into the renovation of multi-family buildings. Examples of such considerations include setting contractor requirements for safety, enhancing courtyard environments, and organizing tenant workshops. Priority is given to post-renovation rent levels, with efforts made to avoid over-standard project renovations that exceed necessary improvements and result in significantly higher costs, potentially making housing less affordable for tenants. While most housing companies consider social aspects in Swedish multi-family building renovations, it is important to note that each company has its own method, and there is no common assessment approach for the social aspect.

The responses from housing companies regarding decision-making tools reveal a lack of standardized tools in the renovation of multi-family buildings. However, several resources—including certification systems, policies, laws, regulations, energy calculation programs, and consultants—are consistently utilized across companies. Decision-making tends to rely heavily on the in-house experience and expertise available within each organization. Key factors influencing decisions include projected energy savings, investment

costs, tenant affordability, energy mapping, networking, tenant consultations, and ease of maintenance.

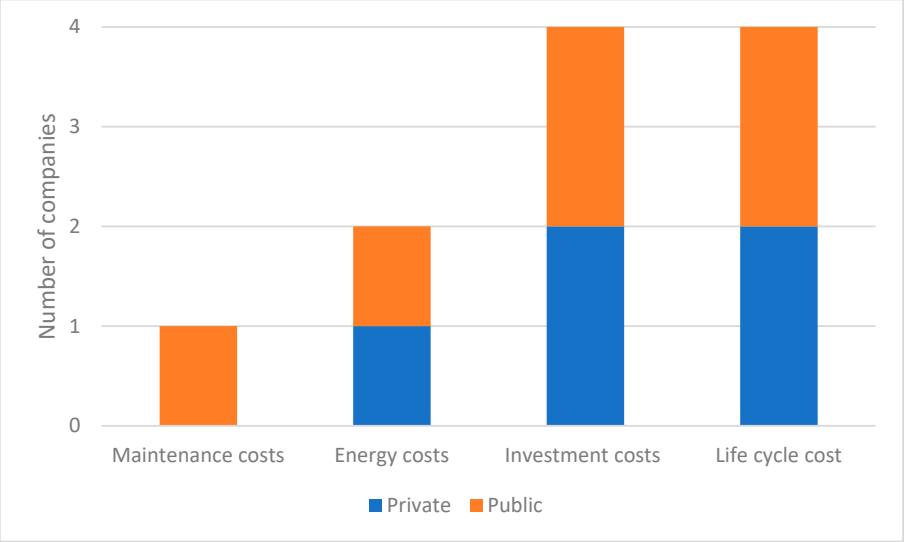

Figure 3. Methods used to assess the economic aspect in the renovation of multi-family buildings.

4.2. The Importance of Sustainability in the Renovation of Multi-Family Buildings

According to the survey responses, housing companies highlight safety, security, and low annual energy costs as key indicators of sustainability in multi-family building renovations. Each decision-maker selected seven indicators from a list of 30. Closely following these priorities are the use of environmentally friendly materials and the maintenance of high indoor air quality, as shown in Figure 4.

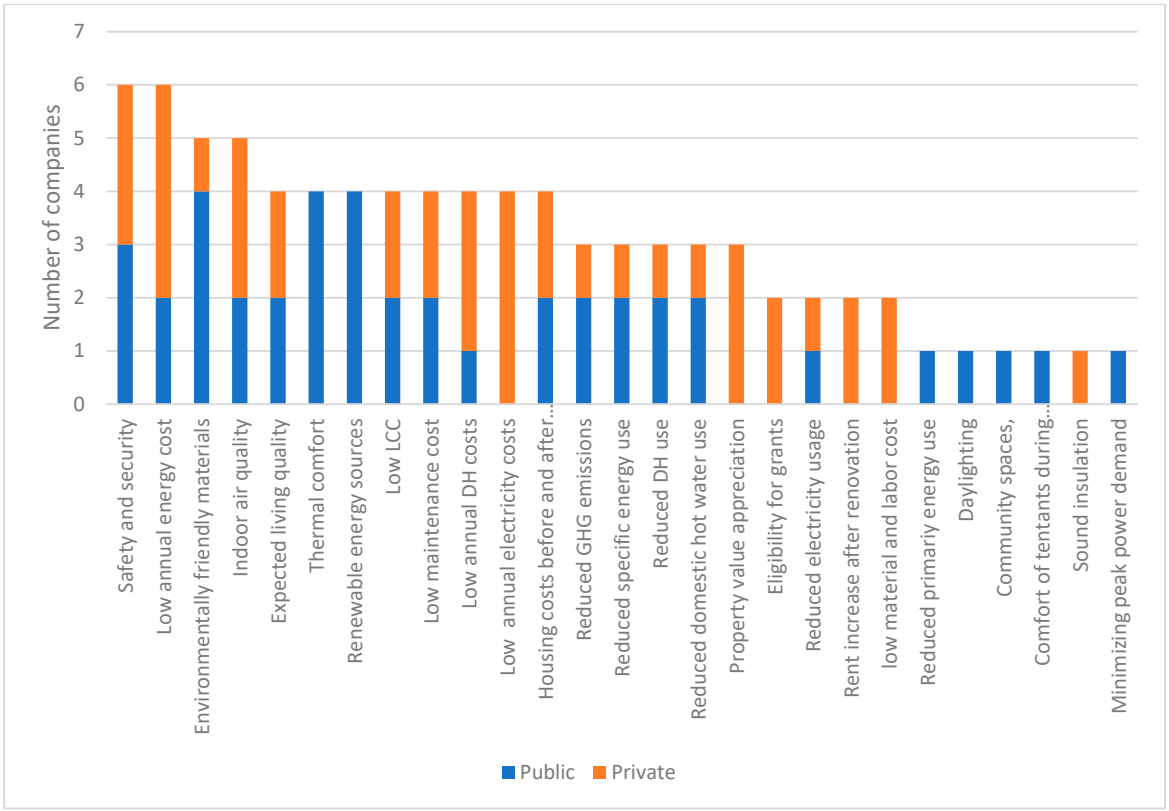

Figure 4. Indicators considered by housing companies when implementing sustainable renovation projects.

Each indicator presented in Figure 4 belongs to one aspect of sustainability: social, economic, or environmental. Based on the collected responses, the perceived importance of these sustainability aspects from the perspective of housing companies can be assessed. Figure 5 illustrates the perceived importance of each aspect in multi-family building renovations, showing that private housing companies prioritize the economic aspect, while public companies focus most on the environmental aspect.

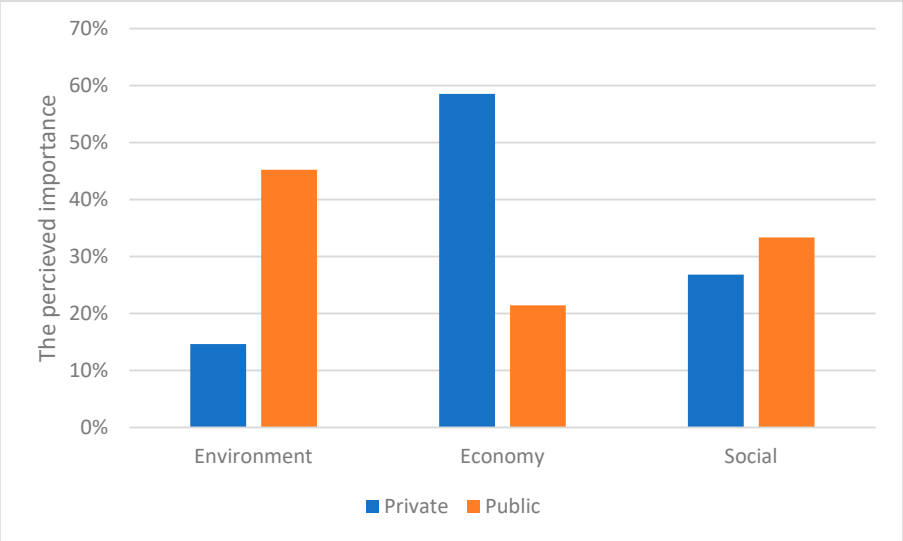

Figure 5. The perceived importance of various sustainability aspects in renovation projects from the perspective of housing companies.

5. Discussion

The selected 11 housing companies surveyed in this study represent a diverse mix of sizes and include both public and private sector entities. This diversity supports the study's goal of capturing a broader view of sustainability practices within the Swedish market for multi-family building renovations.

The results reveal a widespread familiarity among Swedish building owners with the traditional three-pillar framework of sustainability—encompassing economic, environmental, and social aspects—indicating a level of awareness that was not consistently observed in other studies conducted a decade ago [35,36]. No additional criteria were referenced, suggesting that while the foundational pillars of sustainability are well recognized, there may be limited awareness or application of other potentially impactful dimensions. Previous research [27,44] has proposed incorporating additional aspects, such as cultural and technical considerations, which could further enrich and refine sustainable renovation.

Energy use is identified as one of the primary methods for assessing the environmental aspect of renovations, aligning with the findings from a prior study [50]. However, more comprehensive tools, such as Life Cycle Assessment (LCA), which is widely used in academic research [51,58], are only employed by two out of the 11 housing companies surveyed. This limited use suggests that while energy consumption is commonly tracked, broader environmental impacts—such as resource extraction, emissions, and end-of-life considerations—may be overlooked by most housing companies.

Methods typically required for new buildings, such as primary energy assessments and tracking of GHG emissions, are often overlooked by building owners in renovation projects, primarily because these assessments are only mandated for deep renovations or when a building permit is required. This creates a gap in sustainability practices between new construction and renovation. Regulations are key in promoting sustainable practices by setting standards that encourage the adoption of greener solutions across the

industry. To better integrate sustainability into renovation projects, regulations could be expanded to include these assessments for all renovation types, regardless of scope or permit requirements. Additionally, creating incentives or requirements for incorporating energy efficiency and emissions tracking in smaller renovations could promote more consistent sustainability practices across the sector, ensuring that similar compliance is achieved in both new builds and renovations.

The investment cost is the most commonly used assessment method for evaluating the economic aspect of sustainable renovation in multi-family buildings, as reported by four of the surveyed housing companies. This focus on investment costs aligns with findings from other studies [22,23,35,36]. Despite the widespread use of life cycle cost (LCC) as an economic assessment method in research, its application among housing companies remains limited. None of the companies incorporate payback period or net present value (NPV) calculations in their assessments. While four companies use life cycle cost, the remaining seven focus only on a single cost, rather than considering all relevant costs. This indicates that long-term economic assessment tools, essential for evaluating investment feasibility and returns, are underutilized in the sector. These findings align with previous studies, showing that renovation measures are often evaluated based on short-term investments [24], highlighting a gap in the application of comprehensive economic evaluation methods within renovation practices.

Although building owners recognize the importance of the social aspects of sustainable renovations, there is no common method for assessing these dimensions. This gap may result from the challenges in defining and measuring social sustainability, despite its acknowledged significance. Various factors, such as tenant satisfaction, community engagement, and affordability, need to be considered. To address this, a standardized framework could be developed, and increased data sharing among companies involved in renovations across the country could help reduce the challenges of assessing these social aspects effectively.

The findings indicate that although companies utilize various supportive tools, decision-making predominantly relies on individual experiences. This approach may hinder the consistency and scalability of sustainable renovation practices across the sector, especially if the experienced individuals leave the company. The responses from housing companies regarding decision-making tools reveal an absence of standardized tools for renovating multi-family buildings, which aligns with conclusions drawn from other studies [22,23,35,36].

An important finding of this study is the difference in prioritization between private and public housing companies. Private companies tend to prioritize the economic aspect, whereas it is the least important for public housing companies. This difference in prioritization could be due to various factors, one possibility being that the surveyed private companies are small-sized. Their limited budgets may influence their decision-making. Future studies could explore the reasons behind this difference and whether it applies across private companies of all sizes. However, it is important to highlight that the majority of multi-family buildings in Sweden are owned by public companies (municipal housing companies), especially when it comes to rental apartments [67].

Notably, the growing focus on social considerations aligns with findings from other Swedish research, which observed a shift among companies toward more tenant-adapted, step-by-step renovation approaches [33]. This shift not only reflects a commitment to sustainable practices but also indicates a move toward more socially responsible renovations that consider tenant needs and adaptability.

A key takeaway from this study is the disconnect between priorities and assessment methods. While energy costs are recognized as a primary concern, the most commonly used

assessment method is investment cost, which may not fully capture long-term sustainability impacts. Additionally, although the use of environmentally friendly materials is considered essential, Life Cycle Analysis (LCA)—which evaluates the building's overall impact on greenhouse gas emissions over its lifespan—is underutilized. This gap highlights that the challenge lies not in understanding sustainability but in choosing the right tools to implement it effectively.

Housing companies can use these findings to refine their renovation strategies by adopting more comprehensive assessment methods. Integrating LCA for environmental impact assessments and broadening economic evaluations to include tools like life cycle cost (LCC) or net present value (NPV) would allow companies to better align their practices with long-term sustainability goals. Addressing this disconnect could improve decision-making and drive more effective, sustainable renovation practices across the sector.

It is important to highlight that the aim of this study is not to generalize the results to the entire population, as the available data are limited. Instead, the study seeks to explore insights from a random sample of housing companies to gain a deeper understanding of their perspectives on sustainability in renovation projects. The findings provide valuable exploratory insights rather than statistically representative conclusions.

6. Conclusions

The renovation of multi-family buildings is essential to achieving sustainability goals in Europe. This study investigated how housing companies in Sweden integrate sustainability into their renovation projects for multi-family buildings. To achieve this, a semi-open questionnaire was developed to explore how these companies implement sustainable renovation practices. Data were collected from 11 Swedish housing companies across both the private and public sectors, providing an initial overview of sustainable renovation approaches in practice. The questionnaire offered valuable insights into how building owners in Sweden perceive sustainability and how it influences the renovation process.

The results indicate that housing companies are generally aware of the three pillars of sustainability: environmental, economic, and social aspects. The most commonly applied metrics include specific energy use and investment costs, representing environmental and economic considerations, respectively. While most companies incorporate some level of social assessment, there is no standardized assessment method across the sector. Housing companies rely on past experience with individuals guiding social considerations. This reliance on experience suggests that a centralized database capturing quantitative data from various housing companies could aid decision-making and promote consistent social evaluation methods.

Keywords such as safety, security, and low annual energy costs emerged as priorities in multi-family renovation projects. The responses indicate that housing companies do consider all three aspects of sustainability, although with varying degrees of emphasis.

The study concludes that while building owners recognize the importance of sustainability and express interest in sustainable renovations, there remains significant uncertainty about effectively implementing these practices. Life cycle concepts, commonly used in research to assess economic and environmental impacts, are rarely applied by building owners in renovation decisions. Additionally, the assessment methods currently in use often do not align with the stated priorities of housing companies. This points to the need for developing a decision-making tool tailored to sustainable renovation, capable of aligning assessments with housing company goals. Nor are various sustainability aspects in building regulations (primary energy use and climate declaration for new buildings in view of GHG emissions during the material and construction process phase) prioritized—on the contrary.

Despite the availability of tools designed to facilitate sustainable renovation, these tools are infrequently integrated into actual renovation processes. This gap underscores the need for further development and integration of practical, user-friendly tools to enhance sustainability in renovations, as well as being informed about the availability and potential of these tools.

A more in-depth investigation is needed to identify what type of comprehensive tool would be practical and widely adopted for sustainable renovation. Such a tool should address the needs of building owners and industry professionals, offering user-friendly features and ensuring comprehensive assessments of environmental, economic, and social impacts. Developing a tool that integrates easily into existing renovation workflows could greatly boost the adoption of sustainable practices.

Furthermore, regulations commonly applied to new construction projects, such as those related to primary energy use and GHG emissions in the product and construction process phase, are seldom adopted in renovation projects. The findings of this study could provide valuable insights for policymakers, housing companies, and researchers interested in overcoming practical and methodological barriers to sustainable renovation in multi-family buildings.

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