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DOI

[10.1016/j.enbuild.2024.114589](https://doi.org/10.1016/j.enbuild.2024.114589)

Publication date

2024

Document Version

Final published version

Published in

Energy and Buildings

Citation (APA)

Elgendy, R., Mlecnik, E., Visscher, H., & Qian, Q. (2024). Integrated home renovation services as a means to boost energy renovations for homeowner associations: A comparative analysis of service providers' business models. *Energy and Buildings*, 320, Article 114589. <https://doi.org/10.1016/j.enbuild.2024.114589>

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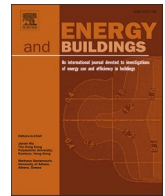
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Integrated home renovation services as a means to boost energy renovations for homeowner associations: A comparative analysis of service providers' business models

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ARTICLE INFO

Keywords:

Business model
Homeowner associations
Energy renovations
Integrated home renovation services
Renovation journey
One-stop-shop

ABSTRACT

Across the European Union (EU), approximately 46% of the population resides in apartment buildings. A majority of these buildings are in need of energy renovation and are managed by Homeowner associations (HOAs). HOAs face distinct challenges in renovating their buildings. Integrated home renovation services (IHRS) have emerged as a potential solution to accelerate highly energy-efficient renovations for HOAs. The question arises: How do current integrated home renovation service providers facilitate energy renovations for homeowner associations, overcoming the prevailing barriers to uptake? This paper explores the current state of IHRS providers operating in four European regions with a focus on the Netherlands and Flanders. The study offers insights into the dynamics of their business models, strategies, and ways forward. The methods employed involve a combination of qualitative approaches. Fourteen business models of IHRS providers in the Netherlands, Belgium, France, and Austria were analysed, to define their strategies within the regional context. The results reveal that while public entities prioritize broad societal challenges, private models focus on operational efficiency and financial sustainability. Public-private partnerships offer a hybrid approach, blending strengths but requiring precise governance to align diverse interests and achieve comprehensive, sustainable outcomes. The findings can inform policymakers, practitioners, and researchers in developing effective and targeted IHRS initiatives in the EU.

1. Introduction

Buildings in the EU are responsible for 40 % of energy use and 36 % of greenhouse gas emissions [1]. In this context, the residential sector is responsible for a significant portion of energy consumption, accounting for approximately 27 % of total final energy consumption [2]. Approximately 46 % of the European population resides in apartment buildings, making them the most common type of housing in Europe [3]. The current energy renovation rate of buildings in Europe is low, accounting for 1 % annually [1,4]. To reach the goals set by 2050 to decrease the reliance on fossil fuels [1] the percentage needs to be increased to 3 % [5]. The revised Energy Performance of Buildings Directive (EPBD), enacted in April 2024, implements crucial updates to hasten the decarbonisation of the building sector throughout the EU. A key element of this update is the establishment of Minimum Energy Performance Standards, which compel renovations of the least efficient buildings,

focusing on enhancing energy efficiency and reducing greenhouse gas emissions. Additionally, according to Article 18 of the directive, Member States are required to establish and operate technical assistance facilities, including one-stop shops, to support all actors involved in building renovations. These facilities aim to provide streamlined information and holistic support, particularly targeting households affected by energy poverty and the worst-performing buildings [6,7].

Many of the existing residential buildings in Europe are managed by Homeowner Associations (HOAs). HOAs are responsible for organizing and coordinating the efforts of multiple co-owners to maintain the building's operation and ensure joint liability [8]. There is a need to speed up the energy transition of buildings managed by HOAs as part of the goals set by the EU [9] to decarbonise the built environment. Conversely, despite the evident benefits, HOAs often face numerous barriers that hinder their ability to undertake successful energy-efficient renovations. These barriers can be financial [10], technical [11], social

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<https://doi.org/10.1016/j.enbuild.2024.114589>

Received 30 May 2024; Received in revised form 10 July 2024; Accepted 22 July 2024

Available online 23 July 2024

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[12], and legal [13], arising throughout the renovation journey of HOAs [14]. Addressing such barriers requires the collaboration of various experts and stakeholders [11,15,16].

Integrated home renovation services (IHRS) have been offered as a viable solution for speeding up the energy transition in the European housing sectors [17–20]. IHRS providers vary in their approaches, strategies, and choices of value creation [14,18–20]. Creating value requires a deep understanding of the target group and their needs, identifying the necessary activities to generate this value, and determining the best approaches to reach them. This can be achieved through the development of a business model that captures, creates, and delivers value to a specific group [21].

Literature presents various models of IHRS providers' business models (BMs), which can be classified into primary categories; Facilitation, Coordination, and Development models and further subdivided categories and archetypes [19] and IHRS providers that are government-driven, industry-driven, ESCO-based, cooperative and store based models [14]. Brown described and compared five BM archetypes which are the atomised market model, market intermediation model, one-stop-shop (OSS) model, energy services agreement model, and managed energy services agreement model [22]. Another study defines possible BM archetypes like district heating BM, Going Green models, Building energy communities BMs, Lock-in oriented BM, Complementarities-oriented energy supply BM, and Efficiency-oriented energy BM [23]. Milin and Bullier identified 3 main models of IHRS according to the services provided which are the advice model, support model, and implementation model [18].

Several European projects have discussed the different types of BMs of IHRS providers for homeowners like ABRACADABRA; Development and demonstration of new renovation strategies based on Add-ons and Renewable Energy Sources [24], STUNNING; Sustainable BMs for the deep renovation of buildings [20], ACE-Retrofitting; Approaches for local authorities to facilitate change to boost energy retrofits in condominiums [25], I-Heros; Strategic approach to accelerate the number of home renovation projects in Europe [26], PadovaFit Expanded; Development of OSSs for home renovations [27], ProRetro; Development of a OSS BM [28], Save the Homes; Decomplexifying, establishing trust relationships, providing clear tailor-made information and offering continuous advice and support for homeowners [29], 4RinEU; Robust and Reliable technology concepts and BMs for triggering deep Renovation of Residential buildings in EU, P2ENDURE; Plug-and-Play solutions for Energy-efficiency deep renovation of European building Stock, ProGET-OnE; Integration of Plug-and-Play solutions and users' centered approach to solving both energy and seismic requirements during deep renovation of residential buildings, MORE-CONNECT; Development and advanced prefabrication of innovative, multifunctional building envelope elements for Modular Retrofitting and CONNECTIONs [11], Green Home; Creation of continuous dialogue and exchange on energy efficiency and investment topics between stakeholders working on energy renovations for HOAs in Germany and INNOVATE; setting up OSSs for integrated home energy renovations [24,20,30] and technical reports from the European Commission discussing OSSs for residential building energy renovation in the EU and concluded three main types of BMs of OSSs which are No cost OSSs, Fee-based OSSs and Bundled cost OSSs [31].

However, the literature indicates a lack of knowledge about the BMs of IHRS providers targeting HOAs as a unique target group with special laws, structures, and regulations within the context of energy renovation and how those IHRS providers are trying to overcome barriers and implement services needed by HOAs to renovate their buildings. The question arises: How do current integrated home renovation service providers facilitate energy renovations for homeowner associations, overcoming the prevailing barriers to uptake? To address this question effectively, it is crucial to first comprehend the organizational structure of HOAs. Understanding the renovation phases HOAs follow when renovating their buildings is also key, as this highlights where barriers

typically arise. By mapping out this journey, we can more precisely identify where the barriers occur and assess how the IHRS specifically address these challenges, thereby facilitating smoother renovation processes for HOAs.

The structure of this paper is as follows. Section 2 describes the unique structure of HOAs, the renovation journey and the common barriers HOAs face when renovating their condominiums. IHRS providers and their role in boosting energy renovations for HOAs are presented in Section 3. Section 4 describes how can the BM theory help understand how IHRS providers facilitate energy renovations for HOAs. Section 5 describes the methodology used in this paper, data collection, and data analysis. The results are presented in Section 6. Section 7 discusses the results and provides recommendations to improve the BMs and policy recommendations. Conclusions are drawn in Section 8.

2. Homeowner associations decision-making structure, the renovation journey and barriers

In this section, we first explore how HOAs represents a distinct collective of apartment owners within a shared building envelope, bearing joint responsibility for the maintenance and improvement of the entire structure [8]. Such collaboration between the homeowners forms a legal association that could be referred to as a homeowners association (HOA), condominium association (CA), or, as known in the Netherlands as VvE "Vereiniging van Eigenaars" and in Flanders as VME "Vereiniging van Mede-Eigenaars". This unique property structure involves dividing a single piece of real estate both horizontally and often vertically into distinct units [32,33]. Another aspect to be aware of is the transition towards privatization in social housing which has led to a significant shift, wherein once publicly-owned apartments were sold, transforming these buildings into legally mandated HOAs [34]. This change has resulted in a diverse ownership structure, comprising individual co-owners and entities possessing multiple units, alongside private companies that rent out several apartments, marking a complex blend of ownership and tenancy within the same community. Another aspect to consider is that, in some cases, there may be multiple HOAs within a single building envelope, particularly in attached buildings, adding an additional layer of complexity.

The laws and governance structures of these associations vary by country; for example, initiating substantial energy renovations often requires a majority vote, and voting requirements are typically specified in the HOAs internal regulations, which can be based on standard models or specifically tailored by the members [35]. These renovations are comprehensive, encompassing everything from conducting energy audits to addressing legal matters, financial resources, and executing a master plan. The process is intricate and costly, prompting governments to offer incentives, renovation loans, and subsidies to alleviate financial burdens [36,37].

In the Netherlands, the laws for HOAs are defined in Title 9 of Book 5 of the Civil Code (BW) Article 106 (Civil Code Book 5) and it clarifies that the rules of a HOA are determined by the deed of division, the contents of the deed of division and the regulations are determined by the leaseholder or installer who divides a building into apartment rights. It results in a form of ownership where individual units are owned and registered in the names of buyers (homeowners), while ownership of shared residential common areas is owned by all homeowners (co-ownership) [39]. The co-ownership share dictates the proportion of common expenses, the allocation of common profits, and the voting authority of each condominium unit owner in the condominium management [8,40]. It is mandatory in the Netherlands that all apartment owners be members of a HOA. The HOA has several obligations, it has to hold a meeting of its members at least once per year, maintain a reserve fund, and issue an annual financial statement. It is mandatory to list HOAs in the Dutch Business Register [35].

The laws do not differ in Flanders as in the Netherlands so much. In Flanders, the law establishes a framework for HOAs through four main

bodies: the General Assembly of Co-owners, the Board of Co-ownership, the Syndicus, and the Association of Co-owners itself [41]. These entities collectively manage the affairs of the association and the Board of Co-ownership executes the decisions made by the General Assembly [41]. The rules governing these associations are typically laid out in the statutes of the building and the regulation of co-ownership, often established by the builder or developer. These rules are usually durable, with changes requiring a significant majority or unanimity in the General Assembly of Co-owners. In the Netherlands and Flanders HOAs legally require a reserve fund for maintenance and renovation [38], but HOAs in Flanders can decide with a 4/5 majority not to create a reserve fund [42,43].

HOAs can play a crucial role in the energy renovation of multifamily apartment buildings. HOAs often hire a professional who is usually referred to as a “property manager” or a “condominium manager” [44]. A condominium manager (CM) is an individual or a legal person who manages and administers the affairs of the syndicate of co-owners but who does not participate, in principle, in the decision-making process. The CM executes, for a fee, the decisions of the owners association. The structure of the HOAs regarding decision-making is elaborated in Fig. 1.

2.1. The full-service renovation journey for homeowners associations to renovate their buildings

Several roadmaps and customer journey frameworks have been identified in the literature [45,14,46,47] and derived from various EU projects [48,49], elucidating the essential tasks and steps required for energy renovations for homeowners. These resources offer comprehensive guides, highlighting the strategic and operational phases necessary to navigate the renovation projects within HOAs. Drawing upon a wide array of sources, Fig. 2 presents the syntheses of these insights, offering a consolidated view of the main phases of the renovation journey for HOAs.

2.2. Barriers for homeowner associations to undertake energy renovations

HOAs face distinct barriers in pursuing energy-efficient renovations. A recent study by Elgendy et al. (2024) [50] conducted a comprehensive literature review of scientific articles and technical reports from various EU projects (ACE-Retrofitting, CondoReno, Green Home, I-Heros, PadovaFIT Expanded, ProRetro, and Save the Homes) focused on home energy renovations. This study aimed to identify and analyze the common barriers that HOAs face when implementing energy renovations in their condominiums. The list of barriers is categorized and presented in Table 1.

3. Integrated home renovation services as a means to boost energy renovations for HOAs

IHRS refers to a comprehensive approach that combines various

services offered by various stakeholders into a bundled offer of energy renovations for homeowners [18,51]. This involves streamlining the renovation process and leveraging available resources, including public support schemes and local market players. These services focus exclusively on private residences, excluding public buildings or commercial properties, with a strong emphasis on low-energy renovation of existing structures, either as a single-phase effort or through a planned, staged approach facilitated by tools [18]. The primary goal is to provide tailored solutions for enhancing energy efficiency and sustainability in residential sectors. Another positive impact of IHRS is its ability to lead to better project outcomes [26,27]. IHRS providers are thought to be necessary to address the demand integration and supply collaboration aspects of home renovation [52]. IHRS providers could be public, public-private, or private organizations offering home renovations to HOAs [53].

4. Business model theory

A BM can be defined as a fundamental framework that outlines how an organization (IHRS Providers) creates, delivers, and captures value in the market (HOAs) [54]. BMs can be used to guide the development of innovative solutions for the energy transition of apartment buildings [52,55,19,56]. The key elements of BMs comprise a unique value proposition, target market, revenue streams, cost structure, partnerships, scalability, and risk assessment [57,19]. To formulate a viable BM and business plan, initiating the process with the widely recognized Business Model Canvas (BMC) that was generated by Osterwalder et al. (2005) proves to be beneficial [30]. BM patterns have been an idea behind trying to identify viable BMs that are readily implementable for delivering a value or service [21,57].

Various authors have used this approach to assess BMs for speeding up energy renovations [58,59,19]. It's worth noting that BMs are not limited to the private sector, as they are also commonly used in public sectors [60]. Researchers and scholars have used the BMC as a foundation for their research in understanding and creating tools to assess value for the built environment [61,62].

Several studies and EU projects have worked on categorizing and understanding the differences and typologies of BMs of organizations working on the energy transition of existing residential buildings [30,31,18,56]. While there is a lack of consensus on terminology among scholars, with some preferring to use ‘facilitation’ instead of ‘advice’, ‘coordination’ instead of ‘support’, and ‘all-inclusive’ for ‘implementation’. The core objectives of these models remain distinct. The advice model focuses on raising awareness and offering general information at no cost to homeowners. The support model assists homeowners in applying for subsidies, coordinating with existing stakeholders, and facilitating matchmaking. Lastly, the implementation model provides homeowners with a comprehensive renovation packages.

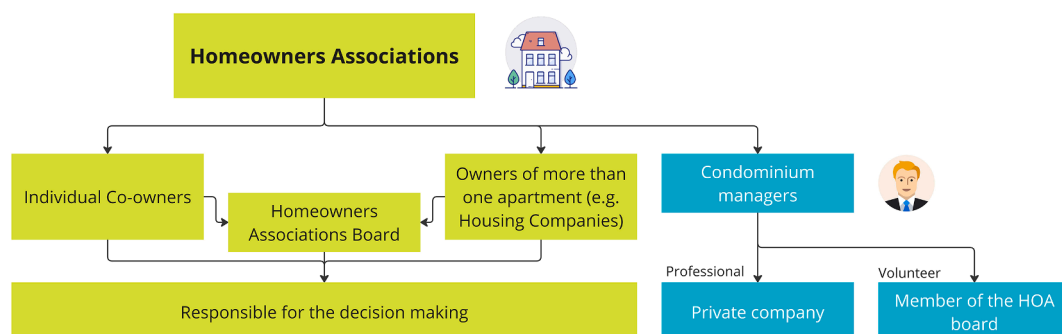


Fig. 1. Homeowners Associations Structure.

Source: Author's synthesis based on relevant literature.

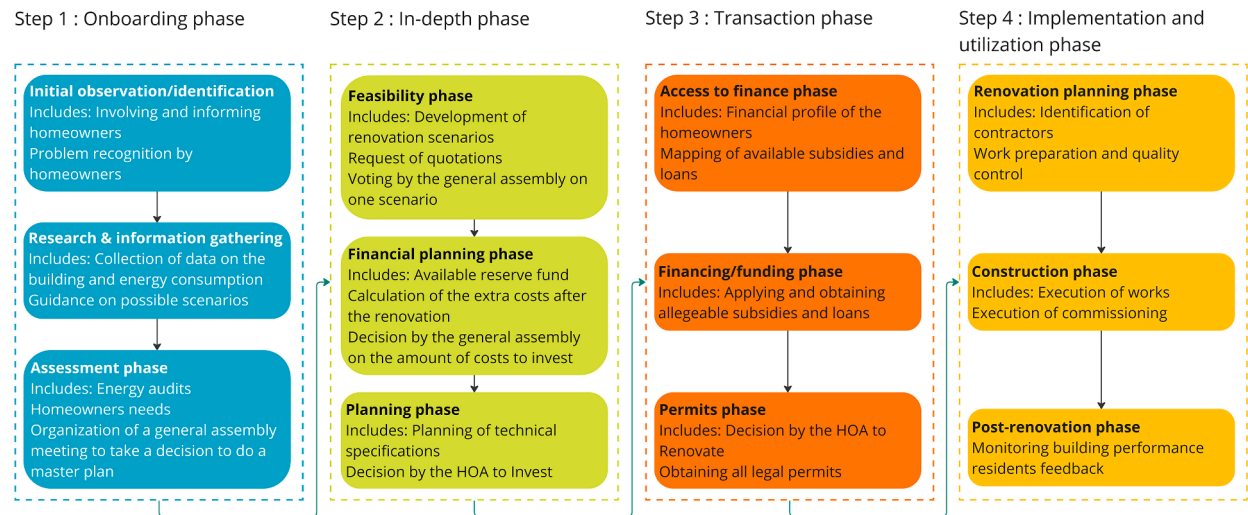


Fig. 2. The main phases of the renovation journey for HOAs. Source: Author's synthesis based on relevant literature.

Table 1
Summary of common barriers faced by HOAs. .

Category	Barrier
Financial barriers	High-upfront costs (FB1)
	Difficult collection of funds (FB2)
	Lack of sufficient funding (FB3)
	Split incentives (FB4)
	The financial burden for individual homeowners (FB5)
	Condominium managers Business case (FB6)
	Higher service costs after renovation (FB7)
	Pre-existing Physical defects in buildings (which leads to extra costs for repair) (FB8)
Legal barriers	Complex ownership structure (Division of the deed) (LB1)
	Limited access to financing due to complex regulations (LB2)
	Limited enforcement of regulations (LB3)
	Complex and multilevel regulations (LB4)
	Animal policies (ecological regulations) (LB5)
	Unregistered HOAs (LB6)
	Limited municipal resources (due to the legal structure of the municipalities) (LB7)
Social barriers	Collective decision-making is complex and lasts long (SB1)
	Lack of awareness and interest (SB2)
	Homeowner's behaviour towards renovation (different interests) (SB3)
	Lack of transparency and communication (SB4)
	Disturbance during renovations (SB5)
	Management by volunteer co-owners (SB6)
Technical barriers	Lack of technical know-how (TB1)
	Lack of Consistent and standardized solutions (TB2)
	Safety and seismic risks (TB3)
	Lack of quality assurance (TB4)
	Differences between predicted and actual savings (TB5)
	Technical challenges in older buildings (TB6)
	Limited storage and power grids (TB7)
	Lack of qualified advisors (TB8)

Source: Elgendy et al. (2024)

5. Methodology, data collection and data analysis

This paper explores the BMs of IHRS providers targeting HOAs. Fourteen case studies were conducted in Europe with a focus on cases from the Netherlands and Flanders, as well as frontrunners in France and Austria, to garner insights from various approaches.

In this study, a ‘case’ refers to an individual example of an IHRS provider, focusing on its BM and how it tackles the barriers faced by HOAs when renovating their condominiums. The case study approach allows for an in-depth examination of complex, real-life phenomena, providing rich insights that other methods may overlook [63]. This method also facilitates comparison across different contexts, highlighting the unique strengths and weaknesses of each model [64].

The analysis aims to provide information and knowledge that can promote highly energy-efficient renovations for HOAs and key stakeholders including policymakers. This study enriches the body of knowledge by exploring how IHRS providers address the barriers faced by HOAs undertaking energy renovations to their buildings. Service providers can leverage these findings to optimize their strategies and offerings for HOAs, while policymakers can use this evidence to shape supportive regulations and incentives, ultimately facilitating more effective and widespread energy renovations in the residential sector.

The methodology of this paper is structured into two distinct parts. The first part involves linking the barriers HOAs face to specific stages of the renovation journey. This provides a foundational understanding of the challenges and potential intervention points within the renovation process.

The second part of the methodology focuses on two key analyses: firstly, the evaluation of service alignment of IHRS providers with the identified renovation journey and barriers, which assesses how well the services offered by IHRS providers match the needs identified in the renovation journey and overcome the identified barriers. This involves a systematic review of service specifications against the renovation journey stages and the barriers nature. Secondly, we conduct a Qualitative Comparative Analysis of the BMs of IHRS providers. This analysis explores the commonalities and differences between these models to understand which aspects are most effective in supporting HOAs in energy renovations. This dual analytical approach elaborated in Fig. 3 ensures a comprehensive evaluation of the current landscape of IHRS offerings and their impact on accelerating energy renovations in condominiums.

5.1. Data collection

First, this research utilized literature to deepen the understanding of IHRS providers operating their BMs. To explore relevant cases of IHRS providers targeting HOAs, archival research was undertaken. Information was compiled from the service providers websites, alongside webinars and presentations given in workshops and seminars

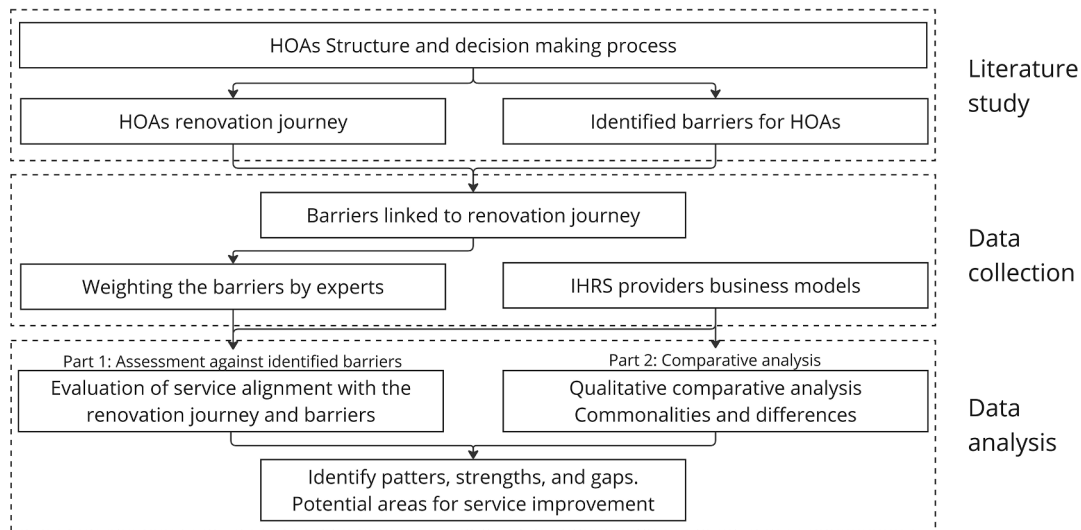


Fig. 3. Methodological Framework.

orchestrated by the EU. Cases of IHRS providers frontrunners who provide services for HOAs were selected with different organizational structures to understand and know best practices. This study focuses mainly on cases from the Netherlands and Flanders. In the Netherlands, the market conditions have historically made it appealing for the private sector to take a leading role in sustainable practices, often more so than municipalities. However, recent shifts have seen provincial governments and the Dutch national government paying increased attention to HOAs, reflecting a growing recognition of the importance of collaborative approaches in achieving energy renovation targets. Conversely, In Flanders, there is a robust push from the Flemish Energy Agency (VEKA), coupled with proactive governance, which spurs municipalities to engage more actively in sustainable building initiatives. This regional policy framework actively supports municipalities, enhancing their commitment to energy efficiency projects. These regions were chosen due to their progressive policies in sustainable building practices [36,37], a high density of homeownership, and the region's pioneering role in adopting energy-efficient practices making them ideal case studies for exploring, they are chosen for their similarities and proximity but distinct regulatory landscapes. Additionally, France was included due to its extensive portfolio of condominiums and its role as a pioneer in sustainable building practices, making it a valuable context for studying large-scale residential energy renovations. Austria provided a unique case study with a public OSS that transitioned from municipal management to an independent entity, allowing it greater freedom to expand its operations beyond municipal limits and explore innovative approaches to energy efficiency. Accordingly, Fourteen Western European cases were identified for examination to observe variations in the methodologies and resources utilized by diverse entities.

Second, a qualitative questionnaire and interviews were respectively conducted with experts from 10 selected providers of IHRS targeting HOAs (see Table 2). The first case involved a climate agency situated in Paris, known for its pioneering efforts, functioning as a public–private entity. A private nonprofit organization in its early stages of development offering IHRS just for HOAs in the Netherlands was included as the second case. The third case involved an OSS based in Vienna, Austria functioning as a public stand-alone entity. Five municipalities were selected for study, three from Flanders and two from the Netherlands. The last two cases involved (market-driven) private IHRS providers targeting only HOAs in the Netherlands.

Information from events, websites and webinars was gathered from representatives from four cases (see Table 3) the 4 cases are as follows: two cases of OSSs that are public–private based in France known for their pioneering efforts in providing energy renovations for HOAs. One

Table 2
Profile of the conducted interviews.

Code	Date	Type of organization	Position interviewee	Duration	Method
BM1	09-01-2023	Public-private climate Agency in a large city	Project leader	1 h	Online
BM2	23-01-2023	Private non-profit organization provider	Director	1 h	Online
BM3	16-11-2022	Public actor large-sized municipality	Renovation advisor	1 h	In person
BM4	13-02-2023	Public actor medium-sized municipality	Consultant	1 h	Online
BM5	15-09-2023	Public actor small-sized municipality	Project coordinator	1 h	Online
BM6	06-03-2023	Public actor large-sized municipality	Project coordinator	47 min	Online
BM7	1-06-2023	Public actor large-sized municipality	Sustainability broker	1 h 30 min	In person
BM8	26-05-2023	Public actor large-sized municipality	Executive project manager	1 h	Online
BM9	08-1-2024	Private organization	Director	2 h	In person
BM10	23-1-2024	Private organization	Project coordinator	2 h	In person

Table 3
Profile of the 4 cases from the events.

Code	Date	Type of organization	Position representative	Event
BM11	20-06-2023	Public-private OSS	Energy Transition Director	How to Set Up an Integrated Home Renovation Service?
BM12	20-06-2023	Public-private OSS	Technical expert	
BM13	16-01-2024	Public actor large-sized municipality	General manager	Belgian renovation week
BM14	13-02-2023	Public actor large-sized municipality	Project leader	Online Workshop

case of a public OSS based in Brussels, Belgium and one case being developed by a European project in Rotterdam, the Netherlands.

The following data was collected: Nine key aspects pertaining to the building blocks of BMs of those providers, namely: customer segments, value proposition, channels, customer relationships, revenue streams, key activities, key resources, key partners, and cost structure (See [Appendix](#)) [21].

During the interviews, the experts were asked to present their BMs to acquire a comprehensive understanding of the organizations BMs. The online interviews were recorded and transcribed for the analysis, and the analysis was sent to the interviewees to be validated.

5.2. Data analysis

The analysis begins with the barriers identified from prior research that are integrated into this renovation journey, providing a contextual framework for the analysis.

Following the linking of these barriers, 22 experts have been asked during two workshops to give a weighting score for each barrier by asking them about the significance, impact and importance of solving those barriers on the renovation journey for HOAs. We employed a Likert scale ranging from 1 (least significant) to 5 (most significant) to gauge the impact of addressing each barrier on the overall renovation journey. Experts were asked to rate the importance of overcoming each barrier, reflecting their professional judgments and experiences. The final weight assigned to each barrier was determined by averaging the scores provided by all participating experts. This average score represents the consensus on the relative importance of each barrier, providing a quantifiable measure of its impact on the renovation process. The methodology ensures that the weighting of barriers is both comprehensive and reflective of expert opinion, thereby enhancing the reliability of our analysis. Several scholars have used this step to identify the most important challenges to pay attention to [65]. The weighted scores assigned to each barrier, as presented in [Tables 4–7](#), are utilized within a weighted scoring model. This model is pivotal in assessing and comparing how the IHRS providers try to overcome such barriers.

The analysis evaluates the capability of the fourteen BMs of IHRS providers to overcome the barriers faced by HOAs. BMs were scored based on their ability to address each barrier: 0 for not addressing, 1 for partially addressing, and 2 for fully addressing. The weighted scores for each barrier were calculated by multiplying the scores by the barrier weights Eq. (1) (i represents each barrier). The method is commonly used in decision-making processes, particularly in the evaluation and comparison of various options or scenarios based on multiple criteria. This method is often referred to as the weighted scoring model or

weighted decision matrix [66].

$$\text{WeightedScore} = \sum (\text{Score}_i \times \text{Weight}_i) \quad (1)$$

These scores were then aggregated by adding the sum of the multiplication of each barrier for each step of the renovation journey to yield a total score per BM.

This methodology provides a comprehensive approach to understanding both the barriers faced by HOAs during renovation projects and the capacity of IHRS providers to address these challenges, ultimately aiming to identify patterns, strengths, and gaps in service delivery.

6. Results

Our analysis focused on identifying how the service offerings of the BMs can overcome the barriers faced by HOAs at different phases of the renovation journey and compare the Fourteen models across the different phases of the renovation journey. The three critical milestones identified were the decision to create a master plan for a privately owned apartment building renovation, the decision to invest, and the decision to renovate (see [Fig. 4](#)). Using comprehensive data from our data collection, detailed in the [Appendix](#), we assessed whether the fourteen IHRS providers addressed these barriers. This approach allowed us to evaluate the capability of each BM to overcome the barriers faced by HOAs in each phase and identify areas for improvement and development among the BMs.

6.1. Connecting barriers to the renovation journey

In our ongoing research, we have made a preliminary investigation to establish a connection between the identified barriers and the renovation journey of HOAs presented in [Fig. 2](#). It has become evident that certain barriers manifest in specific phases and stages of the renovation process, while others are more pervasive, affecting multiple or all phases of a project. [Fig. 4](#) presents our preliminary effort to map out where each barrier typically arises in the renovation timeline. This figure has undergone several iterations, developed through extensive consultation with multiple experts to ensure its accuracy and relevance.

6.2. Analysis of the IHRS providers' capability to overcome the aforementioned barriers

This section offers a detailed analysis of the BMs at each step, based on the data collected (refer to the [Appendix](#) for details). The analysis compares the capability of the BMs to overcome barriers per step.

Table 4
Analysis of the BMs of IHRS providers addressing the barriers of HOAs in Step 1.

Step	Renovation phases	Barrier	Weight	Business models of integrated home renovation service providers														
				Public								Private			Public-Private			
				BM3	BM4	BM5	BM8	BM9	BM10	BM13	BM14	BM2	BM6	BM7	BM1	BM11	BM12	
0= Does not address the barrier 1= Partially addresses 2=Fully addresses																		
Step 1 Onboarding phase	Initial observation/identification phase	Lack of awareness and interest (SB2)	5	2	2	2	2	2	2	2	2	1	1	1	2	1	1	
		Lack of qualified advisors (TB8)	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
		Lack of transparency and communication (SB4)	3	2	2	2	2	2	2	2	2	1	0	1	2	2	2	
	Research & information-gathering phase	Unregistered HOAs (LB6)	3	0	1	1	0	1	2	0	0	0	0	0	2	0	0	
		Limited municipal resources (LB7)	3	2	1	2	1	1	1	2	1	2	0	1	2	2	2	
		Lack of technical know-how (TB1)	5	1	1	1	1	1	1	1	1	2	2	2	1	2	2	
	Assessment phase	Split incentives (FB4)	4	0	1	0	0	0	0	0	0	0	0	0	1	1	1	
		Lack of transparency and communication (SB4)	4	2	2	2	2	2	2	2	2	1	0	0	2	2	2	
		Condominium managers business case (FB6)	3	1	1	1	0	1	1	0	0	1	0	1	2	1	0	
	Total score per phase			70	48	52	51	42	48	51	45	42	41	25	34	61	52	49
	Capability rate per business model to pass step 1			%	69	74	73	60	69	73	64	60	59	36	49	87	74	70

Table 5
Analysis of the BMs of IHRS providers addressing the barriers of HOAs in Step 2.

Step	Renovation phases	Barrier	Weight	Business models of integrated home renovation service providers														
				Public									Private			Public-Private		
				BM3	BM4	BM5	BM8	BM9	BM10	BM13	BM14	BM2	BM6	BM7	BM1	BM11	BM12	
				0= Does not address the barrier 1= Partially addresses 2=Fully addresses														
Step 2 In-depth phase	Feasibility phase	Technical challenges in older buildings (TB6)	4	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
		Safety and seismic risks (TB3)	1	0	0	0	0	0	0	1	1	2	2	2	0	1	1	
		High upfront cost (FB1)	5	1	0	0	1	0	0	1	0	0	1	2	1	1	0	
		Higher service costs after renovation (FB7)	5	0	0	0	0	0	0	0	0	2	1	0	0	0	1	
		Complex ownership structure (Voting system) (LB1)	4	0	1	0	0	1	0	0	1	0	1	2	0	1	0	
	Financial planning phase	The financial burden for homeowners (FB5)	4	1	1	1	1	1	1	1	0	2	1	2	2	2	2	
		Split incentives (FB4)	4	0	0	0	0	0	0	0	0	0	0	0	1	1	0	
	Planning phase	Collective decision-making is complex and lasts long (SB1)	4	1	1	0	1	1	1	1	1	1	1	1	0	1	1	
		Lack of quality assurance (TB4)	4	1	0	1	0	0	0	1	0	1	1	0	1	2	2	
		Lack of sufficient funding (FB3)	3	1	0	0	0	2	0	1	0	0	0	0	1	1	1	
	Total score per phase			76	20	12	8	19	12	11	22	13	32	32	39	28	41	30
	Capability rate per business model to pass step 2			%	26	16	11	25	16	14	29	17	42	42	51	37	54	39

Table 6
Analysis of the BMs of IHRS providers addressing the barriers of HOAs in Step 3.

Step	Renovation phases	Barrier	Weight	Business models of integrated home renovation service providers														
				Public									Private			Public-Private		
				BM3	BM4	BM5	BM8	BM9	BM10	BM13	BM14	BM2	BM6	BM7	BM1	BM11	BM12	
0= Does not address the barrier 1= Partially addresses 2=Fully addresses																		
Step 3 Transaction Phase	Access to finance phase	The financial burden for homeowners (FB5)	4	1	1	1	1	1	1	1	0	2	1	2	2	2	1	
		High upfront cost (FB1)	5	0	0	0	1	0	0	1	0	0	1	2	1	1	0	
	Financing/funding phase	Difficult collection of funds (FB2)	3	1	1	0	1	1	1	1	0	1	1	1	2	2	2	
		Lack of sufficient funding (FB3)	3	1	0	0	2	0	0	0	0	0	1	1	1	1	0	
		Limited access to financing (LB2)	3	1	1	0	0	1	0	0	0	0	1	1	1	1	2	
	Permits phase	Complex and multilevel regulations (LB4)	3	0	1	0	0	1	0	1	1	0	0	1	1	0	1	
		Complex ownership structure (Division of the deed) (LB1)	4	0	0	0	0	0	0	0	0	0	0	2	0	0	0	
	Total score per phase		50	13	13	4	18	13	7	15	3	11	18	38	28	25	19	
	Capability rate per business model to pass step 3		%	26	26	8	36	26	14	30	6	22	36	76	56	50	38	

Table 7
Analysis of the BMs of IHRS providers addressing the barriers of HOAs in Step 4.

Steps	Renovation phases	Barrier	Weight	Business models of integrated home renovation service providers														
				Public									Private			Public-Private		
				BM3	BM4	BM5	BM8	BM9	BM10	BM13	BM14	BM2	BM6	BM7	BM1	BM11	BM12	
				0= Does not address the barrier 1= Partially addresses 2=Fully addresses														
Step 4 Implementation and Utilisation	Renovation Planning phase	Lack of technical know-how (TB1)	5	1	1	1	1	1	1	1	1	2	2	2	1	2	2	
		Lack of quality assurance (TB4)	4	1	0	0	0	0	0	0	0	1	1	0	1	2	2	
		Lack of consistent and standardized solutions (TB2)	4	1	0	0	0	0	0	0	0	2	1	2	0	1	1	
		Complex and multilevel regulations (LB4)	3	0	1	0	0	1	0	1	1	0	0	1	1	0	1	
	Construction phase	Lack of technical know-how (TB1)	5	1	1	1	1	1	1	1	1	2	2	2	1	2	2	
		Lack of quality assurance (TB4)	4	1	0	1	0	0	0	0	0	1	1	0	1	2	2	
		Technical challenges in older buildings (TB6)	4	0	0	0	0	0	0	1	1	2	2	2	1	1	1	
	Post-renovation phase	Differences between predicted & actual savings (TB5)	5	1	0	0	0	0	0	0	0	2	0	0	0	1	2	
		Total score per phase	68	27	13	14	10	13	10	17	17	54	40	39	25	49	57	
	Capability rate per business model to pass step 4		%	40	19	21	15	19	15	25	25	79	59	57	37	72	84	

6.2.1. Step 1 onboarding phase

Table 4 presents the analysis of the BMs of the IHRS providers in the onboarding phase. Public IHRS providers displayed similar patterns with slight variations in their success rates. Notably, BM3, BM5, and

BM13 fully addressed the limitations of municipal resources by stepping outside municipal boundaries, despite being public entities. They achieved this by offering a list of experts capable of handling various tasks. In contrast, private BMs scored the lowest, primarily due to the costs



Fig. 4. Mapping of Barriers within the HOA Renovation journey.
Source: Author's synthesis based on relevant literature and experts' experience.

associated with public awareness campaigns and the limitations on organizing public events, which hindered their ability to effectively reach the public.

Public-private organizations performed well in this phase. BM1, in particular, stood out, scoring the highest. This success can be attributed to their approach to addressing the lack of awareness and interest similar to public entities, but with the added advantage of partnerships with private organizations.

Despite these successes, three main barriers were not fully addressed by most BMs. The first barrier is the challenge of unregistered HOAs, which was fully addressed only by BM1 and BM10. BM1 utilizes an online digital platform that facilitates easy registration and information gathering for HOAs, while BM10 adopts a neighborhood approach, connecting all HOAs and aiding in their registration process.

The second barrier, split incentives, remains largely unaddressed as many apartment homeowners are reluctant to invest in renovations without direct benefits, and tenants lack voting rights for such decisions.

The third barrier is the condominium managers' business case, which is not fully addressed by most BMs except BM1. This is through an online platform that connects condominium managers with other stakeholders through a matchmaking feature, while public IHRS providers such as BM4, BM5, BM9 and BM10 offer training materials and events to educate condominium managers on the importance and benefits of energy renovations.

6.2.2. Step 2 in-depth phase

Table 5 presents the analysis of the BMs of the IHRS providers in the in-depth phase. Public BMs struggled to address most of the barriers, resulting in a low success rate across all public IHRS providers. This poor performance is primarily due to financial barriers for homeowners and the complex ownership structures and decision-making processes involved. Conversely, private IHRS providers demonstrated slightly better effectiveness in this phase compared to their public counterparts. For instance, BM6 and BM7 offer rooftop extensions as a financing

solution for building renovations, and BM2 provides living cost-neutral renovations, which also address the issue of higher service costs post-renovation.

Public-private IHRS providers showed considerable promise in overcoming financial barriers. BM11, for example, offers pre-finance subsidies, while BM1 provides regional subsidies. In contrast, public BMs only assist with applying for subsidies, which limits their impact. Despite these efforts, the overall success rate for this phase remained below 60 % across all BMs.

One notable exception is BM2, which fully addresses the higher service costs after renovation through its living cost-neutral model. This model includes a 30-year calculation of monthly and annual maintenance costs to ensure that post-renovation maintenance expenses remain consistent with pre-renovation levels. Public-private organizations, particularly BM11, scored the highest in this phase, likely due to their innovative financial solutions.

6.2.3. Step 3 transaction phase

Table 6 presents the analysis of the BMs of the IHRS providers in the transaction phase. Public IHRS providers again scored the lowest, struggling to address the critical barriers effectively. One notable exception among the public IHRS providers is BM8, which offers access to subsidies for vulnerable groups, thus better tackling the barrier of insufficient funding.

Private IHRS providers performed notably better in this phase. BM7, in particular, scored the highest by addressing a significant barrier: the complexity of legal regulations and ownership structures. BM7 provides a legal document that resolves issues related to the division of the deed after renovation. Additionally, like BM6, BM7 also addresses the high upfront costs through rooftop extensions and provides legal support for the division of the deed following these extensions, offering a viable financing solution for building renovations.

Public-private IHRS providers, however, do not handle the complexities of ownership structures as effectively as private providers.

Their approach in this phase is similar to that of public IHRS providers, focusing less on legal and structural complexities and more on general financial support.

6.2.4. Step 4 implementation and utilization

Table 7 presents the analysis of the BMs of the IHRS providers in the implementation and utilization phase, which focuses on renovation planning, construction, and post-renovation services, the private IHRS provider BM2 and the public-private provider BM12 scored the highest. Both offer comprehensive services such as energy audits and master planning to ensure quality. BM12 particularly excelled by addressing the barrier between predicted and actual energy savings, which can tarnish the reputation of energy renovations among homeowners when disagreements arise. BM12 mitigates this issue through on-site supervision and monitoring of actual energy performance.

Among public IHRS providers, BM3 scored the highest. As previously mentioned, BM3 and BM13 surpassed municipal limitations by establishing public OSSs outside the municipalities. This strategy enabled both to collaborate with external experts for technical advice, enhancing their service offerings in this phase. However, public IHRS providers overall tend to contribute less in this phase, as it primarily involves construction and on-site work, in areas where they are less active.

7. Discussion and recommendations

The analysis encompasses fourteen cases segmented into three primary categories: public organizations, private organizations, and public-private partnerships.

Public organizations are characterized by their inclusive approach, targeting a broad range of customer segments, including vulnerable groups, and aiming to address larger societal challenges beyond energy efficiency, such as energy poverty and urban liveability. Their value propositions often integrate tailored advice, highlighting their multifaceted role in community welfare. The broad targeting and multifaceted value propositions, introduce complexities in resource allocation and operational focus. Balancing direct service provision with broader societal goals poses inherent challenges, potentially reducing the impact if not managed with strategic precision. Moreover, the heavy reliance on grants and public funding highlights the vulnerability of these models to political and economic shifts, necessitating agile management and innovative funding strategies to sustain impact over time.

Private organizations, on the other hand, demonstrate a focus on operational efficiency, specialized services, and financial planning assistance. Targeting specific customer segments, such as apartment buildings with particular characteristics, these organizations emphasize process management, high-quality renovation standards, and innovative financial solutions as their core value propositions. While this approach fosters innovation and operational excellence, it may also limit the scope of societal impact compared to public counterparts. The emphasis on financial sustainability and efficiency, critical for long-term viability, necessitates a delicate balance between profit motives and broader environmental and societal goals. The challenge lies in expanding the impact beyond the immediate customer base while maintaining financial and operational efficiency.

Public-private partnerships embody a hybrid model, combining the broad societal reach of public organizations with the operational efficiency and specialization of private entities. This collaborative approach aims to leverage the strengths of both sectors to achieve comprehensive and sustainable outcomes in energy renovation and advisory services. However, aligning the diverse interests, metrics of success, and operational dynamics of the public and private sectors is a formidable challenge. Governance, accountability, and performance metrics in Public-private partnerships require careful design to ensure that both societal welfare and operational efficiency are optimized without compromising one for the other.

Across all types of organizations, the use of digital and personal

channels for engagement, customer relationship building based on trust and transparency, and a strong reliance on grants (for public and public-private partnerships) or investment decisions and service fees (for private entities) as revenue streams are common. However, the extent and focus of key activities, resources, partnerships, and cost structures highlight the strategic differences aligned with their core missions and operational contexts.

7.1. Reflecting on the results of the analysis of the BMs across the four steps

Several key insights emerge regarding what each type of organizational structure can learn from the others as shown in Fig. 5.

In the onboarding phase, public organisations could greatly benefit from the operational efficiency and strategies employed by private organisations. For example, BM7's success in handling legal complexities demonstrates the potential for public models to streamline their processes and improve engagement by adopting similar methods. Conversely, private organizations should consider the inclusive approaches of public entities, aiming to reach a broader range of customer segments. Leveraging public subsidies and grants, as BM8 does, could help private models reduce financial barriers and enhance their service offerings. Public-private partnerships, while already leveraging the strengths of both sectors, should focus on refining their outreach and engagement strategies by learning from the most successful practices in both public and private models.

During the in-depth phase, public organizations can learn from the innovative financial solutions provided by private IHRS providers. Strategies such as rooftop extensions offered by BM6 and BM7, and living cost-neutral renovations from BM2, could help public entities better address financial barriers and complex ownership structures this can be done through partnerships with private companies. Private organizations, on the other hand, might benefit from incorporating aspects of public funding strategies to support more vulnerable groups, thereby expanding their societal impact and alleviating the financial burden for homeowners. Public-private partnerships can refine their approach to tackling complex ownership structures, possibly by adopting the successful legal and financial strategies seen in private models, to ensure comprehensive and effective solutions.

In the transaction phase, public organizations need to enhance their capabilities in dealing with legal complexities and high upfront costs. Private organizations should consider the broader societal implications and the funding strategies of public organizations, integrating these elements to support vulnerable groups more effectively. Public-private partnerships could benefit from integrating the successful financial and legal frameworks from both the public and private sectors, ensuring comprehensive support.

In the implementation and utilization phase, public organizations could adopt the detailed planning, supervision, and monitoring techniques used by private and public-private models like BM2 and BM12 to ensure quality and performance. These techniques address the gap between predicted and actual energy savings, which is crucial for maintaining homeowner trust and satisfaction, again this can be done with partnerships with private organizations as seen in the case of BM3 which shows the highest potential as a public IHRS provider among other public BMs. Private organizations should consider adopting community-focused approaches similar to those of public entities, ensuring that post-renovation services are inclusive and beneficial for all societal segments. Public-private partnerships must continue to optimize their dual approach, learning from the detailed oversight and monitoring strategies of private models, and the inclusive, community-focused strategies of public models, to ensure both societal welfare and operational efficiency are maintained.

Eventually, BM3 scored the highest among all public organizations, mainly because it transcended municipal limitations. Although it primarily provides advice, BM3 attempts to address most of the barriers

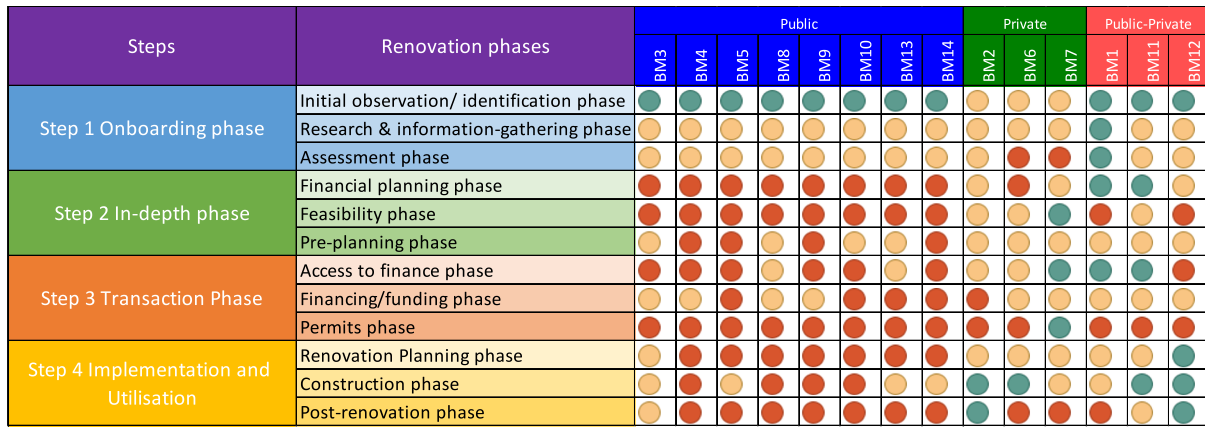


Fig. 5. Comparison of the capability rate per business model to pass each phase. (Green $\geq 67\%$, Yellow when $< 67\%$ and $\geq 33\%$, and finally Red $< 33\%$). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

encountered in the various phases of renovation. This model, which originated in the city, has expanded beyond its initial boundaries, exemplifying a “Municipal growth model” This indicates that some municipalities are actively working to expand their capabilities to accelerate energy renovations within their cities. They are achieving this not only by offering free advice on energy renovations but also by organizing related events, collaborating with experts, and employing energy advisors.

For private BMs, their focus on providing innovative solutions to finance renovations (such as rooftop extensions in the cases of BM6 and BM7, or living cost-neutral renovations in BM2) demonstrates their dedication to overcoming technical and financial challenges. However, they still lack efficiency in the early stages of the process, which is crucial for overall success. Additionally, private BMs often fall short in community engagement and resident education, which are vital for ensuring long-term impact and acceptance of the renovations.

Public-private models, while more successful overall compared to purely public or private models, still rely on subsidies and grants. This dependence might limit their future scalability and expansion, posing a challenge when developing a viable and sustainable BM. Despite their current success, the potential restriction on growth due to funding constraints is a critical consideration.

Overall, an integrated service approach appears essential for managing the complexities of energy renovations. Such an approach involves multiple stakeholders working together to ensure quality and future-proof renovations. This collaborative, comprehensive strategy not only addresses the diverse challenges across different phases but also

promotes sustainable and scalable solutions, paving the way for effective and impactful energy renovations.

Table 8 illustrates that each model type has distinct strengths and faces unique challenges. By learning from each other, these models can potentially enhance their effectiveness in addressing the complexities of energy renovations.

7.2. Recommendations to enhance the business models of IHRS providers targeting HOAs

The following recommendations are designed to address identified challenges, leverage successful strategies, and promote best practices across different organizational structures. Governance, HOAs, Condominium managers and Practitioners including IHRS providers can develop their BMs by implementing these recommendations, and optimising their approaches, ensuring more efficient and impactful energy renovation processes.

- Emphasize stakeholder collaboration: collaborate with various stakeholders. Facilitate joint ventures
- Focus on Early stage success: Strategic initial planning. Customer journey guidance
- Enhance communication and decision-making support: Develop robust communication strategies
- Implement an integrated service approach: Offer comprehensive Service packages

Table 8

Synthesizes the main strengths of the three organizational structures.

BM Type	Strengths	Challenges	Strategic Insights
Public Organizations	Exceptional in addressing broad societal challenges like energy poverty, highly inclusive, and specifically adept at integrating community welfare. Offers extensive tailored advice, leveraging a deep understanding of diverse customer needs, which enhances community trust and engagement.	Complexity in resource allocation, balancing broad societal goals with service provision, vulnerable to political/economic shifts.	Can improve by adopting operational efficiencies from private models, especially in handling legal complexities and engagement strategies.
Private Organizations	Providing high-quality renovation standards and specialized services that maximize property value and energy savings. Notable for developing robust financial planning tools and innovative solutions that cater to specific customer profiles, driving both client satisfaction and financial viability.	Limited societal impact scope, balancing profit motives with environmental goals, needs to expand impact beyond the initial customer base.	Should incorporate public funding strategies to support vulnerable groups, and enhance community engagement and resident education.
Public-Private Partnerships	Merges the best of both by tying the knot between the societal reach of public models with the operational excellence of private entities. Particularly effective in creating sustainable, comprehensive outcomes in energy renovations through a balanced focus on both scalability and community-centric initiatives.	Aligning diverse interests and operational dynamics, governance and accountability challenges.	Focus on refining outreach and engagement strategies, and integrate successful financial and legal frameworks from both public and private sectors.

- Address technical challenges: Quality assurance and standardization. Train installers and craftsmen
- Provide innovative financial solutions: Diverse financing options. Customized financial solutions
- Legal and regulatory facilitation: Advocate for supporting regulations. Streamline legal processes
- Create a scalable and flexible model: Adaptability according to continuous learning
- Engage in community and resident education: Promote benefits. Organize free educational events
- Foster future proof and sustainability: Incorporate sustainable solutions

7.3. Policy recommendations

Despite the favourable conditions identified in this study, experts emphasize the need for enhanced policy actions to support the efficacy and scalability of IHRS tailored for HOAs. To solidify this foundation, it is crucial to establish stringent energy performance requirements and clear national targets. Implementing specialized financial incentives such as tax breaks, subsidized loans, and grants could encourage HOAs to undertake significant energy renovations. Additionally, promoting public–private partnerships can facilitate leveraging both public funding and private expertise, providing HOAs with the necessary resources and assurance needed to commit to large-scale renovations.

Conducting targeted awareness and education campaigns is essential to raise awareness among HOA members about the benefits of energy renovations and the support mechanisms available. These initiatives should aim to increase engagement and participation in IHRS programs. Locally, municipalities should actively support HOAs by establishing local OSSs that can directly manage and facilitate renovations. Offering local grants or tax relief to HOAs participating in IHRS can reduce the financial burden and incentivize more extensive renovation projects.

Exploring innovative financing models like the Property Assessed Clean Energy (PACE) [67] programs at the regional level can provide economic benefits for HOAs. This model ties loan repayments to property taxes, ensuring a reliable repayment mechanism that can be attractive to HOAs. Additionally, it is crucial to streamline legal and bureaucratic processes to make it easier for HOAs to initiate and implement renovation projects, thus reducing delays and lowering costs associated with energy renovations. Additionally, the establishment of dedicated renovation funds, inclusive of risk insurance for lengthy decision-making processes, would provide HOAs with the financial support needed to undertake substantial renovations. These funds would help mitigate the financial risks associated with delays and uncertainties in project approvals.

Providing technical support and establishing quality assurance measures are essential to ensure that renovations meet high standards. This support can help HOAs navigate the complexities of planning and executing energy efficiency upgrades. Encouraging the sharing of energy consumption data and best practices among HOAs enhances transparency and fosters a better understanding of energy usage patterns and the effectiveness of different renovation strategies.

To address the split incentives dilemma, it is recommended that the Netherlands and Flanders adopt a regulatory framework similar to Germany's approach [68], where the CO₂ tax costs are shared between tenants and landlords. This policy would mandate a proportional split in the financial responsibilities associated with CO₂ emissions from residential buildings, encouraging both parties to invest in energy-efficient renovations.

Moreover, supporting the development of a national program for HOA coaches is essential. These professionals would guide HOAs in strategic planning and financial management, ensuring that renovation projects are both sustainable and economically feasible.

Finally, it is crucial to establish advanced regulatory measures that mandate strict compliance and governance standards for HOAs. These

regulations would enforce consistent quality and performance in renovation projects. By implementing these comprehensive policy measures, governments at all levels can provide HOAs with the tools they need to effectively participate in energy renovation initiatives, contributing significantly to regional and national energy efficiency goals.

8. Conclusion

This study aimed to answer the question: “How do current integrated home renovation service providers facilitate energy renovations for homeowners associations, overcoming the prevailing barriers to uptake?” By examining IHRS providers in Europe, particularly the Netherlands and Flanders, insights were gained into their BMs, highlighting the role of stakeholder collaboration, effective communication, and tailored strategies for success. While public entities act as intermediaries, offering initial services for free, their challenge lies in reducing reliance on public funds, addressing barriers in the later stages and fostering collaboration with private organizations by going beyond the municipal limitations. Private models, conversely, face high operational costs due to investments in trust-building and data tools. Crucial factors for BM viability include market demand, financial strategies, regulatory support, innovation, partnerships, and customer engagement. A key finding is the effectiveness of public–private collaborations, which combine municipal support with private expertise, suggesting a promising direction for IHRS providers. This blend of public and private efforts, alongside a focus on comprehensive stakeholder engagement and data-driven strategies, offers a roadmap for overcoming challenges and achieving energy efficiency goals in HOAs.

This study provides valuable insights into the BMs of IHRS providers for accelerating energy renovations in HOAs but is limited by its focus on fourteen Western European cases and occasional data scarcity, impacting the depth of analysis. The primary limitation lies in the evaluative approach, which concentrates on the interplay between BMs and identified barriers, thus narrowing the scope of understanding broader impacts.

Future research should aim to broaden the scope by securing comprehensive data to enhance the robustness of findings. It is essential to employ a more holistic evaluation framework that goes beyond barrier identification to include economic, environmental, and social impacts, ensuring a thorough assessment of the BMs long-term viability. This framework should incorporate a comprehensive assessment of economic factors such as operational efficiency, balance between revenue streams and cost structures, scalability, and market adaptability. Furthermore, it is crucial to extend this evaluation to include environmental impacts, emphasizing sustainability and resource efficiency, as well as social impacts, which consider community engagement and stakeholder satisfaction. In our ongoing research, we are actively applying various BMs in real-world case studies. This approach allows us to assess these models more rigorously, enhancing our understanding of their effectiveness in practical settings.

Future research could focus on developing a matchmaking service for HOAs to streamline their connection with qualified renovation providers. This service would facilitate energy-efficient renovations by ensuring HOAs have access to the necessary expertise and resources, effectively aligning supply with demand. Such a study could assess the service's impact on renovation processes and explore optimal strategies for its implementation. Additionally, exploring the integration of innovative technologies and the influence of regulatory frameworks could provide further insights into optimizing energy renovations in condominiums. Expanding the research in these directions will not only address the current study's limitations but also contribute to a more nuanced understanding of the challenges and opportunities in the field.

CRedit authorship contribution statement

Ragy Elgendy: Writing – review & editing, Writing – original draft,

Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Erwin Mlecnik**: Writing – review & editing, Validation, Supervision, Conceptualization. **Henk Visscher**: Validation, Supervision. **Queenia Qian**: Validation, Supervision.

Declaration of competing interest

This work was supported by the CondoReno Project funded by the European Union's Programme for Environment and Climate Action (LIFE) MGA — Multi & Mono, under grant agreement No. 101076316. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Data availability

The interviews were recorded and transcribed; we can only share the transcriptions and the minutes from the workshops. The interviewees must remain anonymous.

Acknowledgments

The authors wish to express their gratitude for the assistance and support they received from the interviewees in furnishing the information used to formulate the business models in this paper and to Eugenio Muccio for the discussions over the data analysis methodology.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.enbuild.2024.114589>.

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ACE-Retrofitting: Accelerating Condominium Energy Retrofitting funded by EU-Funding INTERREG VB North West Europe. <https://vb.nweurope.eu/projects/project-search/accelerating-condominium-energy-retrofitting-ace-retrofitting/?tab=,undefined&page=3>.

ABRACADABRA, funded by funded by the European Union's programme for SOCIETAL CHALLENGES – Secure, clean, and efficient energy under grant agreement no. 696126. <https://cordis.europa.eu/project/id/696126>.

CondoReno, funded by the European Union's Programme for Environment and Climate Action (LIFE) MGA under grant agreement No. 101076316. <https://condoreno.org/>.

Green Home, funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101033878. https://www.green-home.org/en/what_we_do/projekt/.

INNOVATE, Funded by the European Union's Horizon 2020 research and innovation programme. <https://energy-cities.eu/project/innovate-2/>.

I-Heros, funded by the European Union's programme for SOCIETAL CHALLENGES – Secure, clean, and efficient energy under grant agreement no. 890598. <https://i-heros.eu/>.

MORE-CONNECT, funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 633477. <https://www.more-connect.eu/>.

PadovaFIT Expanded, funded by the European Union's programme for SOCIETAL CHALLENGES – Secure, clean, and efficient energy under grant agreement no. 847143. <https://www.padovafit.eu/home.html>.

ProRetro, funded by the European Union's programme for SOCIETAL CHALLENGES – Secure, clean, and efficient energy under grant agreement no. 894189. <https://proretro.eu/en/>.

P2ENDURE, funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 723391. <https://www.p2endure-project.eu/en>.

Pro-GET-OnE, funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 723747. <https://www.progetone.eu/project/>.

Save the Homes, funded by the European Union's programme for SOCIETAL CHALLENGES – Secure, clean, and efficient energy under grant agreement no. 892749. <https://savethehomes.net/>.

STUNNING, funded by the European Union's programme for INDUSTRIAL LEADERSHIP – Leadership in enabling and industrial technologies – Advanced manufacturing and processing under grant agreement no. 768287. <https://cordis.europa.eu/project/id/768287>.

4RinEU, funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 723829. <https://www.4rineu.eu/index.html>.