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A Sequential Multi-Staged Approach for Developing Digital One-Stop Shops to Support Energy Renovations of Residential Buildings

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Abstract: Buildings account for 40% of the European Union's energy consumption. Deep energy renovation of residential buildings is key for decarbonization and energy poverty alleviation. However, renovation is occurring at far below the needed pace and depth. In this context, building renovation one-stop shops, which bring all project phases under one roof and provide advice, support, and finance to households, are highlighted as a promising solution. Nevertheless, this model is still absent or under-developed in most European countries and remains understudied in the scientific literature. Therefore, the present research goals are as follows: (i) to provide a critical review of emerging one-stop shop models; (ii) to streamline the deployment of building renovation digital one-stop shops by piloting a sequential multi-staged approach for Portuguese households and proposing it for replication elsewhere; and (iii) to compare case-study insights with other one-stop shops and discuss the notion in the context of the European Renovation Wave. In total, for the Portuguese case-study, five steps were conducted. The first three—stakeholder mapping, expert interviews, and customer journey—aimed to gather intel on the local energy renovation market. The results from these stages informed the design of the platform (fourth step). Finally, a post-launch market consultation survey gathered user feedback (fifth step). Insights from this study suggest that digital one-stop shops, while providing a helpful tool to close information gaps and activate specific audiences, may be insufficient on their own. As such, a more comprehensive set of instruments supporting households is needed to accelerate building renovation.

Keywords: building retrofitting; energy efficiency; households; home renovation; business model; web portal; online platform; Portugal; Renovation Wave

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1. Introduction

In the European Union (EU), buildings represent 40% of energy consumption and 36% of carbon dioxide emissions [1,2]. Around 75% of the EU building stock is energy inefficient, and energy poverty affects millions of Europeans [3]. Energy poverty is broadly defined, e.g., in [4], as when a household is unable to secure a level and quality of domestic energy services sufficient for its social and material needs. Building renovation can generate multiple social, environmental, and economic benefits, making it a unique opportunity for climate neutrality and COVID-19 recovery [5–7]. The authors of [8] estimated that 97% of all buildings will need to be upgraded by 2050.

Europeans spend 90% of their time indoors, and the quality of these environments substantially impacts health and well-being. The COVID-19 crisis highlighted the importance and fragilities of the building stock. Some of the effects of the pandemic (e.g., remote working) may continue in the long term with higher occupation schedules and new demands on residential buildings, further reinforcing the need to renovate deeply and on a massive scale [3,9].

The European Commission has proposed a reduction of at least 55% in net greenhouse gas emissions by 2030 compared to 1990 levels. In this context, the building sector needs to reduce its emissions by 60% and its energy use by 14% from 2015 levels [3]. As the construction of new buildings with higher performance standards happens slowly, it is crucial to target existing buildings. At the same time, around 14.8% of the EU's population lives in dwellings with leaks, damp, or rot, while 15.8% of the housing stock is unoccupied [10,11]. However, the EU's weighted annual renovation rate is low, at around 1% (with several countries depicting considerably lower rates).

In contrast, deep renovations that reduce energy consumption by at least 60% are carried out in only 0.2% of buildings [3]. The European Renovation Wave sets out a strategy to double the annual renovation rate by 2030. Further, the authors of [2] highlighted that current annual deep renovation rates need to grow to at least 2% and should approach 3% as soon as possible. In this scope, emphasis is given to the worst-performing segments of the building stock, energy poverty alleviation, and public buildings [3,12].

The main drivers for building energy renovation are cost-saving and improved comfort, though environmental concerns and aesthetics are also factors in homeowners' decisions [13–15]. The main barriers to energy efficiency have been well-researched and include shortages of finance, split incentives between owners and tenants, insufficient knowledge on current consumption, and a lack of information about renovation measures [5,16,17]. In housing, specific barriers include fragmentation of the demand-side mass market, heterogeneity of the building stock, high transaction costs, and mistrust of renovation providers [18,19]. The complex and fragmented nature of the supply-side renovation market, where multiple and diverse stakeholders coexist, also acts as an obstacle [20,21]. Currently, the renovation market is dominated by siloed approaches and individual solutions, often provided by handicraft-based small companies. Meanwhile, the market for deep renovation is yet to develop [22,23]. Due to their vulnerabilities, circumstances, and characteristics, a significant share of households can be regarded as being hard-to-reach with traditional energy policies, financing schemes, and business models [24].

Historically, building renovation schemes have often been oversimplified into only technical and economic concerns, leading to low levels of engagement [25,26]. The lack of easily accessible incentives and financing products is often mentioned as a barrier [15,17,27]. For deep renovations, the absence of long-term energy performance goals may act as a barrier, since homeowners prefer to implement small interventions over time [21]. The management of the energy renovation process can be complex for adopters, as they may need to find, interact, and coordinate multiple actors while simultaneously taking the risk and responsibility for the changes [19,28]. Building owners often do not have the expertise necessary to make decisions, and require professional assistance [21,29]. Finally, even if renovation providers can strongly influence homeowners' decisions, these are primarily micro-enterprises that lack knowledge and interest in more holistic renovations [30,31].

Since the incumbent approaches are falling short, particularly among lower-income and hard-to-reach households, several authors have called for additional efforts to overcome the barriers mentioned above (e.g., [32–34]). One recent and promising solution, backed by the European Commission, is the deployment of one-stop shops (OSS) that deliver tailored technical advice and financing solutions and accompany households throughout their energy-related projects [3]. Although OSSs diffusion in the EU is still in the preliminary stages, the concept seems to be gaining momentum. Bertoldi et al. (2021) [16] estimated that around 2/3 of the EU's Member States have at least one OSS on the national market. However, the authors of [35] argued that their impacts remain limited and understudied. Research gaps persist both in the conceptualization and the practical application of OSSs.

In this context, the goals of this research are three-fold: (i) to undertake a critical review of the OSS concept applied to building energy renovation; (ii) to propose and apply a step-by-step methodological approach for the development of digital OSS for residential building renovation in immature markets; and (iii) to offer insights combining the practical

application in the Portuguese case-study with other empirical OSS cases. Whereas most existing OSSs have surfaced in an unstructured way, the novelty of this paper lies in the proposal of a structured and sequential multi-staged process for the development of OSSs that could be replicated elsewhere and further expanded on. Both methodological and result-oriented outputs are presented and discussed, considering the potential role of OSS business models for the implementation of the EU's Renovation Wave strategy, as well as its key strengths and limitations.

The structure of this paper is as follows. Section 2 critically reviews the current situation regarding OSSs. Building on the literature review, Section 3 details the methodological framework applied in this research, which comprises the following: (i) a description of Portugal as a case-study; (ii) stakeholder mapping and analysis; (iii) semi-structured expert interviews; (iv) customer journey development; (v) deployment of a digital OSS for residential buildings renovation; and (vi) a market consultation survey. Section 4 depicts the step-by-step empirical results of the Green Menu digital OSS case-study in Portugal, which are further discussed in Section 5 and linked to the emerging role of OSSs for large-scale building renovation and energy poverty mitigation. Section 6 concludes the paper and provides perspectives on the usefulness of OSS business models for the European Renovation Wave.

2. Literature Review: Building Renovation One-Stop Shops

The Energy Performance of Buildings Directive (EPBD 2018/844/EU) requested member states to facilitate access to transparent advisory tools, being the first legislative act calling for OSSs [16]. OSS can be considered an umbrella term for services offering combined renovation solutions that simplify the homeowner's customer journey [35]. This approach turns a complex customer journey into a single-entry, customer-friendly one, bridging supply and demand fragmentation [32]. By providing trustworthy advice and supporting decision-making, OSSs can address barriers such as a lack of knowledge and information [28,36]. Several authors have highlighted that OSSs can accelerate and deepen building refurbishments by actively seeking new customers, easing access to finance, and building strong partnerships with local stakeholders (e.g., [32,37,38]). The scientific literature is still scarce on OSSs, with the concept being primarily found in project reports describing empirical case-studies.

An OSS can be a virtual or physical place, present diverse business models, and provide various services, depending on the local context, market maturity, available resources, starting point, and target audience [32,39,40]. The authors of [41] pointed out five main elements that can define an OSS business model: the services offered, the users, the provider, the actors involved, and the revenue streams. In addition, the authors of [39] identified four different OSS types, ranging from simpler facilitation models, usually free of charge and focusing on providing advice during the first stages of renovation, to coordination models and complex all-inclusive and ESCO-type models, where the OSS offers complete renovation packages and financing and assumes responsibility for the result. This more integrated approach maximizes long-run benefits while performance gaps and unintended consequences can be minimized [28]. This contrasts with the highly fragmented supply chains that have characterized most residential renovations [33]. Several authors (e.g., [16,32,41,42]) have also attempted to categorize OSSs according to their governance: local government-supported, public-private partnerships, independent consultants, industry-driven, large store/warehouse based, cooperative-driven, and financial institutions.

Examples of different OSS business models in European countries can be described based on [39], in which the authors detailed 11 OSSs best practices, and [16], in which the authors mapped 63 OSSs located in 22 European countries. In Cyprus, the Aradippou OSS is a municipality-based OSS that benefits from trustful relations to provide free services to its citizens, including recommendations of technical measures, information on financing schemes, and verification of results. In Frederikshavn (Denmark), the preferred OSS

approach involved a public-private partnership, targeting condominiums and single-family houses, where energy renovation and financial plans are offered free of charge, and house owners sign a single contract with the OSS that coordinates all works. Initiated by a private company, the Reimarkt OSS has both physical and virtual shops in several Dutch cities, offering an all-inclusive model that accompanies the customer from the first contact until the final evaluation, with a fixed fee of 10% of the total project costs. A significant number OSSs have been created and/or expanded in the context of EU-funded projects (e.g., [16,41,42]). These selected examples represent innovations that show that OSSs can succeed and surpass difficult circumstances, e.g., budget cuts, competing priorities, and limited powers in local authorities [43].

Although their advantages are widely acknowledged and the business potential is real, OSSs are still rare, since they require extensive knowledge of the local market and may be problematic for small renovation companies [44–46]. Existing initiatives often remain fragile because the business case is uncertain, and there is a high cost of attracting customers [47]. Low customer demand can be one of the larger challenges for the start-up and upscaling of OSSs [33]. Moreover, the challenges and solutions vary according to building typologies, customer needs, and local settings [19,38]. The authors of [16] found that most existing OSSs in the EU focus on single-family houses, with multi-family buildings and condominiums being less attractive target groups. To accelerate building renovation, innovative business models need to be developed, tested, and replicated through joint efforts in research, business, and policy [42,43]. Scientific research on OSSs and their role in building energy renovation are still scarce, and the business model is thus largely absent or under-developed in most European countries [35].

3. Materials and Methods

3.1. Methodological Approach

Herein, we pragmatically unfold the OSS development, design, and implementation process to directly address critical barriers to energy renovation and contribute to market transformation. The proposed methodology follows a sequential five-step approach for developing digital OSSs for residential buildings renovation, comprising stakeholder mapping and analysis, semi-structured expert interviews, customer journey exercise, digital one-stop shop for building renovation, and market consultation survey, as laid out in Figure 1. This approach is applied and explored in the Portuguese context.

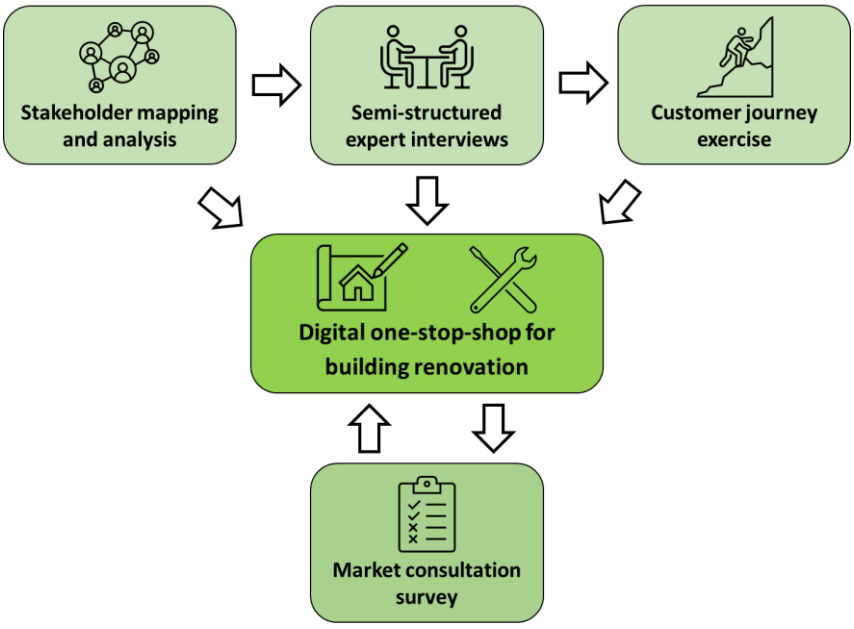

Figure 1. Methodological approach for the development of building renovation digital OSSs.

Outputs from the stakeholder mapping and analysis are inputs for selecting experts to be interviewed. Outputs from the semi-structured interviews and literature review provide insights into the customer journey exercise. Outputs from these three initial steps feed into the actual development of the digital OSS. Finally, after the launch of the OSS, market consultation surveys serve to gather user feedback, and their outputs are used to fine-tune the online platform.

3.2. Case-Study Portugal

Portugal is committed to climate change mitigation, and key targets for 2030 include a 35% reduction in primary energy use. In 2019, the building sector represented 31% of energy use in Portugal (households represent 17%) [48]. The climate in continental Portugal is mostly temperate, with mild and dry summers in the north and coastal regions and hot and dry summers in the south and center inland and in part of the northern inland region [49]. For the last five-year period (2017–2021), Portugal had an average of 1109 heating degree days—the third lowest value among EU Member States—and an average of 214 cooling degree days—the sixth highest value among EU Member States [50].

Portuguese buildings generally have low energy performance and a high incidence of problems such as lack of thermal comfort, indoor air pollution, leakages, and humidity [49]. Available indicators report that 17.5% of households are unable to keep their home adequately warm (fourth highest in the EU and above the average of 7.4% in 2020), 35.7% of the population live in houses that are not comfortably cooled in summer (second highest and above the EU average of 20.9% in 2012), and 25.2% of the population live in dwellings with the presence of leaks, damp, or rot (second highest and above the EU average of 14.8% in 2020) [10,51,52]. In addition, based on available energy performance certificates, around 70% of households are inefficient (C class or lower) [53].

Energy use in Portuguese households is the second-lowest per capita in the EU [1]. Although country-specific factors play a role (e.g., milder climate compared to other EU Member States, cultural normalization of thermal discomfort, and relevant share of unreported energy carriers, such as biomass, in final energy consumption), research has uncovered systemic energy performance gaps and underconsumption (measured as the difference between theoretical energy consumption to attain thermal comfort and actual energy use) in the Portuguese residential sector [54–56]. Economic energy-saving potential for Portugal's residential sector has been estimated at approximately 50% of current consumption [57]. The authors of [58] affirmed that applying the nearly zero energy buildings concept in the renovation of Portuguese buildings could lead to a 73% reduction in energy needs while being cost-effective during the buildings' lifetime. The authors of [59] suggested higher savings of 80–96% in residential buildings.

Energy poverty is a severe societal problem in Portugal that negatively impacts public health, well-being, and the pursuit of overarching social, environmental, and economic goals [60]. According to the index developed by OPENEXP [61], Portugal is the fourth-worst EU country regarding domestic energy poverty. The recently released national energy poverty mitigation strategy for 2021 to 2050, currently awaiting its final version, defines energy poverty as "the inability to maintain one's dwelling with an adequate level of essential energy services due to a combination of low incomes, low energy performance and energy costs", and estimates that up to 29% of the population may suffer from this condition [62].

According to the Portuguese long-term building renovation strategy, virtually 100% of existing buildings will need to be renovated by 2050 [63]. However, building energy renovation rates remain very low, with deep renovation estimated to occur in fewer than 0.1% of buildings annually [64,65]. According to the authors of [66], from 2012 to 2016, Portugal recorded the lowest values in the EU for specific primary energy savings generated from household renovation. During this period, residential building renovation investment was also substantially below the EU average of 83 €/m^2 at just 37 €/m^2 [64]. In contrast, the authors of [67] estimated a minimum investment of 71.7 billion euro for deep

energy renovation of Portuguese residential building stock; this value is several orders of magnitude higher than the public funds currently available for building renovation.

The Portuguese residential sector showcases a hard-to-reach profile with many structural socio-economic vulnerabilities, low housing quality, energy illiteracy, and widespread energy poverty [68]. Meanwhile, viable OSS business models are thus far absent in Portugal, and the market for building energy renovation is widely fragmented and immature. The authors of [16] identified one OSS example in Portugal as part of the CLEAR European project, but it consists solely of an online discussion group managed by the Portuguese Consumers' Association. Likewise, the few other initiatives in Portugal that have approached the OSS concept have produced few practical results thus far.

3.3. Stakeholder Mapping and Analysis

To gather intel on the building renovation market in Portugal and as groundwork for the development of the digital OSS, a stakeholder mapping and analysis exercise was performed. Stakeholders can be considered individuals, groups, organizations, or sectors who may affect, be affected by, or perceive themselves to be affected by the uptake of building renovation [69]. It is vital that stakeholders are identified and characterized and that their views and interests are known [70,71]. This exercise followed a snowballing method, whereby expertise from previous projects (e.g., [72,73]) was combined with a literature review to map and analyze key stakeholders for building renovation in Portugal.

The proposed approach divides relevant stakeholders into three groups according to their relative importance from an OSS viewpoint: core, direct, and indirect. In addition to mapping the stakeholders, these can also be analyzed regarding their current influence and interest/availability in OSSs, following the power/interest grid as defined in [69]. This approach recognizes that different stakeholders have varying levels of responsibility and authority and that a suitable communication strategy should be determined according to their characteristics [69,71]. The communication strategy toward each stakeholder placed on the grid was classified as "monitor", "keep satisfied", "keep informed", and "manage closely", with an increasing level of engagement. The stakeholder mapping and analysis exercise was a useful tool to identify key context-specific players in building renovation who were then contacted for expert interviews. Such analyses could also serve as an initial step to foster deeper engagement and partnerships between the OSS and interested actors.

3.4. Semi-Structured Expert Interviews

Expert interviews are a widely used qualitative method to gain information about a specific field of action [13,74,75]. To understand the different perspectives of the market for building energy renovation in Portugal and map the existing gaps, barriers, and opportunities, exploratory interviews were conducted with 11 experts. The interviews took place in late 2020, were performed individually through an online platform, and were cross-referenced with existing data and research.

The interview script, which can be found in Appendix A, encompassed 32 semi-structured questions organized into six topics: Portuguese buildings characterization, Portuguese renovation market evolution, technical measures, policies and regulations, financing instruments, and citizen engagement and district-scale approaches. Interviewees included four architects, two civil engineers, two researchers, one journalist, one business leader, and one policymaker. Insights from expert interviews provided a better understanding of the current customer journey for household energy renovation and the main gaps and opportunities. Through this Portuguese case study, expert opinions also served as a kick-starter for a deeper discussion on approaches to engage with diverse typologies of households.

3.5. Customer Journey

A customer journey exercise was performed to map the current perception of homeowners regarding building energy renovation and as the basis for decisions about the key

features to be included in the online platform. This exercise is proposed as the final preparatory step for developing a building renovation digital OSS. Customer journeys are commonly defined as a series of touchpoints that customers go through before, during, and after building renovation [42,76]. The customer journey involves all activities, encounters, and events linked to delivering a building retrofit service from a customer's perspective [20].

The exercise was performed from the homeowners' perspective, since they are central to the OSS business proposition [28]. The customer journey was divided into five sequential phases of dwelling renovation linked with the role of OSSs—orientation, advice, finance, implementation, and inspiration (similar to [20,36,40]). For each phase, four key aspects were mapped: (i) jobs to be done, as the main reason for the customer to consult an OSS; (ii) pains, as the main barriers faced when renovating; (iii) gains, as the main benefits from renovating; and (iv) possible solutions, i.e., the act of the OSS filling in gaps in the customer journey. The customer journey offers a holistic picture of the processes of building renovation, which involves interactions with a range of actors [76].

As one of the main challenges for the success of an OSS is to fulfil the homeowner's needs in the local context [32], the customer journey exercise can be used to generate empathy with OSS users. The set of possible solutions identified in the customer journey was a relevant input to better design and target the OSS services.

3.6. Digital One-Stop Shop for Residential Building Renovations

Building on the above-described sequential steps, a Portuguese digital OSS for residential building renovations was developed as a case-study that tested the proposed methodological approach. The following subtasks were performed: (i) selecting a representative building typology; (ii) gathering data on appropriate technical measures, financial instruments, and regulations for the selected typology; and (iii) migrating the information to a visually appealing online platform (Green Menu).

Based on previous work [54,73], a uniform and iconic building typology, defined as a "single-family house built before 1919 in Lisbon", was chosen to showcase the process. Examples of real buildings from this typology, which fed the design of the 3D model for the digital OSS, can be found in Figure 2.

Figure 2. Real buildings from Lisbon that served as concrete examples of the building typology selected to pilot the digital OSS (source: Google Maps).

The prioritization of single-family homes, often owner-occupied, in OSSs is common both in the literature—e.g., [22]—and in empirical case-studies—e.g., 80% of the European OSSs mapped in [16]. In addition, the worst-performing buildings were explicitly prioritized in the Renovation Wave; specific skills are needed for the renovation of older buildings to safeguard their heritage value [3,77]. Other authors (e.g., [26,78–80]) further highlighted homeowners' struggle to implement deep renovation measures when faced with a range of heritage and aesthetic concerns while describing health and environmental problems in dwellings in historic Mediterranean cities. In a comprehensive analysis of

energy renovations in Portuguese dwellings, the authors of [67] found that older building typologies have more potential for cost-effective renovation and that packages of measures lead to higher reductions in energy needs.

Appropriate renovation measures to this specific building typology were derived from the description and technical analysis of building characteristics, such as age, typology, and construction materials (as suggested in [21]). Technical measures were selected and detailed based on extensive previously published work (e.g., [81,82]). Portuguese regulations and ongoing financial schemes, such as soft loans, grants, and tax benefits, were also identified and collected to provide a complete picture of the current financing possibilities and regulatory constraints. The digital OSS, developed in Portugal through the proposed sequential multi-staged approach, followed the customer journey map with detailed information on the five stages of the building renovation process—orientation, advice, finance, implementation, and inspiration.

3.7. Market Consultation Survey

Following the launch of the online OSS (December 2020), online tool users were anonymously surveyed for their perception of the platform and of building renovation in general. The market consultation survey is proposed herein as the last stage in this methodological approach for the development of a digital OSS. The survey was conducted in Google forms and included 21 questions and 17 sub-questions (Appendix B). Given the COVID-19 pandemic situation, the online format was the preferred option for conducting the survey. A communication campaign for the platform launch and the market survey was carried out through social networks, institutional websites, and media.

Firstly, the survey addressed demographic aspects of the population (four questions regarding age, qualifications, and municipality) and their living arrangements (four questions about building type, period of construction, and ownership status). Additionally, four questions and nine sub-questions were focused on the drivers and barriers related to home renovation, based on the homeowner's past experiences and future renovation plans. Finally, the survey gathered feedback on the key features of the Green Menu (nine questions and eight sub-questions).

Due to the number of replies and the bias of participant recruitment, the market consultation survey does not intend to have statistical significance and remains an exploratory tool. Nevertheless, user feedback can be valuable for fine-tuning the OSS services and providing relevant insights into finding appropriate ways to engage with households.

4. Results

4.1. Overview

This section unfolds the multiplicity of results from the five steps proposed for constructing a digital OSS, exemplified through the Portuguese case-study. It aims to illustrate the operationalization of the proposed process pipeline, contributing toward a framework to mainstream building renovation OSSs in European countries in line with the Renovation Wave strategy. The empirical Portuguese case-study also provides insights for a broader discussion on the role of OSSs in leveraging the building renovation market, aiming for large-scale decarbonization and energy poverty mitigation, and on the current strengths and shortcomings of these emerging business models.

4.2. Stakeholder Mapping and Analysis

Figure 3 presents a summarized stakeholder map from the perspective of a building energy renovation OSS. Core stakeholders are the OSS's target audience, i.e., homeowners, tenants, building/property owners, and condominium enterprises.

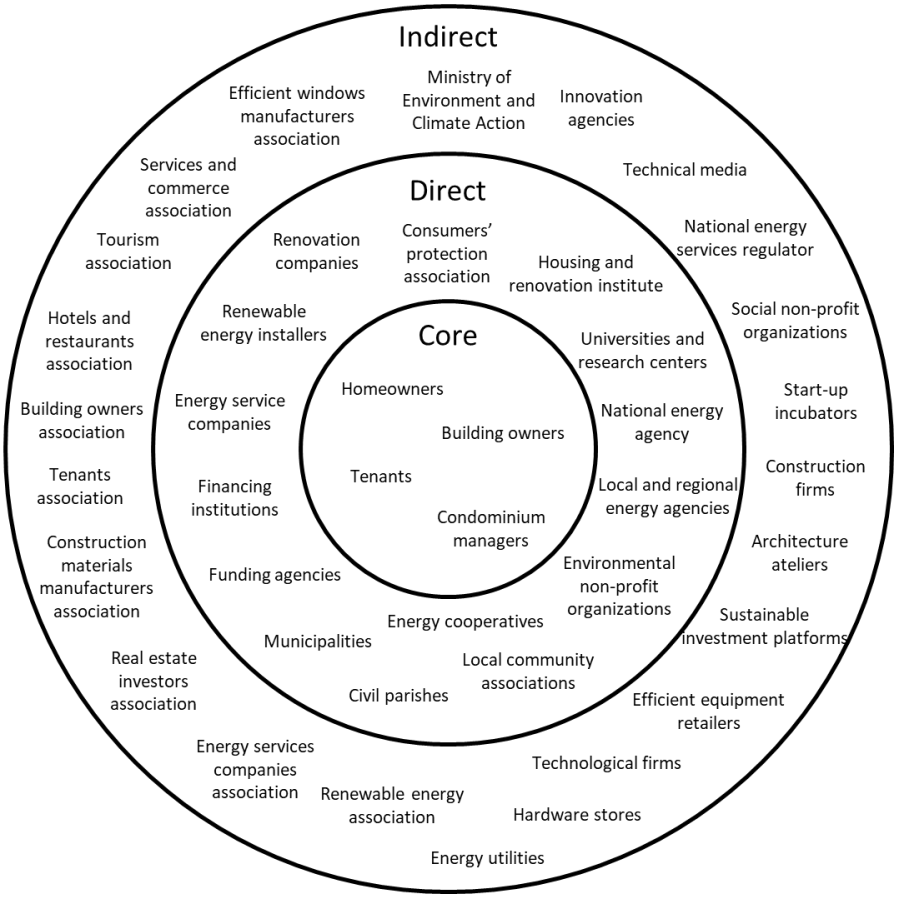

Figure 3. Stakeholder map from the building renovation OSS perspective.

Direct stakeholders include those with an essential role in shaping the renovation market, at a national and local scale, through technical aspects, governance, financing, and citizen engagement. These include companies with business models focused on building renovation, renewable energy and other energy services, municipalities and civil parishes, and energy agencies. Due to the magnitude of the problem (i.e., renovation of a significant proportion of the existing EU building stock), building renovation requires extensive public, private, or innovative mixed investment; thus, financing is a crucial challenge, and banks and organizations that manage existing financing mechanisms were also included in the category of direct stakeholders. Finally, national, regional, and local associations and cooperatives that promote energy literacy can work as trusted intermediaries between OSSs and communities.

Indirect stakeholders are a heterogeneous group of actors associated with at least one of the multidimensional topics covered by building renovation but that, so far, are not expected to have any direct links to OSSs. The Portuguese Ministry of Environment and Climate Action was included in this group as it is a pivotal agent in energy transition throughout all economic sectors. Public organizations and national-scale associations, such as research laboratories, innovation agencies, entrepreneurship incubators, regulators, environmental and social non-governmental organizations, and others, were also identified as indirect stakeholders. A broad group of associations, private firms, and media was included in indirect stakeholders, ranging in scope, scale, and purpose.

Figure 4 presents the stakeholder analysis in the form of an influence and interest/availability grid from the perspective of an OSS. The stakeholders considered with strong influence and high interest/availability for building renovation include those previously identified as core stakeholders and the firms that operate directly with this type of customer. In addition, the Portuguese National Energy Agency, regional and local energy

agencies, research centers, energy cooperatives, and the Consumer Protection Association are also relevant stakeholders that are starting to get involved in building renovation and citizen engagement, with some delving into one-off experiences in OSS-type activities, often linked with EU-funded projects. Stakeholders with a low influence but high interest/availability include local-scale associations, environmental non-governmental organizations, technical magazines, and technical associations. This latter group has deep-rooted interests in the services offered by OSSs and should be available for partnerships. However, in this group, each individual organization has a low input in the building renovation value chain.

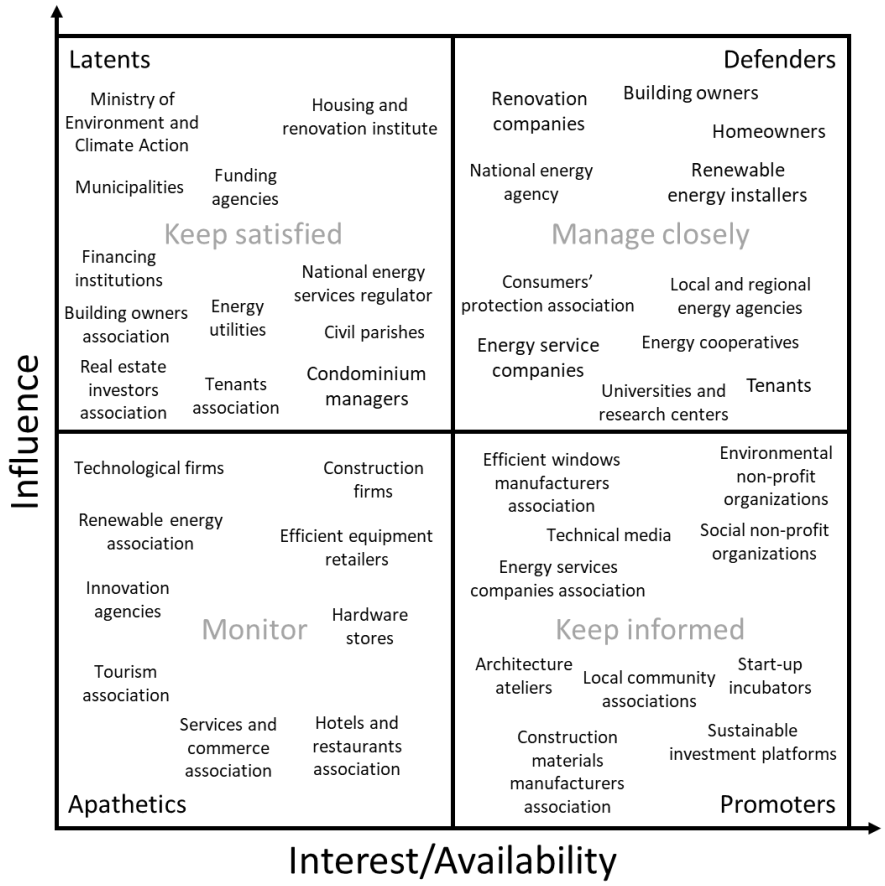

Figure 4. Stakeholder analysis with influence and interest/availability grid.

Stakeholders with a high influence but potential low interest/availability include municipalities, financing institutions, and energy utilities. Although their power is extensive, these agents may not be particularly interested in OSS business models and may lack the motivation to engage in active partnerships. Finally, relevant stakeholders with low influence and low interest/availability include banks, funding agencies, public institutes, and national laboratories.

4.3. Semi-Structured Expert Interviews

Table 1 summarizes the key insights from the expert interviews. While interviewees mostly agreed on the broader benefits of building renovation and the urgent need to increase current renovation rates in Portugal, their answers were less aligned regarding the optimal strategies to attain this goal.

Table 1. Key insights from semi-structured expert interviews.

Topic	Key Insights
Portuguese building stock	- Most Portuguese buildings are of poor construction quality. - The main problems include indoor air pollution, humidity, and low thermal comfort. - Building renovation was highlighted as the future of the construction sector.
Renovation market evolution	- Historically, the urban renovation market in Portugal has been highly residual. - The financial crisis of 2008 was critical for the Portuguese construction sector. - Since 2014, historic centers have seen an impetus in renovation, driven by tourism demand. - However, building renovation did not consistently follow energy performance regulations, mainly focusing on cosmetic renovations, due to an exceptional regime only revoked in 2019. - Interviewees agreed that construction seemed primarily immune to the COVID-19 pandemic and that ongoing trends could return if the pandemic came under control. - Renovation rates remain low and well below the values set by the Renovation Wave. - Financial shortcomings, lack of expertise, insufficient information, slowness of licensing, and small labor forces were mentioned as crucial barriers. - Incoming recovery funds can be a fantastic stimulus for building renovation.
Technical measures	- The priority is to act on the building envelope and ventilation. - Active systems should only be considered later; interviewees were not aligned on the optimal selection of heating, cooling, and water heating technologies. - Be that as it may, three solutions were mentioned as beneficial by most interviewees: solar thermal systems, heat pumps, and biomass-based technologies. - The growing role of renewable energy sources in building renovation was highlighted. - Although technology is evolving, it is not for lack of adequate technical solutions that building renovation rates remain low in Portugal.
Policies and regulations	- The European Union is showing appropriate signs regarding building renovation. - In Portugal, building renovation was transversely facilitated by existing policies; however, practical results may only be visible in the medium-term. - Portugal has a long-term strategy for building renovation, but this plan must be better aligned with short-term visions, practical measures, and effective incentives. - A trade-off persists between heritage protection and large-scale renovation. - Building renovation policies are complex since they confront two essential citizens' rights: the right to adequate housing and the right to private property.
Financing instruments	- In contrast to Northern European countries, a significant share of Portuguese homeowners cannot finance their dwelling renovation and need financial support. - In Portugal, there is a set of financing and tax instruments for building renovation. - Interviewees affirm that their effectiveness has been relatively low due to lack of funds, few projects, poor design, bureaucracy, and insufficient citizen awareness. - Financial support should be assigned according to families' income and investment capabilities; information campaigns and technical support are key to overcome barriers.
Citizen engagement	- Apart from split incentives, condominiums face difficulties in financing, technical limitations, governance inefficiencies, and insufficient information. - Although many benefits were mentioned for taking district-scale approaches to building renovation, there is still a long way to go until full-scale deployment. - OSSs were referred to as an interesting concept, but that is still embryonic in Portugal. - Municipalities and civil parishes were highlighted as key players at local scale. - However, most Portuguese local authorities require additional resources.

4.4. Customer Journey

For the customer journey, the "customer" was defined as homeowners interested in renovating their buildings (Figure 5). This exercise allowed us to visualize the critical

tasks, barriers, and benefits that a customer must undergo at each stage of the renovation project. Touchpoints to increase an OSS audience were identified and included partner websites, websites of direct and indirect stakeholders, social media, traditional media, and multi-scale dissemination events for all customer journey phases. These touchpoints were later used for the launch of the case-study platform. A deeper understanding of the target audience allowed us to consider possible solutions that meet their needs. The customer journey worked as guidance for the development of the digital OSS.

	Orientation	Advise	Finance	Implementation	Inspiration
Jobs to be done	- Awareness of renovation needs and opportunities - Collect building data - Search for measures - Prioritizing actions - Understand the process	- Find trusted information - Look for expert advise - Select the measures - Search for national and local regulations - Search for providers	- Allocate own funds - Search and apply to public funding opportunities - Negotiate bank loans and/or payment methods - Evaluate budgets & offers	- Apply for a permit - Sign the contractors - Oversee the renovation - Control budget & timeline - Monitor renovation results - Comply with regulation	- Share experience - Recommend measures - Recommend trusted providers and contractors - Share financing options - Warn about problems
Pains	- Lack of awareness & time - Energy illiteracy - Information is spread out over different places - Not knowing which data is accurate and trustworthy	- Understanding complex information & technologies - Not knowing who to contact and who to trust - Selecting the best options - Planning the next steps	- Lack of own funds - Applying to complex funding (bureaucracy) - Unattractive bank loans - Aversion to (more) debt - Perception of low return	- Getting a permit - Renovation noise & waste - Budget & time constraints - Managing contractors - Monitoring the correct adoption of measures	- Lack of time to share experience with others - Lack of interest from those not planning a renovation
Gains	- Gaining awareness and motivation to start - Implementing some quick wins for energy saving - Starting to prioritize and plan the renovation	- Gaining a deeper insight on energy consumption - Detailed data for the home - Understanding renovation options and challenges - Finding trusted advisors	- Taking advantage of funding opportunities - Reducing energy costs - Getting a positive return on investment and raising the building's market value	- Improving thermal and acoustic comfort - Energy savings and healthier living environment - Own electricity generation - Reduced maintenance	- Opportunity to renovate more buildings in the area - Recognizing trusted providers and contractors - Raise awareness and activate other stakeholders
Possible solutions	- Provide free online data - Combine all information in one single trusted platform - Attractive layout & clear user-friendly information - Use building typologies	- Provide simple calculation tools for key measures - Direct users towards trustworthy advisors - Inform on regulations for specific measures	- Provide clear information on funding opportunities - Financing tools are connected to the measures - Direct users towards funding/financing agencies	- Provide information on how to apply for a permit - Advise on how to select a good offer and budget - Advise on how to oversee and monitor the renovation	- Provide a platform to share experiences - Disseminate best practices and success cases

Figure 5. Customer journey map from a homeowner perspective.

4.5. Digital One-Stop Shop for Residential Buildings Renovation

The case-study digital OSS for building renovation is showcased in Figure 6, with a 3D model of the selected residential building typology and information on measures, financial schemes, and regulations. The overall structure of the platform is shown in Table 2 and could serve as a reference for the design of other digital OSSs in European countries. For the Portuguese case-study, around 130 measures, tips, points of attention, and innovations were selected, divided into five overarching themes, and disaggregated into several categories. User-friendly calculation tools are available for 12 key measures, allowing case-specific estimates of energy savings, investment costs, thermal comfort impacts, and CO_2 emissions reductions.

The platform also contains up-to-date information on 12 Portuguese financing schemes (e.g., grants and soft loans) and tax benefits available for building renovation in general and for specific measures. Relevant regulations that apply to the implementation of specific interventions are also shown next to the appropriate measure, considering the limitations of heritage protection in older buildings (mainly regarding exterior building alterations). Green Menu users can select the desired measures for their household, run energy-saving simulations, and save them in a tailored energy renovation package. Finally, the Green Menu provides inputs to guide the subsequent phases of a household renovation project, including a set of links where users can seek additional information (e.g., databases on renovation companies).

Figure 6. Layout of the Green Menu online platform [83].

Table 2. Structure of the Green Menu (* marks the categories with calculation tools) [83].

Theme	Category	Number of Measures
Orientation: Quick wins	Energy use	12
	Water use	4
Orientation: Insulation and ventilation	Seams and gaps	6
	Roof insulation	6 *
	Floor insulation	5
	Wall insulation	8 *
	Windows	9
	Ventilation	5
Orientation: Electricity generation and end-use appliances	Electricity generation	10 *
	Monitoring, storage, and electric vehicle charging	4
	Lighting	5 *
	Cooking	4
	Other electrical equipment	6 *
Orientation: Climatization and water heating	Space heating	9 *
	Heat distribution	8
	Water heating	13 *
	Space cooling	6 *
Orientation: Water and greenery	Green roofs and façades	3
	Water use	7
Advise	-	-
Financing	-	12 financing schemes
Implementation	-	-
Inspiration/News	-	-

4.6. Market Consultation Survey

A total of 91 responses were obtained on the survey following the online launch of the Green Menu. Although the small number of obtained answers does not provide a statistical basis for the analysis, the outputs serve to gather feedback on the platform and better understand user needs. Firstly, regarding demographics, the survey was completed by all age groups, with a high share (75%) of people with higher education but with no formal training on the topic at hand. The majority resided in the metropolitan area of Lisbon (66%). Around 31% of the inquired live in single-family houses, while 63% state that they live in multi-family buildings. 84% were homeowners or their relatives. Answers on building construction age were heterogeneously spread between 1946 and 2015.

Around 33% of the survey participants stated that they had performed energy-related renovations in the past, while 57% plan to do so in the future. The main drivers included improving comfort (83%), environmental concerns (53%), and reducing energy costs (43%). The main barriers were the unawareness of adequate measures (43%) and other priorities (28%). Around 68% of the survey participants were not aware of any available financing schemes in Portugal.

Regarding feedback on the Green Menu itself, 97% declared their interest in an OSS platform that brings all information under one roof. Around half of the participants found the platform to be well organized, while the other half selected the option "do not know", possibly due to a lack of time to explore it in detail. The visual aspect was considered appealing to more than 75% of the interviewees.

5. Discussion

The proposed sequential multi-staged approach for developing digital OSSs was successfully tested in the Portuguese case study to create the Green Menu online platform. This methodological toolbox has a high replicability potential, encompassing three initial steps to acquire in-depth knowledge on the status of the local building renovation market, the actual design of the platform, and a market consultation survey to gather feedback and fine-tune the digital OSS. The replicability of OSS approaches is deemed crucial by [35] for the rapid deployment of the model across the EU. In this section, results from the five steps are integrated and discussed in the context of the Portuguese case study, including possible future pathways for the digital OSS. Insights from the application of our methodology in Portugal, as well as the key case-study findings, contribute to the broader discussion on the potential role of renovation OSSs for a sustainable and inclusive energy transition.

The barriers mentioned during our interviews and survey overlap with those found in the literature [5], with lack of knowledge, competing priorities, and insufficient funds seeming particularly severe. The customer journey exercise further highlighted the multiple barriers that appear at each phase of a renovation project. The main trigger for renovations in our case study appears to be the increase in thermal and acoustic comfort (83% of participants), both for past and future renovations, as also found by other authors (e.g., [14,84]). Aesthetic improvements and maintenance are also high on the agenda for these households, which correlates with other research that noted that energy-related renovation has a lower priority [23,85]. Survey results from this study suggest that over half of homeowners are interested in renovating their dwellings, a slightly lower value than that stated in [86]; in that report, the authors conducted a survey of property owners and found that around 70% of Portuguese respondents said that they planned to carry out renovation works. Even though a policy framework is in place and a few financing mechanisms are available in Portugal, expert opinions indicate that their effectiveness has been relatively low. This was further suggested in our survey by the low share of people aware of financing schemes, which is particularly noteworthy, since most of the surveyed individuals were highly educated. The fragmented and complex nature of the mapped customer journey denotes the insurmountable barriers for homeowners that wish to renovate.

Interviewees mentioned OSSs as a promising solution that is still embryonic in Portugal and most other European countries. In addition, our market survey suggests that

the concept is attractive to homeowners, even if the surveyed population was small and is not intended to represent the Portuguese context. The Green Menu offers information on specific building typologies and suitable technical solutions, as well as calculation tools and comparisons, which can help to manage the complex process of renovating real buildings, as also suggested by [19]. In the online OSS platform, besides energy savings, non-energy benefits, such as improving comfort, health, safety, and aesthetics, were also emphasized as an important component of the value proposition of deep energy renovation (as suggested by [28,33,87]). Together with environmental concerns, as mentioned by [22], the importance of these drivers was exposed during our market consultation survey. While the focus of the OSS is on deep renovation, low-cost and self-renovation measures were also included in the platform since these can be particularly relevant for households that are not able to make large investments in home renovation [88]. Portuguese financing schemes are showcased in the OSS since the availability of financing incentives can create customer interest in energy renovations (as found by [28]).

The Green Menu currently follows the facilitation OSS model, where trustworthy information for the first stages of renovation is provided for free [39]. As a more straightforward service with low costs, it is the preferred model to gauge the reception of this innovation in an immature market and pave the way for more integrated solutions, as recommended by [39]. An online portal is considered by the same authors as an efficient method to engage with customers while reducing costs and increasing conversion rates, thus creating a scalable and more viable process. Ref. [40] similarly argue for modular web portals that follow the home renovation customer journey for specific building typologies and provide context-appropriate information and advice at every stage. Online tools also respect COVID-19 restrictions and may be particularly helpful in these uncertain times; privacy and security are growing concerns [40]. However, there is an inherent tension between giving independent energy advice and paying for it (as asserted by [22]). These costs are usually covered by the projects obtained following the free advice, but a digital OSS, such as the one developed in this case-study, may not be able to provide advanced services that can generate revenues, at least during the start-up phase.

Even if the digital OSS seems to address some of the barriers to building renovation, such as lack of information and energy illiteracy, our experience also indicates that it may be insufficient on its own to activate a significant share of hard-to-reach energy users [32]. As in other OSS services and studies (e.g., [22,28,41,89]), the target group for the Green Menu was single-family houses and surveyed customers can be defined as homeowners that are educated, innovative, open-minded, interested in environmental issues, and likely to have above-average income. Ref. [85] further narrow homeowners younger than 45 years old, with dwellings built from 1960 onward, and with environmental awareness, as potential early adopters of OSS concepts. Since the OSS renovation market is immature and full renovations are expensive, only customers with these specific characteristics are expected to show interest in complex building renovation processes (as also found by [28,87,90]). While the Green Menu's online presence is a positive feature, it can also turn off customers who prefer a face-to-face approach, hard-to-reach users with limited access and knowledge of online systems, and users who cannot find the needed information for their building typology on the platform (as suggested by [45]). This risk was uncovered by our market survey, where only half of the survey participants confirmed that they found the information clear and well organized, suggesting that detailed but comprehensible descriptions of measures should be prioritized.

By combining all information in one platform, the digital OSS reduces complexity in the first phases of a project. Nevertheless, since the facilitator model does not imply a follow-up on implementation, the homeowner still needs to deal with the complexity during this critical phase. Besides, as mentioned by [36], the OSS only reaches those already motivated, often with available funds, and just needing guidance. However, the number of homeowners with deep renovation plans for their house is suspected to be minimal, especially when budget limitations are factored in, as reported by [23,90]. For this small

share of homeowners, digital OSSs may provide valuable information, simplify the process, and increase the effectiveness and depth of renovation. Even so, other barriers, such as competing priorities and lack of time, can still constrain homeowners, as exposed in our market survey. It should also be noted that the authors of [23] found that as high as 50% of homeowners may be less interested in the OSS concept because they perceive it as a more expensive option. The authors of [90] stated that 20% of surveyed homeowners in Sweden have a favorable view of OSSs.

In contrast, the OSS will not contribute significantly toward engaging citizens that remain inert regarding renovation for many reasons (e.g., energy and digital illiteracy, and others reviewed by [34]). This is problematic because it seems that the current customer journey only addresses one type of homeowner—a small share of higher-income and educated population—excluding all others from more sustainable housing [20]. Indeed, our case-study's digital OSS services may not match the needs of many Portuguese households. These cannot be activated by online information alone and are the ones that, most likely, will require greater assistance to mitigate energy poverty and keep up with the energy transition; as recognized in the Portuguese energy poverty mitigation strategy (draft version) and the Portuguese long-term building renovation strategy [62,63].

Without targeted intervention, innovative business models, such as OSS, may exacerbate social inequalities [89,91]. Looking beyond single-family houses, OSSs need to be able to support large-scale energy renovation in multi-family buildings, condominiums, social housing, and vulnerable and energy-poor households (as also stated by [16,19,32,42,92]). These audiences present additional challenges for OSSs, such as the inability to make collective decisions due to lack of cooperation between homeowners, tenants, and condominium associations [15]. Further research is needed to discover which groups of households are motivated and satisfied by what type of services and customer journeys.

Some of the aforementioned shortcomings of the OSS case-study in Portugal can be mitigated by providing additional services and moving up the ladder toward more complex, all-inclusive models (as described in [39]). Actively seeking new customers, offering complete packages, and easing access to finance may improve the value proposition and attract larger audiences in the residential sector. While digital platforms are a good place to start an OSS business, the authors of [39] recommend creating a physical shop with qualified personal if sufficient financial resources are available. Trust is one of the decisive factors in selecting renovation services, and credibility must be maintained through quality assurance, monitoring, and follow-up [45,89,90]. It might be relevant to partner with intermediary organizations, building on existing trusted relationships that can simplify the customer journey, lower transaction costs, facilitate project implementation, and help raise awareness on retrofit opportunities [29,93]. Synergies for energy renovation are clear when scaled up to the neighborhood level, creating new business opportunities for OSSs to cluster several houses with similar needs [3,38].

Key stakeholders identified for the Green Menu, apart from homeowners, broadly fall under the four categories described by [22]: (i) renovation providers; (ii) trusted intermediaries (e.g., community organizations, hardware stores); (iii) local, regional, and national authorities; and (iv) financial supporters. While small renovation providers may be interested in participating in OSSs, the authors of [46] suggested that they prefer to leave the coordination role to an external party. The authors of [84] highlighted homeowners' associations, governmental authorities, and environmental agencies as the most reliable sources of information among surveyed Dutch homeowners. By involving some of these key partners, the case-study OSS can build customer trust and better target specific users, for instance, by providing a single customer interface (as recommended in [94]). Collaborative business models for energy renovations and alliances with local authorities, micro-enterprises, and large companies, can speed up the OSS market [22,30]. Several authors (e.g., [16,28]) have suggested a specific focus on local communication channels as an important way to motivate homeowners. Satisfied customers can be ambassadors for

energy renovation in their community (as noted in [22,25]), as planned for the 'inspiration' section of the Green Menu to showcase success stories.

An OSS can be the first piece of a more comprehensive local strategy to support citizens in various aspects of the energy transition, as suggested by the European Commission [3]. Local authorities have in-depth knowledge about the building stock and can take the initiative of combining support, guidance, and group purchasing of energy renovation services, therefore accelerating the building renovation market in their region [40,43,94]. OSSs, local authorities, and other stakeholders can also collaborate to train renovation providers and equipment installers/sellers to better inform and act on energy-efficient solutions [16,28]. This research adds to several authors' statements that public funding should be provided to OSS projects that aim to test different cost-effective business models, develop reference sites, and bring together relevant stakeholders (e.g., [19,95]. This public finance flow is particularly crucial for emerging OSSs, as they may need 5 to 8 years to close market gaps and make the business model financially viable (according to the authors of [39]).

Public finance can make-or-break OSSs in immature markets, as is the Portuguese case, where buildings energy renovation services may not be profitable enough for private companies (due to under consumption situations and energy performance gaps) and may instead need to be regarded as a public service (as also stated in [39,92]). Likewise, [16] see OSSs as an essential tool to alleviate energy poverty, bridging financial and power gaps and mediate split incentives, and [96] explore OSS as a sustainability-oriented business model innovation. Since the challenges to deep building renovation are multifaceted, an effective OSS business model needs to be framed by favorable overarching policy instruments and financial conditions, from the European to the local scale [7,33,95]. For instance, [17] describe an Irish building renovation scheme tailored to low-income households that combines 100% grant funding with the OSSs approach to achieve significant energy efficiency improvements. In the context of the Portuguese case-study, viable OSSs can play a pivotal role in meeting the country's energy and climate targets and implementing the long-term building renovation and energy poverty mitigation strategies [62,63].

6. Conclusions

This research critically reviewed the one-stop shop concept, as an emerging approach that can help to leverage energy renovations of residential buildings by specifically addressing key market barriers. It proposes a sequential multi-staged approach for the development of digital OSSs for building energy renovation, which may be particularly relevant for European countries where the business model is still absent or niche, including (i) stakeholder mapping and analysis, (ii) semi-structured expert interviews, (iii) customer journey, (iv) design of a digital platform, and (v) market consultation survey. The methodological approach was successfully tested for a Portuguese case study, and the authors encourage its replication and further expansion in countries with immature building energy renovation markets.

The case-study digital OSS represented a practical attempt to close information gaps, activate citizens, and leverage Portugal's still immature building renovation market. The online platform combined information on technical measures, financing, and regulations, making the customer journey simpler and more attractive. Based on the facilitation model where only information is provided, it caters mainly to the needs of homeowners who are already motivated regarding building renovation. However, while the digital OSS can address several barriers to citizen engagement, the current scope of services is insufficient for most Portuguese households. These simply do not have the resources, knowledge, and motivation required to kick-start a renovation process in their houses and are also the ones at risk of being left behind in the energy transition. Therefore, a broader range of both virtual and physical OSSs services, including tailored local-scale support, dedicated funding streams, and coordination of the works, may be necessary to engage larger audiences in energy renovations of residential buildings. These should be accompanied by an

enabling national and local policy environment with a comprehensive set of instruments and overarching financing for building renovation.

To fulfil the potential of OSSs to increase building renovation rates in Portugal and elsewhere, and based on our case study, the following key points should be focused on: (i) complement digital OSSs with physical (local or regional) OSSs; (ii) develop partnerships with relevant stakeholders as local and regional authorities, energy agencies, renovation providers, and community actors; (iii) provide trustworthy services that link all project phases; (iv) streamline access to finance and public funds; and (vi) explore neighborhood-scale approaches for building renovation. Building upon the proposed multi-staged approach, innovative OSS business models can flourish, enabling a larger number of households to engage in building renovation and enjoy its multiple benefits.

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Appendix A. Interview Script Used for the Semi-Structured Expert Interviews

Portuguese buildings characterization:

1. What are the most pressing pathologies and needs of residential buildings in Portugal?
2. What kind of construction and materials are more common in old residential buildings in Lisbon (constructed before 1919/1945)? What pathologies are typically present and require intervention? Other common characteristics (area, number, divisions, owner/tenant, among others)?
3. What type of energy consumption is typically found in old residential buildings in Lisbon (e.g., electricity, natural gas, biomass)? What type of energy-consuming equipment exists?

Portuguese renovation market evolution:

4. How has the building renovation market evolved in Portugal over the last few decades?
5. What are the main drivers and barriers from the perspective of the various players involved in the different stages of the energy renovation process of a residential building?
6. What is the average quality of renovation works of buildings in Portugal, taking into account energy performance improvement?
7. Why is the rate of building renovation in Portugal so low compared with the European average and the figures predicted in the European Green Deal and the European Renovation Wave?
8. How has the market for the renovation of historic areas of Lisbon/Portugal been evolving? What are the main drivers? What needs to be addressed to increase the number and quality of projects, without requiring the residents to leave?
9. How to leverage the residential building renovation market in Portugal taking into consideration the decarbonization of the sector by 2050?

Technical measures for the energy renovation of residential buildings:

10. Which energy efficiency and comfort measures must be prioritized in Portuguese buildings? Which of them are most frequently applied? Which could be applied, but are not? Why?
11. What type of measures provide an improvement in thermic performance of buildings in both winter and summer?
12. What type of energy efficiency and comfort solutions are most appropriate for old buildings? Which of them are most frequently applied? Which of them could bring benefits, but are not applied? Why?
13. How is the integration of renewables (mainly solar photovoltaic) evolving in the renovation of residential buildings? And in old residential buildings with historic value?
14. What type of innovative, technical solutions are being developed to improve the energetic and thermic comfort performance, with short/medium term impact on the market?
15. How much importance do you give to local knowledge and techniques in the renovation of buildings? And to the existence of qualified entities in a context of proximity to the community?
16. How important is it to use locally sourced materials, from the perspective of sustainability, circular economy, and thermic performance improvement?

Policies and regulations for the renovation of residential buildings:

17. What is your perspective on the evolution of policies and regulations, in Lisbon and Portugal, which establish the norms for the renovation of buildings? What are their pros and cons when considering a continued and sustainable energy renovation?
18. What policies and regulations, in Lisbon and Portugal, are specific to the renovation of old and historic residential buildings?
19. What are the main barriers to the renovation of historic buildings?
20. Which regulations/measures/processes could be adopted to streamline and expedite the renovation process of a building?

Financing instruments for the renovation of residential buildings:

21. Do you think that financial support instruments for the renovation of buildings in Portugal have been effective? If not, why not?
22. What are the factors that determine the success of this kind of support? What importance do you give to personal and personalized contact for the adoption of financial support?
23. How important are digital platforms to involve people in building renovation and to increasing the rate of adoption of financial instruments by the population. What information do you consider should be on these sites?
24. What financial (or other) barriers are still present in renovation projects for the various participants?
25. What financial (or other) mechanisms could be implemented in order to accelerate the renovation and regeneration of historic areas? And what about the renovation of residential buildings in general to increase the current rate (from 1% to 3.5%)?
26. How should the renovation of buildings, where people on low wages live and who have no ability to invest, be promoted? How could a financial instrument be specifically directed to these people?
27. How could traditional commerce and services, often situated on the ground floor of residential buildings, be involved in the rehabilitation process? What instruments should be directed to these small and medium sized companies?

Citizen engagement and district-scale approaches:

28. Which stakeholders should be involved in the renovation of buildings in Portugal?
29. What type of approach is necessary to involve citizens, companies, and authorities in the renovation of buildings?
30. What possible advantages and disadvantages are there in the adoption of an approach to renovation on a neighborhood or district scale, compared with the tra-

ditional approach at the single building scale? What role should the different stakeholders take on in both situations?

31. What examples are there in Portugal (and other countries) that might be relevant to the boosting of the renovation of residential buildings?
32. Can you recommend another entity or person to interview with respect to this matter?

Appendix B. Structure of the Market Consultation Survey

1. Age

   18–24
   25–39
   40–59
   60–70
   >70
   Does not answer

2. Education level

   4-years
   9-years
   12-years
   Bachelor's
   Master's
   Ph.D.
   Does not answer
   Other

3. Do you work in the energy, construction, or housing sector?

   Yes
   No
   Does not answer

4. Municipality
5. Year of construction of the building

   before 1919
   1919–1945
   1946–1960
   1961–1980
   1981–1990
   1991–2004
   2005–2015
   after 2015
   Does not answer

6. Building typology

   Single-family house (isolated)
   Single-family house (in band/geminated)
   Apartment in a multi-family building with 2 floors or less
   Apartment in a multi-family building with 3 or 4 floors
   Apartment in a multi-family building with 5 floors or more
   Does not answer
   Other

7. Do you own or rent your dwelling?

   Owner
   Family member of the owner (no rent or symbolic rent)
   Long-term tenant
   Short-term tenant
   Does not answer

Other

8. Are you a landlord?

Yes
No
Does not answer

8.1. If "yes" on question 8, do you worry about the energy performance of the houses you rent?

Yes
No
Does not answer

8.1.1. If "yes" on question 8.1, why do you worry about the energy performance of the houses you rent (select all options that apply)?

To increase the value of the rent
To make renting easier
To reduce energy costs
To increase thermal and acoustic comfort
To address worries about sustainability
To fulfill legal concerns
Other

8.1.2. If "no" on question 8.1, why do you not worry about the energy performance of the houses you rent (select all options that apply)?

It is not possible to improve energy performance of the house
I do not know if the measures will bring benefits
I have other priorities
It is not possible to conduct renovation works
I do not pay the energy bill
Other

9. Have you conducted renovation works in your home with the goal to improve energy performance?

Yes
I conducted renovation works but not acted on energy performance
No
Does not answer

9.1. If "yes" on question 9, what drivers led to the renovation works with the goal to improve the energy performance of your house (select all options that apply)?

I had to renovate the house anyway
To increase the house's market value
To reduce energy costs
To improve thermal and acoustic comfort
To improve the environmental sustainability of the house
To fulfill legal requirements
To produce my own renewable energy
Other

9.2. If the answer on question 9 was "I conducted renovation works but not acted on energy performance", what were the barriers to improve the energy performance of your house during the renovation works?

I do not know what measures are appropriate to my house
It is not possible to improve the energy performance of the house
I do not know if the measures will bring benefits
I had other priorities
I had a limited budget

I cannot implement measures in my house
I do not pay the energy bills
Other

10. Are you planning to perform renovation works (even if simple) at some point in the next 10 years?

Yes
No
Does not answer

10.1. If "yes" on question 10, are energy efficiency measures and renewable energy systems among your priorities for renovation works?

Yes
No
Does not answer

10.1.1. If "yes" on question 10.1, what are the drivers to implement these solutions?

To increase the house's market value
To reduce energy costs
To improve thermal and acoustic comfort
To improve the environmental sustainability of the house
To fulfill legal requirements
To produce my own renewable energy
Other

10.1.2. If "no" on question 10.1, what are the barriers to implementing these solutions?

I do not know what measures are appropriate to my house
It is not possible to improve the energy performance of the house
I do not know if the measures will bring benefits
I have other priorities
I have a limited budget
I cannot implement measures in my house
Other

11. Do you know any financing schemes that support the improvement of energy performance in the residential sector?

Yes
No
Does not answer

11.1. If "yes" on question 11, which one?

12. If a digital platform with all the needed information—such as technical measures, financing schemes and regulations—to improve energy performance was available would you be interested in using it?

Yes
No
Does not answer

13. How would you like to receive information about this platform (select all options that apply)?

E-mail
Social networks (Facebook, Instagram, Twitter, LinkedIN)
Written press
Radio
Television
With your energy bill

14. What would be the preferential way of using the platform?

Computer

Tablet
Smartphone

15. Do you consider the visual aspects of the Green Menu (3D model, animations, and pictures) attractive when compared with other platforms?

    Yes, but I do not know others
    Yes, even when compared with others
    No
    Does not answer

15.1. Can you suggest any improvements?
16. The Green Menu combines in the same platform technical information, financing, and regulations. Do you think that this is a useful feature that can facilitate the process of renovation your dwelling?

    Yes
    No
    Does not answer

16.1. Can you suggest any improvements?
17. Is the information on the technical measures well organized, clear, and accessible?

    Yes
    No
    Does not answer

17.1. Can you suggest any improvements?
18. Is the information on the financing schemes well organized, clear, and accessible?

    Yes
    No
    Does not answer

18.1. Can you suggest any improvements?
19. Do you consider useful for the financing schemes to be directly linked to the corresponding technical measures?

    Yes
    No
    Does not answer

19.1. Can you suggest any improvements?
20. Is the information on the regulations and licensing processes well organized, clear, and accessible?

    Yes
    No
    Does not answer

20.1. Do you consider useful for the regulations and licensing processes to be directly linked to the corresponding technical measures?

    Yes
    No
    Does not answer

20.2. Can you suggest any improvements?
21. The Green Menu already includes a short list of key stakeholders to contact to perform energy renovation of the house. Do you consider this information useful?

    Yes
    Yes, but more information is needed
    No
    Does not answer

21.1. Can you suggest any improvements?

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