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RESIDENT-FACING RENOVATION DECISION SUPPORT TOOL FOR COLLABORATIVE DECISION-MAKING

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ABSTRACT

Energy renovation in multi-family apartment buildings is a socially complex decision-making process where collective action often stalls due to financial uncertainty, perceived fairness issues, and the difficulty of comparing options across many households. These challenges are further amplified in district-level programmes that aim to accelerate renovation by bundling multiple buildings, increasing the coordination burden and making the need for decision support more critical for reaching consensus. This paper presents a Design Science Research of a resident-facing decision support tool developed and demonstrated in a renovation pilot involving four similar Soviet-era apartment buildings, where public co-funding was available conditional on housing association approval. The tool defines a bounded decision space and translates renovation scope into household monthly cost terms under explicit financing and energy performance inputs. Rather than relying on technical indicators alone, it presents monthly loan payments together with before-and-after household costs, expressed per square meter and typical apartment size. In facilitated resident discussions, the tool was used as a shared comparison frame, and each building group shortlisted two renovation scenarios for subsequent voting. The case illustrates how simple, transparent cost translation can make scope uplifts discussable and support structured comparison in complex collective renovation decisions.

KEYWORDS

Sustainability, collaboration, stakeholder engagement, visual management, design science.

INTRODUCTION

Renovation is becoming increasingly important for the European construction sector (European Commission, 2020). The decisions involved are not only technical; they depend on establishing shared understanding and common ground about scope, costs, and risks so that actors can make and keep commitments. When common ground is weak, participants rely on different assumptions and interpret the same information differently, which leads to repeated clarification cycles and difficulty maintaining alignment as decisions develop (Koskela et al., 2016).

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In multi-family buildings, creating that shared basis is harder because the client is a group of owners rather than a single decision-maker, with different constraints and value priorities. This aligns with the view that the client setting is a complex system, where outcomes depend on interactions, information, and trust rather than only technical solutions (Bertelsen & Emmitt, 2005).

A common challenge in renovation is the gap between technical information and resident decision needs. Energy performance and saving estimates matter, but residents can often benefit from having outputs translated into terms that support everyday budgeting and risk judgement. In renovation programmes aiming for scale, socio-economic uncertainty and the involvement of many stakeholders are widely noted as factors that slow down decision-making and prolong discussions, even when renovations are expected to be beneficial (Vendel et al., 2025). Fairness adds another layer (Ricci et al., 2025): renovation choices can distribute costs and benefits unevenly across households, and recent renovation literature increasingly frames decision criteria through equity and justice lenses.

Lean construction has a long tradition of using transparency and visualization as coordination mechanisms. Visual systems are used to make complex processes discussable and to support shared understanding and reliable action. While such approaches are often discussed in relation to production control or quality management, the same mechanism can matter in early-stage decision-making, where information needs to be understood and trusted before actions are taken (Neyra et al., 2025; Reinbold et al., 2024).

This paper targets an unresolved problem in multi-family renovation: while technical information and estimates are important, they are not always presented in a way that residents can use to visualize alternatives and build common ground. This creates a gap between available information and understanding needed for collective deliberation, particularly when affordability and fairness are salient. In this study, a collaborative decision support tool developed in an apartment building renovation pilot is therefore presented. The study asks how can a simple decision support tool be structured to make renovation options transparent and comparable for collaborative decision-making in apartment buildings?

RESEARCH METHOD

The study follows a Design Science Research (DSR) process model (Peffers et al., 2006), where the contribution is a practical artefact and demonstration of its use. The artefact is a resident-facing renovation decision support tool intended to make renovation options transparent and comparable in monthly household-cost terms. A pragmatic, artefact-oriented DSR approach was selected because the research aim is to develop and evaluate a usable decision support structure in context. Workshops were used as the primary empirical method because the phenomenon of interest - collective comparison and deliberation - can best be examined in an interactive setting. Accordingly, evaluation focuses on demonstrated utility and observed use in the pilot setting rather than on controlled estimation of causal effects. The work is reported through five steps:

1. **Problem identification and motivation.** The problem was identified by combining the literature framing presented in the study and observations from the pilot setting.
2. **Objectives of a solution.** Design objectives were derived from the problem framing and requirements input from workshop 1, specifying what the artefact needed to enable during collective deliberation.
3. **Design and development.** A spreadsheet-based prototype was developed iteratively to operationalise the design objectives by bounding the scenario space and translating scope choices into comparable monthly household-cost outputs under consistent assumptions. Microsoft Excel was chosen as the development environment because it

is widely accessible, familiar to most end-users, and supports rapid prototyping and iteration of calculation logic without specialised software.

4. **Demonstration.** The artefact was examined in use during a facilitated workshop that served as the demonstration setting. Data collection consisted of structured facilitator observation notes captured during and immediately after the workshop, together with tool-generated scenario outputs used to run the comparisons during deliberation.
5. **Evaluation.** The artefact was assessed through reflective evaluation by the research team using the design objectives as evaluation criteria (bounded scenario space, monthly household-cost framing, and comparison over recommendation). Because workshops were not audio-recorded and no controlled comparison was conducted, findings are reported as observed tendencies grounded in notes and tool outputs rather than causal effects.

PILOT AREA AND WORKSHOPS

The pilot site is located in the Mustamäe residential district of Tallinn, Estonia. It involves four nearly identical five-storey apartment buildings from the 1960s, built with prefabricated concrete panels typical of Soviet-era housing (see Figure 1). These buildings are representative of a common renovation target group in Estonia: ageing apartment buildings with heat losses, comfort complaints, and the need for comprehensive energy renovation. The buildings share a similar technical baseline (envelope condition and building services typical of the local stock), while the resident groups and priorities may differ. The pilot is part of a broader effort to accelerate renovation of this building type by developing repeatable renovation scopes and decision support.

To engage the resident groups in defining and comparing renovation options for these buildings, two facilitated workshops were held as part of the pilot activities:

- **First workshop.** The purpose was to gather resident input on desired renovation measures and priorities rather than to reach binding decisions. Residents worked alongside architects to explore early-stage architectural concepts and visualizations of the buildings, which facilitated discussion on preferred solutions and the qualitative reasons behind them, including balcony dimensions and glazing, the potential for larger windows, adding terraces or balconies to ground-floor apartments, and interest in elevator installation. This stage was essential for defining the qualitative decision space that the tool would later quantify. The workshop was held in April 2024 and included 16 participants.
- **Second workshop.** The purpose was to support decision-making by comparing renovation scenarios and agreeing on two scenarios per building to be taken forward for housing association voting. The tool was used during the workshop to translate preliminary scope choices into comparable scenarios under shared assumptions, including monthly cost implications. The workshop was held in August 2024 and included 22 participants.



Figure 1: Building baseline condition vs visualization from the first workshop, adapted from (*SOFTacademy*, 2024)

RESEARCH BACKGROUND AND PROBLEM IDENTIFICATION

In the pilot context, renovation decisions had to be prepared for housing association voting, where approval requires a majority decision (Apartment Ownership and Apartment Associations Act, 2024) and the proposal must be concrete enough to vote on. Early engagement, however, produced an unconstrained set of potential renovation measures rather than a small selection of clearly defined alternatives. This created a significant practical gap: while residents could express general preferences, the process of synthesizing these into coherent, votable scenarios imposed a heavy mental burden. This suggests that the challenge is not only selecting measures but defining alternatives with comparable assumptions; otherwise disagreement persists at the level of what is being compared rather than which option is preferred.

Such lack of structure prevents the formation of common ground: the shared knowledge and mutual beliefs important for joint action (Klein et al., 2005). As noted by Beers et al. (2006), in the absence of such a structure, participants may use the same terminology, such as 'expensive' or 'beneficial', while maintaining completely different internal thresholds for what those terms represent. This lack of common ground means that while residents appear to be discussing the same proposal, they are actually operating within different mental models of the project's value. The issue is therefore not disagreement alone, but hidden divergence in interpretation. In this situation, discussion can appear productive while still failing to converge, because participants update their positions against different implicit baselines. This conceptual fragmentation also increases the cognitive load of the decision-making process, which is problematic because excessive cognitive demands are linked to poorer logical reasoning and a tendency toward risk-averse or impatient choices (Deck & Jahedi, 2015). Furthermore, without a mechanism to streamline these choices, this mental burden translates into process waste and rework. Conceptualizing design as a flow of information implies that waste is generated when time is spent inspecting or reworking information to achieve conformance with stakeholder needs (Ballard, 2000). In this case, the lack of a structured comparison frame meant that information was constantly being reworked or remained in a state of waiting, preventing collective action and causing the renovation process to stall at the very point where consensus was most critical.

A second, closely related gap concerns the misalignment between information format and stakeholder needs. Presenting renovation information primarily as building-level totals, performance indicators or isolated measure costs implicitly assumes that residents can translate these outputs into an affordability judgement. In collective apartment-building renovations, owners have been shown to require a more integrated and decision-ready framing of financial consequences to judge feasibility and avoid unpleasant surprises (Naeyaert et al., 2026). For example, the absence of a consistent format for comparing monthly loan obligations against projected shifts in service and maintenance costs makes trade-offs difficult to justify. Without such a scenario-based view, decision-making remains abstract (Koskela et al., 2016), leading to a lack of decision-readiness where stakeholders are unable to commit to a formal vote due to perceived financial ambiguity (Schöttle et al., 2018).

Taken together, these gaps indicate that the barrier is not the absence of technical information, but the absence of a resident-facing comparison structure that makes assumptions explicit and translates alternatives into decision-ready affordability terms. This study therefore develops and demonstrates a collaborative decision support tool that bounds the scenario space, standardises assumptions across alternatives, and expresses outcomes in comparable monthly household costs to support deliberation and voting in multi-family renovation.

OBJECTIVES OF A SOLUTION

Based on the identified problem, the solution objective was to support scenario discussion among residents in a form that yields options suitable for formal housing association voting. Input from the first workshop helped define which scope choices needed to be representable in the scenario space. In parallel, findings from literature informed the key design objectives used to guide the solution design and development.

Three design objectives guided the solution requirements:

1. **Bound the scenario space.** Instead of treating scope as an open negotiation, the solution needed a stable baseline renovation scenario as a common starting point, plus a limited set of optional measures to form meaningful alternatives. By mitigating the decision process, the artefact functions as a boundary object: something that can be adapted to local needs, yet stays robust enough to hold a shared identity (Koskela et al., 2016), ultimately moving the group forward without the paralysis of open-ended complexity.
2. **Express scenarios in resident-facing monthly cost terms.** Because residents judge commitments through affordability and household budget impact, scenarios needed to be expressed in monthly terms that are easy to interpret. In this role, the tool functions as a mediating artefact: it formats and structures outputs for its audience by shifting from abstract indicators to contextualised, household-level information, with a level of detail suited to decision-making (Koskela et al., 2016).
3. **Support comparison over recommendation.** The tool should not steer residents toward a single preferred option, but provide a neutral frame for discussing trade-offs and recording what was compared. This matters in collective decisions, where perceived fairness shapes whether outcomes are accepted as legitimate (Spada & Vreeland, 2013).

DESIGN AND DEVELOPMENT

This section reports the design and development of the artefact in two parts: (1) the workflow (the logic pipeline from data to household costs), and (2) the configuration decision space (the baseline and optional add-ons).

DECISION SUPPORT TOOL WORKFLOW

The tool is designed as a linear data pipeline from building selection to monthly cost comparison (see *Figure 2*). The design goal is transparency: the tool translates technical scope into outputs that residents can compare using the same assumptions.

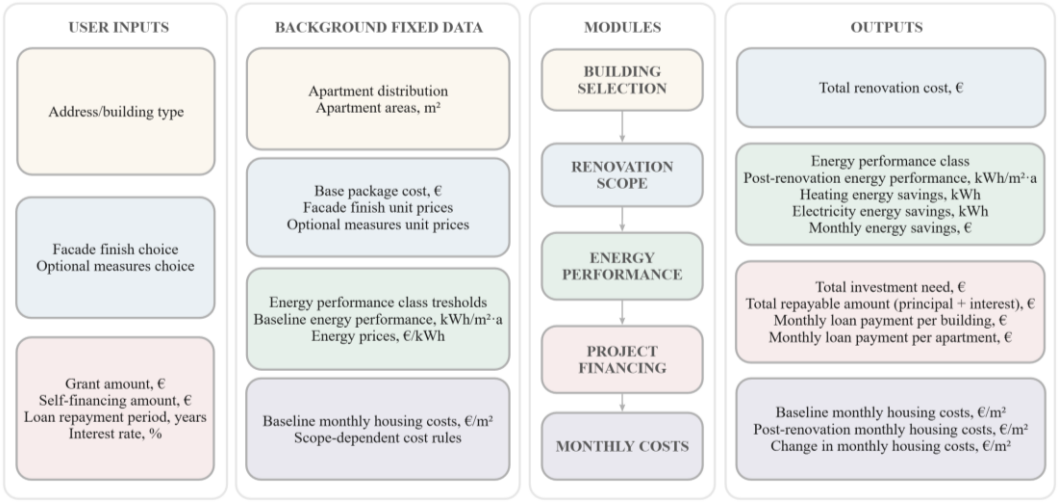


Figure 2: Decision support tool workflow

The workflow consists of five distinct processing modules:

1. **Building selection:** This module loads fixed building data, including apartment distribution and apartment areas. This ensures the model accurately reflects the specific geometry of the building.
2. **Renovation scope:** The user defines the scenario by combining the baseline renovation scenario with façade finish choices and optional measures. The module then calculates the total renovation cost by combining the base package cost with predefined unit prices and quantities for façade finishes and optional measures.
3. **Energy performance:** This module maintains technical performance visibility by determining the energy class and expected savings based on the selected scenario. While thresholds and energy prices are fixed datasets, the tool translates these abstract energy indicators into monetary values at the apartment level, allowing residents to connect technical performance to their personal household budgets.
4. **Project financing:** This module translates the renovation cost and energy savings into investment need. It applies user-entered financing conditions (grants, self-financing, loan periods, and interest rates) to derive the monthly loan repayment amount per building and per apartment type.
5. **Monthly costs:** The final module provides a net-loan perspective, presenting financing needs together with expected energy savings. It combines baseline utilities and maintenance and scope-dependent new maintenance items (e.g., elevator servicing) with the loan payment. These results are consolidated into a before-and-after comparison of monthly housing costs, expressed per m^2 and typical apartment size.

The outputs visualized for residents in the monthly costs module (see *Figure 3*) are specifically designed to bridge the gap between abstract technical indicators and concrete household budget impacts. The interface presents a side-by-side comparison of the current baseline against projected scenarios, categorized by common household cost types: maintenance, repair fund, heating and water, electricity, loan, and insurance. To ensure transparency regarding year-round affordability, the tool explicitly differentiates between the heating season (winter months) and the non-heating season (summer months). The module then calculates a total monthly average, and the net monthly and yearly average change in cost to enable real-time feedback during discussions, allowing residents to immediately see the financial implications of adding or removing optional measures and evaluate their value proposition based on the effect on household costs.

MONTHLY COSTS									
No	**Cost type**	**Pre-renovation costs, €**				**Post-renovation costs, €**			
		m2	**1-room**	**2-room**	**3-room**	**m^2**	**1-room**	**2-room**	**3-room**
1	Maintenance	0.8	23.1	33.9	43.1	0.8	24.8	36.3	46.2
2	Repair fund	0.4	12.8	18.8	23.9	0.5	13.5	19.8	25.2
3	Heating and water	2.1	64.4	94.5	120.3	1.5	40.4	59.2	75.4
4	Electricity	0.1	2.0	2.9	3.7	0.1	2.0	2.9	3.7
5	Loan	0.0	0.0	0.0	0.0	2.1	62.2	91.3	116.2
6	Insurance	0.0	0.7	1.0	1.3	0.0	0.7	1.0	1.3
1	Average monthly cost in heating period	3.9	116.3	170.6	217.1	5.3	158.7	232.8	296.3
2	Average monthly cost in non-heating period	2.7	82.1	120.5	153.3	4.4	133.2	195.4	248.7
3	Average monthly cost	3.4	103.0	151.1	192.3	4.9	143.6	210.6	268.0
4	Average monthly change in costs	-	-	-	-	1.5	40.5	59.4	75.6
5	Average yearly change in costs	-	-	-	-	18.1	486.2	713.1	907.6

Figure 3: User interface of the monthly costs module

DECISION SPACE

A bounded decision space was implemented using a platform-based configuration approach: a stable baseline renovation package is combined with selectable options to generate comparable scenario outputs. Rather than optimising solutions, the tool makes scenario assumptions explicit and keeps the comparison logic consistent across alternatives.

The baseline reflects a typical deep renovation scope for Soviet-era apartment buildings in Estonia and serves as the fixed reference case when façade finishes and optional measures are compared. Optional measures are defined as add-ons that enable higher energy performance levels and additional functional or architectural upgrades. Façade finish is configurable by material type and proportions, which affects finishing cost. The resulting decision space comprises:

- **Baseline renovation scenario:** Includes design and preparatory works, required demolition works, envelope insulation (external walls, roof, basement walls), replacement of windows and external doors, renewal of building systems (with related electrical works), basement floor levelling and storage units, entrance canopies, and minor indoor finish repairs where required by the works.
- **Façade finish (configurable within the baseline):** Material choice and proportions can be configured (fibre-cement board, timber cladding, metal panels, roof tile), which affects façade finishing cost.
- **Optional measures:** PV on roof + battery; PV on façade + battery; elevators; balconies/terraces (variants); enlarged windows; raised roof.

DEMONSTRATION RESULTS

This section documents the demonstration of the artefact in the second facilitated workshop (see *Figure 4*), where residents used the tool to compare renovation scenarios within building groups and to produce two shortlisted scenarios per building for subsequent housing association voting. This shortlisting outcome implemented the bounded scenario space objective by narrowing an unconstrained set of measures into a small set of vote-ready alternatives.



Figure 4: Resident discussion using the tool during the second workshop

The tool was used to structure comparison between alternatives rather than to produce a single recommended option. Residents compared scenarios using monthly cost measures shown by the tool. *Table 1* shows the two shortlisted scenarios per building and the two resident-facing outputs used for comparison: the monthly loan payment and the average monthly cost change after renovation, both expressed in €/m². These indicators deliver the monthly cost framing objective by translating scenarios into comparable affordability terms.

Table 1: Shortlisted scenarios

Building	Façade finish	Optional measures selected	Monthly loan payment (€/m²)	Average monthly cost change (€/m²)
1	Fibre-cement board 60%; metal panels 20%; roof tile 20%	PV on roof and battery; balconies 1.5 m	1.88	0.83
	Fibre-cement board 80%; metal panels 20%	PV on roof and battery; elevators; balconies 1.5 m; enlarged windows; raised roof	2.83	1.90
2	Fibre-cement board 100%	PV on roof and battery; extended balconies 2.4 m; raised roof	2.37	1.42
	Fibre-cement board 100%	PV on roof and battery; elevator; extended balconies 2.4 m; raised roof	3.05	2.22
3	Fibre-cement board 85%; timber cladding 15%	PV on roof and battery; balconies 1.5 m; raised roof	2.28	1.31
	Fibre-cement board 85%; timber cladding 15%	PV on roof and battery; extended balconies 2.4 m; raised roof	2.35	1.39
4	Fibre-cement board 100%	PV on roof and battery; elevator; balconies 1.5 m	2.88	1.66
	Fibre-cement board 100%	PV on roof and battery; elevator; extended balconies 2.4 m	2.96	1.74

Across all eight shortlisted scenarios, the monthly loan payment ranged from 1.88 to 3.05 €/m², while the average monthly cost change ranged from 0.83 to 2.22 €/m². All eight shortlisted scenarios included the PV and battery option targeting A-class. The remaining differentiation between scenarios is driven by elevator inclusion, balcony configuration, raised roof selection, and façade finish proportions. Scenario comparison during the workshop repeatedly returned to the monthly loan payment and average monthly cost change values, with differences typically explained by referring back to the scope elements that drove them. Clarification questions focused on which assumptions and cost components contributed to the monthly differences before each building group converged on its shortlist.

Within buildings, the difference between the two shortlisted scenarios varies. Building 1 and Building 2 produced pairs that differ more strongly in both scope content and monthly indicators, while Building 3 and Building 4 produced pairs that are closer to each other and mainly differ by balcony variants. Overall, the demonstration resulted in a structured shortlisting outcome: two comparable scenarios per building suitable for voting.

EVALUATION

Unlike many lean decision-making studies focused on professional project teams (Arroyo et al., 2022; Arroyo & Long, 2018; Schöttle et al., 2018), this study shows a practical way to support early-stage collaborative decision work in apartment building renovation through a resident-

facing tool that aims to improve transparency and comparability among non-experts. The tool does not "solve" the decision for residents; it makes the decision space legible by defining a stable baseline and expressing scope uplifts through a consistent set of monthly outputs. In lean terms, this reflects transparency as the ability of a process to communicate with people and reduce confusion (Oliveira et al. 2012).

Transparency here is achieved through cost translation. As a simple form of visual management, the tool makes key parameters and implications visible so residents can compare options using shared numbers rather than competing interpretations (Neyra et al., 2024). This aligns with Lean arguments that early cost feedback supports steering decisions before commitments are fixed (Pennanen et al. 2010).

The tool architecture also reflects findings from prior work on decision-making: outcomes are shaped not only by what is decided, but by how the decision process is structured, governed, and documented (Schöttle et al., 2018, 2020). In this case, the tool supports all three: it structures the decision space (baseline renovation scenario plus options), provides comparability (shared assumptions and comparable outputs), and supports documentation through explicit, reproducible scenario calculations. Even though a formal Choosing by Advantages procedure was not applied, the approach aligns with the broader lean view that decision processes benefit when trade-offs are made explicit and when the decision media supports transparent comparison (Schöttle et al., 2022).

The shortlisted scenarios (Table 1) provide a concrete output that illustrates what the tool enabled. Across the four buildings, resident groups converged on two clearly specified scenarios each, compared through monthly outputs (€/m² loan payment and €/m² cost change). This does not prove that decisions became easier or faster, but it shows that a complex and potentially open-ended scope space can be narrowed into options that are comparable and suitable for formal voting. Facilitator notes suggest that the discussion frequently remained anchored in a consistent household-cost frame rather than drifting between technical indicators and aggregate building totals.

Three evaluation insights emerge from the demonstration. First, all scenarios included PV configurations. This may indicate that when monthly cost implications are made transparent and comparable, higher energy performance becomes easier to consider as a realistic investment rather than a vague technical ambition.

A similar observation concerns elevators. Retrofitting elevators into Soviet-era apartment buildings is uncommon in Estonia because it is technically intrusive and financially significant, and discussions can be sensitive given older and budget-constrained residents. In this case, elevators nevertheless appeared in several shortlisted scenarios (Table 1), suggesting that the option was treated as a realistic candidate rather than dismissed immediately as "too expensive." One plausible explanation is that the tool supported discussion by shifting the conversation from an abstract idea toward a comparable monthly-cost view under explicit assumptions. By breaking costs into categories, the module makes visible how increased loan payments relate to changes in other household costs, enabling residents to weigh trade-offs within the same affordability frame used for other measures. Presented this way, elevators may become more discussable than when framed only as an abstract upgrade or an aggregate cost item.

At the same time, the shortlisted pairs differed by building in how far apart they were in monthly outputs and scope. This suggests that the tool did not push groups toward a single preferred level of ambition. Some groups shortlisted a distinct higher and lower cost pair, while others stayed close to a conservative direction, yet all used the same outputs to justify their choices. In that sense, the tool appears to function as a neutral comparison frame, supporting transparency and discussion, rather than as a mechanism that steers residents toward more extensive scopes.

Finally, the case has a decision-memory angle. The tool acts as a stable reference that can carry rationale forward beyond a single meeting, because assumptions and outputs are reproducible. This connects to work on design rationale and project definition, which highlights the importance of capturing and managing the reasoning behind decisions and using group-support tools to support collaboration and learning (Whelton et al., 2001).

The contribution of the paper is therefore not a claim that the tool improved decisions in a measurable way, but rather the contribution is a replicable solution architecture and a resident-facing translation logic that can be tested in other contexts. The case adds an example of how transparency and visual management ideas can be applied to the client decision interface, supporting the work of forming viable, comparable options and enabling clearer commitments, even if commitment reliability is not measured directly in this study.

For practitioners facilitating resident decision-making, the tool provides a repeatable workflow for presenting trade-offs in a consistent monthly-cost frame, which can reduce rework and support preparation of vote-ready proposals. For policymakers, the study reinforces that decision readiness depends not only on technical assessments but also on the interpretability of implications. Academically, the study extends lean visual management ideas to the client decision interface by operationalizing transparency as a resident-facing comparison frame.

Methodologically, this study is limited by the type and depth of available evidence or controlled comparison. The paper documents the tool architecture, the decision space, and the shortlisting outputs, but it does not include detailed recordings of resident discussions or systematic measures of trust or decision speed. Technically, the monthly outputs presented are scenario estimates under stated assumptions; actual costs and realised savings may differ. In addition, the case covers a small set of similar buildings in one pilot context, which limits generalization. Future work should test transferability across building types and governance settings and assess decision-process outcomes such as perceived fairness and commitment stability.

CONCLUSIONS

This study addresses a recurring challenge in apartment-building renovation: decisions are not only technical, but also communicative. Residents must compare complex scope alternatives and long-term financial implications, and prepare proposals that are concrete enough to be approved through collective voting. The resident-facing decision support presented in this paper was developed to support this early-stage decision work by defining a bounded scenario space and expressing renovation alternatives in monthly household-cost terms under explicit inputs. Accordingly, the study shows how a simple tool can be structured to make renovation options more transparent and comparable for collaborative decision-making in apartment buildings.

In the pilot, each building group shortlisted two explicitly specified renovation scenarios suitable for housing association voting using the same monthly €/m² indicators. This demonstrates a practical pathway from open-ended discussion to vote-ready alternatives, without claiming measurable improvements in decision speed or outcomes. The shortlisted scenarios also indicate that scope elements often considered unrealistic in similar Soviet-era buildings, such as elevators, can become discussable when their implications are presented in the same monthly-cost frame as other measures.

The contribution of the paper is therefore a replicable decision support architecture that applies ideas of transparency, boundary objects, and visualisation to the client decision interface. By focusing on how technical information is structured and framed for resident discussion, the study offers a practical approach that can be adapted and tested in other renovation contexts and building typologies. Limitations include the single pilot context and note-based evidence; future work should test transferability across building types and governance settings and assess decision-process outcomes such as perceived fairness and commitment stability.

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