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From policy intent to climate-smart implementation: developing the Saudi climate-smart social housing governance model (S-CSHGM)

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Introduction: Saudi Arabia's Vision 2030 positions social and affordable housing as a strategic lever for climate-smart urban development. However, despite advanced regulatory instruments such as the Mostadam Green Building Rating System and Saudi Building Code (SBC 601), a persistent implementation gap raises critical questions about how governance arrangements shape actual sustainability outcomes in energy use, comfort, and water efficiency.

Methods: Guided by institutional theory and the accountability trap concept, this study develops a six-factor analytical model of the enabling environment for sustainable, AI-ready social housing. A qualitative, multi-method approach triangulates: (i) systematic analysis of 42 national policy documents (2016–2025); (ii) a two-round Delphi survey with 23 experts; and (iii) structured benchmarking against Singapore's Green Mark, Abu Dhabi's Estidama, and Qatar's Global Sustainability Assessment System.

Results: The analysis reveals pronounced institutional voids and accountability traps. While sustainability is strongly embedded in formal regulations, responsibilities for post-occupancy and digital performance are diffuse; procurement and finance remain weakly linked to lifecycle outcomes; and fragmented data systems limit the use of smart-building and AI-enabled tools. Delphi findings prioritize performance-linked procurement, unified housing-performance data platforms, mandatory post-occupancy evaluation, and green finance instruments—practices aligned with international benchmarks.

Discussion: The study proposes the Saudi Climate-Smart Social Housing Governance Model (S-CSHGM), a four-pillar, AI-ready framework designed to realign roles, incentives, digital infrastructures, and feedback loops. This advances theory by operationalizing institutional and accountability concepts into a measurable governance model and provides a concrete roadmap to link Vision 2030 housing ambitions with verifiable, data-driven sustainability performance in Saudi Arabia's built environment.

KEYWORDS

AI-ready housing systems, climate-smart urban development, performance-linked procurement and finance, Saudi Arabia, social housing governance, technological and digital infrastructure

1 Introduction

Saudi Arabia's Vision 2030 has redefined housing as a strategic policy domain at the intersection of economic diversification, social welfare, and environmental sustainability. The Housing Program, one of the Vision Realization Programs, seeks to raise homeownership to 70% by 2030 while improving the quality and resilience of residential environments (Alhajri, 2024). Recent official statistics indicate that homeownership rates have risen substantially since the launch of Vision 2030, signaling rapid progress in expanding access to housing (Alqahtany, 2020). This expansion is supported by a complex constellation of actors led by the Ministry of Municipalities and Housing (MOMAH), with implementation primarily through the National Housing Company (NHC) and ROSHN, as major public and public-private developers (Alhajri, 2019). In this sense, social housing governance is treated not only as an urban management issue but also as a core determinant of built-environment performance in terms of energy use, thermal comfort, water efficiency, and the quality of shared spaces.

In parallel, sustainability and climate resilience have moved from aspirational discourse to codified regulatory requirements (Table 1). Instruments such as the Mostadam Green Building Rating System and Saudi Building Code (SBC 601) now embed energy efficiency, water conservation, and comfort standards into the design and construction of housing (Al-Surf et al., 2021). The Saudi Green Initiative and the Quality of Life Program further situate housing within a broader shift toward decarbonization, improved livability, and greener urban form. On paper, therefore, the institutional and regulatory environment for sustainable housing in Saudi Arabia appears both ambitious and technically sophisticated (Alhowaish, 2025).

However, international research on sustainable housing governance consistently shows that strong regulatory intent does not automatically translate into effective implementation

(Akinsulire et al., 2024; Winston, 2022). In practice, implementation depends on how institutions are configured, how responsibilities are allocated, how financial and procurement systems interact with sustainability criteria, and how performance is monitored and enforced over time (Braams et al., 2024; Carrigan and Coglianese, 2011). In the Saudi context, emerging evidence suggests that sustainability commitments often weaken during procurement, handover, and especially during operation and maintenance, where long-term performance is rarely systematically monitored (Al-Otaibi et al., 2025). This raises a critical question: how does the existing enabling environment—comprising institutions, regulations, financial mechanisms, digital infrastructures, and monitoring systems—shape the actual integration of sustainability and resilience in social housing delivery?

Existing studies of housing in Saudi Arabia have examined institutional structures (Aldalbahi, 2020), PPP frameworks (Alhajri, 2019), affordability and regulation (Alqahtany, 2022), and cooperative and social housing policy trajectories (Al Mulhim et al., 2022; Alzamil, 2024). Together, these works substantially advance understanding of institutional arrangements, critical junctures in policy development, and the effects of regulation and finance on housing delivery in Saudi Arabia and the wider Gulf. However, they still tend to focus on specific instruments or institutional arrangements, or to discuss the enabling environment at a broad qualitative level, rather than on an integrated, AI-ready governance ecosystem that links policy intent to measurable portfolio-wide performance. None of these studies develops and empirically applies a six-factor governance model that simultaneously integrates institutional integration and role clarity, regulatory instruments and standards, procurement and finance alignment, technological and digital infrastructure, monitoring, transparency and accountability, and learning and capacity-building, nor do they translate such a model into a phased,

TABLE 1 Key instruments influencing sustainability in Saudi social housing delivery.

Instrument	Issuing body	Scope	Enforcement stage	Sustainability link	Status
Mostadam rating system	MOMAH/ Mostadam center	Design and construction	Planning → operation	Energy, water, materials, wellbeing	Expanding (active program with 2024 manual updates)
SBC 601 – energy conservation	SBCNC ^b	Envelope and HVAC ^c	Design → construction	Energy efficiency	Mandatory (fully enforced since 2022)
Executive regulation of municipal enforcement	MOMAH	All building categories	Construction → operation	Compliance, safety	Active (standard municipal sign-off)
Housing support and mortgage subsidy rules	REDF ^d /NHC ^e	Financing and eligibility	Pre-delivery	Affordability, equity	Ongoing (no direct performance link)
PPP frameworks (housing program)	NHC/MoF ^f	Developer partnerships	Design → delivery	Affordability, sustainability incentives	Active (criteria often preferred, not mandatory)
Green finance initiatives	SAMA ^g /MoF	Pilot for green mortgages	Financing	Energy/carbon performance	Pilot (limited scale, 2024–2025)

^aMOMAH, ministry of municipalities and housing.

^bSBCNC, Saudi building code national committee.

^cHVAC, heating, ventilation, and air conditioning.

^dREDF, real estate development fund.

^eNHC, national housing company.

^fMoF, ministry of finance.

^gSAMA, Saudi central bank.

climate-smart implementation roadmap. There remains limited analysis of how governance mechanisms interact with technological and digital infrastructures—including smart-building systems, integrated data platforms, and AI-enabled tools—which are increasingly central to “future-proof” housing ecosystems.

While the existing body of work on GCC housing provides essential foundations, this study seeks to advance the literature in three distinct and integrated ways. First, prior studies have typically examined governance elements—such as institutional structures, PPP frameworks, or specific regulations—in isolation. In contrast, this study develops and empirically applies a novel, six-factor analytical model that simultaneously integrates institutional, regulatory, financial, digital, accountability, and learning dimensions to diagnose systemic gaps. Second, and crucially, it explicitly integrates ‘Technological and Digital Infrastructure’ as a core, co-equal governance factor, moving beyond treating smart-building systems and AI as mere technical add-ons to framing them as fundamental enablers of accountability and performance management. Third, it translates this diagnosis into the Saudi Climate-Smart Social Housing Governance Model (S-CSHGM), a tailored operational roadmap that specifies how to realign roles, incentives, and data flows. No prior study in the GCC context has offered such an integrated, diagnostic-to-prescriptive, and explicitly AI-ready governance framework for climate-smart social housing.

Against this background, this article addresses the following overarching research question: *How do governance and delivery mechanisms—across institutions, regulations, finance, digital infrastructures, and accountability arrangements—shape the integration of sustainability and resilience within Saudi social housing, and how can identified institutional and accountability gaps be addressed in an AI-ready, future-proof manner?*

To answer this question, the study pursues three specific objectives:

1. To map and analyze the institutional, regulatory, financial, and digital mechanisms that govern social housing delivery under Vision 2030.
2. To identify specific governance gaps—including institutional voids, accountability traps, and digital fragmentation—that undermine sustainability performance across procurement, construction, and operational stages.
3. To develop a tailored, AI-ready governance model for climate-smart social housing that aligns policy intent, financial incentives, digital infrastructures, and accountability mechanisms.

The study’s originality lies in three elements. First, it develops a six-factor analytical model of the enabling environment for sustainable social housing that operationalizes institutional theory and the accountability trap in a state-led Gulf context. Second, it explicitly integrates technological and digital infrastructure, including AI-ready data platforms and smart-building systems, into this model as a core governance factor. Third, it empirically applies this framework through a triangulated methodology combining systematic document analysis, a Delphi expert survey, and structured international benchmarking against leading housing governance models in Singapore, Abu Dhabi, and Qatar, and

translates the results into a time-bound implementation roadmap for the Saudi Climate-Smart Social Housing Governance Model (S-CSHGM).

The remainder of the article is structured as follows. **Section 2** develops the theoretical framework, drawing on institutional theory, the accountability trap, and recent literature on AI and digital transformation in the built environment to construct a six-factor enabling-environment model. **Section 3** sets out the qualitative, multi-method research design. **Section 4** presents the findings from the document analysis, Delphi survey, and benchmarking, organized around the six governance factors. **Section 5** interprets these results through the lens of institutional voids and accountability traps and introduces the Saudi Climate-Smart Social Housing Governance Model (S-CSHGM). **Section 6** concludes by synthesizing the main contributions, outlining policy implications, and identifying priorities for future research.

2 Theoretical framework

2.1 Institutional theory and institutional voids

Institutional theory conceptualizes institutions as the “rules of the game” that shape economic and social behavior through formal rules (laws, regulations, contracts) and informal constraints (norms, conventions) (North, 1990). In this perspective, policy outcomes depend not only on the content of regulations but also on how institutional arrangements allocate authority, define incentives, and structure enforcement. A critical concept for this study is that of “institutional voids,” gaps, inconsistencies, or weaknesses in the institutional framework that hinder the translation of policy into effective practice (Sydow et al., 2020; Hasan and Bondy, 2025).

In the context of Saudi social housing, institutional voids may appear as missing mandates for post-occupancy monitoring, fragmented oversight over sustainability performance, or misaligned financial regulations that fail to reward long-term efficiency and resilience. Rather than assuming that more or stricter regulation will automatically strengthen sustainability, an institutional perspective directs attention to how existing rules interact, how responsibilities are distributed, and how incentives are structured along the housing delivery chain.

2.2 The accountability trap in multi-actor governance

Complementing this, the concept of the “accountability trap” captures situations in complex, multi-actor governance systems in which responsibility for outcomes becomes so diffuse that no single organization can be meaningfully held to account (Eilstrup-Sangiovanni and Hofmann, 2024; Lee and Ospina, 2021; Papadopoulos, 2024). In such settings, overlapping mandates, shared competences, and unclear performance metrics can lead to a focus on short-term deliverables (e.g., units constructed) rather than long-term outcomes (e.g., energy performance, resident wellbeing), undermining policy ambitions even when technical regulations are in place.

In Saudi Arabia's social housing sector, where MOMAH leads policy, NHC orchestrates implementation, ROSHN and private developers execute large-scale projects, and municipalities and utility providers manage local services, the risk of an accountability trap is high. Without clearly assigned responsibilities for post-occupancy performance, data collection, and disclosure, sustainability requirements can be formally met at the design stage but eroded during procurement, construction, or operation. This theoretical lens helps explain why sophisticated regulatory instruments may co-exist with persistent implementation gaps.

2.3 Six governance factors of the enabling environment

To operationalize these institutional and accountability concepts for empirical analysis, the study develops a six-factor model of the enabling environment for sustainable and climate-smart social housing governance. The enabling environment is defined here as the set of institutional, regulatory, financial, technological, and learning conditions that collectively determine whether sustainability and resilience goals are integrated into housing delivery at scale. The six factors are:

1. **Institutional Integration and Role Clarity:** the degree to which mandates and responsibilities for planning, financing, delivering, and operating social housing are clearly allocated and coordinated across ministries, agencies, and developers.
2. **Regulatory Instruments and Standards:** the scope, coherence, and enforceability of legal and technical requirements (e.g., building codes, rating systems, enforcement regulations) related to sustainability and resilience.
3. **Procurement and Finance Alignment:** the extent to which procurement rules, PPP frameworks, subsidies, and financial products incentivize or reward lifecycle performance rather than short-term outputs.
4. **Technological and Digital Infrastructure:** the availability and integration of digital tools—such as smart meters, building management systems, data platforms, and AI-enabled analytics—that enable performance monitoring, optimization, and adaptive management.
5. **Monitoring, Transparency, and Accountability:** the presence of robust performance metrics, reporting obligations, public dashboards, and audit mechanisms that support enforcement and learning.
6. **Learning and Capacity-Building:** the institutionalized mechanisms through which lessons from practice, data analytics, and benchmarking are translated into updated standards, guidelines, and professional competencies.

These six factors are analytically distinct but empirically intertwined. Technological and digital infrastructure (Factor 4) underpins effective monitoring and transparency (Factor 5), while performance-linked finance (Factor 3) can only be operationalized where roles and standards (Factors 1 and 2) are sufficiently clear. Together, they provide the scaffolding for the four pillars of the S-CSHGM presented in the Discussion, which integrates these governance factors into a coherent reform pathway.

2.4 AI, smart buildings, and digital housing systems

Recent advances in AI, Internet of Things (IoT), and building automation systems have profound implications for housing governance. Smart and self-learning buildings can adaptively manage energy consumption, indoor environmental quality, and maintenance schedules based on real-time data and predictive algorithms, thereby reducing operational costs and improving comfort (Ademowo et al., 2024; Azzi et al., 2024; Ding and Sun, 2024; Shamsuddin and Srinivasan, 2020). Digital twins and portfolio-level analytics can further support planning and investment decisions by simulating scenarios and identifying systemic inefficiencies (Alnaser et al., 2024; Arsecularatne et al., 2025).

From a governance perspective, these technologies expand what can be measured, attributed to, and optimized across social housing portfolios. AI-enabled analytics depend on standardized data infrastructures (Factor 4). However, once established, they can significantly strengthen monitoring and accountability (Factor 5) by generating real-time performance indicators, anomaly alerts, and evidence for compliance or non-compliance. They also create new demands for skills and organizational learning (Factor 6), as planners, developers, and regulators must interpret and respond to digital evidence.

In the context of Vision 2030 and the National Strategy for Data and AI, integrating AI-ready digital infrastructures into the enabling environment for social housing is therefore not merely a technical enhancement but a governance necessity. The analytical framework developed here explicitly incorporates technological and digital infrastructure as a core factor in understanding how institutional voids and accountability traps manifest—and how they might be overcome—in Saudi Arabia's social housing system.

3 Materials and methods

A qualitative, multi-method design was employed to ensure a comprehensive and triangulated examination of Saudi Arabia's social housing governance landscape. This approach integrated three complementary methods: a systematic policy and document analysis, a two-round Delphi expert survey, and a structured comparative benchmarking exercise, all explicitly anchored in the six governance factors outlined in the analytical framework (Section 2.3).

3.1 Research design and data collection

3.1.1 Systematic policy and document analysis

A systematic review was conducted on a curated corpus of documents to map the formal governance structure. The document selection process followed a structured, two-stage protocol to ensure relevance and representativeness, as detailed below.

- **Identification:** An initial pool of 98 documents was identified via the official websites of key Saudi entities (MOMAH, NHC, ROSHN, SBCNC, REDF, Vision 2030 portals) and professional networks.

TABLE 2 Key document sources and types for policy analysis.

Document type	Issuing entity	Years covered	Primary analytical purpose
Vision 2030 strategic plans	Vision realization Offices/ CEDA ^a	2016–2025	Strategic guidance for national transformation, including housing and livability
Housing program reports	MOMAH ^b	2018–2025	Housing policy, targets, PPP structures, and delivery mechanisms
Mostadam rating manuals	Mostadam Center/MOMAH	2021, 2024	Green building standards, certification procedures, and performance guidance
SBC 601 codes	SBCNC ^c	2018–2024	Mandatory building energy regulations and compliance requirements
NHC tender guidelines & PPP frameworks	NHC ^d	2019–2024	Procurement rules, developer obligations, and sustainability clauses
ROSHN design & sustainability guidelines	ROSHN group	2020–2024	Community-level design, livability, and sustainability criteria
Executive regulation of municipal enforcement	MOMAH	2023	Legal enforcement mechanisms for building permits and occupancy
REDF lending guidelines	REDF ^e	2018–2024	Housing finance instruments, subsidy mechanisms, and affordability tools
SGI & quality of life program reports	Ministry of Environment/ VRC ^f	2020–2024	Environmental and wellbeing targets, urban greening, and quality-of-life indicators

^aCEDA, council of economic and development affairs.

^bMOMAH, ministry of municipalities and housing.

^cSBCNC, Saudi building code national committee.

^dNHC, national housing company.

^eREDF, real estate development fund.

^fVision Realization Center.

- Screening: Documents were screened against pre-defined eligibility criteria:
 - Inclusion Criteria: (i) Published between 2016 (launch of Vision 2030) and 2025; (ii) Issued by a national authority or key implementation entity; (iii) Directly addresses housing policy, sustainability regulations, urban governance, or project delivery/finance.
 - Exclusion Criteria: (i) Duplicate documents or earlier versions superseded by a finalized publication; (ii) Documents focusing solely on technical building specifications without governance context; (iii) Press releases or marketing materials lacking substantive policy content.
- Eligibility: 67 documents passed the initial screening.
- Inclusion: The final corpus of 42 documents was selected based on a final review for analytical depth and direct relevance to the research questions. The primary sources and types are summarized in Table 2. All included documents were then coded in NVivo 14 using an *a priori* codebook structured around the six governance factors, as well as the cross-cutting concepts of institutional voids and accountability traps described in Section 2.

3.1.2 Two-round Delphi expert survey

To capture the nuanced perspectives of key stakeholders, we conducted a two-round Delphi study. A purposive sample of 23 experts was selected to ensure representation across the core stakeholder groups in the Saudi housing ecosystem (see Table 3). While Delphi studies inherently involve consultation with ‘elite experts,’ our sampling strategy was explicitly designed to mitigate sectoral bias by incorporating a diverse range of perspectives from government, public and private developers, finance, academia, and

civil society. This diversity ensures that the synthesized consensus reflects a balanced, holistic view of the governance system rather than the bias of a single stakeholder group. All participants had at least 10 years of professional experience and direct working experience with Vision 2030 housing initiatives. Informed consent was obtained prior to participation. The Delphi procedure comprised two sequential rounds:

- Round 1 (Exploratory):

Experts responded to a set of open-ended questions designed to identify critical barriers, enablers, and necessary reforms in the governance system. The interview guide was explicitly organized around the six governance factors, allowing experts to comment on institutional integration, regulatory instruments, procurement and finance, technological and digital infrastructure, monitoring and transparency, and learning and capacity-building. The qualitative data from Round 1 were analyzed using a thematic analysis approach. Responses were coded using a codebook derived *a priori* from the UN-Habitat Urban Governance Index, the sustainable housing governance literature, and the six-factor analytical framework (Supplementary Appendix A). To ensure coding reliability, an inter-coder reliability check was performed on a 20% sample of responses, yielding a Cohen’s Kappa coefficient of $\kappa = 0.81$, indicating high agreement. Discrepancies were resolved through discussion until consensus was reached.

- Round 2 (Prioritization):

The emergent themes from Round 1 were synthesized into a structured questionnaire featuring the top 20 governance levers (Supplementary Appendix B). Each lever was mapped to one or

TABLE 3 Composition of the delphi expert panel.

Stakeholder group	Number of participants (n = 23)	Description
Government officials (MOMAH ^a , NHC ^b , municipalities)	8	Senior planners, policy advisors, and regulatory officials
Real estate developers (ROSHN, contractors)	5	Project managers, design leads, and sustainability officers
Financial & legal experts (REDF ^c , banks)	4	Housing finance specialists and legal advisors
Academic & research institutions	4	Professors and researchers in sustainability, smart cities, and housing governance
Independent consultants & NGOs	2	Sustainability, community development, and civil society advocates

^aMOMAH, ministry of municipalities and housing.

^bNHC, national housing company.

^cREDF, real estate development fund.

more of the six governance factors, enabling experts to prioritize reforms by their importance and feasibility across the enabling environment. Experts rated each lever on two five-point Likert scales (1 = Very Low, 5 = Very High) for importance and feasibility within the Saudi context. Consensus was measured using Kendall's Coefficient of Concordance (W), with an Interquartile Range (IQR) ≤ 1.0 on the Likert scales indicating high agreement among the panel.

The full Round 1 question guide and the precise wording of the Round 2 Likert-scale items (importance and feasibility) are summarized in [Supplementary Appendix C](#) to enhance transparency and replicability.

3.1.3 Structured comparative benchmarking

To contextualize Saudi Arabia's progress and identify transferable practices, a structured benchmarking analysis was performed against three international systems renowned for mainstreaming sustainability in social housing:

- Singapore: Green Mark framework.
- Abu Dhabi: Estidama Pearl Rating System.
- Qatar: Global Sustainability Assessment System.

Data for these case studies were obtained from academic literature, official government publications, and technical manuals. A systematic matrix analysis was performed using a standardized scoring system (0 = Absent, 1 = Partial, 2 = Comprehensive) to compare governance dimensions across the four systems. The benchmarking dimensions were designed to mirror the six governance factors, examining institutional integration, regulatory instruments, procurement and finance, technological and digital infrastructure, monitoring and verification, and equity and livability across the four systems. The resulting framework, shown in [Table 4](#), provides the foundation for comparative analysis and highlights key areas of convergence and divergence.

3.2 Data analysis and triangulation

The data from the three methods were analyzed both independently and collectively.

- Policy Documents: Coded data from NVivo 14 were analyzed using frequency and co-occurrence analyses to identify the most and least developed policy domains, with particular attention to how each of the six governance factors was addressed or left incomplete.
- Delphi Survey: Quantitative data from Round 2 were analyzed using descriptive statistics (mean, IQR) and Kendall's W to determine consensus. Qualitative themes from Round 1 provided rich context for the quantitative rankings and were interpreted to identify which governance factors experts perceived as most critical or most feasible to reform.
- Triangulation: Findings from all three streams were integrated in the Results and Discussion sections. For instance, a gap identified in the document analysis (e.g., lack of post-occupancy evaluation mandates) was cross-verified with expert opinions in the Delphi survey and contrasted with the best international practices from benchmarking. This triangulation was explicitly structured around the six-factor analytical framework, enabling the tracing of institutional voids and accountability traps systematically across policy documents, expert narratives, and international comparators. This triangulation strengthened the validity of the findings and provided a robust evidence base for the proposed governance model.

This triangulated design is appropriate for complex governance domains where experimental or large-N statistical designs are not feasible and where the primary aim is to build and refine an analytical model rather than to produce statistically generalizable estimates. In this study, the Delphi component is therefore used as one pillar of a broader evidence-based, complementary systematic policy analysis and structured international benchmarking—rather than as a stand-alone decision-making tool.

4 Results

The triangulated findings from the three research methods reveal a consistent and compelling narrative across the six governance factors: Saudi Arabia's social housing sector is characterized by advanced policy frameworks that are undermined by significant governance gaps during

TABLE 4 Framework for international benchmarking analysis.

Governance dimension	Singapore (Green mark)	Abu Dhabi (Estidama)	Qatar (GSAS)	Saudi Arabia (current)
Institutional integration	Unified housing and development authorities with clear mandates across the housing portfolio	Municipality–UPC coordination with clearly defined roles	GORD–MME partnership with explicit sustainability responsibilities	MOMAH–NHC–ROSHN fragmentation; overlapping mandates and limited integration
Regulatory instruments	Portfolio-level standards and building codes integrated with green mark requirements	Mandatory design tiers with pearl ratings embedded in approvals	District-level rating and project-level sustainability requirements	Building code (SBC 601) plus rating system (Mostadam) with partial enforcement
Finance alignment	Lifecycle costing and performance-linked finance mechanisms	Incentives and fee reductions for higher pearl levels	Green-bond pilots and incentives for certified projects	Subsidies and finance not systematically linked to operational performance
Monitoring & verification	Post-occupancy audits and estate-level performance reporting	Design-review verification and selective post-completion audits	District audits by GORD with periodic performance checks	Limited reporting; no systematic public KPI data or post-occupancy mandate checks
Equity & livability	Universal access, amenities, and social-mix policies	Accessibility and cultural inclusion integrated into guidelines	Comfort and safety criteria with attention to public realm	Emerging QoL indicators; equity and livability not consistently mainstreamed
Technological & digital infrastructure/Data governance	Advanced building-management systems, smart metering, and estate-level digital platforms used for continuous monitoring and optimization	Digital requirements for higher pearl tiers; Emirate-level data systems emerging for urban performance	District-level monitoring via GORD; growing use of digital platforms for performance reporting	Fragmented platforms (balady, Mostadam, NHC); limited integration of smart-building data and AI-enabled analytics at portfolio level

implementation. The results are structured to present the evidence from the document analysis, expert consensus, and international benchmarking explicitly in relation to these six factors, culminating in a synthesized analysis that directly informs the proposed governance model.

4.1 Policy and document analysis

The systematic analysis of 42 policy documents confirms a sophisticated yet fragmented institutional architecture for sustainable housing delivery. The policy intent is clear and ambitious, but two critical, interrelated issues weaken its operationalization across institutional integration and role clarity (Factor 1), procurement and finance alignment (Factor 3), technological and digital infrastructure (Factor 4), and monitoring, transparency, and accountability (Factor 5).

4.1.1 Institutional fragmentation and accountability gaps

The mapping of institutional roles established a clear policy-setting hierarchy with MOMAH at its apex. However, operational overlaps and ambiguous mandates between MOMAH's housing, municipal, and sustainability directorates were evident. A critical finding was the absence of a formal mandate for post-occupancy performance monitoring for both the National Housing Company (NHC) and ROSHN. This creates a fundamental accountability gap, treating sustainability as a design-and-construction compliance issue rather than a long-term performance outcome. Quantitative analysis underscored this gap: while 71% of documents contained explicit sustainability references, only 38% specified enforceable performance indicators, and a mere 15% mentioned any form of post-occupancy evaluation. Furthermore, none of the documents defined minimum

requirements for digital performance infrastructures, such as standardized smart meters, building management systems, or integrated housing-performance data platforms, thereby limiting the system's capacity to measure, verify, and attribute sustainability outcomes over time and reinforce the accountability trap described in [Section 2.2](#).

4.1.2 Misaligned financial and procurement mechanisms

The analysis of financial instruments and procurement templates revealed a systemic disconnect between funding and sustainability outcomes. NHC's Public-Private Partnership (PPP) frameworks were found to prioritize affordability and construction speed, with weak integration of sustainability criteria. Mostadam certification typically appeared as a "preferred" or "encouraged" criterion rather than a mandatory requirement with financial consequences. Furthermore, Real Estate Development Fund (REDF) subsidies and other funding mechanisms are predominantly front-loaded, focusing on capital expenditure (CAPEX) with no links to operational energy performance or lifecycle cost savings. Current templates also provide little explicit incentive for developers to invest in smart or AI-ready digital solutions, such as advanced building management systems or portfolio-level data platforms, despite their potential to reduce operational costs and improve performance.

4.2 Delphi expert findings

The two-round Delphi survey robustly validated the gaps identified in the document analysis. It yielded a prioritized list of interventions mapped to the six governance factors of the analytical framework.

4.2.1 Round 1: thematic analysis of barriers and enablers

The first Delphi round generated 184 coded statements across the six governance factors. Experts consistently identified the following primary barriers to implementation:

- Fragmented accountability across ministries and developers (83% of experts)
- Procurement misalignment—sustainability excluded from tender evaluation criteria (74%)
- Capacity constraints among municipal inspectors and developers (65%)
- Data fragmentation and lack of an integrated digital platform for housing performance (61%)

At the same time, experts pointed to several key enablers, including:

- Strong national commitment to Vision 2030 (91%)
- The existing regulatory baselines of Mostadam and SBC 601 (78%).
- Rapid advances in digital and AI-related initiatives at the national level (e.g., SDAIA) that could, if connected to housing, support smarter monitoring and optimization (52%).

One expert summarized the data challenge as follows: “*We cannot manage what we barely measure—performance data are scattered across Balady, Mostadam, NHC dashboards, and private systems, with no single source of truth for social housing portfolios.*” These insights reinforce the presence of institutional voids and accountability traps around monitoring, transparency, and technological and digital infrastructure.

4.2.2 Round 2: prioritization of governance interventions

The second round evaluated 20 governance levers for importance and feasibility, demonstrating strong consensus (Kendall’s $W = 0.71$; $p < 0.001$). Top-ranked levers (mean importance ≥ 4.5 , feasibility ≥ 4.0) directly target the procurement, finance, and data gaps identified in the document analysis (see Table 5). When grouped by the six governance factors, the highest-priority interventions clustered around procurement and finance alignment (Factor 3), technological and digital infrastructure (Factor 4), and monitoring, transparency, and accountability (Factor 5), confirming that experts see these as the most critical levers for reform.

Experts emphasized that policy coherence across MOMAH, NHC, and financial regulators is essential for implementation. One participant noted: “*Policies and codes are clear, but performance is no one’s measurable responsibility.*” Another expert highlighted the digital gap: “*We have smart-city visions and AI strategies at the national scale, but social housing projects still operate with fragmented, non-standardized data.*”

4.3 Comparative benchmarking and synthesized analysis

The structured benchmarking against Singapore, Abu Dhabi, and Qatar provided a clear mirror for Saudi Arabia’s governance

landscape, revealing both the scale of the gap and the viability of the solutions proposed by the Delphi panel. The comparison also demonstrated how mature systems integrate technological and digital infrastructures into their governance regimes, using data and digital tools as enablers of enforcement, transparency, and learning.

4.3.1 Identification of governance gaps through international comparison

As detailed in Table 6, comparative benchmarking reveals that Saudi Arabia’s current governance framework for sustainable social housing is only partially developed across most dimensions. Although regulatory instruments such as SBC 601 and Mostadam have strengthened sustainability standards, gaps persist in institutional integration, performance-based financing, and post-occupancy monitoring. Saudi Arabia scores strongly in policy formulation but weakly in the delivery stage of accountability. Regarding technological and digital infrastructure, the benchmarked systems all incorporate standardized digital tools, such as centralized databases, estate-level dashboards, and, increasingly, AI-assisted analytics. In contrast, Saudi Arabia’s limited reporting requirements and lack of public KPI data indicate that digital and AI-enabled capabilities are underutilized as governance levers.

In contrast, Singapore’s Green Mark and Abu Dhabi’s Estidama demonstrate comprehensive alignment among regulation, finance, and monitoring—ensuring lifecycle performance accountability. Fragmentation between MOMAH (policy), NHC (orchestration), and ROSHN (development) further limits feedback loops necessary for adaptive governance. Qatar’s GSAS, meanwhile, shows how public reporting and district-level audits can combine regulatory, financial, and digital instruments to support transparent and enforceable performance standards.

4.3.2 Direct mapping of Delphi levers to benchmarking gaps

The benchmarking exercise confirms that the top governance levers identified by Saudi experts are precisely aligned with proven international approaches to address the Kingdom’s specific deficits and to strengthen the six governance factors of the analytical framework:

- The top Delphi lever—mandatory, performance-linked procurement—directly addresses Saudi Arabia’s “Partial” score in Finance Alignment, mirroring the comprehensive, incentive-based models of Singapore and Abu Dhabi.
- The high priority placed on a unified data platform and public KPI dashboard (Levers 2 & 5) is a direct response to the “Partial” score in Monitoring & Verification. This aligns with Qatar’s GSAS public reporting and Singapore’s estate-level KPI publication, both of which use transparency as a driver of accountability.
- The call for mandatory post-occupancy evaluations (Lever 4) targets the accountability void identified in the document analysis. It would elevate Saudi Arabia from “Partial” to “Comprehensive” in Monitoring & Verification, following the Singaporean model.
- Delphi recommendations to embed smart meters, building management systems, and digital reporting requirements into

TABLE 5 Top governance levers ranked by the Delphi panel.

Rank	Governance lever	Mean importance	Mean feasibility	Consensus (IQR)	Notes on implementation locus
1	Make Mostadam gold mandatory in PPP tenders and link certification to payments	4.8	4.5	0.5	NHC procurement templates; MOMAH tender rules; link sustainability to financial flows
2	Build a unified housing-performance data platform (Balady–Mostadam–NHC)	4.7	4.3	0.7	Cross-agency data MoU; API integration; enables advanced analytics and potential AI-based anomaly detection
3	Introduce performance-linked finance (PLF) (green loans/sukuk tied to KPIs)	4.6	4.1	0.6	REDF & banks; MoF/SAMA guidance; ties financial instruments to verified performance
4	Make post-occupancy evaluation (POE) mandatory for all large projects	4.5	4.0	0.8	NHC/ROSHN operations manuals; municipal sign-offs; periodic performance verification
5	Cross-agency KPI dashboard with public reporting	4.5	4.0	0.7	MOMAH dashboard layer on balady supports transparent benchmarking and data-driven optimization
6	Municipal inspector training and certification (energy/IAQ/comfort)	4.3	4.2	0.6	Mostadam center & MOMAH academy; upgrading field-level enforcement capacity
7	Public disclosure of developer performance (rating level, EUI, IAQ)	4.2	3.8	0.9	Annual sustainability reports; balady cards; reputational incentives
8	Green-finance partnership program with commercial banks	4.1	3.9	1.0	Preferential rates for certified homes; mainstreaming green mortgages
9	Lifecycle-costing clauses in contracts (CAPEX–OPEX–carbon)	4.1	3.8	0.9	Standard annex in PPP/EPC contracts; supports long-term performance thinking
10	Incentivized O&M compliance (bonuses/LDs tied to KPIs)	4.0	3.7	0.9	FM contracts; NHC/ROSHN portfolio policy; linking O&M to measurable outcomes

The top 10 governance levers are presented in this Table. A full list of 20 levers, including additional interventions discussed in the Delphi panel and S-CSHGM, model, is available in [Supplementary Appendix B](#).

TABLE 6 Comparative benchmarking of governance dimensions for sustainable social housing.

Governance dimension	Singapore (Green mark)	Abu Dhabi (Estidama)	Qatar (GSAS)	Saudi Arabia (current)
Institutional integration	Comprehensive (2) Unified housing authority	Comprehensive (2) Municipality-UPC coordination	Partial (1) GORD-MME partnership	Partial (1) MOMAH-NHC-ROSHN fragmentation
Regulatory instruments	Comprehensive (2) Portfolio-level standards	Comprehensive (2) Mandatory design tiers	Comprehensive (2) Mandatory for government projects	Partial (1) Code + rating (partial enforcement)
Finance alignment	Comprehensive (2) Lifecycle costing and performance-linked finance	Comprehensive (2) Incentives for higher pearl levels	Partial (1) Limited green-finance integration	Partial (1) Subsidies not performance-linked
Monitoring, transparency, and accountability	Comprehensive (2) Post-occupancy audits	Partial (1) Design-review verification	Partial (1) District audits by GORD	Partial (1) Limited reporting (no public KPI data)
Equity & livability	Comprehensive (2) Universal access and amenities	Comprehensive (2) Accessibility and cultural inclusion	Partial (1) Comfort and safety KPIs	Partial (1) Emerging QoL indicators
Technological & digital infrastructure/Data governance	Comprehensive (2) Smart metering, BMS, and estate-level digital platforms for continuous monitoring and optimization	Comprehensive (2) Strong digital requirements for higher pearl levels; Emirate-level data systems emerging	Partial (1) District-level monitoring via GORD; digital tools growing but not universal	Partial (1) Fragmented housing-related platforms; limited integration of digital/AI tools for lifecycle performance

Scoring: 0 = Absent, 1 = Partial, 2 = Comprehensive.

procurement contracts directly respond to Saudi Arabia's weak performance on technological and digital infrastructure (Factor 4), bringing it closer to the digitally integrated governance regimes observed in the benchmarked systems.

This synthesized analysis demonstrates that the expert-derived solutions are not novel concepts but are, in fact, validated governance mechanisms that have been successfully operationalized in comparable contexts. By viewing these mechanisms through the lens of the six governance factors, the analysis clarifies how institutional voids and accountability traps can be systematically addressed through procurement and finance alignment, digital and AI-ready infrastructure, and strengthened monitoring and transparency. This triangulation of evidence provides a robust foundation for the governance model proposed in the subsequent discussion.

5 Discussion

This study represents the first comprehensive analysis of the governance mechanisms shaping sustainable social housing delivery in Saudi Arabia. By triangulating policy documentation, expert consensus, and international benchmarking, our findings reveal a critical paradox: the Kingdom has established one of the most advanced regulatory frameworks for sustainable housing in the Gulf region. Nevertheless, its implementation is hampered by fundamental governance disconnects that threaten to undermine Vision 2030's sustainability objectives. Interpreted through the six governance factors of our analytical framework, the results show that institutional voids and accountability traps remain deeply embedded in the delivery system.

Beyond identifying governance deficits, the discussion deliberately shifts from diagnosis to prescription. Drawing on the six-factor analytical framework and triangulated evidence, it develops the Saudi Climate-Smart Social Housing Governance Model (S-CSHGM)—an operational blueprint for reform—and a phased implementation roadmap designed to provide concrete, actionable guidance for policymakers and implementing agencies.

5.1 Clarifying the diagnostic framework and the operational model

A key distinction underpins this study: the difference between the diagnostic analytical framework and the prescriptive governance model. The six-factor framework (Section 2.3) served as our analytical lens to systematically *diagnose* gaps across institutional, regulatory, financial, digital, accountability, and learning dimensions. In contrast, the S-CSHGM is an operational governance model. It is a prescriptive, integrated blueprint that specifies the concrete pillars, actors, mechanisms, and feedback loops required to *reconfigure* the system. While the framework identifies *what* is broken, the model proposes *how* to fix it, translating diagnostic findings into a structured template for policy design and implementation.

Conceptually, the S-CSHGM integrates and tailors broader governance theories to the specific context of state-led housing

delivery. It operationalizes the concept of polycentric governance by designing specific coordination bodies (e.g., the National Housing Sustainability Council) and data flows to manage multi-actor complexity. It moves beyond generic performance-based regulation by bundling performance mandates with performance-linked *finance* and performance-based *data transparency*, creating a mutually reinforcing incentive system explicitly designed to overcome the identified accountability trap. Its distinctive contribution lies in its holistic architecture and its treatment of Technological and Digital Infrastructure as a core governance pillar, making it an AI-ready model for climate-smart implementation.

5.2 The implementation gap: regulatory sophistication vs. governance fragmentation

The analysis of the documents reveals a significant discrepancy between policy objectives and institutional capacity, a common manifestation of what institutional scholars identify as “institutional voids” – gaps in the governing rules that impede the effective implementation of policies. Saudi Arabia's regulatory framework, primarily founded on Mostadam and SBC 601, demonstrates substantial technical sophistication. However, this regulatory progress has not been matched by parallel developments in governance structures.

The core problem is the misalignment between broad sustainability mandates and narrow, weakly enforced accountability mechanisms. While MOMAH establishes ambitious policies, neither NHC nor ROSHN has formal accountability for post-occupancy performance, leading to what governance experts call the “accountability trap”. This explains why sustainability compliance peaks during design and construction but dissipates during operations—the institutional incentives are structured around delivery milestones rather than lifecycle performance. The finding that only 38% of policy documents specify enforceable performance indicators underscores this systemic gap between aspiration and enforcement, reflecting a governance system that prioritizes output (units built) over outcome (sustainable communities). Viewed through the six-factor framework, this gap is most visible in weak institutional integration and role clarity (Factor 1) and underdeveloped monitoring, transparency, and accountability mechanisms (Factor 5), which together prevent the regulatory instruments (Factor 2) from translating into verifiable performance at scale.

5.3 The potency of financial and procurement levers

The Delphi results provide strong empirical evidence that financial and procurement mechanisms represent the most potent—and feasible—intervention points for systemic reform. The expert consensus around performance-linked procurement aligns with transaction cost economics, which emphasizes how contractual arrangements can shape organizational behavior. Currently, the dissociation between financial flows and sustainability outcomes creates a form of “moral hazard”—developers bear no financial consequences for long-term underperformance.

The proposed integration of Mostadam certification into PPP payment milestones represents a fundamental shift from input-based to outcome-based contracting. This approach has proven transformative in Singapore's Green Mark model, where performance-linked contracts have driven continuous innovation. Similarly, the recommendation for green mortgage products applies behavioral economics principles to create market-driven demand for sustainability, effectively leveraging REDF's substantial financial influence to reshape both supply and demand dynamics.

When interpreted as reforms to the "Procurement and Finance Alignment" (Factor 3), these measures directly address the institutional voids identified in Section 4.1.2 by linking public support and revenue flows to lifecycle performance rather than to delivery speed alone. Moreover, performance-linked contracts can be designed to require not only compliance with energy and water benchmarks, but also the deployment of smart meters, building management systems, and digital reporting tools, thereby creating a bridge to technological and digital infrastructure (Factor 4).

5.4 The foundational role of data governance

The high priority given to unified data platforms and public KPI dashboards (Delphi Levers 2 and 5) highlights the importance of information transparency in modern governance. Current data silos between the Balady, Mostadam, and NHC platforms represent "digital fragmentation"—a situation where technological tools exist but are disconnected from governance processes. In terms of the analytical framework, this fragmentation weakens both the "Technological and Digital Infrastructure" factor (Factor 4) and the "Monitoring, Transparency, and Accountability" factor (Factor 5), limiting the system's capacity to detect underperformance, attribute responsibility, and learn over time.

The proposed integrated dashboard would serve multiple functions: an accountability mechanism through public disclosure, a performance management tool for agencies, and a feedback loop for continuous policy improvement. International experience from Qatar's GSAS public reporting demonstrates how transparency can create "reputational markets" that incentivize developers to exceed minimum standards. Furthermore, systematic performance data collection is a prerequisite for evidence-based policy refinement, addressing the current reliance on anecdotal evidence.

Crucially, standardized digital data streams also create necessary preconditions for using AI-enabled analytics—such as anomaly detection, predictive maintenance, and portfolio-level optimization in smart buildings—which recent studies show can significantly reduce energy use while maintaining comfort. In this sense, AI and digital technologies do not simply add technical efficiency; they operate as governance tools that enlarge the informational base on which accountability and adaptive learning depend, directly strengthen Factors 4 and 5, and connect housing governance to the broader Vision 2030 and SDAIA-led digital transformation agenda.

5.5 The S-CSHGM: toward an integrated governance framework

Building on these empirical findings, we propose the Saudi Climate-Smart Social Housing Governance Model (S-CSHGM) (Figure 1). This framework is predicated on the understanding that sustainable outcomes emerge from a coherent governance ecosystem that connects policy, finance, data, and learning within a continuous feedback loop. The model operationalizes the six governance factors identified in the analytical framework by clustering them into four interdependent pillars that together address the institutional voids and accountability traps revealed in the results. Each of these four pillars is translated into specific institutional reforms, contractual mechanisms, digital platforms, and capacity-building initiatives, and is sequenced in the implementation roadmap in Table 8. Together, they move the analysis from identifying gaps to outlining a realistic, time-bound pathway for climate-smart, AI-ready implementation.

1. Institutional Integration and Role Clarity - addressing governance fragmentation
2. Performance-Linked Procurement and Finance - aligning incentives with outcomes
3. Data-Driven Monitoring and Transparency - enabling evidence-based decision-making
4. Adaptive Learning and Capacity Building - ensuring continuous improvement

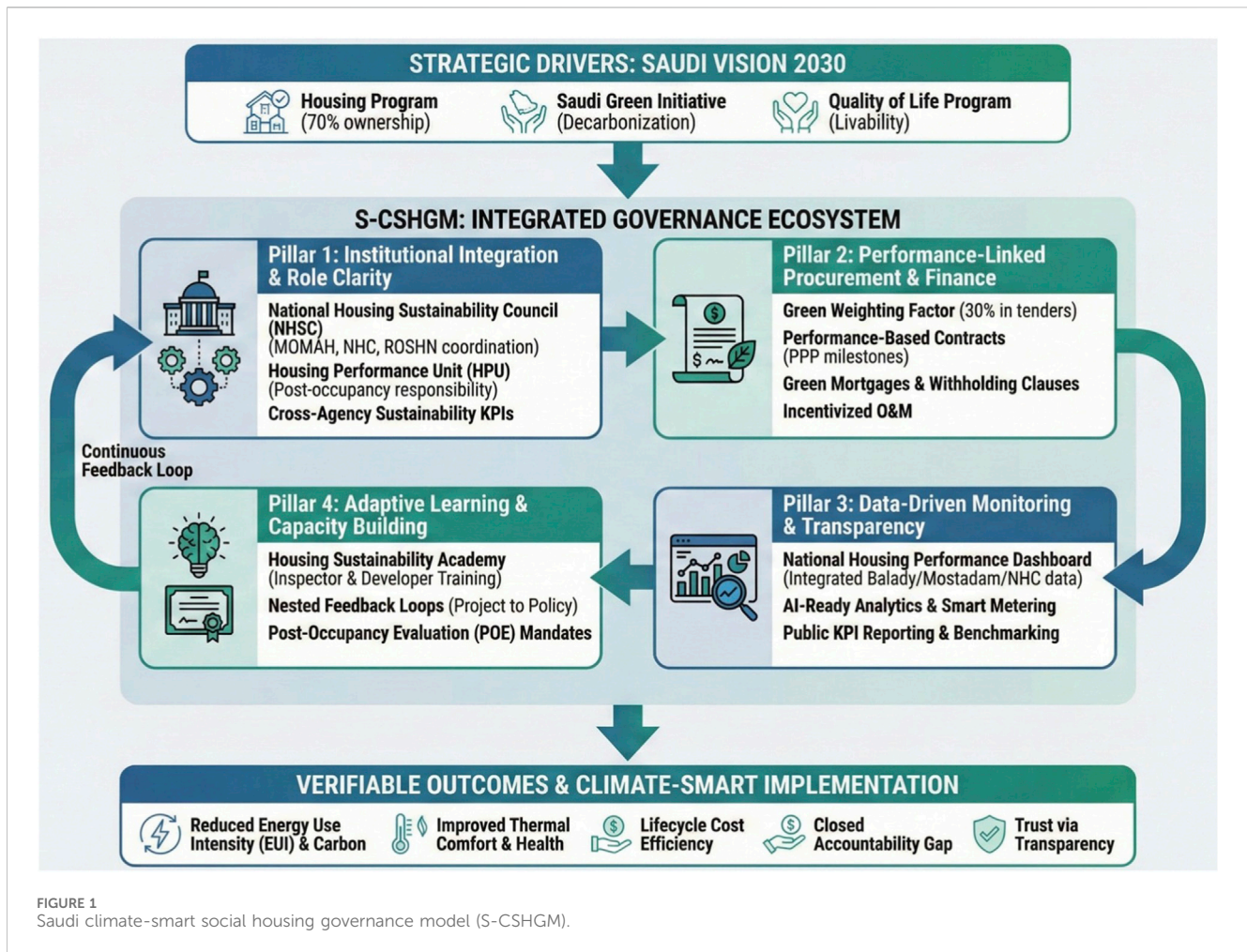
5.5.1 Pillar 1: institutional integration and role clarity

A permanent National Housing Sustainability Council (NHSC) is proposed under MOMAH, bringing together representatives from the National Housing Company (NHC), ROSHN, REDF, Mostadam Center, Saudi Building Code National Committee (SBCNC), and key municipalities.

Its core mandate would be to:

- Define cross-agency sustainability KPIs for all government-supported housing projects.
- Assign clear post-occupancy performance responsibilities.
- Harmonize regulatory updates (e.g., synchronizing *Mostadam* and SBC energy chapters).

An operational Housing Performance Unit (HPU) within NHC should manage project-level sustainability data, collect post-occupancy metrics, and coordinate independent audits every 2 years. The HPU would act as Saudi Arabia's equivalent to Singapore's Green Mark Building Performance Division, ensuring continuous data feedback to policymakers. In terms of the six-factor framework, Pillar 1 directly strengthens "Institutional Integration and Role Clarity" (Factor 1), while also providing an organizational home for monitoring and learning functions (Factors 5 and 6), thereby reducing the accountability traps that currently diffuse responsibility for long-term performance.



5.5.2 Pillar 2: performance-linked procurement and finance

The model introduces transformative procurement mechanisms:

- **Green Weighting Factor:** Mandatory allocation of 30% tender evaluation weight to sustainability criteria, including Mostadam certification levels, material durability, and lifecycle cost analysis.
- **Performance-Based Contracts:** Requirement for all PPP and ROSHN agreements to specify measurable thresholds for energy use intensity (EUI), water efficiency, and indoor air quality as payment milestones.
- **Progressive Certification Standards:** Mandate that all government-funded housing achieve Mostadam Silver upon completion and target Gold certification within 3 years of operation.

Strategic financial reforms include:

- **Green Mortgage Products:** Expansion of REDF and banking partners' lending criteria to include preferential rates and terms for Mostadam-certified homes.

- **Performance-Linked Finance (PLF):** Structural withholding of 15%–20% of developer payments pending verification of operational performance against energy and comfort KPIs.
- **Sustainable Investment Vehicles:** Enablement of green bonds and sukuk issuance for large-scale projects, explicitly tied to transparent sustainability reporting and verification.

Collectively, these measures turn “Procurement and Finance Alignment” (Factor 3) into a central lever for climate-smart social housing, while creating strong incentives for developers to invest in the digital and technological infrastructures (Factor 4) needed to demonstrate and maintain performance over time.

5.5.3 Pillar 3: data-driven monitoring and transparency

The model proposes a National Housing Performance Dashboard that integrates Balady, Mostadam, and NHC databases with the following capabilities:

- Unified reporting of energy, water, thermal comfort, affordability, and maintenance indicators
- Role-based access protocols for ministries, developers, and public stakeholders

TABLE 7 Key performance indicators framework for climate-smart social housing.

Domain	Indicator	Metric/Unit	Data source	Reporting frequency	Responsible entity
Energy efficiency	Energy use intensity (EUI)	kWh/m ² /year	Smart meters	Annual	Developer/HPU ^a
Thermal comfort	Mean outdoor UTCI	°C	On-site sensors/ ENVI-met	Seasonal	Municipality
Water efficiency	Water use per dwelling	L/person/day	Smart meters	Annual	Developer
Indoor air quality	CO ₂ and PM _{2.5} compliance	ppm/μg/m ³	IAQ sensors	Quarterly	Facility manager
Affordability	Monthly housing cost ratio	% of income	Survey/REDF	Annual	NHC/REDF ^b
Public space quality	Green area <i>per capita</i>	m ² /person	GIS/ROSHN	Annual	MOMAH
Maintenance	Preventive O&M compliance	% Tasks on schedule	HPU database	Quarterly	Operator/HPU
Resident satisfaction	Quality of life score	Composite index (1–5)	Online survey	Annual	Municipality/NHC
Technological & digital infrastructure	Smart-meter and sensor coverage; integration of digital platforms	% of dwellings with smart meters and IAQ/temperature sensors; % of projects with integrated BMS/performance platforms	Utility data, developer reports, platform logs	Annual	Developer/HPU/ MOMAH

^aHPU, housing performance unit (within NHC).

^bREDF, real estate development fund.

- API connectivity with Saudi Green Initiative databases for comprehensive carbon accounting
- Real-time performance analytics and benchmarking capabilities

The framework establishes a comprehensive KPI suite to ensure comparability and enforcement across eight critical domains, as detailed in Table 7. Public dissemination of these metrics via the dashboard will enhance transparency, build community trust, and directly support the Quality of Life Program's objectives. This pillar operationalizes the "Technological and Digital Infrastructure" (Factor 4) alongside "Monitoring, Transparency, and Accountability" (Factor 5), positioning digital tools and AI-ready data streams as core components of the enabling environment rather than optional technical add-ons.

5.5.4 Pillar 4: adaptive learning and capacity building

The model institutionalizes learning through three nested feedback loops:

- Project Level: Post-occupancy evaluations directly inform design guidelines and specification updates.
- Institutional Level: Annual cross-agency reviews under NHSC oversight refine KPIs and procurement templates based on performance data.
- Strategic Level: Academic-professional partnerships analyze dashboard analytics, publish performance reviews, and develop evidence-based policy recommendations.

A national Housing Sustainability Academy under the Mostadam Center would deliver specialized certification programs for:

- Municipal inspectors and engineers on energy performance verification and comfort standards.

- Developers and contractors on lifecycle costing, material durability, and sustainable construction practices.
- Facility managers on preventive maintenance protocols and indoor environmental quality management.

Pillar 4, therefore, embodies the "Learning and Capacity-Building" (Factor 6), creating structured pathways for translating digital performance insights, post-occupancy evidence, and international experience into updated regulations, contracts, and professional skills—an essential condition for future-proofing social housing ecosystems in a rapidly evolving technological and climatic context.

5.6 Implementation roadmap and transition strategy

While the S-CSHGM provides a coherent roadmap, its implementation faces significant, non-trivial barriers that must be acknowledged and managed:

- Political and Bureaucratic Inertia: The proposed NHSC would require unprecedented cross-ministerial cooperation. Overcoming entrenched silos and competing mandates will require sustained high-level political sponsorship, likely from the Council of Economic and Development Affairs (CEDA).
- Data Governance Challenges: The unified data platform raises practical concerns about data ownership, standardization, and interoperability between legacy systems. A clear data governance framework that defines roles and protocols must precede technical integration. Early implementation phases will therefore need to focus on pilot projects that align data standards, demonstrate the value of integrated dashboards, and test AI-based analytics in selected social housing developments before wider roll-out.
- Financial and Market Resistance: Withholding 15%–20% of developer payments pending performance verification is an

TABLE 8 S-CSHGM implementation roadmap.

Phase	Timeframe	Key actions	Expected outputs
Phase 1: institutional foundation	2025–2026	Establish NHSC and HPU; formalize mandates via ministerial decree; define cross-agency sustainability KPIs and reporting lines	Governance charter; data-sharing protocols; clear post-occupancy performance responsibilities; KPI specification
Phase 2: digital integration	2026–2027	Integrate balady, Mostadam, and NHC portals into a unified housing-performance dashboard; standardize data formats and APIs; prepare infrastructure for advanced analytics and AI-supported monitoring	Live KPI data feeds; automated reporting systems; role-based access; technical basis for AI-enabled anomaly detection and optimization
Phase 3: procurement & finance activation	2027–2028	Implement performance-linked finance (PLF) clauses; revise PPP frameworks to embed Mostadam-linked milestones; launch green mortgage pilots	Performance-linked tender templates; green financing products; incentive structures aligned with verified performance
Phase 4: full operationalization	2028 onward	Publish annual housing sustainability report; scale inspector and facility-manager training; continuously refine standards and KPIs using performance data and AI-supported insights	National transparency system; mature professional certification ecosystem; continuous improvement mechanisms; data-informed and AI-supported performance management

aggressive lever. While effective, it could deter market participation, particularly from smaller and medium-sized enterprises. A phased approach, starting with a lower percentage and more precise support mechanisms, may be necessary to build market capacity and acceptance.

To address these challenges pragmatically, Table 8 sets out a phased implementation roadmap (2025–2028 and beyond) that moves from institutional foundation (Phase 1), through digital integration and dashboard prototyping (Phase 2), to activation of performance-linked procurement and finance (Phase 3) and full operationalization with annual reporting and continuous learning (Phase 4). Each phase is designed to tackle specific barriers: Phase 1 focuses on creating the NHSC, HPU, and cross-agency KPIs; Phase 2 on resolving data-governance and interoperability issues through pilots; Phase 3 on gradually embedding PLF clauses and green mortgage products; and Phase 4 on scaling up training, audits, and public transparency. This sequenced approach mirrors the logic of polycentric governance by strengthening multiple centers of decision-making and accountability over time, rather than relying on a single, one-off reform. In doing so, it mirrors the logic of “polycentric governance,” gradually strengthening multiple centers of decision-making and accountability rather than relying on a single top-down directive.

5.7 Theoretical contributions and research implications

This study makes specific and substantive contributions to the scholarly literature on housing and urban governance in the Gulf Cooperation Council (GCC) states. While existing GCC research has valuably mapped policy trajectories, institutional arrangements, and the technical aspects of rating systems, it has not previously operationalized institutional theory and the accountability trap into a measurable, multi-factor governance model for the housing sector. By diagnosing gaps across six interlinked dimensions and proposing the integrated S-CSHGM, this research provides a novel, holistic lens to understand the ‘implementation gap’ common in state-led, rapid-development contexts. Furthermore, by centralizing digital

infrastructure and AI-readiness within its governance model—connecting it directly to national strategies like Saudi Arabia’s National Strategy for Data and AI—the study addresses a critical omission in regional literature, which has largely overlooked the governance implications of digital transformation for sustainable housing outcomes. Thus, the study shifts the analytical focus from assessing isolated policy instruments to designing connected governance ecosystems capable of delivering verifiable performance.

Beyond its regional contributions, this study advances governance theory and housing scholarship more broadly. First, it extends the concept of the “implementation gap” from a technical challenge to a governance system failure, demonstrating how institutional misalignments can persist even amidst regulatory sophistication. By operationalizing institutional voids and accountability traps through six concrete governance factors, the study shows how abstract institutional concepts can be translated into diagnosable weaknesses and actionable reform levers in a specific sectoral context. Second, it provides a rare empirical analysis of housing governance in the Gulf context, challenging the presumption that strong state capacity automatically ensures policy implementation. Third, the study advances debates on digital transformation and AI in the built environment by framing technological and digital infrastructure as a governance factor rather than a purely technical domain. AI-enabled smart-building systems, digital twins, and integrated dashboards are conceptualized here as instruments that expand what can be known, measured, and governed in social housing portfolios, thereby reinforcing accountability and adaptive learning rather than simply improving operational efficiency.

The research further illuminates the limitations of top-down policy approaches in complex multi-stakeholder environments. The findings advocate that the provision of sustainable housing necessitates polycentric governance arrangements—a framework comprising multiple, formally independent yet functionally interdependent centers of decision-making, which the S-CSHGM aims to coordinate. Future research should explore several pathways emerging from this study. Longitudinal analysis could track the implementation of the S-CSHGM framework to identify adaptation patterns. Comparative studies could examine governance transitions in other GCC countries to identify regional patterns. Quantitative

research could model the economic impacts of performance-linked financing, while ethnographic studies could examine how frontline bureaucrats interpret and implement these new sustainability mandates. Further work could also investigate how AI-enabled tools, such as predictive maintenance algorithms or occupant-centric comfort optimization, are integrated into governance arrangements and how they reshape professional practices, resident experiences, and the politics of accountability in climate-smart social housing.

5.8 Methodological limitations

As a qualitative, governance-oriented study, this research design has several methodological limitations that shape how the findings should be interpreted. First, the Delphi component, while employing a diverse, purposively sampled panel, is subject to the inherent limitations of elite-expert consultation. This method intentionally engages senior, influential stakeholders, whose perspectives—though essential for understanding high-level policy and implementation barriers—may not fully capture ground-level operational challenges or citizen experiences. The consensus reflects the synthesized judgments of these informed professionals. Although the panel's composition across five key sectors (government, development, finance, academia, civil society) was designed to mitigate sectoral bias and provide a holistic view, the results cannot be statistically generalized to the wider population. Consequently, the Delphi findings should be understood as a structured synthesis of prioritized professional judgment, which was subsequently triangulated with documentary analysis and international benchmarking to strengthen validity.

Second, Delphi-based consensus is inherently subjective. Expert views may be influenced by individual professional backgrounds, institutional affiliations, and sectoral interests. An alternative panel with a different composition might have prioritized certain governance levers differently. The prioritized levers presented here therefore represent a strong, empirically derived indication of reform priorities for the current stakeholder ecosystem, but not a definitive or exclusive ranking.

Third, the benchmarking analysis draws on secondary data from official publications and technical manuals. While these sources are authoritative, they may not fully capture informal practices, implementation nuances, or very recent, unpublished reforms in the comparator systems. Furthermore, the simplified 0–2 scoring system is intended as a comparative heuristic to highlight relative strengths and gaps, rather than as a detailed, weighted performance rating.

Taken together, these limitations affirm that the proposed S-CSHGM should be treated as a theory-informed and empirically grounded framework for guiding governance reform. Its assumptions and proposed instruments constitute a robust starting point for policy redesign but will require iterative testing, adaptation, and further validation in practice.

6 Conclusion

This study offers a comprehensive examination of the governance infrastructure shaping sustainable social housing

delivery in Saudi Arabia, using an analytical framework built around six governance factors: institutional integration and role clarity; regulatory instruments and standards; procurement and finance alignment; technological and digital infrastructure; monitoring, transparency, and accountability; and learning and capacity-building. Applying this framework to policy documents, expert insights, and international benchmarks reveal that, despite an advanced regulatory toolkit, translating policy intent into measurable sustainability outcomes is constrained by institutional voids and accountability traps across these six dimensions.

The empirical analysis shows that sustainability is strongly encoded in formal instruments such as Mostadam and SBC 601. Yet, responsibilities for post-occupancy and digital performance remain diffuse, procurement and finance mechanisms are only weakly linked to lifecycle outcomes, and fragmented data systems limit systematic monitoring and enforcement. These findings informed the design of the Saudi Climate-Smart Social Housing Governance Model (S-CSHGM), a four-pillar framework that realigns roles, incentives, digital tools, and feedback mechanisms along the housing delivery chain.

From a policy perspective, the results underline that governance reform—not only the introduction of new standards or technologies—is essential if Vision 2030 housing investments are to deliver verifiable energy, comfort, and quality-of-life benefits. Strengthening institutional integration and role clarity, embedding performance-linked procurement and finance, investing in integrated digital and data infrastructures, and institutionalizing learning and capacity-building emerge as practical priorities for MOMAH, NHC, ROSHN, REDE, and municipal actors.

Future work should build on these findings by testing and refining the S-CSHGM in other Vision 2030 sectors (such as transport, utilities, and new master-planned communities) and in other Gulf Cooperation Council contexts with similar state-led housing systems. Further research is also needed to examine how AI-enabled tools—such as predictive maintenance, smart building controls, and portfolio-level optimization—are embedded within governance arrangements and how they reshape professional practice, resident experience, and accountability dynamics in climate-smart social housing.

By institutionalizing learning, transparency, role clarity, and digitally enabled performance management, Saudi Arabia can not only close the implementation gap in social housing but also position itself as a regional leader in climate-smart, data-informed urban governance, providing an AI-ready, data-driven governance model that directly improves the performance and resilience of the built environment.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary Material](#), further inquiries can be directed to the corresponding author.

Author contributions

SB: Writing – original draft, Formal Analysis, Project administration, Resources, Supervision, Conceptualization,

Methodology, Writing – review and editing, Data curation, Investigation, Validation.

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Generative AI statement

The author(s) declared that generative AI was used in the creation of this manuscript. In language editing and proofreading.

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