Harnessing Smart Technologies in Real Estate: A New Paradigm for Spatial Planning and Urban Development

Tarek Al-Rimawi*, Michael Nadler
Affiliation: Chair Real Estate Development, Faculty of Spatial Planning, Technical University Dortmund, August-Schmidt-Street 6, 44227 Dortmund, Germany
Email: tarek.al-rimawi@tu-dortmund.de

Abstract
This paper presents a dual-tool system to support the assessment and development of smart cities and smart real estate. The first tool is a comprehensive evaluation framework that independently and jointly measures the smartness of urban systems and real estate projects across seven strategic categories. The second is a smart technology utilization map that identifies the added value of specific technologies across different phases of the real estate lifecycle—from land acquisition to post-operation. Together, these tools enable stakeholders—such as city authorities, developers, and investors—to identify performance gaps, prioritize improvements, and plan smarter, more integrated developments. The study also outlines the role of public and private actors in enabling smart infrastructure and encourages coordinated, data-driven decision-making to advance urban sustainability, efficiency, and resilience.

Keywords smart city, smart real estate, smart technologies, urban planning

1. Introduction

Urbanization is accelerating faster than ever before, with the United Nations estimating that 68% of the global population will be living in cities by 2050 (UN-Habitat, 2022). This trend puts significant pressure on urban infrastructure, urban governance, and real estate markets.

Simultaneously, smart technologies (for example, the Internet of Things (IoT), artificial intelligence (AI), and geographic information systems (GIS)) are altering urban systems, and cities are beginning to adopt these technologies to respond to these pressures (Batty *et al*., 2012; Ahmed *et al*., 2017).

Real estate development, as a fundamental urban development component, provides a major opportunity for technological convergence. However, at present existing models do not provide a reliable framework to identify smart technology interventions through the real estate development space. Most smart city (SC) models also do not appropriately integrate real estate or treat it as a small part of the overall model (Albino, Berardi and Dangelico, 2015; Allam and Newman, 2018) Therefore, there is a need for a hierarchy system that assesses the smartness of developments, identifies the smartness gap, and matches the better innovation and technology intervention to the necessary development stages.

This paper will help fill that gap by offering a practical roadmap for stakeholders (i.e. municipalities, real estate developers, investors, and decision-makers) to determine and improve the assessment of SC systems and smart real estate (SRE) development. The paper proposes two primary tool components that stakeholders can utilize or adjust to their urban and project contexts:

1. An Evaluation Framework: This assessment instrument compares and evaluates the level of 'smartness' of both city and real estate levels, provides a diagnosis for current inadequacies, and identifies objectives for governance, infrastructure, people, environment, building, and technology, and identifies the gaps in each level (Al-Rimawi and Nadler, 2023).
2. A Smart Technology Utilization Map: This component identifies the added value of smart technologies along the real estate life cycle and identifies when and where to use technologies. Utilizing recent integrative reviews (Al-Rimawi and Nadler, 2025)It identifies which technologies, such as GIS, BIM, AI, IoT, VR/AR, and digital twins, are most impactful during specific phases of the real estate life cycle, from land development, development, operation, and redevelopment.

These tools provide strategic purpose and meaningful insights both across and up and down the hierarchy. The framework supplies coordinated planning and a policy context, while the technology map indicates investments that can be made in smart systems that drive more operational efficiency, sustainability, and value over time. The study addresses this need for collaborative integration rather than fragmentation and contributes to a stream of research recognizing the importance of collaboration across sectors and interoperable planning processes. While no case studies are present, illustrative examples are provided to demonstrate how these tools can be applied in practice.

2.Theoretical Foundations and Literature Review

2.1 Defining Smart Cities and Smart Real Estate

The concept of the SC has been developing since the early 1990s, starting the knowledge-based city, which emphasized the importance of knowledge-based urban development (Šiurytė, 2015). Among the key hindrances to both the development and actualization of the SC concept is the lack of a shared definition. This lack results in definitional ambiguity, which weakens conceptual clarity for smart cities and could jeopardize their practical value. The variation in definitions is due to the fact that the SC is an interdisciplinary concept with several fields such as urban planning, information technology, environmental sustainability, and real estate being involved. Scholars and practitioners thus define SC based on their respective areas of specialization.

In response to this challenge, Al-Rimawi and Nadler (2025) propose a comprehensive and inclusive definition that that captures the key dimensions of smart cities and brings together the key elements of SC. Where it is the city that utilizes smart technologies to render its interlinked sectors and essential elements, including city administration, citizens, energy, infrastructure, property, technologies, information, and nature more intelligent, sustainable, integrated, and efficient. This perspective positions smartness as a two-pronged change—technological and strategic—with profound consequences for governance, infrastructure, and the quality of urban life. To avoid what could be termed smart washing—the superficial or misleading application of the term—the SC must move beyond definitions. It must become a tangible and measurable reality, grounded in practical implementations, data-driven evaluation, and meaningful impact across its various systems and stakeholders.

SRE is a similar but distinct concept. It refers to the integration of smart technologies into the property development, operation, and management sectors in order to achieve operational efficiency, user-centered functionality, and sustainable performance throughout the real estate life cycle. In contrast to smart buildings, which focus primarily on building automation and system efficiency (e.g., HVAC, lighting, security) smart real estate permeates the whole property life cycle. These include the land development stage, project development, operational stage, and post-operation activities (Ullah, Sepasgozar and Wang, 2018; Al-Rimawi and Nadler, 2025). In each phase, decision-making, design optimization, predictive maintenance, and user engagement are facilitated by technologies such as IoT, GIS, AI, and big data analytics (Yigitcanlar, 2021; Al-Rimawi and Nadler, 2025).

SRE cannot be an isolated category; rather, it is inherently integrated into the framework of the SC. The interaction between the built environment and urban infrastructure—such as energy networks, transportation systems, and information platforms—allows a synergistic interaction. SRE initiatives are part of essential elements producing and reacting to information at the city level, assuming their position in reinforcing urban efficiency and sustainability goals (Albino, Berardi and Dangelico, 2015; Apanaviciene and Shahrabani, 2023). This integration underscores the need for comprehensive frameworks that evaluate smartness across both scales—urban and real estate—ensuring coordinated innovation, data interoperability, and systemic impact.

2.2 Smart Cities and Smart Real Estate Integration

Integrating SRE within smart cities is critical to the success of efficient, resilient, and sustainable urban systems. SRE, especially smart buildings, constitutes a fundamental element of the overall urban infrastructure, facilitating contributions toward energy management, automation, and adaptive technologies (Al-rimawi and Nadler, 2023). Successful integration, however, requires an integrated approach at three levels: physical (e.g., accessibility to urban infrastructure and utilities), data (interoperable platforms for real-time exchange), and functional (integration with urban goals like energy efficiency and well-being of the citizens) (Apanaviciene and Shahrabani, 2023).

Strategies for SRE integration differ according to technological capability and developer goals. Al-Rimawi and Nadler (2023) discern three principal strategies: leading, in which RE establishes the standard for nearby smart developments; following, in which RE conforms to existing smart standards; and waiting, whereby selective and piecemeal introduction of isolated smart features is undertaken without strategic planning. Every strategy demonstrates disparities in smartness levels and likely influence, underlining the necessity for diligent coordination between real estate developments and city-wide systems. Ultimately, proper integration allows for mutual gains—maximized utilization of resources, improved urban development, and augmented environmental and social returns cementing the position of renewable energy as a core facilitator in SC frameworks.

2.3 Smart Technologies

Smart technologies are the enabling infrastructure, or foundation, for both smart cities and SRE, enabling a digitally transformed built environment and urban space. These technologies facilitate functionality, efficiency, and sustainability across the entire life cycle of city and real estate development and delivery processes. These are the core technologies that enable intelligent decision-making and enable automation and integration within urban contexts and built environmental systems. Figure 1 represents the different smart technologies groups based on their main function and utilization.

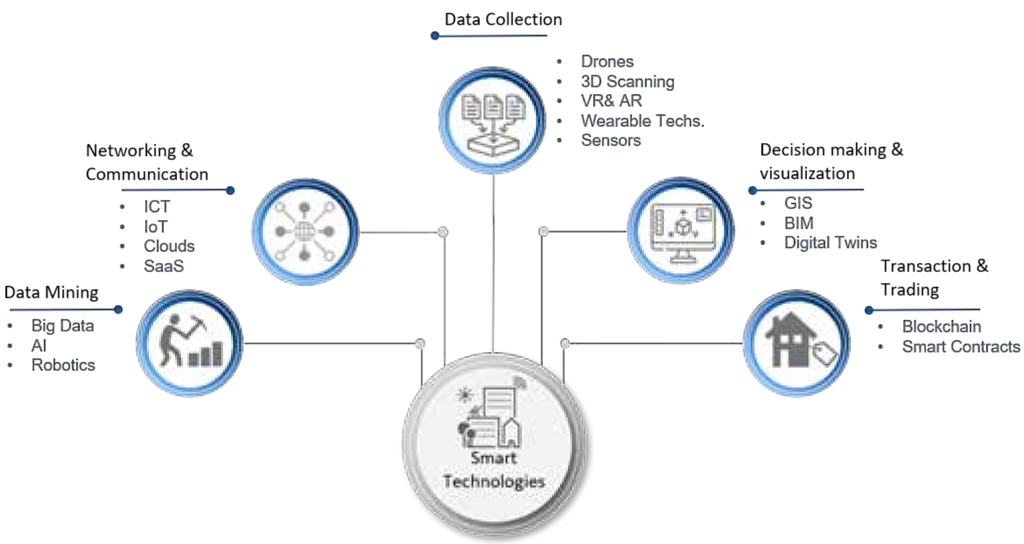

Figure 1 Smart city technologies that impact smart real estate (Al-Rimawi and Nadler, 2025, p. 04)

Data Mining & Intelligence Tools: Technologies such as big data analytics and AI serve a central role in the analysis of complex data sets, to help inform predictive analytics in models of traffic, energy, and operations of building management systems (Kitchin *et al.*, 2015). In assisting in a variety of project marketing processes, as well as maintenance projections and user behavior, AI will improve operational efficiencies and with enhanced service personalization (Ullah, Sepasgozar and Wang, 2018; Al-Rimawi and Nadler, 2025). Networking and Communication Tools: Information and communication technologies (ICT), the Internet of Things (IoT), cloud computing, and software as a service (SaaS) are part of the digital nervous system of smart cities and are the fundamental tools used to facilitate interoperability and communication between all buildings, infrastructure, and user devices (Boulos and Al-shorbaji, 2014).

Data Collection Technologies: Tools such as drones, 3D scanning, wearable devices, virtual reality (VR), and augmented reality (AR) facilitate real-time monitoring, visualization, and augmented experience for users, and are particularly influential in project marketing, design and refurbishment aspects of real estate (Naeem, Rana and Nasir, 2023; Al-Rimawi and Nadler, 2025) Decision-Making & Visualization Platforms: Geographic Information Systems (GIS), Building Information Modeling (BIM), and Digital Twins (DT) can facilitate, support, and contribute towards the urban planning, real estate design, simulating, and lifecycle management processes. GIS has had a strong impact in land development and land selection, while BIM and DT can support integrated design and operations (Bronckers, 2024); (Malik *et al.*, 2021); (Karan, Irizarry and Haymaker, 2016; Arcuri *et al.*, 2020).

Transaction and Governance Tools: Blockchain and smart contracts provide transparent and tamper-resistant systems for land registration services, lease agreements, and real estate trading, which can improve trust and increase efficiency in ownership transfer processes (Ullah and Al-Turjman, 2023).

A recent integrative review (Al-Rimawi and Nadler, 2025) conducted an analysis of how these technologies are contributing to the real estate life cycle. The study discovered that the greatest added value through these technologies was experienced during project acquisition, conception, and operation, with GIS contributing the greatest value during site selection and land development processes. GIS and BIM also dominated during the conception stage, while BIM was the most visible during the realization and construction stage. For promoting marketing a product, either AI, Virtual Reality or Augmented Reality tools assist in portraying the property with simulation and visualizations that attract end-users and experience more traction during this stage of the real estate life cycle.

Emerging technologies like AI, the IoT, wearables, DT, and BIM were key technologies during the operation and maintenance phases, facilitating performance, user interface, and energy consumption improvements. BIM and 3D scanning facilitated refurbishment, however, a transition from vacancy and demolition proved more challenging with limited outcomes. Operational enhancements were generally noted with enhancements in emergent technologies manifested as better decision-making, reduced errors, better resource management, and reductions in operational tasks. Integrating the emergent technologies improves value propositions as they create synergies that lead to new uses and efficiencies. Although the emergent technologies offer transformative potential, there will be challenges to implementation including financial capacity, institutional inertia, and the issue of interoperability with data. However, with some strategic planning, these emerging technologies can be a more useful tool and can cater to urban and real estate development (Ullah, Sepasgozar and Wang, 2018; Al-Rimawi and Nadler, 2025).

3. Materials and Methods

3.1 Research Design

The study takes a conceptual and systems-design approach to create an integrated assessment and enhancement system for SCs and SRE. The research is based on the author's two previous frameworks ((Al-Rimawi and Nadler, 2023, 2025)) that outlined:

1. A comprehensive evaluation framework for determining and measuring the smartness of cities and real estate.
2. A structured model for identifying the added value of SC technologies throughout

This paper presents a framework that is open for use generally and practically, based on academic references and supplemented with examples that demonstrate the inaugural use of the original system in practice. Prioritize smart upgrades in terms of strategic impact and feasibility.

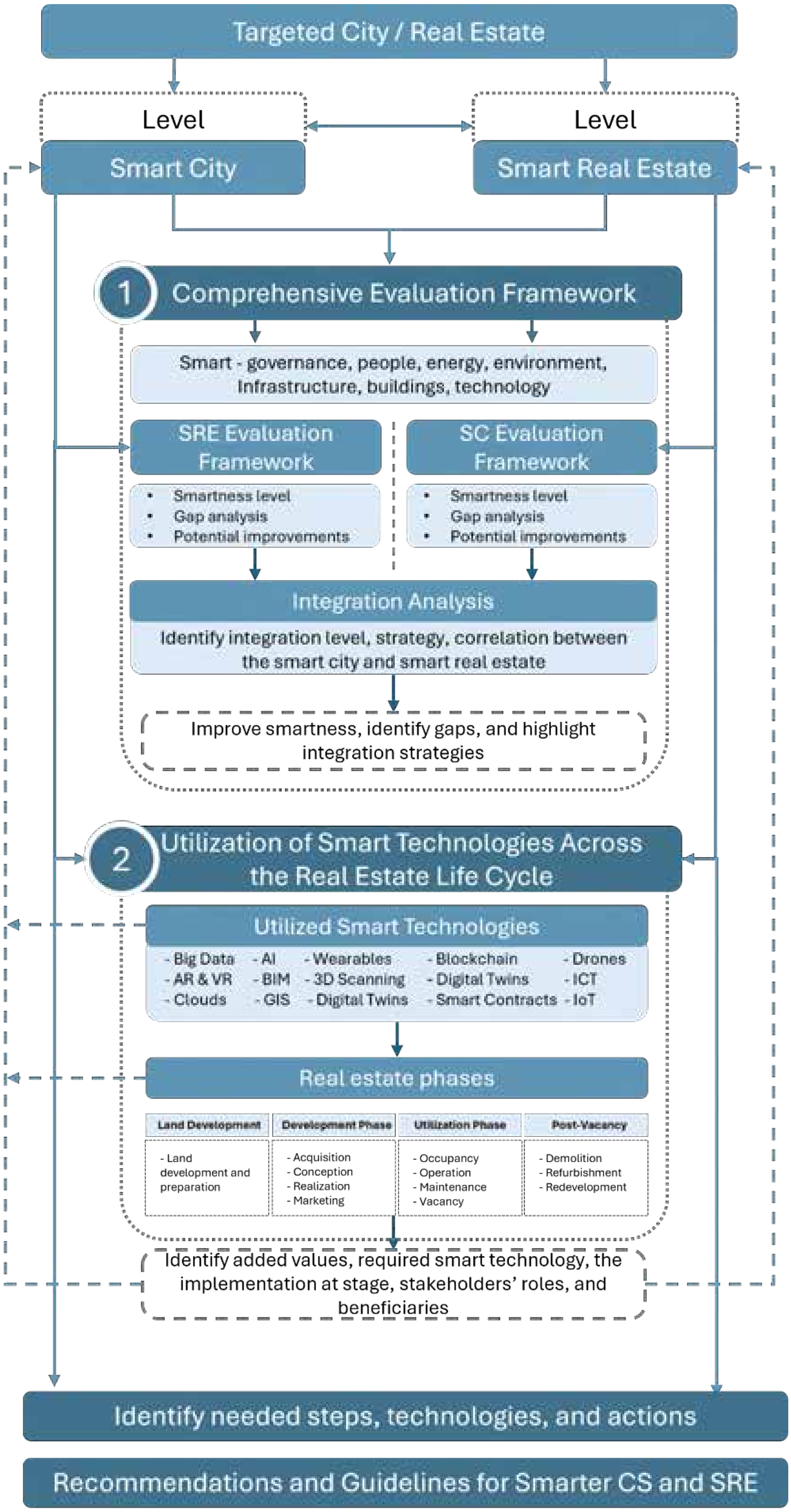

Figure 2 . *Research methodology. Source: Author, 2025.*

4. Roadmap and Tools for Smartness Improvement

The road map proceeds in the following steps:

4.1 Step 1 - Comprehensive Evaluation Framework

Smartness Determination and Assessment

The smartness of both the city and the real estate sector are assessed separately following the evaluative frameworks developed by (Al-Rimawi and Nadler, 2023). This assessment includes:

- Verifying whether the city or real estate qualifies as "smart" based on indicator thresholds.
- Evaluating performance across seven smart dimensions: governance, environment, economy, people, mobility, living, and real estate.
- Assigning scores to each dimension for comparative and developmental analysis.

The comprehensive Evaluation Framework is designed to assess and guide the development of SCs and SRE. It identifies current performance, highlights gaps, and suggests improvements, with a focus on interoperability and future adaptability. The flexible structure allows for the integration of emerging technologies and indicators. This tool supports municipalities, developers, contractors, and investors in planning, evaluating, and enhancing smart initiatives. It is applicable for both assessing existing developments and providing a roadmap for future ones.

The framework is structured around seven shared categories: smart governance, people, infrastructure, energy, environment, technology, and real estate development (RED) status. Each category includes sub-categories and indicators derived from academic research, established indexes, and regulatory frameworks.

For SCs, key references include the Smart City Index (2021), City in Motion Index (2020), EU Taxonomy (2020), and studies by (Kaluarachchi, 2022) and (Shari, 2020). For SRE, indicators were informed by SBISC (Apanaviciene, Vanagas and Fokaides, 2020), Jain's evaluation system (Jain, 2019), and Ullah et al.'s Big 9 study (Ullah, Sepasgozar and Wang, 2018), alongside certification schemes like LEED, BREEAM, and the EU Smart Readiness Indicator (SRI).

Each indicator is scored based on relevance and importance, using three methods:

- Published indexes: Weighted according to indicator significance.
- Quantitative data: Based on figures or percentages within defined ranges.
- Multi-source elements: Scores are compiled from several components, each contributing to the overall value.

4.1.1 Step 1.1- Evaluation Framework City level

The SC evaluation framework includes 28 sub-categories and 85 indicators. Each indicator is assigned a weighted score of 4, 6, 8, or 10 points, based on its relevance and importance. The total possible score is 560 points, evenly distributed across the seven main categories (80 points each). Figure 3 provides a simplified overview of the SC-level framework, as developed by (Al-Rimawi and Nadler, 2023). It outlines the primary categories, their sub-categories, the number of indicators, and the scoring structure—offering a quick snapshot of the framework's scope and focus areas.

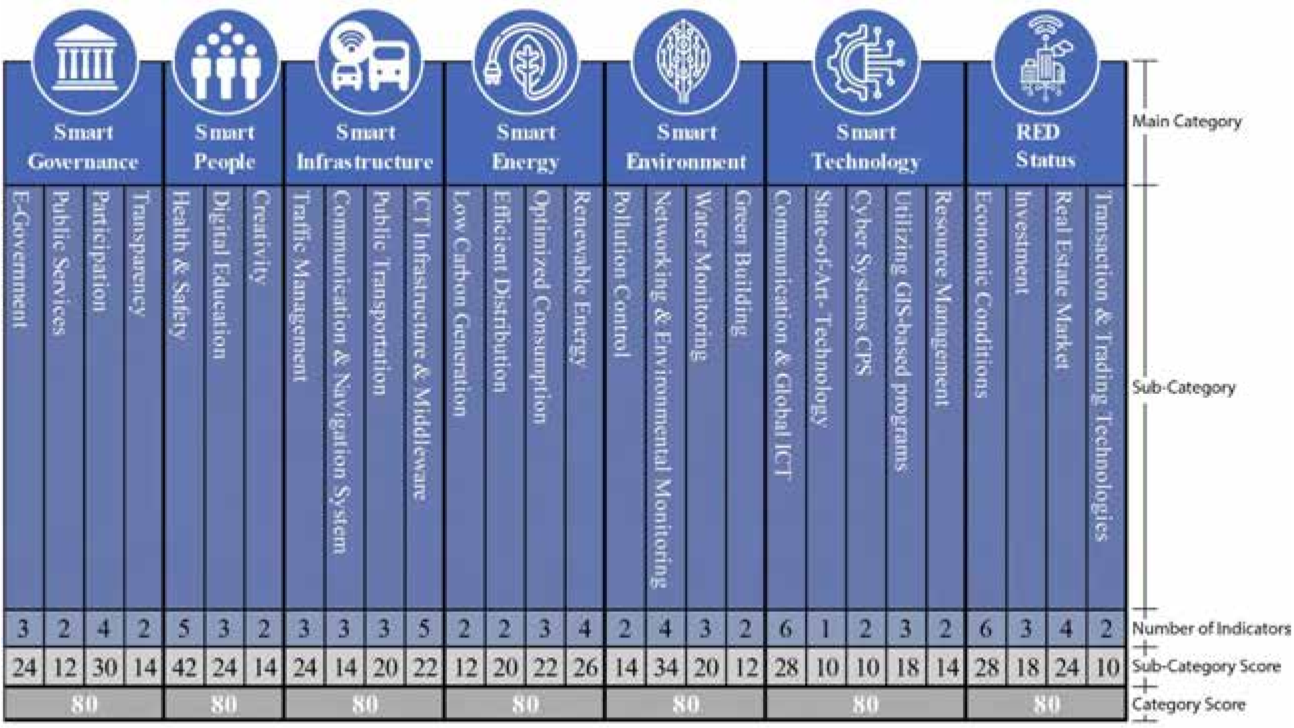

Figure 3 *Smart City Level Simplified Evaluation Framework, Author, 2025.Based on (Al-Rimawi & Nadler, 2023)*

4.1.2 Step 1.2- Real Estate (Project) Level Evaluation

The SRE project evaluation includes 90 indicators grouped into 28 sub-categories, with a total possible score of 255 points. Scores are allocated based on each category's relevance to SRE. Smart technologies, being the core of SRE, received the highest share (60 points), followed by smart energy and environment (40 points each). Smart infrastructure and real estate development (RED) status were allocated 35 points each, while smart people and governance—less directly linked—received 30 and 15 points, respectively.

Each indicator was scored on a 1–5 point scale, weighted according to its importance. Unlike the city-level framework, which uses higher point ranges, the project-level framework focuses on finer evaluation granularity. Although the maximum score per indicator is lower, results are calculated as percentages to maintain comparability and simplify evaluation across different cases. The framework follows the same process and steps as the SC, with different subcategories and indicators.

4.1.3 Step 1.3- Gap Analysis

Following the smartness assessment, the framework provides a gap detection mechanism to:

- Identify underperforming indicators and dimensions;
- Reveal areas with potential for enhancement in smart technologies, policies, or strategies;

To validate the developed evaluation frameworks, in the publication (Al-Rimawi and Nadler, 2023) the evaluation frameworks were applied to seven selected benchmarks, at both levels of SC and SRE. This practical application enabled a comparative analysis across various indicators, revealing performance gaps and opportunities for improvement. These gaps highlight where interventions or strategic enhancements are needed at both the city and project levels.

Figure 4 presents the average performance scores of the selected benchmarks, visualizing the relative impact, utilization, and importance of each indicator. Some indicators demonstrated consistently strong performance across all cities, suggesting they are already well-integrated and can be considered critical success factors for SC development. Conversely, underperforming indicators indicate areas where cities and developers can prioritize future improvements to enhance smartness, efficiency, and integration.

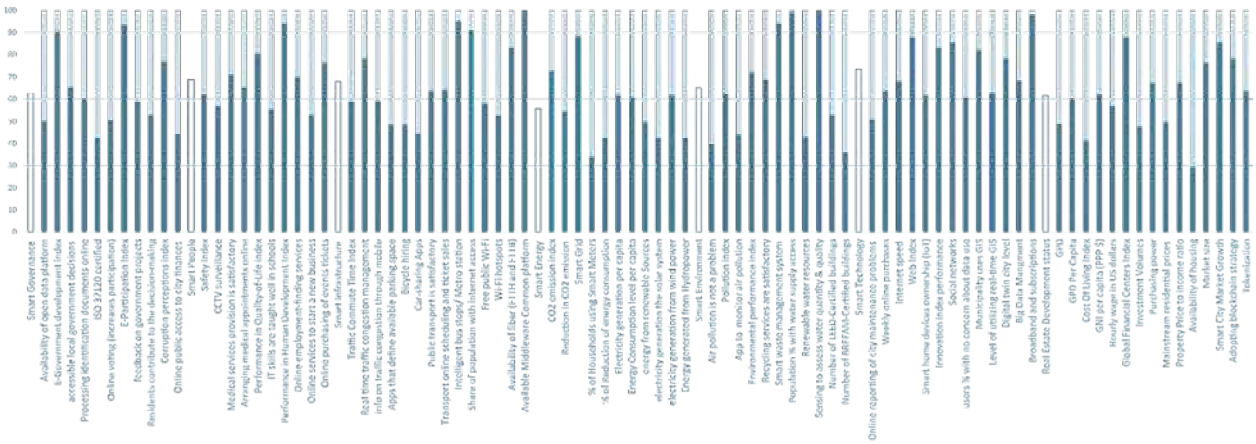

Figure 4 *Average performance and gap analysis example. Based on the case* (Al-Rimawi and Nadler, 2023)

4.1.4 Step 1.3- Integration Level Analysis
Integration between the city and real estate is analyzed using a dual-scope structure:

• Intra-scale integration: Assessing alignment and interconnectivity within the city or the real estate sector at three levels—indicator-to-indicator, sub-category-to-sub-category, and main category-to-main category.
• Cross-scale integration: Assessing the relationship and interdependence between city systems and real estate systems at the same three levels.
• This multi-level analysis will support the identification of ways in which the real estate sector supports or integrates with broader city-level smart strategies.

Several elements represent the integration analysis, Figure 5 represents a cross-sectional analysis, that represents SC and SRE performance.

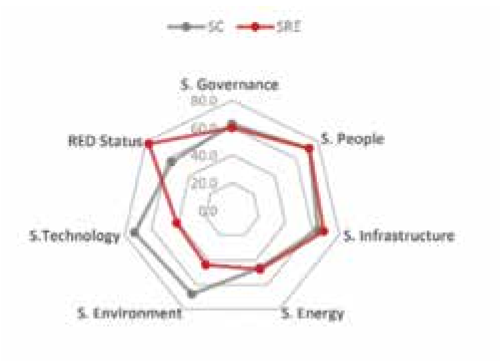

Figure 5 *Example of Sectional analysis, Smart Real Estate integration into Smart Cities and the performance. Author, 2025*

In order to capture the level of impact and correlation at all the levels SPSS (Statistical Product and Service Solutions) software is used on both SC and SRE levels and their integration. The analysis tests the three classifications: main categories, subcategories, and indicators.

4.2 Step 2- Added Value Analysis of Smart Technologies

After evaluating the smartness level, identifying gaps, and integration level, the next step would be implementing technologies to fill these gaps and improve the smartness level of the city or the real estate. The Publication (Al-Rimawi and Nadler, 2025) provides a tool that represents 16 technologies (represented in Figure 1) utilized at both levels, that have been investigated. The research followed an integrative review methodology; the review is based on 168 publications. The compiled results based on metadata analysis displayed the state of each technology's added values and usage in both scales. A total of 131 added values were identified.

4.2.1 Step 2.1 - Identification of Real Estate Life Cycle Phases

It determines how SC technologies provide value throughout a real estate lifecycle as represented in Figure 6. Real estate phases, sub-phases, and processes. (Al-Rimawi and Nadler, 2025) Across the four main phases, and their subphases:

1. Land Development
2. Project Development (Acquisition, Conception, Realization, Marketing)
3. Operation (Occupancy, Operation, Maintenance, Vacancy)
4. Post-Operation (Project Demolition, Refurbishment, Redevelopment)

***Figure 6.** Real estate phases, sub-phases, and processes.* (Al-Rimawi and Nadler, 2025)

4.2.2 Step 2.2 - Identification of Added Values and Critical Elements

Each technology is evaluated in terms of:

• Functional benefits (e.g., efficiency, automation, environmental performance);
• Strategic contributions to SC goals;
• Relevance and feasibility across the lifecycle phases.
• Provider and beneficiaries

Main Phase	Sub Phase	Process/Task	Added Value *	Technologies	Provider **	User
Land Development		Land Surveying	Enhance boundary and detailed topographic mapping with integrated spatial analysis	GIS, Drones	Municipal authorities (urban planners, surveyors)	Real estate developers, municipal authorities
		Zoning and Planning	Enhance analysis of zoning and land-use data and simulate various scenarios	GIS, BIM	Municipal authorities (urban planners)	Real estate developers, municipal authorities, investors
			Improve communication with zoning and permitting authorities	ICT	Municipal authorities, technology providers	Real estate developers, municipal authorities
		Site Preparation	Improve site conditions and constraints analysis	Big Data, GIS	Municipal authorities (urban planners, architects, surveyors)	Real estate developers, municipal authorities
			Coordinate and manage site preparation activities	ICT, GIS, BIM	Municipal authorities, construction managers	Real estate developers, municipal authorities
			Facilitate and enhance site clearing and grading	Drones, 3D Scanning, GIS	Construction managers, surveyors	Real estate developers, municipal authorities
		Infrastructure Development	Improve Infrastructure network management and planning	ICT, IoT, VR and AR, GIS	Municipal authorities (urban planners), technology providers	Real estate developers, municipal authorities, investors
			Coordinate infrastructure development activities	GIS, BIM	Municipal authorities, construction managers, technology providers	Real estate developers, municipal authorities
			Develop and create e-government infrastructure	ICT, Blockchain and Smart Contracts	Municipal authorities, technology providers	Real estate developers, investors, citizens
			Optimize municipal systems and provide geodata	ICT, GIS	Municipal authorities, technology providers	Real estate developers
			Improve essential data access and transparency	Big Data, ICT, Clouds, and SaaS	Municipal authorities, technology providers	Real estate developers, investors
		Environmental Impact Assessment	Provide a simulation of environmental impacts and help mitigate hazards	VR and AR, GIS, BIM, DT	Municipal authorities (environmental scientists, urban planners)	Real estate developers, municipal authorities, investors
		Community Impact Assessment	Increase participation	ICT, IoT	Municipal authorities	Real estate developers, investors, citizens
			Facilitate communication with the stakeholders	ICT	Municipal authorities (urban planners)	Real estate developers, municipal authorities, investors,

* These results are based on metadata analysis, highlighting the technologies that significantly achieve that added value. These technologies can contribute to other added values and have different abilities. The responsibility is not only for the highlighted stakeholders, but those are the key ones, and their significant role is in the scope of smart cities and smart real estate. This applies to Tables 3–6. ** The provider, the stakeholder responsible for activating these added values, can delegate the responsibility to an external expert to activate these added values highlighted between brackets. This applies to Tables 3–6.

Figure 7 *Screenshot of the technology utilization analysis*, (Al-Rimawi and Nadler, 2025)

4.2.3 Step 2.3 - Stakeholder Roles and Technology Utilization

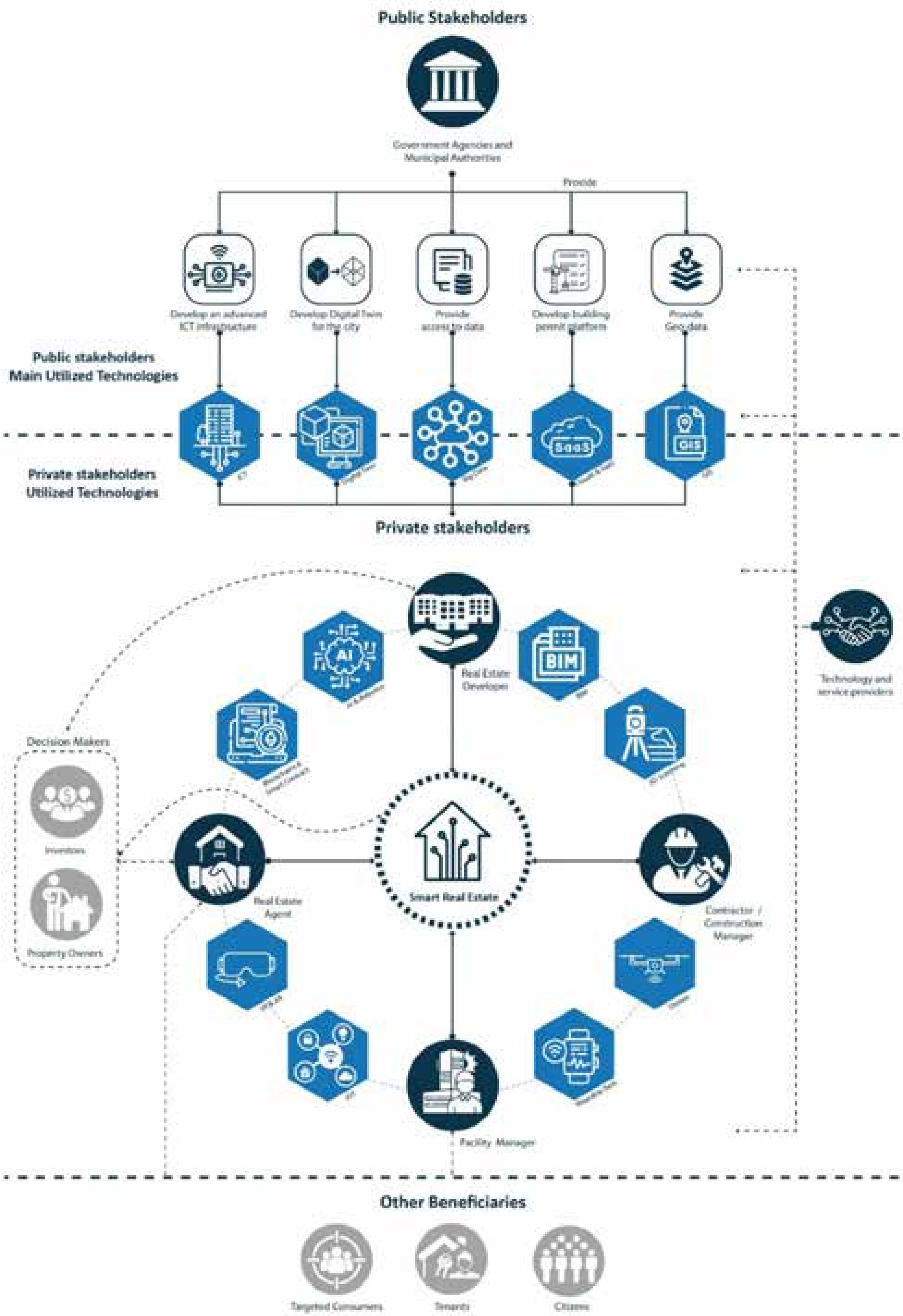

***Figure 8** Public and private stakeholders' relationships and their utilized technologies.* (Al-Rimawi and Nadler, 2025)

SC and SRE development relies on coordinated efforts between public and private stakeholders, each utilizing different technologies at various stages of the development cycle represented in Figure 8 (Al-Rimawi and Nadler, 2025).

Public stakeholders such as municipalities and government agencies—lay the foundation by upgrading digital infrastructure, deploying IoT networks, and creating centralized platforms for data integration. They invest in open geospatial and big data systems, enabling advanced analytics through AI. Technologies like GIS, ICT, and Big Data are commonly used, with a growing influence on AI adoption. Additionally, they support automation in permitting and planning through cloud-based tools and help build digital twins to support urban management. These actions directly enhance land development and early real estate phases, encouraging smarter private sector involvement.

Private stakeholders, including developers, contractors, agents, and facility managers, adopt a broader range of smart technologies. Developers use GIS, BIM, Big Data, and AI for acquisition, design, and planning. Contractors rely on BIM, AI, and wearable tech for safety, coordination, and resource optimization during construction. Agents leverage VR, AR, drones, and blockchain for immersive marketing and secure transactions. Facility managers use BIM, digital twins, AI, and IoT for real-time operations and predictive maintenance during occupancy and operation phases.

Together, both sectors drive smarter, more connected urban and real estate ecosystems by leveraging the right technologies at the right development stages.

4.3 Step 3 - Strategic Implementation and Action Planning

Now that gaps, strengths, and opportunities are identified through the evaluation and technology mapping, the attention should shift to implementing a strategic plan. This step involves:

4.3.1 Step 3.1 - Prioritizing Improvements

- Rank areas with the largest performance gaps or with indicators of high impact.
- Identify quick wins (e.g., tech already available but underutilized) vs. long-term investments.

4.3.2 Step 3.2 - Developing a Roadmap

- Outline short-, medium-, and long-term actions in consideration of stakeholder capacity and goals of the city/real estate.
- Assign responsibilities among public and private actors.
- Define timelines, budgets, and measurable targets.

4.3.3 Step 3.3 - Integration and Collaboration Mechanisms

- Propose ways to **align public and private efforts**, such as:
  - Data-sharing protocols
  - Public-private partnerships (PPPs)
  - Joint investment strategies

4.3.4 Step 3.4 - Monitoring and Feedback Loops

- Establish mechanisms to **track progress** and update the framework as technologies evolve.
- Identify KPIs associated with each indicator to measure ongoing performance.

5. Discussion

The evaluation framework and technology utilization analysis presented in this study offer a structured approach to understanding the smartness of cities and real estate developments. This dual-tool methodology revealed significant insights into the performance status, technological gaps, and opportunities for enhancement across both city-wide and project-level developments.

5.1 Smart Cities and Smart Real Estate Dependence

The evidence presented provides further support for the idea that smart cities and SRE are dependent on one another, one cannot advance fully without the other. Smart cities ultimately provide the foundation of policies and infrastructure whereas SRE projects can offer innovation and scale at the project level. The evaluation framework revealed that categories such as smart governance or smart people tend to lag in privately led projects whereas smart technologies and smart infrastructure are more developed for commercially driven real estate projects. This can mean that a greater emphasis on collaboration between public and private actors is ideally required to ensure appropriate development across all smartness pillars.

5.2 Technological Readiness and Strategic Timing

Differences in technology adoption were evident in the utilization analysis of the lifecycle. Technologies, such as GIS, BIM, IoT, and AI, are performing strongly in the cradle phases of conception, construction, and operation, respectively, and underperforming in transition sub-phases (e.g., vacancy, and demolition). These differences in readiness speak to the importance of strategic timing this includes not only knowing what technology you are going to use but also when and where you are going to utilize that technology relative to its value.

5.3 Stakeholder Roles and Gaps

The review found that public and private stakeholders both had instrumental roles to play. Public entities likely have the foundational enablers - high-speed communication, open data platforms, digital governance tools- while private stakeholders tend to more easily adopt new private innovation technologies (e.g., AR/VR, wearable tech, blockchain), especially around marketing and customer engagement.

However, these efforts remain fragmented without coordinated strategies/research. This reinforces the need for coordinated approaches, including integrated plans, joint data-sharing frameworks, and clear incentives for coordination between public and private stakeholders.

5.4 From Assessment to Action

The gap assessment in the evaluation framework is, diagnostic and directional in orientation. It shows where cities and projects exist today and where to act next (the next step). The next step should focus on:

- Customized action plans to develop high-impact indicators/outcomes.
- Cross-sector partnerships to leverage shared data and infrastructure.
- Capacity-building and awareness programs to ready stakeholders, specifically municipalities and smaller developers.

5.5 Limitations and Future Work

Although comprehensive, the framework is not a complete evaluation process. It has been reflective of the state of the literature and technologies available today, and updates will need to be conducted as urban challenges evolve and technologies emerge. Additionally, this study does not contain primary case studies and, therefore lacks empirical verification. Future work can utilize this methodology in specific urbanities to validate and improve the overall practical value of the evaluation framework.

It was also observed that certain technologies – e.g., Digital Twins, predictive tools with AI – yielded the most value during the utilization and maintenance phases, suggesting that investment priorities are shifting beyond construction whereby optimizing lifecycle use is the highest value proposition for these technologies.

6. Conclusion and Future Directions

This paper presented a dual-tool approach to support the assessment and development of smart cities (SC) and smart real estate (SRE). The first tool a comprehensive evaluation framework was designed to measure the "smartness" of urban areas and real estate projects based on seven key categories and a set of weighted indicators. The second tool analyzed the added value of smart technologies across the real estate lifecycle, identifying when and where each technology could contribute to the real estate development cycle, as well as when and how each technology should fit in the real estate development life cycle (which stage, when, and where in the development cycle) order to maximize value-added performance.

Together, these tools provide a practical roadmap for municipalities, developers, investors, and policymakers. They enable informed decision-making by identifying performance gaps, prioritizing technology integration, and aligning stakeholder efforts. The results emphasize the interconnectedness of SC and SRE, showing that both public infrastructure and private development must advance in tandem to achieve holistic urban innovation.

While the paper does not conduct empirical case studies, it offers a structured methodology and insights that can guide future implementations and research. As technologies evolve and cities continue to grow, the framework is flexible and adaptive, capable of incorporating new indicators and innovations to remain relevant.

In conclusion, advancing smart cities and smart real estate requires strategic planning, coordinated efforts, and the intelligent use of technology. The tools developed in this study offer a foundation for such advancement—helping cities and developments transition from traditional models to smarter, more resilient, and more sustainable futures.

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