Explaining the role of smart urbanization in enhancing urban livability: a case study of district 6, Tehran

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Abstract

In recent decades, cities worldwide have faced complex challenges such as population growth, economic activity density, and resource constraints, making urban smartification and the enhancement of urban livability increasingly essential. This study aimed to elucidate the mechanisms through which urban smartification affects livability in District 6 of Tehran, focusing on the interaction among technology, governance, social justice, and citizens' lived experiences. A mixed-methods approach was employed: thirteen semi-structured interviews were conducted with urban managers, smart city experts, and livability researchers, followed by thematic analysis to identify seven core constructs. Quantitative data were collected via a structured questionnaire and analyzed using structural equation modeling (SEM). Results indicated that the constructs "Governance, Power, and Decision-Making" ($\beta = 0.71$) and "Equity, Inclusion, and Marginalized Groups" ($\beta = 0.71$) had the strongest influence on urban livability. Additionally, "Space and Lived Experience" ($\beta = 0.74$) and "Potential Capacities" ($\beta = 0.75$) significantly contributed to environmental quality and policy adaptability. Integrating qualitative and quantitative findings revealed that citizens' real ability to use technology, limited participation in governance, and spatial inequalities were key constraints on livability. Findings suggest that smart city initiatives without a human-centered, participatory, and justice-oriented approach cannot meaningfully improve citizens' lived experiences or quality of life. The study provides a context-specific conceptual framework that can guide policymakers, urban managers, and researchers in densely populated urban areas.

Keywords: District 6 of Tehran; Livability; Smart Urbanization; Smart Governance; Social Justice.

1.Introduction

In recent decades, cities worldwide have confronted complex challenges such as urban population growth, environmental pressures, the density of economic activities, and resource constraints, making urban livability an essential imperative (Kim et al., 2021; Lim et al., 2021). The development of smart technologies and the emergence of the smart city concept have promised to improve infrastructure, optimize resource management, and enhance the quality of life for citizens. However, global evidence indicates that these efforts have often remained superficial and technology-centric, with their human, social, and environmental consequences not being fully analyzed (Bove & Ghiraldelli, 2025; Osakwe et al., 2025). Furthermore, international studies have typically been conducted in less-challenged cities, and the adaptability of the proposed models for dense and complex urban contexts, including those in Iran, remains limited and under-analyzed (Rui & Othengrafen, 2023).

A systematic literature review reveals significant gaps in understanding the interplay among technology, social innovation, governance, and citizen experience. Existing theoretical efforts have predominantly focused on technology and infrastructure, paying less attention to human and local impacts (Abdelkarim et al., 2023; Lim et al., 2021). Moreover, social innovation and smart governance have not been critically examined, and the relationship between policies, citizen participation, and livability outcomes has not been analyzed in an integrated manner (Mittal & Sethi, 2018; Wang et al., 2025). Concurrently, citizen experience and quality of life in existing studies have often been assessed at the macro level, without a precise representation of local impacts (Hajjarian, 1404; Sharif Ahmadi Farhang et al., 1404). Additionally, livability indicators are frequently techno-centric, with human and environmental dimensions being underrepresented (Bove & Ghiraldelli, 2025; Rui & Othengrafen, 2023).

This analysis indicates that local, context-specific research in the dense cities of Iran, particularly in central and complex urban fabrics like District 6 of Tehran, is severely limited. Furthermore, the systematic integration of qualitative and quantitative methods to localize a conceptual model and test causal relationships has been neglected. The interplay of technology, social innovation, governance, and citizen experience has not been analyzed integratively, and existing livability indicators are often one-dimensional and technology-driven. These gaps underscore the need for research that can provide an integrated conceptual framework while remaining attentive to the local context.

The necessity of the present research is justifiable from several perspectives. First, with its high population density, diversity of economic activities, and managerial complexity, District 6 of Tehran serves as a suitable case study for a critical analysis of the interplay among technology, policymaking, and citizen experience. Second, by employing a mixed-methods (qualitative and quantitative) approach, this study seeks to provide a localized conceptual framework that simultaneously integrates the technological, social, governmental, and human dimensions, and tests the causal relationships among them. This methodological innovation facilitates a detailed and integrative analysis of urban livability issues within the local context and can contribute to the formulation of effective policies tailored to dense urban fabrics.

The primary objective of this research is to elucidate the mechanisms through which smart city development enhances urban livability in District 6 of Tehran. Concurrently, the research seeks to answer the following questions: How do the components of technology and smart infrastructure, social innovation and governance, and citizen experience interact to shape urban livability? And which components have the most significant impact on citizens' quality of life and satisfaction? Answering these questions will be achieved through thematic analysis and Structural Equation Modeling (SEM). While addressing existing research gaps, this study can serve as a guide for urban policymaking and planning in the dense urban fabrics of Tehran.

2.Literature Review

Recent research on smart cities and urban livability indicates that urban technologies and smart policies not only lead to the improvement of physical infrastructure and urban services but also play a significant role in enhancing citizens' quality of life and satisfaction. Conceptually, these studies can be categorized into several key themes. The first theme is technology and smart infrastructure, whose role in advancing the economic, environmental, and social livability of cities has been highlighted. For instance, Abdelkarim et al. (2023), through a qualitative analysis of two smart cities in Qatar, demonstrated that the management of urban facilities and the use of smart technologies lead to improved quality of public spaces and enhanced livability. In a similar approach, Lim et al. (2021) in Singapore, by utilizing 2D and 3D data and developing a geomatics platform, identified improved inter-organizational collaboration, better urban planning decision-making, and an enhanced urban experience as outcomes of the smart city. Sofeska (2017), emphasizing a citizen-centric approach, also showed that smart solutions can bolster urban sustainability and livability. This body of literature clearly identifies technology and infrastructure components as fundamental independent variables, providing a preliminary framework for defining urban indicators in the present study.

The second theme is social innovation and smart governance, whose role in achieving human and social livability in cities has been a focus of attention. Kim et al. (2021) presented a conceptual framework that introduces the interaction between technological and social innovations as a key factor in urban sustainability and livability. Mittal and Sethi (2018), by reviewing international policies and case studies, analyzed the technical, social, and governance challenges in the development of smart cities and proposed the SMART model for urban management. Furthermore, Wang et al. (2025), using a Difference-in-Differences (DID) model across 284 cities in China, showed that smart city policies can enhance urban livability, with the primary impact channels being technological innovation and social governance. These studies demonstrate that the success of a smart city will be limited without considering the social and governance context, and this is precisely the aspect that the current research, with its focus on District 6 of Tehran, aims to address.

The third theme is citizen experience and urban quality of life, which is often assessed through indicators of satisfaction, social interaction, and urban security. Research has shown that active citizen participation and the alignment of policies with local needs have significant positive effects on livability. For instance, Chang and Smith (2023), through a systematic review of 38 global studies, identified the key domains of quality of life in a smart city and emphasized the importance of adapting policies to the local context. Li et al. (2023), using a SWOT-AHP-TOWS model in Nanjing, demonstrated the prioritization of citizens' needs and the development of human-centric policies to increase satisfaction. In Iran, studies by Hajjarian (2025), Sarvestaninejad and Maleki (2025), and Sharif Ahmadi Farhang et al. (2025) have clearly indicated that smart city indicators directly impact citizen satisfaction and quality of life, with components such as a smart economy, transportation, and smart citizens having the greatest influence. This body of empirical evidence confirms the importance of human and social dependent variables for the conceptual model of the present study.

The fourth theme concerns the challenges and limitations of technology-centric indicators, which have been highlighted in many studies. Bove and Ghiraldelli (2025), by analyzing indicators in Athens and Zurich, pointed out the shortcomings of purely technology-centric indicators and proposed alternative indicators based on quality of life and livability. Rui and Othengrafen (2023) also showed that innovative and human-centric street design, regardless of technology, can enhance social interaction and urban livability. These critiques underscore the importance of examining quality of life components and localizing indicators for the current research, emphasizing the necessity of a critical analysis of global literature and its transfer to the local context of Tehran.

Synthesizing these conceptual themes reveals that although existing research has contributed to the development of frameworks and empirical evidence regarding smart cities and livability, significant gaps remain. First, many studies have been conducted globally or across multiple cities, with less attention paid to the local urban context of Iran, particularly central and dense areas like District 6 of Tehran. Second, few studies have managed to combine a qualitative (thematic analysis) and quantitative (SEM) approach to localize a conceptual model and test causal relationships. Third, existing studies often emphasize technology and infrastructure, while the interaction between technology, governance, social innovation, and citizen experience has not been analyzed in an integrated manner. Fourth, many indicators are purely technology-centric, diminishing the human, environmental, and social dimensions of livability.

Accordingly, the present study aims to fill these gaps by employing a mixed-methods qualitative and quantitative approach to analyze the dimensions of the smart city and urban livability in

District 6 of Tehran. This study endeavors to provide a localized conceptual framework that simultaneously incorporates technology, governance, social innovation, and citizen experience, and to test the causal relationships among them using Structural Equation Modeling (SEM). This approach, in addition to addressing the existing research lacunae, will facilitate the provision of practical, policy-oriented solutions for enhancing urban livability in the dense and complex urban contexts of Tehran.

3.Theoretical Framework

Classical research in the realm of urban livability has predominantly emphasized physical elements, density, and urban functionality, with comparatively less attention devoted to the social dimensions and perceptions of residents (Pacione, 1990). While this traditional approach has provided crucial theoretical foundations for urban design, it presents substantial limitations when confronted with contemporary urban complexities, particularly within the context of smart cities. Recent studies indicate that urban livability extends beyond the built environment, encompassing the city's capacity to foster well-being, social equity, citizen participation, and the overall quality of life for its inhabitants (Martino, 2021; Xiao, 2022). In other words, a genuine understanding of livability necessitates the integration of physical analyses with the examination of citizens' perceptions and experiences.

Parallelly, the literature on smart cities underscores that technology, in isolation, does not guarantee an enhancement in the quality of life. Mainstream definitions of the smart city pivot on the utilization of digital technologies, data management, and the analytics of urban services (Caragliu, Del Bo, & Nijkamp, 2011; Bakıcı, Almirall, & Wareham, 2013; Nam & Pardo, 2011). However, critical research has demonstrated that a singular focus on technology frequently overlooks social and governance considerations, potentially exacerbating inequality, a lack of transparency, and constrained citizen participation (Lombardi & Vanolo, 2015; Bibri, 2019). Consequently, contemporary literature posits that a smart city should be conceptualized as an interdisciplinary system wherein technology, governance, and social capital interact synergistically.

Building upon this critical perspective, the present study identifies three primary components to analyze the nexus between the smart city and urban livability:

1. **Technological Capabilities and Smart Infrastructure:** This component encompasses technological coverage (sensor networks and ICT), digital urban services, data management, and infrastructure automation. While these indicators facilitate the empowerment of the urban environment by providing precise data and optimizing service delivery, their actual efficacy remains contingent upon citizen utilization and adoption (Mittal & Sethi, 2018; Wang et al., 2025).

2. **Social Innovation and Participatory Governance:** This component reflects the city's capacity to foster transparency, policy adaptability, active citizen engagement, and social inclusion. Recent scholarship indicates that the absence of participatory governance can constrain the benefits of smart technologies, ultimately culminating in the emergence of unlivable cities (Bove & Ghiraldelli, 2025; Clark, 2020).

3. **Citizen Experience as a Mediating Variable:** The subjective experience and perception of environmental quality, urban services, and security play a vital mediating role. Theories rooted in environmental psychology and phenomenology emphasize that citizen experience serves as a crucial bridge between objective interventions (technology and governance) and livability outcomes. This subjective experience encompasses service satisfaction, perceived quality of life, a sense of belonging, and security, thereby determining how citizens engage with and utilize urban amenities (Lynch, 1960; Nasar, 1992; Seamon, 2012).

Within this framework, urban livability is operationalized as the dependent variable, comprising qualitative components such as citizen satisfaction, perceived quality of life, accessibility to services, and satisfaction with the urban environment. Adopting this approach, the proposed conceptual model posits that the smart city influences the citizen experience through technological optimization and enhanced governance, with this mediated experience ultimately driving the advancement of urban livability.

4.Research Methodology

4.1.Research Design

The present study was designed within a pragmatist philosophical framework, employing a Mixed-Methods approach. Following the multi-layered research onion model (Melnikovas, 2018), the philosophical structure, approach, and research strategy were defined in successive layers. In the first layer, the research philosophy is grounded in pragmatism; this implies that the primary focus was on understanding the research problem and selecting methods that could complementarily explain the various dimensions of the phenomenon under study. Within this framework, the social realities associated with urban smarting were considered not as entirely objective and independent, nor as purely subjective constructs, but rather as outcomes of the interaction between structures, policies, and the lived experiences of citizens.

In the second layer, a combined inductive-interpretive approach was adopted. This means that analytical themes were extracted from the qualitative data, while their interpretation was grounded in theories of the smart city, urban livability, spatial justice, and critical urban studies. This approach facilitated the integration of deep qualitative insights with testable quantitative evidence. In the third layer, the research strategy involved a case study of District 6 in Tehran, as this area provides a tangible and operational example of the urban smarting process and its impact on livability. In the fourth layer, research choices were made purposefully based on expert criteria; specifically, qualitative data were collected through interviews with experts, urban managers, and specialists involved in the smarting process, while quantitative data were gathered via questionnaires administered to citizens of the district. Finally, the fifth layer, the time horizon of the research, encompassed Spring 2025 for data collection and August-September 2025 for data analysis and manuscript preparation. This timeframe was deemed logical as it allowed for access to up-to-date information, coincided with the completion of smart city projects, and mitigated the impact of seasonal variations on user experience.

Given the mixed-methods nature of the research, this study capitalized on the advantages of both in-depth qualitative analysis and the capability to test causal and mediating relationships at a quantitative level. The integration of these two approaches enabled the extraction of theoretical themes related to lived experience, governance, justice, and environmental quality, while concurrently, the validity of the findings was confirmed through Structural Equation Modeling (SEM) and statistical tests.

4.2.Data

The statistical population for the qualitative component of this study comprised 13 urban managers, experts, and specialists involved in the urban smarting process in District 6 of Tehran.

These individuals were selected using purposive and snowball sampling techniques to ensure that participants possessed both practical experience at the policy-making, planning, or implementation levels, and the requisite analytical capacity to interpret the implications of urban smarting for livability. This sampling approach facilitated access to in-depth knowledge, lived experiences, and critical perspectives on the smarting process, thereby enhancing the analytical richness of the qualitative data.

For the quantitative component, the statistical population included all adult residents of District 6 in Tehran who utilized urban services and smart city technologies to at least some extent. The sample size was determined using G-Power 3.1 software. Considering the requirements for Structural Equation Modeling (SEM), with a statistical power of 0.8 and an alpha level of 0.05, a minimum sample size of 375 was estimated. To compensate for potential attrition and enhance analytical precision, 400 questionnaires were distributed, ultimately yielding 386 valid responses (a 96.5% rate). This number confirms the adequacy of the sample for conducting advanced statistical analyses and structural modeling. A simple random sampling method was employed for the quantitative phase to ensure that the diversity of social, economic, and demographic characteristics of the district's residents was represented in the sample, thereby increasing the generalizability of the findings.

Qualitative data were collected through semi-structured interviews. This format was chosen for its flexibility and capacity for in-depth probing, which enabled the detailed capture of participants' lived experiences, viewpoints, and interpretations. The interview guide comprised open-ended and exploratory questions covering themes such as access to smart technologies, user experience with digital services, digital governance and decision-making, spatial justice, the quality of urban lived experience, and the potential capacities of smarting. Interviews were conducted in a controlled environment with the informed consent of the participants, and all data were prepared for analysis following meticulous transcription.

Table 1. Characteristics of Interviewees

ID	Position	Education	Interview Duration
Interview 1	Expert, ICT Information Office	Master's Degree	27 minutes
Interview 2	Expert, ICT Information Office	Master's Degree	22 minutes

Interview 3	Large-Scale Projects Manager	Master's Degree	30 minutes
Interview 4	Former Director-General, Citizen Education Dept.	Master's Degree	30 minutes
Interview 5	Former Director-General, Office of the Mayor of Tehran (Hanachi)	Master's Degree	44 minutes
Interview 6	Smart City Researcher	PhD	14 minutes
Interview 7	City Council Advisor	PhD	53 minutes
Interview 8	Smart City Researcher	Master's Degree	35 minutes
Interview 9	Official for Local & Thematic Plans, Urban Planning Deputy, District 6	Master's Degree	15 minutes
Interview 10	Civil Engineer	Bachelor's Degree	37 minutes
Interview 11	Former Member, Islamic City Council of Tehran	PhD	45 minutes
Interview 12	University Professor	PhD	1 hour 12 minutes
Interview 13	Smart City Researcher	Master's Degree	1 hour

For the quantitative data collection, a structured questionnaire was developed, directly informed by the research's conceptual framework and the findings of the qualitative thematic analysis. This instrument comprised seven primary constructs:

1) Access, Technology, and Usability;

2) Governance, Power, and Decision-Making;

3) Mobility, Time, and Life Pressures;

4) Space, Lived Experience, and Environmental Quality;

5) Justice, Inclusion, and Marginalized Groups;

6) Discourse, Meaning, and Perceptual Gaps; and

7) Capacities and Potentialities.

Each construct was designed with a set of multidimensional items to capture the full conceptual scope of each theme. For example, the "Access, Technology, and Usability" construct included items related to the usability of technology, system complexity, user autonomy, and the surveillance aspects of technology. Meanwhile, the "Governance, Power, and Decision-Making" construct featured items concerning the centralization of power, the dominance of technocratic rationality, and limited citizen participation. All items were framed using a five-point Likert scale (from "Strongly Disagree" to "Strongly Agree") to quantitatively measure the intensity of respondents' perceptions and experiences.

Prior to its final administration, the questionnaire was reviewed by a panel of experts in urban studies and technology to confirm its clarity, conceptual validity, and theoretical coherence. Furthermore, a preliminary pilot study was conducted with 20 residents of District 6 to assess the comprehensibility and answerability of the questions, after which necessary revisions were made. This rigorous process ensured that the questionnaire was not only aligned with the theoretical framework of the research but also reflective of the actual lived experiences of citizens, thereby guaranteeing high reliability and validity for the results of the subsequent structural equation modeling.

The validity of the quantitative instrument was initially assessed through content validity and expert consensus. Subsequently, the convergent validity and construct reliability were evaluated using Confirmatory Factor Analysis (CFA) and Cronbach's alpha coefficient. The results indicated that all factor loadings were greater than 0.6 and Cronbach's alpha values exceeded 0.7, demonstrating the satisfactory validity and reliability of the measurement tool. In the qualitative phase, to ensure data validity and trustworthiness, methodological rigor criteria were applied, including multi-stage analytical memoing, code reviewing, analytical consensus, and the clarification of the coding process. These measures significantly enhanced the reproducibility and analytical coherence of the findings.

Qualitative data analysis was conducted utilizing Braun and Clarke's six-phase thematic analysis approach. This involved a deep familiarization with the data, generating initial codes, searching for themes, reviewing and refining those themes, defining and naming the final themes, and producing a coherent analytical narrative. This procedure was systematically executed using MAXQDA 2022 software to ensure optimal data organization, transparency across analytical stages, and reviewability. The quantitative data, on the other hand, were analyzed via Structural Equation Modeling (SEM). In the primary step, the measurement model was validated, and goodness-of-fit indices—namely CFI, TLI, RMSEA, and SRMR—were evaluated. Following this, a structural path analysis was performed to investigate the direct and mediating relationships among the constructs. Data normality was assessed using Shapiro-Wilk and Kolmogorov-Smirnov tests, and to enhance the accuracy of the estimates, a Bootstrapping technique with 2000 resamples was employed.

Ultimately, the comprehensive data analysis was carried out using a suite of specialized software: MAXQDA 2022 for the qualitative analysis, AMOS 28 for structural equation modeling, and SPSS 28 for descriptive statistics, assumption testing, and correlation calculations. This combination of analytical tools facilitated the systematic integration of qualitative and quantitative data, enabling a robust examination of causal relationships and the generation of valid, reliable results. Consequently, it reinforced the methodological foundation of the research in terms of precision, transparency, and replicability.

4.3.Study area

District 6 of Tehran Municipality, with a population of 250,753 (Statistical Center of Iran, 2016) and an area of 2,144 hectares, constitutes approximately 3.5% of Tehran's total land area. The district is bounded to the north by the Hemmat Expressway, to the south by the Enghelab–Azadi corridor, to the east by the Modarres Expressway and Shahid Mofatteh Street, and to the west by the Shahid Chamran Expressway. The gross population density of the district is 117 persons per hectare, a figure that reflects both its central location and its historical significance in Tehran's urban transformations.

Administratively, District 6 is subdivided into six zones and eighteen neighborhoods, with an average zone area of 357 hectares and an approximate average population of 29,000. Among these, Zone 1 is the least populated, while Zone 2 is the most populated. Furthermore, Zone 4 is the smallest in area, and Zone 3 is the largest. These demographic and spatial disparities, coupled with a misalignment between neighborhood boundaries and established urban networks, have resulted in social, physical, and cultural fragmentation. This, in turn, has led to inefficiencies in service delivery, an overlap of institutional responsibilities, and increased operational costs (Naqshe Jahan Pars, 2007; Statistical Center of Iran, 2016).

From the perspective of its spatial organization, District 6 exhibits significant heterogeneity along its south-to-north and east-to-west axes. The southern part is characterized by a grid-like pattern, whereas the northern part is more radial; due to topographical gradients and natural features, the latter exhibits weaker horizontal cohesion. The distribution of macro-scale elements—such as the Atomic Energy Organization, the Jamshid Garrison, the University of Tehran, and major parks (Laleh and Sa'i)—has profoundly influenced the spatial structure of not only the district but also the broader city of Tehran. In contrast, the southern sectors, with their fine-grained urban patterns and high density, have formed a distinctly different urban environment. The arterial corridors of Enghelab and Valiasr form the primary skeletal framework of the district, organizing accessibility, daily flows, and strategic activities. This multi-scalar composition presents both opportunities and constraints for urban interventions and smart city initiatives.

The rationale for selecting District 6 as the case study is justified by its unique social, spatial, and historical characteristics. First, its high population density, social diversity, and the concentration of economic, educational, and institutional functions provide a rich context for the simultaneous examination of technological infrastructure, urban governance, and livability. Second, its layered physical structure, characterized by the coexistence of large-scale and fine-grained parcels, enables an analysis of the differentiated impacts of urban smartening initiatives on diverse social groups and varied spaces. Third, the district's documented managerial and service-related disjunctures and inefficiencies present a critical opportunity to investigate themes of spatial justice and equitable access to urban technologies, aligning with the critical approach of this research. Finally, the interplay of its developmental history, administrative diversity, and multi-scalar spatial structure renders District 6 a particularly suitable case for testing the study's conceptual framework and analyzing the seven core components of livability and smart city development.

In summary, District 6 has been selected as a key case where technological infrastructure, governance practices, socio-spatial structures, and historical trajectories can be investigated concurrently. The district not only exemplifies the challenges inherent in implementing technology-driven policies within complex urban fabrics but also underscores the potential opportunities for fostering smart, human-centric, and justice-oriented interventions in the city of Tehran.

5.Findings

5.1. Thematic Analysis

This section reports the results of the qualitative data analysis, derived from semi-structured interviews with 13 experts, urban managers, planners, and actors involved in the smart city development process in District 6 of Tehran. The data were analyzed following the six-phase thematic analysis approach proposed by Braun & Clarke (2006; 2021). The research's analytical approach was hybrid (inductive–interpretive); that is, while the themes emerged from the data, their interpretation was situated within the theoretical frameworks of the smart city, urban livability, spatial justice, and critical urban theories. The MAXQDA 2022 software was utilized to manage, code, and organize the data, thereby ensuring the transparency of the analytical process, reviewability, and analytical coherence.

Phase One: Familiarization with the Data

In the initial step, the audio recordings of the interviews were listened to multiple times, and their corresponding transcripts were read repeatedly. During this phase, initial analytical memos were recorded, documenting the overall impressions from participants, conceptual tensions, semantic contradictions, and recurring patterns within their lived experiences. Phrases such as:

- *"The systems exist, but not everyone can use them."*
- *"Smartening brings more order than comfort."*
- *"Decisions are made from above, not from within the neighborhood."*

These observations were indicative of the nascent formation of themes related to digital inequality, technocratic rationality, and the gap between policy and lived experience. They subsequently formed the basis for proceeding to the initial coding phase.

Phase Two: Generating Initial Codes

In this phase, the data were coded line-by-line within the MAXQDA environment. An open coding approach was employed to extract initial concepts without imposing a predetermined structure. The codes were a combination of the participants' exact words (in-vivo codes) and the researcher's analytical concepts. In total, 65 initial codes were identified, encompassing domains such as access to smart services, user experience, digital governance, urban mobility, spatial justice, policy discourse, and the potential capacities of smart city development. These codes revealed that the experience of smartening in District 6 of Tehran is characterized by an inherent tension between "technical efficiency" and "human livability."

Phase Three: Searching for Themes

In this stage, synonymous and related codes were grouped into conceptual clusters. The objective was to identify broader semantic patterns capable of explaining the underlying relationships among the codes. Accordingly, the initial codes were organized into 16 sub-themes, each representing a specific facet of the lived experience regarding urban smartening.

Phase Four: Reviewing and Refining Themes

The extracted themes were rigorously reviewed for internal coherence, conceptual distinctiveness, and relevance to the overarching research objectives. During this phase, overlapping themes were merged, and the conceptual boundaries between the themes were clarified. As a result of this iterative process, 13 sub-themes were categorized under 7 main themes, which articulate the macro-dimensions of the relationship between urban smartening and livability within the study area.

Phase Five: Defining and Naming Themes

Following the final refinement, the themes were named and defined by drawing upon classical and critical urban theories:

Table 2. Coding and Identification of Sub-themes

Theoretical Variable	Main Theme	Sub-themes	Related Codes	Key Quotes
Technological Capabilities and Smart Infrastructure	**Access, Technology, and Usability**	- Technological Access as a Capability - Disjuncture between Technological Design and User Experience - Technology as an Instrument of Control	Technological access; Digital inequality; Digital literacy gap; Technological consumerism; Systems' user-unfriendliness; Perceptual complexity; Reduced user autonomy; Control-oriented technology	"The systems exist, but not everyone knows how to use them; in practice, only a select few benefit." (Interview 3) "The systems are designed more from an engineer's perspective than a citizen's." (Interview 2)
Social Innovation	**Governance, Power, and**	- Dominance of Technocratic	Top-down decision-making; Instrumental	"Decisions are mostly made behind

and Participatory Governance	**Decision-Making**	Rationality - Weakening of Participatory Governance - Reproduction of Power and Inequality	rationality; Centralization of power; Exclusion of participation; Performative transparency; Reproduction of inequality	a desk with numbers and charts, not by seeing the reality on the street.” (Interview 2) “Participation is mostly at the level of information dissemination; the citizen provides data but has no share in the decision.” (Interview 7)
Citizen Experience	**Mobility, Time, and Lived Pressures**	- Time-Space Compression and the Acceleration of Urban Life - Systemic Efficiency without Enhancing the Experience of Mobility	Time compression; Acceleration of life; Reduced temporal autonomy; Psychological burnout; Relative improvement in transport; Prioritization of flow	“Everything has gotten faster, but not easier.” (Interview 5) “Traffic has improved, but the sidewalks have not.” (Interview 3)
Citizen Experience	**Space, Lived Experience, and Environmental Quality**	- Disjuncture of Smarting from the Right to the City - Lived Experience and Environmental Quality	Right to the city; Space as a secondary platform; Technology-space disjuncture	“Technology has arrived, but the space has not improved.” (Interview 4) “The city has become smart, but not livable.” (Interview 9)
Social Innovation and Participatory Governance	**Justice, Inclusion, and Overlooked Groups**	- Inequality in Benefiting from Urban Smarting	Spatial inequality; Selective smarting; Exclusion of groups	“Not everyone benefits equally.” (Interview 7) “Employees and students benefit, but the rest don’t.” (Interview 5)
Citizen Experience	**Discourse, Meaning, and the Perceptual Gap**	- Gap between Official Discourse and Lived Experience	Discourse-reality gap; Symbolism; Distrust	“It’s great on paper, but not in real life.” (Interview 6) “The slogan is ‘smart,’ but the experience is ‘ordinary’.” (Interview 8)

Technological Capabilities and Smart Infrastructure	**Capacities and Potential Possibilities**	- Potential for a Human-Centric Redefinition of Urban Smarting	Potential capacity; Human-centric transition; Contextualization	“If it becomes human-centric, it can be useful.” (Interview 1) “Technology can help; it shouldn’t dominate.” (Interview 5)

Main Theme A: Access, Technology, and Usability

The data analysis revealed that within District 6 of Tehran, mere access to smart technologies does not necessarily translate into meaningful citizen engagement. Despite extensive technological infrastructure, users face limitations such as a digital literacy gap, system complexity, and a non-human-centric design. For instance, one citizen stated: *“The systems exist, but not everyone knows how to use them; in practice, only a select few benefit”* (Interview 3). Another added: *“The design of the systems has been more from an engineering perspective than a citizen-centric one”* (Interview 2). These accounts indicate that technology, without considering the actual capabilities of its users, cannot fulfill its role as a facilitator for enhancing livability.

These findings align with Amartya Sen’s capability approach, which posits that the true measure of development and justice is the *actual* capability of individuals to utilize resources, rather than the mere existence of infrastructure. In the dense and diverse context of District 6, disparities in digital literacy and the ability to use technology have exacerbated inequalities in urban livability, resulting in marginalized groups benefiting only minimally from smart services. From a critical perspective, technology in some instances has become not merely a facilitator but an instrument for controlling the urban experience, thereby constraining lived experiences and reproducing inequalities.

Main Theme B: Governance, Power, and Decision-Making

The data indicate that smart city policies in District 6 are predominantly technocratic and top-down, with citizen participation being largely symbolic. One interviewee noted: *“Participation is mostly limited to information dissemination; citizens provide data but have no stake in the decision-making”* (Interview 7). Another emphasized: *“Decisions are mostly made behind a desk with numbers and charts, not by seeing the reality on the street”* (Interview 2). This suggests that digital governance, without a genuine representation of users' needs and experiences, can intensify the concentration of power and the reproduction of inequality.

A theoretical analysis inspired by Weber and Foucault reveals that instrumental and technocratic rationality often shapes the logic of decision-making, where data and technical efficiency are prioritized over human experience. Furthermore, Healey's approach emphasizes the importance of institutional-social participation, which has been implemented in a limited and superficial manner in District 6. These findings suggest that without a fundamental redefinition of governance processes, smartening may function as a tool for reinforcing existing power structures.

Main Theme C: Mobility, Time, and Lived Pressures

The smartening of transportation in District 6, despite relatively improving traffic flow efficiency, has led to an acceleration of the urban rhythm and an increase in temporal pressures. One citizen expressed: *"Everything has become faster, but not easier"* (Interview 5), while another said: *"Traffic has improved, but the pedestrian experience has not"* (Interview 3). This evidence shows that technical upgrades to systems, without regard for lived experience and the needs of pedestrian movement, merely increase productivity without enhancing the quality of life.

This issue corresponds with the concepts of time-space compression (Harvey) and social acceleration (Rosa), as smart technologies and management accelerate the pace of life, thereby heightening temporal and psychological constraints. Consequently, while smartening may offer instrumental and functional benefits, it fails to alleviate lived and psychological pressures without a human-centric design that prioritizes the lived experience.

Main Theme D: Space, Lived Experience, and Environmental Quality

Data analysis indicates that many smart city projects in District 6 are not aligned with the "right to the city" and the lived experience of users. According to one interviewee: *"Technology has arrived, but the space has not improved"* (Interview 4). Another added: *"The city has become smart, but not livable"* (Interview 9). These experiences demonstrate that technology, without considering spatial and human needs, cannot enhance environmental quality and the lived experience.

This theme aligns with Lefebvre's theory of the production of space and the human-centric approaches of Gehl and Jacobs, as it emphasizes that space is not merely a substrate for technology but must respond to human, social, and mobility needs. The analysis of this theme reveals that in District 6, the design of systems has often prioritized the logic of systems and data over human experience, thereby limiting citizens' right to the meaningful use of urban spaces.

Main Theme E: Justice, Inclusion, and Overlooked Groups

The data revealed that smartening distributes its benefits unevenly. One citizen stated: *"Not everyone benefits equally"* (Interview 7), while another said: *"Employees and students benefit, but others don't"* (Interview 5). These findings indicate that disadvantaged groups, transient users, and individuals with low digital literacy benefit less from the advantages of smart city initiatives.

This theoretical analysis is consistent with distributive justice (Rawls), capability justice (Sen), and difference-based justice (Young). Critically, these findings suggest that without integrating justice and social inclusion into system design, smart city development can lead to the reproduction of urban inequality.

Main Theme F: Discourse, Meaning, and the Perceptual Gap

In District 6, a significant gap was observed between the official discourse and the actual experience of users. A resident noted: *"It's great on paper, but not in real life"* (Interview 6), and another added: *"The slogan is 'smart,' but the experience is 'ordinary'"* (Interview 8). This gap indicates that while policies and programs are articulated in the language of innovation and progress, the actual experience of citizens has not necessarily improved. This analysis is consistent with the critical approach of Flyvbjerg and Hajer, as it underscores that policy discourse may not represent the lived reality of users. In District 6, this gap has led to mistrust and reduced acceptance of smart policies.

Main Theme G: Capacities and Potential Possibilities

Despite the criticisms raised, participants also saw the potential for smart city initiatives to enhance urban livability, provided that the approaches are human-centric, context-based, and participatory. One citizen said: *"If it becomes human-centric, it can be useful"* (Interview 1), and another added: *"Technology can help; it shouldn't dominate"* (Interview 5). This theme adopts a critical-constructivist perspective on the future of smart city development, showing that in District 6, genuine citizen participation and the localization of policies can transform technology from a controlling instrument into an agent for enhancing livability.

Step Six: Formulating the Final Analytical Narrative

In the final stage, the main themes were integrated into a coherent analytical narrative. The results showed that urban smartening in District 6 of Tehran is not a uniform or linear process but rather a multidimensional, contradictory, and context-based phenomenon. While some components of smart city development have contributed to improving managerial efficiency, their consequences for urban livability have been highly dependent on governance, justice, lived experience, and human-centric design.

Overall, the findings confirm that urban smartening can lead to enhanced livability only if it transcends the technological layer and evolves into a socio-spatial mechanism for improving the quality of urban life.

5.2. Structural Equation Modeling (SEM)

This section presents the results of the Structural Equation Modeling (SEM) conducted to empirically examine the mechanisms through which urban smartening impacts urban livability in District 6, Tehran. The integration of the qualitative and quantitative phases was executed cyclically: initially, seven main themes were extracted from the qualitative data via thematic analysis, and subsequently, the sub-themes and associated codes were utilized to design the questionnaire items. Each item was constructed to reflect both the lived experience of the citizens and the theoretical concepts underpinning each theme. This process ensures that the quantitative constructs are directly grounded in qualitative evidence rather than being a mere superficial transposition of themes.

Pre-Test and Measurement Model

The measurement model comprised seven main latent constructs:

- Access, Technology, and Usability (SATU)
- Governance, Power, and Decision-Making (GPD)
- Mobility, Time, and Lived Pressures (MTLP)
- Space, Lived Experience, and Environmental Quality (LSEQ)
- Justice, Inclusion, and Overlooked Groups (EI)

- Discourse, Meaning, and the Perceptual Gap (DG)
- Capacities and Potential Possibilities (HCP)

The fit of the measurement model was evaluated using specific indices. The results indicate an adequate fit for the measurement model and successfully validate the constructs. All factor loadings were above 0.6, confirming the convergent validity of the constructs.

Table 4: Goodness-of-Fit Indices for the Measurement Model

Index	Value	Recommended Threshold	Interpretation
χ^2 (CMIN)	421.35	–	Acceptable
CMIN/DF	1.87	< 3	Good Fit
GFI	0.923	> 0.90	Good Fit
CFI	0.947	> 0.90	Excellent Fit
TLI	0.938	> 0.90	Excellent Fit
RMSEA	0.048	< 0.08	Good Fit
SRMR	0.041	< 0.08	Good Fit
NFI	0.912	> 0.90	Good Fit

Structural Path Analysis

Following the validation of the measurement model, the structural path model was tested to investigate the relationships between the components of urban smartening and urban livability. The results of the direct and mediating paths revealed that all model relationships are statistically significant, thereby confirming the impact of exogenous constructs on mediating and endogenous variables.

Table 5 presents the standardized regression coefficients, standard errors (S.E.), critical ratios (C.R.), Bootstrap means, and significance levels of each indicator relative to its corresponding latent construct. The results indicated that the components of access, technology, and usability significantly influence lived experience and urban livability capacities.

The component “Technological Capability as a Real Opportunity,” with a standardized regression coefficient of 0.68, a standard error of 0.07, and a critical ratio of 9.71, holds high statistical significance ($p<0.001$). This demonstrates that genuine access to technology and its capabilities is a crucial factor in shaping the user experience. The component “Design-User Experience Gap,” with a standardized regression coefficient of 0.72, a standard error of 0.06, and a critical ratio of 11.22, exerts the greatest impact on the Access, Technology, and Usability construct, highlighting the paramount importance of aligning technological design with user experiences. Furthermore, the indicator “Technology as an Instrument of Control Rather than a Facilitator,” with a standardized regression coefficient of 0.63, a standard error of 0.08, and a critical ratio of 8.58, has a significant effect on Access, Technology, and Usability. This indicates that the role of technology is not merely confined to facilitation but can also manifest as a mechanism of control.

Within the Governance, Power, and Decision-Making construct, the indicator “Dominance of Technocratic Rationality,” with a standardized regression coefficient of 0.69, a standard error of 0.07, and a critical ratio of 10.12, is significant, indicating the prevalence of technocratic logic in urban decision-making. The indicator “Weakening of Participatory Governance,” with a standardized regression coefficient of 0.65, a standard error of 0.07, and a critical ratio of 9.29, demonstrates a decline in citizen participation in the urban decision-making process. Furthermore, the indicator “Reproduction of Power and Inequality,” with a standardized regression coefficient of 0.71, a standard error of 0.06, and a critical ratio of 11.02, also possesses statistical significance ($p<0.001$), confirming the reproduction of inequalities through digital governance.

The Mobility, Time, and Lived Pressures construct revealed that “Time-Space Compression,” with a standardized regression coefficient of 0.62, a standard error of 0.08, and a critical ratio of 8.418, along with the indicator “Systemic Efficiency without Enhancing Mobility Experience,” with a standardized regression coefficient of 0.66, a standard error of 0.07, and a critical ratio of 9.43, have a substantial and significant impact on the mobility experience and the compression of urban life.

Within the Space, Lived Experience, and Environmental Quality construct, the indicator “Disjuncture of Smartening from Lived Experience,” with a standardized regression coefficient of 0.74, a standard error of 0.06, and a critical ratio of 11.50, exhibited the most pronounced effect, emphasizing that smartening, without considering the genuine experience of users, restricts the potential for enhancing environmental quality.

The Justice, Inclusion, and Overlooked Groups construct also significantly impacts the urban lived experience. The indicator “Inequality in Accessing Smart Services,” with a standardized regression coefficient of 0.71, a standard error of 0.07, and a critical ratio of 10.14, and the indicator “Digital Exclusion,” with a standardized regression coefficient of 0.69, a standard error of 0.06, and a critical ratio of 10.36, illustrate the impact of access inequality on urban livability.

The Discourse, Meaning, and Perceptual Gap construct, through the indicator "Gap Between Official Discourse and Lived Experience," with a standardized regression coefficient of 0.67, a standard error of 0.07, and a critical ratio of 0.57, demonstrates the divergence between official policies and citizens' actual experiences.

Finally, the Capacities and Potential Possibilities construct, featuring the indicator "Potential for Human-Centric Redefinition of Smartening," with a standardized regression coefficient of 0.75, a standard error of 0.06, and a critical ratio of 12.10, exerts the highest positive impact on urban livability, underscoring the importance of the human-centric dimension in the urban smartening process. All indicators were statistically significant, and a significance level of $p<0.001$ confirms the validity of the results.

Table 5: Standardized Regression Coefficients of the Constructs

Latent Construct	Indicator	Standardized Regression Weight	S.E	C.R	Bootstrap Mean	Significance Level
Access, Technology, and Usability (SATU)	Technological Capability as a Real Opportunity	0.68	0.07	9.71	0.679	< 0.001
	Design-User Experience Gap	0.72	0.06	11.22	0.718	< 0.001
	Technology as an Instrument of Control Rather than a Facilitator	0.63	0.08	8.58	0.629	< 0.001
Governance, Power, and Decision-Making (GPD)	Dominance of Technocratic Rationality	0.69	0.07	10.12	0.692	< 0.001
	Weakening of Participatory Governance	0.65	0.07	9.29	0.648	< 0.001
	Reproduction of Power and Inequality	0.71	0.06	11.02	0.712	< 0.001
Mobility, Time, and Lived Pressures (MTLP)	Time-Space Compression	0.62	0.08	8.41	0.622	< 0.001
	Systemic Efficiency without	0.66	0.07	9.43	0.665	< 0.001

	Enhancing Mobility Experience					
Space, Lived Experience, and Environmental Quality (LSEQ)	Disjuncture of Smarting from Lived Experience	0.74	0.06	11.50	0.739	< 0.001
Justice, Inclusion, and Overlooked Groups (EI)	Inequality in Accessing Smart Services	0.71	0.07	10.14	0.710	< 0.001
	Digital Exclusion	0.69	0.06	10.36	0.693	< 0.001
Discourse, Meaning, and the Perceptual Gap (DG)	Gap Between Official Discourse and Lived Experience	0.67	0.07	9.57	0.668	< 0.001
Capacities and Potential Possibilities (HCP)	Potential for Human-Centric Redefinition of Smarting	0.75	0.06	12.10	0.749	< 0.001

The correlation matrix of the constructs illustrates the degree of interrelationship among the components of urban smartening and urban livability. The analysis of this matrix revealed that all relationships between the constructs are positive and statistically significant ($p<0.01$). The Access, Technology, and Usability construct has a correlation of 0.54 with the Governance, Power, and Decision-Making construct, indicating that improving technological access coupled with effective governance can enhance the urban lived experience. Furthermore, Access, Technology, and Usability correlates at 0.47 with Mobility, Time, and Lived Pressures, and at 0.61 with Space, Lived Experience, and Environmental Quality, confirming its impact on spatial experience and urban livability.

The Governance, Power, and Decision-Making construct demonstrated a correlation of 0.57 with Space, Lived Experience, and Environmental Quality, 0.62 with Justice, Inclusion, and Overlooked Groups (EI), and 0.59 with Capacities and Potential Possibilities, indicating that governance and decision-making power influence not only the lived experience but also social justice and potential capacities.

Mobility, Time, and Lived Pressures also correlates at 0.49 with Space, Lived Experience, and Environmental Quality, 0.5 with Justice and Inclusion, and 0.51 with Capacities and Potential Possibilities, reflecting the mediating role of this construct in reinforcing spatial experience and social justice. Space, Lived Experience, and Environmental Quality holds a correlation of 0.64 with Capacities and Potential Possibilities, emphasizing the significance of the interaction between environmental quality and human capacities in achieving urban livability. Additionally, Discourse, Meaning, and the Perceptual Gap exhibits correlations ranging from 0.41 to 0.53 with the other constructs, highlighting the existing disjuncture between official policies and the actual experiences of citizens in District 6, Tehran.

Overall, the correlation matrix demonstrates that the components of urban smartening—including technology, governance, mobility, environmental quality, justice, and human capacities—operate in an interwoven and mutually influential manner. Consequently, any planning and policy-making in the realm of urban smartening must simultaneously integrate technological, social, spatial, and justice-oriented dimensions.

Table 6: Correlation Test Results Among Research Variables

Construct	SATU	GPD	MTLP	LSEQ	EI	DG	HCP
Access, Technology, and Usability (SATU)	1						
Governance, Power, and Decision-Making (GPD)	0.54	1					
Mobility, Time, and Lived Pressures (MTLP)	0.47	0.51	1				
Space, Lived Experience, and Environmental Quality (LSEQ)	0.61	0.57	0.49	1			
Justice, Inclusion, and Overlooked Groups (EI)	0.55	0.62	0.50	0.58	1		
Discourse, Meaning, and the Perceptual Gap (DG)	0.41	0.48	0.44	0.46	0.53	1	
Capacities and Potential Possibilities (HCP)	0.63	0.59	0.51	0.64	0.61	0.49	1

Note: Based on the provided summary, all correlations are statistically significant at the p<0.01

6. Discussion

The aim of this research was to explicate the mechanism through which urban smartening impacts urban livability in District 6, Tehran, and to analyze the relationships among technological, governance, social innovation, and citizen experience dimensions within a structural framework. Unlike the bulk of the literature, which has either been confined to measuring technological indicators (Abdelkarim et al., 2023; Mittal & Sethi, 2018) or adopted a normative and conceptual approach (Sofeska, 2017; Kim et al., 2021), this study utilized an exploratory-explanatory design. First, it extracted the institutional logic of smartening through a thematic analysis of 13 interviews with urban managers, elites, and experts. Subsequently, it tested the resulting constructs at the level of District 6 citizens using structural equation modeling. Therefore, the core problem was not merely “whether” smartening impacts livability, but “how” and “under what institutional and spatial conditions” this impact materializes.

The research findings indicated that the impact of smart governance and social innovation components on livability is more significant and sustainable than the direct impact of technological infrastructures. At first glance, this finding is consistent with studies by (Abdelkarim et al., 2023; Lim et al., 2021), as these researches have also demonstrated that technology can only improve the lived experience and the quality of public spaces when implemented within a coordinated institutional and policy framework. However, a major difference compared to East Asian studies (Li et al., 2023; Rui & Othengrafen, 2023) is that in those contexts, technological infrastructure is often accompanied by higher institutional coordination, and its direct impact on citizen satisfaction and urban experience is reported to be stronger. Conversely, in District 6 of Tehran, the density of the floating population, administrative concentration, and the complexity of the urban management hierarchy have caused technology to remain symbolic or purely managerial, failing to translate into a livable experience. From a theoretical perspective, this situation can be analyzed within the framework of the critique of instrumental rationality (Weber, 1922; Foucault, 1980): technology in centralized bureaucratic structures primarily serves managerial efficiency and does not necessarily lead to the enhancement of citizens’ lived experience unless the logic of decision-making is fundamentally reconfigured.

Data analysis also revealed that the gap between citizens’ perceptions and official institutional discourse is substantial; the everyday experience of users diverges significantly from managerial success criteria. This finding aligns with the results of studies by (Rui & Othengrafen, 2023; Zhu et al., 2022), which emphasized the necessity of integrating technology with human-centric design and enhancing social interaction. However, the major distinction lies in the fact that in the context of District 6, temporal pressures, spatial density, and mixed land uses have made the actual experience of livability more dependent on the coordination among technology, policy, and human experience than in other contexts. This issue highlights the critical need for a mediating approach to citizen experience, which studies by Hajjarian (2025) and Sarvestaninejad and Maleki (2025) have also emphasized, yet it has been less frequently tested in quantitative models.

In the realm of justice and social inclusion, the results of this research demonstrated that smartening is selectively and limitedly available to more privileged groups, while disadvantaged groups benefit less from technological advancements. This finding is in line with studies by (Bove & Ghiraldelli, 2025; Mittal & Sethi, 2018), which have identified spatial and technological inequalities as primary challenges in smart cities. The divergence from Asian studies, such as (Wang et al., 2025; Li et al., 2023), is that they have found institutional capacity and integrated policy-making to be crucial moderating variables in reducing inequality, whereas in District 6, the absence of participatory mechanisms and the centralization of decision-making have severely limited this capacity.

Methodologically, utilizing an exploratory-explanatory design and combining qualitative thematic analysis with Structural Equation Modeling (SEM) facilitated a linkage between the governance and citizen levels, thereby enhancing the analytical richness of the model; this integration has been less frequently observed in prior studies, such as (Osakwe et al., 2025; Kim et al., 2021). The theoretical contribution of this research encompasses three primary axes: first, providing empirical evidence from a Middle Eastern metropolis indicating that the relationship between smartening and livability is contingent upon the institutional and spatial context; second, formulating the concept of “institutionally conditioned smartening,” wherein technology translates into livability only if coordination and accountability mechanisms are reformed; and third, demonstrating the mediating role of citizen experience in dense, administrative contexts where a floating population and high temporal pressure render the perception of quality of life highly sensitive.

From a theoretical standpoint, this study offers three major additions: first, redefining the smartening-livability nexus as a relationship conditional upon justice and lived experience within a high-density urban environment; second, critically localizing smart city theories in a non-

Western context, demonstrating that institutional capacity and governance culture are determinant variables; and third, presenting an integrated model that leverages qualitative data to construct quantitative constructs, thereby bridging the gap between interpretive and positivist approaches. Methodologically, the cyclical integration of thematic analysis with instrument design and SEM testing demonstrated that the conceptual validity of constructs can be bolstered through qualitative evidence, although longitudinal studies remain essential for strengthening causal inference.

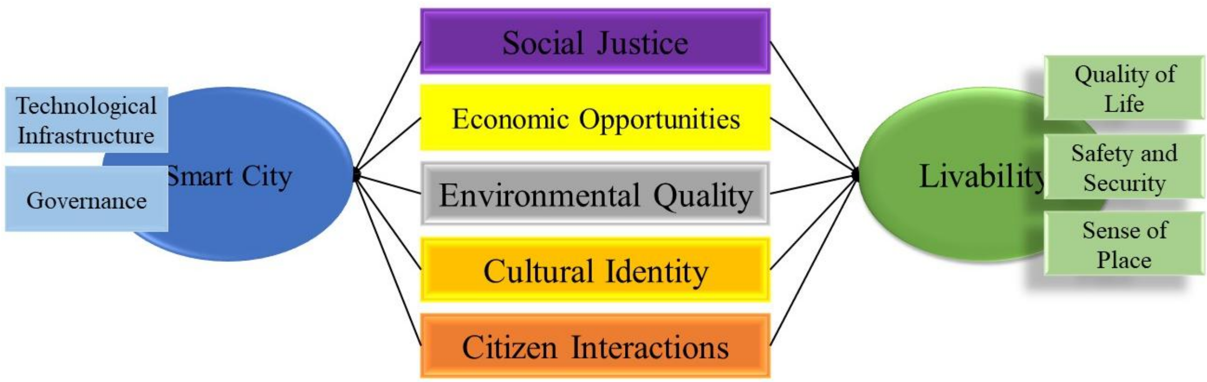

Figure 3: Proposed Critical Framework

The policy implications of these findings are substantial: a sole focus on digital infrastructure development without reforming intersectoral coordination mechanisms will have a limited impact on livability. For District 6, smart policies must concentrate on managing the floating population, the temporal regulation of services, enhancing the quality of public spaces, and establishing mechanisms for genuine participation. Smartening performance evaluation indicators must also shift from technology-centric criteria to experience-centric metrics. Future researchers could investigate the dynamics of structural relationships and the generalizability of these results through comparative studies across different districts of Tehran, as well as through longitudinal studies.

Nevertheless, certain limitations exist. The quantitative data is cross-sectional, precluding definitive causal inferences, although the theoretical framework and thematic analysis assisted in understanding the relationships. The qualitative interviews were limited to 13 participants and may not have captured all institutional perspectives. The focus on District 6 also restricts the generalizability of the results to other districts with disparate characteristics. Furthermore, certain macro-economic and political variables that influence the executive capacity of urban management were not incorporated into the model.

The ultimate conclusion of the research elucidates that urban smartening in District 6 of Tehran can only lead to the enhancement of livability and quality of life when it transcends the realm of technology and transforms into a socio-spatial, human-centric, and justice-oriented mechanism. Key mechanisms include the actual capability of technology, design aligned with user experience, participatory governance, inequality reduction, and attentiveness to temporal and spatial pressures. These findings underscore that the success of a smart city is the corollary of the simultaneous interaction of technological, social, spatial, and justice-oriented dimensions; proposing smart policies and planning without accounting for these dimensions guarantees neither efficiency nor livability.

Author Contributions

All authors had an equal role in the conceptualization, methodology, analysis, and writing of this article.

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Conflict of Interest

The authors declare that there are no actual or potential conflicts of interest regarding the publication of this article.

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