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Designing a Knowledge City Model in Isfahan with Emphasis on the Experiences of Selected Cities

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Abstract

Knowledge cities are among the new models of urban development and emphasize the creation, dissemination, and application of knowledge, human capital development, innovation, and the formation of effective interactions among universities, industry, government, and society. The present study aimed to design a knowledge city model for Isfahan with an emphasis on the experiences of selected cities. The study was qualitative in approach, applied in purpose, and conducted using an inductive approach and thematic analysis. Data were collected through semi-structured interviews with 18 senior urban and public administration managers and experts and academic specialists, selected purposively and through snowball sampling. Data analysis was conducted through repeated reading of the interview transcripts, extraction of initial codes, comparison and classification of similar codes, and development of subthemes, organizing themes, and overarching themes. The findings led to the identification of six overarching themes: administrative structure redesign with a facilitative approach; an interactive university, industry, and community ecosystem; integrated management of resilience to physical crises; governance and empowerment of emerging human capital; reengineering of the urban management revenue system; and management of benchmarking and localization of global experiences. The results show that realizing a knowledge city in Isfahan requires an integrated approach in which urban governance reform, strengthened university–industry interactions, development of smart and resilient infrastructure, empowerment of human capital, creation of innovative financial mechanisms, and intelligent use of global experiences are pursued simultaneously. Accordingly, the Isfahan knowledge city model should be designed and implemented in accordance with the city's local capacities and characteristics, with emphasis on cooperation among the key actors of the knowledge and innovation ecosystem.

Keywords: Knowledge city, knowledge-based urban development, urban management, human capital, Isfahan.

1. Introduction

The accelerating transition from industrial economies toward knowledge-based economies has fundamentally changed the ways in which cities create value, compete, govern resources, and respond to social, economic, technological, and environmental challenges. In the contemporary urban environment, physical capital, land, natural resources, and conventional infrastructure, although still important, are no longer sufficient to secure sustainable competitiveness and long-term prosperity. Increasingly, cities derive their developmental capacity from the production, circulation, absorption, and application of knowledge, as well as from their ability to attract skilled human capital, stimulate innovation, develop institutional learning,

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and establish productive relationships among scientific, economic, governmental, and social actors. This shift has contributed to the emergence of the concept of the "knowledge city," in which knowledge is not merely regarded as an output of universities or research institutions but as a strategic urban resource embedded in economic activity, governance, social relations, technological systems, and the everyday functioning of the city. From this perspective, a knowledge city can be understood as an urban ecosystem in which intellectual capital, innovation, technology, learning, institutional interaction, and quality of life are deliberately connected to achieve sustainable development. Research on knowledge-based urban development in Iran has similarly emphasized that the transition toward a knowledge city requires an integrated framework rather than isolated investments in scientific institutions or technological infrastructure (Behzadpour et al., 2021; Sarvar et al., 2020).

A knowledge city is therefore more than a technologically advanced or digitally connected city. Its distinctive feature lies in the capacity to transform knowledge into economic, social, institutional, and environmental value. Such transformation depends on the existence of mechanisms through which universities, research centers, firms, knowledge-based enterprises, public agencies, civic institutions, and citizens can exchange information and combine complementary resources. Knowledge-based society theory reinforces this argument by suggesting that contemporary development increasingly depends on the ability of individuals and institutions to generate, access, interpret, and apply knowledge rather than simply accumulate physical resources. The development of knowledge societies consequently requires investment in education, digital literacy, research capacity, institutional learning, communication infrastructure, and opportunities for continuous knowledge exchange. Evidence from the development of knowledge-based societies shows that the availability of educational and technological resources alone is insufficient unless these resources are supported by institutional arrangements that encourage participation, learning, innovation, and the effective utilization of knowledge (Kerubo, 2023). Knowledge-city development should therefore be conceptualized as a multidimensional process that simultaneously encompasses human, technological, economic, institutional, spatial, and social dimensions.

At the regional and urban levels, this multidimensional character is particularly evident in regional innovation systems. Innovation is rarely produced by a single organization acting independently; rather, it develops through repeated interactions among universities, industries, government agencies, financial institutions, intermediary organizations, entrepreneurs, and users. Regional innovation-system theory accordingly emphasizes the geographical and institutional embeddedness of innovation and considers the quality of relationships among regional actors to be a crucial determinant of a region's capacity to generate and commercialize knowledge. The evolutionary perspective on regional innovation systems further demonstrates that innovation capacity develops cumulatively through institutional learning, path-dependent processes, and the gradual strengthening of networks connecting knowledge producers and users (Cooke et al., 2024). For knowledge cities, this implies that universities cannot remain isolated centers of education and research, industries cannot function merely as consumers of technology, and urban governments cannot restrict themselves to administrative regulation. These actors must operate as interconnected components of an innovation ecosystem in which ideas, skills, technologies, financial resources, and practical problems circulate across organizational boundaries.

Within this ecosystem, the relationship between universities, industries, government, and society becomes particularly important. Universities generate scientific knowledge and educate skilled human resources, while industries provide the context within which knowledge may be transformed into products, technologies, and services. Government establishes legal, financial, and institutional conditions for collaboration, whereas citizens and civil society contribute contextual knowledge, social needs, creativity, and legitimacy. The knowledge city therefore increasingly reflects a multiple-helix logic in which value creation emerges from interaction among several institutional spheres rather than from a linear transfer of university knowledge to industry. Iranian studies have shown that one of the principal requirements of knowledge-based urban development is the creation of durable institutional linkages capable of connecting scientific capacity with local economic and urban needs (Hosseini et al., 2023). Similarly, analyses of Tehran indicate that the spatial and functional requirements of a knowledge city encompass not merely concentrations of universities or technological firms but also appropriate accessibility, communication networks, innovation-oriented urban functions, and institutional mechanisms supporting interaction among knowledge actors (Pasban et al., 2024).

The effective circulation of knowledge also depends on knowledge management. Knowledge must be identified, generated, stored, exchanged, recombined, and applied if it is to contribute to urban innovation and sustainable development. At the

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organizational level, research has demonstrated that knowledge-management processes can support innovation by enabling actors to access experience, share specialized knowledge, and convert individual learning into collective capabilities. Green knowledge management is especially relevant to contemporary urban development because it links knowledge practices with environmental innovation and sustainability outcomes. Evidence suggests that knowledge management, particularly when reinforced by an organizational culture supportive of sustainability, can enhance green innovation and contribute to broader sustainable-development objectives (Wang et al., 2022). These findings are significant for knowledge-city development because cities face complex environmental challenges that cannot be solved solely through conventional physical planning. Instead, addressing issues such as energy consumption, water scarcity, air pollution, land degradation, transportation inefficiency, and waste management requires the integration of scientific knowledge, digital data, technological innovation, institutional coordination, and citizen behavior.

Technological and digital infrastructure constitutes another essential layer of the knowledge-city ecosystem. High-speed communication networks, open data platforms, data centers, smart urban systems, artificial intelligence, the Internet of Things, and advanced analytical capabilities can substantially increase the speed with which urban knowledge is generated and used. Nevertheless, technology should be understood as an enabling infrastructure rather than the ultimate objective of knowledge-city development. Research on smart-city policy has shown that urban technological initiatives may generate environmental and energy benefits when they are linked to coherent planning and institutional arrangements. For example, evidence from smart-city pilot policies demonstrates that urban planning and digital transformation can support cleaner energy development and improve coordination between technological modernization and environmental objectives (Chen, 2023). Accordingly, the knowledge city differs from a narrowly conceived smart city because it places technological systems within a broader framework of human capital, knowledge creation, innovation, governance, learning, and social interaction.

Knowledge sharing between government and citizens is especially important in ensuring that technological and informational resources contribute to inclusive urban development. A knowledge city requires multidirectional information flows rather than a one-way model in which public authorities merely collect information and deliver services. Citizens can act as knowledge producers by identifying local problems, proposing solutions, contributing data, participating in urban experimentation, and evaluating public services. Comparative evidence across a large number of cities has demonstrated that government–citizen knowledge sharing is influenced by institutional and contextual conditions and that urban governments can strengthen knowledge exchange by creating appropriate participatory and informational mechanisms (Sun et al., 2023). This perspective underscores the importance of open government, transparency, participatory governance, and collaborative platforms in knowledge-city development. Without such mechanisms, substantial scientific and technological resources may remain fragmented and disconnected from the practical concerns of urban communities.

The importance of citizen participation also highlights the role of social capital. Trust, networks, reciprocity, shared norms, and patterns of cooperation facilitate collective action and make the transfer of knowledge across institutional and social boundaries more efficient. Social capital theory suggests that relationships themselves constitute a resource because they enable individuals and organizations to access information, coordinate actions, reduce uncertainty, and cooperate toward shared objectives (Tsounis & Xanthopoulou, 2024). In a knowledge city, strong social capital can facilitate collaboration between researchers and businesses, strengthen public confidence in government institutions, support entrepreneurial networks, increase citizens' willingness to participate in urban projects, and create communities in which knowledge sharing becomes culturally normalized. Conversely, low trust, weak interorganizational relationships, institutional fragmentation, and limited participation can substantially reduce the effectiveness of investments in scientific and technological capacity.

At the micro and organizational levels, the willingness of individuals to seek knowledge represents another critical component of innovation. Knowledge-intensive teams and organizations depend not only on formal access to information but also on employees' intentions and efforts to locate expertise, request information, learn from colleagues, and integrate diverse forms of knowledge. Research in knowledge-based firms has indicated that knowledge-seeking behavior is shaped by individual and organizational antecedents and that effective knowledge creation depends on motivational and relational conditions supporting knowledge exchange (Zhang et al., 2022). Transferred to the urban scale, this finding suggests that the development of a knowledge city requires more than constructing physical research facilities. The city must cultivate a culture

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in which organizations and individuals actively search for knowledge, learn from one another, experiment with new solutions, and treat continuous learning as a normal component of urban economic and social life.

The cultural and institutional dimensions of knowledge-based development are especially relevant because knowledge-city initiatives frequently encounter problems arising from bureaucracy, fragmented decision-making, risk aversion, weak organizational learning, and limited coordination among actors. Analyses of knowledge-based development have emphasized that institutional conditions can either facilitate or constrain the transformation of scientific capabilities into developmental outcomes (Hanafi Neiri et al., 2023). In this regard, knowledge cities require governance structures capable of reducing unnecessary administrative barriers, coordinating multiple institutions, empowering specialized actors, supporting experimentation, and creating intermediary organizations that connect different sectors. Such intermediary structures are particularly important when universities and industries operate according to different incentives, languages, time horizons, and organizational cultures.

Knowledge-city development must also remain sensitive to the broader social consequences of urban transformation. Contemporary urban theory increasingly emphasizes that innovation-oriented urban policies should not be evaluated exclusively through aggregate economic growth, investment, or technological modernization. Questions of spatial inequality, access to housing and services, social justice, displacement, participation, and the distribution of development benefits are equally important. Recent work examining urban governance and residents' experiences demonstrates that development models that prioritize economic attractiveness without sufficient attention to residents' needs may intensify perceptions of injustice and generate social resistance (Gorji et al., 2026). Similarly, critical perspectives on urban theory stress that urban structures are shaped by unequal distributions of economic, cultural, and social capital and that knowledge-based urban policies should therefore account for differences in citizens' capacities to participate in and benefit from urban transformation (Berki, 2025). Hence, an inclusive knowledge city should seek to broaden access to education, innovation, digital infrastructure, entrepreneurial opportunities, and participatory institutions rather than confining knowledge-based development to selected elites, districts, or organizations.

Sustainability represents another indispensable dimension of knowledge-city development. Knowledge-based urban transformation should enhance the ability of cities to address environmental pressures and improve long-term resilience. This requirement is particularly important in cities experiencing water scarcity, air pollution, land subsidence, traffic congestion, aging infrastructure, and pressures associated with rapid physical development. Urban development policies that prioritize construction-based revenues and intensive physical growth may generate significant environmental and spatial consequences. Research on density-selling policies in Tehran, for instance, has emphasized the connections between urban-development policies, physical patterns, and environmental conditions (Rostami et al., 2023). Such evidence illustrates why the transition toward a knowledge city must also involve reconsideration of conventional municipal revenue and development models. Knowledge-based revenue generation, innovation financing, technological entrepreneurship, and sustainable investment mechanisms can potentially reduce dependence on environmentally costly patterns of urban growth.

The experience of Iranian cities indicates that the realization of knowledge-based urban development requires contextualization. Models developed in cities such as Singapore, Helsinki, Seoul, Barcelona, or other internationally recognized innovation centers cannot simply be transferred without consideration of differences in governance systems, economic structure, institutional capacities, cultural patterns, financial mechanisms, and local social conditions. Research on the relationship between the knowledge society and smart-city development in Iranian contexts has emphasized the importance of integrating technological advancement with local knowledge structures, social relationships, and sustainability requirements (Elmi et al., 2025). Likewise, studies focused on Iranian knowledge cities have argued for locally grounded models capable of incorporating national institutional characteristics while benefiting from international experiences (Behzadpour et al., 2021). Thus, benchmarking should function as a learning process rather than an exercise in replication. Successful international practices need to be interpreted, adapted, and recombined according to the specific capacities and constraints of the city in which they are applied.

This issue is particularly relevant for Isfahan. As one of Iran's historically significant cultural, educational, industrial, and urban centers, Isfahan possesses a combination of assets that can support movement toward knowledge-based urban development. The city contains major universities and research institutions, large industrial enterprises, technological and

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entrepreneurial capacities, a substantial pool of educated human resources, and a strong cultural and historical identity. At the same time, these assets do not automatically produce a knowledge city. Knowledge-city development depends on the degree to which these resources are connected within a coherent institutional system. The Iranian literature has repeatedly identified fragmentation among knowledge-producing institutions, economic organizations, public agencies, and urban-management bodies as an important obstacle to knowledge-based urban development (Sarvar et al., 2020). Experiences from Qazvin also indicate that becoming a knowledge city requires systematic coordination among knowledge production, innovation, spatial development, governance, and local institutional capacities rather than the isolated expansion of scientific organizations (Hosseini et al., 2023).

For Isfahan, the spatial and institutional requirements of knowledge-city development are further complicated by the need to reconcile scientific and industrial growth with environmental resilience, infrastructure modernization, social participation, and sustainable urban finance. The city needs mechanisms capable of directing academic research toward local problems, facilitating technology transfer between universities and industries, supporting startups and knowledge-based companies, creating digital and data infrastructures, attracting and retaining talented individuals, and increasing the participation of citizens in knowledge-based processes. The development of a knowledge city should therefore be regarded as a governance transformation as much as an economic or technological transformation. Urban management must gradually evolve from a predominantly direct administrative role toward facilitation, coordination, regulation, evidence-based decision-making, and ecosystem orchestration. Research on Iranian knowledge-based urban development supports the importance of establishing coherent structures through which scientific, institutional, spatial, and socioeconomic capacities can be integrated into a unified developmental framework (Pasban et al., 2024).

Financing is another critical challenge because the formation of innovation ecosystems, smart infrastructure, research networks, entrepreneurial platforms, and resilient urban systems requires substantial and sustained resources. Conventional public budgets are rarely sufficient for this purpose. Knowledge cities therefore require diversified financing mechanisms, including venture capital, corporate venture capital, innovation funds, public–private partnerships, targeted incentives, and institutional procurement of innovative products and services. A knowledge-oriented financial architecture can also stimulate entrepreneurship by reducing the risks faced by emerging firms during early stages of development. Such mechanisms are especially important where municipalities traditionally depend heavily on construction-related revenues. The transition to knowledge-based revenue generation can connect urban financial sustainability to entrepreneurship, digital services, commercialization of innovation, and the creation of intellectual and technological value rather than continued dependence on physical expansion.

Despite the growing body of research on knowledge cities, smart cities, knowledge societies, regional innovation systems, social capital, and knowledge management, an important gap remains between broad theoretical frameworks and the design of locally grounded urban models capable of responding simultaneously to institutional, environmental, economic, technological, financial, and sociocultural realities. Existing studies in Iran have illuminated important dimensions of knowledge-based development, including the conceptual structure of knowledge cities (Behzadpour et al., 2021), the challenges of their realization (Sarvar et al., 2020), spatial and functional requirements (Pasban et al., 2024), the pathway toward knowledge-city development in Qazvin (Hosseini et al., 2023), and the relationship between knowledge communities, smart-city development, and urban sustainability (Elmi et al., 2025). Nevertheless, Isfahan requires a model capable of integrating these dimensions with its own distinctive governance structure, industrial base, scientific capacities, environmental vulnerabilities, human-capital resources, urban financial conditions, and cultural characteristics. Such a model should also benefit from international knowledge while avoiding mechanical imitation, thereby converting benchmarking into a process of contextual learning and institutional adaptation.

Accordingly, the aim of the present study was to design a knowledge city model for Isfahan with emphasis on the experiences of selected cities.

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2. Methods and Materials

This study was qualitative in approach and applied in purpose and was conducted inductively within an interpretive paradigm. Given the exploratory nature of the study and its aim of identifying the dimensions and requirements for designing a knowledge city model in Isfahan with emphasis on the experiences of selected cities, thematic analysis was used to analyze the qualitative data. Thematic analysis is a systematic method for identifying, analyzing, and reporting meaningful patterns in qualitative data and enables dispersed textual data to be organized and converted into a coherent set of concepts and themes.

The study population consisted of experts and scholars familiar with urban management, public administration, urban development, and the knowledge city. The criteria for selecting participants were relevant specialized knowledge and experience, managerial or professional experience in urban and public administration, faculty membership, or scholarly and research activity in the field of the knowledge city and related topics.

Sampling was purposive, and snowball (chain-referral) sampling was also used to identify and access some key informants. Interviewing and data analysis proceeded simultaneously: after each interview, the data were coded and analyzed, and the resulting findings were followed up and examined in subsequent interviews. Data collection continued until saturation was reached, so that no new or distinct concepts were added to the earlier findings in the final interviews. Ultimately, 18 senior managers, urban and public administration experts, and academic scholars participated in the study.

The main study data were collected through semi-structured interviews. The interview guide was developed on the basis of the research objectives and a review of the theoretical and empirical literature and covered topics such as the concept and components of the knowledge city, Isfahan's capacities and challenges, the roles of universities and industry, the roles of government and the municipality, technological and digital infrastructure, university–industry–government interaction, human capital and elite recruitment, citizen participation, culture and social capital, institutional and legal requirements, coordination between the city's physical and knowledge development, and the experiences of selected cities. The semi-structured nature of the interviews made it possible to ask follow-up questions suited to participants' responses and to pursue new topics related to the research objectives. To complete and enrich the data, scientific literature, previous studies, and relevant documents concerning knowledge cities and the experiences of selected cities were also reviewed in addition to the expert interviews. With the participants' consent, the interviews were recorded, transcribed, and entered into the coding process after preparation for analysis.

The interview data were analyzed using thematic analysis, drawing on the stages proposed by Braun and Clarke (2006). The analysis was conducted in six stages. First, the interview transcripts were read several times to develop a deep understanding of the data. Second, meaningful sections related to the research question and objectives were identified and initial codes were created for them. Third, similar and related codes were compared and organized into basic themes. Fourth, the basic themes were reviewed and combined into higher-level or organizing themes. Fifth, the final themes were reviewed, defined, and named, and overarching themes were extracted. Sixth, the thematic network and final findings were developed and reported. The process was iterative, and the themes were continually compared with the original interview transcripts to ensure their internal coherence and conformity with the raw data. Repetitive codes or codes insufficiently related to the research objectives were removed or merged. MAXQDA software was used to organize and manage the codes and themes. The output of this process was a set of initial codes and basic themes that were converted at higher levels into organizing themes and, ultimately, overarching themes related to designing a knowledge city model in Isfahan.

To increase the reliability of the qualitative analysis, test–retest procedures and inter-coder agreement were used. In the test–retest procedure, a portion of the interviews was coded at two points in time and the consistency of the coding was compared. To assess inter-coder agreement, several interviews were independently coded by the researcher and a coder familiar with the research topic, and the level of agreement between them was examined. In addition, continuous review of codes and themes, comparison of the findings with the original interview transcripts, use of diverse expert perspectives, and reliance on previous literature and studies were considered to increase the validity and trustworthiness of the findings. Finally, the results of the thematic analysis were organized into basic themes, organizing themes, and overarching themes, and the resulting thematic network served as the basis for identifying the components and dimensions of the proposed knowledge city model in Isfahan.

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3. Findings and Results

In this study, data collected through semi-structured interviews with experts and specialists in public administration and urban management were examined using thematic analysis. The purpose was to identify latent and manifest meaning patterns in the participants' statements and to extract themes capable of explaining the knowledge city model. At this stage, the interview content was analyzed systematically, and related meaning units were extracted and converted into initial codes. In the next stage, the initial codes from each interview were organized in separate tables. These tables contain key sentences extracted from the interview text, initial labels (conceptual codes), and information about the interviewee, making it possible to trace the data precisely and increasing the transparency of the analysis. This structure facilitates understanding of the data, comparison across interviews, and identification of conceptual similarities and differences among participants' views. In the next step, codes extracted from different interviews were compared and merged and guided toward the formation of subthemes and main themes. This process enabled movement from description to interpretation and allowed the researcher to analyze and explain the relationships among the concepts in the knowledge city model more deeply.

Table 1. Clustering of Merged Initial Labels and Extraction of Subthemes

Row	Merged Initial Labels	Interviewee Codes	Subcode
1	Capable universities; active research centers; scientific knowledge production; specialist training; applied research	M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M15, M16, M17, M18	Scientific and research capacity of the city
2	University–industry relations; research cooperation; technology transfer; knowledge commercialization; solving industrial problems	M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M15, M16, M17, M18	University, industry, and government interaction
3	Science and technology park; incubators; accelerators; knowledge-based companies; innovation ecosystem	M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13, M14, M15, M16, M17, M18	Innovation ecosystem
4	High-speed internet; fiber optics; data centers; digital infrastructure; smart city	M2, M3, M4, M5, M7, M8, M9, M10, M11, M12, M13, M14, M15, M16, M17, M18	Technological infrastructure
5	Data governance; urban data; open access to information; data-driven decision-making	M3, M5, M6, M8, M10, M11, M13, M14, M15, M16, M17, M18	Data governance
6	Artificial intelligence; Internet of Things; blockchain; smart services; big-data analytics	M2, M3, M5, M7, M8, M9, M10, M11, M13, M14, M15, M16, M17, M18	Emerging technologies
7	Knowledge management; smart management; science policymaking; urban management reform	M2, M4, M6, M7, M8, M10, M11, M13, M14, M15, M16, M17, M18	Knowledge governance and management
8	Steering institution; knowledge city custodian; interagency coordination; integrated structure	M4, M5, M6, M8, M10, M11, M13, M14, M15, M16, M17, M18	Integrated governance
9	Bureaucracy; multiple decision-making centers; cumbersome regulations; organizational resistance	M2, M3, M4, M5, M7, M8, M10, M11, M13, M14, M15, M16, M17, M18	Institutional barriers
10	Innovation culture; lifelong learning; creativity; knowledge-based culture	M1, M2, M4, M5, M6, M7, M8, M10, M11, M12, M13, M14, M15, M16, M17, M18	Innovation culture
11	Risk aversion; conservatism; resistance to change; politicization	M2, M4, M6, M8, M10, M11, M13, M14, M15, M16, M17, M18	Cultural barriers
12	Citizen participation; ideation; social learning; advisory groups	M2, M3, M5, M7, M8, M9, M10, M11, M13, M14, M15, M16, M17, M18	Social participation
13	Digital literacy; civic education; manager training; human-resource empowerment	M2, M4, M5, M7, M8, M10, M11, M13, M14, M15, M16, M17, M18	Human capital development
14	Attracting elites; retaining specialists; preventing migration; human capital	M2, M5, M8, M10, M11, M13, M14, M15, M16, M17, M18	Attraction and retention of elites
15	Venture capital; financial support; innovation funds; financial incentives	M2, M5, M7, M8, M10, M11, M13, M14, M15, M16, M17, M18	Financial support for innovation
16	Startups; entrepreneurship; commercialization of ideas; private sector	M3, M5, M7, M8, M9, M10, M11, M13, M14, M15, M16, M17, M18	Entrepreneurship development
17	International cooperation; attracting foreign investment; scientific exchange; science diplomacy	M5, M8, M10, M11, M13, M14, M15, M16, M17, M18	International interactions
18	Singapore; Seoul; Barcelona; Helsinki; Berlin; Manchester; global benchmarking	M3, M5, M8, M10, M11, M13, M14, M15, M16, M17, M18	Use of global experiences
19	Knowledge-based economy; wealth creation; value creation; knowledge-based employment	M2, M5, M7, M8, M10, M11, M13, M14, M15, M16, M17, M18	Knowledge-based economy
20	Performance evaluation; continuous monitoring; knowledge city indicators; continuous improvement	M4, M5, M8, M10, M11, M13, M14, M15, M16, M17, M18	Evaluation and monitoring system

After extracting the initial codes from the 18 interview transcripts and reviewing the data several times, codes with similar concepts were compared, refined, and merged in the next stage of analysis. At this stage, initial labels that overlapped

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semantically or referred to a shared concept were organized as merged initial labels. The purpose was to reduce the dispersion of codes, increase conceptual coherence, and provide an appropriate basis for identifying the study's subthemes and main themes. The process sought to prevent repetition of similar concepts without eliminating the richness of the data and to obtain a more coherent view of participants' perceptions of the different dimensions of the knowledge city in Isfahan. Accordingly, all initial labels extracted from the interviews were examined on the basis of conceptual similarity, semantic relation, and content proximity and were organized as merged labels. Each merged label may include several similar initial codes stated by one or more participants. The table is the product of this stage of analysis and presents, for each merged label, the codes of participants who referred to the concept and the related subcodes. It forms the basis for extracting subthemes and, ultimately, developing the study's main themes in later stages of thematic analysis. The table below presents the complete thematic network, including six overarching themes, 29 organizing themes, extracted basic codes, the frequency of repetition of basic codes in the analysis, and examples of direct quotations. To protect participants' privacy and emphasize the scientific aspects of the study, interviewees' names were omitted and replaced with organizational job titles or interview codes.

Table 2. Overarching Themes, Organizing Themes, and Basic Codes of the Knowledge City Model in Isfahan

Overarching Theme	Organizing Theme	Basic Codes / Extracted Concepts	Frequency (MAXQDA)	Unnamed Direct Quote Sample
1. Administrative structure redesign with a facilitative approach	Reforming the administrative structure and removing debilitating bureaucracy	Reducing bureaucracy, eliminating institutional duplication, increasing administrative agility, reforming permit-issuance processes	42	"One of our main pains in the provincial governorate is precisely this bureaucracy... We have multiple decision-makers." (One of the senior provincial managers)
1. Administrative structure redesign with a facilitative approach	Changing the government's approach from direct administration to facilitation	Government withdrawal from direct implementation, assuming a regulatory role, clearing the way for the private sector, guaranteed purchase of knowledge-based products	38	"The government's role here should not be direct administration; the government should be a facilitator." (One of the senior provincial managers)
1. Administrative structure redesign with a facilitative approach	Decentralization and increasing provincial authority vis-à-vis the capital	Reducing dependence on decisions made in Tehran, granting broad economic powers to the province, removing centralized interactions	29	"Isfahan's main weakness is that, because it is not the capital, its decision-making power is lower, and the thread of major interactions is determined in Tehran." (Interview 2)
1. Administrative structure redesign with a facilitative approach	Establishing intermediary and urban facilitation institutions	Establishing centers to translate industry and university needs, launching an integrated innovation secretariat, urban strategic councils and funds	35	"Above all, we need an intermediary institution... an entity that can translate the language of the university for industry." (One of the senior provincial managers)
1. Administrative structure redesign with a facilitative approach	Meritocracy and the primacy of scientific rationality in management	Employing nonpolitical specialists, avoiding discretionary and traditional decisions, managerial stability despite changes in mayors	31	"A knowledge city is a city in which rationality comes first in management... not the traditional methods of forty years ago." (One of the senior provincial managers)
1. Administrative structure redesign with a facilitative approach	Implementing a data-driven decision-making system	Establishing a KPI command center, urban management dashboards, predicting crises through data analysis	27	"An evidence-based decision-making system should be implemented in urban management. This system must be fully intelligent." (Interview 4)
2. Interactive university, industry, and community ecosystem (multiple helix)	Moving the university out of the ivory tower and directing research toward local issues	Applying theses, focusing on Isfahan's industrial problems, industry scholarships, establishing innovation houses	46	"In a knowledge city, the university must come down from its ivory tower. A university professor must know what problems Isfahan Province's industry faces." (One of the academic elites)
2. Interactive university, industry, and community ecosystem (multiple helix)	Structuring and stabilizing university–industry interactions	Moving from person-centered to organization-centered interactions, repealing restrictive tax regulations that impede research, creating active technology transfer offices	40	"These collaborations are currently more person-centered than organization-centered... the system is still struggling to continue them." (One of the academic elites)

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2. Interactive university, industry, and community ecosystem (multiple helix)	The role of Isfahan's large industries in financing innovation	Entry of holding companies (Mobarakeh Steel and Entekhab) into venture capital (CVC), creation of corporate accelerators, spillover of industrial capital into the ecosystem	34	"The presence of the Mobarakeh Steel holding company has given Isfahan extraordinary economic potential... entities such as Harekat Aval or Mobarakeh Steel's CVC." (Interview 2)
2. Interactive university, industry, and community ecosystem (multiple helix)	Eliminating scientific apartheid and achieving institutional equality between public and non-public universities	Attention to the capacities of Islamic Azad University and Najafabad, equalizing access to provincial research budgets, using the full capacity of universities	22	"I observe a form of scientific apartheid in the relationship between government and universities, in which public universities are recognized more." (Interview 8/9)
2. Interactive university, industry, and community ecosystem (multiple helix)	Popularizing the knowledge city and engaging with lower layers of society	Bringing innovation into neighborhoods, launching knowledge cafés, collecting citizens' ideas, moving beyond a purely elite-oriented view	28	"We should not think that only university centers can produce ideas... sometimes the most creative ideas emerge from the lower layers of society." (Interview 15)
3. Integrated management of resilience to physical crises	Urgent resolution of structural environmental crises (land subsidence and water)	Containing Isfahan's 36-centimeter subsidence rate, reforming water-resource management, recycling industrial wastewater, relocating polluting industries to the coasts	51	"In designing a conceptual model for Isfahan, the first and key component is solving the land-subsidence problem... subsidence is destroying all our infrastructure." (Interview 3)
3. Integrated management of resilience to physical crises	Renewing and dualizing urban infrastructure	Dual piping for drinking and greywater, underground sewage systems and utility tunnels, replacing gas with clean energy	33	"The water-piping system in homes must be dual... Isfahan's sewage system is nearly 70 years old and lacks this feature." (Interview 3)
3. Integrated management of resilience to physical crises	Integrating urban data systems and eliminating data silos	Enabling administrative systems to communicate with one another, creating open-data platforms, ending monopolization of urban data	39	"We have a great deal of data, but the data do not talk to one another! System A is not coordinated with System B." (One of the urban-management specialists)
3. Integrated management of resilience to physical crises	Developing a communications network for emerging technologies	Nationwide 5G coverage and Wi-Fi umbrellas, urban sensors for the Internet of Things (IoT), big-data processing infrastructure	26	"The Internet of Things in Iran requires extensive communications coverage such as a 5G network or nationwide Wi-Fi umbrellas." (Interview 2)
3. Integrated management of resilience to physical crises	Smart urban management of waste, traffic, and energy	Using artificial intelligence (AI) in traffic control, reducing 40% electricity-distribution losses through underground cables, optimizing the sanitation fleet	30	"Artificial intelligence can be used in traffic, energy consumption, and the water crisis or air pollution." (Interview 6)
4. Governance and empowerment of emerging human capital (Generation Z)	Breaking the fear of failure and enhancing managerial risk-taking	Reforming conservative administrative culture, accepting the trial-and-learning model, legal support for innovative managers	37	"This fear of failure is the main enemy of innovation. We must accept a culture of making mistakes and learning." (One of the senior provincial managers)
4. Governance and empowerment of emerging human capital (Generation Z)	Changing society's view from knowledge for a degree to knowledge for problem solving	Reviewing the structures of school and higher education, developing critical thinking, valuing skills over educational credentials	32	"Among the cultural barriers is the view of knowledge for a degree rather than knowledge for problem solving in the education system." (Interview 6)
4. Governance and empowerment of emerging human capital (Generation Z)	Special investment in Generation Z	Empowering creative young people without capital, supporting startup studios, creating urban coworking spaces	24	"Investing in Generation Z is one of the strongest solutions. This generation is capable and creative but lacks financial resources." (Interview 2)
4. Governance and empowerment of emerging human capital (Generation Z)	Strengthening social capital, transparency, and public trust	Responding to citizens' suggestions, preventing people from remaining spectators, creating a sense of urban belonging in development	36	"If people see their suggestion become a practical action the following week, they will participate with greater enthusiasm the next time." (One of the urban-management specialists)
4. Governance and empowerment of emerging human capital (Generation Z)	Addressing livelihood concerns as a prerequisite for knowledge participation	Addressing citizens' welfare problems, focusing on Maslow's hierarchy to release society's	21	"A society facing severe financial challenges will not have the motivation or capacity

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		creative energy, creating sustainable employment		to participate in knowledge projects." (Interview 3)
5. Reengineering the urban management revenue system	Developing new financial instruments and venture capital	Launching urban VC and CVC funds, a municipal innovation fund, facilitating financial transactions	33	"Launching an innovation fund and VC funds is very common in the world... it can support startups here as well." (Interview 7)
5. Reengineering the urban management revenue system	Phased support for startups and the private sector	Reducing direct administration, implementing urban pilot projects, outsourcing executive activities to technology companies	41	"Startups are like saplings that are vulnerable to adversity and need serious support." (Interview 4)
5. Reengineering the urban management revenue system	Marketing and creating a guaranteed market for knowledge products	Municipalities and industries purchasing technological services and products, leveraging tax laws to attract innovation credit	28	"A startup cannot survive on an idea alone; it must sell its product. The government must create a market." (One of the innovation-ecosystem actors)
5. Reengineering the urban management revenue system	Reforming the municipal revenue model	Moving beyond city selling and density selling, moving toward sustainable knowledge-based revenues and digital value creation	19	"If the city budget remains dependent on construction revenues, a knowledge city will not take shape." (Interview 12)
6. Managing benchmarking and localization of global experiences	Leveraging Isfahan's global brand and sister-city capacities	Active urban diplomacy, holding transnational scientific events, attracting foreign capital and elites and Iranians abroad	34	"Isfahan is a brand. The whole world knows Isfahan. This brand is a major asset... we do not need to beg." (One of the senior provincial managers)
6. Managing benchmarking and localization of global experiences	Smart benchmarking and avoiding copying	Localizing the experiences of Seoul, Singapore, and Barcelona to Isfahan's administrative, religious, and cultural context	39	"Can we learn from foreign models? Yes, but we should not copy and paste!... It must be localized to Isfahan's preferences and reality." (One of the academic elites)
6. Managing benchmarking and localization of global experiences	Engaging remote-working and local elites	Circumventing sanctions-related obstacles and attracting knowledge from Iranian elites abroad, valuing local elites familiar with the context	23	"Regarding the recruitment of elites, in addition to in-person options, remote recruitment of elites can also be used." (Interview 6)
6. Managing benchmarking and localization of global experiences	Addressing macroeconomic challenges and sanctions to enhance international attractiveness	Creating economic stability, facilitating currency-exit and investment rules, removing internet restrictions	31	"As long as the country's economic conditions face challenges and stability has not been established, creating attractiveness for foreign investment will be difficult." (Interview 2)

The results of the thematic analysis of interviews with experts and scholars led to the identification of six overarching themes in designing the model of a knowledge city in Isfahan with emphasis on the experiences of selected cities. At the organizing level, these themes encompass institutional, social, technological, economic, and managerial requirements that can interact to create the conditions for a knowledge city. As shown in the thematic table and thematic network, the concept of the knowledge city in this study is not limited to developing universities, increasing the number of scientific centers, or creating technological infrastructure. Instead, it is considered a multidimensional urban system in which the governance structure, knowledge and innovation ecosystem, urban resilience, human capital, financial system, and international interactions operate in an integrated manner.

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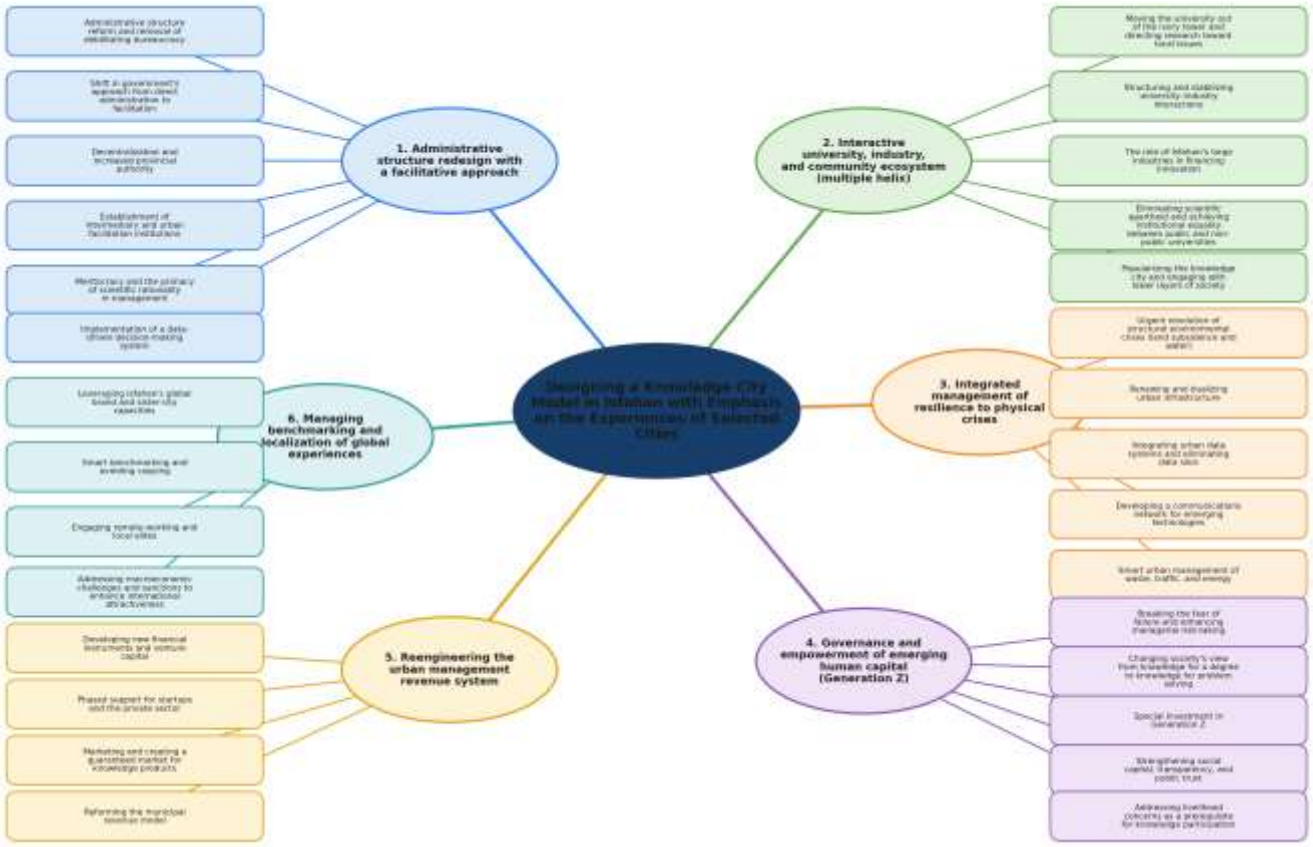


Figure 1. Thematic Network of the Knowledge City Model in Isfahan

4. Discussion and Conclusion

The present study sought to design a knowledge city model for Isfahan with emphasis on the experiences of selected cities. Analysis of the qualitative data obtained from interviews with experts in urban management, public administration, and knowledge-city development led to the identification of six overarching themes: administrative structure redesign with a facilitative approach; an interactive university, industry, and community ecosystem; integrated management of resilience to physical crises; governance and empowerment of emerging human capital, particularly Generation Z; reengineering of the urban management revenue system; and management of benchmarking and localization of global experiences. Taken together, these findings indicate that the development of a knowledge city in Isfahan cannot be understood as a merely technological project or as a process limited to expanding universities, research centers, and knowledge-based firms. Rather, the findings support an ecosystemic interpretation in which governance, knowledge production and exchange, technological infrastructure, human capital, environmental resilience, financing, and international learning operate as mutually reinforcing dimensions. This interpretation is consistent with previous Iranian research emphasizing that knowledge-based urban development requires coordinated interactions among multiple subsystems rather than isolated interventions in science or technology (Behzadpour et al., 2021; Sarvar et al., 2020). It also accords with the regional innovation systems perspective, according to which innovation emerges from the quality of interaction among universities, firms, public institutions, and other regional actors rather than from the independent performance of any single organization (Cooke et al., 2024).

The first major finding concerned the redesign of administrative structures through a facilitative approach. Participants emphasized that bureaucracy, overlapping organizational responsibilities, multiple decision-making centers, centralized authority, and slow administrative processes constrain the effective use of Isfahan's scientific and innovative capacities. The model therefore highlights administrative agility, decentralization, meritocracy, intermediary institutions, and data-driven management, while redefining the role of government and urban management from direct executor to facilitator, regulator, and coordinator. This finding can be explained by the fact that knowledge-intensive development depends heavily on speed,

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flexibility, experimentation, and interorganizational coordination. Innovation ecosystems are characterized by uncertainty and frequent interaction among actors with different organizational logics; rigid administrative systems can therefore increase transaction costs and delay the translation of knowledge into practical solutions. The finding is consistent with Hanafi Neiri et al., who emphasize institutional and structural obstacles as important problematics in knowledge-based development (Hanafi Neiri et al., 2023). It is also supported by Cooke et al., whose regional innovation systems approach stresses that institutional architecture and the relationships linking public organizations, firms, and knowledge institutions substantially influence regional innovation capacity (Cooke et al., 2024). In addition, the emphasis on facilitative governance corresponds with Gorji et al.'s discussion of contemporary urban governance, in which the effectiveness and legitimacy of urban development depend on responsive institutional arrangements and the capacity of governance systems to respond to residents and other stakeholders (Gorji et al., 2026). Thus, the knowledge city requires not only more knowledge but also a governance structure capable of mobilizing that knowledge.

The second finding was the necessity of creating an interactive university, industry, and community ecosystem. The results indicated that universities should move beyond an inward-looking academic orientation and become active contributors to solving industrial and urban problems. Applying research findings, directing academic theses toward local needs, strengthening technology-transfer mechanisms, institutionalizing university–industry relations, involving large industries in venture investment, and incorporating citizens into knowledge creation were identified as essential elements of this ecosystem. This finding supports the argument that a knowledge city is fundamentally relational: knowledge acquires developmental value when it circulates between actors rather than remaining confined within academic or administrative boundaries. Hosseini et al. similarly emphasize that movement toward a knowledge city requires the integration of knowledge-producing institutions with urban development processes and socioeconomic needs (Hosseini et al., 2023). Pasban et al. also identify spatial and functional connectivity among universities, innovative activities, economic functions, and urban institutions as a basic requirement of a knowledge-based city (Pasban et al., 2024). From the perspective of regional innovation systems, this result is theoretically coherent because interactive learning and repeated collaboration among firms, universities, and public institutions are central mechanisms through which regional knowledge is transformed into innovation (Cooke et al., 2024). The inclusion of society and citizens further extends the model beyond a traditional university–industry–government structure. Sun et al. demonstrate that government–citizen knowledge sharing is itself an important component of urban knowledge ecosystems and depends on institutional conditions that make knowledge exchange possible (Sun et al., 2023). Therefore, the Isfahan model appropriately conceptualizes citizens not simply as recipients of urban services but also as potential sources of local knowledge and innovation.

The third major finding concerned integrated management of resilience to physical and environmental crises. The participants considered water scarcity, land subsidence, environmental degradation, deteriorating infrastructure, traffic, energy management, and other physical vulnerabilities to be inseparable from the knowledge-city agenda. The proposed model therefore connects urban resilience with integrated data systems, open data, artificial intelligence, the Internet of Things, advanced communications infrastructure, and smart management of traffic, energy, waste, and crises. This finding is important because it prevents the knowledge city from becoming a purely economic or technological concept detached from the ecological carrying capacity of the urban environment. Knowledge-based development can only be sustainable if scientific and technological capacities are mobilized to solve the city's actual environmental problems. Chen's study of smart-city pilot policies provides support for this interpretation by showing that urban planning and smart-city policies can promote cleaner energy development when technological modernization is aligned with environmental objectives (Chen, 2023). Wang et al. likewise show that green knowledge management can support green innovation and sustainable development, particularly when knowledge processes are reinforced by an appropriate organizational culture (Wang et al., 2022). The findings also correspond with Rostami et al., who demonstrate that conventional urban development policies, including density-selling practices, have consequences for urban development patterns and environmental quality (Rostami et al., 2023). Accordingly, the Isfahan model suggests that becoming a knowledge city requires replacing reactive approaches to environmental problems with data-informed, knowledge-based, and technologically enabled resilience management.

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The fourth finding emphasized governance and empowerment of emerging human capital, with particular attention to Generation Z. The study found that innovation requires more than educated human resources; it also requires a social and institutional environment that tolerates experimentation, reduces fear of failure, supports creative young people, and shifts educational priorities from credential acquisition to practical problem solving. The findings also emphasized coworking environments, access to networks and finance, citizen participation, transparency, social capital, and public trust. This result is consistent with the broader concept of the knowledge-based society, in which human skills, learning capacity, information access, and the ability to apply knowledge are central developmental resources (Kerubo, 2023). It also corresponds closely with Zhang et al., who demonstrate that knowledge-seeking intentions and efforts within knowledge-based organizations depend on motivational and relational antecedents rather than simply on the formal availability of information (Zhang et al., 2022). In other words, people must feel able and motivated to search for, exchange, and use knowledge. The role of social capital identified in the present study is likewise supported by Tsounis and Xanthopoulou, who emphasize trust, networks, reciprocity, and relationships as resources that facilitate cooperation and collective action (Tsounis & Xanthopoulou, 2024). From this perspective, public trust and social participation are not secondary social outcomes of a knowledge city; they are productive assets that enable knowledge to circulate. Berki's discussion of Bourdieu's urban theory also helps explain why access to knowledge opportunities should not remain concentrated among already advantaged groups, because urban social and cultural resources are unevenly distributed (Berki, 2025). The specific focus on Generation Z in the model therefore reflects a broader concern with activating emerging forms of digital, creative, and entrepreneurial human capital.

The fifth overarching theme was reengineering the urban management revenue system. The findings showed that knowledge-city development requires stable and diversified financial mechanisms and that continued dependence on traditional construction-based and density-related municipal revenues is inconsistent with long-term knowledge-based transformation. The model therefore proposes innovation funds, venture capital and corporate venture capital mechanisms, phased support for startups, municipal and industrial procurement of innovative products, urban pilot projects, and the gradual creation of knowledge-based revenue streams. This result is understandable because innovation involves high uncertainty, long development periods, and significant early-stage risk. Without appropriate financing, promising ideas generated in universities, startups, or knowledge-based firms may fail to reach commercialization. Behzadpour et al.'s conceptualization of knowledge-based urban development supports the need for interconnected economic, institutional, and innovation mechanisms rather than a narrow concentration on scientific production (Behzadpour et al., 2021). Hanafi Neiri et al. similarly identify economic and institutional challenges as central to knowledge-based development (Hanafi Neiri et al., 2023). The finding also indirectly responds to the problems associated with conventional urban revenue models identified by Rostami et al., whose analysis demonstrates how density-oriented policies can shape urban patterns and environmental outcomes (Rostami et al., 2023). Thus, replacing unstable physical-development revenues with knowledge-based value creation is not merely a financing reform; it represents a structural transition in the economic logic of urban management.

The sixth finding involved benchmarking and the localization of global experiences. Participants believed that Isfahan could learn from cities such as Seoul, Singapore, and Barcelona, but strongly rejected direct imitation. Instead, international practices should be interpreted in light of Isfahan's governance structure, cultural characteristics, economic conditions, social context, and local capacities. The findings also emphasized the city's international brand, sister-city relations, urban diplomacy, and networks of Iranian experts abroad as potential channels for knowledge transfer. This result is consistent with the evolutionary logic of regional innovation systems, which emphasizes that innovation systems are historically and institutionally embedded and therefore cannot be transplanted mechanically from one context to another (Cooke et al., 2024). It also aligns with Elmi et al., who highlight the relationship between knowledge communities, smart-city development, and urban sustainability within a specific Iranian urban context, implying that models must be adapted to local social and institutional structures (Elmi et al., 2025). Hosseini et al.'s study of Qazvin similarly supports a context-sensitive approach to knowledge-city development rather than a universal standardized model (Hosseini et al., 2023). Consequently, benchmarking should be understood as selective institutional learning: successful cities provide principles, mechanisms, and experiences, but these must be reconstructed rather than replicated.

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When the six themes are considered together, the findings reveal a strong interdependence among the components of the proposed model. Administrative reform establishes the institutional conditions for cooperation; the university–industry–community ecosystem enables knowledge production and transfer; smart and resilient infrastructure allows knowledge to be applied to real urban problems; empowered human capital generates creativity and innovation; new financial mechanisms sustain innovative activities; and localized benchmarking connects local development to international learning. The manuscript's thematic analysis similarly concludes that none of the six dimensions can independently produce a knowledge city and that their value arises from their integration. This integrated interpretation is consistent with Behzadpour et al., who conceptualize knowledge-based urban development through interrelated structural dimensions (Behzadpour et al., 2021), and with Elmi et al., who connect knowledge-community relations and smart urban development with sustainability (Elmi et al., 2025). It is also supported by Wang et al., whose findings indicate that knowledge processes and sustainability outcomes depend on supportive cultural and organizational conditions (Wang et al., 2022). The results therefore suggest that technological investments without institutional reform will have limited effects, just as skilled human resources without financing, participation, and supportive governance may remain underutilized.

A further implication of the findings is that Isfahan's transition toward a knowledge city should be interpreted as a movement toward knowledge-based urban governance. In such a model, knowledge is not simply produced in universities but becomes an operating resource for policymaking, environmental management, economic development, service delivery, citizen participation, and strategic planning. This interpretation provides a bridge between knowledge-city theory and urban governance because it locates knowledge within the daily processes through which the city is managed. Sun et al.'s analysis of government–citizen knowledge sharing reinforces this proposition by showing that knowledge exchange between public institutions and citizens is an important urban capability (Sun et al., 2023). Gorji et al. likewise underscore the significance of responsive governance and the social consequences of urban policy, demonstrating that development strategies gain importance through their effects on residents' lived conditions and perceptions of fairness (Gorji et al., 2026). Accordingly, a successful knowledge city should not be evaluated solely through the number of patents, research centers, digital platforms, or startups; it should also be assessed through its ability to improve urban problem solving, inclusion, resilience, institutional trust, and citizens' quality of life.

Overall, the findings show that Isfahan possesses significant scientific, industrial, human, cultural, and international capacities, but transforming these dispersed assets into a functioning knowledge-city ecosystem requires institutional coordination and long-term strategic integration. The proposed model extends previous Iranian research by bringing administrative restructuring, multiple-actor innovation, physical resilience, Generation Z, urban financing, and localized international benchmarking into one integrated framework. In this respect, the study complements previous work on the challenges of realizing knowledge cities in Iran (Sarvar et al., 2020), conceptual modeling of knowledge-based urban development (Behzadpour et al., 2021), spatial and functional requirements of knowledge cities (Pasban et al., 2024), and the experience of knowledge-city development in Qazvin (Elmi et al., 2025; Hosseini et al., 2023). The main conclusion is that the knowledge city in Isfahan should be approached not as a single infrastructure project but as a continuous institutional transformation in which knowledge, technology, governance, people, finance, environment, and international learning are coordinated within a locally grounded urban ecosystem.

The present study has several limitations that should be considered when interpreting its findings. First, the research adopted a qualitative design and relied on semi-structured interviews with 18 experts, senior managers, and academic specialists; therefore, the findings reflect expert perceptions and cannot automatically be generalized to all urban stakeholders. Second, purposive and snowball sampling, although appropriate for identifying knowledgeable informants, may have increased the likelihood that participants belonged to overlapping professional or institutional networks and therefore shared similar perspectives. Third, citizens, startup founders, younger residents, neighborhood organizations, and some categories of private-sector actors were not examined as separate stakeholder groups, although several themes of the model directly concern citizen participation and Generation Z. Fourth, the study was conducted specifically in Isfahan, and the city's distinctive historical, industrial, cultural, environmental, and institutional characteristics limit the direct transferability of the proposed model to other cities. Fifth, the study identified the dimensions of the model through thematic analysis but did not quantitatively test the causal

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relationships, relative weights, priorities, or interactions among its components. Finally, rapidly changing technological, environmental, economic, and regulatory conditions may alter the relative importance of some components over time, particularly those related to digital infrastructure, emerging technologies, investment, and international cooperation.

Future studies should quantitatively validate the proposed model using a large and diverse sample of urban stakeholders and methods such as confirmatory factor analysis, structural equation modeling, or partial least squares modeling to examine relationships among the six overarching dimensions and their subcomponents. Comparative research could examine Isfahan alongside other Iranian and international knowledge-oriented cities to identify which dimensions are context-specific and which have broader applicability. Separate studies should investigate citizens, Generation Z, entrepreneurs, university researchers, municipal managers, and industrial actors so that differences among stakeholder perceptions can be incorporated into the model. Longitudinal and futures-oriented studies could assess how Isfahan's knowledge-city readiness changes over time and develop alternative scenarios for medium- and long-term transformation. Research should also investigate the economic feasibility of urban innovation funds, VC and CVC mechanisms, municipal procurement of innovative products, and other proposed financing mechanisms. Environmental studies could specifically examine how knowledge-based technologies can address water scarcity, land subsidence, air pollution, energy consumption, waste management, and urban resilience. Future work should additionally develop a locally validated system of measurable knowledge-city indicators to monitor implementation and enable periodic assessment of Isfahan's progress.

For practical implementation, urban policymakers should establish an integrated knowledge-city governance mechanism involving the Municipality of Isfahan, the provincial governorate, universities, major industries, knowledge-based companies, financial institutions, and citizen representatives. Administrative processes affecting innovation should be simplified, institutional duplication reduced, and intermediary organizations established to translate urban and industrial problems into research and technological projects. Universities should be encouraged to direct theses, applied research, and technology-transfer activities toward concrete urban needs, while major industries should participate in corporate venture investment, accelerators, and innovation procurement. Urban management should integrate fragmented data systems, expand open-data platforms, and use artificial intelligence, the Internet of Things, and advanced analytics to manage water, traffic, energy, waste, and environmental risks. Dedicated programs should provide Generation Z and young entrepreneurs with coworking spaces, startup studios, financing, mentoring, and participation opportunities. Municipal revenue reform should gradually reduce dependence on construction-related income and expand innovation-based and digital revenue sources. Finally, Isfahan should institutionalize systematic international benchmarking, use its sister-city relationships and global cultural identity to strengthen knowledge exchange, and adapt successful international practices through careful localization rather than direct replication.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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