

A comparative evaluation of the feasibility of realizing smart cities based on knowledge community within cities (research study area: Qazvin city)

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Abstract

In the competition among cities pursuing modern urban development for growth and progress, smartification, the utilization of the creative class, and knowledge-based endeavors are integral components. Employing creative, intelligent, and specialized individuals alongside the application of artificial intelligence constitutes significant strides towards achieving urban development and transformation goals. Therefore, this research, with a practical aim and in line with improving the quality of smart urban life, seeks to answer the question of to what extent the realization of a smart city based on a knowledge society has occurred in the districts of the city of Qazvin. For this purpose, by reviewing the theoretical literature of the research and explaining its framework, and using a descriptive-analytical method, the criteria and indicators of evaluation in three sections – knowledge society, smart city, and the relationship between these two important aspects – have been identified. Furthermore, criteria such as human capital, knowledge sharing, innovation in relation to smart governance, smart economy, and smart living have been considered in the theoretical model of the research. Subsequently, using Cochran's formula and determining the study sample, questionnaires based on the research's theoretical framework are randomly distributed among Qazvin citizens. Finally, using quantitative and analytical methods, including Pearson's correlation coefficient and a one-sample t-test, the relationships between variables are described. Also a comparative evaluation of the extent of smart technology use within the knowledge community of the four districts of Qazvin is conducted. The overall results of the evaluation were conducted at two levels: in the form of a comparative evaluation across the four districts of the city of Qazvin, and an overall evaluation of the situation of the city of Qazvin. In general, the results indicate that, on average, Qazvin has a near-mid-level (close to the numerical value of three) in utilizing smart city features. This results vary across the four districts, and the central urban district of the city, which has a relatively educated population and a newly constructed and maintainable urban fabric existing together, has the closest connection to a knowledge-based smart city.

Keywords: Smart City; Knowledge-Based City; Knowledge Community; The Four Districts of Qazvin

1. Introduction

The concepts of the knowledge-based city and the smart city are relatively new concepts that emerged at the end of the 20th century with the rapid growth of urban populations and the problems arising from it, along with economic and technological changes resulting from globalization. Among these, there are indicators that are used in both knowledge-based cities and smart cities. One of these is the smart community, knowledge community, as well as knowledge-creating employees who are active in knowledge-based cities around the world these days. A community that increases the skills and knowledge of residents as a means of individual and social development, ultimately leading to a high level of community success. Therefore, this research emphasizes the "knowledge community" as the central focus of a smart and knowledge-based city. The knowledge community, as the social capital of cities, will be very effective in the realization of smart cities. Therefore, what

explains the necessity of this research is, on the one hand, concern about the future and the problems arising from the continuation of the issue, and on the other hand, the emphasis of higher-level documents on the need to address the research issue. The rapid development of modern urban planning and the continuous growth of urbanization in Iran, which is largely inattentive to the issue of intelligence and knowledge and creates a threat to human and natural capital as well as the historical identity of many Iranian cities, and can lead to the elimination of these cities from global competition. Also, the widespread migration of knowledge workers from the country, which is commonly known as "brain drain," clarifies another necessity of addressing the important topic of the knowledge community. Finally, the attention to the fact that urban planning based on the principles of smart knowledge-based cities as successful cities of the smart century can help improve the general situation of cities and countries constitutes another necessity of the research.

Also, at the end, the necessity of producing indigenous theories (the existing general urban planning theories face serious ambiguity) should be mentioned. Therefore, this research seeks to comparatively evaluate the feasibility of realizing smart city indicators with emphasis on the knowledge community in Qazvin city as a case study. For this purpose, it begins with a review of the theoretical literature of the research in the direction of smart city and knowledge-based city, and by presenting the theoretical model and theoretical framework of the research, the evaluation has begun in the study area, and questionnaires have been distributed among citizens of the four districts of Qazvin city to determine the extent of use of smart information and communication technologies in relation to their knowledge level and to be able to achieve a comparative evaluation of the feasibility of realizing the research topic

2. Statement of the Problem And Research Question

In recent decades, the world has witnessed dramatic changes in various social, economic, and environmental fields. These transformations are largely due to advances in Information and Communication Technologies (ICT) and the ever-increasing access to knowledge and information. These phenomena have led to the formation of new concepts such as "knowledge community" and "smart city" (Zhang et al. [1], 2024, 15). These changes in cities have created the context for changing the relationship between knowledge and development and the expansion of knowledge-based activities. The expansion of knowledge-based activities in cities, which are the main and sustainable factors of urban competitiveness and prosperity, has significantly changed the spatial structure of cities as the platform for these changes and the place where knowledge is produced, marketed, and exchanged. On the one hand, it has demanded new spatial patterns and arrangements of cities, and on the other hand, it has created a new stratum called the knowledge community, for which there is extensive competition in the world, and the Tendency to migrate of these individuals is an important and effective factor in the economic and managerial changes of such cities. In knowledge-based cities, knowledge workers remain and, in fact, contribute to resource sustainability and transformations in urban production and service systems (Zhang et al. [1], 2024, 24). Besides, today's smart cities are abstract cities of the 21st century that have not yet been implemented in practice like knowledge-based cities. It seems that one of the influential factors in smart cities and the factor that makes them happen is the knowledge community.

Meanwhile, Iranian cities in recent decades, for many reasons, including political and social conditions, have lagged behind this competition, and there is a possibility of eliminating cities with a long history of urbanization in Iran from this global competition. In this research, Qazvin has been selected as a case study; because Qazvin is a historical and identity-rich city with natural and tourist attractions and a multi-thousand-year history, which has been known as a knowledge-based city since 2010 with the first perspective of the five-year plan; but urban

management has not taken effective steps towards this goal. Similarly, in the perspective of its second five-year development plan in 2016, Qazvin is a leading city in the fields of science and research and based on superior technologies in the position of a national and transnational scientific hub. Considering the vision of Qazvin and its potentials, including intellectual capital, national and international universities, growth centers and science and technology parks, historical background and identity, etc., it is possible to study in this field and realize the smart city approach from the perspective of the knowledge community. According to the studies conducted by Qazvin's urban management, no codified model and fundamental and efficient action in the field of intelligence, both theoretical and practical, has been carried out in this city. In fact, due to the lack of understanding of the concept of knowledge community assets and its resources, there is no written program to move towards a smart city. Therefore, this research, with the necessity of paying attention to the rapid growth of urban population and the problems arising from it, along with the economic and technological changes resulting from globalization, seeks to explain the comparative evaluation of the feasibility of realizing the smart city model based on the knowledge community. In this regard, it first identifies the items and indicators of smart city and knowledge-based city as the main keywords of the research, and then the theoretical model is presented within the framework of the smart city model based on the knowledge community, so that finally, with the research methodology, the relationships between the variables can be understood and the main research question can be answered: How can the smart city approach be achieved in a city like Qazvin through knowledge communities? Finally, the research questions are summarized and answered, and by examining and testing the hypotheses, the relationships between the variables of smart city and knowledge community are explained to measure the feasibility of the topic.

3. Research Hypotheses

In this research, in line with its objectives and question, the following hypothesis is proposed: it appears that, considering the characteristics of the study area, the realization of smart city indicators, with an emphasis on the knowledge community, is possible in the city of Qazvin.

4. Theoretical Literature of the Research

4.1 Smart cities

A smart city [1] is defined as a complex and dynamic system that utilizes Information and Communication Technologies (ICT) to improve the quality of life for citizens, increase the efficiency of urban services, and reduce resource consumption (Nederhand et al. [2], 2022, 85). In a smart city, data and information are collected from various sources and analyzed in real-time to facilitate smarter decision-making in urban management (De Marco and Mangano[3], 2021). A smart city is often defined through its objectives, with "smarter" being

defined as more efficient, sustainable, equitable, and livable (Allahi, 2012). The concept of a smart city primarily examines the city as a system with multiple subsystems (Choorabi et al., 2012). This subsystem functioning as a whole ultimately allows them to behave in a smart and coordinated manner (Koldahi et al., 2013); in other words, the city is a complex system consisting of diverse and unpredictable interrelationships between its subsystems. the goal of smart city models is to find suitable solutions for managing this complexity, especially by addressing the negative consequences of global urbanization and a higher quality of life for the urban population (PourAhmad et al., 2018). The aim of smartening a city is to provide better services for citizens: a better living environment where policy, method, and technology are intelligently used to achieve goals such as:

1. Providing services to citizens to achieve their sustainability and environmental goals through

- innovation;
2. Identifying the need for smart infrastructure;
3. Facilitating innovation and growth; and
4. Creating a dynamic and innovative economy ready for future challenges (Iso, 2018).

A smart city, by utilizing smart infrastructures, enables optimal resource management, reduction of environmental impacts, and increased sustainability (Liu et al. [1], ۲۰۲۴, ۹۳). Six important dimensions of a smart city include smart economy, smart people, smart mobility, smart governance, smart living, and smart environment (Kawyitri and Shekhar, ۲۰۲۱). The concept of smart cities has recently become an influential narrative in urban governance and development at the international level. Today, one-third of British cities and two-thirds of U.S. cities are involved in smart city initiatives (Karvonen et al., ۲۰۱۹ & Soderström et al., ۲۰۲۱).

Smart Governance	Smart Life and Smart Society	Smart people	Smart Environment	Smart Mobility	Smart economy
<p>"In adapting to the new technologies, smart governance strives to facilitate the formulation and implementation of effective policies.</p> <p>the aim is to keep citizens up-to-date and, at the same time, improve the overall transparency of the system."</p>	<p>"Smart cities have developed smart agent technologies to add social behavior to the smart objects society. Social capital is considered a key factor for sustainability, resilience, and a good quality of life in smart cities."</p>	<p>"Smart technologies can help integrate social and human capital within a city. Smart people are integrated with governance through citizens' participatory role in the urban environment in a smart yet transparent decision-making process."</p>	<p>"There is a need to improve air and water quality and the necessity to create a healthy and enjoyable environment for city residents. Strategies should be in place to enhance biodiversity within the city while also promoting outdoor living and green spaces."</p>	<p>The difference between mobility and smart mobility is public access to real-time information. Mobility is an integral part of smart cities.</p>	<p>As a fundamental basis for urban development, focusing on a vision for enhancing sustainability, new investments, job opportunities, and a conducive environment for entrepreneurship</p>

Fig. 1. The six dimensions of a smart city

The knowledge community is formed based on the concept of the knowledge-based city; knowledge-based cities are the only dynamic centers where knowledge is created and applied. Due to their focus on human capital, infrastructure, values, and entrepreneurship, these cities are capable of facing the challenges arising from the vital issues of the planet, controlling them, and creating new opportunities (Carilo, 2004). A knowledge-based city can be considered as an integrated city that physically and institutionally combines the functions of a science and technology park with civil and residential functions, offering one of the effective paradigms for future sustainable cities. A knowledge-based city cannot be built solely through strategy design but also requires a strong cultural, economic, and human capital base to help nurture and develop a knowledge-based city. The knowledge-based city offers one of the effective models for future sustainable cities (Yigitcanlar, 2007). The knowledge-

based city is a networked city where knowledge-based areas and clusters are its main forms. Communication is the main pillar of knowledge-based cities (Bouanze, 2007). The knowledge-based city is a type of smart city. Considering the two dimensions of urban futures and the knowledge economy and innovation, the concept of a smart city goes far beyond new technologies. The first dimension is closely related to the impact of new technologies on the future development of a city, while the second dimension includes the so-called knowledge management (KM) in the context of cities, in other words, focuses on knowledge-based cities (Anjelido, 2015). The concept of a "knowledge-based city" should include a specific harmony between human quality of life, economic activity, and the use of non-renewable resources, in other words, include economic, social, and environmental sustainability, and finally, we arrive at a planned city (Navarro, 2017).

A knowledge community refers to a community in which knowledge is considered the primary source of power and development. In this type of community, information and knowledge are widely produced, distributed, and utilized (Marchesani et al., 2022, p. 33). Active citizen participation in knowledge production and sharing is a prominent feature of a knowledge community (Ju et al., 2024, p. 72). In this research, the knowledge community is considered a key variable in the formation and development of smart cities. Furthermore, the role of collective knowledge and citizen participation in urban decision-making and planning processes is emphasized.

The KBUD framework encompasses four domains of knowledge development: economic, socio-cultural, environmental-urban, and institutional (Yigitcanlar 2011, 2014a).

The economic development domain is based on and organized around a knowledge-based economy, where knowledge is the key factor in producing added value to create prosperity and welfare. The socio-cultural development domain seeks to establish equity by designing and implementing several educational and cultural strategies to strengthen human and social capital and create a wide range of opportunities for individuals to develop their skills. The environmental-urban development domain creates sustainability in which

spatial quality is achieved by enhancing appropriate urban development and a better quality of life and place. The institutional development domain creates the enabling factors for knowledge-based governance, which creates a good governance climate and ultimately establishes organizational quality (Chang, 2018). Thus, any effort to develop a knowledge city must be actively supported by the entire knowledge community, i.e., local government, citizens, the private sector, organizations, universities, and so on. This requires a coordinated strategy that begins by examining the city's strengths, the local government's political will, the regulatory environment, resources, and the population's ability to develop a knowledge-sharing culture. Local governments have different strategies for transforming their cities into knowledge cities (Ergazakis, 2006). The KBUD model introduced by Van Winden, Van den Berg, and Peter (2007) identifies seven structural characteristics that make a city compatible with the requirements of the knowledge age. These characteristics are considered essential for a city to be able to acquire, create, disseminate, and effectively use knowledge for further economic and social development. The seven main characteristics of KBUD strategies that have been identified are: knowledge base, industry structure, quality of life, diversity, accessibility, social equity, and scale.

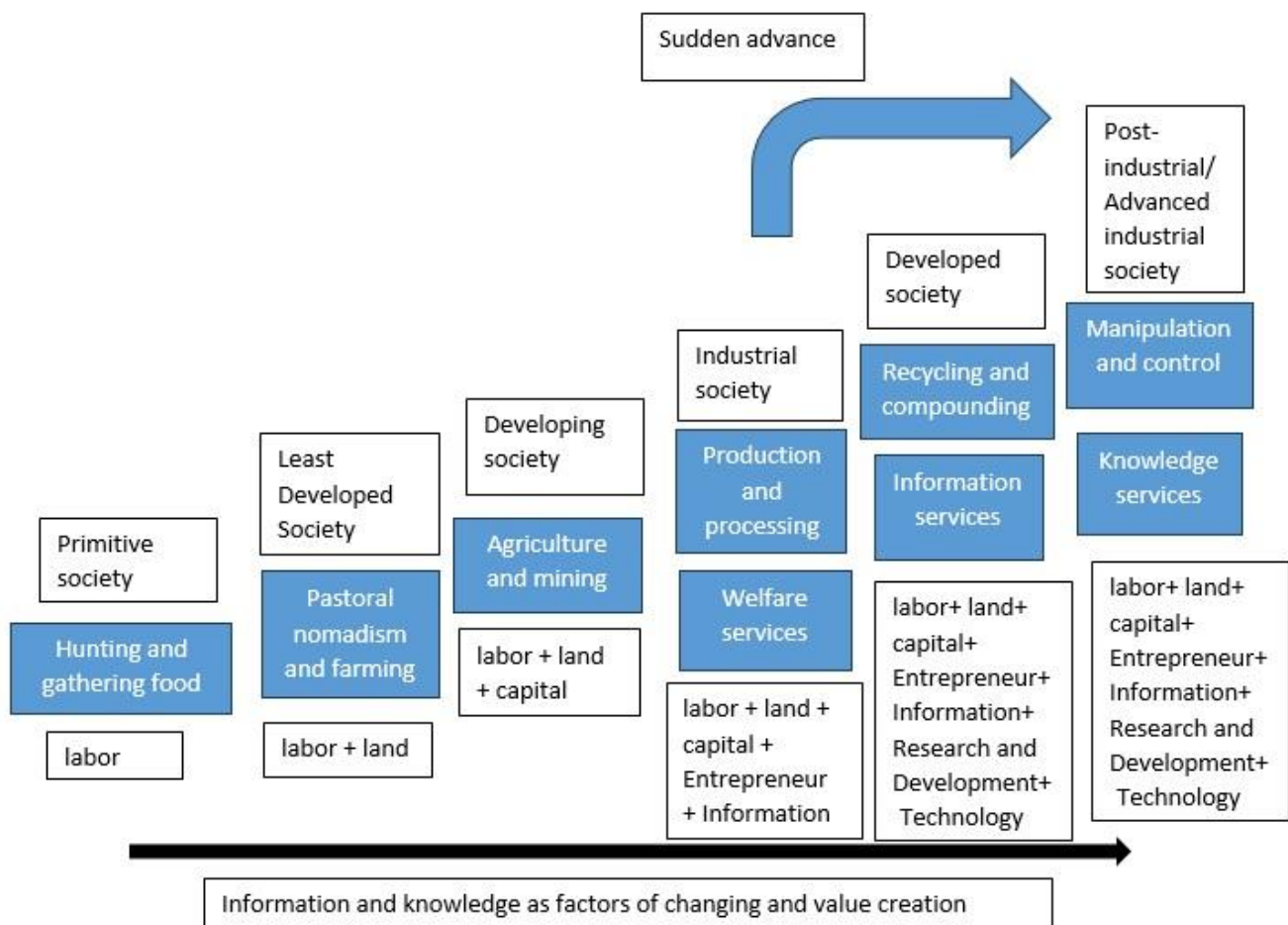


Fig. 2. Urban transition towards the knowledge-based city
 (source: Navarro, 2017)

Table. 1

Classification of the convergent and divergent theories in smart city and knowledge-based city

Convergent theories	Divergent Theories
<p>Yigitcanlar et al., 2018 and De Marco Mangano, 2021</p> <p>Both emphasize the importance of new technologies and smart infrastructures in urban development. They seek to integrate urban management using information and communication technology, which is jointly examined under the title of smart city.</p> <p>Iqbal and Olariu (2021) and Stenvall et al. (2021)</p> <p>Both theories emphasize the role of the knowledge community and social networks in sustainable urban development. There are slight differences in how local knowledge is used to improve urban governance, but they essentially have the same goal of strengthening social participation and improving the quality of urban life.</p> <p>Bouanze (2007) and Navarro (2017)</p> <p>They emphasize sustainable urban development and social, economic, and environmental integration.</p> <p>Both theories seek the optimal use of urban resources and the improvement of environmental quality, which generally align with sustainable urban development.</p>	<p>1. Yigitcanlar (2007) and Ergazakis et al. (2005):</p> <p>Difference in Focus: Yigitcanlar (2007) emphasizes knowledge-based cities and the role of universities and science and technology parks, while Ergazakis et al. (2005) focuses more on science parks and technological innovations that contribute to the development of knowledge-based cities.</p> <p>2. Taamallah et al. (2017) and Oiarzabal (2022): Difference in Focus and Application: Taamallah et al. (2017) emphasizes smart urban governance and social participation, while Oiarzabal (2022) focuses on the importance of plurality and diversity in knowledge societies and their impact on urban planning.</p> <p>3. Huovila et al. (2019) and Sadorfski (2017):</p> <p>Difference in Approaches: Huovila et al. (2019) emphasize smart urban governance and the use of technology to improve public services, while Sadorfski (2017) offers a critique of traditional governance models and proposes reforms that focus more on urban policymaking aspects.</p>

This analysis shows that different theories, each focus on a specific aspect of urban development and the knowledge society, and some of them complement each other (convergent), while others are different and independent of each other (divergent).

A knowledge community can create and strengthen knowledge-based cities; Knowledge-based urban development thinking is based on a city where actions have been taken to encourage continuous creativity, sharing, evaluation, innovation, and updating of knowledge in order to achieve knowledge-driven development. This is achieved through continuous interaction among citizens, and at the same time, between them and the citizens of other cities. The culture of knowledge sharing among citizens, appropriate urban design, infrastructures, and information technology networks improve these interactions. Therefore, a knowledge-based city is a city that takes action to continuously encourage knowledge management processes with the aim of knowledge development. This is achieved through the cooperation and continuous interaction of knowledge-based agents. The term "knowledge-based agents" refers to any entity, including individuals, organizations, universities, science and technology parks, and research centers, that manages knowledge.

The concept of knowledge-based urban development represents a systemic, comprehensive, and creative perspective of cities. In this regard, cities are considered as dynamic and constantly changing and evolving habitats. Emerging knowledge cities should not only focus on improving soft infrastructures such as knowledge bases, industrial infrastructures, quality of life, urban diversity, and social justice, but they must also upgrade hard infrastructures such as transportation, energy and water distribution, waste and wastewater collection, and so on.

Carillo believes that knowledge-based cities are the only dynamic centers where knowledge is created and applied. These cities, due to their focus on human capital, infrastructure, values, and entrepreneurship to create solutions, are capable of facing the challenges arising from the vital issues of the Earth, controlling them, and creating new opportunities. A knowledge-based city, or KC (Knowledge City), can be seen as an integrated city that, from a physical and institutional perspective, combines the functions of a civic and residential science park. Knowledge-based cities offer one of the efficient paradigms for the sustainable cities of the future.

Dvir and Pasher have defined knowledge as an umbrella over geographical entities that engage in the creation of knowledge and encompass other knowledge areas such as

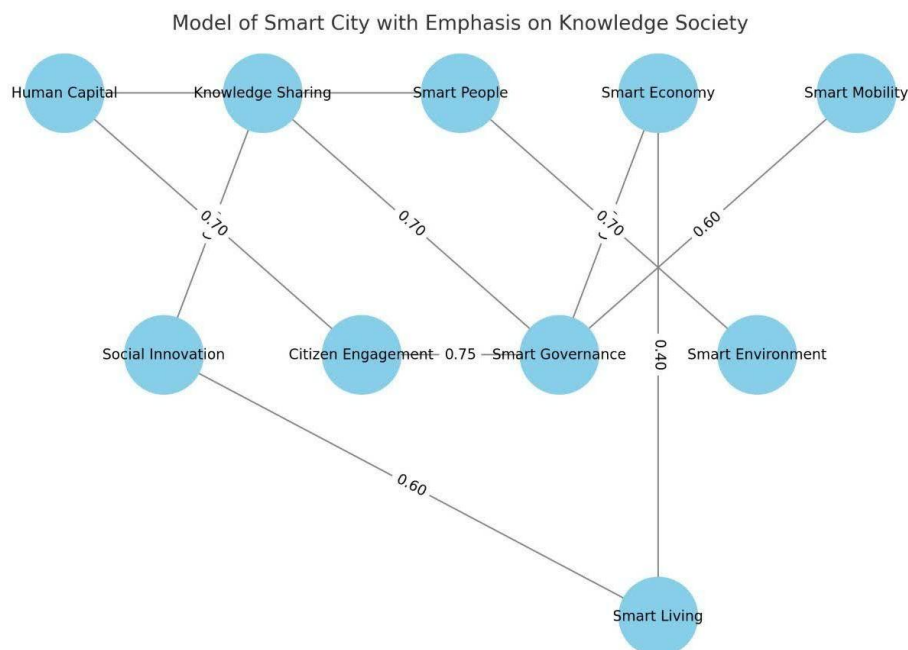


Fig. 3. Theoretical model of the Research

Each connection (arrow) represents the influence or interaction between two constructs. This structure demonstrates the systematic and integrated approach of the research model.

knowledge corridors, knowledge ports, knowledge villages, and knowledge regions. (Vaziri, Ali, 2024)

4.2 Theoretical model of the research

As we know, a city's "smartness" lies not only in its infrastructure but also in the social capital that a region can generate to promote social innovation and regional development. On the other hand, empowering residents does not simply mean that their voices are heard, but that they should be considered key stakeholders. This contributes to the formation of a smart city as a knowledge-based community (Park, Fujii, 2022).

The research's conceptual model is designed to demonstrate the relationship between the "knowledge community" and the "smart city" in order to achieve "urban sustainability." This model posits that the "knowledge community," through active citizen participation and the optimal use of knowledge and information, can contribute to the development and strengthening of "smart cities." Specifically, this participation can lead to improved resource management, increased efficiency of urban services, and reduced negative environmental impacts (Dashkevych & Portnov, 2023, p. 47). Furthermore, the "smart city," by using advanced technologies and analyzing data obtained from the "knowledge community," can make optimal decisions for urban management, which ultimately leads to increased "urban sustainability" (Carrillo et al., 2020, p. 36). This two-way and synergistic relationship between the "knowledge community" and the "smart city" plays a crucial role in achieving urban sustainability (Penco et al., 2020, p. 22). The theoretical framework of this research is based on the following three sections:

Knowledge Community Section:

The main components include human capital, knowledge sharing, social innovation, and citizen participation. The relationships between these components, especially between knowledge sharing and social innovation, indicate a strong synergy.

Smart City Section:

It includes six key dimensions such as smart governance, smart economy, and smart living. Internal relationships, including the impact of smart governance on smart economy and smart mobility, have been highlighted.

Connection between two sections:

The most important relationships are seen between human capital and smart people, as well as between citizen participation and smart governance.

5. Research Methodology

This research is a descriptive-analytical study and belongs to the case study category. It is descriptive because it includes a set of methods whose goal is to describe the conditions or phenomena under investigation (Sarmad, 1381: 82). And it is analytical because, considering the main objective of the research, which is a comparative evaluation of the feasibility of realizing a knowledge-based smart city in Qazvin, it analyzes the relationships in the case study. The main approach of the research is a mixed quantitative method with an exploratory strategy. In understanding the theoretical literature of the research (smart city, knowledge-based city, knowledge community), the descriptive-analytical method and the identification of criteria based on the principles of Sandelowski and Barroso have been chosen in accordance with the objectives and methods of the research. In order to comparatively evaluate the criteria for the realization of

a smart city based on a knowledge community in the study area, a quantitative method using SPSS software and Pearson's correlation coefficient has been used. At this stage, questionnaires were distributed among the people, and indirectly, the way they use communication technology in line with the smart city and their knowledge level were asked to explain the relationships of the smart city model with emphasis on the knowledge community.

5.1. Sample and population size

The statistical population consisted of the citizens of Qazvin. Based on the population statistics of Qazvin in 1400 (Iranian calendar year, equivalent to 2021-2022 Gregorian calendar), the number was 384,000 people on average according to Cochran's formula. In designing the questionnaires for this statistical population, we were looking for the relationship and connections between the smart city with an emphasis on the knowledge community in Qazvin. The questionnaires were also randomly distributed in four urban districts in the study sample of Qazvin.

Table 2
Study Population and Sample Size. Source: Qazvin Master Plan

	District 1	District 2	District 3	District 4
(Population Size/Community Size)	103,882	100,237	91,311	107,318
(Community Size in the Studied Areas)	(Area 2) (17,390)	(Area 4) (11,314)		(Area 19) (22,419)
(Sample Size)	372	376		378

6. Understanding the Research Area

The city of Qazvin is a combination of an organic texture remaining from previous periods and a grid texture resulting from recent developments. The old urban fabrics are located in the south, and the northern areas are the result of new urban developments. According to the estimates, the population of Qazvin in 1400 (Iranian calendar year, equivalent to 2021-2022 Gregorian calendar) was 401,761, with approximately 100,000 residents in each district. Due to its location at the intersection of communication routes between the northern and western provinces of the country, its proximity to Tehran, the presence of several industrial cities (Lia and Alborz Industrial Cities, Caspian, Arasanj, etc.), as well as several universities, including Imam Khomeini International University, Medical Sciences University, and Islamic Azad University (Takestan, Barajin), and a number of non-governmental universities, Qazvin has always been a destination for non-native students seeking education. This trend has led to the establishment of many universities along the Tehran-Qazvin highway and even within Qazvin province. Therefore, the ground for a knowledge-based city can be seen, but the extent to which this knowledge is used

among Qazvin citizens in utilizing smart city facilities will be evaluated through a random questionnaire in this research. For this purpose, Kowsar town as a newly built area, the areas of Khayyam and Ferdowsi streets in the central areas of the city, where new constructions are located alongside preservable and restorable fabrics, and Molavi neighborhood as an old fabric resulting from the history and background of Qazvin, have been selected for the research.

However, recognizing Qazvin based on the use of information and communication technology (ICT) for smart city development in Qazvin's urban management, considering the visions of 1389 (2010-2011 Gregorian calendar) and 1395 (2016-2017 Gregorian calendar), which envisioned Qazvin as a leading city in the field of science and research and based on superior technologies in the position of a national and transnational scientific hub, shows that urban management has not had a coherent plan for this goal and has only taken steps in urban processes by carrying out scattered measures as described below.

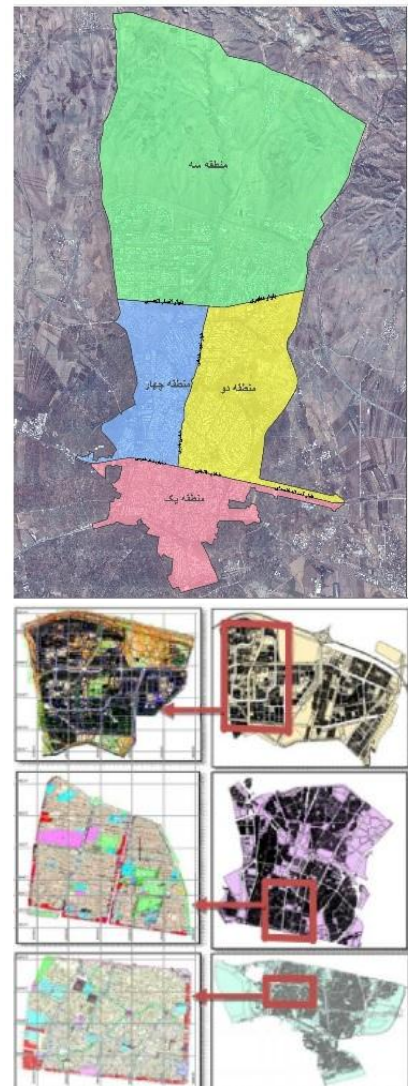


Fig. 4. Illustrations of the Study Area
Source: The authors based on the master plan of Qazvin

Table 3
Some of the Actions of Urban Management Regarding the Smartification of Qazvin.

Actions of Urban Management Regarding the Smartification of Qazvin	Implementation of Smart On-Street Parking Management System	Special attention to traditional orchards surrounding the city and preparation of information layers.
	Implementation of an Online Vehicle tax Collecting System	Smart Monitoring of Contractors in Waste Management Organization
	Intelligent Traffic Management System	Creating Information Layers for Smart City Management
	Smart Urban Mobility and Traffic Management	Managing Electricity Consumption of Municipality Buildings
	Equipping Urban Services Fleet with GPS and Smart Control and Monitoring	Using Advanced Telephony and Communication Systems for Cost Management
	Equipping City Buses with Free Wi-Fi for Passenger Use	Smart and Online Delivery of Urban Planning Services
	Electronic Service Desk	Virtual Tourism Systems
Construction/Building of a Fiber Optic Network Throughout the City (60 Kilometers)		

(Source: Authors, summarized from Urban Management Statistics 2021 – Statistics and Information Technology Organization of Qazvin Municipality)

7. Analysis of the Research Findings

To quantify the research's empirical model and analyze the data, the scaling method was used. As mentioned, scaling in this research was based on a 5-point Likert scale. So that a score of 1 indicates the lowest level of resident satisfaction regarding each of the questions, and a score of 5 indicates the highest level of satisfaction. Thus, the number 3 is chosen as the theoretical midpoint of the responses. ($1 < X < 5$) To compare the average score of the feasibility of smart city indicators based on the knowledge community in the four mentioned districts of Qazvin city, the normality of data distribution was first examined in all four districts. Based on the results of this test, the collected data in all four districts follow a normal distribution. Now, considering the normal distribution of data within the four district groups, Pearson's correlation coefficient analysis was used to compare the average scores, and its results are presented in the table below. Null hypothesis (H_0): The means are equal across the all four groups

Alternative hypothesis (H_a): There is a statistically significant difference between at least one of the group means.

Table 4
One-Way ANOVA Results Source: Authors, 2024

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	79.713	2	39.857	1.435E3	.000
Within Groups	31.244	1125	.028		
Total	110.957	1127			

According to the table above, the value in the last column ($p < 0.05$) indicates that the null hypothesis is rejected, and there is a difference between the means in the four districts. However, this test does not specify in which districts and how the means differ. To examine the difference in feasibility of each criterion pairwise, a pairwise comparison test was used. The table below shows the results of this test.

Table 5
LSD Test Results – Pairwise Comparison of Indicators in the Four Districts of Qazvin Source: Authors, 2024

	Code i	Code j	Mean Difference	Std.Error	Sig	Lower Bound	Upper Bound
Tukey HSD	1	2	-.64782*	.01215	.000	-.6763	-.6193
		3	-.38091*	.01215	.000	-.4094	-.3524
	2	1	.64782*	.01215	.000	.6193	.6763
		4	.26691*	.01215	.000	.2384	.2954
	3	1	.38091*	.01215	.000	.3524	.4094
		2	-.26691*	.01215	.000	-.2954	-.2384
	4	4	-.64782*	.01215	.000	-.6717	-.6240
		3	-.38091*	.01215	.000	-.4048	-.3571

*. The mean difference is significant at the 0.05 level.

According to the table above, it is observed that:

- The average feasibility of realizing smart city indicators based on the knowledge community in districts 1 and 2 are significantly different ($p < 0.05$).
- The average feasibility of realizing smart city indicators based on the knowledge community in districts 1 and 3 are significantly different ($p < 0.05$).
- The average feasibility of realizing smart city indicators based on the knowledge community in districts 1 and 4 are significantly different ($p < 0.05$).
- The average feasibility of realizing smart city indicators based on the knowledge community in districts 2 and 3 are significantly different ($p < 0.05$).
- The average feasibility of realizing smart city indicators based on the knowledge community in districts 2 and 4 are significantly different ($p < 0.05$).
- The average feasibility of realizing smart city indicators based on the knowledge community in districts 3 and 4 are significantly different ($p < 0.05$).

Thus, using the obtained results, the feasibility of realizing smart city indicators based on the knowledge community in Qazvin can be divided into three distinct groups. District 2 has the highest feasibility compared to other districts.

Hypothesis Test

The research question addressed the evaluation of the feasibility of a smart city based on the knowledge community in Qazvin, comparatively across its four districts. The above analysis presented pairwise evaluations. Subsequently, the research hypothesis seeks to evaluate the overall situation of Qazvin, for which a one-sample test was used. The results are shown below.

Table 6
One-Sample Test

Mean	Std. Deviation	Std. Error Mean
2.8852	.27085	.01397

As can be seen, the average evaluation of Qazvin's status in moving towards a smart city based on the knowledge community is close to three. This indicates that it is generally below the average level, but it can approach the average level with planning and providing technical and knowledge-based grounds. Thus, the research hypothesis is confirmed.

8. Conclusions

According to what has been said so far, a smart city is a new paradigm in urban planning that, by integrating advanced technologies and considering the feasibility of smart cities, especially by citizens, provides the necessary knowledge base among citizens. In particular, information and communication technology (ICT) utilizes artificial intelligence to improve the efficiency and quality of citizens' lives. The goal of creating such a city is to integrate ICT and various physical devices connected to the Internet of Things (IoT) to optimize urban processes

and provide optimal services and communication with citizens. Smart city technology enables city managers to directly interact with the community and urban infrastructure and provide immediate and appropriate responses to the needs of the city and citizens. In other words, a successful smart city has a strong, technology-based infrastructure that enables environmental initiatives. With this description, by combining knowledge (specialized citizens) and smart technologies, cities can be transformed into places that enjoy better services, preserve the environment, promote the economy, and improve the social and cultural capabilities of the community. This explanation plays an important role in structuring future cities and improving the quality of citizens' lives. Therefore, it can be stated that the knowledge community is an essential component in a smart city that affects external factors such as economy, government, culture, technology, and environment. Because the framework of the knowledge community is related to other factors of the smart city and emphasizes its importance in creating knowledge-based and smart cities. Also, the role of knowledge-based experts in creating a knowledge-based and smart city is really prominent.

Analysis and evaluation of the qualitative conditions of the smart city status through quantitative methods and empirical models is an approach used to identify and evaluate the overall status of the research subject. The overall results of the evaluation were conducted at two levels: a comparative evaluation in the four districts of Qazvin and an overall evaluation of Qazvin's status. In the pairwise evaluation of criteria in the research area, the central texture of Qazvin, which has a relatively educated population and a combination of new and maintainable textures, where the main focus of the city's activity is dominant, has received a higher score than other studied areas; while this capability is not seen in the old texture of District 1 of Qazvin and even the new texture of District 3 of the city. One of the reasons is that the old texture of Qazvin has residents with higher age groups, and population displacement has occurred in these areas, and the new texture under study, although it has future developments and a relatively young population, but groups with lower knowledge levels live in it. This has caused these two areas to have a lower score compared to the central texture. At the second level, the overall evaluation of Qazvin's status in relation to the components of a smart city based on the knowledge community indicates a near-average level of the city's status in relation to smartness, which is hoped to move towards smartness and increase public knowledge with codified planning.

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