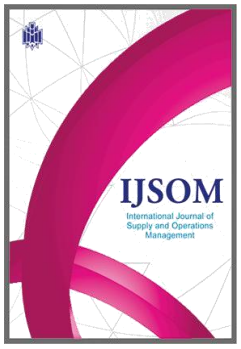
International Journal of Supply and Operations Management

IJSOM

February 2023, Volume 10, Issue 1, pp. 76-88
ISSN-Print: 2383-1359
ISSN-Online: 2383-2525
www.ijsom.com



A Model for the Success of Smart City Services with a Focus on Information and Communication Technology

Abbas Khamseh [a,*], Shiva S. Ghasemi [b], and Ali Khamseh [c]

[a] *Department of Industrial Management, Karaj Branch, Islamic Azad University, Karaj, Iran*
[b] *Department of Technology Management, Science and Research Branch, Islamic Azad University, Tehran, Iran*
[c] *Department of Industrial Engineering, Karaj Branch, Islamic Azad University, Karaj, Iran*

Abstract
One of the most important issues in smart cities is identifying the factors that affect their services' success. The purpose of this study is to provide a model for them and also to identify its indicators based on information and communication technology (ICT). In this research, data collection has been done by a desk research method and field studies, during which the factors (smart economy, smart citizens, smart governance, smart transportation, smart environment and smart living) affecting the services' success in smart cities have been identified.. We designed and distributed a research questionnaire in order to gather data from related communities. At this stage, by fuzzy Delphi method, the indicators related to the identified factors were also identified. In the next step, by using the structural equations and Smart PLS software, the effect of factors on the main component of the research (Success of Smart City Services) was evaluated. The results show that all factors have a significant and positive impact on the services' success of smart cities and government actions have the greatest impact on it.

Keywords: Smart City; Service Chain; Information and Communication Technology; Fuzzy Delphi; Smart PLS.

1. Introduction

Cities are inherently facing complex and wide-ranging interrelated challenges, and the rapid growth of cities is not commensurate with the capacity to expand their infrastructure and imposes increasing pressure on urban infrastructure; In other words, this pressure is beyond their capacities and capabilities. Therefore, they always suffer from the adverse consequences of this issue, so urban planners around the world try to develop models for the development of 21st century cities to meet the new demands and expectations of today's world and meet the challenges ahead by taking an integrated look at all aspects of urbanization. One of the new concepts to address the current challenges of cities in the field of urban planning is the development of smart cities, which has attracted much attention in recent years (Pour Ahmad A., Ziari K., Hatami Nejad H. and Parsa S., 1397). Despite the extensive literature on the concept of smart city, there is still no clear understanding and general consensus on this issue, and researchers in various fields of science have proposed a variety of content to define smart city, but at a glance, the smart city points to smart solutions that allow modern cities to improve the quality of citizens' life in terms of quantity and quality (Pour Ahmad et al., 1397). But the bottom line is that every city has its own characteristics and coordinates, both physically and geographically, as well as demographically, culturally and socially, so intelligent solutions cannot be easily copied from one city to another. In fact, in order to enjoy the benefits of a smart city, we must first know the characteristics of a city, then we should answer the question: why the cities of each country may have different priorities for smartening and providing services according to their characteristics? (These priorities may not necessarily be the same in all cities).

*Corresponding author email address: abbas.khamseh@kiau.ac.ir
DOI: 10.22034/ijsom.2022.109548.2474

On the other hand, Due to the increase in population of cities and the consequent emergence of challenges in large cities, using of ICT to better use of available resources and improve the living standards of people and smart cities is inevitable. Unfortunately, in the rapid movement towards the smartening of cities, if the characteristics of a city are not considered and only copying and creating the necessary infrastructure for the smartness of that city is done, the expected productivity of this intelligence will not be achieved. Also, if we do not have a template to prioritize smart issues in a city, creating the required infrastructure will be a waste of money, Therefore, before creating or developing the infrastructure needed to make a city smart, the priority of the issues that need to be made smart must be determined. Elite migration and creating a suitable environment for attract them in cities, waste of resources due to complex administrative bureaucracy, waste of other resources such as water, electricity, energy, etc. and the need for optimal use of these resources and the need for proper management in other issues (including in transportation) is another reasons for cities to move towards intelligence (Pour Ahmad et al., 1397), which explains the need for the present study.

So, one of the main and biggest advantages of the present paper is to consider the various factors of services' success in smart cities to propose a model for them and also evaluate their impact on the main component of the research (success of services in smart cities based on ICT). The remaining sections of this article, which will be organized as follows: Section 2 reviews the subject literature and related work. The third section describing the methodology and research implementation steps. In the fourth section, the findings are presented with explanations for fuzzy Delphi and factor analysis findings. In the rest of the section, the initial and structural model are given. Finally, in the fifth section, discussion, conclusions, and suggestions for future research are stated.

2. Theoretical foundations and Research background

A review of different definitions shows that the meaning of a smart city is multifaceted and each author has emphasized different aspects of a city. Therefore, measuring a smart city is complicated because every city has its own administrative, economic and social situation and its own geographic background as well as different priorities. Some definitions of smart city are given in Table 1.

Table 1. Some definitions of smart city

definition	**Reference**
An urban space that uses ICT to improve the quality of everyday life of citizens	Said and Tolba, 2020
Smart City integrates ICT and various physical devices and sensors connected to the Internet of Things to optimize the efficiency of urban services and better communication with citizens.	Jovanovic et al, 2020
A smart city should be (1) "instrumental", referring to the immediate tracking of data from different sources, (2) "interconnected", referring to the integration of captured data, and (3) "smart", referring to the analysis of this data Connected, be.	Stahli, Giannopoulos and Raubal, 2020
The smart city is defined as an urban space that manages its community services more efficiently through digital technology.	Daniela et al, 2020
The concept of smart city can be divided into 1) academic, 2) industrial and 3) governmental.	Mosannenzadeh and Vettoratob, 2014
A smart city is a sustainable and efficient city with a high quality of life that aims to meet urban challenges through the use of information and communication technologies in services and infrastructure, cooperation between stakeholders and key stakeholders, and investment in social capital.	Mosannenzadeh and Vettoratob, 2014
A smart city is the effective integration of physical, digital and human systems into an environment built to provide a sustainable, prosperous and inclusive future for its citizens.	Smart Cities Overview-Guide, 2015
A smart city must enable every citizen to engage with all the services provided, both public and private, in a way that suits their needs. The smart city brings together solid infrastructure, social capital, including local skills and community institutions, and (digital) technologies to ensure sustainable economic development and an attractive environment for all.	Department for Business, Innovation & Skills, 2013
A smart city is a city where individual urban systems are managed in a more integrated and cohesive way, through the use of new technologies and in particular through the increasing availability of data and a way that can provide strong evidence for decision making.	International Electrotechnical Commission, 2019

In general, the main currents that lead cities to smart approaches are as follows:

- ***Accelerated urbanization***

The world is at an unprecedented level of urbanization. This urban growth trajectory is not an interesting fact, because the world wants sustainable development and a better life. In the 18th century, less than 5% of the world's population lived in cities. According to a 2008 report by the United Nations entitled Urban Outlook, 2008 was a year in which more than 50 percent of the world's population lived in cities. This trend is currently growing rapidly and is projected to reach more than 70% of the world's population by 2050. In Europe, 75% of the population now lives in urban areas. Thus, the

early urbanization of the world is an inevitable reality that brings with it many problems and issues. Therefore, rapid urbanization and efforts to reduce the problems caused by urban population growth is one of the main factors in the emergence and introduction of smart cities (Chourabi et al., 2012).

- ***Environmental concerns***

The second issue in moving towards intelligence, given the population growth in cities and their main role in the economic and social dimensions around the world, refers to the effects of cities on the environment. Human development has had a significant impact on the environment since the Industrial Revolution; we live in an age where global change is largely attributed to widespread and destructive human behavior (Steffen et al., 2011). UN Habitat (2015) wrote in its article that cities are the engine of economic growth and 80% of world GDP is allocated to cities. But despite consuming 2% of the world's land surface, they consume about 75% of the world's energy (Fraru, 2013). Today, most resources are consumed in cities around the world; which have high economic importance and poor environmental performance (Albino et al., 2015). According to Colldahi, Frey, and Kelemen (2013), this consumption leads to 70% of greenhouse gas emissions, which play a major role in climate change. UN Habitat (2015) also wrote in his article that global carbon dioxide emissions increased by 45% between 1990 and 2010, which is largely due to the growth of cities. Thus, as Batagan wrote in her 2011 article, environmental problems and the need to develop more sustainable cities are at the heart of many smart city projects. As smart cities in Europe have focused mainly on energy and sustainability issues, these issues have been considered as very important issues to maintain a high quality of life in cities (Major, 2013). According to Nam and Padro (2011), this unprecedented rate of urban growth creates a need to find smart ways and solutions to manage the challenges ahead. Smart cities have a forward-looking view of environmental issues and one of the core of the smart city is the use of technology to increase the sustainability and better management of natural resources (Chourabi et al., 2012).

- ***Economic crisis***

Harrison and Donnelly (2011) identified the main motivation for cities to move towards intelligence in their desire for economic development. In their view, during the economic crises of 2008 and 2009, cities realized that they were in competition with other cities but in ways they have not experienced before. They were not only competing with their neighboring cities in their province or nationally, but also competing with their counterparts across the world for different generations (present and future) in terms of global supply-demand networks and the Internet. Hence the need for innovative and intelligent approaches in the face of the greatest economic crises was a global necessity. The requirements of the current economic crisis provide the right incentive to overcome resistance to change and turn problems into opportunities; In other words, the most obvious stimulus for the development of smart cities were economic crises and the need to generate more wealth. The global economy is now globally integrated and more service-oriented, centered on cities. According to the researches of Musannazadeh and Vatoratub (2014), cities attract business activities and turn them into centers of global competition. Cities are also key players in global competition that need to mobilize their resources to generate more wealth (Florida, 2002). On the other hand, the Mackenzie World Institute predicts in 2011 that by 2050, 600 of the world's largest cities will produce 60% of the world's gross domestic product. Cities, meanwhile, are competing to attract younger, more skilled workers (what Richard Florida calls the creative class) to generate more wealth. In a 2008 article, Florida found that high-value jobs that make the city attractive are concentrated in a small number of cities and counties. In this regard, Glaser and Barry (2006) showed that the highest urban growth rates are obtained in cities where there is a high share of educated labor. Therefore, reducing urban problems and creating a suitable environment with a high quality of life to attract the creative class in order to generate more wealth and economic competitiveness is another major reason for cities to move towards intelligence (Albino et al., 2015).

- ***Demographic changes***

The fourth major trend that is destroying the capabilities of cities is related to the series of demographic changes. Fararu (2013) acknowledged in his article that he expects the older generation over the age of 65 worldwide to almost double in the next ten years, from 7% to 13%; this means that many infrastructures need to be adapted. Hence, major changes are expected in the healthcare and geriatric sectors. Here, smart solutions are needed for cities whose goal is to increase or at least maintain the overall quality of life of their inhabitants. He believed that rapid growth in the number and population of cities would give them a greater central role in technological, political, and economic power than ever before (Florida, 2013). It can be said that one of the most useful functions of a smart city is to help the elderly and disabled people to do their daily chores. The need for in-person visits for treatment and administrative work is one of the examples of this assistance (Hatami Nejad et al. 2015).

- ***Advances in Information and Communication Technology***

The 21st century urban model can be understood by exploiting the potentials of ICT (UN Habitat, 2015). Toffler points out that advances in ICT have created a third wave in the evolution of cities (Castells 2001). Communication systems connect citizens, companies and organizations like a nervous system. With the help of technology and internet connection, citizens receive services without time and space restrictions. Without investing in broadband infrastructure, the flow of information between different parts of a city and between cities is cut off. This slows down economic activities and has a

negative impact on financial services. Connection is therefore an important aspect of urban life that is possible in the light of technological advances (Karadeg, 2013).

• ***Other factors***

Elite migration and creating a suitable environment for their absorption in cities, waste of resources due to complex administrative bureaucracy, waste of other resources such as water, electricity, energy, etc. and the need for optimal use of these resources and the need for proper management in other issues, including Transportation is another reason for cities to move towards intelligence (Pour Ahmad et al. 1397). Kiani (2011) writes in his article that the existence of an electronic and Internet model city in any country can provide the basis for the gradual, logical, scientific and economic presence of this valuable phenomenon, which is currently a measure of scientific ability and power of countries to use and produce knowledge. Slowly. Their results of expertise in the world showed that sporadic development in this field has not been successful and will not be of appropriate quality. Also, Hamamurad et al. (2022) evaluated the smart city concept by four primary city functions depend on citizen requirements and availability of ICT; which includes Intelligent City, Digital City, Live City, and Open City. These four primary types of the smart city combine Social Infrastructure, Physical Infrastructure, Information Infrastructure and Open Government.

A summary of the key success factors of the service chain in smart cities is given in Table 2.

Table 2. Key factors of service chain success in smart cities

Dimension	Indicator	Reference
Built infrastructure success factors	Infrastructure / Technology Infrastructure / Information Technology Infrastructure / Security & Privacy / Operating Cost / Intelligent Information Services	Chourabi et al (2012)
Economic success factors	Social diversity as a source of innovation / Entrepreneurship and Innovation / Productivity / Economic reputation and trademarks / Labor market flexibility / International relations / Economic level	Benamrou, Mohamed, Bernoussi, Ouardouz (2016)
Environmental success factors	Energy conservation / Environmental sustainability / Sustainability / Environmental protection / Pollution / Natural environment / Natural resources / Impacts of climate change / Urban ecosystems / Comprehensive approach to environmental and energy issues	Benamrou et al.(2016), Chourabi et al (2012)
governance success factors	Leadership and Heroism / Participation / Communication / Responsibility / Transparency / Information Exchange / Public-Private-People Participation / Transparency in Governance / Cohesion of Regions / Flexible Government / Public and Social Services / Associations / Citizen Interaction / Citizen Participation / Civic Participation	Chourabi et al (2012), Nam (2011), Benamrou et al. (2016)
Government success factors	Open government / open data / strategies and political views	Benamrou et al. (2016)
Management and organizing success factors	Project size / Manager attitude and behavior / Users or organizational diversity / Non-alignment of organizational and project goals / Multiple or conflicting goals / Resistance to change / Digital asset management / Physical asset management / Performance management / Customer / Stakeholder focus / Service capability / Delivery Services / Resource Management / Sustainable Resource Management / Lack of staff integration skills and culture	Chourabi et al (2012), Benamrou et al. (2016)
Popular societies success factors	Social Cohesion / Cyber Security / Capacity / Education / Social and Human Capital / Social Infrastructure / Digital Gap (s) / Viewing Information and Society / Participation / Communication / Quality of Life / Social and Ethnic Multiplicity / Flexibility / Worldview / Open Mindset / Participation Public life	Chourabi et al (2012), Benamrou et al. (2016)
Technology Success Factors	IT skills (IT training programs) / Availability of ICT infrastructure / Lack of ICT infrastructure / Technology infrastructure / Mobility / Speed / Real-time monitoring / Interoperability	Chourabi et al (2012), Nam (2011), Benamrou et al. (2016), , Nam (30)

By examining the definitions of smart city, it can be seen that a fixed and accurate definition of smart city cannot be provided, but most definitions refer to the use of information technology and economic and social development of the city and improving the quality of life of citizens. Infrastructure must also be considered. Looking at the most important factors for the success of service delivery in a smart city, it can be seen that there is a consensus on approximately 6 key factors: smart economy, smart citizens, smart governance, smart transportation, smart environment, and smart life.

3. Methodology

Considering that the present study deals with the effective factors in implementing the service chain in the smart city and these results can be used by municipalities and other organizations involved in urban management, so it is practical in terms of purpose and since data collection and collection Expert opinion is done through questionnaires and interviews, so the research is methodical, descriptive-survey. Also, considering the use of qualitative method to extract effective factors and indicators in the implementation of smart city and the use of quantitative method to confirm these factors and indicators, the research is of mixed type.

Participants in the quality department include experts and researchers in the field of smart cities, who were selected for their characteristics, which include: having a doctorate, having more than 10 years of experience in the field of research on smart cities. These individuals (12 people) were selected by snowball method and fear of theoretical saturation. The statistical population of the quantitative section includes 30 managers and experts related to the field of smart cities who were selected by purposive and accessible sampling.

The validity of the Delphi questionnaire was assessed and validated using Maxwell validation criteria and Newman validation method, and the reliability was assessed and confirmed using the open-test reliability method. The validity of the quantitative questionnaire was confirmed by 3 experts of Tehran Municipality and also the convergent and divergent validity in PLS software was confirmed and the reliability was measured and confirmed by Cronbach's alpha coefficient which was obtained for all dimensions of Cronbach's alpha coefficient above 0.7.

In this research, descriptive statistics and excel software will be used to summarize data and compile many tables. Cronbach's alpha coefficient and SPSS software were also used to evaluate the reliability of the questionnaire. In the next step, to extract the indicators defining the research factors, the fuzzy Delphi method has been used. In order to ensure the accuracy of the items used in the questionnaires were used to measure the relevant variables.

Figure 1 shows the implementation steps of the research.

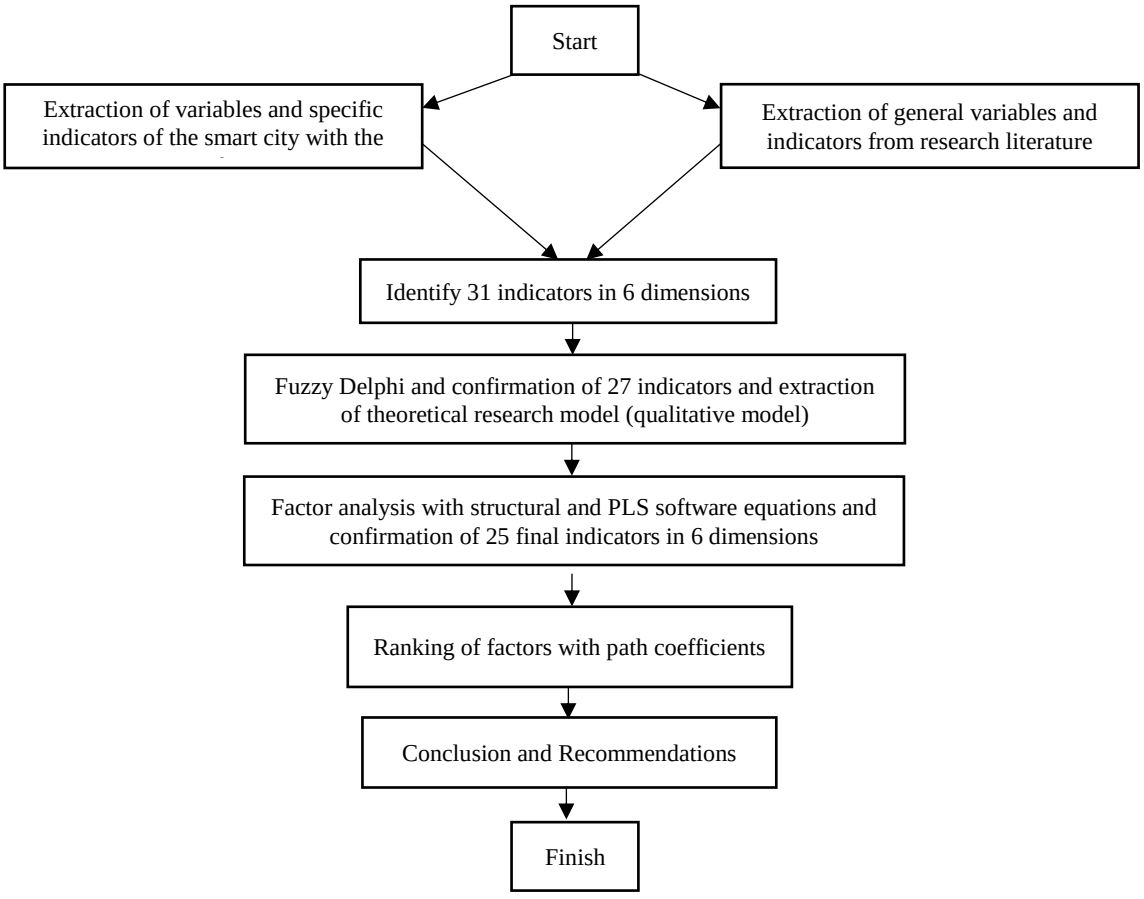


Figure 1. Research implementation steps

4. Findings

Based on doing desk research, studying research background and obtaining expert opinions, the most important factors affecting the success of services in smart cities have been identified. These factors and also their related indicators are introduced in Table 3.

Table 3. Dimensions and indicators of service chain success in smart cities

Subject	Dimensions	Indicators	Symbol
Service chain success in smart cities (SC)	Smart economy (SE)	E-commerce development	SE1
		Creating new businesses in the city	SE2
		Activity and fertility of the economy	SE3
		Labor market flexibility	SE4
		International status	SE5
	Smart citizens (SP)	The extent to which citizens use ICT-based services	SP1
		Increasing citizens' digital literacy	SP2
		The extent to which citizens benefit from virtual education	SP3
	Smart governance (SG)	Reducing face-to-face visits to offices to receive services	SG1
		Reducing waiting time to receive services	SG2
		Reducing financial and administrative corruption	SG3
		Reducing response time to urban problems and natural disasters	SG4
		Increasing employment rate	SG5
		Creating new business models	SG6
	Smart transportation (ST)	Reducing urban travel	ST1
		Reducing the number of cars	ST2
		Reducing the use of fossil fuels	ST3
		Eliminating some redundant administrative activities	ST4
		Reducing accidents	ST5
		Reducing environmental pollution	ST6
	Smart environment (SN)	Reducing environmental pollution (such as noise)	SN1
		Environmental Protection	SN2
		Municipal waste and wastewater management	SN3
		Designing and construction of environmentally friendly houses and buildings	SN4
		Controlling and monitoring of energy and water distribution networks	SN5
		Increasing the amount of green space	SN6
	Smart life (SL)	Increasing personal safety	SL1
		Reducing social crime	SL2
		Reducing the incidence of disease in the community	SL3
		Increasing urban facilities commensurate with vulnerable people in society	SL4
		People's Satisfaction	SL5

4.1. Fuzzy Delphi findings

In the first stage of Delphi, questionnaires were designed based on previous research results and experts were asked to use the verbal variables very low, low, medium, high and very high the importance of each of the identified indicators on the dimensions of Specify each indicator. The right number of experts is an important point to consider. The number of participants, like other methods of data collection, depends on factors such as the availability of people, the time available and the budget available to the researcher. Although most previous studies put the number of participants at between 10 and 20, some also believe that with the increase of experts, new information is not obtained and in other words, the answers are repeated. The selection of experts in this study is non-random and purposeful and is 12 people.

Table 4. Sample results of the first fuzzy round

Dimensions	Indicators	Symbol	Consolidation of expert opinion			De-fuzzy value
			Lower	Middle	Upper	S1
Smart economy (SE)	E-commerce development	SE1	0.458	0.708	0.917	0.694
	Creating new businesses in the city	SE2	0.542	0.792	0.979	0.771
	Activity and fertility of the economy	SE3	0.063	0.229	0.479	0.257
	Labor market flexibility	SE4	0.521	0.750	0.896	0.722
	International status	SE5	0.563	0.813	0.958	0.778
Smart citizens (SP)	The extent to which citizens use ICT-based services	SP1	0.521	0.771	0.938	0.743
	Increasing citizens' digital literacy	SP2	0.458	0.708	09.17	0.694
	The extent to which citizens benefit from virtual education	SP3	0.438	0.688	0.896	0.674

In the second stage, another questionnaire was provided to them along with the previous opinion of each expert and the extent of his / her disagreement with the average opinions of the panel members. The repetition of the Delphi process went so far that the absolute value of the average difference of expert opinion between the two stages of the survey reached less than 0.2, in which case the poll process was stopped. Considering that with the second round of Delphi, the absolute difference between the averages of experts in all indicators is less than 0.2, so it can be concluded that the poll has reached a consensus. Due to the fact that in this study, the indicators of 1- economic activity and fertility 2- reduction of financial and administrative corruption 3- protection of the environment and 4- reduction of the incidence of disease in the community were below the threshold. And 27 indicators were confirmed.

Table 5. Sample results of the second round of fuzzy Delphi

Dimensions	Indicators	Symbol	Consolidation of experts in the second round			First round De-fuzzy	Second round De-fuzzy	The difference between the two stages
			Lower	Middle	Upper	S1	S2	S1-S2
Smart economy (SE)	E-commerce development	SE1	0.458	0.708	0.917	0.694	0.780	0.086
	Creating new businesses in the city	SE2	0.542	0.792	0.979	0.771	0.790	0.019
	Activity and fertility of the economy	SE3	0.063	0.229	0.479	0.257	0.274	0.017
	Labor market flexibility	SE4	0.521	0.750	0.896	0.722	0.810	0.088
	International status	SE5	0.563	0.813	0.958	0.778	0.850	0.072
Smart citizens (SP)	The extent to which citizens use ICT-based services	SP1	0.521	0.771	0.938	0.743	0.760	0.017
	Increasing citizens' digital literacy	SP2	0.458	0.708	09.17	0.694	0.770	0.076
	The extent to which citizens benefit from virtual education	SP3	0.438	0.688	0.896	0.674	0.780	0.106

According to the fuzzy Delphi output, the theoretical model of the research was drawn according to Figure 2.

4.2. Factor analysis findings

To validate the theoretical model of the qualitative part, we have used factor analysis with structural equations and Smart PLS software. This method enables several variables to be analyzed simultaneously in an integrated model and provides useful insights into the conceptualization of structures and theories tested with experimental data and can reveal the complexities of causal modeling (Hair et al., 2011). This method also allows estimating a model using a small sample with many hidden variables (Akter et al., 2017). Based on this, external model analysis or measurement and internal or structural model were performed with Smart PLS software. Structural validity was evaluated by convergent validity and divergent validity. Convergent validity, which shows the degree of dependence of the indicators with the relevant variable, and divergent validity, which compares the degree of correlation of one factor with its indicators against the correlation of that factor with other factors, by Smart PlS3 software has been reviewed and approved. On the other hand, Cronbach's alpha was used to assess the reliability of the questionnaire. The appropriate criterion for Cronbach's alpha for all factors is above 0.7 (Florida, 2008). In this study, the calculated Cronbach's alpha value for all factors was higher than 0.7, so it

has the necessary reliability questionnaire. Also, to measure the reliability of the model, the indices of combined reliability and common reliability in the least squares least squares method were used.

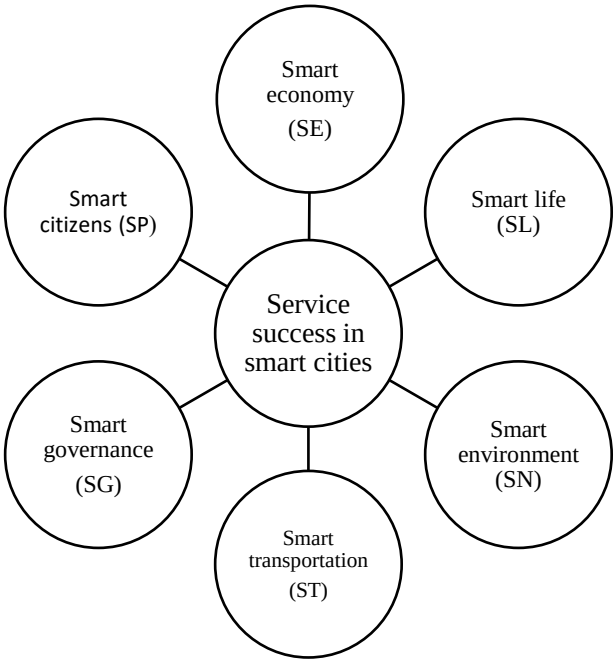


Figure 2. Theoretical model of service chain success in smart cities

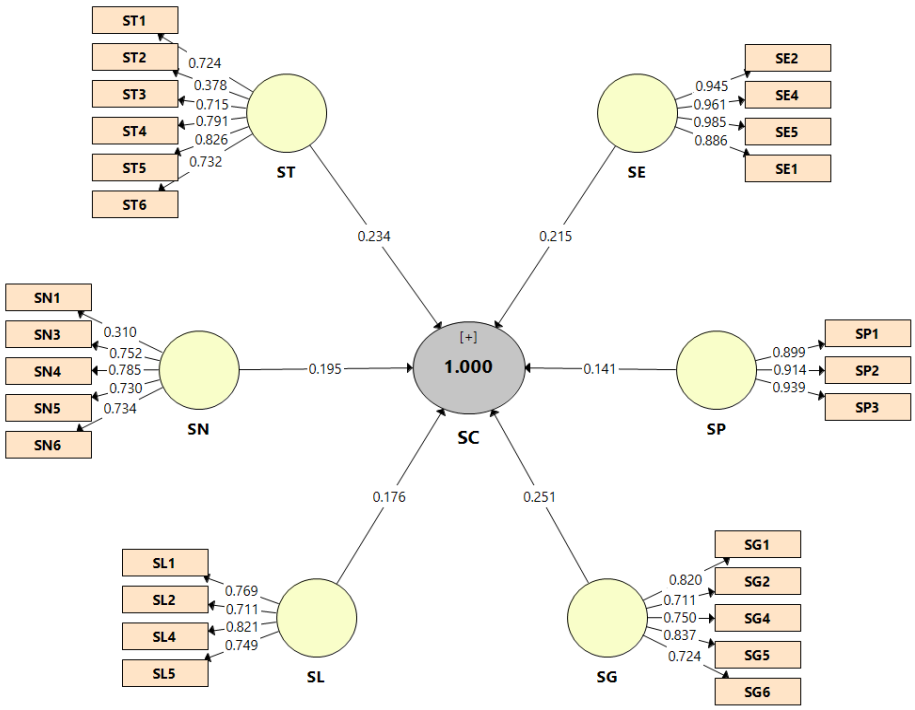


Figure 3. Initial measurement model in standard coefficient estimation mode (factor load)

In the partial least squares method, the condition for accepting factor load coefficients is 0.7 and higher (Azar, 2012). According to Figure (3), out of 27 indicators, 2 indicators ST2 and SN1, which had factor coefficients less than 0.7, were removed and the homogeneity and fit of the measurement model was confirmed. Then, based on the results of the modified model, Table (6) shows the validation tests of the measurement model, all of which are within the permitted and approved range.

Table 6. Results of reliability, convergent validity and quality of the measurement model

Concealed variables	Reliability			Convergent validity	
	Cronbach's alpha	Shared reliability	Combined reliability	AVE	CR>AVE
SE	0/940	0/940	0/940	0/893	OK
SG	0/828	0/828	0/828	0/593	OK
SL	0/761	0/761	0/761	0/583	OK
SN	0/749	0/749	0/749	0/569	OK
SP	0/908	0/908	0/908	0/842	OK
ST	0/827	0/827	0/827	0/591	OK

Figure (4) and Figure (5) show the structural models. Three criteria are used to evaluate the structural model. Z significance coefficients are used to fit the structural model, the coefficients must be higher than 1.96 to be able to confirm their significance at the 95% confidence level (Azar, 2012). According to Figure (4), all cases have significant coefficients higher than 1.96. Criterion R2 is also the criterion of path determination coefficient, which indicates the effect of an exogenous variable on an endogenous variable. For R^2, three values of 0.19, 0.33 and 0.67 are considered as the criterion values for weak, medium and strong values, respectively (Hair, 2006). In this study, the value of R2 is equal to 0.98, which indicates its suitability. On the other hand, the Q^2 criterion determines the predictive power of the model, and if the value of Q^2 for an endogenous structure achieves three values of 0.02, 0.15 and 0.35, respectively, it indicates the predictive power. Weak, medium and strong have related exogenous structures (Wetzels and Odekerken 2009). The value of Q^2 obtained for the model of this research is 0.38, which indicates the very good predictive power of the model.

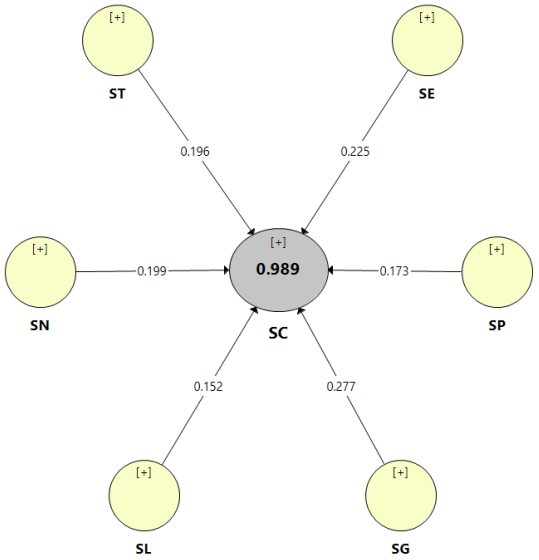


Figure 4. Structural model in the case of significant path coefficients

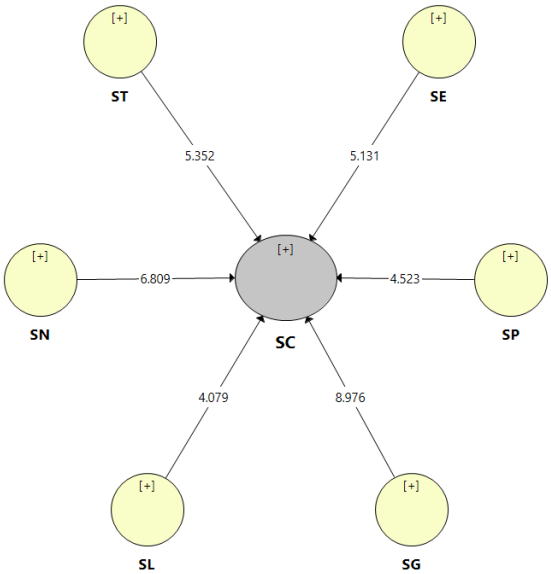


Figure 5. Structural model in the case of estimating the path coefficients

Finally, GOF index was used to evaluate the quality of the structural model. The values of 0.01, 0.25 and 0.36 have been described as strong, medium and weak, respectively (Hair, 2006). Since the obtained GOF value is 0.819, the appropriate quality of the quality model is confirmed.

5. Discussion and conclusion

The purpose of this study was to provide a model for the success of services in smart cities based on ICT and also to identify its factors and indicators. In this research, we did a data collection by a desk research method and also by field studies; based on these data, the factors (which are affecting the success of services in smart cities) were identified. These factors include smart economy, smart citizens, smart governance, smart transportation, smart environment and smart living. We designed a research questionnaire and distributed them among the related community in order to find answers. At this stage, by fuzzy Delphi method, the indicators related to the identified factors were also identified. In the next step, by using the structural equations and Smart PLS software, the effect of research factors on the main component of research (success of services in smart cities based on ICT) was evaluated. The results show that all factors have a significant and positive impact on the success of services in smart cities and government actions to create a smart city have the greatest impact on the success of services in smart cities. In previous researches, although the factors have been introduced as well as the indicators related to each factor, but in none of them the impact of the success of services in smart cities has been introduced. From this point of view, the study of the effect of each of the enumerated factors on the success of services in smart cities can be considered as the difference between this study and previous studies.
The following suggestions are based on the results of the research and are presented in order to improve the efficiency of the model and the practical use of research-related organizations:

- The results obtained from the factor analysis show that smart governance with a path coefficient of 0.277 has the greatest impact on the success of services in smart cities, so it is suggested that city managers to implement smart cities to implement projects that provide public and social services. Prioritize issues such as the development of digital banking or the provision of administrative services in organizations such as health centers, municipalities, the registrar or the tax office.
- In this regard, in particular, the participation of citizens at the municipal level can be suggested. A transparent governance system allows citizens to participate in decision-making. ICT facilitates the participation of citizens and access to information and data related to the management of their city. Barriers to communication and cooperation can be removed by creating a continuous and efficient governance system.

- The next suggestion is to use the G5 for IoT. This will monitor the total energy consumption in the city, thus enabling government officials and city managers to get accurate and valuable information about the energy services needed. Access various public areas (eg, public lighting, traffic lights, surveillance cameras, heating / cooling of public buildings, etc.).

- Smart economy is the second factor that has the greatest impact on the success of services in smart cities after smart governance with a path coefficient of 0.225. In order to strengthen this factor, measures such as supporting the development of e-commerce can be proposed. For this purpose, it is possible to provide financial facilities for start-ups and start-ups that are based on ICT. These financial facilities can be proposed. Include low-interest loans or tax breaks.

- The smart environment with a path coefficient of 0.199 is the third factor that affects the success of services in smart cities based on ICT, and since this factor emphasizes the need to manage environmental resources and is a concept that is possible. Includes the use of advanced technologies for urban environments, which results in increased quality of life for citizens. It is recommended to use 5G for IoT, monitoring and measuring environmental parameters such as water pollution of dams or rivers, as well as production Industrial effluents are made possible by industrial units. Another part of these measures is related to creating the necessary infrastructure for this.

- Intelligent transportation with a path coefficient of 0.196. It is the fourth factor that affects the success of services in smart cities based on information technology and communications, and with its realization, we will see a reduction in air pollution, traffic, consumption of fossil fuels, etc. To strengthen this factor, it is suggested that lights Smart traffic lights that are adjusted to the volume of vehicle traffic should be installed, as well as planning the movement and stopping of trains and city buses according to the intra-city travel patterns of each area of the city separately.

- Smart citizen with a path coefficient of 0.173 is the fifth factor that affects the success of services in smart cities based on ICT. Citizens, as the main beneficiaries of the urban management intelligence project, should be able to make the most of the opportunity provided to them. In order to strengthen this factor, it is suggested that formal

education programs by organizations such as education or the creation of learning networks by the municipality, empower citizens to use the services of the smart city.

- Smart living; It seeks to improve the quality of life of citizens by providing safe and healthy living conditions. And in this research with a path coefficient of 0.152 is the last factor that affects the success of services in smart cities based on ICT. Citizens in smart cities have easy access to a variety of healthcare services, e-health management and social services. Therefore, it is suggested to emphasize the development and application of health care equipment that records the functions of the human body and sends vital health information to the user in real time to prevent and monitor medical emergencies. The security of homes and offices and industrial buildings can also be monitored continuously through video surveillance remotely using smartphones.

Among the limitations of this research, we can mention the existence of limited specialists and experts related to the subject of research, the lack of study of moderator variables and the lack of study of the effect of factors on each other. In this regard, it can be suggested to future researchers to study the effect of moderation variables such as technology acceptance on the success of the smart city service chain. It is also suggested to study the factor of intelligent governance and its effect on each of the other five factors.

References

Akter, S., Fosso Wamba, S. and Dewan, S. (2017). Why PLS-SEM is suitable for complex modeling? An empirical illustration in Big Data Analytics Quality. *Production Planning and Control,* Vol. 28 (11-12), pp. 1011-1021.

Albino, V., Berardi, U. and Dangelico, R. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *Journal of Urban Technology*. Vol. 22(1), pp. 3-21.

Anindra F., Supangkat S. H. and Kosala R. R. (2018). Smart Governance as Smart City Critical Success Factor (Case in 15 Cities in Indonesia), *2018 International Conference on ICT for Smart Society (ICISS)*, pp. 1-6.

Azar, A; GholamReza, R; and Ghanavati, M.(2012). Route structural modeling in management: application of Smart PLS Software, Tehran:Negah Danesh Publication (In Persian).

Batagan, L. (2011). Smart Cities and Sustainability Models. *Informatica Economica*. Vol. 15(3), pp. 80-87.

Benamrou, B, Mohamed, B, Bernoussi A.S, Ouardouz, M. (2016) Ranking Models of Smart Cities. 4th IEEE International Colloquium on Information Science and Technology (CiSt), Tangier-Assilah, 24-26 October, 872- 879. Doi: 10.1109/CIST.2016.7805011.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J., Ramon M., Sehl. N., Karine Pardo, T. and Scholl, H. (2012). Understanding Smart Cities: An Integrative Framework. 45th Hawaii International Conference on System Sciences.

Colldahi, C. Frey, S. and Kelemen, J. E. (2013). Smart Cities: Strategic Sustainable Development for an Urban World. Blekinge Institute of Technology, Karlskrona.

Daniela, M., Zamar, G., Segura, E., Cano, E., Meneses, E., (2020), IoT Technology Applications-Based Smart Cities: Research Analysis, *Electronics Journal*, Vol. 9(8), pp. 1246.

Department for Business, Innovation and Skills. (2013). Smart Cities: background paper. https://www.gov.uk/government/publications/smart-cities-background-paper

Fareghzadeh N. and Jamshidi H. (1396). Smart city with a sustainable development approach. 3d Annual Conference on Architectural, Urban Planning and Urban Management Research (In Persian).

Ferraro, S. (2013). Smart Cities, Analysis of a Strategic Plan. Master thesis.

Florida, R. (2008). Who's Your City?: How the Creative Economy Is Making Where to Live the Most Important Decision of Your Life. Basic Books, Random House Publication.

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Milanović, N., and Meijers, E. (2007). Smart cities - Ranking of European medium-sized cities. Vienna University of Technology Publication.

Guevara, C., and Auat Cheein, F. (2020). Role of 5G Technologies: Challenges in Smart Cities and Intelligent Transportation Systems. *Sustainability*. Vol. 12(16), pp. 6469.

Hataminejad H., Zarghamfard M., Khademi A., and Mirseyedi Anbaran S., (1396). *Spatial policies in urban planning - with emphasis on development*. Tehran: Papoli Publication (In Persian).

UN Habitat III Conference (2015). *Smart cities*. Conference on Housing and Sustainable Urban Development.

Hair, J.F. (2006). Multivariate Data Analysis. Pearson Prentice Hall.

Hair, J.F., Ringle, C.M., Sarstedt, M. (2011). PLS-SEM: indeed a silver bullet. *Journal of Marketing theory and Practice*, Vol. 19(2), pp. 139-152.

Harrison, C., and Donnelly, I. (2011). A Theory of Smart Cities. 55th Annual Meeting of the International Society for the Systems Sciences 2011.

Hatami Nejad, H., Zargham Fard, M., Khademi, A. and Mirseyedi Ambaran, S.M. (1395). Spatial policies in urban planning (with an emphasis on interdisciplinary development and smart growth). Mashhad: Papoli.

Hamamurad, Q., Mat Jusoh, N., and Ujang, U. (2022). A Literature Review of Smart City: Concept and Framework. *Journal of advanced geospatial and science technology*. Vol. 1(1), pp. 92-111.

International Electrotechnical Commission. (2019). STRATEGIC BUSINESS PLAN (SBP).

Jovanović, D., Milovanov, S., Ruskovski, I., Govedarica, M., Sladić, D., Radulović, A., and Pajić, V. (2020). Building Virtual 3D City Model for Smart Cities Applications: A Case Study on Campus Area of the University of Novi Sad. *ISPRS International Journal of Geo-Information*, Vol. 9(8), pp. 476.

Karadag, T. (2013). An Evaluation of the Smart City Approach. Master thesis. Middle East Technical University.

Kiani A. (1390). The smart city is the necessity of the third millennium in the integrated interactions of e-municipality (presenting a conceptual-executive model with emphasis on Iranian cities). *Amayesh-e mohit Journal*, Vol 4 (14), pp. 39-64 (In Persian).

Lai, C.S., Jia, Y., Dong, Z., Wang, D., Tao, Y., Lai, Q., Wong, R., Zobaa, A., Wu, R., and Lai, L.L. (2020). A Review of Technical Standards for Smart Cities. *Clean Technologies*, Vol. 2(3), pp. 290-310.

Manville, C., Cochrane, G., Cave, J., Millard, J., Pederson, J.K., Thaarup, R.K., Liebe, A., Wissner, M., Massink, R., and Kotterink, B. (2014). Mapping Smart Cities in the EU. Available online: https://www.rand.org/pubs/external_publications/EP50486.html.

Manuel K. (1380). Information Age: Economy, Society and Culture. Translated by Aligholian, A. And Khakbaz, A. Tehran: Tarh-e No Publication (In Persian).

McKinsey Global Institute. (2011). Urban world: Mapping the economic power of cities.

Meijer, A. (2013). Governing the Smart City: Scaling-Up the Search for Socio-Techno Synergy. Utrecht School of Governance. Utrecht University.

Mosannenzadeh, F., And Vettorato, D. (2014). Defining Smart City. A Conceptual Framework Based on Keyword Analysis. *TeMA - Journal of Land Use, Mobility and Environment*, DOI: 10.6092/1970-9870/2523

Nam, T. and Pardo, T. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. ACM International Conference Proceeding Series.

Pérez, L., Oltra-Badenes, R., Oltra, J., and Gil-Gómez, H. (2020). A Bibliometric Diagnosis and Analysis about Smart Cities. *Sustainability*, Vol. 12(16), pp. 6357.

Pour Ahmad A., Ziari K., Hatami Nejad H. and Parsa S. (1397). Smart City: Explaining the intelligence necessities and requirements of Tehran, *New Attitudes in Human Geography*, Vol. 10(2), pp. 1-22 (In Persian).

Pour Ahmad A., Ziari K., Hatami Nejad H. and Parsa S. (1397). Explanation of Concept and Features of a Smart City. Bagh-e- Nazar, Vol. 15(58), pp. 5-26 (In Persian).

Said, O. and Tolba, A. (2020). DORS: A data overhead reduction scheme for hybrid networks in smart cities. *International Journal of Communication Systems*, Vol. 33(2), DOI: 10.1002/dac.4435

Staehli, L., Giannopoulos, I., and Martin, R. (2020). Evaluation of pedestrian navigation in Smart Cities. *Environment and Planning B: Urban Analytics and City Science*, Vol. 48(6), pp. 1728-1745.

Steffen, W., Grinevald, J., Crutzen, P. and Mcneill, J. (2011). The Anthropocene: conceptual and historical perspectives. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences*, Vol. 369(1938), DOI: https://doi.org/10.1098/rsta.2010.0327.

Smart cities overview – Guide (2015).
https://www.thenbs.com/PublicationIndex/documents/details?Pub=BSI&DocID=309893

Wetzels, M. and Odekerken, G. (2009). Using PLS Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration. *Management Information Systems Quarterly – MISQ*, Vol. 33(1), pp. 177-195.