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RESEARCH ARTICLE **Open Access**

Identification of Influencing Factors on Implementation of Smart City Plans Based on Approach of Technical and Social System

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Abstract
The current research seeks to identify the influencing factors on implementation of smart city plans based on approach of technical and social systems. For this goal, the library study is done and then based on that a research plan is written that include using expert opinions and data mining technique, feature selection ,clustering and also Delphi technique to identify and screen factors and then using clustering, the final factors are leveled. Here the aim is not ranking but is leveling. Meanwhile because of high numbers of factors, screening them in both steps using Delphi and feature selection is conducted. Delphi is one of the classic tests in qualitative approaches and feature selection include data mining techniques. Finally leveling factors include technical and social factors and the most influencing ones are determined. technical factors including digital infrastructure, ICT base transportation, ICT based logistic, building alarm systems, energy consumption adjustment, ICT based process are placed in level one. Social factors including digital and smart innovation, knowledge sharing, smart education, participation in sustainable development, access to educational plans, waste recycling, pollution control, productivity and flexibility of labor market are placed in level one.
Keywords. *Smart city, Data mining, Big data, Technical and social systems, Sustainable development*

Introduction

Rapid urban development has affected human life in several decades and caused environmental instability. With the increase in the number of issues and problems in cities, the experts of this field proposed the theory of sustainable development as a saving factor for environmental protection. This issue has gradually turned sustainable development into a dominant model in the popular scientific literature on urban development and planning (Judki et al., 2015). According to this theory, through reducing the reliance on natural resources, trying to minimize environmental pollution, paying attention to energy efficiency, increasing biodiversity, etc., it can improve the quality of urban environments in addition to It also protects the natural landscape as much as possible. Currently, one of the basic problems facing the planners of urban areas is how to apply policies and implement sustainable programs in cities (Dadder et al., 2015). In this regard, due to the fact that environmental issues are the priority of urban plans, it becomes more important to pay attention to this issue on a smaller scale, i.e. urban public spaces. For this reason, in recent decades, the humanistic approach to the quality of the city environment and urban spaces, in contrast to the technical, specialized approaches to the quality of the

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environment, has been emphasized and seriously focused by experts (Islampanah and Salimi 2015). Information technology as the main origin of the information society was due to the emergence of computers, the development of telecommunication networks and the increasing need for information. The studies conducted on the development programs of most countries show the centrality of the role of information and communication technology in such programs. The very wide nature and dimensions of this technology make its exact definition difficult. (Ramirez, 2017)

Information technology, which is a combination of telecommunication achievements, problem solving solutions and the ability to solve problems using computer knowledge, has been able to prove its efficiency in the last few years, understanding the importance of the use of information technology, the effect of the government sector, and the role that information technology can play. To play a role in the reforms of the public sector has prompted policymakers of different societies to provide institutional and executive platforms for the use of information technology in the public sector by putting it on the agenda and establishing related policies (Antopoulos, 2017).

In fact, in order to deploy a smart city that seems will be a requirement for the future of cities there will be need to some infrastructure that we divide it to type: social and technical. An smart city will be formed based on 2 term that is referred above. A smart should be ready both from social and technical view and if the cited conditions are not ready smart city implementation will not be possible. Therefore, in this research we try to identify the influencing factors on implementation of smart city from the social and technical view.

Considering the importance of the mentioned topics, this research seeks to investigate the factors affecting the smart city. The smart city has become very important in today's technological world and is followed as an important model in advanced countries, but for the realization of a smart city, there are requirements and essentials as well as components that are necessary to identify them in order to realize this importance. In previous researches The aforementioned components have not been correctly identified, while from the technical and social point of view, there is no clear and comprehensive identification of the components affecting the implementation of the smart city in the research literature.

Using a combination of qualitative and quantitative techniques, the present research seeks to determine the social and technical factors affecting the realization of a smart city. The achievements of the present research can be used as a model for the implementation of the smart city, and from a scientific point of view, it can contribute to enriching the literature in the field of the smart city. In the end, the researcher is looking for an answer to this key question: what are the effective factors on the implementation and implementation of smart city plans with the approach of technical-social systems?

Literature Review

The focus of the research literature on the topic and concept of smart city has increased in recent years, but despite the high importance of this field, the correct indicators regarding the smart city have not been presented in the conceptual research literature. In this section, the literature on the subject in the field of smart city is introduced. Taverna et al. (2013) presented a study titled business model innovation for urban smartness. The purpose of this research work is to investigate how a metropolis should organize and reconfigure the components of its business model to become a smart city. Researchers examine whether cities are innovating their business models to become smart or not.

(Susanti et al. 2016) in a research called smart growth, smart city and density in search of a suitable index for residential density in Indonesia, showed that density is

not related to the level of people's satisfaction.

(Liu et al2016) presented a research entitled Smart Innovative Cities: The Impact of Smart City Policies on Urban Innovation. In this research, the new data set collected for this analysis includes data related to smart city characteristics for 309 European metropolises, the intensity of smart city policies, and the outputs of urban innovation.

(Midlars et al, 2017) in a research titled Smart City, Safety and Security, put their main focus on safety and security in future smart cities, and their study on the Smart City program shows the lack of importance they give to this issue. shows to be (Meijer and Bolivar, 2018) in a research entitled the social effects of environmental innovations in Italian smart cities, present the results of research conducted on smart environmental projects implemented in Italy based on the qualitative analysis of environmental projects. The environment is presented in order to analyze their social effects, especially with reference to the issue of social society and environmental risk.

(Snow et al,2018) in a research titled Urban innovation through political coalition: Critical views of 100 smart city missions in India, the complex mechanisms of planning and governance in the fastest growing economy in the world, India, which is an ambitious mission has started to transform 100 urban areas across the country into smart cities.

Han and Hawken (2018) in a research called innovation and identity in smart cities of the next generation, consider cultural difference and human behavior and social identity as needing more attention in modern cities and identity and urban culture as the main challenge of the smart city. Take into account (Borskova et al. 2018) in a research titled efficiency between the size and indicators of smart cities: a research challenge with political implications on the concept of a smart city and its specific components in relation to the size of the city, which is of key importance among academic disciplines and planning The city is increasingly focused, and they write that the idea of a smart city is the dream of urban planners around the world and the subject of many research and business initiatives as well as political debates.

(Nielsen ,2019) presented the development of a typology of smart city innovation. This research investigates the consequences of different understanding of the concept of smart city for an initiative in the ability of cities. Based on the existing scientific contributions on smart cities and innovation literature, this research creates a typology of smart city initiatives based on the amount and types of innovations involved in them.

(Kashef et al. 2021) investigates urban monitoring systems to identify the main limitations and its sources. It is concluded that the value of network technology should be assessed. It is also concluded that it is not necessary to bring only citizens back to the discussion about the smart city (Somastoti et al2022) seeks to investigate the factors affecting the search and sharing of information in digital platforms of the smart city. The results showed that social factors have a dominant role in determining the intention of residents to search for information in smart city platforms.

(Duigan et al, 2022) investigated 22 Swiss cities with smart city projects and used qualitative comparative analysis of fuzzy set to determine the condition configuration. The results show that the configuration of the high share of the service sector, the presence of research institutions and high urban density are sufficient for this, while the size of the city, the development of new settlements, and participation in international networks appear to be less important.

(Zhou et al2022) introduce a smart city mechanism to better guide the development of smart city towards a human-centered direction. As a result, the smart city can be achieved in the direction of happiness through dynamic evaluation and adjustment.

(bahrami et 2022) aim to identify and analyze of the dimensions of innovation capability, clustering and ranking indexes in urmia food industries. Ahmadi panah et

al(2022) aim to produce new arrangement by using artificial neural networks. Ahmadi et al(2022) aim to identify the futures of marketing in banking industry with a focus on block chain technology.

Table 1
Review of research literature

Row	researchers	Year	Target	findings
1	Susanti	2016	Searching for a suitable index for residential density in Indonesia	The lack of connection between density and people's satisfaction
2	Midlars et al	2017	Focus on safety and security in smart cities	There is a gap in the field of safety studies
3	Meijer and Bolivar	2018	Examining the social effects of environmental innovations	Presenting a model about the social effects of environmental innovations
4	Snow et al	2018	Examining critical views of smart city missions in India	Screening views and providing appropriate solutions
5	Hahn and Hawken	2018	Investigating innovation and identity in smart cities of the next generation	Urban identity and culture as the main center of the smart city challenge
6	Borskova et al	2018	Investigating political concepts on the concept of smart city and its specific components	Examining the idea of the smart city as a dream for urban planners
7	Taverna et al	2013	Examining how to organize and reconfigure the components of the business model by the metropolis	Cities can innovate their business models
۸	Nielsen	2019	Developing a typology of smart city innovation	Providing a typology of smart city initiatives based on the amount and types of innovations available
9	Liu et al	2016	The impact of smart city policies on urban innovation	Smart city policies can affect urban innovation
10	Kashif et al	2012	A survey on urban monitoring systems to identify the main limitations and its sources	It is not necessary to bring only citizens back to the discussion about the smart city
11	Kosomastuti et al	2022	Investigating the factors affecting information search and sharing in smart city digital platforms	Social factors have a dominant role in determining the intention of residents to search for information in smart city platforms
12	Doigan et al	2022	Survey of Swiss cities with smart city projects	The configuration of the high share of the service sector, the existence of research institutions and high urban density are enough for this, while the size of the city, the development of new settlements and participation in international networks appear to be less important
13	Zhu et al	2022	Providing a smart city mechanism to better guide the development of the smart city towards a human-centered direction	A smart city can achieve happiness through dynamic assessment and adjustment

Based on the literature review table, it can be seen that in none of the researches carried out in the field of smart city, the factors affecting the implementation of smart city have not been investigated separately from social and technical factors, and this issue can be considered as a Considered an important research gap. The current research is subject to innovation due to the attention of the effort to fill the gap in existing studies and to extract

and identify the effective factors on the implementation of the smart city by separating the social and economic factors.

Research Method

The current research is applied in terms of purpose and descriptive in terms of data collection. The type of research is of a mixed type, in the qualitative part, the factors affecting the smart city were identified with the approach of technical and social systems that for this goal we will use from content analysis technique, and in the second part, the determined dimensions were reduced using feature selection algorithms, and then, using the clustering approach, the most important factors were The separation of social factors and technical factors is determined for the realization of a smart city.

First, using library studies, the research gap is extracted and research innovation is determined, then social and technical factors affecting the choice of a smart city are identified by using interviews with experts. After identifying the factors, these factors are re-reviewed by Delphi method and then entering the quantitative phase, the dimensions of the selection model are reduced by using feature selection algorithms. After determining the final variables, the data of these variables are extracted and then using the Cummins clustering technique, the most important factors or variables are identified and placed in the relevant cluster.

Data collection in the present research is done at two levels, field and library. In order to examine the research gap and discover innovations, the library method is used, while using this method, the theoretical foundations and background of the research are extracted, but in order to identify the effective factors on the implementation of the smart city, interviews with experts are used, while In order to extract the data, the databases of the government and the municipality of Tehran will be used.

The data collection tool in this research includes an interview and a Delphi questionnaire. The interview includes the following two questions.

What are the technical factors affecting the implementation of a smart city?

What are the social factors affecting the implementation of a smart city?

The validity of this interview was confirmed using the opinions of ten professors

However, the questionnaire includes a Delphi questionnaire on a scale of 10, and each of the extracted factors in the previous step is entered as an item in this question. The validity of this questionnaire is checked using the opinion of ten professors and its reliability is checked using Cronbach's alpha test.

The statistical community of the current research includes all experts and activists in the field of smart city and also the intelligentization of organizations, offices and schools in the field of Tehran, who must have been working in the relevant field for at least 10 years, while they can also be among the managers of Tehran Municipality. sample used Considering the judgmental nature of the sample, the selection of 10 to 20 people leads to the adequacy of the sample. The sampling method is in the form of a snowball, that is, after interviewing the first person, he is asked to introduce another person for the interview, and this procedure continues until theoretical saturation is achieved.

Data analysis in this research is done at four levels

1- Content analysis: Using this technique, the topics of the interview are extracted under the title of technical and social factors.

2- Delphi: Using this technique, the extracted factors are reviewed and refined.

3- Feature selection: By using feature selection algorithms, the dimensions determined using the previous method can be reduced and reviewed, which is done quantitatively.

4- Clustering: By using the Cummins algorithm, the factors are grouped into different clusters, and the most important clusters are determined by separating the technical and social factors as the clusters

that contain the best and most effective factors.
The software used in feature selection and Cummins clustering will be MATLAB software.

Research Findings

In this section, by using the combination of content analysis techniques, Delphi, feature selection and clustering, technical and social factors affecting the smart city are extracted. Using interviews with experts, factors are first extracted and then refined using the Delphi technique. Then it enters the data mining phase and at first, the second phase of the data is done using the feature selection technique to obtain a more acceptable amount of data, and finally, using the Cummins technique, extracting factors in three very effective levels. Medium impact and small impact are stratified according to social and technical factors. In the Delphi phase, Excel software will be used, and in the Cummins feature selection phase, MATLAB software will be used

Extraction of factors affecting the smart city

In this section, factors affecting the smart city are extracted using the content analysis technique. These factors have been extracted using interviews with experts. The interview of experts along with the extracted codes in the table below also determines the symbol of each factor

As can be seen, based on the opinion of experts, 55 factors have been extracted, and these factors should be divided into technical and social factors. The results of this division are presented in Table 2-4.

Table 2
Technical factors and social factors extracted according to experts

social factors		**Technical factors**	
Smart crime control	c1	Digital infrastructure	c10
Intelligent and mechanized waste management	c2	Information technology infrastructure	c13
Using intelligent systems to control prisoners	c3	Smart business environment	c15
Smart public parking	c4	Internet infrastructure development	c20
Traffic control with intelligent systems	c5	Smart heating and cooling	c21
Social cohesion and mobility	c6	ICT-based transportation	c23
Strong social capital	c7	ICT based logistics	c24
Digital and smart innovation	c8	Intelligent driver assistance systems	c25
Access to capital	c9	Smart maintenance	c26
Entrepreneurial culture	c11	Urban sensors	c29
Dissemination of knowledge	c12	Building alarm systems	c30
Exchange of information	c14	Emergency response systems to crisis	c31
Smart healthcare	c16	Use of renewable energy	c32
Political stability	c17	Adjustment of energy consumption	c33
Economic stability	c18	Smart educational facilities	c36
Smart education	c19	ICT-based production process	c44
Participation in sustainable development	c22	Taking advantage of electronic business applications	c45
Safe transportation	c27	Biomedical sensors	c51
Sustainable transportation system	c28	Controlling patients at home Smart market	c52
electronic government	c34	Smart market	c53
Financial and economic transparency	c35	Increase personal businesses based on ICT	c54
Access to educational programs	c37	Development of e-commerce systems	c55
Development of green space	c38		

social factors	**Technical factors**
Efficient use of water	c39
recycling	c40
Pollution control	c41
The existence of single industries	c42
Efficiency	c43
Labor market flexibility	c46
Entertainment centers	c47
Public libraries	c48
Cultural facilities	c49
Health houses	c50

As can be seen, out of 55 extractive factors, 22 factors are of technical nature and 33 factors are of social nature. After determining the factors, in the Delphi stage, the extracted factors are reviewed and refined separately from technical and social factors, and factors are eliminated if there is no consensus about them in the first three stages.

Refinement of Extraction Agents

In this section, the Delphi method is implemented regarding technical and social factors. First, the results of the Delphi test for technical factors are presented, and then social factors are presented. Of course, only the first stage of Delphi is presented in this section.

Table 3
The first stage of the Delphi test for technical factors

Factor	A	B	C	D	E	F	G	H	I	J	Average
Digital infrastructure	10	10	1	4	9	10	10	4	9	9	7.6
Information technology infrastructure	2	9	4	9	10	6	10	6	10	10	7.6
Smart business environment	7	8	8	8	10	5	8	4	5	9	7.2
Internet infrastructure development	5	7	8	8	7	8	9	4	7	6	6.9
Smart heating and cooling	7	7	6	4	9	6	2	10	8	6	6.5
ICT-based transportation	3	4	6	8	4	9	6	9	7	9	6.5
ICT based logistics	9	1	5	10	7	2	8	8	6	8	6.4
Intelligent driver assistance systems	7	5	4	3	10	10	3	10	2	10	6.4
Smart maintenance	10	4	9	4	10	8	6	1	5	6	6.3
Urban sensors	9	6	10	7	8	5	4	5	3	6	6.3
Building alarm systems	8	2	7	6	9	5	9	5	2	9	6.2
Emergency response systems to crisis	9	6	3	7	4	6	9	4	5	9	6.2
Use of renewable energy	10	10	10	5	3	2	9	2	8	2	6.1
Adjustment of energy consumption	3	1	9	10	4	8	9	3	6	7	6
Smart educational facilities	6	7	3	4	1	4	10	9	6	10	6
ICT-based production process	7	8	5	4	3	10	8	6	8	1	6
Taking advantage of electronic business applications	4	6	8	7	1	9	5	6	8	5	5.9
Biomedical sensors	10	8	4	8	1	8	3	6	6	5	5.9
Controlling patients at home	4	1	7	7	5	6	7	9	7	5	5.8
Smart market	7	7	10	2	5	9	5	4	3	6	5.8

Factor	A	B	C	D	E	F	G	H	I	J	Average
Increase personal businesses based on ICT	6	8	4	5	9	4	9	1	9	3	5.8
Development of e-commerce systems	7	10	8	8	6	3	5	2	6	1	5.6

In the first stage, the average opinions of ten news regarding 22 technical factors were obtained. Next, the second and third stages are implemented and the comparison of the average of the second and third methods determines the final factors by separating social and technical factors.

Table 4.
Comparison of the average of the first and second stage

Factor	The average of the first stag	The average of the second stage	difference
Smart crime control	5.8	4.1	1.7
Intelligent and mechanized waste management	5.2	4.2	1
Using intelligent systems to control prisoners	5.3	4.9	0.4
Smart public parking	7.4	6.9	0.5
Traffic control with intelligent systems	4.2	3.5	0.7
Social cohesion and mobility	4.5	3.2	1.3
Strong social capital	6	4.3	1.7
Digital and smart innovation	4.8	2.3	2.5
Access to capital	4.7	3.3	1.4
Entrepreneurial culture	6.6	4.8	1.8
Dissemination of knowledge	5.3	3.9	1.4
Exchange of information	7.1	6.1	1
Smart healthcare	5.1	3.5	1.6
Political stability	6.6	5.3	1.3
Economic stability	5.6	4	1.6
Smart education	6.4	4.3	2.1
Participation in sustainable development	6	5	1
Safe transportation	6.2	5.3	0.9
Sustainable transportation system	5.2	4.6	0.6
electronic government	5.4	4	1.4
Financial and economic transparency	5.2	3.2	2
Access to educational programs	5.4	4.4	1
Development of green space	5.6	3.8	1.8
Efficient use of water	5.6	4.4	1.2
Recycling	5.1	4.7	0.4
Pollution control	3.9	3.1	0.8
The existence of single industries	4.8	4.4	0.4
Efficiency	6.1	5.4	0.7
Labor market flexibility	5.4	5.1	0.3
Entertainment centers	5.8	5.7	0.1
Public libraries	4	5	1
Cultural facilities	4.5	5	0.5
Health houses	5.4	5.4	0

In the above table, factors that have a threshold value less than 0.9 are considered as final factors, and factors that are higher than this threshold are sent to the third stage. After the third stage, the average of the third and second stage is compared and this screening is repeated based on the threshold of 0.9.

Table 5
Comparison of the second and third steps for social factors

Factor	The average of the first stag	The average of the second stage	difference
Smart crime control	4.1	3.4	0.7
Intelligent and mechanized waste management	4.2	3.5	0.7
Social cohesion and mobility	3.2	2.4	0.8
Strong social capital	4.3	3.9	0.4
Digital and smart innovation	2.3	2.1	0.2
Access to capital	3.3	2.9	0.4
Entrepreneurial culture	4.8	4.3	0.5
Dissemination of knowledge	3.9	3.2	0.7
Exchange of information	6.1	5	1.1
Smart healthcare	3.5	3.1	0.4
Political stability	5.3	4.3	1
Economic stability	4	3.5	0.5
Smart education	4.3	4	0.3
Participation in sustainable development	5	4.3	0.7
electronic government	4	3.5	0.5
Financial and economic transparency	3.2	2.7	0.5
Access to educational programs	4.4	3.8	0.6
Development of green space	3.8	3.2	0.6
Efficient use of water	4.4	3.3	1.1
Public libraries	5	4.4	0.6

By comparing the second and third stages for social factors, it can be seen that factors such as efficient use of water, political stability, and knowledge exchange are still subject to doubts and contradictions because their average difference in all three stages is more than the threshold of 0.9. Relevant factors should be excluded from the analysis. By removing them, the final social factors will be as described in the table below.

Table 6
Final social factors

Row	Social Factors
1	Smart crime control
2	Intelligent and mechanized waste management
3	Using intelligent systems to control prisoners
4	Smart public parking
5	Traffic control with intelligent systems
6	Social cohesion and mobility
7	Strong social capital
8	Digital and smart innovation
9	Access to capital
10	Entrepreneurial culture
11	Dissemination of knowledge
12	Smart healthcare
13	Economic stability
14	Smart education
15	Participation in sustainable development
16	Safe transportation
17	Sustainable transportation system
18	electronic government
19	Financial and economic transparency
20	Access to educational programs
21	Development of green space
22	Recycling
23	Pollution control
24	The existence of single industries
25	Efficiency
26	Labor market flexibility
27	Entertainment centers
28	Public libraries
29	Cultural facilities
30	Health houses

Therefore, the 33 social factors extracted in the extraction phase were reduced to 30 factors and the 3 additional factors mentioned were removed after three stages of the Delphi test. Now there are 18 technical factors and 30 social factors, which will be removed again in the data mining stage using the feature selection technique.

Feature Selection

Feature selection includes techniques by which the input variables to the problems are reduced while the error term is not only increased but also decreased. In fact, by using the feature selection technique, both the number of input variables and the amount of error in the neural network are optimized, and we face a double-objective problem. Of course, the important point is that for problems with a large number of input variables, feature selection is more important because a large number of input variables will be removed by the feature selection technique. In this section, the input variables were selected using the feature selection technique. The results are presented according to technical and social factors in the following tables.

Table 7
Feature selection for technical factors

Row	Factor	Feature selection
1	Digital infrastructure	1
2	Internet infrastructure development	1
3	ICT-based transportation	1
4	ICT based logistics	1
5	Intelligent driver assistance systems	1
6	Smart maintenance	0
7	Urban sensors	1
8	Building alarm systems	1
9	Emergency response systems to crisis	1
10	Use of renewable energy	1
11	Adjustment of energy consumption	1
12	Smart educational facilities	1
13	ICT-based production process	1
14	Taking advantage of electronic business applications	1
15	Biomedical sensors	0
16	Controlling patients at home	1
17	Increase personal businesses based on ICT	1
18	Development of e-commerce systems	1

As can be seen in the above table, the value of 1 indicates the selection of the feature and the value of zero indicates its non-selection. For example, biomedical sensors have been removed based on the feature selection algorithm and this variable has been found to be ineffective, or intelligent maintenance has also taken a zero value and has been considered as ineffective factors.

The same action was taken regarding social factors, the result of which is presented as follows.

Table 8
Feature selection for social factors

Row	Social factors	Feature selection
1	Smart crime control	1
2	Intelligent and mechanized waste management	1
3	Using intelligent systems to control prisoners	1
4	Smart public parking	1

Row	Social factors	Feature selection
5	Traffic control with intelligent systems	1
6	Social cohesion and mobility	1
7	Strong social capital	1
8	Digital and smart innovation	1
9	Access to capital	1
10	Entrepreneurial culture	1
11	Dissemination of knowledge	1
12	Smart healthcare	1
13	Economic stability	1
14	Smart education	1
15	Participation in sustainable development	1
16	Safe transportation	1
17	Sustainable transportation system	1
18	electronic government	1
19	Financial and economic transparency	1
20	Access to educational programs	1
21	Development of green space	0
22	Recycling	1
23	Pollution control	1
24	The existence of single industries	1
25	Efficiency	1
26	Labor market flexibility	1
27	Entertainment centers	0
28	Public libraries	1
29	Cultural facilities	1
30	Health houses	0

In the above table, three factors have been set to zero and have been identified as ineffective from the point of view of the feature selection algorithm. These factors include health centers, recreation and entertainment centers, and green space development. Other factors have a value of 1 and are recognized as effective factors and can be used in the next stage, i.e. clustering.

Clustering

The clustering stage is considered as the final stage of the present analysis. In the previous stages, variables were identified, screened and refined. But at this stage, the final factors are subjected to clustering and their leveling is done by clustering. First, the final technical and social factors that are derived from Delphi methods and feature selection are presented in the following tables.

Table 9
Clustering results for technical factors

Row	Technical agent	Cluster determined
1	Digital infrastructure	1
2	Internet infrastructure development	3
3	ICT-based transportation	1
4	ICT based logistics	1
5	Intelligent driver assistance systems	2

Row	Technical agent	Cluster determined
6	Urban sensors	2
7	Building alarm systems	1
8	Emergency response systems to crisis	2
9	Use of renewable energy	3
10	Adjustment of energy consumption	1
11	Smart educational facilities	2
12	ICT-based production process	1
13	Taking advantage of electronic business applications	3
14	Controlling patients at home	3
15	Increase personal businesses based on ICT	3
16	Development of e-commerce systems	3

As can be seen in the above table, the index of each cluster is placed against each factor. Considering that the purpose of clustering in three levels is very effective, with medium effect and low effect, index number 1 indicates high effect, index number 2 indicates medium effect, and index number 3 indicates weak effect. . Therefore, if we want to have the leveling of the above factors in a schematic way, we can see it in the format of Figure 1-4.

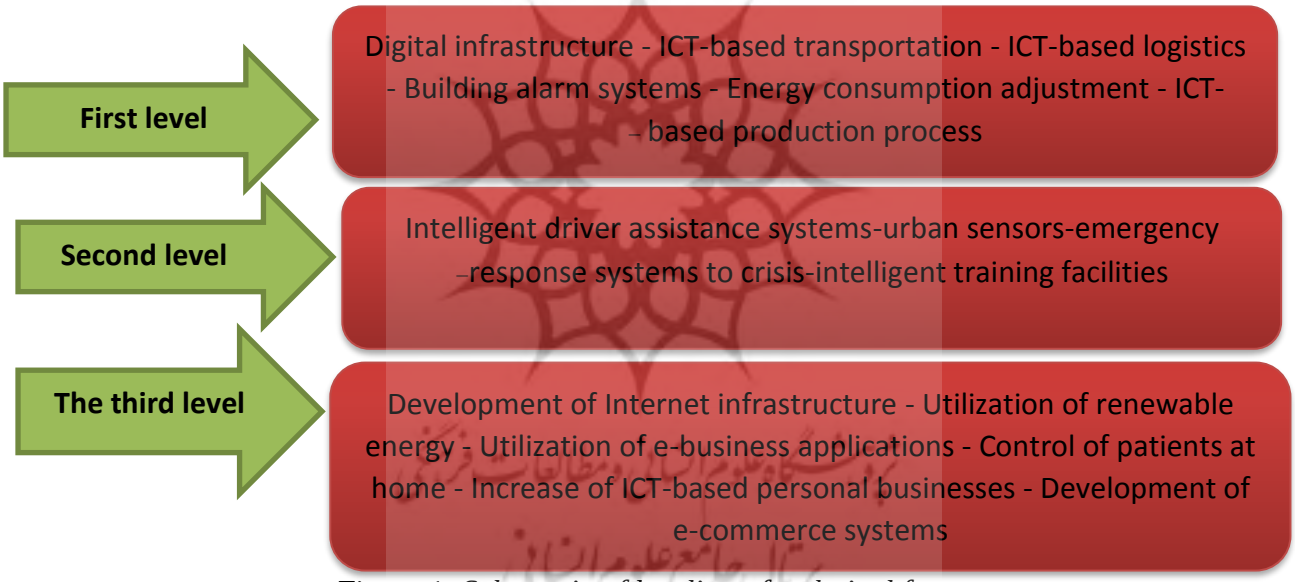

Figure 1. *Schematic of leveling of technical factors*

As can be seen in the schematic above, the factors have been leveled. The most important and most effective technical factors are placed in the first level, and other factors are in the next levels. The same steps are taken for social factors.

Table 10
Clustering results for social factors

Row	social factors	Cluster determined
1	Smart crime control	3
2	Intelligent and mechanized waste management	3
3	Using intelligent systems to control prisoners	2
4	Smart public parking	2

Row	social factors	Cluster determined
5	Traffic control with intelligent systems	3
6	Social cohesion and mobility	2
7	Strong social capital	2
8	Digital and smart innovation	1
9	Access to capital	3
10	Entrepreneurial culture	2
11	Dissemination of knowledge	1
12	Smart healthcare	3
13	Economic stability	2
14	Smart education	1
15	Participation in sustainable development	1
16	Safe transportation	2
17	Sustainable transportation system	3
18	electronic government	3
19	Financial and economic transparency	3
20	Access to educational programs	1
21	Recycling	1
22	Pollution control	1
23	The existence of single industries	3
24	Efficiency	1
25	Labor market flexibility	1
26	Public libraries	3
27	Cultural facilities	3

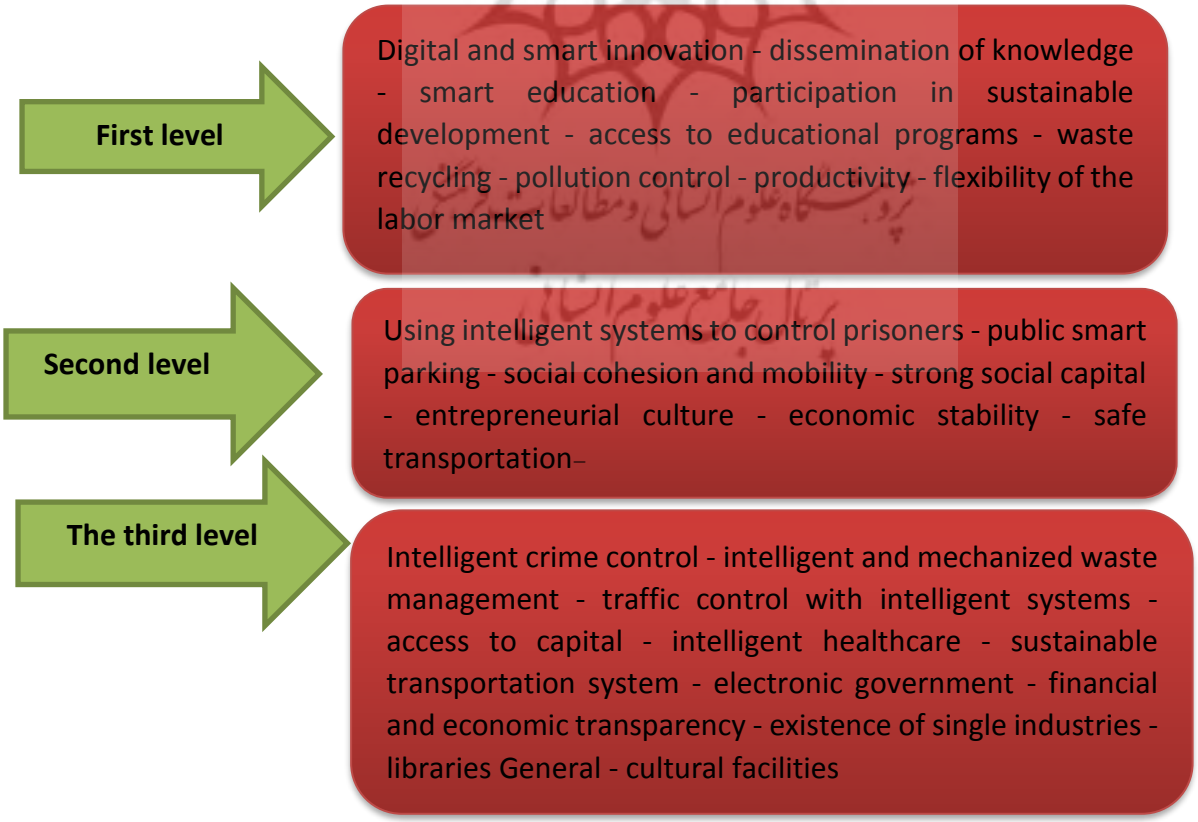

Figure 2. *Schematic of social factor stratification*

In the above leveling, the most important factors have been determined according to the first, second and third levels. As it can be seen, digital and smart innovation - dissemination of knowledge - smart education - participation in sustainable development - access to educational programs - waste recycling - pollution control - productivity - flexibility of the labor market as the most important and effective social factors at the highest level Effects have been recognized and other factors are at the next levels of importance.

Discussion and Conclusion

In the near future, the smart city will emerge as an important paradigm in the field of urban management and urban planning, while in the developed world, this concept is more institutionalized than in the developing world, so research in this field and identifying the factors affecting it is a necessity. It is considered inevitable. In this article, the technical and social factors affecting the smart city were first identified using the opinion of experts and then revised and refined using the Delphi technique. The total number of technical factors, which was 22 in the identification stage, was reduced to 18 after the Delphi test. Also, social factors, which consisted of 33 factors, reached 30 variables after the Delphi test. Then, using the feature selection technique, 18 technical factors were again reduced to 16 factors and 30 social factors to 27 factors to finally obtain the final model for clustering. At the end, factors were clustered using the Cummins technique, and thus their stratification was done. The stratification results showed the most effective factors in the highest level and the weakest factors in the third level.

Considering that the last stage, i.e. clustering, is the extract of all research achievements, regarding technical factors, it can be seen that at the first level, the most important factors include digital infrastructure, ICT-based transportation, ICT-based logistics, building alarm systems, Adjustment of energy consumption and production process is based on ICT. What is shown as a distinct feature at this level is the focus on ICT and the emphasis of research experts on this issue, that is, transportation, production and logistics based on ICT, as well as the formation of a digital infrastructure, which is the most effective factor on the city. It has been recognized as intelligent. In addition, building alarm systems during crises and energy consumption have also been recognized as important by experts. In other words, it can be said that from a technical point of view, there should be more focus on these things, although this does not mean that the second-level factors are less effective factors. In other words, factors such as intelligent driver assistance systems, urban sensors, emergency response systems. The crisis and educational facilities are conceptually not much different from the first-level factors, but the fact is that the effect of these factors has been recognized as less important than the first-level factors, and these factors can also affect the implementation of a smart city be effective.

Regarding the analysis of social factors, we also face such a pattern. For example, digital and smart innovation, dissemination of knowledge, smart education, participation in sustainable development and other factors determined in the first level have been recognized as the most effective factors on the smart city, but second level factors such as the use of smart systems to control prisoners , public smart parking, cohesion and social mobility are also important, but they cannot have a direct effect on the smart city like the level factors. In fact, the second level factors are more mild and weaker in nature, but they are definitely not without effects.

Based on the findings of the research, the following suggestions are made.

1. Attention to digital and smart innovation should be prioritized. At the same time, the paths for the dissemination of knowledge, smart education and

participation in sustainable development will be paved.
2. Educational programs should be updated and applied in line with smart innovations in order to disseminate knowledge.
3. Issues such as pollution control and waste recycling should be prioritized in the country's macro plans, while special attention should be paid to the issue of productivity in production, which is at a low level due to the high participation of the public sector.
4. From an infrastructural point of view, strengthening the digital infrastructure is very important and serious considering the inherent problems in the discussion of digital infrastructure
5. Strengthening transport and logistics based on ICT can create the right conditions for creating a smart city.
6. Building alarm systems still do not exist in many modern buildings in the country, so it should become a requirement.
7. Energy consumption should be managed.
8. Intelligent driver assistance systems should be installed in cars and public vehicles.

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