



International Challenges of Smart Cities*

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Received 26 March 2017;

Revised 12 November 2017;

Accepted 29 November 2017

ABSTRACT: The world's urban population is expected to be proliferated due to raised use of energy, increased air pollution, increasing traffic in urban areas, increasing usage of food, and reduced food production. There are numerous available solutions in this field, but achieving smart cities is one of the furthestmost effective ways. Smart city has improved ICT infrastructure as a versatile, reliable, changeable, accessible, safe and flexible one and thus has enhanced the quality of life and health of citizens. It has achieved remarkable economic growth while it is stable and has developed physical infrastructure-based services. It also has straighten the prevention and management of natural and human-caused disasters and ascertained moderation in law fulfilment through governmental, political and participatory processes mechanisms. The purpose of this study is to identify challenges in regard to realization of smart cities and identify challenges after their creation. This research is a narrative review; that is a type of methodological approach and Status quo review. In this research, challenges were identified and analyzed by analyzing available data; consequently, challenges are classified to: challenges before creation of smart city and challenges afterward. Finally challenges such as: infrastructure challenges, economic challenges, managerial challenges, challenges of integration between sciences, technology and theory in advance, cultural challenges, technology trap challenges, and educational challenges after achievement have been extracted. For a successful planning in the field of smart cities, it is vital to take all of the mentioned challenges to account.

Keywords: Future City, Smart City, Smart Cities Challenges, Smart Cities Problems, Challenges of Technology Trap.

INTRODUCTION

On 31 October 2011, the world's population reached 7 billion for the first time; each second 2.6 person was adding up and in 2015 the population reached 7.5 billion people (United Nations, Sustainable Development Challenges, World Economic and Social Survey 2013, 2013). Today 54 percent of the world's population lives in cities, and it is expected to reach 66 percent in 2050 (Gurjar & Nagpure, 2015; United Nations D. O., 2014). Existing cities will continue developing. In development and emerging of countries, hundreds of new cities should be built and grown; therefore, they can adapt with growth

and migratory trend of the world population (United Nations, Revision of World Urbanization Prospects, 2010) (UNDP, 2010; Behzadfar, 2004). Simultaneously, cities are struggling with a wide range of challenges and threats, including transport, water, energy, communications, healthcare and social services (Dublin, 2015). As it is observed in the worldwide, long-term urbanization trends will lead to new challenges for cities; to exemplify, the vast number of commuters should face with daily traffic over the world (Hatzeloffer, 2012). Hence, smart city as a solution can solve urban challenges; nevertheless, smart

* This article is extracted from the M.A thesis entitled 'Urban Design Based on Smart city criteria, Case Study: District 3 of Isfahan City' that is written by the third author under the supervision of the first and second author.

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cities will possess some challenges before and after its creation. The aim of this article is to assess challenges

and benefits that cities will face, in the coming years according to creation of smart cities.



Fig. 1. Urban and Rural Population of the World, 1950-2050 (United Nations D. o., 2014, p. 7)

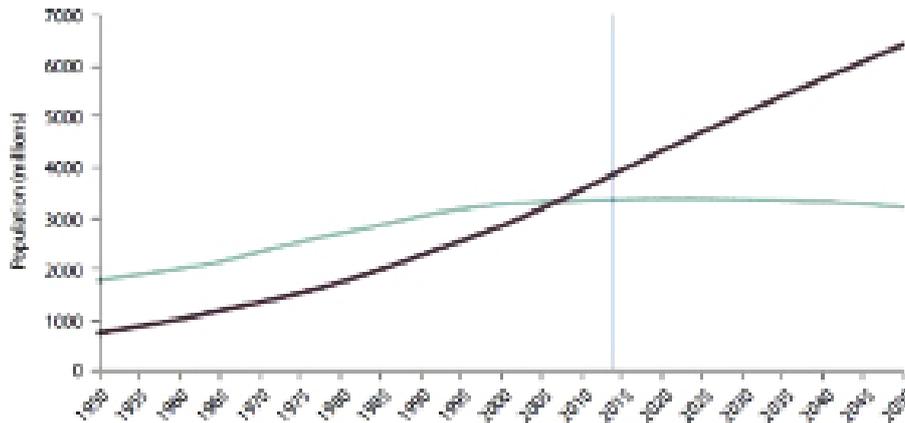


Fig. 2. Global Urban Population Growth is Propelled by the Growth of Cities of all Sizes (United Nations D. o., 2014, p. 13)

THEORETICAL FRAMEWORK OF SMART CITIES

In academic, industrial, and governmental

(enterprise) researches, different definitions and approaches of smart city is presented (Lombardi, et al., 2011). Table 1 shows the main definitions of the smart city.

Table 1. Definitions of Smart City

Authors	Definitions	Main Areas
(Hall, 2009)	“A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens”.	Infrastructure and Public Services



(Giffinger et al., 2007)	“A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens”.	Economy, People, Governance, Mobility, Environment
(Eurocities, 2009)	“A city that makes a conscious effort to innovatively employ information and communication technologies (ICT) to support a more inclusive, diverse and sustainable urban environment”.	Information and Communication Technologies
(Harrison et al., 2010).	“A city connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city”.	Physical, IT, Social and Business Infrastructure
(Toppeta, 2010)	“A city “combining ICT and Web 2.0 technology with other organizational, design and planning efforts to dematerialize and speed up bureaucratic processes and help to identify new, innovative solutions to city management complexity, in order to improve sustainability and livability”.	ICT and Web Technologies, Management
(Washburn, et al., 2010)	“The use of Smart Computing technologies to make the critical infrastructure components and services of a city - which include city administration, education, healthcare, public safety, real estate, transportation, and utilities - more intelligent, interconnected, and efficient”.	Critical Infrastructural Components and Services
(Lombardi, et al., 2011)	“... The city is called “smart” when investments in human and social capital and traditional and modern communication infrastructure, fuel, sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance. Furthermore, cities can become “smart” if universities and industry support government’s investment in the development of such infrastructures”.	Social and Natural Resources, Communication, Infrastructure, Wise Management, Supportive Educational and Industrial Systems
(Chourabi, et al., 2012)	A city should integrate IT infrastructures, social and economic issues in order to particular, more useful and more flexible responses.	Social, Economic and IT Infrastructure
(Giovannella, 2013)	“A Smart City should be a city well performing in a forward-looking way in six smart characteristics (also called soft factors: smart economy, smart mobility, smart environment, smart people, smart living, smart governance), built on the smart combination of endowments and activities of self-decisive, independent and aware citizens”.	Smart Economy, Mobility, Environment, People, Living and Governance
(Komninos, Bratsas, Kakderi, Tsarchopoulos, 2015)	Smarter Cities, include three components: a core model with classes such as events, messages, stakeholders, departments, services, city landmarks, key performance indicators (KPIs), etc.	Governance, Smart Devices, Smart Services

According to the table 1, authors defined main areas that a smart city is involved with:

- Information
- Governance and management
- Economy
- Environment
- People and society
- Infrastructure and public services
- Education and training
- Integration

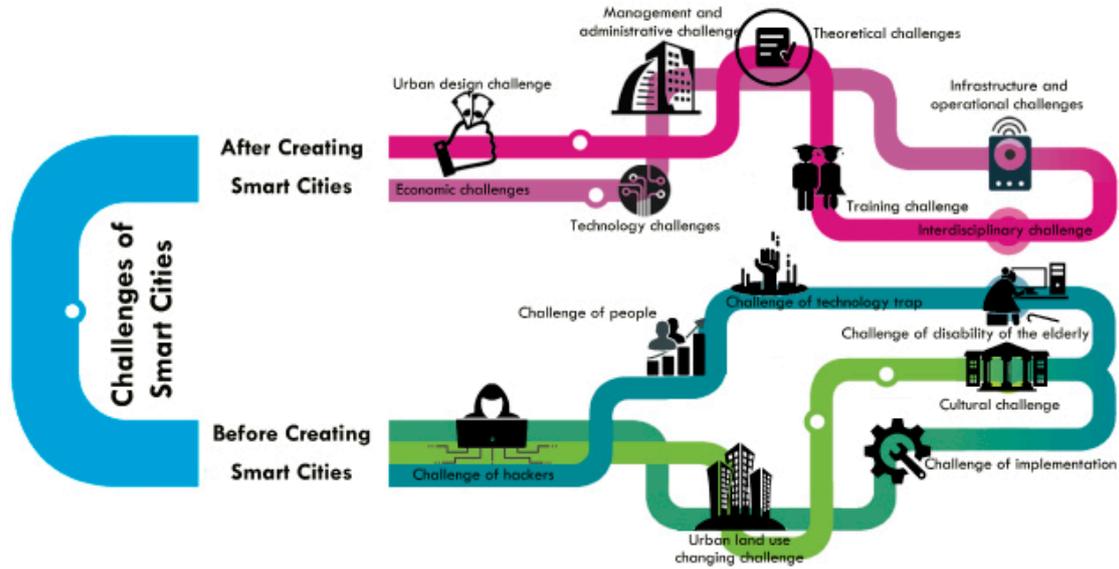


Fig. 3. Mapping of Smart City Challenges

SMART CITY CHALLENGES

Smart city challenges can be divided into two main categories; challenges before creating smart city and challenges after creating it:

Challenges before Creating Smart City

Economic Challenges

Creating smart city needs technology and ICT bases (Hollands, 2008), they are commodious (IBM, 2012) and providence in using energy, reducing pollutions, reducing travel costs, making the cities competitive, increasing GDP and tourist and leading to economical outreach and development. For instance, Amsterdam can be noted; it supplies electrical appliances, energy-saving bulbs for street lights during calm hours, trash compactor machines that work with solar energy, smart meter and monitors for energy consumption, stimulations and benefits derived for energy saving (Leucci, 2011). In Climate street more than 50 percent of maintainable waste and 70 percent of energy saving has been reported (Deakin, 2013). However, creation of smart cities need national and international support and needs a heavy budget.

Technology Challenges

Meanwhile, smart cities require smart technologies in the field of solar cells, routers, transparency and urban information sharing, online banking, and welfare, etc.

(Correia & Wünnstel, 2011) while in many countries, these facilities are not available or are in low rank. Technology can create and improve quality of life and on the other hand, it has the risk of class conflict (Washburn et al., 2010). In fact, the benefits of ICT in many cities remains unclear (Chourabi et al., 2012) thus, city managers should notice to certain factors through implementing ICT due to available resources, institutional capacity and also with regard to inequality, digital gap, and cultural changes (Washburn et al., 2010). Other ICT challenges are technical, and security-based and a smart city needs data security (encryption, authentication, and authorization), devices connection and interaction, the essential power for devices, end-user interface, and service discovery (Correia & Wünnstel, 2011). It seems that there are some certain and pre-required technologies for the global realization of the smart cities that would just be possible through participation and cooperation of international research centers and multinational companies.

Main Idea of dynamic liberator concept, just like what goes on in Dynamic European Network of laboratories which this paper is based on, is continuously integration of user production of goods and services, while their expectations are reviewed and reflected in a systematic process (Deakin, 2013). Technology in a smart city should appear in all aspects and sectors and shouldn't be limited in making some luxury smart items. Some urban spaces such as parks, malls, streets, and so on, need a new point of view; while communications have evolved, many of



our urban spaces are not being developed anymore and are not in line with generations.

Smart Cities are characterized by the availability of a wide range of technologies capable of working together to deliver complex systems and solutions. Smart Cities need robust and resilient technologies to help:

- Providence of a shared understanding of the core concepts for underpinning Smart Cities ;
- Facilitation of instruments through the use of multiple types of device for sensing, capturing, storing, and exploiting the use of data from multiple, fixed as well as mobile sources (International Organization for Standardization, 2015).

Management and Administrative Challenges

Governing a smart city and its various aspects is raised by some experts (Toppeta, 2010; Giffinger et al., 2007; Madakam, 2014). In some countries public participation and political decentralization policy has not taken place or is in basic levels.

In order to start the process of a smart city, the central government should put the public participation and empowerment to the citizens in their agenda (Dadkhah & Shahbazi, 2015; Seisdodos, 2012). In fact, access to information, open data, transparency and informing are gains of smart cities, which is needed for

further cooperation and more consolidation of central government, local government and people (Deakin, 2013; Rodríguez Bolívar, 2015). Active participation of people, in different levels for solving the problems, and providing especial infrastructures by the government to achieve this, is one of the prosperity factors in smart cities (European Parliament, 2014; Rodríguez Bolívar, 2015). Smart technologies are an important opportunity to rebuild the ideas and innovations in government to achieve transparency, democracy, responsibility (Townsend, 2013). Of course, some regimes may use smart technologies and tools for reaching their totalitarian aims to crack down the people (Greenfield, 2013).

Theoretical Challenges

Michelle in 1999 is one of pioneer theorists in the field of smart city (Deakin, 2013). This theory was raised in 2007 and projects in European Union were done (Giffinger et al., 2007). In Addition, nowadays it is developed in many scientific industrial and governmental communities (Lombardi, 2011). However, from theory levels to practical levels there is not a specific movement; additionally, there are many complexities in indexes and criteria.

In table 2, there are common practical examples in the field of smart cities with its ambiguities.

Table 2. Limits of Methodological Aspects of Smart Cities

Authors	Methodological Aspects	Limits
Giffinger, Smart cities Ranking of European Medium-sized Cities (2007)	6 dimensions (smart economy, smart people, smart governance, smart mobility, smart environment and smart living), 74 indicators 70 European medium size cities Standardization and aggregation Output: ranking	Correlation among indicators Medium-sized cities* A significant number of indicators (35%) available only at national level
Fast Company, Smart City Wheel http://www.fastcoexist.com/1680856/the-top-10-Smartest-European-Cities (2012)	6 key components of smart cities and three key drivers for each component 28 indicators 10 European and North American cities Output: ranking	Unclear methodology Correlation among indicators
Forum Pa, Icityrate http://www.icitylab.it/il-rapportoicityrate/edizione-2012/metodologia/ranking (2012-2013)	6 dimensions (Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment and Smart Living), 89 indicators 103 provincial capitals Standardization and aggregation Output: ranking	Correlation among indicators A significant number of indicators were available only at regional/provincial level Some indicators are not updated
Between, Smart City Index http://www.between.it/pdf/Between_SmartCityIndex2013.pdf (2012-2013)	9 dimensions (Smart Health, Smart Education, Smart Mobility, Smart Government, alternative mobility, energetic efficiency, natural resources, renewable energies, Broad Band) 153 indicators 116 primary provincial capital as defined by I stat Output: ranking	Correlation among indicators Supply side analysis only (from the firms' perspective) Unclear weighting procedures The majority of indicators are at municipal level (95%) Unclear procedure for data collection

(De Santis, Fasano, Mignol, & Villa, 2014)



Infrastructure and Operational Challenges

Technology has been improved increasingly and many of developed and developing countries have the required urban areas in the field of making smart cities. But they have weak ICT infrastructures, and this turns out to be a challenge for implementation of smart city. In other words, ICT infrastructures don't have the necessary qualities (Giffinger et al., 2007) (Chourabi et al., 2012). One of the most important challenges between different excessive governments is the development of infrastructures and debt due to developing infrastructures so that many companies are trying to pay it for years (Mathew, 2015).

Adam Greenfield (2013) is doughty about implementation of smart cities and he defines a smart city as an object, unity and complete knowledge that is not available anywhere (Greenfield, 2013).

Training Challenges

Smart city needs to train citizens (Dadkhah & Shahbazi, 2015). Citizens in this city should have the ability and talent of using technologies and should intend to learn all their lifetime (Deakin, 2013) unless they are incapable of living in smart cities and will face problems (Foster, 2011). In some studies, indicators of education level, tendency to learning in lifetime, dominance of the PC computers and etc., are given (Giffinger et al., 2007) (Correia & Wünstel, 2011). The question is how we should encounter with the raised challenges caused by training needs and requirements of data transformation between cyber organizations (Deakin, 2013) and how learning, knowledge management and digital library that are now available as e-government services, can be merged with smart city platform and how it can be available to the public over the internet.

Urban Design Challenges

Smart city has been assessed in different aspects from the definitions to its indicators and ways and tools of making smart, but enough studies have not been done in the field of urban design and creation of environmental quality with smart methods. In fact, one way to evaluate the effectiveness of smart cities, is to meet in executive levels (Greenfield, 2013). Smart city is meaningful in the city when it can promote urban spaces in line with the other sectors (Dadkhah & Shahbazi, 2015). Nowadays, gaming devices, cellphones, computers and etc. have had much development but children parks (local parks) and their facilities have not had any notable development.

Interdisciplinary Challenges (Linkage between Sciences)

Smart city needs all experts from different disciplines, while there is a challenge of connection and linkage of sciences and then it can manage all the sciences in these fields. For example, Tomari et al. (2014) have designed smart navigation for movement with wheelchair and it has used face recognition method (Tomari, Kobayashi, & Kuno, 2014). This Study can be connected with concepts such as elderly friendly city, disabled friendly city in the field of smart city and on the other hand, making smart of the wheelchairs wheels is a solution for solving the problem of disabled people. Zhu et al., (2015) has given a method for facilitating smart transportation (Zhu, Wu, Zeng & Mai, 2015) that can play an important role in smart transportation and urban issues. Chen et al. (2015) in their research have taken to account the design and implementation of an intelligent flood control support system by statistical analysis in order to define the relation between data and integration of data technology for achieving a digital city management¹ (Chen, Sun, Li, He & Zhang, 2015). Identification of needs and presenting them by urban planners and designers can give good ideas for developing the smart systems. It seems that a reciprocating relationship between engineering, urban planning and other sciences is needed for us so that we can identify existing needs better and can propose appropriate solutions for it.

Challenges after Creating Smart City

Challenges of Hackers

Dealing with hackers has been one of the most important challenges in field of smart city (Townsend, 2013). Hackers can easily enter into city and handle it. If the network security is not provided, hackers will control banking, purchase, statistical, notification, transportation, survey, etc. systems and disturb cities. A solution can be related to adjustment of network as online and offline in order to prevent hackers to access to all sectors.

Another recommendation is to create a classified access for information so that employees would be able to access working sites from anywhere of the world. Users can only access to confirmed programs; it is not possible to access a corporate network; hence, the influence of hackers will be prevented (Hatzelhoff, 2012). This issue would make information more available for many of people and there would be class conflict and injustice. Another solution for this issue is to create popular hacker



networks, leading them to create networks. However, the mentioned solution would have its own challenges.

Urban Land Use Changing Challenges

According to conducted studies by World Bank, ICT is creating new jobs and making labor markets more innovative, inclusive and global² (World Bank, 2013). There are many destroyed uses in city due to its smartness while there have been new usages and applications. A review on settlement of new usages which are appropriate and compatible would be problematic. Commercial sectors might form through online system and effect on activity of urban spaces. The scale of new uses of smart city should be determined in order to have a new and precise view on land use and land location.

Challenges of Disability of the Elderly

Digital classification based on the age is not just applied for elderlies but this is implemented for middle-aged people that have more limited media knowledge and application compared to young people. Young people would attribute less ICT capability to elderlies while they have also limited abilities to accept and use technologies. According to a study, many of interviewees stated that they tend to use technology under any circumstance, but in many cases, it would be harder to elderlies than young generation to learn program. The Elderly has no practice to manage ICT and help of young people is usually insufficient and most of the times hard for them to follow. According to a middle-aged housewife, "young people have many information, but they would show you in many times that they have been brought up with this information" (Hatzelhoff, 2012; Iranshahi, 2015).

Challenge of Big Data

It has happened many times that a project has properly planned and designed but is not perfectly implemented so it failed. Providing big data is a very big problem for create smart cities. A Smart City, as a "system of systems", can potentially generate vast amounts of data, especially as cities install more sensors, gain access to data from sources such as mobile devices, and government and other agencies make more data accessible. Consequently, Big Data techniques and concepts are highly relevant to the future of Smart Cities (Satyam & Calzada, 2016) (International Organization for Standardization, 2015).

Challenges of People

People might not be reluctant to make the urban space

smart or they might lose their tendency due to some reasons such as low network security. The smart urban theories have some problems that might not be accepted by people if they are not solved. People might not be satisfied with virtual stores, waves in the environment, virtual life, etc. And they might be against all positive and negative aspects of Smart City.

Challenges of Technology Trap

The change from "digital cities" to "intelligent cities" was easy to follow, even the potential for spatial and urban planning. The possibility to collect geo-data in near real-time and to generate information about spatial processes opens up new possibilities in analyzing cities. "Real-time cities" combine the physical world with virtual space over sensor networks and sensor technology (Zeile et al., 2015).

Many people think that Smart Cities emphasis too much on technology and not on what really matters: a better living environment. 'It is a shame that the term Smart Cities has led people to believe that to be smart, you need to do X, Y and Z', says Jonathan Leucci from the Scottish European Green Energy Centre. 'The risk is that cities pursue the wrong concepts and think that there needs to be huge amounts of money. They do not realize that there are quick-win solutions that suit the city (Smart Cities in Europe, 2011). The matter that brought a challenge for electronic city was the matter of low interactions between people and lack of attention toward physical-social aspects of human. Human needs face-to-face social relationships and it will be a problem if such feature is ignored due to the use of technology.

Cultural Challenges

Smart City is considered as an important factor in creation, spreading, transformation and destroying of culture. Paying attention to indigenous issues and popular culture can be strengthened by using technology and lack of attention to native culture of regions might create new cultures through technology. There are many examples of this case; costumes can be available through purchasing online sites and networks while global markets and lack of attention to costumes might destroy such cultures during time. There are strong structures of family in some cultures that can be negatively affected due to improper use of technology.



DISCUSSION

Many studies have been conducted in order to solve the problems of cities all over the world. There have been some in field of Smart Cities in which, analysis, definition, criteria and implementation methods of Smart city as well as technology applications. One of these studies, is Monzon’s (2015) research. In his study, a selection of Smart City initiatives was presented in order to establish relations between the identified city challenges and real Smart Projects designed to solve them. As a result of the project, a Projects Guide were developed as a tool for the implementation of Smart City projects. Mazon has assessed the challenges of the European and Mediterranean cities. However, his work is one of the new studies that has focused on challenges it still lacks in a comprehensive look at the issue (Monzon, 2015). However, there has not been any research to identify challenges before and after implementation and it is strength point of present study. This interdisciplinary research has been conducted to discuss challenges of Smart City through a general discussion in order to consider different relevant majors to this issue.

Challenges of Smart Cities are divided into two general groups; some of challenges are related to access methods to Smart City and others are related to the time after creation of Smart Cities. The classified challenges have been expressed in different researches and sciences separately and sometimes intangibly. If we want Smart Cities, we should be familiar with challenges of smart cities and find appropriate solutions for them. Relevant

challenges which might happen before accessing to Smart City are as follows:

- 1- Economic challenges
- 2- Technology challenges
- 3- Management and administrative challenges
- 4- Challenge of theory
- 5- Infrastructural challenges
- 6- Educational challenges
- 7- Urban design challenge
- 8- Cooperation challenges

There are some relevant challenges to time after implementation of smart city as follows:

- 1- Challenges caused by hackers and design of urban networks
- 2- Challenge of change in urban land uses
- 3- Challenge of inability of elderlies to learn
- 4- Challenge of implementation
- 5- Challenge of people
- 6- Challenge of technology trap
- 7- Cultural challenge

It would be hard to criticize Smart Cities but it would be harder to solve their problems. The human beings need to make their cities smart in order to optimize energy, solve problems, decrease unnecessary physical transportations, use clean energies, produce urban food staff, and strengthen relationships between people. Therefore, it would be essential to have an inclusive planning and participation within all scientific, executive and political sectors through local and global conversations.

For dealing with the challenges (before-after creation) of smart city, possible solutions are presented in table 3.

Table 3. Suggested Solutions for Smart City Challenges, before and after Implementation

Main Areas	Challenges before Implementation	Challenges after Implementation	Suggestions
Information and Technology	Technology Challenges		In order to realize smart cities, there should be a UN-mandated world wild organization to provide necessary technology and perform a global cooperation
		Hackers	Multi-layer network design can prevent theft of all of information because the hacker has to go through different layers for accessing to the information and in each layer he has access to the small portion of information and the risk of its detection increases
		Technology Trap	The appropriate introduction of basic innovations and technological tools can be considered as a responsive solution because people often experience this problem as they are not familiar with new technologies
Governance and Management	Management and Administrative Challenges		Delegation of power Cooperative relationships between private and governmental sectors Transparency and awareness



Economy	Economic Challenges		Participation of public and private sectors and financing of government
Environment	Urban Design Challenge		Urban design can does making smart with smart codes but in terms of environment and elements design, more creative research and design is needed. It is suggested that specialists of this field pay more attention to this issue
	Interdisciplinary Challenge		To build the smart city, all the expertise are needed and it seems to be difficult to gather together all specialists of all fields. Fortunately, different fields gas an increasing trend to the issue of smart city. But it is better to suggest new interdisciplinary areas in the urban planning, industry and management so that manage all other specialists.
		Urban and Land Use Change	Adopting urban design knowledge in implementation of smart city through smart management
People and Society		Disability of Elderly	Making technology understandable and easy to use by all people
		Cultural Challenges	Smart city doesn't destroy the culture, but it is a platform that cultures should find their place in and promote their strengths
Infrastructure and Public Services	Infrastructural and Operational Challenge		Infrastructure of smart city is not available for all cities and it is expensive. It seems a UN-mandated world wild organization can be effective in this regard
		Big Data	Artificial intelligent can be designated and adopted to manage the huge amount of information
		Ppeople Challenges	People supervision should be an integral part of the smart city
Education and Training	Training Challenge		Teaching the ways of use of technology in a simple and understandable way as user friendly technology
	Theoretical Challenges		Defining the aspects, concepts and critical items in priority according to the local situations
Integration	Interdisciplinary Challenge		Developing integrated management of urban systems

CONCLUSION

Many researches have been performed to solve the issues of cities all over the world. One of the new issues that is suggested for solving the cities different problems in the last decades, is smart city. Despite the effective influence of making smart in solving the problems of the cities, making a city smart, has own challenges. These challenges may occur before or after creation of smart city. Knowing the mentioned challenges and their various aspects can be an essential step in practical making smart the cities. Present study aimed at assessing the global challenges of smart cities. In this regard, challenges before and after creation of a smart city, were assessed and discussed and a complete classification of them were provided. These challenges placed within suggested areas by authors: information and technology, governance

and management, economy, environment, people and society, infrastructure and public services, education and training and last, integration. Eventually, solutions in response to challenges were provided. All the discussed challenges were derived from different implemented or enrolling projects or researches in this area of study in the practice of making the city smart, all the stakeholders and influencing parties are going to face with. In this regard, provided solutions can be helpful. Although during next years some new challenges may appear, future studies can take them into account. However present study has tried to take into account all of the facing challenges of smart city, giving practical detailed solutions or guidelines are correlated with the context of implementation. Therefore, studying and providing detailed action plans to a specific city is a place-based issue. In this regard following steps are suggested in implementation of smart city:



- Assessment of purpose cities in terms of making them smart
- Clarification of facing challenges
- Prioritization of challenges in terms of getting them solved
- Creating specified directives and action plans for each challenge
- Solving the challenges with provided solutions in 8 main areas

ENDNOTE

1. an intelligent flood control decision support system (IFCDSS) using statistical analysis to determine the relationship between the data.
2. ICTs are creating new jobs and making labor markets more innovative, inclusive, and global.



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