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COMPARATIVE ANALYSIS OF SMART CITIES WITH THE AIM OF QUALITATIVE AND QUANTITATIVE PROGRESS OF IRAN FUTURE CITIES

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ABSTRACT

The current smart cities are patterned after real cities of the world. The intelligence has the most significant effect on citizens' daily life and leads them toward intelligence. In these types of cities, physical activities have been lessened and most of the tasks are being performed with the help of internet and technology which solves the majority of city problems. In this research, some questions are discussed and answered: what properties are required to make a city smart? How can we make Iran cities smart? So, the main purpose is to introduce the features of smart and electronic cities, make a comparative analysis among smart cities of the world and recognizing the executed programs in Iran to build smart cities. Iran is in more urgent need for using urban system and building smart cities in comparison with current smart cities of the world, because our country is facing numerous traffic, pollution and urban economy problems. The descriptive-analytic method is used in the present research. The results indicate that we will be able to solve a major part of city and city building issues by virtual urban planning and using proper strategies which are accordant with the prevalent culture in current cities.

Keywords: Smart City, Electronic City, Communication and Information Technology, Songdu

INTRODUCTION

Due to improvement of knowledge and electronic science, the mechanization thought and modern communication of man urban patterns and life qualities have begun to change with an unpredictable speed. The practical efforts for building smart cities in the world have been intensified since early 90s. as a consequence, the administrative system such as bus movement schedules, university activities, buying and selling, office communications and banking started to exchange information through smart techniques.

With the occurrence of information revolution and rapid expansion of information and communication technology (ICT) since the last years of 20^{th} century, electronic communications entered the human life as a type of communication and due to its various advantages compared to conventional communication methods, found more and more advocates and consolidated its status in citizens' daily life. Therefore, urban researchers and planners in Western countries have brought up the "smart city" idea in order to guide the electronic communication tools usage for solving city problems. In this way, they expanded the concept of "electronic city".

Electronic city

In an electronic city, citizens have the electronic access to all administrations and various types of information in a stable, reliable and secure way throughout the day. In other words, citizens' requirement is provided via computer networks in an electronic city. In fact, electronic city is a ground from which administrators of city benefit in order to provide urban service to the citizens. Electronic cities are the necessary context for building virtual cities which brings 3-dimensional world up to two decades from now, because the paper maps and written plans are not able to depict 3-dimensional local information, while virtual world is the ideal space for presenting and processing such local information. The concept of digital city is the result of accordance between real and virtual city for building spaces in internet in order for people to observe the body and context of the cities.

Fundamental features of electronic city

The aim to build an electronic city is offering better and more diverse services with less cost and higher efficiency. Any city can organize the electronic city system of its own considering the society needs. Thus, the fundamental features of electronic city are:

- **Small space:** the space of electronic city should not exceed a certain measure to be able to prevent waste of human resources and invests. Thus, it is recommended that big electronic cities are divided to smaller local ones.
- **Ethics:** an electronic city should be committed to electronic ethics and safeguard the privacy of citizens.
- **Responsiveness:** electronic city should be responsive to probable problems of the social, economic and political activities which are carried out, that is, the citizens can obtain necessary awareness of the progress course of these activities.
- **Responsibility:** electronic city should be responsible for emerging problems caused by the required activities of the city.
- **Clarity:** electronic city should take a clear position toward citizens' affairs **(Jalali, 2003)**.

Smart city

Smart city is defined as a city in which citizens' affair administration including state services and private organizations is carried out online, throughout the day with high quality and security using ICT tools. Therefore, citizens do not need to make physical movement in order to access state and private services and organizations.

Smart city is the product of information era and digital revolution which contains a massive amount of wired and wireless technology. Activities such as social communication, security, healthcare, education, new employment methods such as remote working, buying and selling, banking, urban government, urban administration, urban designing, and intelligent transportation system **(Veisi and Gheisvandi, 2011)**.

Providing communication infrastructure, networks, software and human resources, security infrastructures and developing information institutions are considered as the prerequisites for building an electronic city. In some regions of the world such as U.S.A, successful instances of electronic cities can be found. Building smart cities are one of IT most important aims and municipalities have a major part in realizing it **(Kiani, 2011)**.

Smart city features

Nowadays, most cities of the world are planning to achieve the smart city aims in order to use the maximum potential opportunities of urban life. First, it should be considered that making smart cities does not mean that all the urban processes should become electronic. Building smart cities includes using all the available backgrounds

in order to promote the quality of urban life and IT can be used as one of the enhancing factors for having a smart city. In the first years of its emergence, smart city was introduced by 6 main features: smart people, smart life, smart transportation, smart government, smart economy and smart environment.

The most important characteristic of smart city which makes it distinguished from other urban management items is "smart citizen". The people are the most important differences between smart cities and digital cities in modern world. One of the most significant ways for constructing and realizing a smart city is presenting a proper planning to coordinate the activities with various urban cultures and meet the requirements of diverse society classes. In order to fully benefit from a smart city advantages, following the 6 main axes is not sufficient and different cultures and ideologies in urban life scope should be observed and examined in different regions of the world. If this item is not attended to properly, the planning will not be as efficient as it is expected to be and inconsistency of equipment with people's lifestyle and culture would be the essential reason of failure of plans. Smart culture can be a factor for enhancing the life quality in its different fields, so that the highest efficiency rate can be achieved with city mass cooperation in different levels of society while the minimum investment has been carried out in the process (www.aahosseini.persianblog.ir)

Smart city components

Smart city is defined by 4 principles which any of them plays a vital role in implying the smart city concept.

Knowledge-based development

Since 1980s, human community has entered the information era which manifests itself with ever-increasing role of information and knowledge in all scopes of economic, political, social and cultural life and the unprecedented development of communication in local, national and international levels. In this new era, the essential concepts related to development, economy, technology, planning and management have undergone basic changes and the concept such as "information-orientation", "knowledge-based economy", "knowledge-based planning" and "knowledge-based management" have replaced the conventional concepts. Therefore, knowledge-based development means using the benefits of information and communication technology (ICT) in daily life and increasing the citizen's skills in the form

of people's improvement in information gathering.

Sustainable development

According to the definition of "World Commission on Environment and Development" in the report of "our common future", sustainable development is a type of development which considers fulfilling the current requirements without reducing the future generation ability in meeting their needs. This type of development has introduced some criteria in economic, social and environmental fields **(Table 1)**.

Consolidating the city integration

The gradual deterioration of building in city poor regions parallel with rapid population growth made large cities of the world face issues like social isolation and life quality degradation in other regions of the city. This problem led to emergence of various kinds of injustice in the city with consequences such as urban poverty and prevalence of living in huts. Thus, the risen urban planning movements in U.S and Europe in the late 20^{th} century declared justice in all aspects of urban life as one of their most essential objectives. Meanwhile, smart city theory has set forth the subject of opposing injustice in the form of urban integration consolidation as a prerequisite for realizing smart city in order to improve the residence quality.

Participation of Citizens

According to Skeffington Committee in UK, citizen participation is defined as people's cooperation in the regulation of policies and suggestions. Providing awareness by executives and giving the chance to discuss the information is a significant part of participation process, but not all of it; complete participation is only realized when people are given the opportunity to take an active part in designing process.

Smart city pattern supports people's wide participation in urban designs and projects because their cooperation in implementation and decision making process will result in obtaining advantages such as achieving real knowledge of the conditions of interest scope, planning based on existing realities and needs and elimination or reduction of conflicts and contradictions. All aforementioned items will finally lead to plan realization and enhance the probability of its implementation, thus moving it in development path more rapidly **(Khazaian and Razpour, 2012)**.

Smart city advantages

Smart cities can possess all the advantages of environment improvement and using electronic cities. These advantages are expressed briefly as follows:

- A major part of responsibility burden and workload is taken off of

governmental managers and organizations and is transferred to the people.

- The process repetition rate, trial and error decision making and time wasting are reduced.
- The costs of coordinating city for events are minimized and the city institutions will find the required flexibility and ability to oppose disasters.
- Information gathering rate will be maximized.
- Smart city can be a ground for generating urban development sustainable processes.

The role of electronic city in making smart cities

In this chapter, the electronic city status in fulfilling smart city requirements is discussed in order to clarify the electronic city role in smart cities.

Electronic city role in achieving knowledge-based development

As it was stated in the definition of knowledge-based development, this type of development is inherently dependent on information and communication technology and aims at expanding people's knowledge on information, technology, innovation, entrepreneurship, etc. in fact, knowledge-based development depends on human and mental software factors more than any other factor.

Electronic city role in urban sustainable development

As it was mentioned, sustainable development is a fundamental pillar in the process which leads to smart city construction. Meanwhile, using information and communication technology and getting help from electronic city in general, has a significant role in realizing this type of development. The advantages of electronic city and their role are discussed further.

Economic

Electronic city contributes to having sustainable development because it provides the following advantages: offering cheaper services to citizens, developing international business among cities, promoting E-banking, preventing time and cost wasting, facilitating economic affairs due to 24-hour service offering, creating more commercial opportunities by electronic commerce, etc.

Social

Due to emergence of information and communication technology in electronic city, information gather has become a rather simple process for everyone and this increases the public satisfaction of government and their active participation in cultivation

processes. Some of other social effects of electronic cities are offering 24-hour services, waiting time reduction, creating equal opportunities for achieving information and so on.

Environmental

By expanding virtual spaces, electronic city reduces the number of visits to administrations and organization which diminishes the traffic congestion and air pollution. Also, the traffic congestion diminishment will have a positive psychological effect on citizens. So, electronic city not only facilitates all types of communication through providing the virtual communication opportunity, but also helps reduce pollution and wasted time and facilitate accessing to all types of information. Thus, it plays a key role in realizing the sustainable development.

The role of electronic city in achieving urban integration

The most important roles of electronic city in achieving and strengthening urban integration can be summarized as follows:

- Simple and equal accessibility to information for all people
- Simple and equal accessibility to city services
- Removal of location concept and fading the special differences between city neighborhoods
- Reduction of poverty rate through popularizing internet, easy access to computer, etc.

The role of electronic city in people participation

Due to their design and technology, digital media of internet are different from mass communication media such as newspaper, radio, TV and journals. Digital communication has higher communication and participation capacity, equal accessibility and lacks hierarchy in comparison with mass communication media. Thus, any type of communication which is based on digital media has the same characteristics. In mass communication media, the majority of participators are the information receivers, while in digital communication media most of the participants are the active information producers as well as receivers **(Khazaian and Razpour, 2012)**.

Introducing smart cities of the world

Boyd Cohen published the first ranking of 10 smart cities of the world considering criteria such as innovation and stability. Surprisingly, Austria was in the first rank. After Vienna, Toronto and Paris are in the second and third places respectively. Other ten smart cities of

the world are New York, London, Tokyo, Berlin, Copenhagen, Hong Kong and Barcelona. In his opinion, innovation and stability are the most important factors of a smart city. Also, using information and communication technology for optimum resource management is one of the prominent features in the ranking **(www.mardomsalari.com)**.

In **Table 2** below, the position, characteristics and components of some of the smart cities of the world are mentioned:

Table 1: Components and characteristics of sustainable development

	Basic components	Criteria	
Community	**Society**	**- Life quality - Human welfare - Citizen participation in decision making - Healthcare - Equal opportunities for all individuals - Social problems reduction**	
	Economy	**- Economic efficiency in using development resources - Active participation in global financial networks - Stable pattern for finance and commerce - Employment**	
	Human-made Environment	**- Residence for all people - Optimum and standardized construction**	
Resources	**Environment**	**- Preventing environment deconstruction - Preventing air pollution - Preventing water contamination - Sustaining the soil quality**	
	Energy	**- lessening fossil fuels consumption - Reducing the wasted energy of production process - The technology of renewable energy use**	
	Habitat	**- Maintaining the live environment and biodiversity - Maintaining life cycle of all organisms**	
	Skill	**- Utilizing information knowledge and technology**	

Table 2: Studying the features of some smart cities in the world

City	Location	Population	Space	Main features	Other
Vienna	**Northern east of Austria and the capital**	**1.7 million (2012)**	**416.6 km^2**	**- Urban innovation - Green space - Life quality - Digital city**	**Peerless activities in information public accessibility and hard work in City protocol development**
New York	**The most populated city in the U.S**	**8.337 million (2012)**	**8700 km^2**	**- Electronic vehicles - Rebuilding urban green spaces - Optimum management of ecosystem entrepreneurship - Implementing the Commercial Analysis Center**	**One of the cultural, political and economic poles.**
Malmo	**Located in south of Sweden, the third biggest city of the country**	**523278 (2007)**	**158.4 km^2**	**- Developing the infrastructures of public transportation - transferring and providing drinkable water systems - concentrated and optimized systems for generating clean energy - new models of clean transportation structures - using bicycles**	
London	**The capital and most important city of UK, located in the south of the country**	**8.308 million (2013)**	**1572 km^2**	**- Intelligent public transportation - Electronic government - Intelligent economy**	**- One of the world international poles - Huge effect on politics, education and media - One of the major commercial, financial and cultural centers of the world**
Copenhagen	**Capital of Denmark and its biggest city**	**1.2133 million (2014)**	**88.25 km^2**	**- Creative activity in preserving environment - Infrastructure stability - Development of resource use - Energy sustainability and smart urban processes**	**The first city in the world which can achieve the required conditions of cities without Carbon Dioxide production**
Paris	**Capital of France**	**2.211 million (2008)**	**105.4 km^2**	**- collective bicycles - Electronic vehicles - Intelligent transportation**	**Pioneer in economy, culture, art, politics and science**

Songdo, a Smart City

Songdo is the city of the future. Its current population is 22000 people and 5000 citizen are supposed to reside in it soon. But after the completion of this city which will take place in 2015, the residents of Songdo are expected to be 65000. It is not named "smart" because due to the high IQ of its residents, but the main reason is the intelligence which lies in the road pavments, parks and structures of this city. This city is a highflying project which is being constructed in an artificial island 56 kilometers away from West of Seoul. Construction of Songdo started since 2001 and the main reason for this investment was using internet network for all of urban affairs, as not only people but objects from vehicles to houses are interconnected with internet. To establish this internet connection, Songdo designers have benefitted from technological products and solutions. Cisko has placed sensors in street and road

pavements and structures of every inch of the city from the very start. Each of these sensors transmits a direct current to the central control building in which the data of organization, required energy, the road traffic and the weather temperature is collected and analyzed. According to Cisko director, they are building a city which moves and is controlled on a ground of data. So, the central control building of Songdo can be seen as the brain of this city. In order to clarify the concept and performance of this control center, an example is given: the closed-circuit cameras in the street are controlling the number of people on the sidewalks. Therefore, the radiation of street lights is regulated considering the number people who are present in the streets; in crowded streets, the light intensity increases and in the secluded location, the light diminishes. This will lead to reduction of power cost. Moreover, an RFID label is attached to the plate of all vehicles in order to avoid the traffic problem. All vehicles are equipped with this system and are connected to control center. So a precise depiction is given of the momently traffic status of the city, allowing data controlling center to schedule traffic lights, suggest alternative routes and publish preventive warnings. Even traffic lights are of high-technology because LED diodes are used in them instead of light bulbs with only 1% of their power consumption. But the most exciting feature of the city is the presence of video conversation displayers which are known as "remote conversation displayers".

The need for water imposes a great pressure on the existing resources. Each citizen consumes between 250 and 300 liters of water per day. So, Songdo designers have prepared a smart location to collect and save rainfalls and infiltrate the sewer. By this method, only 10% of consuming water of other cities is used for Songdo. Also, the multitude of plants makes the city weather cool and fresh. Other than these items, a very interesting point in Songdo is that no car or truck exists for garbage collecting! Instead, a concentrated system with high pressure takes out wet and dry waste of the collection place by tubes which are placed under the street surface. The system of a smart city should be mutual to carry out the energy consumption process in a smart way. Songdo constructors are presenting the city as a masterpiece and a pattern for future cities and are daydreaming about building 20 similar cities from china to India, a dream that will alter the Earth appearance, if it comes true.

Iran status in relation with virtual communication, electronic city and smart city

The word "electronic city" was brought up since 2001 after the failure of Electronic city of Kish project, although the preliminaries for moving toward construction of an electronic city was provided through offering electronic services and considering intelligent systems by the government. Kish project was never accomplished and the Pearl of Persian Gulf never turned into an electronic city, but it was observed as a beginning to the formation of some essential concepts in today urban life.

After ending the imposed war, the construction rhythm in Tehran seemed faster than other cities and many of cities of Iran (even big cities) have not many essential requirements even now. The modern theories of urban designing and models of urban planning in this era focus on decentralizing new experiences which are supposed to result in the development of a communication through an integrated plan; choosing the pilots of development in a country, dependent on its social, political, cultural and geographical features of the region, is one of the requirement for increasing the success probability of a program; it is an ignored item in our country, either deliberately or by negligence. Thus, many of the plans and designs are being implemented in Tehran for the first time. This centralization is rooted in political and economic convergence of power. On the other hand, lack of a comprehensive and integrated development model intensifies the mentioned problem. Fortunately, with the help of 20-year development prospect (which is designed absolutely sagaciously) and the presence of 5-year plans which looks more precisely and meticulously into the development issue, this problem has been worked out to some extent and the implementation of aforementioned plans can be more helpful in solving these issues completely. A megacity with more than 8 million population and considerable expansion should be prepared to face the problems according to its characteristics. In such city, the separate action of organization and institutions (which are mostly governmental in our country) can be efficient, if only it is implemented through a consistent program with an integrated management. Considerable difference between use of high-tech devices and semi-electronic services (such as electronic banking and electronic teaching) in Tehran and other cities of Iran confirms the mentioned point. Many sections, like 137 Internet system and GIS-based Intelligent System, are providing services for Tehran citizens. But in other sections, the inconsistency and confusion is apparent.

Mashhad has a completely different situation. The unique characteristics of this city, which

most of them is related to Imam Reza Holy Shrine, have made this city have particular conditions. Anyone who has recently travelled to Mashhad has clearly recognized a new wave of urban development. Expansion plan and organization of surrounding space of Imam Reza Shrine along with reconsideration of city roads networks seem to manage to renew the old and traditional context of the city to a significant extent. Mashhad can be mentioned as the most successful smart city in country. The city executives regulated the strategic code for electronic city of Mashhad with the cooperation of university community and established a well-equipped base which holds an independent identity and provides various types of service for citizens. The entity of such base and its association with the informative website of Mashhad municipality has generated a combination that places Mashhad much higher than its peers. Moreover, providing services based on an urban integrated management system and the function of smart public transportation systems are other examples that indicates the superiority of Mashhad over similar cities.

Studying the procedure of electronic city formation in our country (of which a summary was presented in the research) shows that the decision makers have been confused on the basic concepts. In Iran, the concept of "electronic city" is confused with "internet city" and even "electronic municipality". This false perception leads to neglecting other aspects of electronic cities. A city is a collection of many factors and the human is placed in the center of them. urban services include only one part of these factors. Examining the successful implemented examples throughout the world shows that the governments have provided comprehensive plans considering the cultural situation of their society and attempted to prepare the requirements and implement the plans. The first step to all of the plans is creating a proper and integrated infrastructure which is associated with citizens' education and training and teaching the principles of living in a smart city **(www.vista.ir)**.

Suggestions

According to the conducted researches and studying the successful smart cities, some strategies are suggested for building smart cities in Iran:

1- Intelligent services for citizens in management the use of parking lots: by using intelligent parking system especially in crowded areas, citizens can spend less time and find the closest parking vacancy which helps reduce the fuel consumptions. Also, it contributes to air pollution and traffic

diminishment and allows city administrators to manage the parking lots with a higher degree of ease.

2- Installing intelligent speed bump throughout the city: improving traffic culture and fulfill citizens' satisfactions with reduction of vehicle depreciation.
3- Scheduling management of the traffic lights: installing smart traffic lights using sensors to detect the traffic congestion in street pavements of the intersections
4- Sharing the bicycle, walking and using electronic vehicles in order to meet citizens' daily needs to help them live a healthy life de
5- Improving the culture of public transportation and offering intelligent services to citizens: we can install special sensors for detecting the temperature, humidity and pollution rate in the city. Some monitors are installed to show the detection results.
6- Intelligent management in using urban trams: installing entering and exiting gates to control the coming passengers and distribute the passengers in wagons in a proportional way.
7- The management of passages waterlogging: sensors in waterways will detect the waterlogging and its intensity and report it to the control center.
8- Garbage collecting: sensors can be installed on garbage bins throughout the city to be informed on their garbage mass. Through this method, the necessary action will be taken when a bin is full.
9- Separating different types of garbage: installing sensors in garbage separation stations which operate automatically in case of citizens' mistake
10- Management of optimum energy consumption in the city: sensors can detect the presence of citizens in pavements and amusing parks. So, the lights will be on in the crowded passageways.
11- Improving the citizenship culture: smart games can help improve the culture of citizens, especially children, in dealing with urban affairs.
12- Constant weather forecast: this process will lead to proper using of energy and reduction of losses due to inclement weather.
13- Using more plants and designing more green spaces in the city to reduce the air pollution and freshen the air

14- Smart traffic management: vehicle guiding system to direct it to routes with less traffic congestion using the installed sensors throughout the city

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