A Review on Importance of Smart City Indexes for Citizens' Health Case Study: Esfahan City

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Abstract

Smart city has been considered by urban developers and municipalities as an innovative concept in urban developing and as a strategy to contribute to the mitigation of urban problems. Smartening of cities may result in mental health and alleviation of citizens' stress, improvement of life quality, upholding a city and citizens' hygiene, decrement of commutations and preservation of resources. The prompt growth and sprawl of urbanization followed by high degrees of pollutions and negligence of environment have consequences for urbanites' health, but IT is able to resolve most of those issues. The goal of present inquiry is compiling and scaling the significance level of indexes attributed to the smart city in elevation of Esfahan city health. In this regard, the researcher has exploited 22 indexes attributed to health from smart city indexes regarding practitioners' viewpoints and elucidated the significance of which in achieving smart health through Analytic Network Process (ANP) method, the results depict that focusing on smartening in visions, plans, and initiatives of public and private organizations, considering skilled practitioners as well as designation of budgetary and funding to attain the smart health are of great importance.

Keywords: smart city, smart city indexes, citizens' health, Information and Communication Technology (ICT), Esfahan city

1. Introduction

Coupled with urbanization and its unpleasant consequences, urban health has turned to one of most important issues in urban planning and administration. In last 50 years, urban population has been doubled and in developing countries it has reached to five-time growth. Prompt growth and broad urbanization have consequences for health. Statistically, in Esfahan more than 90% of death causes are stemmed from maladies which over 50% of that is due to cardiovascular diseases as well as cancer (Esfahan megacity Atlas, 2015, 144), air pollution and stress have a key role in aggravation of these maladies that should receive specific attention. Carried out scrutinizes suggest that the information technology and movement toward smart city, may be efficient in diminution of environmental pollutions and help the improvement of city and citizens' health.

1.1 Research Background

The concept of "smart city" was introduced in 1994 (Dameri & Cocchia, 2013) and the number of publications in this regard was significantly increased from 2010 onward following to the emergence of smart city projects (Ahvenneimi, Huovila, Pinto, Seppa, & Airaksinen, 2017). Whereas, this concept is pervasively used recently, there is no specific and solid discernment for which and the verification of its concept is needed. Ferraro considers the features of smart city in three major aspects as: planning and administration, people and human capital, and infrastructure. He believes that to consider a city intelligent, it is needed to be developed in all above aspects (Ferraro, 2012). Giffinger proposed six major dimensions for the smart city: smart economy, smart people, smart government, smart movement and mobility, smart environment and smart life; these are known as the major dimensions of smart city to now (Giffinger et al., 2007).

In 1994, in 2nd conference of environment and health held in Helsinki, the importance of urban health and its priority was addressed for the first time. In which, it was suggested that many affairs related to city health should be assigned to local authorities while in that time, decisions were mostly made by central government (Lawrence & Fudge, 2009: 15). There are many papers focused on integration of ICT in health. Vavilis et Rudowski suggest that smart health consists of discourses such as S-health, M-health, and E-health that aim at advancement, acceleration and facilitation of health-care services (Rudowski, 2007; Vavilis et al., 2012). Safdari et al in an inquiry aiming at exploring innovative information technologies in urban health development considered the role of ICT in enhancement of urbanites' health significant and underlined the systematic planning, economic-social factors and infrastructures in this regard. Most of carried out scrutinizes in the context of smart health, is pertaining to the discourse of smart care and smartening of equipment and medical services and less to the effects of smart city feasibility on city and citizens' health, and this, reveals the requirement of addressing the above issue.

1.2 Smart City

A smart city implicates an urban innovation which has been developed through the leverage of ICT potential, harnessing real and social infrastructures, natural resources, and knowledge for the purpose of environmental and economic regeneration along with social and public services (Bibri & Krogstie, 2017). In table 1 the definitions of smart city from the perspective of practitioners and theoreticians are outlined:

Table 1. Smart city definitions

Definitions	Aspect	Theoreticians
The desirable function of a city will be provided through prospective view in aspects of economic, community, mobility and movement, environment and life based on an intelligent combination of subsides, autonomous activities, self-governance and presence of informed citizens.	theoretical	Giffinger et al., (2007)
A smart city is able to connect physical capital with social capital for creating better service and infrastructure.	theoretical	Correia and Wünstel (2011)
A smart city may be considered as a secure city, compatible with environment and efficient in future, along with advanced infrastructure like sensors, electronic communications and networking to trigger sustainable economic growth and high quality of life. This comprehensive definition implicates the simplicity of balance between various economic and social desires as well as implicit needs in urban development, whereas, it could encompass ambient and less developed cities.	theoretical	Schaffers, (2012)
A smart city is as an urban environment in which "ICT combines with infrastructure, architecture, daily things, or even our bodies to solve economic, social, and environmental problems." remarkable development of ICT has transformed two subjects: 1- the method of communication with other people 2- the way to communicate with the environment	theoretical	Townsend (2013, p.15)
Sustainable smart city is typically known as a city that "is content-aware and integrates IT to optimize energy and efficiency of other resources". From Hitachi vision, this city is a place to meet the desires and values of its habitants. Leverage of advanced IT is desirable for the improvement of energy efficiency and entails importance for the environment as a prerequisite and this results in the emergence of "proper balance between human and the planet".	enterprise	Hitachi, (2014)
In a smart city, the city connection and behavior role for more utilization of urban services to access more benefits and sustainability has a great importance.	theoretical	Belanche, Casalo, & Orus, (2016)
Indeed, a non-sustainable city is not a "smart" one. The primary goal of smart cities, is to reach the sustainability of a city contributed by modern technologies effectively in some smart city structures.	theoretical	Ahvenniemi, Huovila, Pinto-Seppä, Airaksinen, (2017)

A smart city can effectively integrate technological, build, infrastructure, operational, architectural, physical, environmental, and human systems in build environment across certain spatial scales aiming to integrate ICT as a constellation of tools and smart solutions to improve sustainable development, thereby, it comes to a promising future for the citizens. A smart city tries to consolidate advanced digital technologies with urban planning methods to find innovative solutions which contribute in viability and sustainability enhancement. Indeed, real smartness is what is obtained through logical strategies to disseminate ICT innovations and the orientation of their adaption to back up urban sustainability long-term objectives.	theoretical	Bibri & krogstie, (2017,p 225)

Source: accumulation based on enquiry findings.

1.2.1 Smart City Indexes

Giffinger suggests six major dimensions as the smart city indexes: this model is a classified system by which smart cities are developed and evaluated through these distinguished characteristics consist of: smart economy, people, governance, mobility, environment and life. Through which, cities can investigate their current situation (Colldahi et al., 2013). Summarized descriptions of these indexes are outlined in Table 2.

Table 2. General view of smart city

Characteristic	Description	Source
Smart economy	The intent of smart economy is mainly electronic business, electronic trade and commerce, more productivity, production and delivery of advanced services centering Information and Communication Technology Organization as well as offering products, contexts and services with all new business models. Smart economy results in emergence of clusters and smart localization (such as electronic business and digital entrepreneurship).	Manville etal, 2014 Colldahi et al., 2013
Smart people	The concept of smart people entails skilled citizens to operate with electronic terminals and systems, work in ICT organization-oriented occupations, accessibility of people to education, human resources and human capabilities' management in a ubiquitous community aiming at dissemination of creativity and development of innovations. This characteristic, enables people and community to provide databases and process them in case of necessity to integrate in decision making, content production and delivery of products and services.	Manville et al., 2014 Colldahi et al., 2013
Smart governance	Smart governance is the seamless inner-city governance across the city which entails interactions and services that connect civic, public, private and organizations and global system and integrates them in case of necessity for the city to continue its life as an effective and fruitful organism. The most principal tool to gain above objective is Information and Communication Technology (ICT) Organization (consists of soft and hard infrastructures as well as service-type superstructure which has been triggered by intelligent procedures and enhanced contribution and supplies its feed from available data. Here, smart goals consist of transparency, making available the information in electronic service domain through contribution of Information and Communication Technology Organization and E-government.	Manville et al., 2014 Madakam & Ramasway, 2014 Colldahi et al., 2013
Smart mobility	The aim of smart mobility, is the function of integrated systems of supply and backup or logistic, transportation and supply chain management supported by Information and Communication Technology Organization. For instance, secure transportation systems, seamless and compatible with the environment include street cars, buses, trains, subway cars, vehicles, bikes, bicycles, and pedestrians which integrate one or more transportation methods in case of necessity Smart mobility, focuses on adaption of non-motorized and more clean options	Manville et al., 2014 Madakam & Ramasway, 2014 Colldahi et al., 2013

	for movement. Valid data for direction and transportation system should be accessible for the community to prevent from GHG emissions as well as energy savings and to evoke a mechanism for the networked transportation administrators to improve their services and efficiency of citizens' commutation and mobility.	
Smart environment	In smart environment, the focus locates on smart energy like renewable energies, ICT Organization-oriented scale systems, contamination control and monitoring, building renovation and amenity centers, green buildings and urban green planning and along with that, subjects such as productivity in integration and replacement of resources toward achieving the above goals will be addressed. Urban services such as thoroughfares' lighting, waste management, wastewater discharge systems, water source systems that are leveraged in improvement of water quality, are significant examples of smart environments.	Manville et al., 2014 Madakam & Ramasway, 2014 Colldahi et al., 2013
Smart life	Smart life means lifestyles, consumption attitudes and behaviors emerged from integration of ICT. Moreover, smart life is considered as a healthy and secure life in a cultured, vital, together with diverse cultural amenities involving high accommodational standards and high quality dwellings. Smart life is also in conjunction with a high level of social integration and social resources.	Colldai etal,2013 Manville etal, 2014

Source: accumulated based on enquiry findings.

1.2.2 Smart City Goals

In this section, six major characteristics of smart city are proposed in compliance with table no. 3 followed by exigency, factors and IT contribution for each characteristic.

Table 3. Smart city goals

indexes	objectives
Smart life	Improvement of habitants' life (Hall, 2000)
	Enhancement of healthcare division (Washburn et al., 2010)
	Upgrading public safety (Witters, 2011)
Smart environment	Mitigation of emitted carbon level (Angoso, 2009)
	Wastewater management advanced technologies (Maloney, 2011)
	Efficiency of water and energy usage level (Stancic, 2009)
Smart mobility	Traffic level decrease
	Enabling intelligent transportation system
Smart people	Education section enhancement (Toppeta et al., 2010)
Smart economy	Occupation rate improvement (Lombardi et al., 2011)
	To define new commercial models to encourage corporations for economic growth
Smart government	Offering transparent and efficient E-government services

Source: Chair.mo, 2011.

1.3 Information and Communication Technology (ICT)

Information and Communication Technology (ICT) is a general phrase involving all advanced technologies as to the communication procedure and data transmission in telecommunication systems. This system could be a telecommunication network or multiple connected computers linked to telecommunication network as well as their integrated programs (Bibri & Krogstie, 2017, 223).

1.4 Health

Health is characterized as benefiting from high level of welfare. According to health theory, a healthy person is the one who holds the higher degrees of health indexes (Blanco & Diaz, 2007). Davani et al believe that real health, is the procedure of empowering and enabling accompanied by a decent life (Zakki & Khoshouei, 2003).

The fundamental of healthy city is based on that, health is something more than medical cares; healthy environment and community fostering are also key elements (Christopher J. Bon, 2000, 80). Thereby, holistic approach toward health means that the individual's health is in conjunction with certain factors. A person who benefits from decent physical conditions could be in pain for lack of health due to air pollution or even because of solitude. Shortage of greening may weaken people's spirit for strolling or doing exercise. Those who are deprived to access clean water, food, housing, and healthcare are obviously in pain of health issues in comparison with the people who enjoy from those amenities (Tabibian, 2009, 79).

1.4.1 City and Citizens' Health

Urbanites' health within the urban environment is from the most important issues considered by today's life. Through last 50 years, the urban population has been doubled in number, while, it is grown up to five times in developing countries. Prompt growth and urbanization sprawl have negative consequences for health.

Carried out studies depict that IT as a powerful tool is the most effective factor in efficiency improvement and effectiveness of institutions. Thereby, different industries have taken efficient paces in order to keep on their existence in competitive environment and upgrading its consequences in order of using this technologies. Health industry is not an exception and different countries have addressed the IT to expand and develop the data on health and healthcare system enhancement as to the direct role and the importance of healthcare industry and its direct and indirect effects on different aspects of society (Mohammadzadeh, 2006). Further, today the information is considered as the most important aspect of institutional development and information systems are form the most appropriate tools for managers for the purpose of decision making and planning. To put it differently, accessibility to information improves processing capability further to facilitation and acceleration of institution's running operations and empowers administrators in different levels of organizations in supervision and control of institution activities (Ghazisaeedi, 2007). Therefore, IT is known as the most important method of evolution and development in today's world and its achievements has been significant in people's lives in various ways (Nejati, 2009). It entails capability to solve many recent problems of cities as one of emerging techniques (Habibi & Senshenas, 2009).

Health as a real need for citizens is from the most substantial necessities even in virtual world, and ICT development in past two decades have demonstrated that the man today is in need of integrating any demanded living substance with innovative ICT in coming electronic world (Khalifesoltani, 2010). In general, 70% of people live in urban areas. Urban life is the wrestling with health challenges like water and other environmental aspects, violence and damages, non-contagious diseases, and lifestyles such as smoking, unhealthy diet, physical immobility, alcohol abuse, and emergence of diseases but the integration of IT can tackle many of these issues (WHO, 2010).

1.4.2 E-Health

E-health refers to the integration of modern ICT in line with the citizens' needs and their health as well as their environment (E-health EU Ministerial Declaration, 2003). Smart cities entail significant factors in line with reaching to a healthy environment and enhancement of life quality and citizens' health.

Generally, World Health Organization (WHO) addresses such issues. This organization has been initiated his work in 1987 and continued its activity hitherto. It defines healthy city as a city that perpetually is developing, or physically and socially is improving the environment and expansion of society resources in a way that enables people to support each other in implementation of all life's functions and optimized development of potentials.

"City Health" by WHO is an innovative, universal, and long-term compiled program aiming at focusing on health in decision makers' plans and improvement of local and comprehensive strategies to protect health and sustainable development. Hitherto, 90 cities are members of WHO European healthy cities' network and 30 networks of national healthy cities among WHO European districts consist of more than 1400 ones. The primary goal of this organization is to underscore the health in political, economic, and social priorities of municipals (WHO, 2010).

As for the postulated subjects, E-health underscores environmental, social, economic, and political health, etc., and does not merely address topics in conjunction with citizens' healthcare.

2. Methodology

The recent research is based on field and library studies carried out based on review, criticize and analyze of available inquiries in the field of research core concepts in three sections. First, the theories and definitions available around smart city and health were addressed followed by exploring the conjunction between these two parameters. Second, the smart city indexes related to health topic has been exploited deploying questionnaire as to the viewpoints of theoreticians and practitioners.

ANP method is integrated for the analysis of acquired data from questionnaires. The procedure method considers the analysis of sophisticated interactions between and among decision-making elements through replacement of hierarchical structure with that of network (Zebardast, 2000). Any of these indexes is specified through applying ANP method and the degree of Esfahan city E-health is estimated based on the acquired data for any of these indexes in Esfahan city.

In recent research, first, the prioritizing model of smart city indexes is formed based on their effect on E-health followed by turning the subject to a network structure, and the interactions between target clusters, indexes and sub-indexes are established.
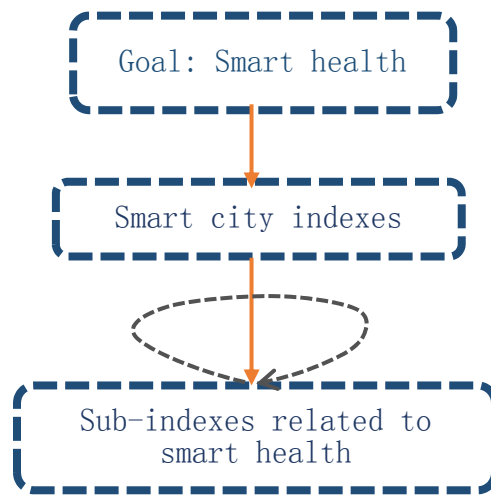

Figure 1. AMP model interactions in smart health

Source: author

3. Results

To specify smart indexes related to city health, 10 specialists were asked to score 45 sub-indexes in the field of smart city in terms of city health and citizens through integrated Delphi method, and eventually, 22 sub-indexes that entail a score above 0.7 were selected as smart city sub-indexes related to health. Nearly half of the sub-indexes of smart city were affected on health which indicates a high dependence between making smart and health. These sub- indexes are as follows:

Table 4. Sub-indexes related to health

City indexes	Sub-indexes related to health
Smart people	Integration of smart technologies
	Social learning and education
Smart life	Technology infrastructure
	Smart amenities and software
	Consumption per capita
	Social justice
	Security

	Culture and physical education
	Recreation and amusement
Smart governance	E-governance
	Specialty
	Plans and proceedings
Environment	More appropriate utilization of resources
	Availability of ecologic and natural resources in area
	Mitigation of CO emission
	Waste management
Smart economy	Budget and capital
Smart transportation	Clean transportation
	Decrement of inevitable trips
	Transportation safety
	Public transportation
Smart framework	Framework compressing

Source: author.

In the first phase of ANP method, pairwise indexes were compared from the aspect of significance to reach smart health and their importance coefficient is presented in following diagram.
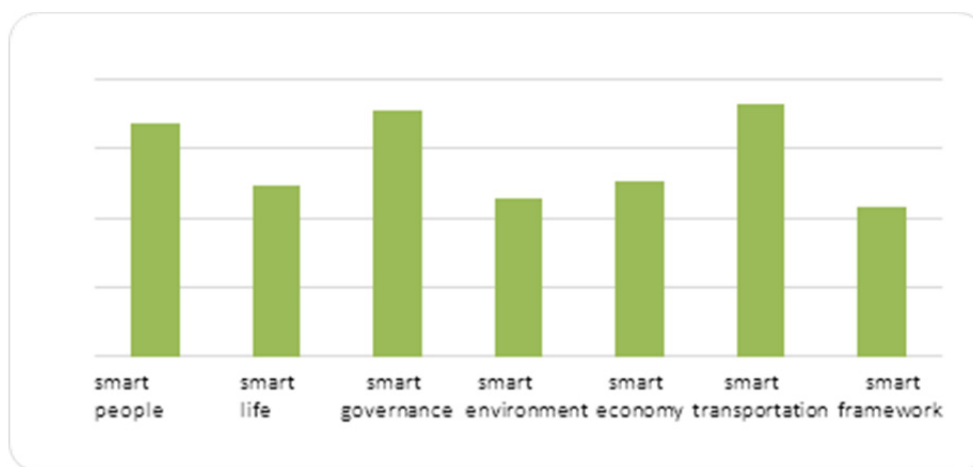

Diagram 1. Importance coefficient of smart city indexes for health

Source: author.

As it is obvious from above chart and table, smart transportation, governance and smart people have the most influence to reach city and citizens' health. Governance can provide smartening infrastructures whose effects are on smart transportation and people; thereby, a smart environment could be achieved that entails a key role in city and citizens' health. It can be argued that smart transportation and governance are the causes and people as well as environment are the effects in achieving health.

In this regard by comparing the paired relationship between the sub-indexes that are related to each other, the importance coefficient of the health – related smart city sub-indexes is presented in the following diagram:
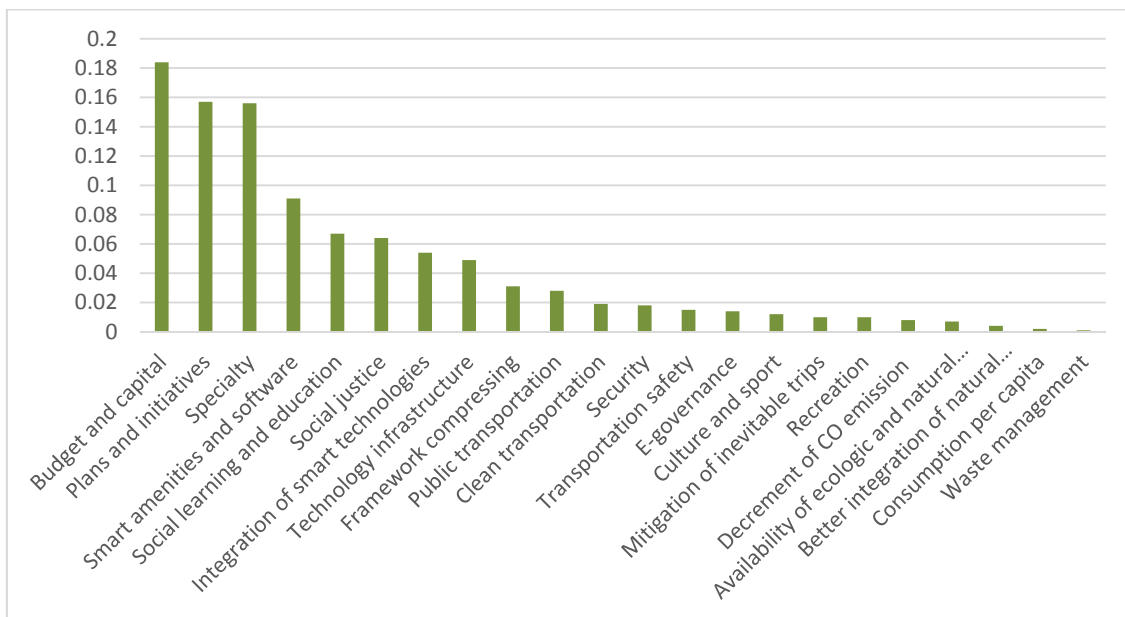
Diagram 2. Importance coefficient of sub-indexes related to smart city health

Source: author

4. Discussion

4.1 Case study: Esfahan City

Esfahan megacity, accommodating a population of 2 million people is the third megacity of Iran and is of great importance among the state cities from political, economic, cultural, and historical aspects. In Esfahan city projects and perspectives, the smartening of the city is underscored and presently, its IDI index has been 6.08, i.e., above the country average (5.44) (Ministry of Information and Communication Technology, 2016).

Esfahan city status is aggravating from the aspect of increasing air pollutions and the toxic pollutants available in the air. The percentage of clean days in city is only 0.3% and unhealthy days' rates for sensitive groups and that of for public are 29.9% and 3.6%, respectively (Esfahan statistics, 2015). For this reason, the percentage of cardiovascular diseases as well as cancer are progressively increasing and more people are passing away from those diseases.

Based on this, it seems necessary to measure the health – related sub- indexes in Isfahan city. Therefore, the studies carried put in the previous stages have been investigated according to the current situation in Isfahan. The number of each of the measures of sub-indexes for the Isfahan city, depending on the nature by means of questionnaires filled out by two groups of citizens and authorities and the available statistics and information are calculated. Then the average of each sub-indexes is measured and then coefficients are in the range between 0 and 10 is presented in the table below.

Table 6. Importance coefficient and value of smart city sub-indexes related to health in Esfahan city

Sub-indexes related to health	Importance coefficient	Sub-index number in Esfahan (from 0 to 10)	The number of each sub-index in Isfahan according to the importance coefficient
Budget and capital	0.184	2.00	0.37
Plans and initiatives	0.157	5.05	0.66
Specialty	0.156	4.57	0.76
Smart amenities and software	0.091	5.38	0.49
Social learning and education	0.067	4.99	0.34
Social justice	0.064	5.23	0.34

Integration of smart technologies	0.054	5.26	0.36
Technology infrastructure	0.049	3.97	0.22
Framework compressing	0.031	3.34	0.10
Public transportation	0.028	4.08	0.17
Clean transportation	0.019	4.92	0.05
Security	0.018	4.19	0.09
Transportation safety	0.015	5.64	0.07
E-governance	0.014	2.65	0.06
Culture and sport	0.012	5.06	0.05
Mitigation of inevitable trips	0.010	3.75	0.03
Recreation	0.010	2.00	0.03
Decrement of CO emission	0.008	2.54	0.04
Availability of ecologic and natural resources	0.007	2.51	0.02
Better integration of natural resources	0.004	4.65	0.02
Consumption per capita	0.002	6.27	0.01
Waste management	0.001	3.23	0.01
SUM	1		4.27

Source: author.

As for the diagram, sub-indexes of budget and funding, plans, initiatives, and specialty are the priorities and locate in a far distance from other indexes. Following to them, the indexes of amenities, smart software, social learning, education and others are located. As for the above table, smart health level in Esfahan is 4.27.

4. Conclusion

According to what was argued, it could be concluded that smart city can have positive effect on city and citizens' health. Considering that the smart health rate in Isfahan is 4.27. Through moving in line with feasibility of smart city indexes, health rate can be upgraded. Considering investment and budget designation are of great importance for implementation of smart city and smart health, for the reason that one of the feasibility pillars is the implementation of plans and projects as well as appropriate funding. To put it differently, considering a long-term perspective and macro-scale planning is of great importance. Considering smart city infrastructures, education, and making a culture for citizens lead to implementation of people's dimension and smart life, and eventually smart environment. Feasibility of smart environment that is affected by adaption of renewable energies as well as diminution of CO gas level, mitigation of environmental pollutions, waste management, etc., entails direct conjunction with the city and citizens' health. In other word, alleviation of stress and anxiety that are raised from necessary commutations for urgent affairs and passing long time in traffic and urban pollutions leads to mental health and citizens' tranquility.

In a holistic view, the feasibility of smart city followed by achieving city and citizens' health, requires a dynamic and potent economy, so that by integrating expertized practitioners, the city perspective could be directed toward smartness; as a result, the disadvantages of today's vibrant life which is accompanied by tremendous pollution, psychological tensions, stresses, etc., could be declined.

Competing Interests Statement

The authors declare that they have no competing or potential conflicts of interest.

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