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Defining the social-sustainable framework for smart cities

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ABSTRACT

BACKGROUND AND OBJECTIVES: Smart cities have been criticized for being too technologically driven and reinforcing entrepreneurial thinking rather than focusing on citizens and social sustainability. This paper aims to "define the implementing principles for Smart Cities in Tehran as a social construct". In this regard, this study tries to develop smart city indicators and suggest a set of implementing principles for smart cities, citizens, and civic organizations in Tehran. Furthermore, this paper illustrates how in-progress smart city projects are meeting the citizens' needs in 22 districts of Tehran Municipality.

METHODS: The present study has used a qualitative and quantitative methodology based on theoretical frameworks. In this paper, Maslow's hierarchy of needs acts as a meta-method for defining the principles of social sustainability to implement smart city projects. First, smart sustainable cities and associated indicators were evaluated based on Maslow's hierarchy of needs. Second, a case study approach was utilized to assess Tehran's smart city projects. Finally, the Strengths, Weaknesses, Opportunities, Threats and Quantitative Strategic Planning Matrix techniques were used to define strategies based on internal and external environmental factors and relation to social sustainability.

FINDINGS: The results indicated that promoting innovation centers and living labs to create a vibrant, active, and healthy public realm was the most effective strategy for smart city development in Tehran (Weaknesses-Opportunities8=.1.323). Two important additional strategies were "involve stakeholders and focus on people and consider urban residents not only as recipients or users of smart cities but also as designers of smart cities" (Strengths-Opportunities3=1.075) and "promote community involvement in council decision-making by developing interactive platforms" (Strengths-Opportunities8=0.884).

CONCLUSION: This paper contributes knowledge on how cities such as Tehran can achieve and implement social sustainability using a smart city approach. Plans and projects for a smart city in Tehran were deemed neither realistic nor sufficiently strategic, and they are assumed to satisfy neither policymakers nor citizens. Social sustainability-based principles and strategies are necessary to incorporate citizen perspectives into Tehran's smart city plan and policies. The present study adds several significant insights to the existing frameworks for implementing smart city frameworks in Tehran.

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INTRODUCTION

Sustainability is considered as a value, goal, or set of norms that need indicators for describing a balance situation between people's needs and "environmental," "social," "economic," and "institutional" dimensions (Badi *et al.*, 2022; Sharifi, 2021). Sustainable development was originally defined by the World Commission on Environment and Development (WCED) (Shmelev and Shmeleva, 2019). These dimensions are inextricably intertwined, making it futile to pursue one while ignoring the others (Fig. 1) (Song *et al.*, 2017).

Diverse urban indicators were developed to provide an assessment tool for planning and decision-making to create a sustainable city (Agency, 2012; Marzukhi *et al.*, 2011), where these indicators can be used as a guide for sustainability policies. In this regard, indicators focus on evaluating the performance of the presented policies. Phillis *et al*. (2017) define the Sustainability Assessment by a Fuzzy Evaluation (SAFE) model, which uses environmental and socioeconomic indicators to rank 106 cities. Gonzalez-Garcia *et al.* (2018) define indicators from a sustainability perspective. The Reference Framework for Sustainable Cities (RFSC) is one of the toolkits designed to facilitate the implementation of sustainability objectives in European cities. The indicator set consists of 16 key and more than 300 supplementary indicators covering the economy, society, environment, and governance (European Commission DG, 2012). Reviewing the sustainable city indicators reveals that sustainability assessments are a prevalent tool that attempts to address sustainability by controlling the sustainability indicators in all steps of the urban development process or measuring the performance of cities aligned with sustainability. However, a comprehensive framework for policy-making from the visionary level to the operational level is neglected in the literature related to sustainability. Reviewing sustainability indicators show that the normative aspect, which focuses on qualities and implication indicators, specifically in the field of social sustainability, is ignored (Branny *et al.*, 2022). Thus, this study aims to define principles as a guide for the implication of sustainability whit emphasis on a social aspect related to smart cities (Freestone and Favaro., 2022). A social and sustainability critique of how Information and Communications Technology (ICT) infrastructure and new technologies are used in cities has led to the development of sustainable smart cities (Harrison *et al.*, 2010; Marsal-Llacuna, 2016). Consequently, some experts criticized smart cities as being too technically oriented and suggested adding a strong citizen-oriented approach that emphasizes the role of social capital and governance in this concept (Albino *et al.*, 2015; Komeily and Srinivasan, 2017; Jiang *et al.*, 2022). The term "smart sustainable city" is defined as "a city that meets the needs of its present inhabitants, supported by ICT infrastructure" (Höjer and Wangel, 2014; Martin *et al.*, 2018). The significance of sustainability in smart cities motivates the development of sustainability assessment indicators for smart cities. In recent years, studies on smart city indicators have increased continuously. Multiple research has addressed the assessment and evaluation of smart cities, but cities' strategizing and operationalizing indicators have received less attention. Huovila *et al*. (2019) introduced published indicator standards for smart sustainable cities to assist city managers and policymakers, select the indicators and standards that correspond most closely to their assessment needs and objectives. A taxonomy was developed to evaluate each of their 413 indicators against five conceptual urban focuses (types of urban sustainability and smartness), ten sectorial application domains (energy, transport, ICT, economy, and others), and five indicator types (input, process, output, outcome, impact). The indicators used in the current study were collected from resources to emphasize standardization, including International Telecommunication Union, International Organization for Standardization, The European Telecommunications Standards Institute, and United Nations, to create an assessment framework for smart cities. Moreover, they were aligned with their respective stage in smart sustainable city implementation. Most of the sustainability assessment indicators suggested in this study consist of people (social sustainability), planet (environmental sustainability), and prosperity (economic sustainability). In addition, Bouzguenda *et al*. (2019) focus on the importance of citizen participation in developing a smart sustainable city and introduce a hierarchical model between sustainability and digital citizen participation based on an exhaustive review.

Bouzguenda *et al*. (2019) show that ICT is vital in planning smart and sustainable cities. Yigitcanlar *et al*. (2019) proposed that cities could not be smart without being sustainable, even when evidence in the practical application of "smartness" point to the contrary. However, sustainability is not limited to environmental concerns. It also incorporates social and economic aspects, although the social aspect is addressed the least. Ben Yahia *et al*. (2019) discuss the concept of collaborative governance in the context of smart cities, focusing on supporting and recommending performing organizational structures for Sustainable Collaborative Networks. The work conducted by the British Standards Institution is one of the most-discussed attempts to operationalize the smart city approach to urban sustainability (Caird, 2018; Caird and Hallett, 2019; Joss *et al.*, 2017). This research aims to create an "interface between research, policy, and practice" (Joss *et al.*, 2017). A study by Mora and Deakin (2019) demonstrates that implementing smart cities is a complex issue that requires distinguishing between utopian ideas and reality and that strategizing smart city development practice is necessary to deal with the complexity of a socio-technical transformation triggered by the alignment of technological development with human, social, cultural, economic, and environmental factors. Humans are the primary focus of the sustainability concept, but social sustainability has received less attention in built environment disciplines. In the past decade, academics from various disciplines have discussed social sustainability's academic and policy implications within urban studies (Hosseini *et al.*, 2020). Less emphasis has been placed on social sustainability's conceptual framework and practical reporting (Monfaredzadeh and Krueger, 2015). Sustainability is the most significant element in the definitions and concepts of the smart city, which is paying attention to and meeting human needs in all areas. Social sustainability is considered one of the basic elements of sustainability, as seen in Fig. 1. As such, this study examines smart cities from the perspective of social sustainability. Maslow (1954; 1967) theory of motivation, commonly called the "Hierarchy of Needs," organizes a set of human needs into five general categories: physiological, safety, belongingness, esteem, and self-actualization needs. Regarding Maslow's hierarchy of needs, Lang (1994) conceded, "No design can meet all of everybody's needs simultaneously." However, he successfully documents the complexity and occasionally contradictory user experience concerns that urban designers should incorporate into their work (Lang, 1994). In this respect, a study evaluating smart cities in China using an evaluation index system based on resident needs was conducted by Zhang *et al.* (2019). According to Maslow's theory and the literature review on social smart city indicators, there are common needs among communities to

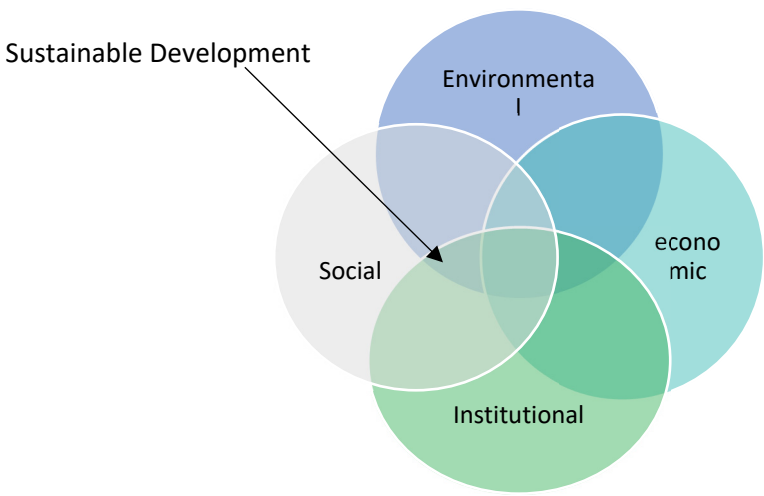

Fig. 1: The proposed diagram of sustainable development dimensions

which cities must respond. To this end, the current study tries to define and develop the hierarchy of needs in the context of smart cities as a meta-method for defining the implementation framework for smart cities with a focus on social sustainability. The hierarchy of human needs in smart cities based on what Maslow (1954) and Lang (1994) stated includes Physiology (Smart city infrastructure), Safety (Reliable and resilient city), belonging (Smart collaboration cities), Esteem (Recognized smart communities), and Self-actualization (Smart vision) Fig. 2.

By using a descriptive-analytical approach, this paper attempted to "define the implementing principles for Smart Cities in Tehran as a social construct." This study's academic merit is that it emphasizes social sustainability and citizen needs perspectives, which are frequently neglected in smart city research, in order to develop a policy framework for smart cities in Tehran. The implementing principles for Smart Cities in Tehran refer to finding the right tools and approaches to reduce urbanization's impacts and leverage the potential that bringing people together can offer. Based on theoretical frameworks, a qualitative and quantitative study method was employed to define implementing principles for sustainable cities from a social perspective in Tehran. Two major steps to achieve the study's goal are:1-Adjustment of sustainable smart cities indicators to the hierarchy of needs: in this step, a review of the literature about smart cities, social sustainability, and smart sustainable cities indicators are carried out to understand the relationship between the theoretical foundations and indicators of smart cities and the relationship between them and operational issues. In order to provide a general overview of the smart city development process in Tehran, 22 districts have been selected to illustrate how in-progress smart city projects are meeting the needs of the citizens in those districts. 2-Analysis of Tehran's smart city context and requirements: In this step, a case study approach was used to evaluate Tehran's smart city projects. SWOT and QSPM were used to determine strategies based on internal and external factors and their relation to social sustainability. Through QSPM, the implementing principles of smart city development in Tehran are defined. These principles are primarily concerned with social sustainability. According to the synergistic value of this research, smart cities must be developed in consideration of citizens' needs and wishes. Therefore, people-centered policies and strategies are critical in the realization of a smart city. The current study has been carried out in Tehran in 2022.

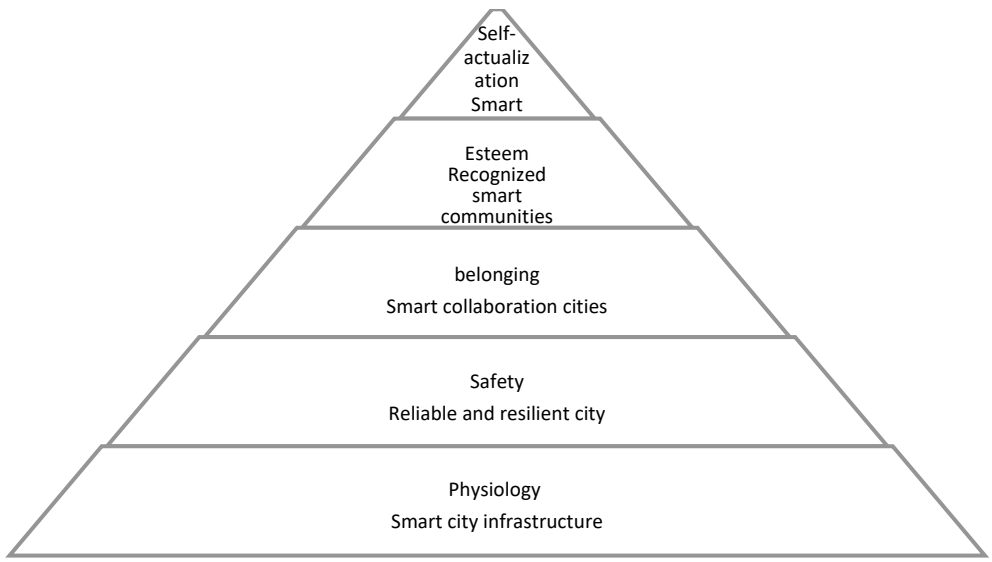

Fig. 2: Hierarchy of needs: application in smart communities (Maslow 1954; Lang1994)

MATERIALS AND METHODS

From the perspective of Maslow's hierarchy of needs theory, a research by Zhang *et al.* (2019) established an evaluation model of smart cities based on residents' needs. Also in the subject of sustainable smart cities, diverse urban indicators were developed intensively to provide an assessing tool for planning and decision-making to create a sustainable city (Agency, 2012; Marzukhi *et al.*, 2011). This paper's main difference and innovation are related to developing principles for smart cities and strategies for improving citizen engagement in Tehran. The study also focuses on social sustainability and citizen needs, which have been neglected in many smart city studies. In the present study, Maslow's hierarchy of needs theory was used as a basis meta-method for defining the sustainable smart city principles with an emphasis on social sustainability. The mixed approach utilizes both qualitative and quantitative methods. First, using a qualitative approach, content analysis was employed on the subject of smart sustainable cities and related indicators to evaluate approximately 359 indicators using the focus group method based on Maslow's hierarchy of needs. Second, in order to develop a thorough understanding of Tehran Municipality's smart city projects based on Maslow's hierarchy of needs, a case study approach was used to evaluate Tehran Municipality's smart city projects based on five levels: physiological demand, safety demand, social demand level, esteem demand, and self-actualization demand, in order to clarify the social sustainability level of these projects. Finally, the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis and The Quantitative Strategic Planning Matrix (QSPM) techniques were used to analyze the smart city plan in Tehran based on the hierarchy of needs. The strategies were defined based on internal and external environmental factors and weighed regarding social sustainability. In conclusion, smart sustainable principles emphasizing social sustainability were defined. The research method structure of this study is mentioned in Table 1.

Adjustment of sustainable smart cities indicators with the hierarchy of needs

Focus groups comprised of a mix government officials, experts, academics, and information technology specialists. So, the purposive sampling technique was used. According to Babbie (2013), purposive sampling is used when a study focuses on a particular setting with specific experts and study domains. The criteria for choosing experts include the following. (i) Working in smart cities theme and sustainable indicators. (ii) Working or having sufficient knowledge of Tehran innovation ecosystem. 30 experts were purposefully selected with the help of experts' selection criteria, and 25 of these experts participated in the focus group (about 80 percent). The response rate was considered appropriate according to Moser and Kalton (2017) affirmation that the survey results could be considered insufficient and biased if the return rate is lower than 30–40% of the totals sampled or distributed. In each focus group meeting, several smart city indicators were compared with the hierarchy of needs to reach a consensus. Approximately 359 smart, sustainable city indicators collected from various sources (Table 2) were classified based on Maslow's hierarchy of needs through the focus group method. Finally, the 359 indicators were matched to the five levels, including physiological, safety, social, esteem, and self-actualization demands. The frequency of smart sustainable city indicators in each level of the hierarchy of needs is presented in Table 3. Most indicators are related to physical, social, and safety demands. The frequency of esteem demand and

Table 1: The Summary of The research method structure

Steps	Methods	Details
Adjustment of sustainable smart cities indicators with the hierarchy of human needs	Focus groups of a mix of government officials, experts, academics, and information technology specialists to classify smart, sustainable city indicators	Purposive sampling is considered. After purposively targeting 30 experts, 25 (80%) experts participated.
Exploratory Case Study in Smart City of Tehran	Case study approach was used to evaluate Tehran's smart city projects and SWOT and QSPM were used to determine strategies.	Analysis of the internal and external factors of smart cities in Tehran and their relation to social sustainability through documentary and library information.

Table 2: The Summary of indicator on Smart sustainable cities from various sources

Name	Year	Subject
ISO 37120:2018	2018	Sustainable development of communities, indicators for city services and quality of life
ISO/DIS 37122:2018	2018	Sustainable development in communities, indicators for Smart cities
ETSI TS 103 463 (2017)	2017	Key performance indicators for sustainable digital multiservice cities
ITU-T Y.4901 (2016)	2016	Key performance indicators related to the use of information and communication technology in Smart sustainable cities
UN IAEG SDG 11+ (2016)	2016	Sustainable Development Goal 11+ monitoring framework
U4SSC KPIs for smart sustainable cities	2019	Key performance indicators for Smart Sustainable Cities

(Huovila *et al.*, 2019; Wang *et al*., 2022)

Table 3: The frequency and percentage of smart sustainable city indicators in each level of the hierarchy of needs

	Level of needs	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Esteem demand	42	11.7	11.7	11.7
	Physical demand	109	30.4	30.4	42.1
	Safety demand	87	24.2	24.2	66.3
	Self-actualization demand	11	3.1	3.1	69.4
	Social demand	110	30.6	30.6	100.0
	Total	359	100.0	100.0	

self-actualization demand indicators is low. The low number of sustainability indicators of smart cities in the high levels of human needs makes it impossible to evaluate smart cities at high levels of human needs.

Exploratory Case Study: Smart City of Tehran

Tehran is the capital of Iran and the Tehran Province. With the population of approximately 9 million in the city and 16 million in the surrounding metropolitan area, it holds a unique position among Iran's other major cities (Statistical Center of Iran, 2016). The high concentration of population and facilities results in complex issues and problems, such as pollution, traffic, poverty, and unequal access to facilities. The method of urban management contributes significantly to this issue. Using traditional urban management methods like in the past or utilizing new technologies and smart strategies to solve urban problems. To this end, the concept of a smart city and virtual space can reduce problems and aid the real space in Tehran in terms of global connectivity between cities, thereby enhancing the quality of life.

Smart City Approach in Tehran

Three phases (phase zero, phase one, and phase two) are planned for the Smart Tehran program, which is the Municipality of Tehran's primary smart city initiative. Due to internal and external resistance, a lack of proper executive guarantee, a lack of efficient monitoring mechanisms, a lack of citizen participation, and weak inter-organizational partnerships, the projects outlined in the first phase (approximately 54 projects) have not been effective in improving the quality of life. Based on the Smart Tehran vision, Tehran is a city with an ever-increasing quality of life, based on citizens, public and private partnerships, and a place to live a healthy and happy life, with an integrated infrastructure managed by an efficient and economically dynamic urban administration. Strategic objectives of the Smart Tehran program include achieving sustainable urban development, guiding urban innovation and citizen satisfaction, and fostering participation and openness. (Smart Tehran Center, 2019) Consequently, "citizen participation" is one of the central pillars of the smart Tehran program. For this reason, defining a coherent program for citizen engagement and active participation is essential for enhancing social capacities. Each year, the Municipality of Tehran hosts smart programs, plans, and initiatives from various organizations; some of these actions encounter several difficulties, particularly in communicating with people, resulting in the dissatisfaction of citizens and the failure of these actions. From the perspective of Maslow's theory of the hierarchy of needs, this paper evaluates

Table 4: The frequency of Tehran smart city projects in the level of the hierarchy of needs

Hierarchy of needs in smart initiatives	Frequency of each need in Districts 1-22
Physical demand	54
Safety demand	8
Social demand1	19
Esteem demand	11
Self-actualization demand	6

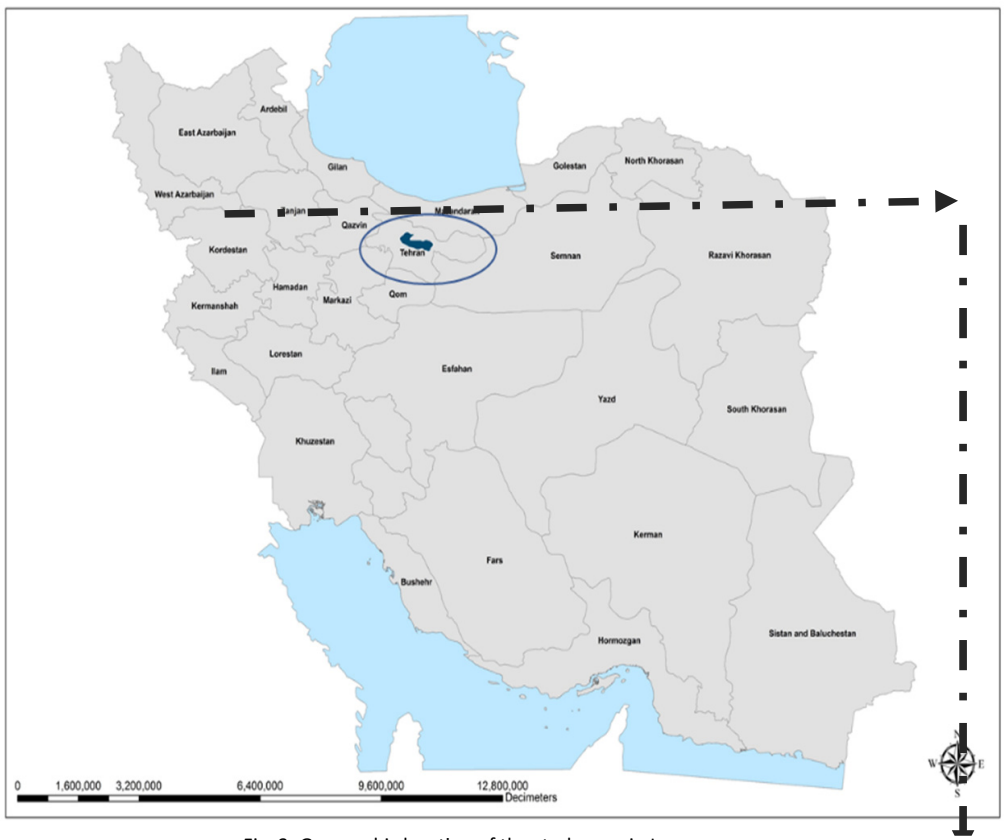

Fig. 3: Geographic location of the study area in Iran map

the smart city projects of Tehran Municipality based on five levels: physiological, safety, social, esteem, and self-actualization demands, in order to meet the various levels of citizen needs. As shown in Table 4, most projects are associated with the physical demand of human needs and smart city infrastructure.

The geographic location of the study area in Iran map is shown in Fig. 3. The distribution of the smart projects in the 22 districts of the Tehran Municipality is an additional important aspect of these projects. As depicted in Fig. 4, each region has projects addressing varying degrees of human needs. The lack of effective evaluation and performance assessment models to demonstrate the smart cities projects implemented in 22 Tehran districts is the primary obstacle in how projects respond to human needs.

RESULTS AND DISCUSSION

Analysis of the contexts and requirements for Tehran smart city implementation

Information regarding smart projects implemented in 22 districts of Tehran in 2020 and smart

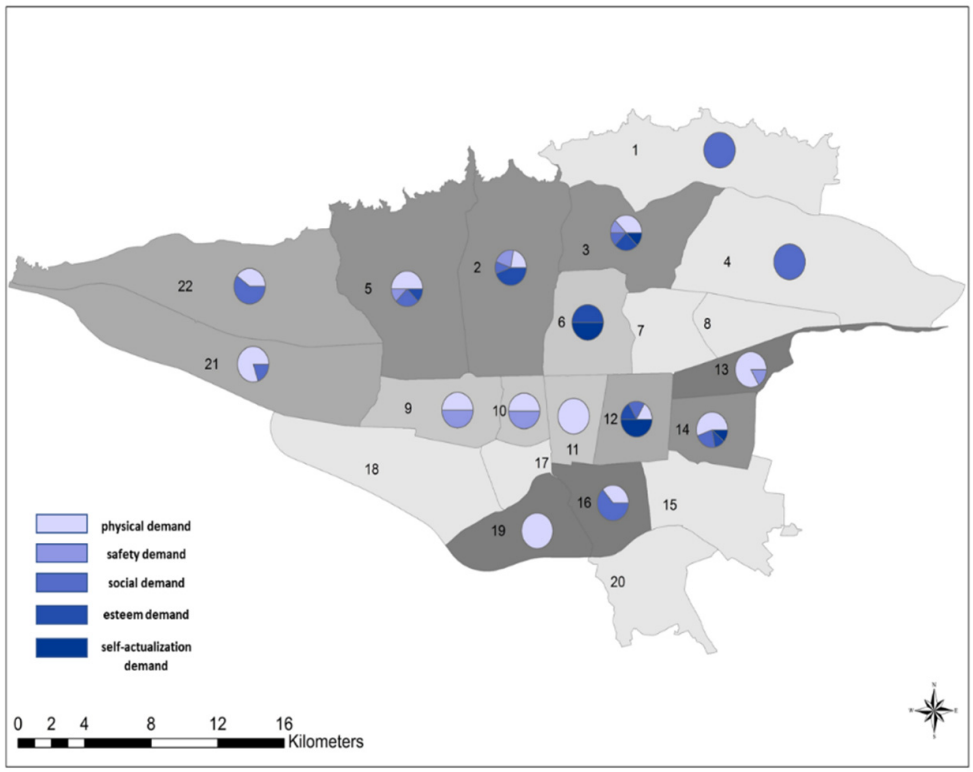

Fig. 4: Smart cities implemented projects in 22 districts of Tehran from the perspective of Maslow's hierarchy of needs

city indicators are analyzed in this study from the perspective of human needs. Based on the hierarchy of needs, Tehran smart city project's strengths, weaknesses, opportunities, and threats were evaluated using SWOT analysis. The SWOT analysis matrix is shown in Table 5. Thus, SO strategies (aggressive strategies) utilize strengths and are opportunities to capitalize on opportunities. ST Strategies (diversification) utilize the strengths to avoid potential threats. WO Strategies (review strategies) take advantage of opportunities to reduce weaknesses, whereas WT Strategies (defensive strategies) reduce vulnerabilities and avoid the threats indicated in Table 5 (Pourahmad *et al.*, 2013). A weight or coefficient is assigned to the external and internal factors crucial to achieving the objectives. In the subsequent step, the matrices from the second phase were compared, and the strategies the system will adopt and implement were determined. The top row of the strategic planning matrix lists these strategies. Then, strategies are ranked in order of importance based on their scores (Mohebbi *et al.*, 2020).

As shown in Table 6, the weighted score of the opportunities equals 2.26, indicating the dominance of potential opportunities that necessitate strategies to realize these capacities. Overall, 2.2 weighted strength and weakness scores indicate that the internal environment dominates the external environment. SWOT analysis was used to develop four types of strategies that can be used effectively to define strategic principles after selecting and evaluating the most important internal and external factors and identifying relationships between internal and external features. For example, strong interactions between strengths and opportunities (SO) can represent favorable conditions for the development of smart cities in Tehran and allow for the use of aggressive strategies. On the other hand, strong interactions between weaknesses and opportunities (WO) could be analyzed as a potential for using review or overview strategies. Furthermore, strong interactions between weaknesses and threats

Table 5: SWOT analysis in the smart city of Tehran based on the hierarchy of needs

Internal factor evaluation matrix			STRENGTHS	Weighted score
	1	S1	Capital of Iran and the largest city in the country	0.1
	2	S2	The high number of innovation-based acts and rules	0.2
	3	S3	Access to advanced modern technologies: sensors, devices, and measuring instruments	0.1
	4	S4	The high number of video surveillance cameras for monitoring road traffic	0.1
	5	S5	Willingness and culture to use information technology	0.2
	6	S6	Information platforms and electronic services for citizen participation	0.1
	7	S7	The specialized knowledge of the private sector in the production of electronic systems and the enhancement of the technological level	0.1
	8	S8	The existence of unique qualities and potential for each neighborhood in Tehran	0.1
			WEAKNESSES	Weighted score
	1	W1	Lack of sustainable infrastructure and environment	0
	2	W2	Lack of free Wi-Fi coverage in streets and public places	0
	3	W3	High project costs and lack of inter-organizational communication with foreign companies due to sanctions	0.1
	4	W4	Lack of public awareness of the project's advantages	0.1
	5	W5	Vulnerability to cyber security threats and insecure data storage	0.1
	6	W6	Lack of resources, especially highly qualified human resources	0
	7	W7	Lack of active innovation centers	0.1
	8	W8	Lack of integration in Tehran Municipality's existing systems	0
	9	W9	Lack of suitable and reliable statistical system	0
	10	W10	High unemployment and poverty rate in Tehran	0.1
	11	W11	Neglecting Tehran's most pressing problems and challenges in smart city projects	0.1
	12	W12	Lack of physical and mental healthcare services, including telemedicine, sustainable infrastructure, and environment	0
	13	W13	Neglecting inclusive ICT education	0.1
	14	W14	Weakness in crisis management and innovative methods of city flexibility	0
	15	W15	Lack of equal access to affordable ICT services and facilities	0.1
External factor evaluation matrix			OPPORTUNITIES	Weighted score
	1	O1	Expertise and human resources in the field of ICT	0.4
	2	O2	The potential for transforming older structures into innovation and technology centers	0.3
	3	O3	The possibility of using the social capacities of the neighborhoods (councils, N.G.O.s, Sarai Mahalat, and others) to increase people's participation	0.4
	4	O4	The concentration of top Iranian universities in Tehran	0.3
	5	O5	The potential for cooperation and partnership with innovative and creative information technology companies	0.2
	6	O6	Appropriate medical equipment and a large number of specialists and doctors	0.3
	7	O7	High investment opportunity in the development of the urban district of Tehran	0.4
			THREATS	Weighted score
	1	T1	Lack of investors	0.1
	2	T2	Cyber security threats and vulnerabilities of the city's integral information system	0.2
	3	T3	Outdated planning system	0.1
	4	T4	Aggravation of transportation problems	0.2
	5	T5	Increased environmental pressures	0.1
	6	T6	Instability of management in the field of smart city	0.1

Table 6: Factors analysis of Tehran

Factors	Weight	Score	Weighted score
Strengths	65	26	1.18
Weaknesses	116	23	1.02
Opportunities	57	27	2.26
Threats	41	8	0.58

Table 7: The Strategies prioritization by QSPM matrix for smart city developments in Tehran

No	Strategies	Factors	Total score
WO8	Promoting innovation centers and living labs to create a vibrant public realm, active and healthy lifestyle	O5O4O2O1W7	1.323
SO3	Involve stakeholders and focus on people and consider urban residents not only as recipients or users of smart cities but also as designers of smart cities	S5S6S2O3	1.075
SO8	Promote community involvement in council decision-making by developing interactive platforms	S6S2O3O5	0.884
SO4	Promote social participation in all the smart cities project processes	S5S6O3	0.711
WO10	Considering the main challenges of cities and stakeholders' preferences for designing and planning smart city initiatives	W11O5O3	0.684
ST2	Show that the analysis will be reported to stakeholders and discussed with them, and show the basis on which it may be considered accurate and honest.	S2S5S7S6T3	0.673
WT2	Do not exaggerate - when defining smart city initiatives, consider financial and specialized resources	W1W3W6W9 W10T6T1T4T5	0.66
SO2	Make the city more responsive to the public and open it up to the public by utilizing data and analytics	S4O1	0.568
WO6	Manage cyber attacks, information infrastructure, and data needed to prevent and manage cyber attacks	W5O1	0.568
SO1	Promoting efficient energy infrastructure by transforming utilities, manufacturing, transportation, energy, and waste treatment sectors to reduce the carbon footprint and greenhouse gas emissions for a cleaner, healthier environment	S3S7O5	0.535
SO7	Enable benchmarking of regions and neighborhoods across cities to expand the competitive atmosphere in cities	S8O7	0.522
SO6	Create opportunities for people to personalize places with artificial intelligence, augmented reality, and virtual reality	O1S1	0.494
WO1	Improve healthy life through increasing access to physical and mental healthcare services, including telemedicine, integrated health information systems, and ambient assisted living	O1O6W12	0.482
WO2	Develop an inclusive education to provide education for all resident's ages, gender, culture, and status	O1W13	0.467
WO5	Responding to damages related to information infrastructure and data needs to prepare for damage reduction and rapid response to emergencies occurring in the city	W14O1	0.439
SO5	Enhance community identity by providing new technology to heritage and historical sites	O2S7	0.435
WO3	Prevent traffic offenses, road violence, and accidents by supporting smart mobility and ITS infrastructure	O5W11W1	0.435
WO7	Promote social justice and equity by providing equal access to affordable digital services and facilities	O7W15	0.422
ST1	Define a clear, transparent, and accountable framework for the engagement process in line with authority, proposed timeline, targeted objectives, expected outcomes, and others	T3S5	0.33
WO9	Strengthen entrepreneurship and support start-up businesses to improve an inclusive, equitable economy	W10O5	0.306
WO4	E-Government implementation providing all eligible public services through digital channels and targeting full digital adoption	W8O5	0.299
WT1	Improve cross-departmental coordination and data-sharing to deliver optimized experiences	T6W8	0.096

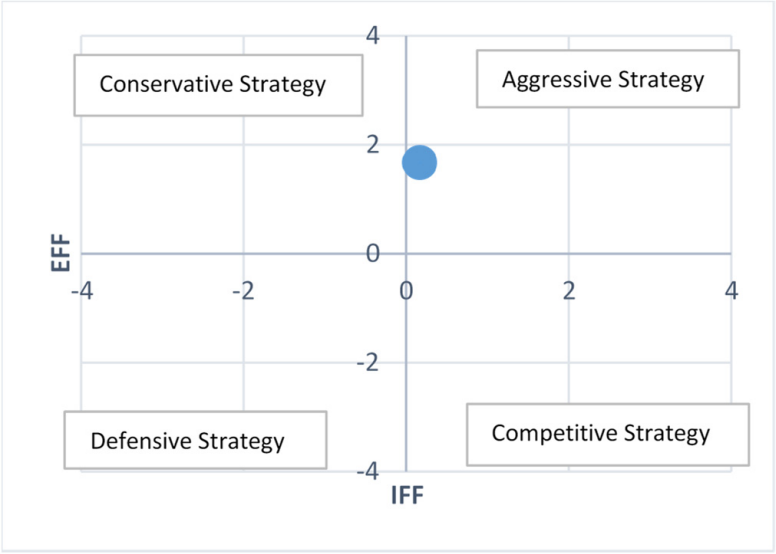

Fig. 5. Position of smart city strategies in Tehran

(WT) could be interpreted as a potential warning and recommendation to employ defensive strategies. In addition, strong relationships between strengths and threats (ST) allow for the use of a variety of strategies. Table 7 displays the results of this stage. As shown in the SWOT matrix in Table 5, key strategies for smart city development in Tehran were identified through pairwise matching of SO, WO, ST, and WT. The SO strategies proposed opportunities that were complementary to Tehran's strengths. The best SO strategy was the "involvement of stakeholders and considering people not only as users of smart cities but also as designers of smart cities." The ST strategies identify methods for reducing vulnerability to external threats. "Being transparent - demonstrate the basis on which the analysis may be considered accurate and honest" was the best ST strategy realized. The WO strategies identify ways to overcome weaknesses in order to identify opportunities. This study identified the best WO strategy as "Promoting innovation centers and living labs to create a vibrant public realm, active and healthy lifestyle." The WT strategies establish a defensive strategy to prevent the wetland's flaws from making it vulnerable to external threats. According to Table 4, the best WT strategy was "improving cross-departmental coordination and data-sharing to deliver optimized experiences." Table 7 shows the details of the results. The QSPM analysis was performed to provide additional principles for smart city developments in Tehran and classify strategies based on priorities. Based on the final results of the QSPM analysis (Table 7), the following ranking can be obtained. The best strategy for smart city development in Tehran, according to the QSPM results, was WO8 (promoting innovation centers and living labs to create a vibrant public realm active and healthy lifestyle) (Table 7). Following that, two other important strategies are SO3 (Involve stakeholders and focus on people, and consider urban residents not only as recipients or users of smart cities but also as designers of smart cities;) and SO8 (Involve stakeholders and focus on people and consider urban residents not only as recipients or users of smart cities but also as designers of (promote the community involvement in council decision-making by developing interactive platforms). The results are shown in detail in the. Fig. 5 depicts the position of smart city strategies in Tehran, which are classified as Conservative or Aggressive. It demonstrates the significance of the internal environment. The alignment of strategies with the goal is shown in Fig. 5. Moreover, the implementing principle for smart city development in Tehran is defined by the featured strategies via QSPM. These principles are primarily concerned with social sustainability. Table 8 depicts the application of smart city principles for the smart city of Tehran based on Maslow's hierarchy of needs.

The implications of this study directly address a

Table 8: Smart city implementation principles for Tehran smart city based on Maslow's hierarchy of needs

Human needs	Smart cities Needs	Principles
Physiology	Smart city infrastructure	• Connecting communities by equipping households with internet and wireless broadband coverage • Transforming utilities to promote efficient energy infrastructure • Improving city services and broadening public access • Promoting the Tehran City Council's crowdsourcing network through well-known institutions
Safety	Reliable and resilient city	• Defining the security and safety attachment for each Tehran smart city initiative, with safety as the foundation of smart city plans • Enhancing the information and data infrastructure needs to prepare for damage reduction for responding to damages and crises • Enhance public supervision through the usage of artificial intelligence and digital technologies
Belonging	Smart collaboration cities	• Increasing transparency and accountability framework for citizen engagement • Providing equal access to public services through digital services and facilities • Promote social participation in all steps of smart city processes • Equipping heritage and historic places with new technology and creating an innovative identity
Esteem	Recognized smart communities	• Benchmarking of the 22 districts of Tehran and neighborhoods to expand the competitive atmosphere • Develop an inclusive education to increase knowledge and capacity of smart citizen's rights for all residents' age, gender, culture, and status • Capacity building at the local level to develop smart city strategies and attract people's participation in all areas of Tehran
Self-actualization	Smart vision	• Using artificial intelligence, augmented reality, and virtual reality to beautify places • Promoting innovation centers and living labs to Create a vibrant public realm, active and healthy lifestyle • Defining a realistic vision by considering financial and specialized resources in defining smart cities projects

gap in the literature regarding implementing a smart sustainable city from a social perspective. Despite the advances in smart city indicators, these lack the ability to strategize and operationalize social sustainability principles in an integrated way, which requires interaction between all dimensions of smart cities. For example, Zhang *et al*. (2019) evaluate the level of smart city construction in five hierarchies of needs, but less attention has been given to the definition of strategic principles to improve the level of needs that, smart cities are capable of responding to. Citizen participation is essential to implementing smart sustainable cities, so Bouzguenda *et al*. (2019) propose a hierarchical model that connects sustainable cities with citizen participation in digital media. But indicators or principles relating to socially sustainable smart cities are ignored. The present study covers the shortcoming of Strategizing and operationalizing principles, particularly in the field of sustainability, in smart cities. These results add a few significant insights to Tehran's existing smart city implementation frameworks. Smart cities and sustainability are characterized by practical elements, standards, indicators, and sub-indicators, but fewer include socially oriented and implementing principles. In this paper, a new set of implementing principles for smart cities, citizens, and civic organizations is presented in order to aid in the focus on social sustainability in smart cities by researchers, policymakers, and planners.

CONCLUSION

This paper aimed to "define the implementing principles for Smart Cities in Tehran as a social construct through a descriptive-analytical approach." The current study's academic merit is that it developed a policy framework for smart cities in Tehran by emphasizing social sustainability and citizen needs perspectives, which have often been overlooked in smart city research. An in-

depth study of the existing literature and an examination of Tehran's internal and external environments were conducted to identify the city's strengths, weaknesses, opportunities, and threats to becoming a smart city. This study proposes principles for implementing smart city transition in Tehran. Furthermore, these principles suggest social sustainability requirements in smart cities for developing a social-centric strategic plan. It also addresses the following questions: Does Tehran meet the basic needs of its citizens? Is Tehran bridging the gap between basic needs and deeper engagement? According to the literature review, reviewing the sustainable city indicators focuses on sustainability assessments, while implication indicators, particularly in the field of social sustainability, are ignored. As a result, this study attempted to define implementing principles for the development of smart cities in Tehran. The 359 indicators were then matched to the five levels of the need's hierarchy. Most indicators are concerned with physical, social, and safety demands. The low frequency of indicators in high levels of Maslow's hierarchy of needs makes evaluating smart cities at high levels of human needs impossible. The case study method was used in this paper to investigate and analyze smart city projects in Tehran. This analysis revealed that most needs are at the basic level, and adequate attention has not been paid to higher levels of human needs. Furthermore, a spatial analysis of Tehran's 22 districts reveals that different areas of Tehran respond to varying levels of human needs, and the level of these projects varies according to the socioeconomic and local conditions in each region of Tehran. Consequently, future policies must consider each district's unique capacities and conditions. As a result, smart city principles based on social sustainability were compiled in Tehran using SWOT and QSPM analysis methods. Tehran has planned to become smart, but it appears its plans are neither realistic nor strategic. It does not appear to satisfy either policymakers or citizens. To include citizen perspectives in Tehran's smart city plan and policies, principles, and strategies based on social sustainability are required. Compared to good practices of sustainable smart cities indicators, the smart cities principles proposed for Tehran provide a clear horizon and systematic guide through social sustainability analysis in Tehran. The current study adds a few significant insights to Tehran's existing smart city implementation frameworks. This paper adds to our understanding of how cities like Tehran can achieve and implement social sustainability using a smart city approach. One significant limitation of our work is that the application of Maslow's theory of the hierarchy of human needs to respond to societal demands appears individualistic and subjective. Regardless of the ambiguity surrounding the Classification of Human Needs, the hierarchy of human needs should be viewed as a starting point for discussing social sustainability in a smart city. Future research may examine Maslow's theoretical framework in greater depth in conjunction with other aspects of smart cities, such as urban governance and developing human needs in response to the specific needs of smart city actors. As a result of the Social Smart City framework, digital strategies for citizen engagement in smart cities can be refined. In this framework, various digital strategies for citizen engagement in smart cities are described. Although the framework provides a refined approach to social strategies for smart cities, it should also be used as a tool to implement smart city initiatives. It is possible to add other strategies that are not already included in this overview. This framework could be adapted into a benchmarking tool for smart social cities in the future. Based on the findings of the current study, it can be concluded that Tehran can define a framework for citizen engagement that is transparent and accountable. In addition, it is suggested that promoting innovation centers and living labs is necessary to create a vibrant public realm and an active and healthy lifestyle. Consequently, developing a realistic vision for smart cities in Tehran by considering financial and specialized resources for smart city projects is the key to achieving reliability and resiliency. There have been few studies conducted in recent decades that have focused on the feasibility and operationalization of smart cities, and of those few that have, they were conducted based on the positivist paradigm, which ultimately led to either confirming or rejecting the research hypotheses. One of the most important knowledge gaps in smart cities involves the absence of a critical perspective that can explain a comprehensive framework built upon pragmatism and quantitative and qualitative approaches. This research seeks to determine

the principles for the realization of smart cities in Tehran with a social approach. For future research, it is suggested that the representation of social qualities of urban design in smart cities should be investigated. Also, the processes and procedures for developing smart cities at the neighborhood scale are highly recommended.

AUTHOR CONTRIBUTIONS

M. Behzadfar developed the idea of this study; designed, analyzed, and interpreted the data. While L. Tavanaei Marvi worked out the literature review and compiled the data and formatted the manuscript. M. Mofidi Shemirani helped in the literature review, analyzed, and interpreted the data. M. Behzadfar and L. Tavanaei Marvi contributed to the manuscript preparation and performed some of the remaining work like the formatting of the manuscript and placement of maps.

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CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest in the publication of this work. Furthermore, the authors observed ethical issues such as plagiarism, informed consent, misconduct, data fabrication or falsification, double publication and submission, and redundancy.

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ABBREVIATIONS (NOMENCLATURE)

EFE	External Factor Evaluation
EI	Environmental Indicators
ICT	Information and Communications Technology
QSPM	Quantitative Strategic Planning Matrix
RFSC	Reference Framework for Sustainable Cities
SAFE	Sustainability Assessment by a Fuzzy Evaluation
SO	Strengths and Opportunities strategies
ST	Strengths and Threats strategies

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