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An approach to define smart sustainable urbanism locally through expert's perspective

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ABSTRACT

The attainment of smart urbanism and sustainable urbanism are amongst the most prevalent topics in international urban research. Different communities are likely to promote slightly, or even significantly, varying understandings of smart sustainable urbanism, depending on their local circumstances and the value judgment of the community. Using a quantitative methodology, this study employs surveys to examine the definition of smart sustainable urbanism in Bahrain through the perspective of specialists in the built environment. Indicators listed under the ISO 37120:2018 and ISO 37122:2019 standards were evaluated. The results indicate that sustainable urbanism and smart urbanism are of equal importance to the perspective of specialists in Bahrain. Wastewater, water and population and social conditions were the top-rated themes in both standards. Sports and culture, economy and recreation were the least rated themes. The findings revealed a linear relationship between the themes as identified by the specialists and Maslow's hierarchy of needs. The study presented an arranged performance assessment indicators list to report on smart sustainable urbanism in Bahrain. The study further offers a novel methodology that is suitable for adoption elsewhere in the world, in countries that aim to define or redefine smart sustainable urbanism locally to achieve smart sustainable development targets.

Keywords: smart sustainable urbanism; quality of life; smart cities; performance assessment; indicators

Introduction

There are today tens of city initiative variations that are used in urban policy, design and planning discourses: sustainable cities, ecological cities, green cities, digital cities, smart cities, information cities, intelligent cities, knowledge cities, eco-cities, zero and low carbon cities, resilient cities, liveable cities and even some combinations of those such as sustainable liveable cities, resilient eco-cities, eco low carbon cities, sustainable low carbon cities and many more. The research stressed on the need for a rigour use of these terms to comprehend their implications on urban regeneration practices and development policies. The literature highlighted that the "sustainable city" is the most frequently used terminology; it is also the largest and the most interconnected [1]. The recently established narrower concepts of the ecological city and the smart city have also been gaining popularity in the literature. The smart city concept, in particular, appears to have become an essential idea in urban modernization policies. The literature highlighted that the two concepts of Smart Cities and Sustainable Cities in particular needs to be understood in relationship to each other [2].

The change in the 21st-century urbanization prototype offers a unique set of opportunities for making a city smart. The century endorsed a move from sustainability assessment to smart city goals [3]. Discussions on smart and sustainable cities are increasingly influencing debates about the future of urban developments around the globe. Nevertheless, despite numerous examples of what makes a city smart or sustainable, we know surprisingly little about so-called smart sustainable urbanism because of its lack of definitional precision, and an underlying self-congratulatory tendency. New technological advances installed a massive change in the way both smart and sustainable cities are understood and studied and how they are organized, planned, design, operated, managed and governed in an era of accelerating urbanization [4]. The smart city concept and its associated technology initiatives prove to be a catalyst for improving the quality of life for citizens in urban areas. Such interventions enhance the digital intelligence of urban infrastructure, economy, social capital, environment and various other dimensions of the city, thereby boosting the citizen's interaction with their urban environment.

The objective of the smart city implies much more than the definitions of digital cities, intelligent cities and informative cities; because it reviews technologies as a smarter way to help people live better life's and make cities work more efficiently. Urban Sustainability aims at achieving environmental, social, economic, political and cultural efficiency. The notion encourages the use of locally available resources and digital innovations that creates adequate, resilient and sufficient cities, which is a part of the smart city agenda. Although there is a clear relationship between smart urbanism and sustainable urbanism, the literature highlighted the gap between the smart city and sustainable city definitions and frameworks and presented a need to develop local understandings of smart sustainable urbanism depending on the specific circumstances and value judgement of the local community [5, 6]. This research, thus, presents a methodology to define and set performance assessment tools for smart sustainable urbanism locally using two ISO standards. The investigation employs a quantitative methodology using two extended surveys that are administered to experts in fields related to the built environment to identify the most important themes and key indicators needed to measure the smartness and sustainability of the local urban environment and to determine how professionals conceive Smart Sustainable Urbanism in Bahrain.

Literature Review

Adopting Smart Urbanism to achieve sustainable liveable communities

The concept of smart cities offers a new conceptualization for the implementation of sustainable principles in urban design [7]. Through utilizing intelligence applications and technologies, smart cities incorporate socio-economic factors to transform life in urban areas. In an attempt to develop, plan and implement strategies and initiatives towards the goal of achieving smarter living. Many countries and cities are today analyzing what it means for them to be "smart" [8, 9]. Since the end of the twentieth century, the literature suggested that a 'communicated centric society' can be achieved through the 'information highways' in our future urbanism that will be created through the utilization of the unparalleled amount of information data that we will obtain from various subjects such as households and businesses [10]. Another pioneer to the smart city initiative is the 'digital

city'; a technologically defined city that utilizes a widespread of broadband infrastructures to support e-Governance and a global environment for daily public transactions [11]. Research showed that while urban sustainability agendas contained a large number of indicators gauging environmental sustainability, smart city initiatives lacked environmental indicators and focused on social and economic aspects [12]. The literature recommended the use of the term "smart sustainable cities" instead of smart cities [12] to describe technologically enabled urbanism that is planned and designed in line with the five pillars of sustainability: the social, cultural, economic, political and the environmental. The literature also highlighted that there is a gap between smart city and sustainable city definitions and frameworks [13]. It further stressed on the need to develop more robust and defined smart city frameworks that will not only use output indicators to measure the efficiency of developing smart solutions but also impact indicators that gauge the contribution towards ultimate goals such as cultural, political, environmental, economic or social sustainability [12].

What makes urbanism smart and sustainable?

There is still no agreement in practice on what Smart Sustainable Cities mean. Yigitcanlar (2018) presented a 'more than human' definition of smart sustainable urbanism; *"Smart and sustainable city is an urban locality functioning as a healthy system of systems with sustainable and balanced practices of economic, societal, environmental and governance activities generating desired outcomes and futures for all humans and non-humans."* The research highlighted that current smart city efforts are not proper to resolve the challenges of the Anthropocene epoch; an urban environmental buzz word that scientists proposed as the latest geological epoch in the early 2000s. The epoch is characterized by human devastating activities and impacts on the geology of earth. The research stressed on the importance of smart sustainable urbanism initiatives to avoid imminent urban ecocide and to move towards Post-Anthropocentric urbanism [14].

The 21st century witnessed a shift from sustainability assessment to smart city goals. There is, however, no clear definition of what constitutes a "smart" or "sustainable" urban environment [3]. Both terminologies benefit from the international debates on the different definitions and meanings of sustainability and smartness [15]. The literature indicated that different societies should develop slightly, or even significantly distinctive understandings of smart sustainable urban forms depending on their local social, cultural, economic, political and environmental circumstances and the value judgement of the local society [5, 6].

The literature highlighted that economic competitiveness and innovation that is achieved through the knowledge-based economy marks a city as intelligent, allowing it to generate a competitive spatial advantage through other regions, industrial districts and clusters [16]. A number of pillars were identified to judge the level of urban smartness and sustainability of cities including smart economy, smart people, smart governance, smart environment, smart mobility and smart living [17, 18].

The literature emphasized that smart sustainable city initiatives are successful only when all stakeholders including citizens can interact with each other and play an active role in making the concepts of the smart

sustainable city possible [19]. The ideologies of the smart sustainable city should be sensitive enough to maintain an equilibrium between the various needs of different stakeholders in the community. Smart sustainable city initiatives should, thus, not be limited only to the understanding of local lawmakers, governance populists and enthusiasts. Planning smarter and more sustainable should have a real significant impact on the quality of life of the city inhabitants.

A smart sustainable city with no doubt, thus, needs smart and conscious citizens. A smart city is one that emphasizes the Smart Citizen rather than on the implementation of smart technologies [20]. There are currently many measures taken to inform city inhabitants on how to use the abundance of public information and the processes governing their community and its supporting infrastructure [6]. Citizens are today also encouraged to explore how they can become actively involved in the design and planning process of their communities. Their involvement could take place both in situ or remotely using data, scenarios and models that are informed by the vast information collected from the urban environment and communication technologies [21].

Nevertheless, smart city ideas are, without a doubt, still invisible to many sections of the society despite the importance of the involvement of all relevant stakeholders in the development and implementation of such initiatives. Smart cities are about the various aspects of life from the daily routine chores to the highly sophisticated city planning responsibilities. Smart city initiatives should be about the sharing and availability of information at the fingertips of everyone involved in the making and using of the city.

Measuring Smart Sustainable Urbanism

Setting sustainability indicators have been proven to be the best technique for driving smart sustainable urban development. Literature suggested that the number of indicators selected and the format for presentation should vary according to the targeted stakeholders: scientists, evaluators, non-governmental organizations, the general public or policymakers [22]. Research has also shown that a framework of indicators can be useful to develop qualitative and quantitative descriptors of urban environments [23].

City planners, designers, managers and lawmakers need indicators for target setting, performance assessment, administration, monitoring and decision-making purposes. The choice of the most appropriate set of indicators is important, however difficult, as it requires expertise, specific knowledge and the availability of data [24]. Indicators should provide measurable and straightforward evidence that experts can use to create and maintain healthy and technologically enabled urban environments that are economically viable. Indicators should provide [25]:

· Explanatory tools that translate concepts into implementable actions
· Pilot tools to evaluate policy-making procedures
· Performance assessment tools to evaluate the efficiency of various implementation efforts.

This study focuses on the third and presents a methodology to define smart sustainable urbanism locally using a set of indicators to assess performance in 19 themes identified by two ISO standards.

The role of statutory law-making bodies and professionals

A smart sustainable city is an outcome of efforts put forward by various stakeholders. Surveying stakeholders' perceptions to define KPIs related to the attainment of Smart Sustainable Urbanism is a method that has been used in the literature. See, for example, the works of [26-28]. Statutory law-making bodies play a vital role in the process of developing smart sustainable communities through setting the required guidelines and procedure's and making sure that mitigation plans, corrective measures and implementation actions are being carried out thoroughly.

Research indicated that the impact of development becomes enormous when the government is actively involved in growing smart sustainable city initiatives [29]. Furthermore, the literature presented a need to look at e-governance from a different perspective. For a long time, e-governance literature was dominated by specialists who are from the information technology and computer science backgrounds. Nevertheless, today's challenges concerning the development of both smart and sustainable communities require us to take a departure and look at e-governance from a broader perspective. E-governance needs to be assessed from an urban domain specialist viewpoint, for example: specialists in urban development, urban design and planning, climate change, carbon accounting, energy and water governance, and public realm [30]. Thus, this paper attempts to investigate the perception of experts in the built environment and related fields to define smart sustainable urbanism locally and to identify the most important themes and key indicators needed to measure the smartness and sustainability of the local urban environment.

Local perspectives on Smart Sustainable Urbanism

The increased focus on the need to diversify the economy into anon-hydrocarbon sectors and the ongoing decline of oil price pushed the Gulf cooperation Council (GCC) countries to initiate and develop smart city plans. Digital tools and technologies are today being used to improve public services and to boost trade and tourism [31]. The literature identified several challenges to achieving smart sustainability in the Arab Region. The barriers included a) the need for advanced technology infrastructure and policies to ensure functioning and administration transparency b) the high levels of adult illiteracy and the lack of public political participation c) the limited reliability and validity of data because of the inadequate collection methods that are of utmost importance for decision-making d) Bounded rationality that negatively impacts the planning process. The literature further highlighted that attempts to implement smart sustainable urbanism solutions in countries of the illiterate and impoverished majority could cause social segregation, loss of public space and a dysfunctional democracy [32].

Since the launch of Bahrain's 2030 vision in 2007, the government focused on attaining sustainability. The focus in the country's vision was, however, very much economically driven. The detailed implementation plan that was completed in 2010 highlighted several aspects related to social and environmental sustainability that the government aspires to achieve through its new vision. The drawback of the implementation plan was the lack of national cadres that are capable of the implementation [33]. Today, the government in Bahrain is encouraging through its various initiatives the attainment of smart sustainable urbanism. For example, Bahrain focuses today on renewable energy and e-governance. There is also more attention in recent years on the devastating environmental

impact of urbanisation. The attention sought immediate governmental actions such as the establishment of the Supreme Council of the Environment and the enforcement of a number of environmental laws, guidelines and regulations.

Bahrain needs a clear definition of smart sustainable urbanism and a set of indicators that govern and monitor the process of digital transformation. Local municipal innovation and information technology corporation in collaboration with urban planning are the two areas that hold importance in future smart cities. Saxena and Al-Tamimi (2018) showed that while IT-led "smart city" initiatives that are deployed by the GCC countries, a roadmap should be set to answer the concerns of various stakeholders to ensure sustainable results.

Research Methodology

Literature indicated that communities focusing on becoming smart and sustainable should consider following ITU 4901 or ISO 37122 indicators [34]. The ISO 37122 is broader in scope than the ITU 4901, and it includes some additional environmental and social impact indicators. The literature suggested that when there is a need to report real impacts, the suitable standards are the UN SDG 11+ and the ITU 4902 indicators. Alternatively, if it was of more importance to also repost on the immediate implementation of policy measures, then the ISO 37120, ETSI 103463 or the ITU 4903 are more suited [24]. Thus, this research defines Smart Sustainable Urbanism for Bahrain using two of the latest standards published by the International Organization of Standardization (ISO) as a guideline:

· The ISO 37120:2018 sustainable cities and communities — indicators for city services and quality of life and
· The ISO 37122:2019 sustainable cities and communities — indicators for smart cities

Each standard is built around 19 themes, and each theme specifies a number of indicators to measure the smartness and sustainability of communities: 102 indicators for city services and quality of life and 80 indicators for smart cities totalling to 182 indicators for smart sustainable urbanism. This study uses surveys administered to professionals working within fields related to the built environment in Bahrain (with 95% confidence, n=149, and E= 8%) to rate, using a five-point Likert scale the importance of the indicators listed under each of the themes in the two standards. The participants came from several backgrounds: Architecture, Landscape, Interior Design, Urban Design and Planning, Engineering, Building Technologies, Environmental Planning and Real Estate.

The results were analysed to define what experts in Bahrain think core indicators should be to report on the achievement of smart, sustainable urbanism locally. The study presents a new methodology that could be used internationally by policymakers to priorities and select the indicators needed to assess the smartness and sustainability of their communities.

The total percentages numbers were normalised with the number of indicators in each theme to align the entire adjusted values for comparison purposes. It is worth mentioning here that the indicators were used in the administered survey to obtain the specialist's opinion on their importance locally and also to instruct the participants on what each theme included.

Many varying interpretations in the literature examined Maslow's hierarchy of needs in relation to urbanism, see, for example, the works of [35-37]. Thus, the themes of the ISO standards were mapped to Maslow's hierarchy of needs and were examined alongside the results of the administered survey to identify relationships.

Research Findings and Discussion

The findings of the study showed that overall, the participants average ratings to both the indicators for city services and quality of life and the indicators for smart cities was similar, (83% average importance to all indicators) as seen in Table 1 Given that the two sets of indicators were administered in two separate surveys, the findings imply that professionals working in fields related to the built environment in Bahrain understand the importance and value behind designing, planning and monitoring sustainable interventions to ensure proper quality of life in urban areas, as well as acknowledge the impact of using smart technology applications to attain sustainability. Table 1 shows both sets arranged based on their level of importance, the average percentage of the two and the differences. The table demonstrates that a few themes were rated similarly in both sets: housing, energy, and solid waste. The majority of themes had a slight variation between the two sets of indicators (1-4 points); population and social conditions, health, urban/local agriculture and food security, economy, water, environment and climate change, urban planning, sport and culture, finance, wastewater, safety, and transportation. Furthermore, a few themes had a more substantial variation (5 or more points); recreation, education, governance and telecommunication.

Table 1. The ISO 37122:2019 Sustainable Cities and Communities — Indicators for Smart Cities and Indicators for Smart Cities Themes Arranged Based on Their Level of Importance

Theme	Percentage % City Services and Quality of life	Percentage % Smart Cities	Average Percentage %	Difference
Wastewater	90	86	88	4
Water	88	86	87	2
Population and social conditions	86	87	87	1
Environment and climate change	87	85	86	2
Education	89	82	86	7
Housing	86	86	86	0
Energy	85	85	85	0
Solid waste	85	85	85	0
Urban Planning	83	85	84	2
Safety	82	86	84	4
Health	84	83	84	1
Transportation	85	81	83	4
Urban/local agriculture and food security	83	82	83	1
Governance	78	85	82	7
Telecommunication	78	85	82	7
Finance	79	82	81	3
Recreation	83	77	80	6
Economy	78	79	79	1
Sport and culture	76	78	77	2
Average	83	83	83	3

No more than 7 points difference was found between the two sets for any of the themes. For those indicators, the importance of education was rated higher for city service and quality of life, while both governance and telecommunication were given more importance when reporting on smart city initiatives.

As seen in Table 1, wastewater (90%), education (89%) water (88%) and the environment and climate change (87%) were the top-rated themes under the city services and quality of life set of indicators. The least rated was sport and culture (76%) followed by the economy (78%), governance (78%) and telecommunication (78%). The findings show that the highest-rated themes under the set of indicators for smart cities are the population and social conditions (87%), housing (86%), safety (86%), wastewater (86%) and water (86%). The least rated were recreation (77%), sports and culture (78%) and the economy (79%). It appears from the data presented here that the local specialists' perspective is that wastewater and water are themes of the utmost importance when measuring both smart and sustainable city initiatives locally. This could be attributed to the fact that Bahrain is one of the world's most water-stressed countries and that up to 30% of the population could face water shortages by 2025 [38].

It is interesting here to note that sports and culture was one of the least critical themes in the perspective of specialists despite the rise in sports and cultures activities and the increasing governmental attention to this theme in recent years [39]. The specialists seemed to be, however, somewhat aware in their ratings of Maslow's hierarchy of needs. Figure 1 shows the ISO 37120:2018 and ISO 37122:2019 themes mapped to Maslow's hierarchy of needs. Many varying interpretations in the literature examined Maslow's hierarchy of needs in relation to urbanism, see, for example, the works of [35-37]. The findings here indicate that there is a linear relationship between the needs as defined by Maslow in his hierarchy and their ratings by experts in relation to their importance in the attainment of a good quality of life and smart cities initiatives. Themes that are related to self-actualization such as sports and culture and recreation were considered the least important by Maslow's model and were also rated lower than others by the participants.

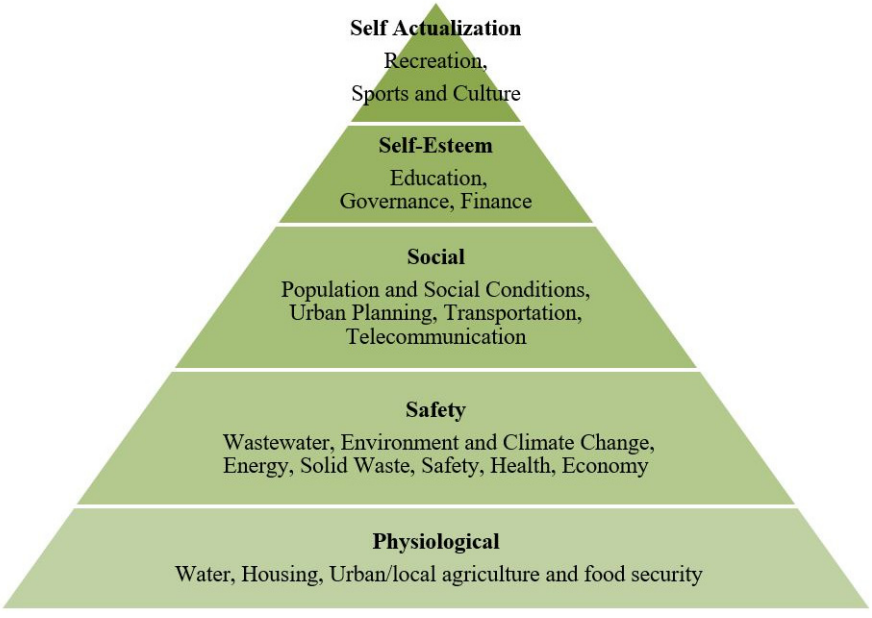

Figure 1. The ISO 37120:2018 and ISO 37122:2019 themes mapped to the Maslow Hierarchy of needs -Adopted from (Maslow, 1943).

Table 2 shows that the highest-rated indicators under the city services and quality of life set of indicators are the percentages of the school-aged population enrolled in schools (92.9%), the percentage of city population living in inadequate housing (92.9%), and the percentage of the population with access to improved sanitation (92.4%).

Table 2. Highest rated themes and indicators to measure smart sustainable urbanism in Bahrain arranged by importance

Standard	Indicator	Importance Rating		
		indicator %	Standard %	Theme %
	Wastewater			
City Services and Quality of Life	Percentage of population with access to improved sanitation	92	90	88
	Percentage of city population served by wastewater collection	91		
	Compliance rate of wastewater treatment	91		
	Percentage of city's wastewater receiving centralized treatment	87		
Smart Cities	Percentage of treated wastewater being reused	93	86	
	Energy derived from wastewater as a percentage of total energy consumption of the city	90		
	Percentage of total amount of wastewater in the city that is used to generate energy	88		
	Percentage of biosolids that are reused (dry matter mass)	84		
	Percentage of the wastewater pipeline network monitored by a real-time-data-tracking sensor system	76		
	Water			
City Services and Quality of Life	Percentage of city population with potable water supply service	92	88	87
	Compliance rate of drinking water quality	90		
	Percentage of city population with sustainable access to an improved water source	89		
	Percentage of water loss (unaccounted for water)	89		
	Average annual hours of water service interruptions per household	86		
	Total domestic water consumption per capita (litters/day)	86		
	Total water consumption per capita (litres/day)	86		
Smart Cities	Percentage of drinking water tracked by real-time, water quality monitoring station	88	86	
	Percentage of buildings in the city with smart water meters	88		
	Percentage of the city's water distribution network monitored by a smart water system	85		
	Number of real-time environmental water quality monitoring stations per 100 000 populations	84		
	Population and social conditions			
City Services and Quality of Life	Percentage of city population living below the international poverty line	92	86	87
	Percentage of city population living below the national poverty line	88		
	Gini coefficient of inequality	78		
Smart Cities	Percentage of public buildings that are accessible by persons with special needs	95	87	
	Percentage of municipal budget allocated for the provision of mobility aids, devices and assistive technologies to citizens with special needs	87		
	Percentage of marked pedestrian crossings equipped with accessible pedestrian signals	86		
	Percentage of municipal budget allocated for provision of programs designated for bridging the digital divide	79		
	Education			
City Services and Quality of Life	Percentage of school aged population enrolled in schools	93	89	86
	Percentage of students completing secondary education: survival rate	91		
	Percentage of students completing primary education: survival rate	91		
	Percentage of female school-aged population enrolled in schools	88		
	Number of higher education degrees per 100 000 population	86		
	Primary education student-teacher ratio	85		
Smart Cities	Percentage of the city population with professional proficiency in more than one language	84	82	
	Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population	83		
	Number of computers, laptops, tablets and other digital learning devices available per 1 000 students	78		

Table 3 shows that the least rated are the number of new patents per 100 000 population per year (72.9%), the percentage of persons in full-time employment (73.5%) and the annual number of cultural events per 100 000 populations (e.g. exhibitions, festivals, concerts) (73.5%). The findings here showed that education, housing and hygiene are to the expert's opinion of the utmost importance when reporting about city services and the quality of life while innovation, the economy and sports and culture were not considered of high importance.

The highest-rated indicators under the themes for smart cities as shown in Table 2 are the percentage of public buildings that are accessible by persons with special needs (95.2%), the percentage of the total amount of plastic waste recycled in the city (94.4%), and the percentage of treated wastewater being reused (92.8%). The least rated as shown in Table 3 are the number of online bookings of cultural facilities per 100 000 population (72.0%), the percentage of public transport routes with municipally provided and/or managed internet connectivity for commuters (73.6%), and the percentage of the city's land area covered by an online food-supplier mapping system (74.4%). The above shows that even when reporting on the attainment of smart cities, specialists identified environmental indicators as a top priority. This highlights the strong relationship between smart city concepts and sustainable urbanism [1].

Table 3. Lowest rated themes and indicators to measure smart sustainable urbanism in Bahrain arranged by importance

	Recreation			
City Services and Quality of Life	Square meters of public outdoor recreation space per capita	86	83	81
	Square meter of public indoor recreation space per capita	79		
Smart Cities	Percentage of public recreation services that are booked online	77	77	
	Economy			
City Services and Quality of Life	City's unemployment rate	90	78	79
	Youth unemployment rate	84		
	Assessed value of commercial and industrial properties as a percentage of total assessed value of all properties	78		
	Commercial air connectivity (number of non-stop commercial air destinations)	76		
	Number of businesses per 100 000 population	75		
	Percentage of persons in full time employment	74		
	Number of new patents per 100 000 population per year	73		
Smart Cities	Percentage of service contracts providing city services which contain an open data policy	82	79	
	Survival rate of new businesses per 100 000 population	81		
	Percentage of the labour force employed in occupations in the education and research and development sectors	80		
	Percentage of labour force employed in occupations in the information and communication technology (ICT) sector	75		
	Sport and culture			
City Services and Quality of Life	Number of cultural institutions and sporting facilities per 100 000 population	78.2	75.7	77
	Percentage of municipal budget allocated to cultural and sporting facilities	75.3		
	Annual number of cultural events per 100 000 populations (e.g., exhibitions, festivals, concerts)	73.5		
Smart Cities	Percentage of the city's cultural records that have been digitized	81.6	78.2	
	Percentage of city population that are active public library users	80.0		
	Number of public library books and e-books titles per 100 000 population	79.2		
	Number of online bookings of cultural facilities per 100 000 population	72.0		

Conclusion

Literature suggested that the various city initiatives that are today used in the urban policy, design and planning discourses such as sustainable cities, ecological cities, green cities, eco-cities and others related to smart cities like digital cities, intelligent cities, and knowledge cities need a rigour use to comprehend their implications on the urban environment. The literature stressed that 'sustainable cities' is the most frequently used terminology and is also the largest and most interconnected [1]. The literature also emphasized that the new emerging narrower definition of the smart city appears to have become an important notion in urbanization and that the two concepts of smart cities and sustainable cities need to be understood in relationship to each other [2]. Research further showed that while discussions on smart and sustainable cities are influencing discussions about the future of global urban development, we know little about the so-called smart sustainable urbanism. Studies underlined the importance of developing local understandings of smart sustainable urbanism depending on the specific circumstances of the local community and the value judgment of its people [5, 6].

Setting indicators have been proven to be the best method for driving smart sustainable urban development. The literature suggested that the number of indicators selected and the format for presentation should vary according to the targeted stakeholders: scientists, evaluators, non-governmental organizations, the general public or policymakers [22]. This research presented a methodology to define smart sustainable urbanism locally and showcased how performance assessment indicators can be defined for this purpose using two ISO standards: the ISO 37120:2018 sustainable cities and communities — indicators for city services and quality of life and the ISO 37122:2019 sustainable cities and communities — indicators for smart cities. The investigation employed a quantitative methodology using surveys administered to experts in fields related to the built environment to identify the most important themes and indicators needed to measure the smartness and sustainability of the local urban environment and to determine how professionals perceive smart sustainable urbanism in Bahrain.

The findings showed that the average ratings to both the indicators for city services and quality of life and the indicators for smart cities were similar. Given that the two sets of indicators were administered in two separate surveys; the results indicate that experts in Bahrain understand the importance of designing, planning and monitoring sustainable interventions and also recognize the vital role of using technologies to attain a better quality of life.

For the ISO 37120:2018, the top-rated themes were wastewater, education and water and the lowest rated themes were sports and culture, the economy, telecommunication and governance. Likewise, for the ISO 37122:2019, the top-rated themes were population, and social conditions, water, wastewater and safety and the lowest rated themes were recreation, sports and culture and the economy. The findings showed that wastewater, water and population and social conditions were the top-rated themes in both indicators and sports and culture, economy and recreation were the least rated themes in both indicators. The findings, further, showed that indicators and themes as defined by the ISO could also be interpreted in relation to Maslow's hierarchy of needs and that the specialist's average ratings to the different themes in the two sets of indicators have a linear relationship to those identified in Maslow's model.

While this paper attempted to define smart sustainable urbanism locally using professionals' perceptions, further research is needed to look into performance assessment indicators from the perspective of other stakeholders, most importantly, local and international evaluators and the general public. The study presents a new methodology that could be used internationally by policymakers to prioritize and select indicators needed to assess the smartness and sustainability of their local community. The research further recommends incorporating the smart, sustainable urbanism indicators to the Government Action Plan in Bahrain for more robust attainment of smart sustainability goals.

References

[1] M. De Jong, S. Joss, D. Schraven, C. Zhan,and M. Weijnen, *Sustainable-smart-resilient-low carbon-eco-nowledge cities; making sense of a multitude of concepts promoting sustainable urbanization*, J. Clean. Prod. 109 (2015), pp. 25-38.

[2] E.P. Trindade, M.P.F. Hinnig, E.M. da Costa, J.S. Marques, R.C. Bastos, and T. Yigitcanlar, *Sustainable development of smart cities: a systematic review of the literature*, J. Open Innov. Technol. Mark. Complex. 3 (2017), pp. 1-11.

[3] M. Höjer and J. Wangel, *Smart Sustainable Cities: Definition and Challenges*, in *ICT Innovations for Sustainability. Advances in Intelligent Systems and Computing*, L.M. Hilty and B. Aebischer, eds., Springer, Cham, 2015.

[4] S.E. Bibri, *Smart Sustainable Urbanism: Paradigmatic, Scientific, Scholarly, Epistemic, and Discursive Shifts in Light of Big Data Science and Analytics*, in *Big Data Science and Analytics for Smart Sustainable Urbanism. Advances in Science, Technology & Innovation (IEREK Interdisciplinary Series for Sustainable Development)*, Springer, Cham, 2019.

[5] T. Clayton and N. Radcliffe, *Sustainability: A Systems Approach*, Routledge, London & New York, 2018.

[6] M. Roseland, *Toward Sustainable Communities: Solutions for Citizens and Their Governments*, New Society Publishers, Canada, 2012.

[7] M. Deakin and H. Al Waer, *From intelligent to smart cities*, Intell. Build. Int. 3 (2011), pp. 140-152.

[8] R.P. Dameri, *Searching for smart city definition: a comprehensive proposal,* Int. J. Comput. Technol. 11 (2013), pp. 2544-2551.

[9] H. Chourabi, T. Nam, S. Walker, J.R. Gil-Garcia, S. Mellouli, K. Nahon et al., Understanding smart cities: An integrative framework, in 45th Hawaii international conference on system sciences, 2012, pp. 2289-2297.

[10] C. Freeman, *Information highways and social change*, Ontario, 1995.

[11] W.J. Mitchell, *E-Topia "Urban Life, Jim—But Not As We Know It,"* MIT Press, Cambridge, 2000.

[12] H. Ahvenniemi, A. Huovila, I. Pinto-Seppä, and M. Airaksinen, *What are the differences between sustainable and smart cities?*, Cities 60 (2017), pp. 234-245.

[13] E.P. Trindade, M.P.F. Hinnig, E.M. da Costa, J.S. Marques, R.C. Bastos, and T. Yigitcanlar, *Sustainable development of smart cities: A systematic review of the literature*, J. Open Innov. Technol. Mark. Complex. 3 (2017), pp. 1-11.

[14] T. Yigitcanlar, *Smart city policies revisited: Considerations for a truly smart and sustainable urbanism practice*, World Technop. 7 (2018), pp. 97-112.

[15] V.W. Maclaren, *Urban sustainability reporting*, J. Am. Plan. Assoc. 62 (1996), pp. 184-202.

[16] N. Komninos, *Intelligent Cities and Globalisation of Innovation Networks*, Routledge, London, 2008.

[17] The Government Summit, *Smart cities: Regional prespectives*, in *The Government Summit Thought Leadership Series*, ESCWA, UAE, 2015.

[18] P. Lombardi, S. Giordano, H. Farouh, and W. Yousef, *Modelling the smart city performance*, Eur. J. Soc. Sci. Res. 25 (2012), pp. 137-149.

[19] T. Nam and T.A. Pardo, Smart city as urban innovation: Focusing on management, policy, and context, in Proceedings of the 5th international conference on theory and practice of electronic governance, 2011, pp. 185-194.

[20] D. Hemment and A. Townsend, *Smart Citizens,* FutureEverything, Manchester, 2013.

[21] S. Kindon, R. Pain, and M. Kesby, eds., *Participatory Action Research Approaches and Methods: Connecting People, Participation and Place*, Routledge, London & New York, 2007.

[22] V. Maclaren, *Urban Sustainability Reporting*, J. Am. Plan. Assoc. 62 (1996), pp. 184-202.

[23] C. Garau and V.M. Pavan, *Evaluating urban quality: indicators and assessment tools for smart sustainable cities*, Sustainability 10 (2018), pp. 575.

[24] A. Huovila, P. Bosch, and M. Airaksinen, *Comparative analysis of standardized indicators for Smart sustainable cities: What indicators and standards to use and when?*, Cities 89 (2019), pp. 141-153.

[25] L.-Y. Shen, J.J. Ochoa, M.N. Shah, and X. Zhang, *The application of urban sustainability indicators-A comparison between various practices*, Habitat Int. 35 (2011), pp. 17-29.

[26] C.J. Balsas, *Measuring the livability of an urban centre: an exploratory study of key performance indicators*, Planning, Pract. Res. 9 (2004), pp. 101-110.

[27] P.O. Alumbugu, I. Saidu, A. Abdulazeez, W.A. Ola-awo, and T.A. John, *Evaluation of perception of stakeholders on key performance indicators for UBE building projects*, Evaluation 2 (2015), pp. 277-285.

[28] H. Alwaer and D.J. Clements-Croome, *Key performance indicators (KPIs) and priority setting in using the multi-attribute approach for assessing sustainable intelligent buildings*, Build. Environ. 45 (2010), pp. 799-807.

[29] A. Visvizi and M. Lytras, *Rescaling and refocusing smart cities research: From mega cities to smart villages*, J. Sci. Technol. Policy Manag. 9 (2018), pp. 134-145.

[30] T.M.V. Kumar, ed., *E-Governance for Smart Cities*, Springer, Singapore, 2015.

[31] S. Saxena and T. Al-Tamimi, *Visioning "smart city" across the Gulf Cooperation Council (GCC) countries*, Foresight 20 (2018), pp. 237-251.

[32] A.O. El-Kholei and G. Yassine, *The mirage of smart sustainable cities in the Arab Region*, Open House Int. 44 (2019), pp. 8-16.

[33] F. Al-Khalifa, *Urban Sustainability in the Transforming Culture of the Arabian Gulf: The Case of Bahrain,* University of Sheffield, 2015.

[34] A. Huovila, P. Bosch, and M. Airaksinen, *Comparative analysis of standardized indicators for Smart sustainable cities: What indicators and standards to use and when?*, Cities (2019).

[35] T. Zhang and H. Dong, *Human-Centred Design: An Emergent Conceptual Model,* Royal College of Art, London, 2009.

[36] N. Ellin, *Integral Urbanism*, Routledge, New York and London, 2013.

[37] C. Hendrigan, *A Future of Polycentric Cities: How Urban Life, Land Supply, Smart Technologies and Sustainable Transport Are Reshaping Cities*, Springer, Singapore, 2019.

[38] S. Lehane, *Bahrain food and water secuirty*, Dalkeith, Australia, 2015.

[39] K. Bromber, B. Krawietz, and J. Maguire, *The United Arab Emirates, Qatar and Bahrain as a modern sports hub, in Sport across Asia: Politics, cultures, and identities*, Routledge, New York and London, 2013, pp. 189-211.