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The Effect of Smart Sustainable Urban Spaces on Quality of Life

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ABSTRACT

Sustainable urban spaces are those where all scales of development aim towards accomplishing a better-quality built environment. Therefore, sustainable urban spaces emphasize the association between green urban design and sustainability as an entry point to ensure quality of life.

This research aims to recommend key performance indicators (KPIs) of smart sustainable urban spaces which affect the quality of life and can be easily applied by users as self-assessing criteria for evaluating urban spaces.

The research methodology relies on an inductive approach to determine KPIs for measuring or achieving smart sustainable cities (SSC) and urban spaces. Besides, various dimensions of quality of life are studied. An analytical method was also applied in the study through a questionnaire that enquired/questioned the impact of smart sustainable urban spaces and their relationship to achieve quality of life.

Finally, a set of results, including KPIs of smart sustainable urban spaces affects quality of life (QoL). The relative weight of KPIs was developed of smart sustainable urban spaces to make self-assessments to improve or create an urban space.

KEYWORDS:

key performance indicators (KPIs), smart sustainable urban spaces, urban spaces, quality of life (QoL), smart sustainable cities (SSC).

الملخص

يمكن تعريف الفراغات الحضرية الذكية المستدامة على انها الصلة بين التصميم العمراني والاستدامة كنقطة هامة لتحقيق استدامة العمران. ومن ثم فإن الفراغات العمرانية المستدامة يمكن اعتبارها كخطوة لتحقيق وتحسين جودة الحياة. يهدف البحث هو التوصية بمؤشرات الأداء الرئيسية (KPIs)للفراغات الحضرية الذكية المستدامة التي تؤثر وتعزز من جودة الحياة؛ والتي سيتم تطبيقها بسهولة من قبل المتخصصين كمعايير للتقييم الذاتي للفراغات الحضري الحالية، او انشاء فراغاتحضرية جديدة.

تعتمد منهجية البحث على نهج استقرائي لتحديد مؤشرات الأداء الرئيسية لقياس أو تحقيق المدن الذكية المستدامة (SSC) والفراغات الحضرية. بالإضافة إلى ذلك ، يتم دراسة الأبعاد المختلفة لجودة الحياة. كما تم تطبيق المنهج التحليلي في الدراسة من خلال استبيان عن مدى تأثيرالفراغات الحضرية المستدامة الذكية وعلاقتها بتحقيق جودة الحياة.

أخيرًا، توصل البحث إلى مجموعة من النتائج، بما في ذلك مؤشرات الأداء الرئيسية للفراغات الحضرية الذكية المستدامة التي تؤثر على جودة الحياة (QoL). بالإضافة إلى ذلك، تم تطوير الوزن النسبي لـ (KPIs) للمساحات الحضرية المستدامة الذكية لإجراء تقييمات ذاتية لتحسين أو إنشاء فراغات حضرية.

الكلمات المفتاحية مؤشرات الأداء، الفراغات الحضرية الذكية المستدامة، الفراغات الحضرية، جودة الحياة، المدن الذكية المستدامة

INTRODUCTION

Urbanization and urban areas belong to a set of multiscale phenomena that profoundly alter the relationship between community and environment. Using sustainable urban spaces is a strategic approach that is now welcomed worldwide, especially in developing countries, which aspire to make urban spaces part of their smart sustainable cities. The benefits of "smart cities" go beyond cost savings and efficiency improvements. Henceforth, smart city technology already started to provide better lives, and more changes are on the way.

Quality of life (QoL) is an indicator of many aspects of urban living, from the time residents spend sitting in traffic to how safe they feel walking around urban spaces (Coolfire Core, 2019). Although there is no a universal rubric for QOL, many organizations have utilized a mix of both objective and subjective factors to define the concept. Through the research study, the relationship between KPIs of smart sustainable urban spaces and their impact on QoL was assessed.

I. RESEARCH PROBLEM

There are KPIs for measuring and achieving smart sustainable cities. The research raises the question: Can urban spaces within cities be turned into smart sustainable spaces, and what are key performance indicators (KPIs) that can measure or achieve that? What is the effect of KPIs for smart sustainable urban spaces on the quality of life?

II. RESEARCH AIM

The study aims are:

- Determine KPIs for smart sustainable urban spaces which are used to develop and establish the criteria to make them smarter and more sustainable, and to provide us with universal self-assessment criteria for urban spaces.
- Develop the relative weight of each KPI and all three sustainable dimensions of smart sustainable urban design.
- Analyze aspects of quality of life which are affected by smart sustainable urban spaces.

III. RESEARCH METHODOLOGY

The research methodology is based on:

- Inductive approach: Theoretical study to identify urban spaces as well as key performance indicators (KPIs) for measuring or achieving smart sustainable cities (SSC) and urban spaces.
- Analytical approach: The analytical study is applied through a questionnaire to determine the impact of smart sustainable urban spaces and their relationship to achieve quality of life from the viewpoint of architects and urban designers, as well as analyzing quality of life aspects that can be measured with subjective measurement.

1- THEORETICAL FRAMEWORK FOR THE STUDY

Through the theoretical part, urban spaces are identified and their roles as part of urban design are determined. Studying dimensions of smart sustainable cities (Economic, Environmental, and social). Identifying and analyzing benchmarks of indicators for urban spaces.

The quality of life concept is also recognized, and general dimensions and indicators that can be measured within smart sustainable urban spaces are addressed.

1-1 Urban spaces

The definition of urban spaces, as socio-ecological systems, represents five domains (Romero-Lankao, 2016): Socio-demographics, Economy, Technology, Environment, and Governance. Urban space is the main tool utilized to integrate a city. However, urban spaces are shared by various users, acting as the environment in which they convey and relearn cultural accumulation (İnceoğlu, 2009).

Urban design is the science and art of creating sustainable places. All substantive urban design theories have dealt with "place quality" concept and have attempted to establish techniques towards quality assessment of a place (Kourosh, 2005). Urban public spaces offer a shared service to various society groups, namely where individuals and groups of various social, cultural, and economic structure, from different ages, sex, and education level, traditions, customs, and backgrounds are together. Meeting the needs and demands of this large user group is a common task of urban designers (Şatir, 2005). Some urban designers define cities as a particular human association form characterized based on criteria of

population size, built-environment form, and economic function (Wirth, 1938).

1-2 Smart Sustainable Cities/Urban spaces

The main differences between two types of frameworks with respect to sustainability are that while smart cities focus much more on education, culture, science and innovation, and ICT, the urban sustainability frameworks place more importance on environment-related sectors, such as natural and built environments (Ahvenniemi, 2017). Long-term sustainability is the capacity of natural systems to survive and retain their diversity and productivity over time, and this is a key factor necessary for human development. Sustainable development is the practice of humans arriving at a level of economic and social development that does not inevitably change ecological balance (Almusaed, 2018). While sustainable urban spaces are those at all development scales, such ongoing adaptation and change processes are positively channeled in an integrated manner to achieve a higher-quality built environment (UDG, 1998). Sustainable urban spaces always emphasize the connection between green urban design and sustainability as an entry point to ensure quality of life.

From the viewpoint of sociologists, sustainable communities are places where people want to live and work now and in the future. They meet the diverse requirements of existing and future residents, are sensitive to their environment, and contribute to a high quality of life, Figure 1.

The United for Smart Sustainable Cities (U4SSC) [1] defined "Smart urbanization" as building safer, healthier, resilient and sustainable cities of tomorrow (U4SSC, 2016).

Sustainable construction of cities using smart growth principles, effective urban planning models, ICTs, and energy systems with low carbon can assist in creating more habitable and efficient urban centers.

The United Nations definition of a sustainable city is where achievements in social, economic, and physical development are made to last. A sustainable city preserves lasting security from environmental hazards that can jeopardize development achievements (United Nations, 2001).

Quality of life is an essential issue that sustainability aims to achieve by meeting people's needs in environments that fail to meet their needs and in which poorly shared resources are unlikely ever to be sustainable.

Figure (1). Dimensions of sustainability

Source : Researcher

[1] The "United for Smart Sustainable Cities" (U4SSC) is a UN initiative coordinated by ITU, UNECE and UN-Habitat and supported by CBD, ECLAC, FAO, UNDP, UNECA, UNESCO, UNEP, UNEP-FI, UNFCCC, UNIDO, UNOP, UNU-EGOV, UN-Women and WMO to achieve Sustainable Development Goal 11: "Make cities and human settlements inclusive, safe, resilient and sustainable". It provides an international platform for information exchange, knowledge sharing and partnership building, with the aim of formulating strategic guidance to achieve the Sustainable Development Goals (SDGs), and implement the New Urban Agenda and other international agreements.

1-3 key performance indicators (KPIs) for smart sustainable cities (SSC)

The United for Smart Sustainable Cities (U4SSC) offers cities with a methodology for collecting data or information from key performance indicators (KPIs) for smart sustainable cities (SSC) (U4SSC., 2017). This set of KPIs for SSC was developed to establish the criteria of making cities smarter and more sustainable and offer cities with means of self-assessments. KPIs could be realized by Sustainable Development Goals (SDGs), leading to a smarter and more sustainable city.

Each indicator forms a part of overview of a city's performance in three dimensions; Economy, Environment, and Society and Culture. Within each dimension, there is a sub-dimension that focuses on more specific areas. There is a total of 91 KPIs, including 45 for Economy dimension 17 for Environment dimension and 29 for Society and Culture dimension.

Through the benchmark of each key performance indicators (KPIs), urban spaces were identified. This KPIs' set was chosen for establishing criteria to make urban spaces smarter and more sustainable and providing us means of self-assessments for urban spaces.

There are 8 sub-dimensions with a total of 36 KPIs, including 18 for Economy dimension, 8 for Environment dimension, and 10 for Society and Culture dimension, Table 1.

Table (1). key performance indicators (KPIs) for smart sustainable urban spaces -smart cities

KEY PERFORMANCE INDICATORS (KPIs) FOR SMART SUSTAINABLE URBAN SPACES -(SMART CITIES)			BENCHMARKING
Dim.	**Sub-Dim.**	**Indicators**	
1. KPIs on Economy dimension	**1-1 ICT (Infra-structure)**	**A. Wireless Broadband Subscriptions**	Such indicator shows the access to information and technology connectivity and is vital given that connectivity across regions (spaces) to be smart.
		B. Wireless Broadband Coverage	
		C. Availability of WIFI in Public Areas	Wi-Fi hotspots at public venues, thereby providing individuals with augmented internet access at inexpensive or no cost all over urban spaces.
		D. Drainage / Storm Water System ICT Monitoring	Optimal control techniques in urban drainage networks assist in generating control strategies in advance to control sewer overflow (especially in climate change).
		E. Electricity Supply ICT Monitoring	Modern SCADA (supervisory control and data acquisition) systems substitute manual labor for performing electrical distribution tasks and manual processes in distribution systems with automated equipment within urban spaces to convert it into a smart sustainable urban space.
	1-2 ICT Transport	**F. Dynamic Public Transit Information**	Investment in public transport is one of the most efficient methods for moving people around urban spaces and offering riders with dynamic information.
		G. Traffic Monitoring	Monitoring of major streets and spaces can allow for better traffic flow management. Such monitoring can be carried out by means

		of in-spaces sensors and cameras.
	H. Intersection Control	Traffic control comprises measures like embedded road sensors that cause traffic signals change according to actual vehicles flow in streets.
	I. Public Transport Network	Public transport shall include both high capacity (subway systems) and light capacity (e.g., buses, trolleybuses) to facilitate individuals' movement between regions.
	J. Public Transport Network Convenience	Public transport can be costly without considering need as well as demand (it makes difficult movement between spaces).
1-3 Transport (Infra-structure)	**K. Bicycle Network**	Cycling holds environmental effect lower than other vehicles, and it can be a method to reduce traffic congestion. Bicycles are more available to lower-income inhabitants, who in turn gain health profits. Bicycle lanes are designed to be separated from the road by physical barriers.
	L. Transportation Mode Share	Cities should disclose on public transportation modes, personal vehicles, bicycles, walking, and paratransit moving to and from work to facilitate individuals' movement between regions.
	M. Travel Time Index	Such indicator is traffic congestion indicator that concentrates on each trip in urban space from one place to another.
	N. Shared Bicycles	The provision of shared bicycle services results in instant transportation choices and avoids the use of automobiles, thus decreasing traffic congestion noise, and air pollution.
	O. Shared Vehicles	Shared vehicles are a viable substitute to personal vehicles and this may lead to a reduction in personal vehicles number in a city, and spaces can be better utilized rather than parking.
	P. Low-Carbon Emission Passenger Vehicle	All-electric vehicles (EVs) operate solely on electricity and are propelled by one or more electric motors, which are driven by rechargeable battery packs. It is a better way to transport between region without pollution effect.
1-4 Urban design and planning (Infra-structure)	**Q. Pedestrian infrastructure**	Pedestrian spaces are reserved for pedestrian use only. It tends to improve the urban spaces in terms of pollution, noise and safety.
	R. Urban Development and Spatial Planning	Urban spaces should possess the following five principles to be deemed "sustainable": Compact, places and locations to demonstrate high.

2. KPIs on Environment dimension	2-1 Air Quality & Environmental Quality (Environment)	**A. Air pollution**	Urban areas offer the greatest exposure to ambient air pollution and consequent health issues. Air quality improvement is a vital aspect to promote sustainable human settlements.
		B. GHG Emissions	To help avoid the most significant consequences of climate change, countries have signed on to United Nations Framework Convention on Climate Change (UNFCCC), and have promised to coordinate together with the goal of keeping global temperature rise to an acceptable limit.
		C. EMF Exposure	It concerns about possible health risks resulted from EMF exposure, in addition to concerning for implementation of wireless facilities in urban spaces.
		D. Noise Exposure	Exposure to long-term excessive noise has been associated with negative health outcomes and effects on individuals' quality of life.
	2-2 Public space &Nature (Environment)	**E. Green Areas**	Green areas are essential to a city's sustainability. Green spaces capture pollutants, reduce the heat impact, and provide recreational areas.
		F. Green Area Accessibility	It is essential to emphasize if the local inhabitants have greater accessibility to such spaces as they can result in a better quality of life for residents of the city.
		G. Protected Natural Areas	A "protected area" refers to a clearly defined geographical space that managed to achieve the long-term conservation of nature with associated ecosystem services and cultural values.
		H. Recreational Facilities	Recreational facilities are significant to keep individuals' health and provide chances for public assembly and social activities.
3. KPIs on Social and culture dimension	3.1 Education and Culture	**A. Higher Education Degrees**	The diverse set of public and private educational institutions forms a network of support to produce higher-order capacity requred for space development and conservation.
		B. Adult Literacy	The population percentage aged 15 years and over can read and write with understanding a short simple statement on his or her everyday life.
		C. Cultural Infrastructure	UNESCO implies that there is no sustainable development lacking a strong culture aspect. Actually, the development based on mutual respect and open dialogue among cultures can result in long-term and inclusive results.
	3.2 Safety and Social Inclusion	**D. Informal Settlements**	Informal or inadequate housing are precarious circumstances' indicator that some individuals may live under. These areas make a real effect on the surrounding urban space.
		E. Disaster Related Economic Losses	Direct economic loss is the monetary value of total or partial destruction (physical damage). But indirect economic loss is an economic value decline added due to direct economic loss (human and environmental impacts).
		F. At Risk Population	The extent of disasters' impact on individuals in urban spaces.

G. Emergency Service Response Time	Emergency services comprise police, fire fighting and ambulance services (such as transport and urgent care) in urban spaces.
H. Police Service	The number of sworn police officers indicates the overall crime prevention capabilities in urban spaces.
I. Fire Service	Firefighting services are a fundamental ones delivered by cities and to protect life in open spaces.
J. Violent Crime Rate	The violent crimes' number in an urban space is regarded as a benchmark measure of overall safety level in a city.

1-4 Quality of Life

In the English dictionary, quality of life (QoL) is satisfaction and comfort level that a person or group enjoys.

QoL is defined as individuals' perceptions of their position in life in the context of culture and value systems in which they live and in association with their goals, expectations, standards and concerns (WHOQOL., 1996). It is a broad-ranging concept impacted in a complex way by person's physical health, psychological state, personal beliefs, social relationships, and their relationship to salient features of their environment (WHOQOL., 2020). The QoL term is ambiguous meaning, as it can refer to individual's experience in his own life and to living conditions in which individuals find themselves. Therefore, QoL is highly subjective. Whereas people may define QoL according to wealth, another may define it in terms of capabilities (e.g., ability to live a good life in terms of emotional and physical well-being). Disabled people may report a high QoL, whereas a healthy person who recently lost a job may possess a low QoL. So, QoL is viewed as multidimensional, incorporating emotional, physical, material, and social well-being. Figure 2.

The concept of quality of life has a strong influence on social and political trends being applied to The QoL concept has a strong impact on social and political trends employed in several fields, such as urban and regional planning, health promotion, disability, social indicators research, and economic and mental health research (Turkoglu, 2014).

Many organizations worldwide have developed many dimensions to measure quality of life, including the World Health Organization (WHOQOL., 1996). They are four main dimensions: physical health, psychological, social relationships, and environment, each of them has a

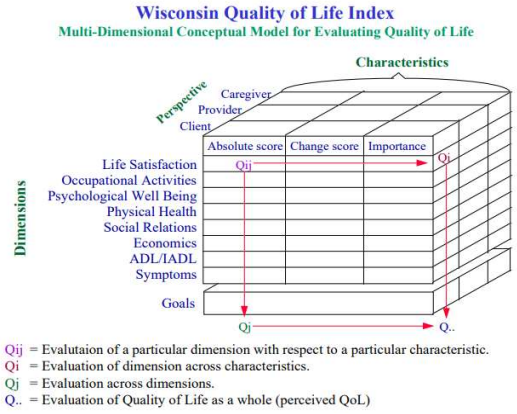

Figure (2). Dimensions of Quality of Life (QOL)

Source [9]: Marion A. Becker, Bret R. Shaw, Lisa M. Reib, "QUALITY OF LIFE ASSESSMENT MANUAL."

set of indicators, which must be measured to know quality of life.

European Union (EU) presents a detailed analysis of many different dimensions of quality of life, complementing the indicator traditionally used as a measure of economic and social development, gross domestic product (GDP) (Eurostat., 2020). The indicators list that Eurostat set up[2] was based on academic research and several initiatives. QoL dimensions/domains (8+1) have been defined as an overarching framework for measuring well-being. These dimensions are material living conditions, productive or main activity, health, education, leisure, social interactions, economic and physical safety, governance and basic rights, natural and living environment, and overall experience of life. Each of the dimensions has a set of indicators that differ in how they are measured between objective or subjective methods.

Personal feelings or opinions do not influence the objective method in considering and representing facts. However, subjective is based on or influenced by personal feelings, tastes, or opinions.

The set of dimensions and indicators set by the European Union (EU) to measure QoL, methods for measuring either objective or subjective were specified. Through the study and analysis, the indicators that can be measured by the subjective method were identified, which include taking people's opinions about their satisfaction, and what the urban spaces indicators express about QoL. And which of the smart sustainable urban space's indicators can be covered by QoL indicators, Table2.

2- APPLIED STUDY

The applied study has done through an electronic questionnaire for architectural and 37 urban design specialists to take their views on smart sustainable urban spaces and extent of how it achieves the desired quality of life. The questionnaire was chosen for specialists due to their responsibility for designing or transforming urban spaces into smart sustainable urban spaces. The applied study's aims include: -

- Examining the validity of smart sustainable urban spaces KPIs selected based on their benchmark from KPIs of smart sustainable cities excluding all indicators in which individuals' satisfaction average with less than 3 was not produced (within a scale of 1 to 5).
- KPIs of smart sustainable urban spaces that use all three dimensions of sustainability were examined, and their effect on achieving the quality of life was determined.
- Analyzing the percentages of quality of life for each dimension according to the samples' opinions.
- Calculating the relative weight for each dimension and indicator of KPIs for smart sustainable urban spaces to assess the pre-existing urban spaces for development or evaluation.

2-1 validity of KPIs for smart sustainable urban spaces

After studying KPIs of smart sustainable cities and benchmarking for each of them, they were tested through an electronic questionnaire. This test average was calculated by summation of all sample's opinions on each indicator divided by 37 (the number of samples) to calculate the average. The indicators that obtained less than 3 (on a satisfaction scale from 1 to 5) were excluded from the result, as these indicators were considered less than average.

Although this indicator is removed from KPIs of smart sustainable urban spaces, it remains within the smart city measurement indicators. There are (8) sub-dimensions with a total of (33) KPIs, including 15 for economy dimension, 8 for environment dimension, and 10 for social and culture dimension. The indicators that have been omitted within the economic dimension of sustainable development are as follows in Table 2: -

(1-1-D.) Drainage/Storm Water System ICT Monitoring, (1-1-E.) Electricity Supply ICT Monitoring and (1-2-F.) Dynamic Public Transit Information.

[2] Eurostat is the statistical office of the European Union, based in Luxembourg (LU). It publishes official, harmonised statistics on the European Union and the euro area, offering a comparable, reliable and objective portrayal of Europe's society and economy.

Table (2). The dimensions of quality of life (QoL) affected by Urban design

Dimensions of (QoL)	Indicators	Objective measurem	Subjective measurem	Subjective points to measure	Affected by urban design Indicator
Material living condition	- Income	•			
	- Consumption	•			
Productive or main activity	- Quantity of employment	•			
	- Quality of employment	•	•	-Assessment of the job quality	
	-Main reason for economic inactivity	•			
	-Unpaid work	indicators to be developed			
Health	- Outcomes	•	•	-Self-perceived health	
	- Determinants (healthy and unhealthy behaviors')	•			
	- Access to healthcare.	•			
Education	- Competences and skills	•	•	-Individuals' level of internet	(1-1-A/1-1-B/

				(digital) skills	(1-1-C/ 1-2-F)-(3-1-A/3-1-B)
	- Lifelong learning and	•			
	- Opportunities for education.	•			
Leisure and social interaction	-Leisure	•	•	-Satisfaction with time use	(1-1-A/1-1-B/1-1-C/ 1-2-F/1-3-L/1-3-P/ 1-4-Q/1-4-R) (2-1-D/2-2-E/2-2-F/ 2-2-H) (3-1-C/3-2-J)
	- Social interactions	•	•	-Satisfaction with personal relationships Participation in informal voluntary activities -Perception of social cohesion	
Economic security and physical safety	-Economic security	•			
	- Physical safety	•	•	- Perception of crime, violence or vandalism in the living area - Safety feeling (population feeling safe when walking alone in their area after dark)	(3-2-D/3-2-E/ 3-2-F/3-2-G/ 3-2-H/3-2-I/3-2-J)
Governance and basic rights	- Institutions and public services		•	-Trust in the legal system, the political system and the police	
	- Discrimination and equal opportunities	•			
	-Active citizenship.	indicators to be developed			
Nature and living environment	- Pollution (including noise)	•	•	-Urban population exposure to air pollution by particulate matter -Perception of pollution, grime or other environmental problems	(2-1-A/2-1-B/2-1-C/ 2-1-D/2-2-E/2-2-F/ 2-2-G/2-2-H)
	- Access to green and recreational spaces		•	-Satisfaction with recreational and green areas	
	-Landscape and built environment		•	-Satisfaction with living environment	
Overall	- Life satisfaction		•	-Overall life satisfaction	**All previous**

experience of life	- Affects	• -Negative affects -Positive affects (being happy)	**(KPIs)**
	- Meaning and purpose of life	• -Assessing whether life is worthwhile	

(KPIs), cannot inquire about it . **(1-1-d/1-1-E/ 1-1-G)**

(Source: Researcher)

2.2 The impact of smart sustainable urban spaces on the quality of life.

This analysis was done by studying each dimension of sustainability separately, including its own set of indicators, Table 3. By analyzing the economic dimension (Figure 3), we found a series of conclusions as follows:

- It was found that four main sub-dimensions were represented by lines that appeared far apart. The explanation for this is that despite the similar educational level of the sample, their different economic level causes difference of opinion by affects quality of life within the same dimension.
- It must be considered that the three factors excluded from Economy dimension could perhaps be the indicators for urban spaces; however, we were unable to measure them from a subjective take on the quality of life.
- The highest sample satisfaction level reached between the four sub-dimensions under economic branch, when evaluating 5 as the highest, was at (37%) in Urban Design and Planning (Infra-Structure) indicator, and this is because the sample is uniform in terms of educational qualifications in the field of architecture and urban design.
- The large fluctuation in urban design indicators can be explained by the fact that there is a problem that architectural education does not adequately cover human, social and cultural sciences which explain various concepts of quality of life for different segments.
- Despite the great role that information technology has played, represented in ICT (Infra-structure) indicator within community, the sample considered it less important than the design of urban and pedestrian spaces.
- The economic dimension recorded the largest difference between the three dimensions of sustainability in the graph, which must be considered that the economic disparity between members of a single sample requires re-representation using a normal distribution curve to distance the points farther from the graph line with a line that is more compatible with all points, Figure 4.
- After representing the effect of KPIs on Economy dimension of smart sustainable urban spaces on the quality of life on a normal distribution curve, it produced logical and streamlined results.

Table (3). key performance indicators (KPIs) for smart sustainable urban space- relative weight

KEY PERFORMANCE INDICATORS (KPIs) FOR SMART SUSTAINABLE URBAN SPACES – (SMART CITIES)			
		(KPIs) FOR SMART SUSTAINABLE URBAN SPACES	Relative Weight %
1. KPIs on Economy dimension	A-1 ICT (Infra-structure)	B. Wireless Broadband Coverage	2.9
		C. Availability of WIFI in Public Areas	2.8
		D. Drainage / Storm Water System ICT Monitoring	
		E. Electricity Supply ICT Monitoring	
	ICT Transport	F. Dynamic Public Transit Information	
		g. Traffic Monitoring	3.2
		H. Intersection Control	3.2
	1-3 Transport (Infra-structure)	I. Public Transport Network	3.4
		J. Public Transport Network Convenience	3.2

Table (3). continuous- key performance indicators (K

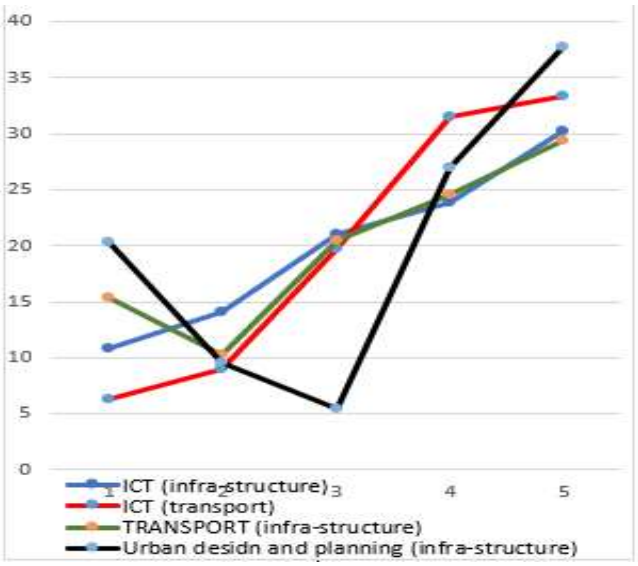

Figure (3). The effect of KPIs on Economy dimension of smart sustainable urban spaces on (QoL)

Source: Researcher

		K. Bicycle Network	**2.9**
		L. Transportation Mode Share	**2.9**
		M. Travel Time Index	**2.8**
		N. Shared Bicycles	**3.2**
		O. Shared Vehicles	**3**
		P. Low-Carbon Emission Passenger Vehicle	**3**
	14 Urban design and planning (Infra-structure)	**Q. Pedestrian infrastructure**	**2.9**
		R. Urban Development and Spatial Planning	**3**
	SUM		45.2

(Source: Researcher)

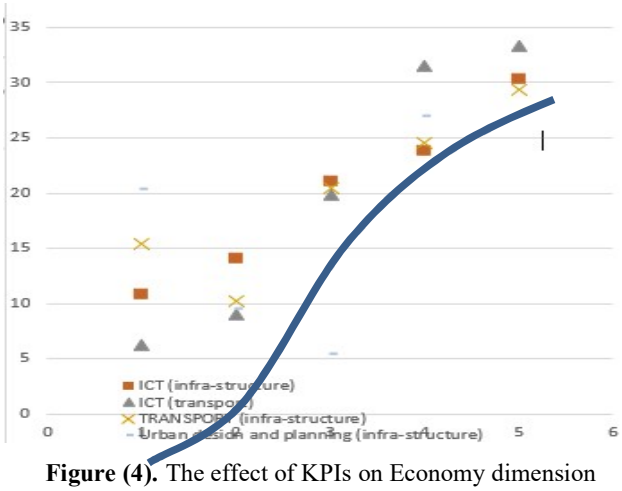

Figure (4). The effect of KPIs on Economy dimension of smart sustainable urban spaces on (QoL)-Normal Distribution curve

(Source: Researcher)

2. KPIs on Environment dimension	2-1 Air Quality & Environmental Quality (Environment)	A. Air pollution	3
		B. GHG Emissions	3
		C. EMF Exposure	3
		D. Noise Exposure	3
	2-2 Public space &Nature (Environment)	E. Green Areas	3.1
		F. Green Area Accessibility	3
		G. Protected Natural Areas	2.8
		H. Recreational Facilities	2.9
	SUM		23.8
3. KPIs on Social and culture	3-1 Education and Culture	A. Higher Education Degrees	3
		B. Adult Literacy	3.1
		C. Cultural Infrastructure	3.2
	3-2 Safety and Social	D. Informal Settlements	3.1

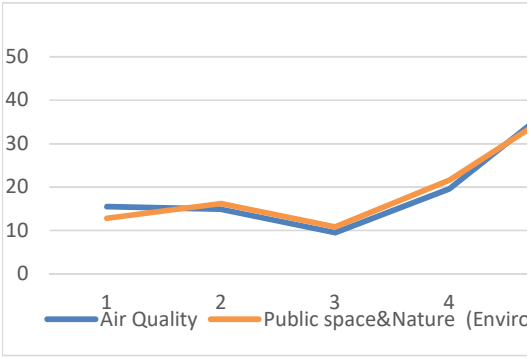

Figure (5). The effect of KPIs on Environmer dimension of smart sustainable urban spaces on (

-The second dimension (the Environmental dimension) appeared as the most consistent dimension between the two main indicators, indicating that the sample agreed to a large extent on the impact of environmental indicators on the quality-of-life Figure 5.

-The Environmental dimension obtained the highest percentage, when evaluating 5 to be the highest value, more than 40% of the total dimensions of sustainable development, and this indicates how important this dimension is in achieving smart sustainability.

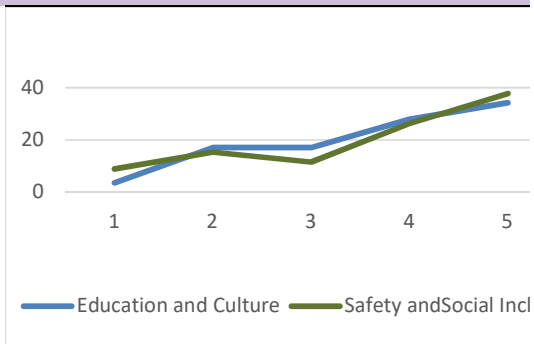

Figure (6). The effect of KPIs on Social &Culture dimension of smart sustainable urban

- After studying the curves of the sub-

	E. Disaster Related Economic Losses	**2.9**
	F. At Risk Population	**2.7**
	G. Emergency Service Response Time	**3**
	H. Police Service	**3.3**
	I. Fire Service	**3.4**
	J. Violent Crime Rate	**3.3**
	SUM	**31**
	SUM OF RELATIVE WEIGHT OF ALL DIMENSIONS	**100**

(Source: Researcher)

2-3 The relative weight for KPIs of smart sustainable urban spaces.

Using the questionnaire, the relative weight of each of the indicators of smart sustainable urban spaces was identified, and the overall total of the three basic dimensions was known. By knowing the relative weight of each indicator, assessment can be made of the pre-existing urban spaces for development or evaluation, Table 3.

- The computational method for calculating the relative weight of KPIs indicators is as follows: the sample opinions for each indicator is divided by the total number of opinions for all indicators multiplied by 100.
- Through statistical calculations, it was found that economic dimension, due to its large number of indicators, accounted for 45.2% of the sample (15 indicators), followed by the social and cultural dimension 31% (10 indicators), then the environmental dimension 23.8% (8 indicators).
- By comparing various indicators between the three dimensions, it was found that they are very close in their relative weight (from 2.7% to 3.4%), and this indicates the equal value of indicators in affecting the quality of life. The economic dimension's importance is almost equal in importance with the other two dimensions (the environmental dimension and the social and cultural dimension).

dimensions, we found that Education and Culture, ICT, ICT Transport (Infra-structure) indicators appeared as the most streamlined and logical graphical lines and included in the satisfaction of individuals and the achievement of values from 5 to 1, and this indicates the importance of these elements and their control over the quality of life in a logical manner Figure 3,6.

3- DISCUSSIONS

Based on KPIs' existence for smart sustainable cities, various dimensions and indicators of smart sustainable urban spaces were extracted according to benchmarking of them to design them or evaluate what is already there. This was by learning about various indicators used to assess quality of life and methods of measuring them. Indicators of smart sustainable urban spaces were tested for their potential influence on indicators of quality of life that could be measured by the subjective method.

By knowing the relationship between cities' urban spaces and their relationship to quality of life of citizens, spaces can be created on functional, technological, and human sides. Besides, recent studies that emphasize quality of life importance as a basic dimension of cities' transformation from developing to developed has become necessary to discuss this dimension mainly on all indicators. Although mental health index or happiness index is one of the indicators that measure the quality of life, but until we reach ideal mental health or happiness, we must aspire to architecture and urbanization around us as it plays a large part of effect.

The study concluded results on two different levels; on level of smart sustainable urban spaces and on level of the quality of life.

First: On the level of smart and sustainable urban spaces:

- Smart sustainable urban spaces can be evaluated in terms of quality of life on a model that includes three main sustainability dimensions (economy, environment, social, and culture), 8 main indicators, and 33 secondary indicators. The economic dimension includes 15 indicators, environmental dimension includes 8 indicators, and social and cultural dimension includes 10 indicators.
- The same KPIs can create smart sustainable urban spaces that fulfill the quality-of-life standards of citizens.
- The relative weight of each of indicators in urban spaces is converging in its impact on quality of life of citizens (2.7% to 3.4%), and this indicates that indicators are equally important in affecting the quality of life.
- Although the educational level of sample is approximately the same or equal, the economic dimension of developing and evaluating urban spaces was greatly affected by the economic level of the sample.
- Major indicators affect the quality of life in a large logical manner, namely ICT-infrastructure, ICT, transport, education, culture, safety, and social interaction.
- The smart sustainable urban spaces frameworks should be focused on more environment-related sectors, such as natural and built environments as well as ICT infrastructure.

Second: On the level of quality of life (QoL):

- The economic dimension's effect is roughly equivalent to both environmental dimension and social and cultural dimension in terms of the total relative weight of indicators, as it represents approximately 45%, which indicates this dimension importance.
- It must be taken into consideration that relative weights of indicators of smart sustainable urban spaces were deduced through measuring subjective indicators of quality of life.
- Quality of life can be considered the fourth dimension of sustainable development because of its influencing role on quality of life. Or quality of life indicators can be increased within social and cultural dimension indicators that must be achieved to create or evaluate smart sustainable urban spaces.
- Quality of life is not limited to an index of happiness or mental health level but can be measured by various indicators such as architecture and urbanism KPIs.

4- Recommendations:

- Understanding the importance of incorporating social sciences and quality of life in architectural and urbanism education courses because of its influential role in achieving the quality of design and urban dimensions.
- Future research is needed to develop a mechanism to include quality of life dimensions within social and cultural dimensions of sustainable development.
- Applying the model and using indicators' relative weights to re-evaluate urban spaces into smart sustainable urban spaces.

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