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A Proposed Model for Measuring the Performance of Smart Cities in Egypt

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ABSTRACT
Smart communities/cities are technology-based urban communities, those measures supporting a city to improve its social, economic, and environmental conditions and provide a better life for the city's residents with their participation in the planning of city projects. Many classifications indices, reference frameworks, forums, and assessment centers have developed; such classifications indices and centers govern and measure the performance of existing traditional and smart communities/cities and also work as guide lines to create new Smart communities/cities or transforming existing traditional cities into smart ones. The criteria of such new communities vary from one category to another and lack or omit some dimensions to interact and merge with the surrounding urban environment, especially the already existing communities. That would have a negative impact not only on smart communities but also on the entire community as the new smart communities that would appear secluded form neighboring urban environment. Therefore, the need to reduce these negative influences of existing communities and gradually transform them into smart communities is important to enhance the interaction efficiency. Therefore, the necessity of activating the existing cities and transforming those into smart ones in Egypt is essential. Therefore, the research proposed a comprehensive model to measure the performance of smart cities in Egypt that derive the dimensions, standards and indicators governing the global rankings and add what is missing from these classifications achieving a reference framework or mechanism to serve as a new classification helps to assess performance in response to the requirements of smart communities.

Keywords: *smart city; key performance indicators (KPIs); smart environment; cultural dimension.*

1. Introduction

The information economy, with the effects of the digital revolution and the new global economy, has had a significant impact on changing the role of cities and societies. The term "smart communities/cities" is used to refer to technology-based urban communities, a comprehensive term for developmental means aimed at supporting a city to improve its social, economic, and environmental conditions. Furthermore, to provide a better life for the city's residents, also considering the idea of citizen participation in the planning of city projects. In order to preserve and sustain these communities and to highlight their role as smart communities, many classifications indices, reference frameworks, forums, and assessment centers have developed Such as: CSCI, 1995, Komninos, 2009-2011, ICF, 2011 - ISO / TS 37151, 2015, and many more that employ dimensions, criteria, and indicators (KPIs). Such classifications indices and centers not only govern or measure the performance of existing traditional and smart communities/cities such as but also work as guide lines for creating new Smart communities/cities or transforming existing traditional cities into smart ones.

The research problem is that the criteria of such new communities vary from one category to another and lack or omit some dimensions to interact and merge with the surrounding urban environment, especially the already existing communities that have not yet taken their chance towards such improvement. That would have a negative impact not only on smart communities but also on the entire community as the new smart communities would appear secluded form neighboring urban environment, Nevertheless, interaction with existing communities is imperative, which emphasizes the need to reduce these negative influences of existing communities and gradually transform them into smart communities to enhance the interaction efficiency .

On the other hand, there is no local / national mechanism in Egypt to measure the performance of smart or traditional communities, or reference frameworks for adopting the policy of establishing smart cities and transforming the existing traditional ones into smart cities. In addition to the lack of global standards for smart cities as some dimensions, standards and indicators are absent that represent negative internal dimensions in smart communities themselves. For example, the dimensions of cultural identity, civilization or social features, visual configuration, architectural iconography, symbolic value, unique personality, harmony with the urban environment, etc.

2. Research Significance, Aim, and Methodology

Egypt is one of the countries possesses the ingredients qualified to adopt the policy of establishing smart societies / cities, especially the environment that stimulates this type of cities, instead of gradual depletion of such environment, which confirms the inevitability of activating the existing cities.

The Research Aim: Therefore, the research aims to extract and derive the dimensions, standards and governing indicators from the global classifications, to **add the missing culture identity dimension to classifications;** accordingly reaching a reference framework or mechanism for measuring the performance of smart and traditional societies / cities alike. That would serve as a new classification that helps to evaluate performance in a way that responds to the requirements of smart societies.

The Research Methodology: The methodology is following the deductive methodology to identify and derive the standards governing smart communities according to their approach regarding performance, order, services and the ability to learn and link with the standards of green and sustainable societies. Then an analytical approach would be adopted to drive new classification based on indicators (KPIs) to measure the performance of these smart communities / cities as well as traditional communities to increase their effectiveness towards the gradual transformation to smart communities.

3. The Concept of Smart Community/City

There is no single definition of what makes a community "smart", "flexible", "viable" or "sustainable," and no one understands community as its citizens do, nor a clear definition of smart communities / cities. Other terms have been appeared to describe the "Smart" such as: "wired", "broadband", "digital", "networked", "smart community network", "community informatics", "smart" and "green" were used Interchangeably among researchers, but all mean communities that are making "a conscious effort to understand the world that is closely related" [1].

Although there are some differences in the way the above terms are used by different researchers, all definitions have three main common aspects:

- Communications means (network infrastructure / technology / ICT)
- Communication between different action authorities
- Target (public participation or others)

For example, the Canadian Federal Government (CFG) defines SMART as communities where local leaders and stakeholders, through the use of electronic networks and the Internet, forge alliances and partnerships for innovation and extracting new economic resources [2]. Social value lies in this definition, focusing on network deployment (transport, ICT), as well as investments in human and social capitals in support of sustainable community objectives and life quality, through social participation as well as user technologies and smart community applications.

Smart City is "a city that makes a conscious effort to use ICTs in a creative way to support a more inclusive, diverse and sustainable urban environment". This concept adopted by California Institute of Smart Communities [3] focusing on the importance of social and environmental capital in urban development; which means communities that teach their citizens to learn, adapt and innovate. Also focuses strongly on social inclusion and participation in community affairs and decision-making processes to achieve social and environmental goals.

3.1 The concept of "smart" criteria S.M.A.R.T.:

The expression "smart" SMART is the abbreviation of the letters S and M usually means specific and measurable, the most common that the remaining letters A, R and T refer to achievable, relevant and time-bound. Doran and George T. have identified the standards of S.MA.R.T. "As a method of writing management objectives, management review" 2008 as follows: [4]

- Specific: Target specific area for improvement.
- Measurable: or suggest at least an indicator of progress.
- Achievable, Assignable or Attainable: Select who will do this.
- Relevant or Realistic: results that can be realistically achieved given the resources available.
- Time-bound or Time related: Determine when the result can be achieved

Criteria are illustrated and explained in Table (1)

Table 1- The most common meanings of SMART standards and their alternatives [5]

Letter	Most common	Alternative
S	Specific	Strategic and specific
M	Measurable	Motivating (Source: One Minute Manager)
A	Achievable	Agreed, attainable, action-oriented, ambitious, aligned with corporate goals, (agreed, attainable and achievable)
R	Relevant	Realistic, resourced, reasonable, (realistic and resourced), results-based
T	Time-bound	Trackable (Source: One Minute Manager), Time-based, time limited, time/cost limited, timely, time-sensitive, timeframe, Testable

Doran and George T. on SMART standards said:

"Notice that these criteria don't say that all objectives must be quantified on all levels of management. In certain situations it is not realistic to attempt quantification, particularly in staff middle management positions. Practicing managers and corporations can lose the benefit of a more abstract objective in order to gain quantification. It is the combination of the objective and its action plan that is really important. Therefore, serious management should focus on these twins and not just the objective."[4].

3.2 Dimensions of Smart City Development:

Regarding the economy, a "smart" city can be a city that hosts a "smart" industry (i.e., an industry that is either a producer or user of innovative ICT), or a city that develops high-ICT-based business parks in its territory. Also smart term is used to describe a city with a high "intelligent" population, i.e. highly educated local human resources [3]. Smart city is a city relies heavily on government-citizen interaction on ICTs, or a city that shows strong ICT participation in decision making (Electronic Democracy) [6], moreover, may refer to a city taking advantage of modern ICT in urban processes in order to improve the quality of life of its population (such as 'smart' transportation systems to support urban traffic management), and finally, the term uses To describe a city that uses ICT to improve services in several areas, for example: Security/safety, health, green development, or sustainable energy consumption [7].

In the European Smart Cities Project (Vienna University of Technology), six dimensions of "intelligence" were identified, indicating: economy, local citizens, governance, mobility, environment and way of living, shown in Figure (1), along with a set of indicative issues rose within each category [3].

How to turn cities into smart cities :

- Organize a fair distribution of resources and responsibilities in various areas of government and strengthen local governments to enable them to act as autonomous institutions that deliver services effectively and efficiently
- Provide an integrated and transparent governance framework as well as clear directions of authority and accountability to achieve the objectives of "good urban governance."
- Facilitate and promote the principle of inclusiveness, civic participation and the active involvement of civil community in city administration.
- Enable cities to work towards operation and maintenance to provide planned and integrated infrastructure.
- Develop partnerships with the public, private and other sectors to enhance providing and delivering service.
- Extend the scope of information technology and e-government to all aspects of city management in order to provide services effectively, efficiently and quickly [8].

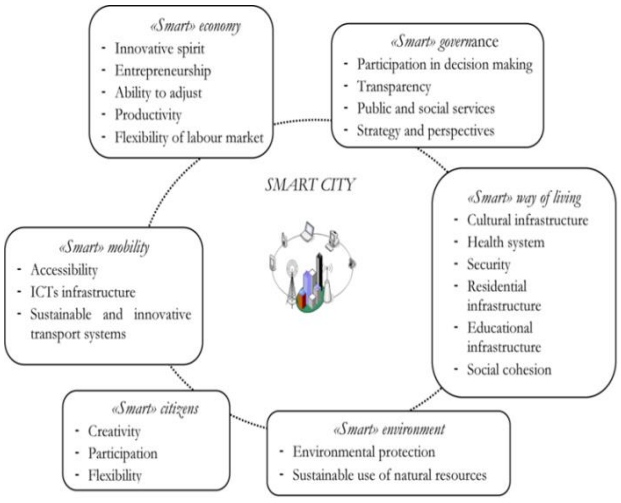


Figure 1- Dimensions of Smart City Development [9] (Adapted by Tsarchopoulos, 2006)

4. Global Classifications
(Frameworks and models used to measure the performance of smart communities/cities)

The Canadian Smart Cities Institute (CSCI), organized the SMART95, the first smart city conference, held in Toronto in September 1995. Then moved from Canada to New York City in the late 1990s in what is called the Smart Community Forum as a non-profit global center; afterwards called "smart cities" since the mid-nineties. Smart Cities / Communities well known as SMART21 where 7 smart clusters/cities are chosen on October each year among the best 21 smart cities from all over the world, for measurement purposes, called TOP7. Then in January, a typical example out of TOP7 is chosen annually to represent the "Smart Community of the Year" which serves as the best reference community and most recently the ECV Summit in Columbus, Ohio, 2016 [10].

Cities are expected to benefit from the use of these performance indicators, which take into account the elements of a sustainable smart city that is heavily ICT-based and provide a documented measure of progress in the transition to sustainable smart cities, where they have joined the United Nations Smart Sustainable Initiative (U4SSC) launched by ITU. International Telecommunication Union and the United Nations Economic Commission for Europe in Rome on 18 May 2016.

There are many models to measure the performance of smart cities even they might vary in measurement indicators for which a relative weight is assigned for quantitative evaluation. Those models frames are:

4.1 City Keys Smart Cities Performance Framework

The City Keys framework contains five basic dimensions; varying relatively in weights between 13% and 27%, and distributed to each dimension according to the performance measurement indicators shown in Table (2) [11]. Based on the study of indicators from 43 existing indicators, a set of indicators was designed to evaluate the Smart City projects and the performance of Smart Cities for the City Keys framework; also new indicators were proposed to fill the gaps in existing frameworks, mostly related to specific characteristics of Smart City projects. [12]

The indicators were arranged in an expanded bottom-up tripartite sustainability framework: People, planet and prosperity, finishing with specific smart city indicators, and sub-themes were identified that match key policy ambitions. This framework contains 92 project indicators and 73 city indicators, with all three-level sustainability indicators:

- Indicators for evaluating smart city projects that assess or evaluate individual projects, which indicate the difference that the project has made, or compare projects with each other.

Smart city indicators focus on monitoring the development of the city towards a smarter city "development over the years" and city indicators can be used to show the extent to which public policy objectives have been reached [13][14].

Table (2) – City Keys: Smart city indicators framework

People	**Weight**	**Planet**	**Weight**	**Prosperity**	**Weight**	**Governance**	**Weight**	**Propagation**	**Weight**
Health	3	Energy & Mitigation	7	Employment	2	Organization	6	Scalability & Replicability	10
Safety	4	Materials, Water & Land	10	Equity	2	Community Involvement	5	Aspects of success	8
Access to Other Service	8	Climate Resilience	1	Green Economy	3	Level -Multi Governance	2		
Education	3	Pollution & Waste	4	Economic Performance	5				
& Diversity Social Cohesion	3	Ecosystem	2	Innovation	5				
Quality of Housing & the Built Environment	6			Attractiveness & Competitiveness	1				
	27		24		18		13		18
100%									

4.2 ICF Standards as Performance Indicators for Smart Communities:

ICF - Intelligent Community Forum is a global network that connects hundreds of cities and regions on five continents to collaborate on economic development and exchange experiences and information that drive comprehensive prosperity, solving social problems and enriching the quality and quality of life in these communities :

- Broadband
- Knowledge Workforce
- Innovation
- Environmental Sustainability
- Advocacy

4.3 International Standardization Organization (ISO)

In October 2015 the ISO/TS 37151 issued for :

- Smart community infrastructures
- Principles and requirements for performance metrics.

International Standardization Organization (ISO) is a global federation of national standards bodies (ISO member bodies). International standards are usually prepared by ISO technical commissions, and each interested member body has the right to establish a technical committee to be represented in that committee, intergovernmental and non-governmental organizations also participate in liaison with the International Organization for Standardization (ISO) technical Standardization) [16].

The committee responsible for this document is ISO / TC 268, on sustainable development in communities, and SC1 on smart community infrastructures. Communities have different goals to achieve such as quality of life, economic growth, poverty reduction, pollution control, and alleviation of congestion. Community infrastructure such as energy, water, transport, waste control and ICTs are supportive of communities and their activities. Therefore, investment in such infrastructures enables communities to achieve internationally recognized societal goals (such as the UN Nations Millennium Development Goals (MDGs [17]) and promote pro-poor growth [18]. According to The Organization for Economic Co-operation and Development (OECD) Infrastructure 2030 accumulated to reach about 53 trillion US dollars during the period 2010/2030.

4.4 The de Bord Urban Framework (de Bord 2014, R. P. Dameri) for measuring smart city performance

The de Bord urban framework is a comprehensive framework that aims to link quantitative and qualitative indicators to a specific smart city strategy, select the most appropriate indicators, using urban statistical data already available in the municipality database, design a software program to achieve the smart city intelligence system, and determine the ability of this system to support more and expand Smart City Initiatives [19][20.[

The de Bord urban framework includes some key components: the regional dimension, technologies, products (services and infrastructure) and objectives, i.e. the life quality of citizens that respect the environment. This definition is able to describe the behavior of cities that trying to implement smart initiatives, even if they are not aware of the results and goals [21]. The definition of a Smart City describes this general framework as shown in Figure (2); it resembles the Smart Value Chain of Smart City [22].

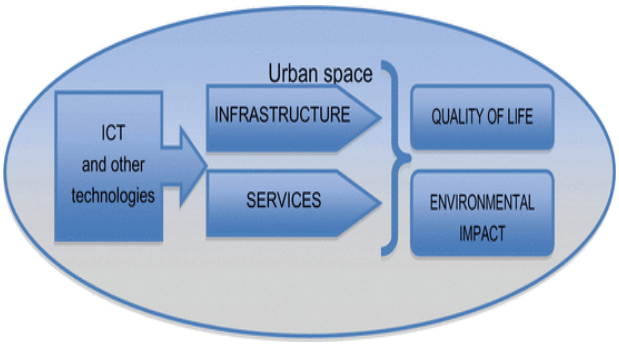


Figure 2- The general framework of the Smart City according to de Bord [17]

This classification reflects the OECD S-curve model to assess the impact of ICTs on people [22, 23]; Table (3) describes the multidimensional nature of the de Bord framework.

Table (3) – Brad framework for measuring smart cities performance

:Topic vision Fields of Interest	Context :Vision The Stakeholders	:Dynamic Vision Output and Outcome
• Smart Mobility • Smart Environment • Smart People • Smart Living • Smart Governance • Smart Economy	• Citizens • Public Administration • Businesses	• Used Technology • Services & Infrastructure • Quality of Life & Environmental Impact

4.5 Framework of the Regional Science Center at the Vienna Technical University

A group of researchers at the Regional Science Center at the Technical University of Vienna identified 31 factors for assessing smart cities: (smart economy, smart people, smart government, smart mobility, smart environment, smart life), Eleven indicators were selected to analyze the performance of each factor [24]. The criteria were selected based on the concept of Smart City, which was used to reflect areas that use ICTs or cities with smart industries, including smart industries, as well as other industries using technologies in production processes, as well as cities seeking development of the education system.

This concept also includes the nature of relationship between government and citizens. Also, the use of modern technologies in daily life, not only limited to information and communication technologies, but also extends to modern transport technologies, in addition to many other concepts such as: security, safety, sustainability, and energy. Therefore, evaluation takes place through a hierarchical structure; each level expresses the level that precedes it. Each dimension is represented by a number of factors, and each factor is represented by a number of indicators.

4.6 Relative weights for smart city performance indicators in the framework of the University of Vienna:

The relative weight is divided equally among the six main dimensions, each of which constitutes 16.67% of the total relative weight. Table (4) shows the relative weight of each sub-criterion separately. The Vienna Technical University framework (as an integrated framework) was applied to measure the performance of seven cities: Bonn, Bristol, Stockholm, Rennes, Helsinki, Amsterdam and Copenhagen that is in several European countries: Germany, England, Sweden, France, Finland, Norway and Denmark according to the data of 2015. The evaluation of the six dimensions of the framework is evaluated for each dimension in the range from +2 to -2 as shown in Figure (3), the last column represents the overall average rating.

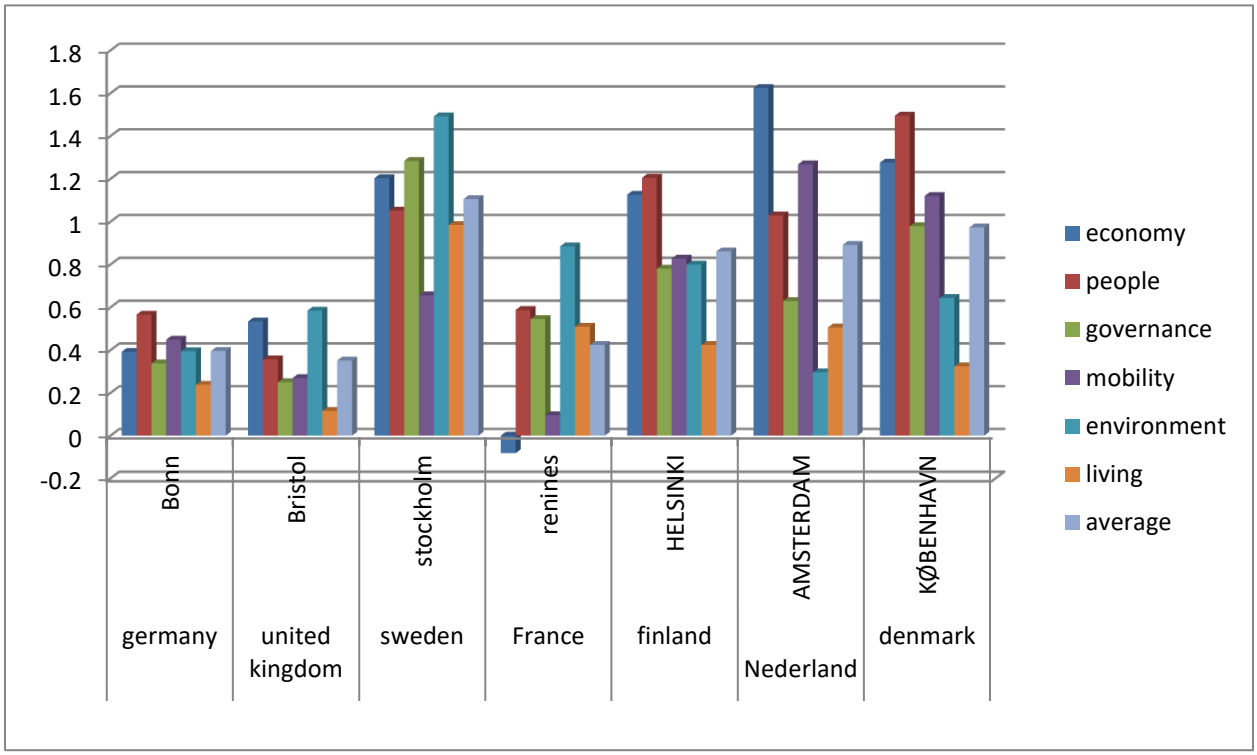


Figure 3- Application of the Vienna Technical University framework to measure the performance of smart cities on seven European cities [24]

Table 4- Relative Weights of Smart City Performance Measurement Frameworks at the Technical University of Vienna [24]

Criterion	Factors	**Relative weight**
Economy Smart	Innovative spirit	2.78%
	Entrepreneurship	2.78%
	Economic image & trademarks	2.78%
	Productivity	2.78%
	Flexibility of labor market	2.78%
	International embeddedness	2.77%
	Total	16.67%
Smart People	Level of qualification	4.17%
	learning Lifelong	4.17%
	Ethnic plurality	4.17%
	mindedness-Open	4.16%
	Total	16.67%
Smart Governance	Participation public life	5.55%
	Public and social services	5.55%
	Transparent governance	5.55%
	Total	16.65%
Smart Mobility	Local accessibility	4.17 %
	International accessibility	4.17%
	Infrastructure-Availability of IT	4.17%
	Sustainability of the transport system	4.16%
	Total	16.67%
Smart Environment	Environmental conditions	4.175%
	(Air quality (no pollution	4.17%
	Ecological awareness	4.17%
	Sustainable resource management	4.16%
	Total	16.67%
Smart Living	Cultural facilities	2.38%
	Health conditions	2.38%
	Individual security	2.38%
	Housing quality	2.38%
	Education facilities	2.38%
	Touristic attractiveness	2.38%
	Economic welfare	2.39%
	Total	16.67%
Total		**100%**

5. GAP Analysis and Identification of Absent Dimensions and Indicators in the Performance Frameworks of Smart Communities

From the previous analysis of the global frameworks that measure the performance of smart cities, it is clear that the absence of the dimensions of civilization, urban and cultural identity makes smart cities repetitive in all environments, no matter how different these environments are regarding cultural and urban identity. This blurs the identity of people and civilizations throughout the ages as if smart cities have become templates regardless the social aspects. That leads to absence of urban formation, architectural iconography, uniqueness and mental and visual image of the city, in addition to the lack of frameworks for strategic planning and the economic base of the city and some elements of environmental sustainability.

Also, the measurements were based on dividing the relative weight equally on the main dimensions, although the number of indicators varies for each dimension, which makes the relative weight of the index is linked to the number of indicators of one dimension which lacks neutrality as the less the number of indicators the greater the relative weight of the index and the more the number of indicators the less weight of each index.

Therefore, there was an urgent need to add the culture and civilization dimension to confirm the identity of the smart city with the subsequent measurement indicators, in addition to proposing an accurate mathematical method to calculate the relative weights of the dimensions and indicators other than equal division to ensure the true measurement according to the priority and weight of each dimension and indicator (shown in Table: 5).

Table 5- Calculation of the relative weights of the dimensions (KPIs) indicators of the proposed model

Main Dimensions	Sub-Dimensions	Examples of Smart Cities evaluation			Average of 3 Cities Evaluation	Percentage / Dimension	Average of 7 Cities Evaluation Figure (3)	Relative weight	
		Singapore, Singapore	Trikala, Greece	,Barcelona Spain					
D1	D1-1	0.25	0.30	1.4	1.95	50.0	4.807	14.1	7.050
	D1-2	-0.2	0.10	-0.3	-2.2	15.0			2.115
	D1-3	-1.75	-0.15	1.0	-0.95	35.0			4.935
D2	D2-1	-0.25	0.25	0.5	0.5	23.0	4.687	13.8	3.174
	D2-2	-0.5	1.0	1.75	2.25	30.0			4.278
	D2-3	-0.2	0.5	2.0	0.5	23.0			3.174
	D2-4	-0.3	0.05	0.75	0.5	23.0			3.174
D3	D3-1	-0.4	-0.8	-0.3	-0.5	10.0	5.098	15.0	1.5
	D3-2	0.8	0.7	-0.1	0.5	35.0			5.25
	D3-3	0.7	0.3	0.3	0.4	20.0			3.0
	D3-4	0.6	0.05	0.05	0.5	35.0			5.25
D4	D4-1	0.7	0.1-	-0.1	0.2	9.5	3.103	9.1	0.854
	D4-2	0.5	-0.5	0.8	0.3	14.2			1.281
	D4-3	-0.1	0.1	0.02	0.01	1.1			0.100
	D4-4	0.1	0.7	1.2	0.7	33.0			3.002
	D4-5	0.2	1.3	0.3	0.6	28.4			2.573
	D4-6	0.5	-0.02	-0.02	0.1	4.8			0.436
	D4-7	-0.2	0.2	0.2	0.2	9.5			0.854
D5	D5-1	1.0	-0.1	2.1	3.0	40.5	5.704	16.8	6.603
	D5-2	-0.8	-0.9	0.2	-1.5	7.7			1.083
	D5-3	0.4	-0.2	2.0	2.2	29.7			4.790
	D5-4	-0.2	1.2	0.5	1.5	20.2			3.193
	D5-5	0.2	0.2	0.2	0.2	10.9			1.631
D6	D6-1	-0.3	0.25	0.3	0.25	4.00	6.073	17.9	0.716
	D6-2	0.1	-0.25	0.6	0.45	8.00			1.432
	D6-3	1.5	0.125	2.00	3.6	42.0			7.519
	D6-4	0.3	0.5	0.5	1.3	20.0			3.58
	D6-5	-1.75	-0.4	1.5	-0.35	2.00			0.358
	D6-6	0.3	0.125	2.00	2.4	24.0			4.297
D7	D7-1					27.0	4.500	13.3	3.591
	D7-2					25.0			3.325
	D7-3					20.0			2.66
	D7-4					13.0			1.729
	D7-5					15.0			1.995
Total							**33.972**	**100**	

6. Proposed Model for Measuring the Performance of Smart Communities / Cities in Egypt

The Model Architecture (The Absent Dimension):

The model was based on a set of dimensions derived from global frameworks with the addition to new dimensions as a result of studying the gap between what exists and what is proposed to emphasize the dimensions of civilization, cultural and social identity as well as the mental and visual image and economic base ... etc. According to the characteristics of each sub-dimension, indicators have been identified.

As for the relative quantitative weights of the indicators, a mathematical method was followed to determine the frequency of the main and sub dimensions, after adding the absent/new dimensions into two groups of cities, with a total number of 10 cities. The frequency averages were updated for the first group of 7 cities after adding the civilization and urban identity dimension and the relative weights of the main dimensions were extracted. The frequency averages were also updated for the second group of 3 cities after adding the new sub-dimensions to determine the frequency ratio for each sub-dimension within its group to the dimension. Then Adding up all those frequencies and considering them 100% for the group and for all groups and thus calculate the relative weight of each sub-dimension, following the same means, divides it evenly among the indicators of each sub-dimension to calculate the relative weight of each indicator as shown in Table (5).

6.1 Proposed Model

The proposed model consists of 7 main dimensions, 34 sub-dimensions, and 93 indicators as indicated in Table (6) by which the performance of smart cities can be measured in addition to measuring the performance of cities wishing to convert to smart cities as well. This measuring method would be done periodically to evaluate how the city developing its performance.

Table (6)- The proposed model for measuring the performance of smart communities/cities

Proposed Assessment Model for the Performance of SMART Communities / Cities							
Dimensions	**Sub-Dimensions**	**Characteristics**	**Key Performance Indicators (KPIs)**	**Relative Weight (%)**	**Evaluation**	**Assessment**	**Total**
D1. Smart Governance	**D1-1. 7.050%** Participation in public life	The rate of participation	City representatives in relation to the population	2.35			7.050
		The rate of participation	Political activities for individuals	2.35			
		Type of participation	The importance of politics for individuals	2.35			
	D1-2. 2.115% and social Public services	Spending rate	Municipal spending in relation to the population	0.705			2.115
		Childhood representation	Children's participation in care centers	0.705			
		Quality satisfaction measurement for education	Individual satisfaction with the quality of schools	0.705			
	D1-3. 4.935% Transparent governance	Equal opportunity	Satisfaction with transparency	2.4675			4.935
		Accountability	Consensus on fighting corruption	2.4675			
Total of the dimension							**14.1**

Table (6) (Continued) -model for measuring the performance of smart communities / cities The proposed

Dimensions	Sub-Dimensions	Characteristics	Key Performance Indicators (KPIs)	Relative Weight (%)	Evaluation	Assessment	Total
D2. Smart Mobility	**D2-1 3.174%** Local accessibility	Public transportation availability	Public transport network in relation to the number of individuals	1.058			3.174
		Access to public transport	Individual satisfaction with ease of access	1.058			
		Public transportation efficiency	Individuals' satisfaction with the quality of public transportation	1.058			
	D2-2. 4.278% International accessibility	International mobility	Global accessibility	4.278			4.278
	D2-3. 3.174% Availability of IT-Infrastructure	Home communication capabilities	Availability of computers at homes	1.587			3.174
		Internet service	Availability of broadband internet in homes	1.587			
	D2-4. 3.174% Sustainability of the transport system	The Preservation of the environment	Transport sharing	1.058			3.174
		Safety and Security	traffic Safety	1.058			
		Economic mobility	Use economical cars	1.058			
Total of the dimension							**13.8**
D3. Smart Environment	**D3-1. 1.5%** Environmental conditions	Clean energy sources	Sunrise hours	0.75			1.5
			Availability of green areas	0.75			
	D3-2. 5.25% Air quality (no pollution)	Air pollution	Summer smog	1.75			5.25
		Environmental Pollution	A specific environmental problem	1.75			
		Public Health	Respiratory diseases / number of individuals	1.75			
	D3-3. 3.0% Ecological awareness	Awareness of environmental protection	Individual efforts to protect the environment	1.5			3.0
		Awareness of environmental protection	Opinion on the subject of environmental protection	1.5			
	D3-4. 5.25% Sustainable resource management	Water waste	Effective water consumption / use In relation to GDP	2.625			5.25
		Waste of energy	Electricity consumption / usage relative to GDP	2.625			
Total of the dimension							**15.0**
D4. Smart Living	**D4-1. 0.854%** Cultural facilities	Entertainment	Cinema visit rate per person	0.284			0.854
		Education	Museum visit rate per person	0.285			
		Entertainment	Theater visit rate per person	0.285			

Table (6) (Continued) -proposed model for measuring the performance of smart communities / cities The

Dimensions	Sub-Dimensions	Characteristics	Key Performance Indicators (KPIs)	Relative Weight (%)	Evaluation	Assessment	Total
D4. Smart Living	**D4-2. 1.281%** Health conditions	Public health measurement	Life rate / average age of individuals	0.321			1.281
		Material resources for health	Number of hospital beds population /	0.320			
		Human resources for health	The number of doctors in population relation to the	0.320			
		Public health system	Quality of the health system	0.320			
	D4-3. 0.100% Personal Security	Security	Crime rate	0.033			0.100
			Crime death rate	0.033			
		Measuring security efficiency	Personal satisfaction with personal security	0.034			
	D4-4. 3.002% Quality of housing	The right to housing	Providing minimum standards	1.001			3.002
		Per capita	Area of populated area / number of individuals	1.001			
		Measuring housing efficiency	satisfaction Individual with housing	1.000			
	D4-5. 2.573% Education facilities		The number of students in relation to the number of residents	0.858			2.573
		Teaching and learning	Easy access to the education system	0.858			
			Quality of the educational system	0.857			
	D4-6. 0.436% Touristic attraction		Importance as a tourist site	0.146			0.436
		Tourism development	The number of annual tourist stays in relation to the population	0.145			
	D4-7. 0.854% Economic welfare		Realizing the seriousness of poverty	0.427			0.854
		Economic awareness	Poverty rate	0.427			
Total of the dimension							**9.1**
D5. Smart People	**D5-1. 6.603%** Qualification Level	Importance as a knowledge center	The best research centers and universities	1.651			6.603
		International standard classification of Education (ISCED)	The number of qualified individuals at level 5-6	1.651			
		Stage (1 & 2) of higher education	The number of members of the two phases of the population	1.651			
		Cognitive competence	language skills	1.650			

Table (6) (Continued) -The proposed model for measuring the performance of smart communities / cities

Dimensions	Sub-Dimensions	Characteristics	Key Performance Indicators (KPIs)	Relative Weight (%)	Evaluation	Assessment	Total
D5. Smart People	**D5-2. 1.083%** Lifelong learning	Cognitive perception	Borrowing books according to the number of individuals	0.361			1.083
		Continuous education	Contribution to long-term education	0.361			
		Cultural awareness	Contribute to language courses	0.361			
	D5-3. 4.790% Ethnic pluralism		Participation of foreigners	1.596			790. 4
		Citizenship	Participation of citizens residing abroad	1.597			
			Providing a climate conductive to migration	1.597			
	D5-4. 3.193% Open Mindedness	The importance of regional participation	Turnout for regional elections	0.798			3.193
			Information about regional associations	0.798			
			Getting a new job	0.798			
		Creativity	Others participate in a creative industry	0.799			
	D5-5. 1.631% Contribution to public life	The importance of local participation	Demand for civil elections	0.815			1.631
		Self-efforts	Contributing to volunteer work	0.816			
Total of the dimension							**16.8**
D6. Smart Economy	**D6-1. 0.716%** Innovative spirit	Total research and development expenditures	Expenditures from GDP	0.239			0.716
			The employment rate in the Knowledge-based sectors	0.239			
		Patents	Patent applications relative to population	0.238			
	D6-2. 1.432% Entrepreneurship		Self-employment rate	0.716			1.432
		Create job opportunities	Number of new registered companies	0.716			
	D6-3. 7.519% Economic image & trademarks	Commercial licenses	Decision-making centers and brands	7.519			7.519
	D6-4. 3.580% Productivity	The standard of living of an individual	GDP per capita	3.58			3.58
	D6-5. 0.358% Flexibility of labor market		Unemployment rate	0.179			0.358
		Labor market requirements	Partial employment rate	0.179			

Table (6) (Continued) -The proposed model for measuring the performance of smart communities / cities

Dimensions	Sub-Dimensions	Characteristics	Key Performance Indicators (KPIs)	Relative Weight (%)	Evaluation	Assessment	Total
D6. Smart Economy	D6-6. 4.297% International embeddedness	Pushing toward globalization	The headquarters of international companies	1.075			4.297
		The local stock market	Market Contribution	1.074			
			transportation for Air passengers	1.074			
			Goods' air transportation	1.074			
Total of the dimension							**17.9**
D7. Civilization and Urban Identity	D7-1. 3.591% Cultural Identity	Symbolism	Historical / philosophical / functional reference	1.197			3.591
		Tie to intellectual significance	Political / religious / social significance	1.197			
		Development of the spirit of national belonging	civilizational Trait	1.197			
	D7-2. 3.325% Iconography	Formation	Singularity / adding personality / meaning affirmation	0.832			3.325
		Amazingness	Volumetric / technological / strength / control / glory	0.831			
		Urban context	Harmony with the surrounding environment	0.831			
		Economic return	Attracting investment (global / regional / local)	0.831			
	D7-3. 2.66% Mental Image		Landmarks	0.665			2.66
		Visual structure elements	Visual sequences and tracks	0.665			
			Squares and visual nodes	0.665			
			Neighborhoods, borders and landscape	0.665			
	D7-4. 1.729% Zero Carbon	Energy consumption	Reduction of energy consumption	0.577			1.729
		Land use	Standard ratios (zero (carbon	0.576			
		Environmental sustainability	Technologies, materials, and operating systems	0.576			
	D7-5. 1.995% Strategic Plan	Site	access / Ease of availability of resources	0.499			1.995
		The influence	Global / regional / local level	0.499			
		The economic base	Renewable growth poles	0.499			
		The possibility of growth	Growth opportunities (horizontal / vertical)	0.498			
the dimension Total of							13.3
TOTAL							**100.00**

7. Measuring the Performance of Smart Cities Locally (New Administrative Capital)

7.1. Reasons for choosing the New Administrative Capital for performance evaluation as a smart city

:First The administrative capital is considered, in the world in terms of intelligence [25]; which makes it not only in the ranks of smart cities, but in the forefront in those cities as it includes a group of high technologies :epresented inr

- Unified digital infrastructure.
- A smart utility network.
- Sensors and smart sensors (surveillance cameras - smart parking spaces - smart lighting systems)
- The Security Authority Center, which is affiliated with the Ministry of Interior.
- The city's administration and operation center, which belongs to the company responsible for the administration of the capital.

:Second The city was designed according to seven basic principles that confirm its design concept as a smart city. These principles are ummarized as :follows

a) The city is designed to exceed a 15 per capita share of green areas and open spaces, which is higher than the world standard :A green city m^2 .average

b) Use all the determinants and standards of sustainability such as energy generation from renewable sources and waste :A sustainable city .recycling

c) Allocating 40% of the road network for pedestrians and bicycles in order to encourage people to exercise and in the same time reducing car exhaust :A pedestrian city .

d) The housing represents only 30% of the city area, and the city was divided into three regions according to the :following densities :A city of habitation and life

- of high density housing %35
- singaverage density hou %50
- low density housing %15

e) The city is planned with a progressive and diversified road network of smart transportation and includes all means of transportation such as train, tram, metro, .microbus and taxi :A connected city

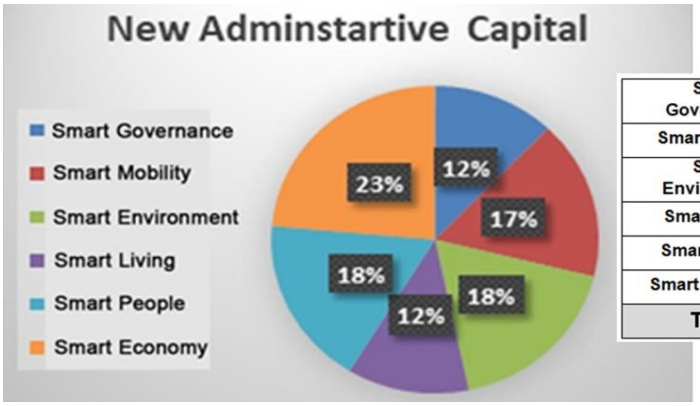
f) esigned with the aim The city was d of becoming one of the most intelligent cities in the world; it contains all available digital technology that would be provided to the population, as well as all electronic methods of .dealing with the public or monitoring systems :A smart city

g) It includes an international center for finance and business that includes the .Greater Cairo sector and the Suez Canal region :business city The

Therefore, the New Administrative Capital in Egypt is one of the cities that possess the components of societies/cities, as well as the first Egyptian smart experience, that makes it a good candidate to be chosen to validate the capability of the proposed .model in measuring the performance of smart cities

7.2. Measuring the performance of the New Administrative Capital as a smart city:

The proposed model was applied to the administrative capital to test the capability of the model and to evaluate the Egyptian experience in establishing smart cities/communities according to from global the dimensions and indicators extracted the measurement result was ‹**(4) ureFig** models ‹after adding new dimensions and indicators ‹%63.51 the measurement result was ‹**(5) ureFig** ‹**(Table (7** and this confirms the correspondence of the ‹%73.45 models. measurement result with global and regional That confirms and maximizes the benefits of using the new model to measure the performance of smart cities at all global, regional and local levels. Also the ability of using it to evaluate and measure the ave been performance of traditional cities those h .transformed to smart cities or wish to do so



Smart Governance	7.65
Smart Mobility	10.55
Smart Environment	11.25
Smart Living	7.596
Smart People	11.15
Smart Economy	14.855
Total	63.051

Figure (4) - Evaluating the New Administrative Capital according to the dimensions from international models

Table (7) - Evaluation of the performance of the New Administrative Capital in Cairo
(after adding new dimension indicators)

Proposed Assessment Model for the Performance of SMART Communities / Cities							
Dimensions	**Sub-Dimensions**	**Characteristics**	**Key Performance Indicators (KPIs)**	**Relative Weight (%)**	**Evaluation**	**Assessment**	**Total**
D1. Smart Governance	**D1-1. 7.050%** Participation in public life	The rate of participation	City representatives in relation to the population	2.35	1.5		7.050
		participation The rate of	Political activities for individuals	2.35	1		
		Type of participation	The importance of politics for individuals	2.35	1.5		
	D1-2. 2.115% Public and social services	Spending rate	Municipal spending in relation to the population	0.705	0.6		2.115
		Childhood representation	Children's participation in care centers	0.705	0.6		
		Quality satisfaction measurement for education	Individual satisfaction with the quality of schools	0.705	0.5		
	D1-3. 4.935% Transparent governance	opportunity Equal	Satisfaction with transparency	2.4675	0.75		4.935
		Accountability	Consensus on fighting corruption	2.4675	1.2		
Total of the dimension					**7.65**		**14.1**
D2. Smart Mobility	**D2-1 3.174%** Local accessibility	Public transportation availability	Public transport network in relation to the number of individuals	1.058	0.8		3.174
		Access to public transport	Individual satisfaction with ease of access	1.058	0.8		
		Public transportation efficiency	Individuals' satisfaction quality of public with the transportation	1.058	0.8		
	D2-2. 4.278% International accessibility	International mobility	Global accessibility	4.278	4		4.278
	D2-3. 3.174% Availability of IT-Infrastructure	Home communication capabilities	Availability of computers at homes	1.587	1.3		3.174
		Internet service	Availability of broadband internet in homes	1.587	1		
	D2-4. 3.174% Sustainability of the transport system	The Preservation of the environment	Transport sharing	1.058	0.9		3.174
		Safety and Security	traffic Safety	1.058	0.75		
		Economic mobility	Use economical cars	1.058	0.2		
Total of the dimension					**10.55**		**13.8**

Table (7) continued - Evaluation of the performance of the New Administrative Capital in Cairo (after adding new dimension indicators)

Dimensions	Sub-Dimensions	Characteristics	Key Performance Indicators (KPIs)	Relative Weight (%)	Evaluation	Assessment	Total
D3. Smart Environment	**D3-1. 1.5%** Environmental conditions	Clean energy sources	Sunrise hours	0.75	0.65		1.5
			Availability of green areas	0.75	0.7		
	D3-2. 5.25% Air quality (no pollution)	Air pollution	Summer smog	1.75	1.45		5.25
		Environmental Pollution	A specific environmental problem	1.75	1.6		
		Public Health	Respiratory diseases / number of individuals	1.75	1.6		
	D3-3. 3.0% Ecological awareness	Awareness of environmental protection	Individual efforts to protect the environment	1.5	1		3.0
		Awareness of environmental protection	Opinion on the subject of environmental protection	1.5	1		
	D3-4. 5.25% Sustainable resource management	Water waste	Effective water consumption / use In relation to GDP	2.625	1.5		5.25
		Waste of energy	Electricity consumption / usage relative to GDP	2.625	1.75		
Total of the dimension					**11.25**		**15.0**
D4. Smart Living	**D4-1. 0.854%** Cultural facilities	Entertainment	Cinema visit rate per person	0.284	0.26		0.854
		Education	Museum visit rate per person	0.285	0.26		
		Entertainment	Theater visit rate per person	0.285	0.26		
	D4-2. 1.281% Health conditions	Public health measurement	Life rate / average age of individuals	0.321	0.3		1.281
		Material resources for health	Number of hospital beds population /	0.320	0.3		
		Human resources for health	The number of doctors in relation to the population	0.320	0.3		
		Public health system	Quality of the health system	0.320	0.25		
	D4-3. 0.100% Personal Security	Security	Crime rate	0.033	0.03		0.100
			rate Crime death	0.033	0.03		
		Measuring security efficiency	Personal satisfaction with personal security	0.034	0.02		
	D4-4. 3.002% Quality of housing	The right to housing	Providing minimum standards	1.001	0.9		3.002
		Per capita	/ Area of populated area number of individuals	1.001	1		
		Measuring housing efficiency	Individual satisfaction with housing	1.000	0.7		

Table (7) continued - Evaluation of the performance of the New Administrative Capital in Cairo (after adding new dimension indicators)

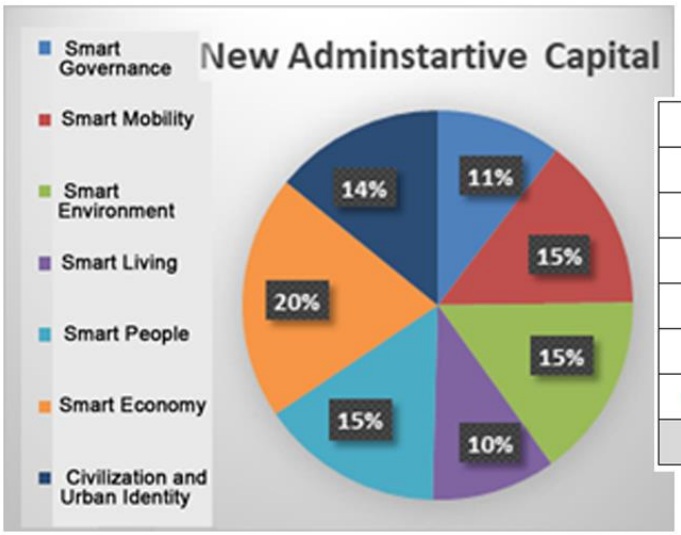
Dimensions	Sub-Dimensions	Characteristics	Key Performance Indicators (KPIs)	Relative Weight (%)	Evaluation	Assessment	Total
D4. Smart Living	D4-5. 2.573% Education facilities		The number of students in relation to the number of residents	0.858	0.7		2.573
		Teaching and learning	Easy access to the education system	0.858	0.65		
			Quality of the educational system	0.857	0.6		
	D4-6. 0.436% Touristic attraction		Importance as a tourist site	0.146	0.086		0.436
		Tourism development	number of annual The tourist stays in relation to the population	0.145	0.15		
	D4-7. 0.854% Economic welfare		Realizing the seriousness of poverty	0.427	0.4		0.854
		Economic awareness	Poverty rate	0.427	0.4		
Total of the dimension					**7.596**		**9.1**
D5. Smart People	D5-1. 6.603% Qualification Level	Importance as a knowledge center	The best research centers and universities	1.651	0.9		6.603
		International standard classification of Education	The number of qualified individuals at level 5-6	1.651	0.65		
		Stage (1 & 2) of higher education	The number of members of the two phases of the population	1.651	1.4		
		Cognitive competence	language skills	1.650	1.2		
	D5-2. 1.083% Lifelong learning	perception Cognitive	Borrowing books according to the number of individuals	0.361	0.2		1.083
		Continuous education	Contribution to long-term education	0.361	0.15		
		Cultural awareness	Contribute to language courses	0.361	0.2		
	D5-3. 4.790% Ethnic pluralism		Participation of foreigners	1.596	1.25		790. 4
		Citizenship	Participation of citizens residing abroad	1.597	1.25		
			Providing a climate conductive to migration	1.597	1.2		
	D5-4. 3.193% Open Mindedness	The importance of regional participation	Turnout for regional elections	0.798	0.3		3.193
			Information about regional associations	0.798	0.3		
			Getting a new job	0.798	0.6		
		Creativity	Others participate in a creative industry	0.799	0.4		

Table (7) continued - Evaluation of the performance of the New Administrative Capital in Cairo (after adding new dimension indicators)

Dimensions	Sub-Dimensions	Characteristics	Key Performance Indicators (KPIs)	Relative Weight (%)	Evaluation	Assessment	Total
D5. Smart People	**D5-5. 1.631%** Contribution to public life	The importance of local participation	Demand for civil elections	0.815	0.4		1.631
		Self-efforts	Contributing to volunteer work	0.816	0.75		
Total of the dimension					**11.15**		**16.8**
D6. Smart Economy	**D6-1. 0.716%** Innovative spirit	Total research and development expenditures	Expenditures from GDP	0.239	0.05		0.716
			The employment rate in the Knowledge-based sectors	0.239	0.17		
		Patents	Patent applications relative to population	0.238	0.085		
	D6-2. 1.432% Entrepreneurship		Self-employment rate	0.716	0.65		1.432
		Create job opportunities	Number of new registered companies	0.716	0.5		
	D6-3. 7.519% Economic image & trademarks	Commercial licenses	Decision-making centers and brands	7.519	6.5		7.519
	D6-4. 3.580% Productivity	The standard of living of an individual	GDP per capita	3.58	2.7		3.58
	D6-5. 0.358% Flexibility of labor market		Unemployment rate	0.179	0.1		0.358
		market Labor requirements	Partial employment rate	0.179	0.1		
	D6-6. 4.297% International embeddedness	Pushing toward globalization	The headquarters of international companies	1.075	1		4.297
		The local stock market	Market Contribution	1.074	1		
			Passengers' air transport	1.074	1		
			Goods' air transport	1.074	1		
Total of the dimension					**14.85**		**17.9**
D7. Civilization and Urban Identity	**D7-1. 3.591%** Cultural Identity	Symbolism	Historical / philosophical/ functional reference	1.197	0.7		3.591
		Tie to intellectual significance	Political / religious / social significance	1.197	1.1		
		Development of the spirit of national belonging	civilizational Trait	1.197	1.1		
	D7-2. 3.325% Iconography	Formation	Singularity / adding personality / meaning affirmation	0.832	0.4		3.325
		Amazingness	Volumetric / technological / strength / control / glory	0.831	0.65		
		Urban context	Harmony with the surrounding environment	0.831	0.65		
		Economic return	Attracting investment (regional / local / global)	0.831	0.7		

Table (7) continued - Evaluation of the performance of the New Administrative Capital in Cairo (after adding new dimension indicators)

Dimensions	Sub-Dimensions	Characteristics	Key Performance Indicators (KPIs)	Relative Weight (%)	Evaluation	Assessment	Total
D7. Civilization and Urban Identity	D7-3. 2.66% Mental Image		Landmarks	0.665	0.6		2.66
		Visual structure elements	Visual sequences and tracks	0.665	0.6		
			Squares and visual nodes	0.665	0.6		
			Neighborhoods, borders and landscape	0.665	0.6		
	D7-4. 1.729% Zero Carbon	Energy consumption	Reduction of energy consumption	0.577	0.4		1.729
		Land use	Standard ratios (zero (carbon	0.576	0.35		
		Environmental sustainability	materials, ،Technologies and operating systems	0.576	0.35		
	D7-5. 1.995% Strategic Plan	Site	Ease of access / availability of resources	0.499	0.45		1.995
		The influence	Global / regional / local level	0.499	0.35		
		The economic base	Renewable growth poles	0.499	0.35		
		The possibility of growth	Growth opportunities (horizontal / vertical)	0.498	0.45		
Total of the dimension					**10.4**		13.3
TOTAL					**73.451**		**100.00**



Smart Governance	7.65
Smart Mobility	10.55
Smart Environment	11.25
Smart Living	7.596
Smart People	11.15
Smart Economy	14.855
Civilization and Urban Identity	10.4
Total	73.451

Figure (5) – Evaluating the New Administrative Capital after adding the missing dimensions.

8. Conclusions

Smart cities are expected to form a better future for the world especially regarding environmental issues; therefore continues assessment for such cities performance will help developing the whole approach in an efficient way. Hence, the study ew dimensions added to what has been identified n extracted from the dimensions of global frameworks to measure the performance of smart cities. Correspondingly, proposed a new model as a new approach (2020) to measure the performance of smart l can be used, as well, by cities. The proposed mode traditional city administrations looking for switching into smart cities on annual basis. In addition to that the proposed model helping to determine the progress of cities towards smart and can be used to assess the of cities and rank them among the cities performance .of the world

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