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ORIGINAL STUDY

The Indicators of the Smartness to Assess Egypt's New Administrative Capital as a Smart City

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Abstract

Smart cities have become a world-leading trend all over the globe, as they can induce an improved environment and a more acceptable quality of life. It is important to realize the main aspects of designing these cities and the variables affecting the extent of the smartness that the new cities can achieve. The indicators of achieving smartness vary from one country to another according to certain influential variables. So, to assess the extent of smartness that the New Administrative Capital 'NAC' in Egypt had achieved, the research concluded a literature review for the concept of smart cities and the most important indicators that have been applied lately to the highest-ranking smart cities, the (Statistical Package for the Social Sciences) SPSS program had been used in reaching the most effective indicators referring to the most powerful and influential variables in the smart cities. Then the results of the statistical study were applied to the new administrative capital, which is considered the leading model in Egypt. Finally, the paper deduced the smart achievements of the new administrative capital in Egypt that pushed it to be one of the smart cities of the world.

Keywords: Indicators, Influential variables, Smart city, The Egyptian New Administrative Capital 'NAC', The Statistical Package for Social Sciences (SPSS)

1. Introduction

For change, creativity, and economic growth, cities have historically functioned as the hubs. City governments are having an increasingly difficult time keeping up with citizens' evolving expectations while also tackling the difficulties and complexities of global sustainability as trends toward global urbanization continue Clarke, Stratigea and colleagues (Clarke, 2013; NIST and IES-City Framework, 2018; Stratigea et al., 2015). Due to the scale, size, and complexity of citizen demands, as well as the issues associated with sustainability, Urban planning and management must transition from conventional to more creative and effective methods. Cities all over the world are depending more and more on information and communication technologies (ICTs) to create innovative solutions for enhancing the effectiveness and efficiency of service provision and management as well as for promoting sustainability solutions in cities in response to this requirement Ahvenniemi and colleagues, Berst and colleagues, Huovila and colleagues, Kourtit and colleagues, Woods and colleagues (Ahvenniemi et al., 2017; Berst et al., 2014; Huovila et al., 2019; Kourtit and Nijkamp, 2018; Woods et al., 2017). The idea of a 'smart city' has become increasingly popular since the late 2000s, and various initiatives have been created since then in keeping with this trend Ahvenniemi and colleagues, Caragliu and colleagues, Monfaredzadeh and Berardi (Ahvenniemi et al., 2017; Caragliu et al., 2011; Monfaredzadeh and Berardi, 2015). In recent years, this tendency has picked up speed, and it is anticipated to continue Angelidou (2015). The interest in smart city projects has grown for many reasons. For instance, smart city projects are seen as essential to maintaining and gaining a competitive advantage in a globalized economy Giffinger and colleagues, Giffinger and colleagues (Giffinger et al., 2007a, 2007b; Giffinger and Gudrun, 2010); to

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drawing in the most talented, knowledgeable, and innovative people; to solve the resource challenges and sustainability concerns that demand efficiency increases; to accelerate the shift to a low-carbon civilization in order to help stabilize the climate; to increase urban management transparency; to increase Quality of Life (QOL) and address various socioeconomic issues like unemployment, insecurity, inequality, and aging populations; and, in general, to make progress toward the Sustainable Development Goals (SDGs) Angelidou, Huovila and colleagues (Angelidou, 2015; BSI, 2014; Huovila et al., 2016).

The NAC is one of the smartest city projects Egypt is attempting to establish. This city is being built in collaboration with experts in the design of such cities. Over the next five years, the capital will be built in a digital community that is friendly to the environment and encourages learning and innovation. Egypt has spent several years getting ready to enter the smart city era. New Urban Communities Authority (New Urban Communities Authority, 2022) is oriented to spread out through the establishment of these new communities, which number up to 14 cities. These 14 cities are 1- the NAC 2- New Alamein 3-New Mansoura 4-East Port Said 5-Nasser and West Assiut 6-West 7-Qena 8-New Ismailia 9-New Rafah 10-Galala City and Resort 11-New Farafra 12-New Obour City 13-New Toshka 14-East Owainat. During this time, the government's primary goal is to achieve the necessary development in the context of the transition to a digital society. In support of the directives of the political leadership, the ministries and the governmental entities have to apply the aspects of digital transformation and a paperless community. Under the supervision of the Ministry of Housing, Utilities and Urban Communities (Ministry of Housing, Utilities & Urban Communities, 2022), the government is oriented toward global technological standards to move to the new capital in a new, digital, and smart form and tactic. In its plan, the Egypt's government intends to offer all of these facilities to provide services to citizens in an easy, effective, and efficient way.

As the number of smart city projects grows, Cities throughout the world are being evaluated and ranked by a number of organizations, including universities and private consulting firms Toh (2022), there is also an increase in the development and implementation of tools and sets of indicators to assess their performance (Caird and Hallett, 2018). As smart city initiatives spread quickly, smart city assessment is playing a bigger role in monitoring their development. The IMD Smart City Index, which investigates individuals' perceptions towards the smartness of their own city (IMD Smart City Observatory, 2022), provides one way to evaluate a smart city's effectiveness and distinguish it from others. Two pillars—the Structure pillar (current infrastructure) and the Technology pillar (technology services)—serve as the foundation for the assessment Hajek and colleagues (Hajek et al., 2022).

These include research on the compilation and analysis of IMD smart city indicators using the Statistical Package for Social Sciences (SPSS) software to reach the most effective and efficient indicators to achieve the concept of smart city and will be applied to the NAC. It has not yet been ranked among the world's smart cities, and lacks any influential variables.

2. Literature review

The literature review section in this research is divided into two sections. The first section introduces smart city concepts and attempts to gain the best perception. The second section presents indicators and standards for measuring the effectiveness of smart cities, which is the main scope of this research.

2.1. The smart city concept

The term ‘smart city’ does not have a single, agreed-upon definition, and different contexts may lead to different interpretations Li and colleagues (Li et al., 2019). Digital city, virtual city, ubiquitous city, intelligent city, creative city, knowledge city, hybrid city, information city, and wired city are only a few examples of earlier paradigms that are combined, improved upon, and extended in this concept Albino and colleagues, Zygiaris (Albino et al., 2015; Zygiaris, 2012). Over the past few decades, the concept of a ‘smart city’ has changed, moving from a technology-driven approach that aimed to maximize efficiency of the hard urban infrastructure (i.e., transportation, communications, waste, energy, water, etc.) to adopting a more comprehensive approach that emphasizes the central role of people and the soft infrastructure (i.e., institutions, citizen engagement, data, social innovation, etc.). Angelidou, Meijer and Bolivar (Angelidou, 2014; Meijer and Bolivar, 2016). Through the integration of several aspects, smart cities seek to serve as agents of strategic transformation and provide resources and pathways for enhancing operational effectiveness, competitiveness, and quality of life as well as for approaching sustainability Stratigea and colleagues, Ahvenniemi and colleagues (Stratigea et al., 2015; Ahvenniemi et al., 2017). As a result, even if technology is the foundation and the point at

which smart cities are developed and advanced Meijer and Bolivar, Dehnath and colleagues (Meijer and Bolivar, 2016; Debnath et al., 2014), for efficient delivery, the success of smart cities both now and in the future, proper consideration of various aspects and their interconnections is crucial Manville and colleagues (Manville et al., 2014). In fact, ICT is expected to significantly boost interlinkages by providing connected and interoperable platforms for multi-agent and multi-stakeholder involvement, as well as increase the capacity to better understand their underlying dynamics (ISO, 2014).

In terms of smart city characteristics, The literature presents three scenarios for what makes a smart city Stefano Andreani and colleagues (Stefano Andreani et al., 2019): There are three possible scenarios: (1) a scenario focused on technology, in which technology is obviously impacting and driving the development of a smart city through technological infrastructure (hardware and software), including digital networks, mobile technologies, and virtual technologies; (2) a situation that puts people and human capital as the focus, as in the promotion of education and creativity; and (3) a scenario that considers both the technological landscape and human capital.

Previous studies implemented many definitions that deal with the concept of smart cities for multiple directions and components of these cities, as Hall defined as 'A city that monitors and integrates all elements of vital infrastructure, including roads, bridges, tunnels, railways, subway, airports, ports, telecommunications, water and power stations, and even major buildings, helping to improve resource management, plans preventive maintenance of activities; and monitors security aspects while maximizing services for its citizens' Hall (2000)., Rios (2008) It is a city that gives inspiration and spreads culture, knowledge and life, a city whose inhabitants are motivated to be herald and succeed in their own lives'. Toppeta (2010) 'The city, which combines information technology, connectivity, web technology, and other organizational structures, with design and planning efforts aimed at achieving and accelerating administrative processes to help find new and innovative solutions to the complex management of the city, to improve sustainability and the way of life'. Karadag, 'A city that uses technology to transform its core systems and effectively manage its resources, Smart use of resources drives innovation, supports competitiveness and economic growth, and investing in a smart city is a kind of sustainable employment. All platforms can be more intelligent by making them digital, allowing quick, knowledge-based decisions' Karadag (2013). Cocchia examined and contrasted works on the digital city and the smart city from 1993 to 2012. The idea of a digital city was eventually merged into the concept of a smart city. The evaluation neglected to explore the impacts of that application although noting that smart or digital cities come from the actual application of technology. Cocchia (Cocchia, 2014). In a review of the literature on smart cities from 1992 to 2012, Komninos and Mora gave an explanation of the development of the concept and study area. They also discussed the three main organizing principles used in the literature on smart cities. These comparisons highlight the differences between human initiative and technological use, top-down planning and bottom-up planning, and collective intelligence and data-driven intelligence Komninos and Mora (Komninos and Mora, 2018). In addition to the aforementioned definitions, the advantages and disadvantages of smart cities have been researched, with the major advantages being (1) increased citizen investment, (2) environmental protection, (3) social development, (4) sustainable development, (5) innovation, and (6) increased social capital. There are two key disadvantages in this regard: (1) worries about security and privacy; and (2) a deterioration in democracy and free speech Lim and colleagues (Lim et al., 2019).

These studies aid in understanding how the idea of the 'smart city' came to be, how it differs from other, related ideas like 'the digital city' and 'the sustainable city,' and how the principles of the 'smart city' are put to use in many areas of city governance. According to the previous definitions, the most important and visible concepts of smart cities refer to the use of ICT as the main common factor, as some concepts have focused on the basic product of smart cities and identified them as services and infrastructure supported using ICT, Some focused on the goal of smart cities to reach a more living, more functional, competitive and modern cities, more encouraging knowledge, innovation and management, and sustainable, many of which focused on the key themes of smart cities, the most important of which are economy, mobility, environment, people, quality of life and governance. Over the past ten years, smart city projects have expanded at an astounding rate. We anticipate that growth to continue in the years to come, especially as technologies like 5 G become more advanced. The need for efficient smart city evaluation schemes is growing quickly given that there were more than 1000 smart city projects operational in the world as of 2017 alone (Yan et al., 2020), By 2025, it is expected that the market for these projects would have doubled Hajek and colleagues (Hajek et al., 2022).

2.2. Indicators and criteria for evaluating the performance of smart cities

Indicators are signals and senses used to monitor, measure document, and evaluate progress toward the targeted goals (UNAIDS, 2007). Indicators are used to specify how close the risk is, define the current situation, and identify what actions should be taken by the decision-makers (United Nations Development Programme, 1997). It can clarify to predict the expected problems, challenges, future needs, compatibility with the vision of the political leadership, and risks (Arab Institute for Urban Development, 2001). An indicator can be defined as a quantitative and qualitative scale, used to measure a particular phenomenon or performance over a given period (UNAIDS, 2008). Thus, the indicators measure the phenomenon in its current state or through a specific period. Indicators can identify the strengths and weaknesses so SOWT analysis can be clear for the phenomenon (http://www.quickmba.-com/strategy/swot/, 2022).

Indicators are needed at all stages of development and performance-measurement planning, decision-making processes toward sustainability (Global AIDS Program, 2003), from the preparatory phase of urban projects, planning, design, implementation, follow-up, monitoring, and evaluation, and therefore the various indicators and their divisions vary in performance, timeliness, clarity, level, information type, and sustainability (UNAIDS, 2008).

Many researchers, institutes, and organizations have developed criteria and indicators to evaluate the performance of smart cities such IMD-SUTD Smart City Index, AT Kearney Global Cities Index, IESE Cities in Motion Index, Easy Park Cities of the Future Index, Mori-Foundation Global Power City Index and Smart Eco City Index Toh (2022), which in turn enhance the competitiveness of smart cities, as shown in Table 1.

A critical evaluation of 34 smart city assessment methods was carried out by Sharifi (2019), who looked at their thoroughness, viability, adaptability, participative development, context relevance, and alignment with strategic goals. In addition to 164 papers were examined in order to undertake a content analysis of recent research on smart city assessment by Hajek, P., Youssef, A., Hajkova, V., (2022). They distinguished three stages of study and development: the first, which began in 2011, focused on the creation of frameworks for measuring sustainability and smart cities; the second, which began in 2015–2016, concentrated on smart city indicators and standards, assessment frameworks and tools, and implementation issues; and the third, which began after 2016, concentrated on sustainable smart cities, comprehensive evaluation, citizen involvement, and data connectivity.

This evaluation is required to compare cities and benefit from the best experience, identify smart city features, weaknesses, and the effort required to overcome them, identify each city's comparative advantages, and potential development opportunities, and assess the city's current state of development in comparison to the other cities. Moreover, it attracts people's attention to issues concerning the development of smart cities. The statistical analysis of smart city indicators in this research was done from Smart City Index (2022) report which issued through IMD Smart City Observatory which is the most popular used indicators and They are the most widespread and the most applicable to Egyptian state policies, presidential initiatives and https://arabdeve-lopmentportal.com/sites/default/files/publication/sds_egypt_vision_2030.pdf, 2023.

Table 1. Criteria and indicators for evaluating the performance of smart cities.

NICOS Komninos	Nicos Komninos developed 40 indicators to evaluate the performance of smart cities, classified into four axes (education and individual skills, knowledge institutions, digital infrastructure, electronic services, and innovation) (Komninos and Sefertzi, 2009).
ICF: Intelligent Community Forum	The standards were based mainly on information and communication technologies, knowledge, and innovation, and 40 smart cities were evaluated to benefit from the best experience (Intelligent Community Forum (ICF), 2009)
The Center of Regional Science at the Technical University of Vienna	A group of researchers at the Regional Science Center at the Technical University of Vienna identified several axes (Smart economy, smart people, smart government, smart mobility, smart environment, Smart Life) and the number of indicators reached 74 (Giffinger et al., 2007a, 2007b).
World government summit (Smart Cities: Regional Perspectives)	33 indicators have been developed to evaluate the performance of smart cities, classified into six axes (smart economy, smart people, smart governance, smart mobility, smart environment, and smart life.
IMD Smart City Observatory	39 indicators have been developed to evaluate the performance of smart cities, classified into five axes (Health & Safety, Mobility, activities, opportunities (work & School), and Governance).

Source: (Komninos and Sefertzi, 2009); Intelligent Community Forum (ICF), 2009 (Giffinger et al., 2007a, 2007b).

A smart city index is introduced by the IMD to measure the technological, ethical, and economic elements of smart cities. The terms 'humane aspects' stand for 'quality of life,' 'environment,' and 'inclusivity.' IMD conducted a survey in July 2021 with hundreds of residents from 118 communities to create this index, asking questions about their cities' infrastructure and technologies. Technology describes the tools and services made available to citizens, whereas structures relate to the cities' current infrastructure. Both the structural and technology application categories are assessed based on five main factors (1) health and safety, (2) mobility, (3) activities, (4) opportunities, and (5) governance. The questions for each element of structures and technologies are distinct, as shown in Table 3. Sanitation, recycling, public safety, air pollution, medical services, and housing are some of the topics covered within the health and safety category's questions. But for the technology category, the inquiries are about issues with city maintenance, mobile apps for citizens to dispose of unwanted items, open WiFi, Closed-Circuit Television (CCTV) for public safety, apps to track air pollution, and online scheduling of medical appointments. (Toh, 2022).

As well as, the Egyptian governmental policies oriented to build the Egyptian citizen through several Presidential initiatives to preserve the citizen's health, providing adequate housing and reducing unemployment when mentioned in Table 3 (Health and safety). Moreover, since 2016 the thirs goal of vision of Egypt (2030) targeted Strong economy: a competitive and diversified economy when mentioned in Table 3 (Opportunities (Work and School)). Additionally, the fifth goal was concerned with environmental sustainability: an integrated and sustainable environmental system when mentioned in Table 3 (Activities). As well, 6th goal was interested with the institutions and institutions of society and the state when mentioned in Table 3 (Governance). Finally, the political leadership during the last 8 years has invested in infrastructure, especially in the transport and road sectors, electricity and energy, and oil and natural gas. This led to an improvement in Egypt's ranking in the infrastructure index in the 2019 Global Competitiveness Report. Egypt ranked 52nd, compared with 56th, in the 2018 report (The Global Competitiveness Report, 2019) when mentioned in Table 3 (Mobility).

3. Case study

3.1. The new administrative capital of Egypt

The Egyptian government announced the NAC on March 13, 2015, during the Conference on Support and Development of the Egyptian Economy. Its capital is on the borders of Badr City, between the Suez Road and the Al-Ain Al-Sokhna Road, as shown in Fig. 1. The construction of the NAC began with the goal of transforming Cairo into a major political, social, and financial center for the Middle East and North Africa region through a thriving economic environment supported by various financial activities and sustainable development to work with its inhabitants through an effective framework, taking into account its unique location. The NAC was designed around seven main lines: (being a green city, a sustainable city, a smart city, a business city, a walkable city, a connected city, and a livable city).

The NAC covers an estimated 170 000 acres, which is four times the size of Washington and Singapore. The vast expanse was divided into three sections, as shown in Fig. 2. The first stage was announced to open in early 2022 on 40 000 acres, the second stage is spread out over a large area and covers

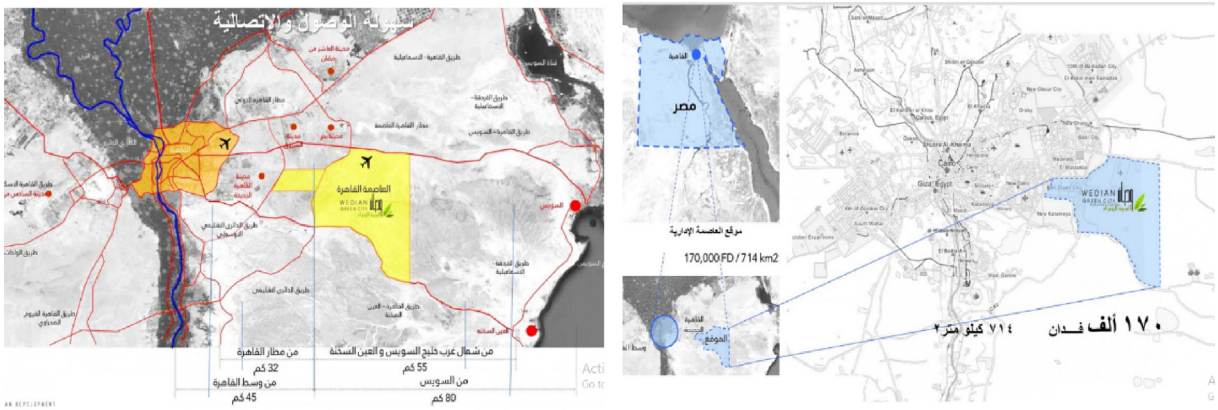

Fig. 1. Location of the NAC. Source.

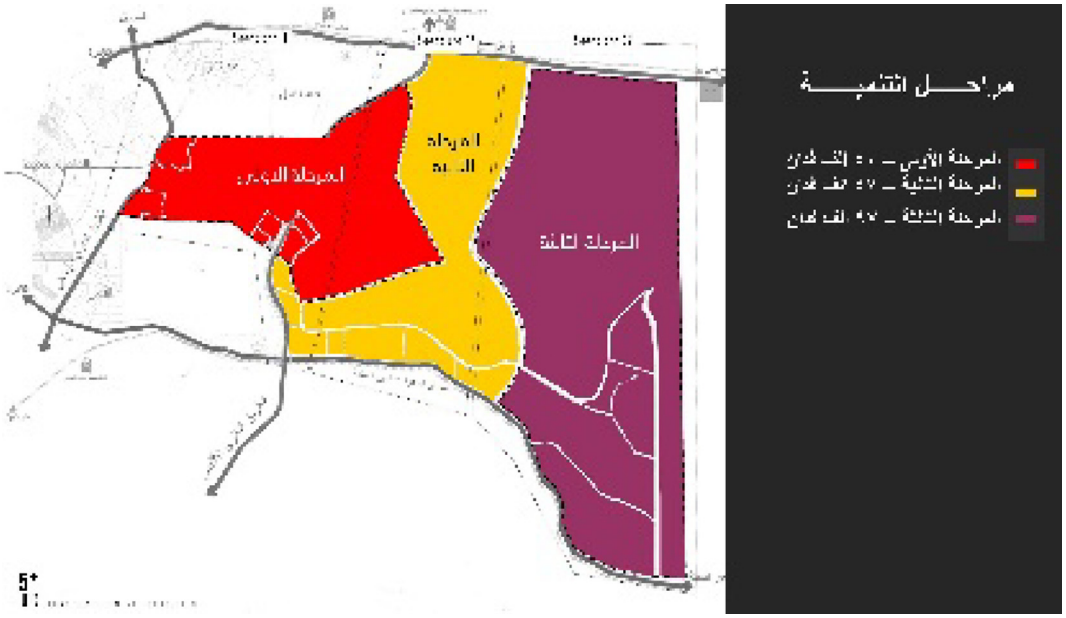

Fig. 2. Stages of development in the new administrative capital. Source.

approximately 47 000 acres, and the third stage encompasses 79 000 acres. The architecture of the administrative capital is adaptable and dynamic, reflecting Egypt's national identity as well as a historical and cultural vision of the country's future as its people aspire to it. To avoid traffic problems, the new capital's roadways, entrances, and axes have been meticulously calculated. All administrative buildings in the NAC are powered by solar energy. The major projects are as follows: Money and Business District, Green River, Government District, High-Speed Train Line Project, City of Arts and Culture, and Egypt's International Olympic City, as shown in Fig. 3.

3.2. The smart city's components in the NAC

As shown in Table 2, the NAC was developed with the strategic vision of a smart city, integrating its smart infrastructure to offer a wide range of services to inhabitants through a set of essential elements that it was based to become a smart city.

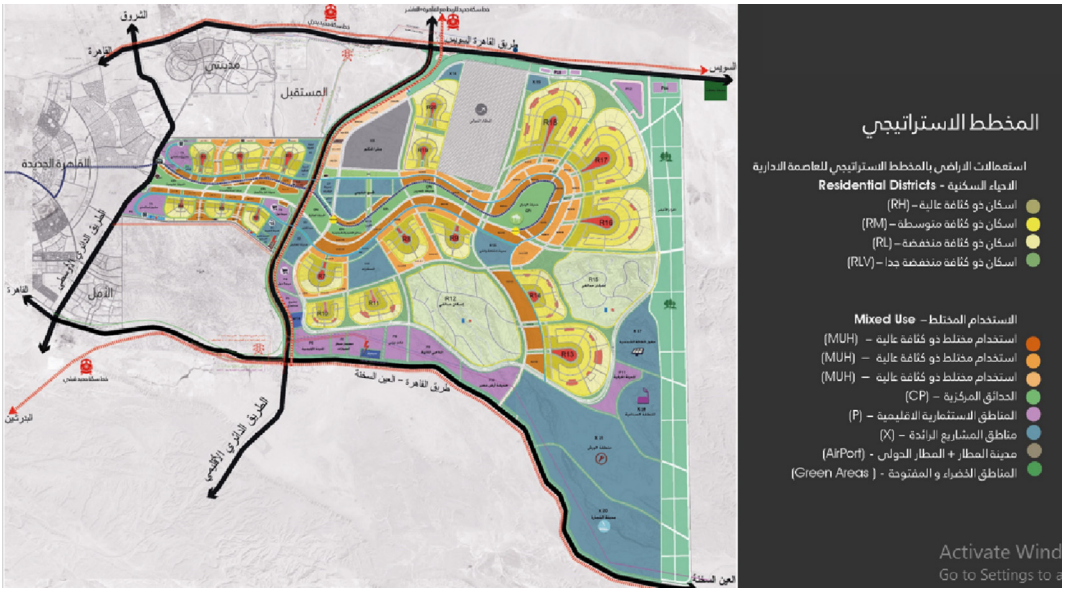

Fig. 3. Strategic plan of the new administrative capital. Source.

Table 2. Main components of the concept of smart cities in the NAC.

Smart Traffic	Well-designed streets with intelligent traffic congestion and accident monitoring.	
Smart Utilities	Electricity, gas, and water management and operation to reduce usage and costs.	
Safe City	CCTV cameras and control sensors are installed around the city and are linked to the city control center.	
Smart Buildings	Buildings detect the most efficient ways to conserve resources and offer a healthy environment on their own.	
Smart Energy Management	Using IoT to reduce power use while focusing on renewable energy for a greener environment.	
Connected city	Using FTTX technology, establish an optical fiber infrastructure that connects every building.	

Source: The Capital Egypt Smarter future, http://www.acud.eg/.

4. Methods

4.1. Methodology for analyzing smart city indicators using SPSS

The SPSS is one of the statistical programs that have been most commonly used by researchers to perform statistical analysis. It is an integrated computer package for data entry and analysis (b), typically used in all scientific research, which includes a lot of digital data and is not just for social research even if it was designed for this (https://www.techtarget.com/whatis/definition/SPSS-Statistical-Package-for-the-Social-Sciences, 2022). Although it can perform almost all statistical tests, its superior data processing capabilities, compatibility with most popular software, and ability to read data from most file types so that it can be used to extract results in the form of statistical reports or formats have made SPSS an effective tool for analyzing different types of scientific research (https://www.kau.edu.sa/Files/0000837/files/11794_spss_ahd.pdf, 2022).

The working methodology for studying smart city indicators from Smart city rank 2022 is a ranking system based on a set of indicators approved from smart city index 2022 with SPSS is divided into several phases. First, the Authors apply the available data in the Correlation Matrix between the indicators for 32 smart cities, factor analysis was chosen for statistical analysis of indicators, four courses utilized Principal Component Analysis, and smart city indicators were reduced from 39 to 18 indicators. Finally, the Factor Score will provide each city with clear dimensions and relative weights, The research used (+, -), it estimates the numerical magnitude and direction of its effect. The statistical analysis findings, the most important smart city indicators, and the Stepwise Multiple Regression equation were created for use in Egypt's NAC, which is the first city built on the concept of smart cities. As shown in Fig. 4.

4.1.1. Collecting the indicators

Out of 109 smart cities worldwide, the most important indicators that helped a group of cities achieve the smart city principles by a significant percentage for a higher ranking in the smart city index 2022 were gathered for a group of smart cities that received the top positions in the 32 smart city index 2022 report, as shown in Fig. 5.

4.1.2. Organization of indicators data

The indicator data is organized within the table, and the collected data is encoded by assigning a code to each indicator, as shown in Table 3, so that the data can be entered into the SPSS statistical analysis program.

4.1.3. The correlation matrix between the indicators of smart cities

When examining the correlation between smart city indicators to see the quadratic and reverse correlation between the set of indicators shown in Fig. 6, both Public safety is not a problem (A3) and Corruption of city officials is not an issue of concern (E2) indicators show that one of the strong quadratic indicators with about 9 indicators within the group STRUCTURES, especially Public safety is not a problem (A3) with Basic sanitation meets the needs of the poorest areas (A1) with a very strong package relationship at a 0.79 rate followed by Basic sanitation meets the needs of the poorest areas (A1), Traffic congestion is not a problem (B1), Most children have access to a good school (D2) and Lifelong learning opportunities are provided by local institutions (D3) with a strong package relationship of 8 indicators within the STRUCTURE group and found that there is no correlation between the Businesses are creating new jobs (D4) index and the rest of the total smart city indicators, Processing Identification Documents online has reduced

Table 3. Organizing and coding indicator data.

	Group	Key survey data collected	Indicator	Symbol
Smart city index 2022		Health & Safety	Basic sanitation meets the needs of the poorest areas	A1
			Recycling services are satisfactory	A2
			Public safety is not a problem	A3
			Air pollution is not a problem	A4
			Medical services provision is satisfactory	A5
			Finding housing with rent equal to 30% or less of a monthly salary is not a problem	A6
		Mobility	Traffic congestion is not a problem	B1
			Public transport is satisfactory	B2
			Green spaces are satisfactory	C1
		Activities	Cultural activities (shows, bars, and museums) are satisfactory	C2
			Employment finding services are readily available	D1
	STRUCTURES	Opportunities (Work and School)	Most children have access to a good school	D2
			Lifelong learning opportunities are provided by local institutions	D3
			Businesses are creating new jobs	D4
			Minorities feel welcome	D5
			Information on local government decisions are easily accessible	E1
			Corruption of city officials is not an issue of concern	E2
		Governance	Residents contribute to decision making of local government	E3
			Residents provide feedback on local government projects	E4
			Online reporting of city maintenance problems provides a speedy solution	F1
		Health and Safety	A website or App allows residents to easily give away unwanted items	F2
			Free public Wi-Fi has improved access to city services	F3
			CCTV cameras has made residents feel safer	F4
			A website or App allows residents to effectively monitor air pollution	F5
			Arranging medical appointments online has improved access	F6
		Mobility	Car-sharing Apps have reduced congestion	G1
			Apps that direct you to an available parking space have reduced journey time	G2
			Bicycle hiring has reduced congestion	G3
			Online scheduling and ticket sales has made public transport easier to use	G4
			The city provides information on traffic congestion through mobile phones	G5
	TECHNOLOGIES	Activities	Online purchasing of tickets to shows and museums has made it easier to attend	H1
		Opportunities (Work and School)	Online access to job listings has made it easier to find work	I1
			IT skills are taught well in schools	I2
			Online services provided by the city has made it easier to start a new business	I3
			The current internet speed and reliability meet connectivity needs	I4
		Governance	Online public access to city finances has reduced corruption	J1
			Online voting has increased participation	J2
			An online platform where residents can propose ideas has improved city life	J3
			Processing Identification Documents online has reduced waiting times	J4

Source: https://www.imd.org/smart-city-observatory/smart-city-index/, by authors.

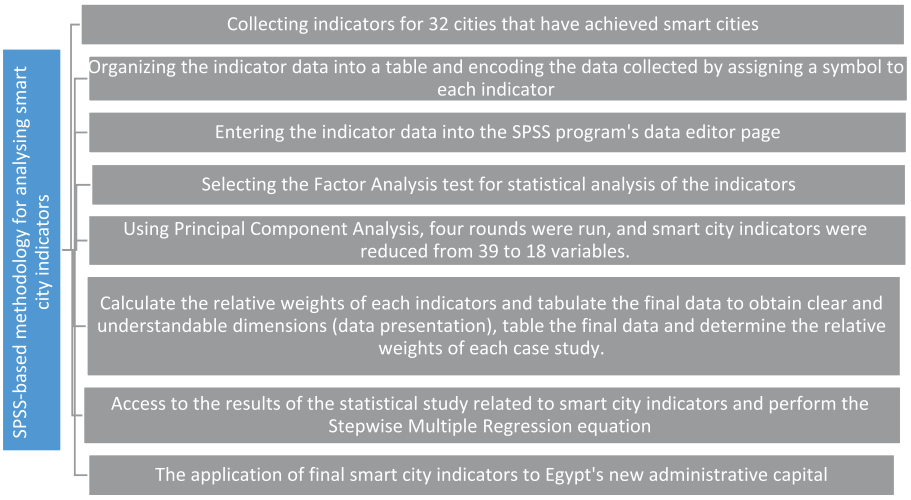

Fig. 4. SPSS-based methodology for analyzing smart city indicators program ((Source: by authors).

waiting times (J4) was also found to have a strong firing relationship with about 15 out of 20 indices within the Group of Technologies, especially with the Online services provided by the city has made it easier to start a new business (I3) Index with a very strong firing relationship at 0.91 followed by both Free public Wi-Fi has improved access to city services (F3) and CCTV cameras has made residents feel safer (F4) with a strong firing relationship of about 14 indices within the Group of TECHNOLOGIES. Online access to job listings has made it easier to find work (I1) with the lowest indices came in a package relationship with the rest of the total smart city indexes with only one parcel relationship with the Car-sharing Apps have reduced congestion (G1) index at a rate of 0.57.

4.1.4. Using factor analysis to conduct statistical analysis on the indicators of smart cities

To identify the impact of multiple Smart City indicators, factors, and variables on city experiences as well as to measure the advantage of smart cities, statistical analysis of indicators is performed using factor analysis, employing the principle of Component Analysis. This is accomplished by filtering the variables using different analysis Periods and excluding the variables with lower impact (-0.5, +0.5). It then groups variables with similar effects into packages, reducing the enormous number of analytic variables to a smaller number of components from which the key forces driving the explanation of date change for cities may be extrapolated. By measuring the force of each variable's effect and

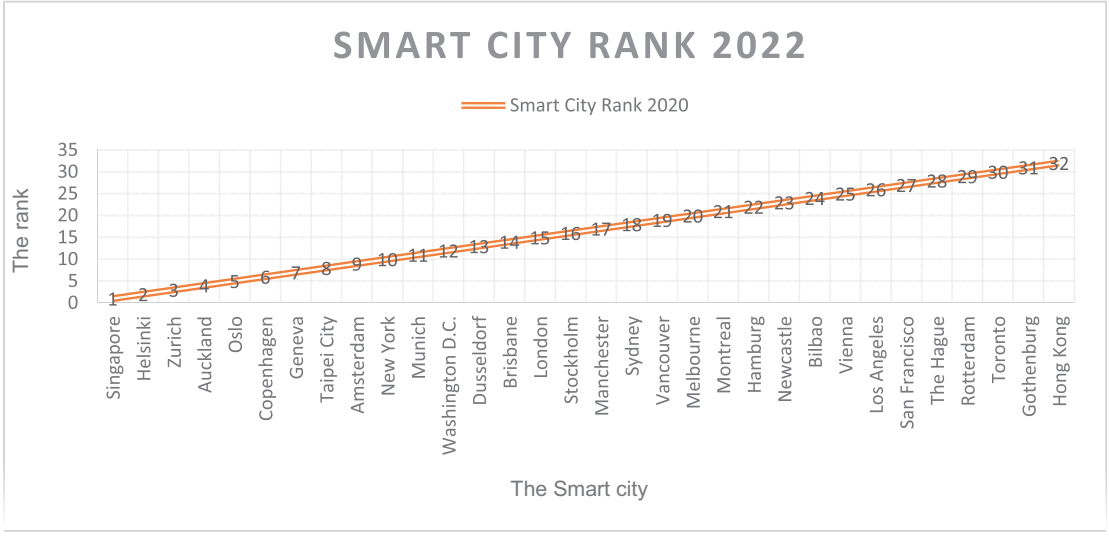

Fig. 5. Smart city rank 2022. Source: (by authors).

Correlation Matrix(a)

Correlation		A1	A2	A3	A4	A5	A6	B1	B2	C1	C2	D1	D2	D3	D4	D5	E1	E2	E3	E4	F1	F2	F3	F4	F5	F6	G1	G2	G3	G4	G5	H1	I1	I2	I3	I4	J1	J2	J3	J4
	A1	1.00		0.79		0.67		0.52	0.57				0.62	0.62				0.51			0.55																			
	A2		1.00			0.54				0.60	0.69								0.56											0.55										
	A3	0.79		1.00	0.64	0.64		0.63	0.68				0.73	0.72				0.61											0.59										
	A4			0.64	1.00			0.52		0.75			0.66	0.75				0.51		0.50																			
	A5	0.67	0.54	0.64		1.00			0.58									0.56	0.53																				
	A6						1.00																	0.67															
	B1	0.52		0.63	0.52			1.00	0.68			0.55		0.58				0.66												0.55									
	B2	0.57		0.68		0.58		0.68	1.00				0.51					0.63																					
	C1		0.60		0.75					1.00	0.66		0.54	0.60																									
	C2		0.69							0.66	1.00																												
	D1							0.55				1.00	0.53	0.68						0.53																			
	D2	0.62		0.73	0.66				0.51	0.54		0.53	1.00	0.68				0.61																					
	D3	0.62		0.72	0.75			0.58		0.60		0.68	0.68	1.00																0.51									
	D4														1.00																									
	D5															1.00	0.53																						
	E1															0.53	1.00		0.59	0.60												0.58					0.51			
	E2	0.51		0.61	0.51	0.56		0.66	0.63				0.61					1.00	0.54										0.53										
	E3		0.56			0.53											0.59	0.54	1.00	0.84								0.53	0.55										
	E4				0.50							0.53					0.60		0.84	1.00																			
	F1	0.55																			1.00		0.63	0.57	0.72	0.60	0.53	0.57					0.57	0.76	0.57	0.80		0.76	0.78
	F2																					1.00																	
	F3																				0.63		1.00	0.65	0.68	0.50	0.66	0.55			0.68	0.60		0.61	0.70		0.70	0.66	0.68	0.79
	F4						0.67														0.57		0.65	1.00		0.65								0.62					0.64
	F5																				0.72		0.68		1.00	0.53	0.68	0.75	0.52		0.67			0.57	0.86	0.58	0.88	0.58	0.77	0.86
	F6																				0.60		0.50	0.65	0.53	1.00	0.56							0.55	0.66		0.54		0.68	0.67
	G1																				0.53		0.66		0.68	0.56	1.00	0.73			0.79	0.51	0.57		0.77		0.71	0.73	0.69	0.76
	G2																				0.57		0.55		0.75		0.73	1.00	0.53		0.66				0.78	0.51	0.83	0.57	0.84	0.67
	G3																		0.53						0.52			0.53	1.00	0.60							0.59		0.61	
	G4		0.55	0.59				0.55						0.51				0.53	0.55										0.60	1.00										
	G5																						0.68		0.67		0.79	0.66			1.00	0.50			0.71		0.65	0.58	0.57	0.68
	H1																0.58						0.60				0.51				0.50	1.00								0.56
	I1																										0.57						1.00							
	I2																				0.57		0.61	0.62	0.57	0.55								1.00	0.58					0.68
	I3																				0.76		0.70		0.86	0.66	0.77	0.78			0.71			0.58	1.00	0.63	0.88	0.55	0.80	0.91
	I4																0.51				0.57				0.58			0.51							0.63	1.00	0.56			0.51
	J1																				0.80		0.70		0.88	0.54	0.71	0.83	0.59		0.65				0.88	0.56	1.00	0.65	0.85	0.83
	J2																						0.66		0.58		0.73	0.57			0.58				0.55		0.65	1.00	0.66	0.61
	J3																				0.76		0.68		0.77	0.68	0.69	0.84	0.61		0.57				0.80		0.85	0.66	1.00	0.77
	J4																				0.78		0.79	0.64	0.86	0.67	0.76	0.67			0.68	0.56		0.68	0.91	0.51	0.83	0.61	0.77	1.00

a. This matrix is not positive definite.

Fig. 6. SPSS-based methodology for analyzing smart city indicators program Source: by authors.

using (+, -), it estimates the numerical magnitude and direction of its effect.

The smart city index has 39 variables, which reflect Key Survey Data Collection on structures and technologies, organized into five key areas: health and safety, mobility, activities, opportunities, and governance. For the statistical study of the Smart cities index, 18 variables were created using factor analysis over four cycles. The first cycle provided 39 key factors, which is the same as the number of variables, to explain the shift in Smart cities metrics. They were identified as 9 essential elements that influenced the underlying forces influencing the explanation of the change in smart city experience data, with the remainder of the components being ignored since the underlying root values of Eigenvalues are less than 1, The indicators were reduced to 27 in the second cycle since the power values of the variables were larger than (+0.5, −0.5), indicating that it was 50% effective. In the third cycle, the indicators were lowered to 20 because all technology variables such as Free Public Wi-Fi have expanded access to City Services, Bicycle hiring has reduced congestion, and Online Public access to City financing has reduced corruption values (+0.5, −0.5). More in the sense that it has the largest impact on change, and 18 metrics reflecting the most critical indicators of smart city experiences were obtained in the fourth and final cycle, as shown in Table 4.

5. Results and discussion

5.1. Relative weights of smart city experiences

This is the final stage of the analysis phase, in which each city is evaluated by assigning a relative weight to the rest of the smart city experiences using the factor score method, which assigns a relative weight to each city based on the presence of strong variables with a positive impact and increases the city's weight as the number and impact of these variables increases. Based on the component matrix and Fig. 7, we can conclude the following.

(1) Taipei City ranked first in city ranking and the highest factor score of 3.25977 in terms of achieving Smart cities indicators according to the relative weight of SPSS analytics, as opposed to Smart City Rank 2022, ranked 8th out of 109 smart cities worldwide; and ranked Singapore The second place which is the

Table 4. The final smart city indicators resulting from the analysis of indicators using SPSS.

	Group	Key survey data collected	Indicator	Symbol	Effect Power
Smart city index	STRUCTURES	Governance	Information on local government decisions is easily accessible	E1	0.560
			Online reporting of city maintenance problems provides a speedy solution	F1	0.825
			Free public WIFI has improved access to city services	F3	0.827
		Health and Safety	CCTV cameras have made residents feel safer	F4	0.602
			A website or App allows residents to effectively monitor air pollution	F5	0.886
			Arranging medical appointments online has improved access	F6	0.695
		Mobility	Car-sharing Apps have reduced congestion	G1	0.827
			Apps that direct you to an available parking space have reduced journey time	G2	0.800
			Bicycle hiring has reduced congestion	G3	0.545
	TECHNOLOGIES		The city provides information on traffic congestion through mobile phones	G5	0.746
		Activities	Online purchasing of tickets to shows and museums has made it easier to attend	H1	0.619
			IT skills are taught well in schools	I2	0.624
		Opportunities (Work and School)	Online services provided by the city have made it easier to start a new business	I3	0.921
			The current internet speed and reliability meet connectivity needs	I4	0.611
		Governance	Online public access to city finances has reduced corruption	J1	0.911
			Online voting has increased participation	J2	0.709
			An online platform where residents can propose ideas has improved city life	J3	0.888
			Processing Identification Documents online has reduced waiting times	J4	0.935

Source: The authors analyze using the statistical analysis program SPSS.

reverse ranking of Smart City Rank (2022), where it ranked first with 109 smart cities worldwide. Hamburg City has the final and lowest factor score of −1.14536 in terms of achieving Smart cities indicators according to the relative weight of SPSS analytics, as opposed to Smart City Rank 2022, which ranked 22 out of 100 smart cities worldwide.

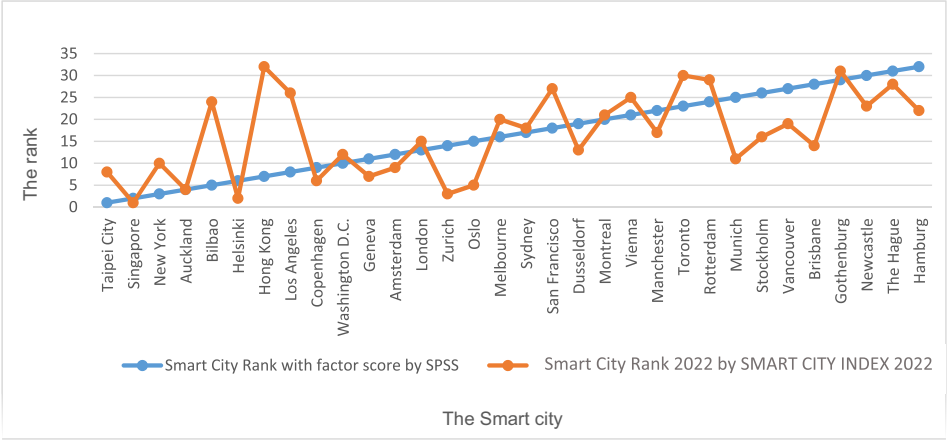

Fig. 7. Ranking smart cities by factor score from SPSS analyses and ranking them in Smart City Rank (2022) Source (by authors).

(2) Auckland, Bilbao, Helsinki, and Hong Kong have a relative weight of 0.98852, 0.83066, 0.78553, 0.70459, respectively, so these cities follow a positive relative weight rating of more than 0.5 in terms of achieving smart city indicators. We note that Hong Kong has ranked seventh in terms of smart city ranking according to the relative weight of SPSS analytics, as opposed to the Smart City Rank 2022 ranking of 32 of the world's 109 smart cities.

5.2. The multiple linear regression equation for the results of the statistical study on smart city indicators

The numerous linear regressions are an advanced statistical method that ensures the accuracy of inference to improve the outcomes of the Smart cities indicators statistical study by optimizing the data for causal linkages between smart city variable phenomena. The regression of the dependent variable (y) on many independent variables x1, ×2 is known as multiple linear regression. It is also a regression of the dependent variable (y) on a large number of independent variables (x1, x2). Thus, the XK is used to predict changes in the dependent variable that are influenced by multiple independent variables, i.e. its concept is based on semantic relationships that use dispersion or diffused, and the linear equation in linear multi-linear regression is:

$$\mathbf{Y = a + b1X1 + b2X2 + \ldots\ldots\ldots + e} \quad (1)$$

Where that:

Y = dependent variable

a = Constant

b1 = Slope of the regression y on the first independent variable

b2 = Slope of the regression y on the second independent variable.

1X = The first independent variable.

2X = The second independent variable.

Access the multiple regression lines and equation model in SPSS using the Stepwise approach. Assuming that the value of Factor Score for smart city experiences is dependent on the variable and that the variables derived from the fourth cycle of statistical analysis of smart city indicators for city experiences using Factor Analysis's 18 variables are independent, we highlight the value of the constant and the regression coefficients, as well as their statistical significance, for independent factors over the dependent variable in Coefficient Table 5, which shows the value of the constant and the regression coefficients for independent factors over the dependent variable.

From the above table, the 18 variables resulting from the fourth cycle of statistical analysis of smart city indicators were reduced to the 10 variables shown in Table 6, which represent the most important and influential indicators for smart city achievement. The indicators have already been reduced to a goal that the researchers think suitable and can be explained as followings.

(1) The reason is to choose the most important indicators that are compatible with political orientations, according to the context of Egypt.
(2) The use of the SPSS statistical analysis program depends on analyzing the current situation based on political trends and visions.

Table 5. The most important variables that work to achieve smart city indicators.

Coefficients(a)						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
10	(Constant)	−10.912	0.297		−36.785	0.000
	J3	0.025	0.004	0.180	5.990	0.000
	E1	0.021	0.004	0.102	5.459	0.000
	G5	0.010	0.003	0.081	3.642	0.002
	I3	0.051	0.006	0.310	8.496	0.000
	F4	0.018	0.002	0.154	8.084	0.000
	J1	0.010	0.005	0.074	1.849	0.079
	H1	0.025	0.005	0.099	5.112	0.000
	F5	0.016	0.003	0.147	4.699	0.000
	J2	0.010	0.003	0.074	3.598	0.002
	G3	0.006	0.002	0.054	2.564	0.018

a Dependent Variable: REGR factor score 1 for analysis 4.

Source: The authors analyze using the statistical analysis program SPSS.

Table 6. Multiple regression line equation variables to achieve smart city indicators.

	Group	Key survey data collected	Indicator	Symbol
Smart city index	Structures	Governance	Information on local government decisions is easily accessible	E1
		Health and Safety	CCTV cameras has made residents feel safer	F4
			A website or App allows residents to effectively monitor air pollution	F5
		Mobility	Bicycle hiring has reduced congestion	G3
			The city provides information on traffic congestion through mobile phones	G5
	Technologies	Activities	Online purchasing of tickets to shows and museums has made it easier to attend	H1
		Opportunities (Work and School)	Online services provided by the city has made it easier to start a new business	I3
		Governance	Online public access to city finances has reduced corruption	J1
			Online voting has increased participation	J2
			An online platform where residents can propose ideas has improved city life	J3

Source: The authors analyze using the statistical analysis program SPSS.

(3) It is a system that is not fixed for analyzing data, but rather is characterized by flexibility, and therefore measuring indicators can be changed according to the context of the country and according to the orientations of decision makers.

From Table 6 the authors found the final indicators are all indicators that relate to ICT as well as main components of the concept of smart cities in the NAC through Smart Traffic by Well-designed streets with intelligent traffic congestion and accident monitoring, Smart Utilities, Safe City through CCTV cameras and control sensors are installed around the city and are linked to the city control center, Smart Buildings, Smart Energy Management, Connected city by using FTTX technology, establish an optical fiber infrastructure that connects every building. According to many experts, the different concepts of Smart City are highly related to ICT in all areas of city life, as well as smart city is defined by six characteristics: smart governance, smart environment, smart mobility, smart economy, smart people, and smart living. (Evgeny Popov, Konstantin Semyachkov, 2021). A combination of human capital, infrastructure capital, social capital, and entrepreneurial capital led to the development of the smart city. According to Darawan Napitupulu, M Syafrullah, Robbi Rahim et al. (2018), a smart city is a system that employs digital technology to increase efficiency and welfare, decrease cost and resource consumption, and engage citizens more effectively and actively.

Egypt discovered that in order to create smart cities, it needed a strong, trustworthy government that was made up of imaginative and open-minded individuals. This would boost local productivity and speed up a city's economic development. To provide customer happiness, the smart city is run by a system that makes use of digital technologies. The plans for 'smart cities' aim to make efficient use of resources for more pleasant living, more functional effectiveness, competitive cities, innovation, and management systems to go 'smart and sustainable'.

In addition to The Authors have made interview with (General/Khaled Fouda: Governor of South Sinai, Miss. Hoda El-shawatfi: Assistant of the Minister of environment, and Mr. Mohamed El-eiwa: Executive director for Green sharm project), The interview was about the city of Sharm elsheikh. The most popular city in Egypt in 2022 due to hosting COP27. It was an open question and then closed questions to select specific indicators affect the city where host the COP27 to the way for smart cities. The indicators concluded through the paper were discussed through this interview and those final indicators were approved but Mr. Mohamed El-eiwa (Executive director for green sharm project) requested in addition to the A website or App allows residents to effectively monitor air pollution indicators should also exist for environmental management to measure the area of green flats, public parks and energy consumption due to the significant use of technology as well as the waste disposal index and the recycled waste index. Then the paper extract from the interview the related indicators so that researchers can apply in Egypt.

As shown in Table 5, the value of Significance 0.00.00 is less than 0.05, indicating that the variables are conjectured and follow H1 while rejecting H0 because the regression between the dependent variable and the independent variables is not equal to zero, implying that the moral regression and the independent variable are related to the dependent variables resulting from the fourth cycle of statistical analysis of smart city indicators.

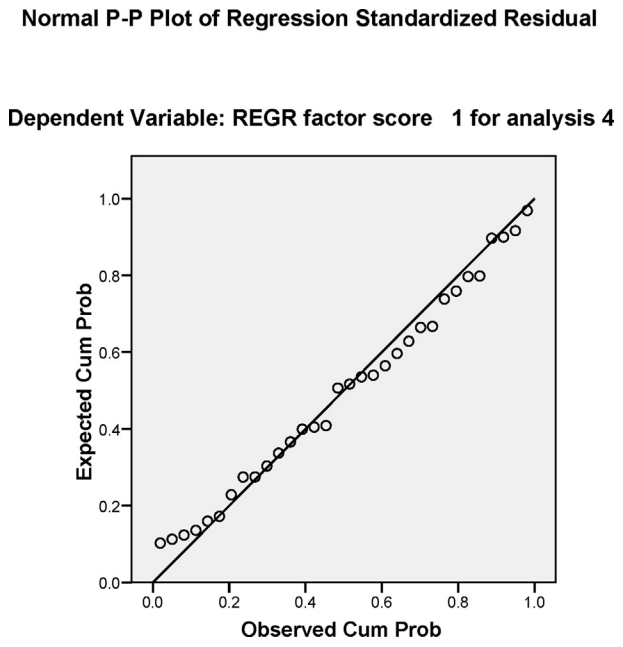

Fig. 8. The P–P plot of the smart city indicators equation (Source: by authors).

Fig. 8 shows the P–P Plot graph, as the data are gathered around the straight line, and therefore the residuals are distributed by natural distribution, which is a condition of the regression test and Fig. 9 also shows that the diagram is the diffraction form of the rectifiers with the expected values, from which it is apparent that there is no particular pattern of points in the Figure, which is consistent with the linear requirement required for the regression test.

Following an examination of those cities' experiences, linear regression indicators will be applied to The Egyptian NAC, Egypt's first leading city to be created as a smart city out of 14 new cities built at the national level. As a result, the Egyptian NAC will be assessed on how well the Smart City Indicators have been met in order to determine the reality of the current status quo in terms of how well it meets the requirements, criteria, principles, and indicators required to become a smart city with a global impact among the most well-known and successful cities.

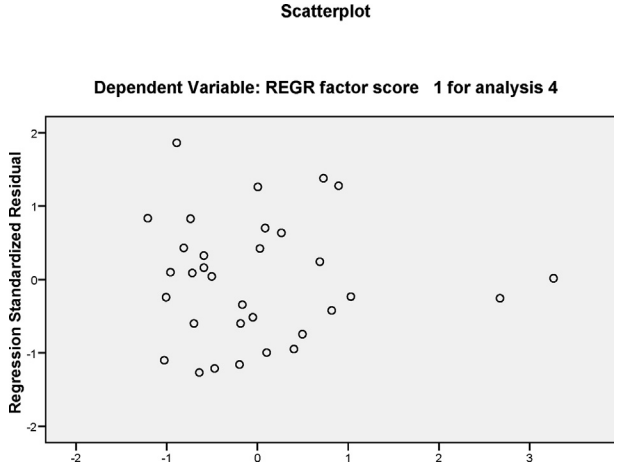

Fig. 9. The diffusion form of the residuals of the equation of smart city indicators (Source: by authors).

5.3. Assess the NAC as a smart city

The final set of key indicators drawn from the linear regression equation of smart city indicators using SPSS will be used to value NAC in terms of the extent to which it achieves these values, as shown in Table 7.

According to a previous study, the NAC accounts for half of the set of characteristics that are most influential in bringing the smart city concept to life: 'safe city, bicycle hiring has reduced congestion, online purchasing of tickets to shows and museums has made it easier to attend, an online platform where residents can propose ideas has improved city life, information on local government decisions is easily accessible'. Failure to meet a set of metrics, most of which are related to the operational efficiency of both websites and mobile apps, has resulted in a slew of problems with the city's electronic services. Each of the following must be provided in order for the city to achieve its goal of becoming a smart city and for all indicators to be achieved through the integration of all institutions and organizations involved in implementing and monitoring the performance of each indicator, as well as linking it to the main city information network.

(1) A website or App allows residents to effectively monitor air pollution: To provide a healthy environment for city residents, the city's Department of the Environment must use air quality indicators to assess the extent to which it is polluted, with high-tech sensors linked to websites and a mobile app to properly monitor air quality.
(2) The city provides information on traffic congestion through mobile phones: The mobile app allows users to analyze various streets and transportation traffic in order to help citizens locate traffic congestion, avoid traffic accidents, schedule trips, buy tickets, and pay for public transportation in the city online.
(3) Online services provided by the city have made it easier to start a new business: To entice global

Table 7. Evaluate of the extent to which the NAC has achieved smart city indicators.

Main axes	Indicators	Achieved	Not achieved	How to achieved
Health and Safety	CCTV cameras has made residents feel safer	√		Using control sensors and CCTV cameras to monitor and cover every area of the city, all of which are connected to the city control center.
	A website or App allows residents to effectively monitor air pollution		√	Although the city has a per capita green and open surface of 15 m^2/person in accordance with global quality of life standards, as well as the use of sustainability determinants in energy and waste recycling, there is nothing on the city's e-site or App that shows the provision of an air pollution control service.
Mobility	Bicycle hiring has reduced congestion	√		The city's districts continue through a network of pedestrian and bicycle lanes, as 40% of the road network is reserved for pedestrians and cyclists.
	The city provides information on traffic congestion through mobile phones		√	The NAC is a well-connected city with all transportation and communication networks (Metro-Tram-Trolley-Bus-Taxi), but there is no special App in place to show where the traffic is.
Activities	Online purchasing of tickets to shows and museums has made it easier to attend			
√	Tickets are booked for shows and museums in the City of Arts and Culture via the website:			
https://cairoopera.org/reservation.php				
Opportunities (Work and School)	Online services provided by the city has made it easier to start a new business		√	Despite the fact that there is a money and business district in the city and that it is a smart city that provides all services in the city electronically and is covered by the Global Information Network, there is no website to assist in the start-up of a new business.
Governance	Online public access to city finances has reduced corruption		√	The financial resources allocated to the city have not been made available on the city's website or website to the Ministry of Housing, Utilities and Urban Communities http://www.mhuc.gov.eg/Home/Contact.
	Online voting has increased participation		√	Electronic voting is not yet available on the city website
	An online platform where residents can propose ideas has improved city life	√		Citizens can propose ideas or offer problems through the city's website and website to the Ministry of Housing, Utilities and Urban Communities
	Information on local government decisions are easily accessible	√		All local government decisions are easily accessible through the city's website and website to the Ministry of Housing, Utilities and Urban Communities

Source: by Authors.

investment into the NAC, electronic services are required to provide adequate information on the areas of investment available in the city, as well as to facilitate the completion of all necessary actions to initiate and follow up on the new business activity.

(4) Online public access to city finances has reduced corruption: The importance of reducing corruption by providing information on the financial resources of each of the city's various sectors in order to promote transparency among citizens and city administration, as well as the existence of a continuous system of monitoring the expenses of the city's various services and the extent to which they are carried out in accordance with the established budget.

(5) Online voting has increased participation: Work to make voting in all areas available electronically on the city's official website in order to improve community engagement between voters and the government in a simple, quick, and effective manner.

Once all previous indicators have been met, the Smart City Index in the NAC can be valued using the multiple linear regression equation to determine where it is considered to be one of the world's smartest cities, and ensure that it achieves the goal for which it was established as the first smart Egyptian city.

6. Conclusions

Indicators are one of the most effective mechanisms for evaluating and measuring how far urban communities at various levels have progressed toward the desired outcomes in order to achieve the concept of smart cities. The most significant and successful indications for achieving the 10 indicators of Smart City, according to statistical study in this research, are as follows: Information on local government decisions is easily accessible, CCTV cameras has made residents feel safer, A website or App allows residents to effectively monitor air pollution, Bicycle hiring has reduced congestion, The city provides information on traffic congestion through mobile phones, Online purchasing of tickets to shows and museums has made it easier to attend, Online services provided by the city has made it easier to start a new business, Online public access to city finances has reduced corruption, Online voting has increased participation, and finally An online platform where residents can propose ideas has improved city life.

In addition to the previous indicators, the authors propose a set of indicators that should be added and paid attention to and their impact on future studies of smart cities assessment, such as the Transport Applications and Digital Capabilities Index, the Electric Vehicle Incentive Index, the Cities of Innovation Index, the Entrepreneurship Environment Index, the Ease of Starting Business Index, the Quality-of-Life Index and the Cost-of-Living Index and the mobility.

So, the government must follow-up at all levels on the establishment of urban observatories to measure and monitor these indicators, using various statistical programs such as SPSS, because they are critical in the study and analysis of these indicators, To achieve a higher level of progress among cities that are more capable of achieving the concept of smart cities at the global level, in order to benefit from these experiences in policy and procedure knowledge to achieve the highest levels of achievement of smart city indicators and variables, such as the experiences of Singapore, Helsinki, and Zurich, as well as to assist decision-makers in understanding the opportunities, strengths, and weaknesses, As a result, the city's quality of life will improve significantly, and it will achieve sustainable development in all of its economic, social, environmental, and governmental dimensions.

Credit authors statement

Eman Metwally: Conceptualization, Methodology, Software, Writing, Original draft preparation. Enas samir: Writing, Reviewing and Editing, Visualization. Marwa Ayman: Writing, Data curation.

Conflicts of interest

The authors declare that they have no competing interests.

Appendix.

The Administrative Capital of Egypt: Egypt's capitals have been numerous since ancient times Uphill (2001), depending on the time, spatial and political circumstances, Where in ancient times the capital was situated in an intermediate place between the Kingdom of the North and the Kingdom of the South to emphasize the unity between the two countries Jefferys (2007), after which the capital should have been on the sets of the Nile either in the north or in the south s political conditions', depending on Egypt's political circumstances at the time, and in times of weakness, the capital was close to the occupier, and in times when the capital was dependent on the religion prevalent in Egypt Uphill (2001), Among the most famous Egyptian capitals throughout the different ancient and modern times: Minf, Taiba, Tel Amarneh, Alexandria, Fostat, Fatimah Cairo, Modern Egypt, Khadiyah Cairo and finally the State went to establish the NAC east of Cairo City with the concept of smart cities within Egypt's fourth generation cities. It was designed in the form of green areas linked to growth centers in the governorates via a network of transportation, and the new capital's planning was inspired by downtown areas such as the Pala's des Niles and Masr El gdida, as well as world capitals that combine history and modernity. As the first step in attempting to annex Egyptian cities to smart city indexes in various smart cities around the world, smart city indicators will be applied to the NAC to see how far they have progressed with this concept.

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