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Assessing the Level of Intelligence of New Cities as a Tool to Improve Quality of Life and Achieve Sustainability

"Case Study – New Minya City"

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Abstract: In the era of the digital revolution, cities worldwide have heavily invested in smart city projects to improve sustainability and quality of life. This paper explores the concept and global standards of smart cities and their intelligence assessment tools by focusing on new cities and their potential to be transformed into smart cities. A field study was conducted on New Minya City in Egypt using one of the approved evaluation criteria. **United FOR Smart, Sustainable Cities** (U4SSC) was selected to develop and determine the relative weight of each of its categories. The study assessed the city's intelligence through questionnaires distributed to academics, city officials, and a representative sample of residents, covering 1% of the population. Key findings include the critical role of smart technologies in infrastructure, particularly in water, sewage, and electricity networks, which achieved the highest relative weights. Strengths identified in New Minya City include low unemployment rates and abundant public spaces, while weaknesses such as the lack of smart systems for monitoring water and electricity consumption were noted. This paper provides adjusted relative weights for the indicators, tailored for application in new Egyptian cities, offering a practical framework for advancing these cities toward sustainability and smartness. The conclusions and recommendations aim to assist policymakers and urban planners in enhancing the performance of new cities and fostering smart urban development in Egypt.

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Keywords: smart cities; city intelligence indicators; city intelligence measurement standards; assessment tool.

List of Abbreviations.

ICT	Information and Communications Technology
U4SSC	**U**nited **FOR S**mart, **S**ustainable **C**ities
PIP	**P**robability of the **I**ndicator achieving **P**ositive results
TRA	**T**ime **R**ange for **A**chieving it
RWI	**R**elative **W**eight of **I**ndicator intelligence level
SWOT	**S**trengths - **W**eaknesses – **O**pportunities - **T**hreats
ISO	**I**nternational **O**rganization for **S**tandardization
ITU-T	**I**nternational **T**elecommunication **U**nion - **T**elecommunication Standardization sector
KPIs	**K**ey **P**erformance **I**ndicators
SSC	**S**mart **S**ustainable **C**ity
UNECE	**U**nited **N**ations **E**conomic **C**ommission for **E**urope
SDGs	**S**ustainable **D**evelopment **G**oal**s**

1. INTRODUCTION

The population of the world's cities is constantly increasing. More than 60% of the world's population is expected to live in cities by 2030 [1, 2]. The increasing growth of cities is expected to pose unprecedented sustainability challenges in infrastructure and the environment [3], affecting city dwellers' quality of life and the city's efficient operation [4, 5]. Against this backdrop, many city administrations worldwide believe that "ICT Smart City Development" is a beacon of hope in addressing the various significant challenges these cities face [6]. The reasons for the growing interest in smart city projects of late can be to achieve gains, maintain competitiveness in a globally interconnected economy, and appeal to the most talented and skilled. Creative citizens overcome sustainability challenges and resource constraints that require improved efficiency to enhance the quality of life and achieve sustainable development goals [4, 7, 8].

Although there is no universally agreed definition of smart cities, there is a broad consensus that a Smart City is a city that uses ICT-based solutions in various social, economic, institutional, and environmental fields to increase the sustainability and resilience of quality of life and maintain the competitiveness of cities [9, 10]. With

the rapid spread of smart city projects and initiatives, there has been increasing interest in developing and implementing "city intelligence standards and indicators" to monitor and evaluate their progress and impacts over time and address potential shortcomings [11]. Many studies and research have raised awareness of the benefits of intelligent city assessment and contributed to a better understanding of the basic principles of smart city assessment [12-14]. In 2019, Sharifi provided information on the scope and characteristics of existing evaluation criteria, helping stakeholders to choose the evaluation plan that best suits their purposes [13]. This paper aims to develop a mechanism to assess the level of intelligence of Egypt's new cities, identify their strengths and weaknesses, and identify the tools needed to achieve this through operational actions and priorities.

2. RESEARCH METHODOLOGY.

The goal of assessing new cities' intelligence levels is to improve the quality of life by using technologies and providing appropriate services. Within a sustainable and long-term vision, that goal can be attained. The research methodology is based on the analytical approach based on extrapolation. The qualitative approach was based on a survey of the focus group. The results were analyzed and the study outputs applied to the proposed criteria. The qualitative weights were determined to be ready to apply to the case study. The methodology used consists of 5 steps.

- The theoretical part.

This part aims to study what smart cities are and their types. Study the evaluation criteria regarding intelligent cities. It also aims to classify smart city indicators; the evaluation criteria were compared to choose one of them and apply it to the case study to reach the final form of the chosen criterion valid for application to new cities in Egypt.

- A focus group survey.

This survey was done based on data obtained from the theoretical part with specialists and city officials. The target sample asks to assess each of the indicators of intelligence with vertical variables by developing an evaluation of the possibility of achieving positive results (probability of the indicator achieving positive results) PIP in New Minya city. Another assessment of the time range for achieving it (TRA) was developed to get the relative weight of indicator intelligence level (RWI). A sample of 70 individuals was selected between specialists and decision-makers (city officials in the New Minya City Authority). Specialists who are university professors with experience in city planning represent 64.3% of the sample, which are 45 individuals. City officials and managers from the New Minya City Authority represent the remaining 25 individuals and 35.7% of the piece. Likert scale was used through five assessments (very high, high, medium, few, very few). The Likert scale is characterized by being easy to build and allowing participants to answer the questionnaire according to the degree of feeling about the statements.

Statistical Methods Used:

- Descriptive Statistics: Mean and standard deviation were calculated to summarize TRA and PIP values for each indicator.
- Weighted Average: Each indicator's importance was factored into the weighted average to ensure accurate representation in the overall analysis.

Through the questionnaire of specialists and experts on the advantages and problems of the study area, strengths, weaknesses, opportunities, and Threats areas were identified, and access to SWOT analysis.

- The criterion of the United for Smart Sustainable Cities (U4SSC) initiative has been amended to suit the New Minya city and its potential by excluding advanced indicators and some fundamental indicators that do not affect the opinion of the respondents.
- The relative weights resulting from the questionnaire process were applied to the United for Smart Cities initiative criterion after its amendment. The relative weights of the twenty-six factors, the seven dimensions, and the three sectors were determined.
- The results of the SWOT analysis and their relationship to the relative weights of the indicators were also reviewed to confirm the results. The research methodology is presented in (Fig.1).

3. CONCEPTS RELATED TO SMART CITIES.

Smart cities can be defined as a set of interconnected urban components through an integrated technology platform that enhances connectivity, efficiency, well-being, and sustainability with complex and highly effective security services. These urban components include health care, government, education, transportation, energy and services, safety, public security, and Real Estate Media.[12, 15]

The International Organization for Standardization (ISO), which developed a standard that specifies methodologies and indicators for measuring the performance of smart cities, has been defined as “a city that increases the pace of providing the results of social, economic and environmental sustainability and responds to challenges such as climate change, rapid population growth, and political and economic instability by improving

how society is involved. Fundamental and applied methods of collaborative leadership, system work, and city systems, and uses data information and modern technologies to provide better services and a better quality of life to city residents (residents, companies, and visitors), at present and in the foreseeable future, without harming others or deteriorating the natural environment.[16]

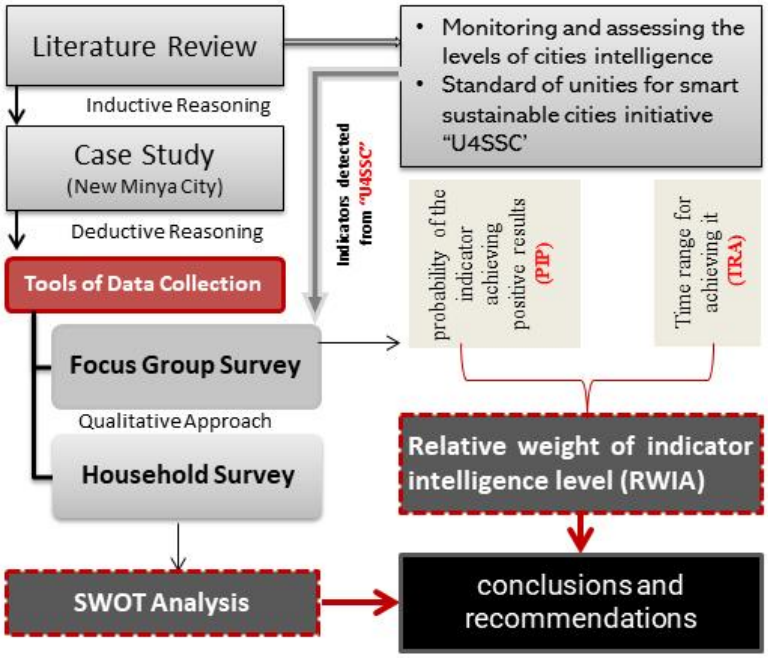

Fig. 1. The research methodology (Authors).

3.1. Types of Smart Cities

Several definitions and names of smart cities have emerged and evolved from digital, e-city, virtual, knowledge, and connected cities.[12, 17, 18] **The digital city** is a comprehensive simulation based on technologies to implement the normal functions of city dwellers electronically, and has four types (economic - governmental - virtual - multi-purpose) and consists of four levels (database - application level - user environment - management) [19]. **The e-city** is defined as a metropolis with communication links that are governed by the information technology sector to carry out information exchanges, and its functions include the supply of fixed information, direct services, instant information, and relationship with the outside world: discussion of previous jobs with other cities [20]. **The Knowledge City** is the city that mainly aims to encourage science and knowledge and is considered the result of the knowledge economy and the information society. Their applications are manifested in government services, the economy, and the community [18, 21]. **A connected city** is a city that technically supports urban systems such as transportation, health, public services, and safety to digitize them and deliver them through applications and communication systems without considering the axis of sustainability or the compilation and reanalysis of information [18, 22]. **A smart city** can be defined from the urban perspective of cities as connected, but not every connected city is smart [18]. Through the previous definitions, we find that the term smart city is based on the communication infrastructure and the representation of the virtual reality of the city. Still, this alone is not enough to establish a smart city without an intelligent society, as contemporary interpretations of the smart city concept increasingly incorporate environmental dimensions, emphasizing sustainability and ecological balance, i.e., intelligent cities are environmentally sustainable.

3.2. The concept of measuring the level of intelligence of cities

It is usually said that what cannot be measured cannot be developed, so different indicators and variables had to be used to measure all aspects of "intelligence" in cities by calculating a unique measurement. Although there is no unified official classification of indicators for measuring smart cities at the global level, there is a set of well-established indicators and measurement methods for smart cities that can be used efficiently. These indicators are used by several organizations, city governments, and professionals. Most smart cities are, in any case, based on indicators developed to measure e-readiness and e-services as well as other intelligent features; they can be grouped according to the nature and purpose of their use. Each set of these indicators focuses on a specific dimension of the smart city. [23]

3.3 two main types of indicators are available

- Type I: Highlights the features of the city by measuring its essential characteristics, and each of these indicators is a composite indicator, representing a measure calculated from several variables. For example, an individual-related indicator may consist of several variables, including population census, the proportion of children to the population, the proportion of young people to the population, and others. At the same time, other indicators include housing, economy, government, geography, and climate. When determining the values for all variables, the appropriate measures can be defined to integrate them and obtain the value of the people index [15].
- Type II: comprises a set of city performance indicators and is usually organized into many topics. They measure a wide range of city services and quality of life factors and include city services such as education, energy, recreation, fire emergencies, speed of response, governance, health, safety, solid waste, transportation, urban planning, and wastewater. As for the quality of life, its indicators are civic participation, culture, economy, environment, shelter, social justice, technology, and innovation. Each of these indicators measures several variables [12, 15].

3.4. Multiple Potential Benefits of Assessing Smart Cities

The importance of smart city assessments is due to their important implications for both cities and their authorities, investors, funding bodies, researchers, and citizens, as follows [24]:

Cities and local authorities: It allows monitoring of the city's performance to improve the international image and its competitive position in the eyes of investors and citizens [11, 25], establishes a sufficient justification for the value of smart city investments, and promotes transparency of management [26].

It identifies the strengths, weaknesses, and orientation of smart city planning [27, 28]; it also contributes to tracking the progress of achieving the goals and locating the city in its efforts leading to intelligence achievement [28, 29]. In addition, it helps in understanding the social, economic, environmental, and technical requirements of smart city projects, allows learning from past experiences (when evaluation involves setting benchmarks), and displays the best cases of city assessment to benefit from its results [30, 31].

Investors and funding bodies: Assessments allow smart cities to evaluate completed or ongoing projects based on evidence and are also the scientific means to prioritize funding allocation and enhance the ability to make decisions regarding the best locations for future investment as well as the ability to identify and take advantage of new business opportunities and stimulate discussions among various stakeholders that may lead to improved use of resources[11, 32].

Researchers: It allows them to develop new strategies to improve the performance of smart cities and simplifies the complexities of the smart city concept [17, 33].

Citizens: This leads to increased awareness of the benefits of smart city projects and the ability to make informed decisions regarding upcoming investments. It motivates participation in smart city development activities and informs the city authorities of their wishes and priorities [11, 31].

4. MONITORING AND EVALUATION OF SMART CITY PERFORMANCE

Many researchers have developed criteria and indicators to assess smart cities' performance, enhancing the competitiveness of intelligent cities and guiding investors' choices [12, 24, 29]. This assessment is necessary for comparing cities and leveraging better experience, identifying the driving forces of smart cities, identifying weaknesses and knowing the effort to overcome them and identification of the comparative advantages and strengths of each city, potential development opportunities, as well as assessment of the current state of the city's development, compared with the rest of the cities. This assessment also draws the attention of individuals to issues related to the development of smart cities, contributes to the awareness of individuals, through which individuals learn about the viability of their city, and its location within the group of cities [34]. In 2019, Sharifi conducted a classification of smart city assessment criteria and indicators [24]. It examined the strengths and weaknesses used in various smart city assessment frameworks. It also studied and looked at 34 smart city performance evaluation benchmarks to better understand the assessments used in smart cities. This study provides general information on the characteristics of such evaluations, such as focusing on the geography of the regions, the size of the analysis, the beneficiaries' target, as well as methods of application; In addition, identifying the planning focus areas and providing detailed information on the methods and theories used in assessing smart cities [24]. The results of the study indicated that there were common factors in the evaluation processes between different evaluation methods and the method of evaluation criteria and indicators prevailing during the study method, which were based on the following: Economy, people, government, infrastructure, mobility, and living.

Sharifi classification method can also be used for multiple purposes. It can serve as a frame of reference for researchers or those wishing to evaluate the performance of smart cities using appropriate methods and as a basis for further operational analysis of the assessment method and plans [12]. A review of the previous study showed that most of the criteria do not provide specific indicators of details and data or do not publish all the information necessary for in-depth analysis, except for three criteria that provide the essential details about the indicators and are more comprehensive; which the researchers selected and studied a comparative study in preparation for reaching an appropriate and applicable standard to the new Egyptian cities, which are as follows:

4.1. United For Smart Sustainable Cities "U4SSC" standards

evaluation process was development of a list of general criteria by which all the physical and moral components of the smart city and the management system of all sectors and administrations of the city, including

the human engine, are measured; Through a hierarchical structure at which each level reflects the level preceding it. Each dimension represents several factors. Each factor describes by many indicators developed in the light of global sustainable development indicators, and each indicator has a weighting factor (relative weight) or degree. It is not essential for the indicator to have a high score but at least provide the minimum required availability.

Evaluation dimensions in 3 specific sectors define by seven dimensions divided by 26 performance factors, measured against performance and metric indicators by 93 indicators [35],When combined in one city, these indicators achieve the overall view of a sustainable smart city [12, 15].Fig.2.shows Hierarchical structure for the evaluation of smart cities of the "U4SSC" Standard.

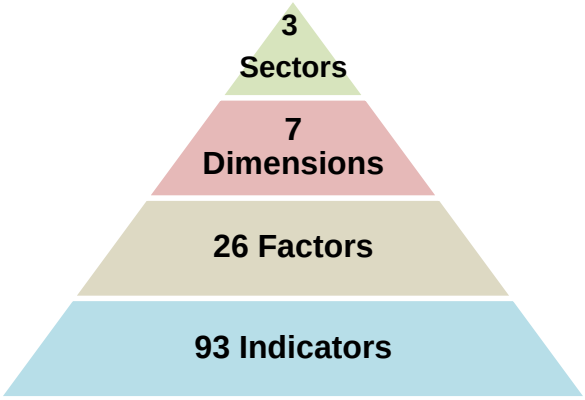

Fig. 2. Hierarchical structure for the evaluation of smart cities of the "U4SSC" Standard (Authors).

These indicators divide into 56 Basic indicators, of which cities should be able to implement at present. 37 Advanced indicators, the importance of which follows the fundamental indicators, giving a more in-depth view of the city and measuring progress in the most progressive initiatives; However, there is a disparity in the ability of some existing cities to implement them. Indicators categorize into:

- Forty-four smart indicators (communications and smart applications).
- Twenty sustainable (environmental) indicators.
- Twenty-nine structural indicators for construction and infrastructure

4.2. CITY-Keys Standards for Smart Cities

The evaluation indicators in this Standard were selected according to the needs of cities and citizens, the working definitions of the evaluation keys were defined which included (people, planet, prosperity and governance). The structure and framework of the assessment and the objectives of the smart city were defined as follows:

- Improve the quality of life of its residents, guiding workers, students, and other visitors. (People)
- Significantly improve the efficiency of their resources, reduce their pressure on the environment and increase their resilience. (Planet)
- Building an economy based on innovation and greenery. (prosperity)
- Promote evolving local democracy. (Governance)

These indicators can be used:

- From decision makers in city councils and administrations to follow up on the level of intelligence over time.
- From national governments to follow up on whether smart city policies have resulted in more attention to overall goals (reducing energy use and greenhouse gas emissions, increasing citizen participation, etc.) and to compare the level of intelligence of cities with each other
- Used to monitor the progress made in the city to be evaluated towards the smart city goals and the time it took the city to achieve those goals.
- Indicators can be used to compare cities to each other. [37, 38]

Table 1. illustrates Smart city dimensions structure according to CITYKeys standard.
Fig.3. shows the most important objectives of the smart city according to the CITY-Keys standard.

- Table 1. Smart city dimensions structure according to CITYKeys standard [38]

People	Planet	Prosperity	Governance	Propagation
Health	Energy and	Employment	Organization	Scalability

	mitigation			
Safety	materials, water, and land	Equity	Community involvement	Replicability
Access to (other) services	Climate resilience	Green economy	Multi-level governance	
Education	pollution and waste	Economic performance		
Diversity and social cohesion	Ecosystem	Innovation		
Quality of housing and the built environment		Attractiveness and competitiveness		

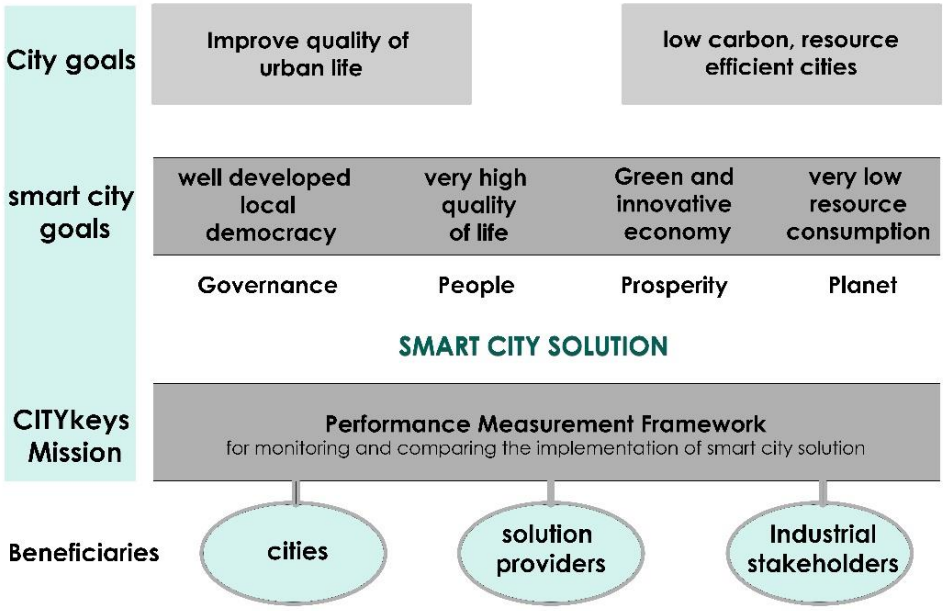

Fig.3. The most important objectives of the smart city are according to the CITY-Keys standard**.**

4.3. Key Performance Indicators related to the impacts of ICTs in ITU-T Smart Sustainable Cities

According to [ITU-T Y.4900] standard, smart sustainable city is an innovative city based on the use of information and communication technologies (ICTs) and other means to improve the quality of life, efficiency of urban processes and services and competitiveness while ensuring that the needs of present and future generations are met in terms of economic, social, environmental and cultural aspects.

Presents explicitly key performance indicators related to the impacts of information and communication technologies (ICTs) on the sustainability of cities in the context of smart, sustainable cities. This recommendation is part of a series of recommendations that define key performance indicators (KPIs) in smart, sustainable cities. It was released in June 2016 and focused on key performance indicators (KPIs) in Smart Sustainable Cities (SSC). [39, 40]

Evaluating these indicators can help cities, their planners, and managers understand how these cities can be considered smart, sustainable cities. The recommendation describes the applicability of key performance indicators, principles, dimensions, and definitions of corresponding indicators for adaptation to the overall framework of city indicators. This recommendation reuses the classification according to the UN-Habitat Urban Prosperity Index, and the sustainability of the smart city is based on four main aspects:

- First Economic aspect: the ability to generate income and employment opportunities to ensure the population's livelihoods.
- Second Social aspect: the ability to ensure the well-being (safety, health, and education) of the population on an equal footing despite their differences in terms of social class, race, or gender.
- Third Environmental aspect: the ability to protect the quality of natural resources and their ability to reproduce in the future.

- Forth Governance aspect: maintaining stable, democratic, participatory, and just social conditions.

This recommendation could be used by:

- Cities and Municipal Administrations: The participation of cities and municipal administrations including policy-making organizations related to smart, sustainable cities and government sectors, allow to develop strategies and understand progress in using ICTs to make cities more intelligent and sustainable.
- City residents and their non-profit organizations: allowing them to understand the evolution and progress of smart, sustainable cities concerning the impacts of ICTs.
- Organizations involved in developing and managing smart sustainable cities: including planning units, producers, service providers related to smart, sustainable cities, and management and maintenance organizations, which help them to perform the tasks of exchanging information on the use of ICTs and their impact on the sustainability of cities.
- Evaluation agencies and academic institutions help them select relevant KPIs to assess the contribution of ICTs to the development of smart cities.

4.4. Comparison of smart city performance evaluation criteria

The criteria can compare by type of classification, whether global or international, or in terms of the number of cities covered by the category, the number of indicators used in the evaluation, and the ranking methodology. Five dimensions can be identified to analyse the methods of city assessment. [34]
Table 2. compares the smart city assessment methodology between the three selected criteria
U4SSC – CITY-Keys – ITU-T.

By comparing the previous criteria, we find that the standards of the United for Smart Cities initiative characterize by current data and the breakdown of the criteria where they are divided into (sectors, dimensions, factors, and indicators); they are more detailed. It also stands out from the rest of the criteria because it can be used by all stakeholders and contains 93 indicators. It is more than the CITY-Keys standards, which include 76 indicators, and the ITU-T standards, which hold 90 indicators. The U4SSC standards are also an initiative that has relied on the ITU-T Recommendation after its development and elaboration.

Contribute to evaluating the performance of smart cities, enhancing the positives and avoiding the negatives. The main objective of this initiative is to help planners, administrators and researchers understand the extent to which these cities can be considered smart and sustainable cities, giving possible results to the case of the study. The U4SSC criteria classify indicators into basic indicators that existing cities must be able to implement at the moment so that an existing city can be said to meet a minimum of intelligence and advanced indicators that may exceed the current capabilities of the city and through which existing cities can be evaluated.

Through the above, the U4SSC standard is the best criteria that provide details of indicators and facilitate the process of measuring the intelligence of cities transparently and objectively, so it is possible to rely on the standards of "U4SSC" in applying the dimensions of these standards to the New Minya, measuring the level of intelligence and extracting strengths and weaknesses.

Table 2. Comparison Methodology of Evaluating Smart Cities Between Three Selected Criteria (Authors)

Dimension		U4SSC Standards	CITY-Keys Standards	ITU-T Standards
Authorship & Publishing	Author and publishing type	International Telecommunication Union (ITU) and the Land Management Committee of the United Nations Economic Commission for Europe (UNECE)	Netherlands Organization for Applied Scientific Research, Austrian Institute of Technology, Technical Research Centre of Finland	ITU Group on Smart Sustainable Cities.
Sectors	Main focus	Focus on Smart Development Goals (SDGs11) and the development of smart and sustainable cities	Smart in general - multiple dimensions	Multiple dimensions related to Smart and sustainable cities; alignment with smart development goals
	Main Sectors	Economy, environment, society, and culture	Environment, Economics, and Management	ICTs, environmental sustainability, productivity, quality of life, social justice, and infrastructure

Database	The time range of data used	2017	2016	2015
	Available data sources	United for Smart Sustainable Cities based on ITU-T Recommendation	Netherlands Organization for Applied Scientific Research	ITU Telecommunications Measurement Sector
	Methods of calculating results Final	Use standard values	Use standard values	Use standard values
Use of Indicators	Number of Indicators	93 Indicators	76 Indicators	90 Indicators
	Who can use it	All concerned parties	Relevant organizations	City Administrations – Relevant Organizations
	Calculation method	Use standard values	Use standard values	Use standard values
Spatial Dimension	Spatial dimension	Global	Global	Global
	Number of Cities	100	50	No information
	Criteria for selecting cities	Set of criteria	Set of criteria	No information
Final Results	Results of the final evaluation	More detailed results	Mid-detail results	Less detailed results

5. FIELD STUDY OF THE NEW CITY OF MINYA

The field study applied to New Minya city was divided into two parts:
Part I: aimed to develop the indicators of the U4SSC initiative, which is the criterion chosen based on the theoretical study of application to new Egyptian cities to assess the level of intelligence of the city. This was done through conducting a field study and questionnaire for the opinion of experts, specialists, and decision-makers in New Minya city to: -

- Develop the indicators of the initiative in addition to deletion or replacement.
- Determine and add the relative weight of each intelligence indicator included in the initiative in proportion to the application to the new city of Minya.

As well as to make adjustments to the relative weight of each of the factors, dimensions, and sectors in an attempt to reach a final formula to assess the level of intelligence of New Minya City, ensuring that this formula is applicable and serves as a motivation for the creation of contemporary societies and intelligent new Egyptian cities.

Part II: was aimed at conducting a questionnaire on a sample of New Minya City residents to explore the strengths, weaknesses, opportunities, and threats of the new city of Minya as an example of new cities in Egypt and to try to link this study with the intelligence indicators proposed for application to new cities in Egypt. A sample of 600 respondents representing 1% of the city's population was randomly selected.

5.1. Results of the field study

Likert scale of five ratings has been used in the evaluation (very high, high, medium, little, very little). The Likert Scale is easy to build and allows participants to answer the questionnaire according to the degree of feeling about the declarations [41, 42] and is a very reliable measure compared to open questions. The result of the questionnaire is shown in Table 3. Figure . shows the inputs and outputs of assessing the relative weights of smart city indicators. According to the results of the questionnaire on the Likert scale, the results were determined as follows:

1. **Determining Values Using a Specialist Survey**:
    - A survey was designed using the **five-point Likert scale**, where specialists were asked to evaluate the indicators based on specific questions.
2. **Measuring the Probability of Positive Results (PIP)**:

- For example, participants were asked:
  "IN YOUR OPINION, WHAT IS THE LIKELIHOOD OF THE INDICATOR ACHIEVING POSITIVE RESULTS IN NEW MINYA CITY?"
- Responses ranged from 1 (Not at all likely) to 5 (Very likely).
- The **average score** of the responses was calculated and normalized to a relative value between 0 and 1.

3. **Measuring the Time Range for Achieving Results (TRA)**:
   - For instance, participants were asked:
     "WHAT IS THE EXPECTED TIMEFRAME FOR THE INDICATOR TO ACHIEVE TANGIBLE RESULTS IN NEW MINYA CITY?"
   - Responses followed the same five-point Likert scale.
   - The average score was then converted into a relative value (0–1) based on the responses.
4. **Final Calculation**:
   - After obtaining the average **PIP** and **TRA** for each indicator, the two values were multiplied to calculate the **RWI (Relative Weight Index)**, which represents the final percentage.

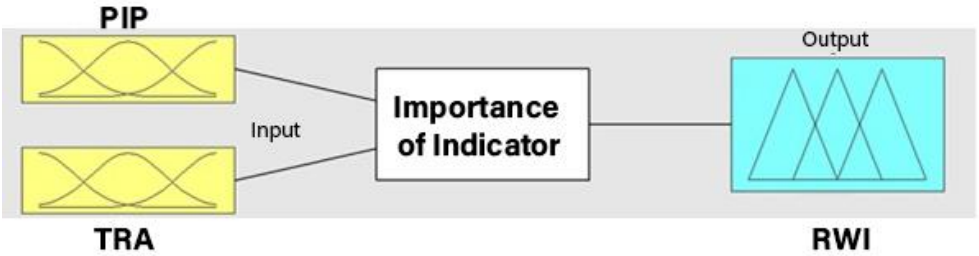

Figure 4. inputs and outputs to determine the relative weight of indicator intelligence level (Authors)

Table 3. Results of the relative weight of the importance of smart city indicators (Authors)

basic indicators	PIP	TRA	RWI Average	importance of indicator %
Fixed Broadband Subscriptions	0.94	0.87	0.90	2.59
Wireless Broadband Subscriptions	0.82	0.86	0.84	2.41
Wireless Broadband Coverage and Surveillance Cameras	0.56	0.67	0.62	1.78
Household Internet Access	0.84	0.82	0.83	2.39
Smart Water Meters	0.25	0.78	0.52	1.49
Drainage / Storm Water System ICT Monitoring	0.12	0.35	0.24	0.69
Smart Electricity Meters	0.78	0.89	0.84	2.41
Dynamic Public Transport Information	0.18	0.69	0.44	1.26
e-Government	0.25	0.82	0.54	1.55
R&D Expenditure	0.10	0.71	0.41	1.18
Patents	0.03	0.61	0.32	0.92
Unemployment Rate	0.89	0.62	0.76	2.18
Youth Unemployment Rate	0.91	0.74	0.83	2.39
Basic Water Supply	0.98	0.99	0.99	2.85
Potable Water Supply	0.65	0.35	0.50	1.44
Water Supply Loss	0.20	0.51	0.36	1.03
Wastewater Collection	0.60	0.54	0.57	1.64
Household Sanitation	1.00	1.00	1.00	2.87
Solid Waste Collection	0.89	0.77	0.83	2.39
Electricity System Outage Frequency	0.62	0.65	0.64	1.84
Electricity System Outage Time	0.50	0.60	0.55	1.58
Access to Electricity	0.80	0.59	0.70	2.01
Public Transport Network	0.85	0.56	0.71	2.04
Bicycle Network	0.38	0.56	0.47	1.35

basic indicators	PIP	TRA	RWI Average	importance of indicator %
infrastructure	0.12	0.31	0.21	0.6
Air Pollution	0.95	0.75	0.85	2.44
GHG Emissions	0.92	0.80	0.86	2.47
Drinking Water Quality	0.40	0.36	0.38	1.09
Water Consumption	0.75	0.61	0.68	1.95
Freshwater Consumption	0.65	0.53	0.59	1.7
Wastewater Treatment	0.61	0.40	0.51	1.47
Waste collection and sorting systems	0.78	0.85	0.82	2.36
Solid Waste Treatment	0.65	0.64	0.65	1.87
Waste Recycling	0.81	0.88	0.85	2.44
EMF Exposure	0.62	0.73	0.67	1.93
Green Areas	0.85	0.79	0.82	2.36
Renewable Energy Consumption	0.09	0.29	0.19	0.55
Electricity Consumption	0.85	0.87	0.86	2.47
Residential Thermal Energy Consumption	0.06	0.49	0.27	0.78
Public Building Energy Consumption	0.65	0.70	0.68	1.95
Student ICT Access	0.55	0.76	0.66	1.9
School Enrolment	0.92	0.92	0.92	2.64
Higher Education Degrees	0.69	0.39	0.54	1.55
Adult Literacy	0.80	0.62	0.71	2.04
Life Expectancy	0.65	0.33	0.49	1.41
Mortality Rate	0.60	0.31	0.46	1.32
Cultural Expenditure	0.26	0.60	0.43	1.24
Informal Settlements	0.27	0.47	0.37	1.06
Gender Income Equality	0.72	0.70	0.71	2.04
Gini Coefficient	0.69	0.69	0.69	1.98
Poverty Share	0.66	0.52	0.59	1.7
Voter Participation	0.32	0.38	0.35	1.01
Natural Disaster Related Deaths	0.28	0.34	0.31	0.89
Violent Crime Rate	0.62	0.78	0.70	2.01
Fire Service	0.69	0.88	0.79	2.27
Traffic Fatalities	0.65	0.89	0.77	2.21

This table highlights the relative importance of various smart city indicators based on the opinions of specialists and decision-makers. The results indicate that indicators related to **basic water supply**, **household sanitation**, and **waste recycling** scored the highest relative importance. This underscores the priority of infrastructure and environmental management in the assessment of New Minya City's intelligence level. Conversely, indicators such as **drainage/stormwater system monitoring** and **patents** showed lower importance, reflecting areas where development may currently be limited. These findings guide the prioritization of interventions for enhancing the city's smart and sustainable infrastructure.

Based on the analysis of the results of the field study

- The 37 advanced evaluation indicators were excluded because they exceeded the current capacities of some cities to implement them .
- Add a relative weight to each indicator and not equal all indicators in the relative weight as in the initiative (U4SSC).
- Adjustment of the relative weight of sectors, dimensions, and factors.

Table 4. shows the relative weights of sectors, dimensions, and factors, and Figure . shows Sectors' relative weight according to survey results.

Table 4. shows the relative weights of sectors, dimensions, and factors (Authors)

Sectors	Relative Weight	Dimension	Relative Weight	Factors (Category)	Relative Weight
Economy	44.90	ICT	16.59	ICT Infrastructure	9.17
				Water supply and control	1.50
				sanitation	0.69
				Electricity Supply	2.41
				Transport	1.27
				Public sector	1.55
		Productivity	7.67	Innovation	2.1
				Employment	4.57
		Infrastructure	21.64	Water and sanitation	9.83
				Waste	2.39
				Electricity Supply	5.43
				Transport	3.39
				Buildings	0
				Urban Planning	0.6
Environment	27.82	environmental sustainability	22.08	Air Quality	4.91
				Water and Sanitation	6.21
				Waste management	6.67
				Environmental Quality	1.93
				Public Spaces & Nature	2.36
		Energy	5.75	Energy	5.75
Society and Culture	27.28	Education, Health, and Culture	12.1	Education	8.14
				Health	2.73
				Culture	1.24
		Safety, Housing, and Social Inclusion	15.18	Housing	1.06
				Social Inclusion	6.73
				Safety	7.39

The table provides a breakdown of the relative weights assigned to different sectors, dimensions, and factors in evaluating the city's intelligence. The **economy sector** received the highest weight (44.90%), emphasizing the importance of economic indicators such as ICT infrastructure and productivity. The **environmental sector** follows with a focus on sustainable practices, while the **social and cultural sector** highlights the role of education and safety. These weights reflect the city's development priorities and serve as a framework for assessing its progress toward smart city goals.

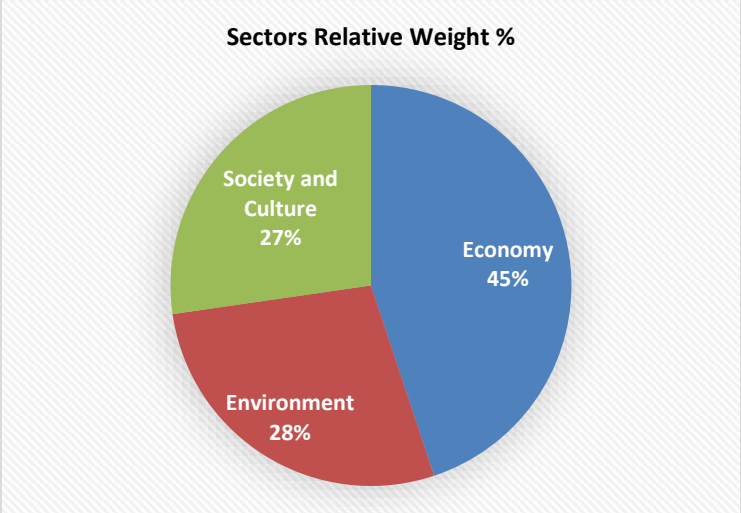

Figure 5. shows Sectors' relative weight according to survey results

5.2. The sample of the study used to identify strengths, weaknesses, opportunities, and threats in New Minya City (SWOT)

The New Minya City Family Segment (Population Survey) represents the Household Survey. A sample of 1% of the city's households, with a population of about 60,000 people, was selected, where the number of families in the city is estimated at 12,000 families with an average number of 5 families per family, according to the results of the preliminary questionnaire, which showed that the average number of households predominantly among the city's population is five members per family.

The questionnaire used this segment to monitor the features and problems of the new city of Minya to

identify its strengths and weaknesses, exploit its strengths and identify the city's possibilities that help develop intelligent solutions to problems.

5.3. The result of the field study of the SWOT analysis of New Minya city

The survey of the city's people found that some advantages cannot be overlooked and that can be considered strengths of the city that can be exploited. It also turned out that some problems in the town are weaknesses that must be solved and placed among the development priorities. Through the researchers' study of the study area and the opportunities and threats associated with the city, the researchers found the following, as shown in

Table. 5.

Table. 5. SWOT Analysis of New Minya City

Strengths	**Weaknesses**
A well-developed water and sewage network.	Lack of smart monitoring systems for water and electricity consumption.
Low unemployment rates and abundant job opportunities.	Dependence on non-renewable energy sources.
Proximity to the industrial zone for economic growth.	Absence of public Wi-Fi in open spaces.
High education levels and skilled youth population.	Limited availability of electronic data in government systems.
Opportunities	**Threats (Risks)**
Strategic location near the industrial zone and regional roads.	Increasing traffic accidents on the main road connecting to the city centre.
Potential for investment due to abundant land.	Rising land and residential unit costs.
Calm environment away from urban congestion.	Rapid technological advancements may outpace current city infrastructure.

Key Comparisons and Insights:

1. **Strengths vs. Weaknesses**:
   - While the city benefits from strong water and sewage networks, the absence of smart monitoring systems limits efficiency and responsiveness to issues. This highlights an opportunity to integrate smart systems to build on existing strengths.
   - The city’s low unemployment rates can be contrasted with the lack of smart infrastructure, emphasizing the need to direct skilled human resources toward implementing smart technologies.
2. **Opportunities vs. Threats**:
   - The strategic location and abundant land present significant opportunities for economic investment and infrastructure development. However, these must be leveraged to address risks such as rising land prices and infrastructure limitations.
   - The city’s calm environment is an advantage, but it must adapt quickly to technological changes to avoid falling behind in smart city competitiveness.

This table summarizes the strengths, weaknesses, opportunities, and risks associated with New Minya City. Key strengths include a well-developed water network, low unemployment rates, and proximity to the industrial zone. However, weaknesses such as the absence of smart systems for water and electricity monitoring and the lack of public Wi-Fi in open spaces highlight critical areas for improvement. Opportunities, such as the city's tranquility and its strategic location, present potential for growth, while risks like dependence on non-renewable energy and traffic accidents require mitigation strategies. The SWOT analysis provides a foundation for tailoring the smart city framework to the unique characteristics of New Minya City.

6. Results

In light of what was previously studied in the research paper on assessing the level of intelligence of new Egyptian cities through the application of the initiative (U4SSC) United for Smart Sustainable Cities, the researcher drew some conclusions as follows:

(1) Our vision of the future of intelligent cities in Egypt should include both smart infrastructures based on communications, technology, and virtual reality representation and a smart society whose members have

sufficient awareness to absorb and interact with the available systems, as well as the environmental dimension of the city to be an environmentally sustainable smart city.

(2) The intelligence of cities can be measured either by measuring indicators that illustrate the characteristics of the smart city itself, such as the characteristics of the population, economy, government, and climate, or through indicators that measure the city's services and quality factors such as transportation, health, waste disposal, and culture and includes characteristics or factors and services in both cases a set of variables that can be measured and combined to obtain the value of each of these factors and then determine the level of intelligence of the city.

(3) Comparative Analysis of the Three Standards:
While the study primarily focused on the **U4SSC** standard, a comparison with the other two standards (**CITY-Keys** and **ITU-T**) provides valuable insights:

- **U4SSC**: Chosen for its comprehensive approach, U4SSC aligns with the **UN's SDGs** and covers all three sustainability pillars (environmental, economic, and social), making it highly suitable for New Minya City.
- **CITY-Keys**: Offers a strong framework but focuses more on benchmarking and inter-city comparisons, which is less adaptable for new cities like New Minya.
- **ITU-T:** Focuses on ICTs and sustainability, but its narrower scope makes it less comprehensive for evaluating broader city development factors.

Conclusion: U4SSC was selected due to its detailed, holistic approach, while CITY-Keys and ITU-T could complement the evaluation in future studies, particularly in the areas of citizen engagement and ICT.

(4) The field study applied to a group of specialists and officials of Minya New City was based on the criteria of an initiative (U4SSC). Selected by the researchers due to its comprehensiveness and precise detail, it was developed by deleting some advanced indicators to reduce the number of indicators to 57 indicators and adding relative weight for each indicator, adjusting the relative weight of both factors and dimensions, resulting in an adjustment in the relative weight of the economic sector from 43.96% to 44.90. In contrast, the relative weight of the environmental sector decreased from 29.15% to 27.28%, and the relative weight of the social and cultural sector increased from 25.55% to 27.28%. After development, the scale also highlighted the relative weights of both factors and dimensions.

(5) The study showed in the economic aspect the great importance of the use of intelligent technologies in the infrastructure represented by indicators related to water networks, sewage networks, and electricity, where it achieved the highest relative weight (2.87% - 2.85%), which also appeared in the analysis (SOWT) The weaknesses showed the lack of smart systems to control networks for water and identify malfunctions and speed of response to them, which reflects the importance of infrastructure when evaluating cities. In comparison, the relative weight of the index of rain drainage control systems decreased by relative weight 0.67%.

(6) The study on the environmental aspect of the new city of Minya also showed the great importance of indicators in the fields of waste collection and recycling systems, which achieved the highest relative weights (2.44%-2.36%). The index of pollution by gases and the increased consumption of electricity from thermal plants gained an essential hand in measuring the level of intelligence in the environmental aspect with relative weights (2.47%-2.44%); this was also clearly shown in the analysis (SOWT), considering air quality in the city as one of its most important strengths and required maintenance.

(7) The study also showed in the cultural and social aspect the importance of the education index with relative weight (2.64%) and the security aspects represented by the speed of response to fires and natural disasters, which achieved a relative weight in (2.27%-2.21%). The population confirmed it in the analysis (SOWT) regarding opportunities for high education, culture, and social integration in the city and high safety rates.

(8) At the level of factors, the water supply and control factor achieved the highest relative weight in the proposed indicators, where it gained (9.83%) relative weight, followed by the ICT infrastructure factor (9.17%) and then the education and security workers by (8.14% - 7.39%) respectively.

7. Conclusions

The research paper concludes with a series of recommendations, the most important of which are:

(1) Interest in transforming Egypt's new cities into smart ones; New cities can achieve positive results because of the ease with which the community responds to the idea of raising the level of intelligence in towns. It is also characterized by high education rates and young groups in new cities.

(2) The local authorities of the Ministry of Local Development, Governorates, and Planning Departments should adopt the idea of assessing the level of intelligence of cities before initiating policies and strategies to monitor the current state of the city to be converted into intelligence and to identify the needs of each town by its circumstances.

(3) Using opportunities and strengths of each city as a starting point for the direction of intelligence in Egyptian cities, solving problems and vulnerabilities, and protecting against threats.
(4) It is recommended that local authorities prioritize the integration of smart monitoring systems and renewable energy solutions to address the city's infrastructure gaps and enhance sustainability efforts, ensuring that New Minya City aligns with the evolving standards for smart cities.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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