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A PROPOSED ASSESSMENT SCHEME FOR SMART SUSTAINABLE URBAN DEVELOPMENT

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Abstract: The opportunities created by new technologies challenge the way in which we conceive our cities, how we plan, design and construct them and how we live in them. The current large gap between smart city and sustainable city frameworks implies that there is a need for developing their frameworks further or re-defining the smart sustainable city concept, which is relatively new. The aim of this study is to conduct and perform qualitative and comparative analysis of International Standards and case studies, to provide a foundation for developing a framework for the planning of a Smart Sustainable City based on rigorous criteria and sub-criteria. The criteria have been selected according to international standards via ISO37120 and the Focus Group of Smart Sustainable Cities of International Telecommunication Union (ITU-T FGSSC), as a base for the framework. The framework developed in this study is more oriented towards achieving aspects of urban life at the design and planning stage versus other models existing in the literature that are more oriented towards progress in International Communication Technology (ICT) as a dimension by itself and as means to transform already built cities to smart cities. The proposed study is intended to build up and complement key dimensions and sub-dimensions that were developed by ITU-TFGSSC, by adding sub-dimensions and key indicators. The outcome of this study could be used to generate a framework and develop recommendations that has been tailored for urban planners, owners, operators and occupiers, to successfully and cost effectively adopt smart sustainable solutions

1. INTRODUCTION

1.1 Background

Cities were ruled first by empires followed by nation states, all urban activities, Social, Economic and Environmental services take place in cities, this has led to a global wave of urban development projects. The Smart City is an essential part of this wave, and will be explained further in this study. In the Twenty First Century, many cities are transforming from sustainability assessment to smart city. The main objective of smart cities is to use advancement and applications in Information Communication Technology (ICT) to achieve sustainability. Hence, we recommend the use of a more applicable terminology —smart sustainable cities‖ (instead of —smart cities‖), as suggested also by Kramers et al. (2014). The smart sustainable city terminology will ensure that sustainability and urban aspects are not over looked in smart city development. For the first time in history, we have the opportunity how smart sustainable urban planning can redefine the way we build our cities in the Twenty First Century

1.2 Problem Statement

The Twenty First Century belongs to the cities. 50% of the world population lives in cities and that number is expected to rise to 70% by 2050. The opportunities created by new technologies challenge

the way in which we conceive our cities, how we plan, design and construct them and how we will live in them. The current large gap between smart city and sustainable city frameworks implies that there is a need for developing their frameworks further or re-defining the smart sustainable city concept, which is relatively new and can be seen as a successor of information city, digital city and sustainable city. Furthermore, rating standards like Leader in Energy and Environment Design (LEED) and the Green Pyramids Rating System (GPRS) do not cover all the topics behind the Smart Sustainable City Concept.

1.3 Research Objective

The aim of this study is to conduct and perform qualitative and comparative analysis of International Standards and case studies, to provide a foundation for developing a framework for the planning of a Smart Sustainable City based on rigorous criteria and sub-criteria. This framework could be used to assess the smart sustainable urban development of the new administrative capital of Egypt, one of the most ambitious and important urban development projects at present in Egypt, and developing an action plan to achieve smart sustainable urban development. The criteria have been selected according to international standards via ISO37120 and the Focus Group of Smart Sustainable Cities of International Telecommunication Union (ITU-T FGSSC), as a base for the framework. The framework developed in this study is more oriented towards achieving aspects of urban life at the design and planning stage versus other models existing in the literature that are more oriented towards progress in International Communication Technology (ICT) as a dimension by itself and as means to transform already built cities to smart cities. The proposed study is intended to build up and complement key dimensions that were developed by ITU-TFGSSC, which developed the key dimensions and sub-dimensions. The proposed study has developed sub-dimensions and key indicators. Collective methodology for core indicators has been presented. Debates about environmental challenges are often hindered by lack of problem definition, uncertainty about the nature of these challenges, and ill-defined solutions. Gathering data into the recommended proposed framework helps to resolve these difficulties. To sum up, the goals of the study are:

a) Understand how the Smart Sustainable City Concept can be seen as the driving engine in achieving urban development aspects and in defining the Smart Sustainable Cities
b) Develop a framework to assess and prioritize Smart Sustainable City
c) Develop guidelines and recommendations to be implemented and applied for planning, construction and management of Smart City Projects.

1.4 Definition of smart sustainable cities (FGSSC, October 2015)

Fearing that the sustainability aspect in smart cities might be overlooked, the ITU Telecommunication Focus Group on Smart Sustainable Cities (ITU-TFGSSC) conceptualized the new term —Smart Sustainable Citiesǁ and developed a new definition on October 2015 “A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects.” After critical analysis of the literature, this definition provides a standardized basis for assessment models that has been adopted on the global level, It is oriented towards achieving aspects of urban life in the Smart Sustainable City context, hence it is the most suitable to be adopted and used in this study.

1.5 Scope of research

Conduct and perform qualitative and comparative analysis of relevant International Standards and case studies of existing and future cities to be built

1.6 Research Methodology

International Standards like FG-FSSC- ITU, ISO 37120, Habitat III 2016 and Sustainable Development Goals 2030. Case studies of existing cities transforming into smart cities like Singapore, Copenhagen and Dubai, Case studies of new sustainable smart cities to be built, Google affiliated city Sidewalk Toronto

2. Research work and discussions

2.1 Key dimensions of smart sustainable cities

Literature illustrates a difference in the dimensions also referred to as pillars, axes or sectors of a SSC. An extensive analysis of these dimensions was recently conducted by the focus group on SSCs

of the ITU, which serves as the international platform for sharing knowledge and developing best practices associated with smart sustainable cities. The analysis led to setting the dimensions to six, namely: smart economy, smart people, smart governance, smart mobility, smart living and smart environment (ITU-T FG-SSC, 2014)**.** (Lombardi et al., 2012) associated the six components presented in (Giffinger et al, 2007) with different aspects of urban life.

2.2 Sub- dimensions of smart sustainable cities

The sub-dimensions that have been listed by the United Nation Habitat III, Master Plan for Smart Sustainable Cities (Habitat III 2016) are adopted in this study and are being used as a base for this model. In the presented model, illustrated in figure 1, ICT forms part of the general Infrastructure category, ICT is a mean to achieve development, instead of technology as the master. It has been made to serve development, versus other models available in the literature via ITU-T group's developed model, in this model, ICT has been identified as a Key dimension and an objective by itself , The model developed by ITU-T used the quality of life as one of the dimensions of SSC, in-contradiction to what researchers agreed upon, that the quality of life is a cross cutting concern for all dimensions and should not be used as a key dimension The general goal is to improve sustainability with the help of technology.

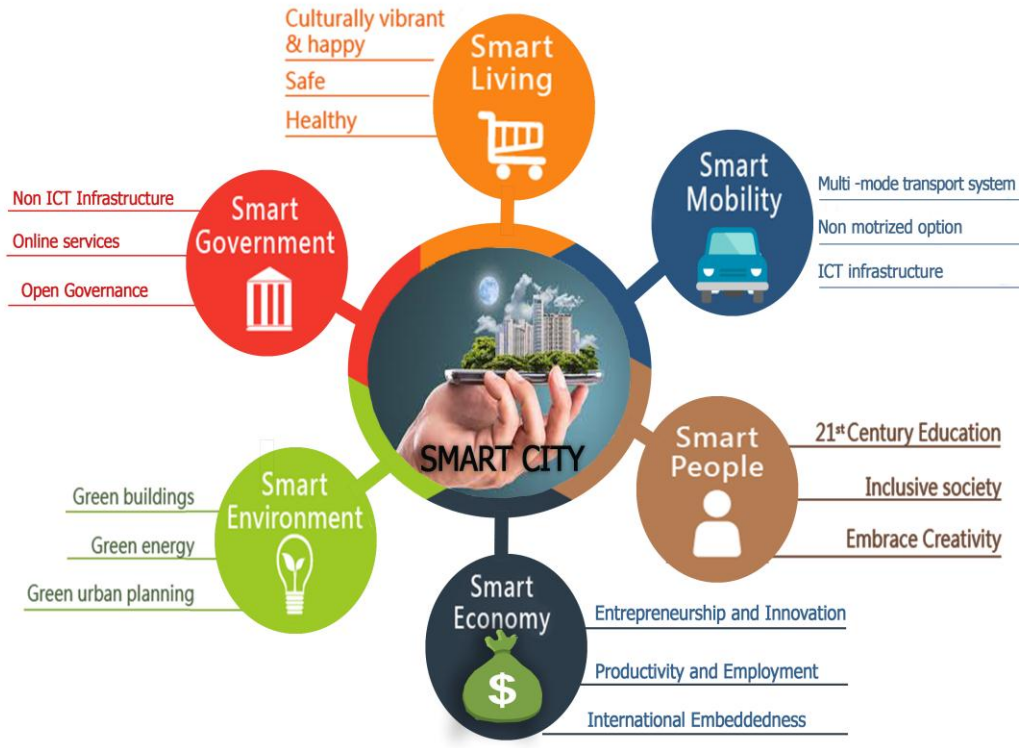

Figure 1 : Key Dimensions and Sub-dimensions for Smart Sustainable Cities
https://www.urban.com.au/urban-industry/2015/06/23/smart-cities-habitat-master-planning-framework

Each dimension is divided into core sub-dimensions that have been identified concretely through a set of indicators. In this study further research has been conducted to identify those key indicators. Tables (1,2,3,4,5 and 6) illustrate the Key Indicators for smart cities developed by the author and had been assessed with Yale University Urban Design

Workshop, through interviews and panel discussions. The framework developed is divided into core indicators that have been selected according to official documents of international standards via ISO37120 and the Focus Group International Telecommunication Union (ITU-TFGSSC), and identified in the tables by a superscript letter C at the end of each core indicator. The collection methodology for core indicators is referenced in a report for United for Smart Sustainable Cities U4SSC (2017). Additional sub-dimensions and indicators have been added by the author, after critical analysis and review of the literature and case studies to build up on the framework proposed in this study

2.3 Key Indicators of Smart Sustainable Cities

Table1 Key Indicators for Smart Mobility

SMART MOBILITY
1. Multimode Transport Systems Accessible and integrated
1.1Public Transportation 1) Kilometers of annual high & low capacity public transport trips /100000 ITU-T [C] 2) Transportation mode share% of commuters using transport other than a vehicle [C] 3) Central underground Metro stations to be connected to City 4) Bus Rapid Transit BRT in addition to franchised buses by private sector (all using clean energy) 5) New Railway development strategy and speed trains 6) More carpooling and sharing activities with incentives like free parking and free gas (platform for carpooling) 7) Freight Tunnel to separate private cars , public transportation traffic and freight traffic
2.Information Communication Technology (ICT) Infrastructure
2.1 ICT and internet of things 1) No of Fixed Broadband Subscription/100000 population ISO37120/7.1 [C] 2) No of Wireless broadband Subscription/100000 population ISO37120/7.2 [C] 3) Percentage of the city served by Wireless broadband Coverage 4G and 5G 4) Availability of Wi Fi coverage in public areas **2.2 Monitoring and Real Time Information Technology** 1) Percentage of Dynamic public transport information available to the public in real time [C] 2) Percentage of road intersections using adaptive traffic control for light signals or prioritization measures [C] 3) Percentage of major streets monitored by ICT 4) Real time for parking spaces available 5) Metering and Sensors Coverage for services (Electricity, water, energy, waste) 6) Build technology hubs and advance manufactory centres 7) Develop a scalable data platform for smart city data sharing
3. Sustainable
3.1 Innovative and Safe 1) Percentage of total trips of public transport achieved with smart cards 2) International Easy and Efficient Travel with Smart Airport 3) Advancement of Technology Vehicles, Vehicles for all (V2X)and Autonomous **3.2 Non-motorized options** 1) Percentage of bicycle paths for 100,000 ISO37120 /18.7 [C]

2) Promote walking through pedestrian finding and recommend walking routes
3) Establish "bicycle-friendly" new towns with cycling tracks and bicycle parking facilities and applications. The public transportation should complement the cycling tracks to final destination

Tables 2 Key Indicators for Smart Government

SMART GOVERNOMENT
1. Online services
1.1 ICT aimed at improving access to information and building capacities
1) Number of public services delivered through electronic means [C]
2) Percentage of public sector procurement activities that are conducted electronically [C]
3) Unified access point for all government services on a single platform
2. Infrastructure
2.1 Electricity
1) Electricity Supply,% of households with authorized access to electricity [C]
2) Electricity System Outage Time Average length of electrical interruptions [C]
3) Electricity System Outage Frequency, Average number of electrical interruptions per customer per year [C]
2.2 Water and sanitation
1) Basic water supply Percentage of households with access to a basic water supply [C]
2) Potable Water Supply Percentage of households with a safely managed drinking water service [C]
3) Sanitation, Percentage of households with access to basic sanitation facilities [C]
2.3 Waste
1) Solid waste collection
2.4 SENSORS
1) Sensors and meters coverage for monitoring services consumption
3. Open Governance
1) Open Data
1) Use central data management to assess growth and sustainability
2) Percentage of mobile applications available based on open data
3) Privacy of Information
4) Voters participation in last municipal election percentage of eligible voters

Table3 Key Indicators for Smart Economy

SMART ECONOMY
1. Entrepreneurship and Innovation
1.1 Research and Development
1) Percentage of GDP invested in Research and Development [C]
1.2 Patents
1) Number of Patents for 100000 population ISO 37120 [C]
1.3 Entrepreneurship
1) Assessed value of total commercial and Industrial properties as a percentage of total assessed value of all properties [C]

2) Number of Businesses for 100000 population ISO 37120 C
3) Facilitate business licensing and registration to foster entrepreneurship in the city
4) Develop economic plans and policies, identify and support the growth of strategic sectors, and provide services to domestic and international investors and businesses.

2.Productivity and Employment

2.1Productivity
1) Broad band internet connectivity /100 capita C
2) Mobile broadband internet subscription/100 capita C
3) Fixed broadband internet subscription /100capita C

2.2 Employment
1) City's unemployment rate ISO37120 C
2) Employment rate for every 100 capita C

2.3 Poverty
1) Percentage of city population living in poverty C

3. International Embeddedness

3.1 Export
1)Percentage of GDP based on foreign export C

3.2 Attraction of city for foreign investment
1) network of industrial and commercial areas including: business parks, specialized free zones of international distinction, a world class seaport, a major international airport, a cargo village, a modern highway network, state-of-the-art telecommunications, and reliable power and utilities
International conferences and fairs

Table4 Key Indicators for Smart People

SMART PEOPLE

1. Education

1.1Primary and Secondary Education
1) Percentage of students completing Primary Education ISO37120 C

1.2 Student teacher ratio
1. Primary education student to teacher ratio ISO37120/6.3 C

1.3 College Education
1.College education (number of higher education degree for 100,000 C

1.4 Adult literacy
1. Adult literacy rate.

2.Social Inclusion

2.1 Student ICT Classroom access
1) % of students with classroom access to ICT facilities
2) Smart phones penetration (% of residents with smartphones access**) C**

2.2 Civic Engagement
1) Percentage of civic engagement activities offered by municipality last year

3. Creativity

3.1 Plurality
1) Social and Ethnic plurality

3.2 Creative Industry

1) Creative Industry jobs

3.3 Urban Living Lab

Table5 Key Indicators for Smart Environment

SMART ENVIRONMENT
1. Green Energy
1.1Monitoring Energy 1) Development of a database to monitor energy consumption footprint (kWh/m2) in buildings Total residential Energy use per capita in KWH /year ISO 37120 /[C] 2) Total Public building energy use per Capita in KWH/Year ISO37120/ [C] **1.2 Renewable Energy** 1) The percentage of energy driven from renewable energy sources in kwh/Yr as a share of total energy consumption ISO 37120 /7.4 [C] **1.3 Electric Energy** 1.Percentage of city population with authorized electric energy **1.4 Set Targets** 1) Set targets for clean energy power capacity via 25% 2020 and 75% by 2030
2. Sustainable and Resilient Resources Management
1.1 Waste Management 1) Percentage of solid waste recycled ISO37120/16.2) & total collected solid waste /capita in Kg ISO 37120/16.31. [C] **2.2 Water Management** 1) Percentage of city water receiving primary, secondary, tertiary treatment ISO 37120 ISO 37120 20.3/ 20.4 /20.52. [C] 2) Percentage of commercial buildings with smart water fittings
3. Sustainable Urban planning
3.1 Air Quality and Carbon footprint1. 1) Greenhouse gas emissions measured in ton/capita 5.5 Urban stakeholders should focus their efforts on reducing the carbon footprint of their city (in line with the COP-21 targets and SDG13 **3.2 Green Area** 1) Green area /100,000 in m2 ISO 37120 /19.6 [C] **3.3 Climate Resilience** 1) Climate Resilience Planning **3.4Smart Buildings** 1) Promoting green and innovative building Systems in construction and buildings (BIM,, Self Healing concrete for maintenance of bridges and new construction methods)

Table 6 Key Indicators for Smart Living

SMART LIVING
1) Culture and wellbeing
1.1budget allocated to culture 1) Percentage of municipal budget allocated to culture **1.2 Gini Index** 1) Gini Index of zero expresses perfect equality

1.3 Quality of life

1) Quality of life ranking
2) .Education facilities
3) Housing quality
4) .Social cohesion
5) Touristic attractively

2.Safety(SL.2.1)

2.1 Crime

1) Number of crime rate for 100,000 population C

2.2 Crime prevention

1) Smart crime prevention
2) Number of police officers for 100,000 population C

2.3 ICT and Artificial Intelligence (AI)

1) Smart police Applications of ICT and AI(Artificial Intelligence Applications

3. Health

3.1 Single Unified Health History

1) Single health history (% of residents with single unified health history facilitating patients and health provider access to complete medical record)

3.2 Health Services

1) Number of inpatient hospital beds /100,000 C
2) Number of physicians for 100,000 population C

3.3 Life expectancy

1) Average life Expectancy C

3.4 Recreation

1) Square meter of public outdoor and indoor recreation facilities

3. ACTION PLAN FOR SMART SUSTAINABLE NEW ADMINSTARTIVE CAPITAL, EGYPT

3.1Launch Smart Sustainable Administrative Capital Initiative

Launch Smart Sustainable Administrative Capital Initiative that complies with the city vision and long term development. This will bring together teams working on various aspects of Smart Nation and Digital Government policy, Creating a partnership with government agencies, industry and citizens to apply digital and smart technology, that will enhance quality of life and create a vibrant eco-system promoting more effective resource management. Create an office to trace the journey of the city-state since the adoption of its Smart Sustainable City initiative till implementation and monitor the city ongoing performance *(Smart Sustainable New Administrative Capital Office)* in the Prime Minister's Office will play a key role in orchestrating multi-agency effort to achieve smart sustainable administrative capital. In the Prime Minister's Office illustrated

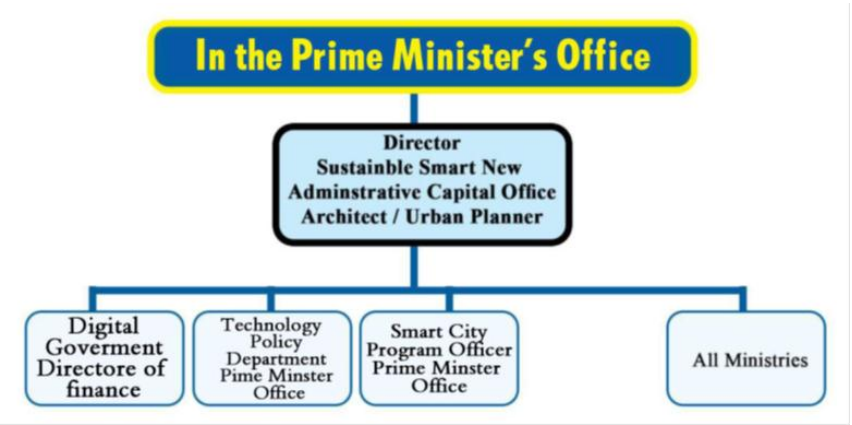

Figure 2: Organization chart for Smart sustainable Administrative New Capital City Office (Elfiky et al. 2019)

3.2 Apply the framework presented in this study.

Explore and link the various smart city activities adopted under the Smart city initiative, with the Key Performance Indicators dimensions presented in this study, offering a deeper understanding of Egypt‘s efforts in each of these domains **(**Elfiky et al. 2019). The study revealed that Administrative Capital has achieved to a good extent smart mobility especially after signing the agreement with the Chinese government for a loan for launching the speed train between El-Salam city and the New Administrative Capital, but still needs to work on the Environment, Government, Economy, living and people key dimensions to a large extent.

3.3 Pilot Area

Announce a pilot area in administrative capital to explore the feasibility of a smart city and it‘s applicability, to illustrate how the proposed frame work, organization chart for Smart Sustainable New Capital City Office, Set Goals to be achieved by fixed dates and provide a description of New Administrative Capital‘s Sustainable Smart City Initiative, goals and guidelines, measure progress of the goals. The proposed framework is also intended to be used for monitoring the city‘s ongoing performance with respect to its smart city goals. Launch more ICT-based applications to stimulate public interest in this area

4. CONCLUSIONS

We have the opportunity how urban planning can redefine how we build our cities in the Twenty First Century. The current large gap between smart city and sustainable city frameworks implies that there is a need for developing their frameworks further. The key indicators developed in this study, provide cities at the planning and design stage with a credible framework when adopted at the planning stage and after construction, previous models in the literature were created to help cities transform into smart cities after being built. This study is more oriented towards achieving aspects of urban life with the ICT as a mean for development. Previous models developed frameworks and key indicators that were more oriented towards enhancing ICT. Literature illustrates a difference in the key dimensions, adopted by different models, the key dimensions created by the ITU-T FG-SSC is the one adopted in this study, as it is more oriented towards achieving aspects of urban life to create smart sustainable cities after extensive analysis of the literature. Building up on the key dimension model that was developed by the ITU-TFGSSC emphasizes the importance of standardization in facilitating knowledge sharing and achieving the appropriate guidelines for implementation. This study developed sub-dimensions and key indicators for the key dimensions model that was created by ITU-TFGSSC. Debates about environmental challenges are often hindered by lack of problem definition, and ill-defined solutions, gathering data into the recommended proposed framework helps to resolve these difficulties

5. RECOMMENDATIONS

5.1 Recommendations for the Industry

The industry should take advantage of all opportunities embedded in the Smart Sustainable City Concept, a $1.5 Trillion market opportunity (Forbes 2105). The industry should create an environment in which new ideas can be tested through start-ups, research centers and partnerships with universities. Expand research and development platform through building Innovation and technology parks as Silicon valley. Establish a living laboratory for urban planning and civic technology experimentation at different pilot areas, construction Companies should implement different and innovative methods of Environmental, construction and ICT, Innovative physical solutions under real urban conditions. A Smart building does not have to be high rise with glass façade. The city should maximize the use of mobility assets through the use of sharing concept, example carpooling, bicycle sharing and Autonomous car, the ultimate goal is to ban the use of private cars or decrease it to minimum. The industry should implement new solutions and innovative ideas to achieve those goals. Advanced technology applications for renewable energy solutions should be integrated into our urban fabric and be interactive with local residents on a physical and digital level. The industry should present a solar system model to the residents to be implemented by all house owners and the government should provide incentives for

implementations that allow home owners to claim a tax credit for qualified expenditures related to the installation of a solar PV system.

5.2 Recommendations for Future Research

The methodology for developing the model is a qualitative comparative analysis of the literature that was generated to gather data and all aspects of smart sustainable city in a single framework that could be a base for developing future quantitative research or rating system for smart sustainable cities.

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