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## A Development Framework for Smart Cities Assessment

**AL-ALWANI Mustafa**

University of Babylon, Faculty of Engineering, Iraq, mustafalwani@yahoo.com

### Abstract

A smart city is rising as a strategy to reduce the problems generated by rapid urbanization and the urban population growth. Although, cities continue to develop and purify their social, economic and environmental goals along with the strategies to achieve them, this phenomenon has been discussed by little research yet. However, due to the urgent need for practical application of the principles of smart cities, city authorities, stakeholders and local communities need to understand how their city is performing today and where progress is being achieved in their systems. Therefore, constructing a guiding framework for smart cities assessment is a crucial key to help communicate emerging strengths and weaknesses, and highlight where real progress is taking place and inform a plan for future progresses. Moreover, this assessment is able to assist cities prioritizes actions. This paper developed a guiding assessment framework for smart cities that will facilitate the formulation, selection and priorities of key indicators that can then guide the assessment and monitoring of the smart cities performance. Drawing on the exploration of an extensive and wide array of literature from a variety of disciplinary areas and based on the conceptual literature on smart cities, in addition to interviews this study identify a good tool to help understanding of relative achievement of smart city. Furthermore, it is important to be taking into consideration in assessing the extent of smart city.

### Keywords

smart city, framework, indicators, assessment

### 1. Introduction

Recently, smart city concept review has shown different definitions and ideas of smart city [1]. Generally, many researches characterized a smart city by its information and communication technology infrastructures [2, 3, 4, 5].

Cities worldwide have an urgent need to be converted into smart cities and control their infrastructure and resources to meet current and future needs of its citizens. Smart city includes smart infrastructure, smart operation, smart service and smart industry, and there is a balance of the technological, economic and social factors participatory in an urban system. Moreover, it can be seen that the integration of all systems in the city becomes essential for a smart city [6]. From these meanings, it can be conclude that the concept of Smart City involve a comprehensive approach to city development and management. Moreover, smart city reflect a holistic approach, taking advantage of the new technologies so that relationships between the stakeholders and the urban model could be redefined [7, 8, 9, 6, 10, 11]. Moreover, tens of various ideas about a smart or intelligent city can be found in the literature. Hence, there is no agreed description about smart cities [12, 13, 6, 14].

Presently, Angelidou [15] stated that smart cities represent a model of conceptual urban development based on technological capital for the development of urban agglomerations, the utilization of human, and collective. Research, frameworks and academic literature of smart city remain at a preliminary stage. Moreover, investigation delays are following the actual practice of how diverse cities are moving in the direction of transforming themselves into a smart city [16].

The objective of this paper is to define the Smart City concept and to develop a methodology to assess Smart City. Smart principles which are: Specific, Measurable, Achievable, Relevant and Time-bound, need to be satisfied by developed indicators to measure the smartness of a city [17].

Although, unified approach is the best and encouraged so that it is allowed to compare the effectiveness of smart city on a national or international basis, at present no appropriate set of indicators, neither a methodological approach are found so far. Therefore, methodological approach for

developing smart city indicators is a rising and significant idea. In this regard, this paper proposes a methodological framework for smart city assessment.

## 2. Smart City Concept

The concept of smart city created from a variety of descriptions including those of the intelligent city, knowledge city, information city, digital city and ubiquitous city [16]. However, Smart city is a higher stage of intelligent and digital city [18].

Making city smart is a strategy to deal with urban infrastructure and overcoming the challenges of urbanization. The concept of smart city became towards the urban development of cities to approve the renovation and city competitiveness [19]. In other word, Smart city development is a strategic process that needs originality in planning, approach, networking, operations, and management of urban projects [19]. A smart city is characterized as intelligent, interconnected, and instrumented city [20]. In other word, the definitions of smart city are various [6]. Because the concept of smart city is popularly known, however, used worldwide with the different names. Holland [12] described smart city as an urban phenomenon. He believes that smart city is unclear concept and used in ways that are not dependable all the time.

Andres [21] shows that smart city concept has changed from implementation of specific projects to implement global strategies to address the challenges of cities. Therefore, it is essential to obtain an overview of probabilities and to connect them to the city challenges. A number of definitions had developed by several researchers such as [22, 23, 8, 24, 25].

Currently, smart city term has been used with a city that increases its citizen's quality of life [26]. Moreover, Giffinger et al. [2] highlighted the performance of smart city in traditional fields such as smart people, smart economy, smart environment, smart governance, smart mobility, and also in the field of the quality of life of the citizens.

## 3. Smart City Assessment

There is a lack of methodologies and standardized metrics to assess, and prioritize, of Smart City projects which are being developed in multiple fields, in spite of the many initiatives which currently analysing the conception procedure and operation processes of the Smart City projects.

When a city decided to transform to a smart city, a city ought to assess its needs and opportunities for innovation. Some organizations have formed some tools to achieve this procedure, which is the Smarter City Assessment Tool [27].

The absence of appropriate concepts and indicators could be a reason for not performing broad studies on smart cities. Because, without an appropriate concept of smart city and smartness indicators, it is complicated to decide whether the city has become a smarter, or what should be done to make it smarter [28].

Naphade, Milind et al. [29] describe that assessment ought to be flexible enough to allow city select the fields which is largely significant to them and provide measuring progress. As a result of the development of the thought of smart city in addition to of the vagueness of this concept, assessing the smartness of a city is going to be very difficult subject. Actually, there is no set of indicators for measuring city performance that is applicable for each purpose [30].

Moreover, the complexity of measuring the smartness of a city is exacerbated by the need of policy makers to measure the well-being of the citizens rather than the productivity of the public services. Some researchers such as Lazaroiu and Roscia [4], PA Forum [31], deal with the aggregation of the variables of city and indicators into final index so as to provide a measure of the smartness of city. Another researcher suggests specifically to a particular city and leading to generality lack [32]. All existing models in literature for assessing the smart city are mainly derived from the model proposed in Giffinger [30].

## 4. Methodology

In order to establish a smart city assessment framework that is both adaptable to different contexts and able of creating common ground indicators, following important tasks were used:

- Challenges identification
- Describe the steps needed to develop an assessment framework for smart city

These tasks would be used to construct the smart city assessment framework. Each task will discuss separately. However, a model Developed for each city should be revised in order to contain the specific requirements and needs of their societies, because the starting conditions, challenges, citizens' willingness and available resources may be completely different.

#### **4.1. Challenges identification**

Progress toward smart city is not only inadmissible, but it is also disappointing and slow. Therefore, assessment tools are significant. Many issue in urban cites are driving cities to sustain the resources and balance the supply demand such as urbanization, the population growth, and environmental challenges. Moreover, sustaining the energy, food and water supply scarcity, waste management, and reducing greenhouse gas emissions are the major challenges to overcome. Moreover, during the past twenty years many challenges in the cities have occurred. The primary one is urbanization [33].

These challenges have enforced the popularization of the smart city idea and triggered the urgency alarm to locate smarter ways. Developing sustainable and intelligent city is also the way to go ahead.

Making a city smart is an approach to ease and manage the urbanization challenges and urban infrastructure. Therefore, there is practicable necessities in worldwide cities to develop into smarter city by manage resources and efficiently operate the infrastructure to include the existing and future needs.

While, evolving city will face challenges of sustainable development in upcoming days [34], the rapidly increasing population and migration towards urban cities are causing variety of threats and troubles. These lead to severe stress in urban city infrastructure and pressing will be hard to deliver essential services as supplies exceeds the demand [19].

The urban growth and its challenges have generated the alarm of urgency to set smarter approach to deal with the challenges. Assessment tools can assist overcoming these challenges throughout recognition of most excellent practices and focusing the efforts of city on improvement. Smart city assessment tools must be developed, constructed and implemented to achieve these advantages. The aim of this paper is to develop assessment framework to assist city to be smarter and to meet this goals.

#### **4.2. Describe the steps needed to develop an assessment model for smart city**

A series of existing smart city assessment methodologies, model and performance benchmarking tools from government, business, education and community organizations were critically examined and reviewed. The smart city assessment framework was developed in this study by using these other tools as launching points.

##### **4.2.1. Review the literature by means of formulating a proper concept of smartness, and developing smart city assessment framework**

Extensive literature review was the first step in developing a smart city assessment framework by analysing existing smart city assessment models. However, there is no methodological framework and there is no set of indicators exist for measuring the smartness of a city that is applicable in each situation and for each purpose. Therefore, measuring the city smartness is an extremely compound matter and the difficulty of measuring the smartness of a city is aggravated by the policy makers require to measure the comfort of the citizens sooner than the efficiency of the public services [30]. However, the research of Giffinger et al. [2] is an excellent reference point for measuring smartness of cities, as the other few existing models in the literature for assessment the smartness of a city are mainly derived from the model proposed by Giffinger et al. [2].

Some studies lack generality because they refer especially to a specific city [32]. Other studies, such as PA Forum et al. [31], The Mori Memorial Foundation [35], and Lazaroiu and Roscia [4], deal with a process that cause a loss of information and knowledge on the city leading to loss of the concept of smart city by aggregation of indicators into a final index so as to give a comprehensive measure for the smartness of city.

This study was carried out principally throughout literature review and documents analysis to

identify the major features of a smart city and models of assessing smart city. The developed framework begins with a review of literature on smart city in addition to smart city assessment models. An archival research method was achieved over many smart city models, smart city dissertations, and smart city articles. The aim of this procedure was to recognize smart city assessment framework.

The major documents, which their articles related to smart city projects had analyzed, were Journal of Cities, Journal of Telecommunications Policy, Journal of Cleaner Environment, Journal of Engineering & Technology, Journal of Landscape and Urban Planning, and Journal of Civil Engineering and Urban Planning. Moreover, lot information has been collected through website search. Moreover, this study observed the aspects and approaches summarized in the previous studies and selected of related factors for possible adoption in the smart city assessment framework.

#### **4.2.2. Interview**

Semi-structured interviews were designed to use to explore the issues in-depth. To ensure the survey is clear and easy to answer, the interview survey was piloted prior to the study proper. This allows identifying points of confusion and problems leading to alterations the final version of the interview. Interviewees which are experts from different fields and countries both in the academic and professional world, public leaders, private entrepreneurs, and consultants were selected for participation in the interview by recommendations using the snowballing technique. Snowball sampling is an approach for selecting interviewees who can provide additional information. The process started by asking an already known interviewee, with whom else one might carry out an interview. The process might be used to secure a wider range of interviewees by means of experts already known by the researcher to recommend other interviewees who might have knowledge or expertise in areas of smart city. The results issues were reviewed and the findings from each research technique were listed on the same page. The data which derived from the interviews was simplified and organized. Through collecting all these experts and diverse points of view, the interview permitted the researcher to get a comprehensive knowledge of the present and future of the Smart Cities

#### **4.2.3. Generating indicators of smartness of cities**

City indicators are most significant tool for assessing performance of a city that planned to describe something important about the products or services that are being carried [30]. Obviously, a smart city requests indicators to assess its smartness and to advance its smartness characteristics. Indicators assist and enable stakeholders to make smart decisions to communicate city performance to citizens and to make decisions about where to focus resources and time.

The development of indicators for assessing the smartness of a city needs to satisfy some principles such as Specific, Measurable, Achievable, Relevant and Time-bound [17]. However, the six common indicators of smart cities are smart people, smart economy, smart governance, smart mobility, smart living, and smart environment [2]. It is challenging to identify the appropriate indicators of smartness. However, this paper proposes an indicators framework for assessing a smarter of a city to support policy makers in identifying the technologies that able to be adopted so as to smartly assessing a smart city. The development of indicators adapted to the key challenges of the cities and through a literature survey and secondary sources systematic search process. The indicators had been developed in consultation with experts and through a careful review of the literature on smart cities. Basically, the formulation of indicator has followed the approach developed by UNESCO [36] to develop a list of potential indicators.

This approach involved five steps as follows:

1. Reviewing all challenges identified through previous step,
2. Thinking about possible indicators for each challenges,
3. Carrying out deep thinking,
4. Consulting experts,
5. Drawing on findings from other studies and initiatives.

Moreover, it is necessary at this stage (formulation stage) to think about how to measure progress towards smart cities during implementation and select the most appropriate indicator. This should help in assessing the smartness of cities. Taking inconsideration the SMART principles developed by

Schomaker [17] which are Specific, Measurable, Achievable, Relevant and Time-bound. Furthermore, experts' opinions and professionals' judgments on the significance and relevance of the indicators had been used to weight the scores of indicators based on their relative importance to the study context.

## 5. Case Study

The selected case study is among the oldest, most popular and most important city in Middle East. Baghdad city was founded in the 8th century when it became the Abbasid Caliphate capital and after short time of its foundation it developed into a significant, intellectual, cultural, commercial, and centre within the Islamic world and considered as the biggest city in the world for the period of the High Middle Ages see Figure 1.



Fig. 1. Baghdad map, 2016 (Google Earth Image/Iraq slogger)

Semi-structured interviews were designed to use in the selected case study to explore the issues in-depth. To ensure the survey is clear and easy to answer, the interview survey was piloted prior to the study proper. This allows identifying points of confusion and problems leading to alterations the final version of the interview. Experts were selected for participation in the interview by recommendations using the snowballing technique. Snowball sampling is an approach for selecting interviewees who can provide additional information. The process started by asking an already known interviewee, with whom else one might carry out an interview. The process might be used to secure a wider range of interviewees by means of a person already known by the researcher to recommend other interviewees who might have knowledge or expertise in areas of smart city. The results issues were reviewed and the findings from each research technique were listed on the same page. Many challenges within the case study had been explored. The data that derived from the interviews was simplified and organized. The indicators had been developed in consultation with experts and through a careful review of the literature on smart city. Basically, the formulation of indicator has followed the approach developed by UNESCO [36] to develop a list of potential indicators. Furthermore, indicators have to reflect the following important indicator characteristics, namely: specific, measurable, achievable, relevant and time-bound.

## 6. Results

The results of the indicators development process for the case study are presented in this section (Table 1). Applying the framework and its developed indicators can support the policy makers and give new insights to them in plan implementation and in creating a strategy a more realistic manner than using other ways. Moreover, the different indicators developed by the framework intend to give responds to the challenges that may be faced by the city while constructing its strategy. A city can use those developed indicators to identify whether their level of smartness has the required results related to the value it desires to produce furthermore a city be able to employ those developed indicators to recognize if the actions they obtain goes with the policy goals they aim to attain.

Table 1. Title of the table list of smart city assessment indicators for the city of Baghdad

Indicators
Political strategies
Transparent governance
Decision making participation
Pollution prevention
Health conditions
Fuels availability
Information and communications technology infrastructure availability
Safe transportation
Facilities of education
Tourist attraction
Individual safety
Level of qualification
Market flexibility
Ethnic pluralism
Social pluralism
People creativity
Housing quality

## 7. Conclusion

Building an intelligent and smart city is the way forward. Transformation of Smart city is a strategic process, which needs uniqueness in approach. Cities increasing interest, to be smarter can be aided together with the use of assessment tools that permit comparison between cities. Currently the few available tools are difficult to apply in contexts where the efforts to be smarter are at an early stage of development. The most important strength of this research is that it successfully and effectively reviews most of the existing smart city assessments tools prepared in the world and gathers the most excellent ideas from all of them to form an assessment framework. The framework formed is very helpful, extensive, a broad, and highly analytical work. Moreover, a transparent framework was delivered which consists of steps and can be applied by any person or organization that have an interest in promote smart city. Moreover, this framework is a powerful communication tool that possibly will highlight smart city and attract the attention of institutions and leaders. Finally, the author believes that the use of the proposed framework in this article could be very useful since it offers an easy, understandable, extensive, a broad and highly analytical methodology and mechanism.

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