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A Development Framework for Smart Cities Assessment

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Abstract

A smart city is rising as an approach and strategy to reduce the troubles produced by rapid urbanization and the growth of urban population. 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 requiring immediate action or attention for practical application of the principles of smart cities, city authorities, stakeholders and local communities need to know the current reality of their city and where development is being attained in their systems. Therefore, constructing a framework for smart cities assessment will help share or exchange the newcomer strong and weak points, and emphasize where actual development is taking place and update a plan for future developments. Moreover, this assessment is able to assist cities prioritizes actions. This paper developed a guiding assessment framework for smart cites that will help the creating, carefully choosing and priorities of crucial indicators. These indicators can then show the way to the smart cites performance assessment and monitoring. Drawing on the investigation of an extensive and wide collection 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 recognizing of virtual achievement of smart city. Furthermore, it is significant to be taken into consideration in assessing smart city smartness level.

Keywords :- Smart city, Framework, Indicators, Assessment .

الخلاصة

يزداد استخدام المدينة الذكية كاستراتيجية للحد من المشاكل الناجمة عن التحضر السريع والنمو السكاني الحضري. وعلى الرغم من أن المدن تواصل تطوير وتنقية أهدافها الاجتماعية والاقتصادية والبيئية إلى جانب استراتيجيات تحقيقها، فقد نوقشت هذه الظاهرة من خلال أبحاث قليلة. ونظرا للحاجة الملحة لتطبيق عملي لمبادئ المدن الذكية، وسلطات المدينة وأصحاب المصلحة والمجتمعات المحلية هناك حاجة إلى فهم كيفية أداء المدينة الذكية اليوم وكيف يتم تحقيق التقدم في أنظمتها. ولذلك، فإن بناء إطار لتقييم المدن الذكية هو مفتاح حاسم للمساعدة في التوصيل الى نقاط القوة والضعف الناشئة، وتسليط الضوء على أين يتم إحراز تقدم حقيقي ووضع خطة للتقدم في المستقبل. وعلاوة على ذلك، فإن هذا التقييم قادر على مساعدة المدن على إعطاء الأولوية للإجراءات. وقد وضع هذا البحث إطارا لتقييم اداء المدن الذكية من شأنه أن يسهل صياغة واختيار أولويات المؤشرات الرئيسية التي يمكن أن توجه عندئذ تقييم ورصد أداء المدن الذكية واستنادا إلى الأدبيات السابقة على المدن الذكية، بالإضافة إلى مقابلات تم اجرائها فان هذه الدراسة تقوم على تحديد أداة جيدة للمساعدة في فهم الإنجاز النسبي للمدينة الذكية. وعلاوة على ذلك، من المهم أن نأخذ في الاعتبار تقييم مدى المدينة الذكية.

الكلمات المفتاحية : المدينة الذكية، الإطار، المؤشرات، التقييم .

1. Introduction

Recently, a smart city concept review has shown different definitions and ideas of smart city (Chin *et.al.*,2010). Generally, many researches characterized a smart city by its infrastructures of communication technology and by its information (Giffinger *et.al.*, 2007).

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 contains a smart operation, smart service, smart infrastructure, and smart industry, and there is a balance of the economic, scientific, and social factors in an urban system. Moreover, it can be seen that the combination of all systems in the city becomes essential for a smart city (Nam& Pardo, 2011). Beginning from these meanings, it is able to conclude that the concept of Smart City involves an inclusive approach to city development and management. Moreover, a smart city reflect a holistic approach, taking benefit of the most modern technologies so that relationships

between the stakeholders and the urban model could be redefined (Caragliu *et.al.*, 2009). Moreover, tens of various ideas about a smart city have been discovered by chance or unexpectedly in the literature. Hence, there is no description discussed or negotiated and then accepted by all parties about smart cities (Nam& Pardo, 2011).

Presently, Angelidou (Angelidou, 2014) stated that smart cities bringing a model of conceptual urban development into existence for the development of urban assemblages, the human utilization, and collective. Research, frameworks and academic literature of smart city remain in 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 (Lee *et.al.*, 2014).

The aim of this research 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 (Schomaker, 1997).

Although, unified approach is the best and encouraged so that it is allowed to compare the effectiveness of smart city on a local or global basis, at present no suitable set of indicators, and no methodological approach is found so far. Therefore, methodological approach for developing smart city indicators is a rising and significant idea. Incidentally, this research recommends a methodological framework for assessment of smart city.

2. Smart City Concept

A smart city concept created from a variety of descriptions including those of the intelligent city, knowledge city, information city, digital city and ubiquitous city (Lee *et.al.*, 2014). However, smart city is a superior step of intelligent and digital city (Mao *et.al.*, 2014).

A strategy of making a city smart is dealing with urban infrastructure and overcoming the difficulties of urbanization. Smart city concept became towards the urban development of cities to approve the renovation and city competitiveness (Halepoto *et.al.*, 2015). In other word, Smart city progress is a detection of long term or in general goals and interests and the means of accomplishing the procedure that needs originality in planning, approach, networking, management and operations of urban projects (Halepoto *et.al.*, 2015). A smart city is characterized as intelligent, interconnected, and instrumented city (Shelton *et.al.*, 2014). In other word, the definitions of smart city are various (Nam and Pardo, 2011). Because the concept of smart city is popularly known, however, used worldwide with the different names. (Holland , 2008) explained that smart city is an urban experience. He supposes that smart city is an indistinguishable concept in addition to apply in techniques that are not dependable all the time.

(Monzon , 2015) shows that smart city concept has modified from implementation of clearly defined projects to implement international 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 (Washburn *et.al.*, 2010)

Currently, smart city term has been used with a city that raises the quality of life of its citizen (ABB & European House-Ambrosetti, 2012). Moreover, (Giffinger *et.al.*, 2007) highlighted the presentation of smart city in conventional scope for instance, smart governance, smart environment, smart people, smart economy, smart mobility, in addition to citizen’s quality of life.

3. Smart City Assessment

There is a deficiency in methodologies and standard measures to assess, and prioritize, of smart city schemes which are being elaborated to a specified degree in numerous 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 into 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 (Kehoe *et.al.*, 2011).

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 (Debnath *et.al.*, 2014).

(Naphade *et.al.*, 2011) 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 a very difficult subject. Actually, there is not available set of indicators for assessing city qualification that is applicable for each purpose (Carli *et.al.*, 2013).

Some researchers such as (Lazaroiu and Roscia , 2012 ; PA Forum ,2012), deal with the aggregation of the variables of indicators into concluding index so as to provide an assessment of the city smartness. Another researcher suggests specific to a particular city and leading to generality lack (Hsieh, 2011). All existing models in literature for assessing the smart city are mainly derived from the model proposed in (Giffinger , 2010).

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 must be modified so as to contain the exact requests 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 the smart city is not only inadmissible, but it is also disappointing and slow. Therefore, assessment tools are significant. Many issues in urban cites are driving cities to balance the supply demand and sustain the resources such as urbanization, the population growth, and environmental challenges. Moreover, sustainable energy, sustainable food and water supply scarcity, sustainable waste management, and reducing emissions of greenhouse gas are the most important difficulties to overcome. Moreover, during the past twenty years numerous difficulties in the cities have occurred. The primary one is urbanization (United, 2012).

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

Creation a smart city is a process to ease and manage the urbanization challenges and urban infrastructure. Therefore, there are practicable necessities in worldwide cities to develop into a smarter city by administering resources and economically operate the city to take account of the recently and prospect necessitates.

While, evolving city will face challenges of sustainability in future (Childers, 2014) the rapidly increasing population and movement in the direction of urban cities are causing a 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 exceed the demand (Halepoto *et.al.,* 2015)

The challenges of urban expansion have generated an anxious awareness of risk and necessity 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 an assessment framework to assist city to be smarter and to meet these goals.

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

A sequence of present smart city assessment model, methodologies and performance standard tools for administration, companies, and learning were critically examined and reassessed. 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, a methodological framework and indicators set not yet listed for estimating the city smartness 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 it is aggravated by the policy makers require to quantify the comfort of the civilians sooner than the efficiency of the community services Carli *et.al.,* 2013). However, the research of (Giffinger *et.al.,* 2007) is an excellent reference point for measuring smartness of cities, as the other submitted models for assessment the smartness of a city in the literature are mainly copied from the model derived by (Giffinger *et.al.,* 2007)

Some studies lack generality because they particularly refer to an exact city (Hsieh *et.al.,* 2011). Other studies, such as (PA Forum *et.al.,* 2012 ; Mori Memorial Foundation , 2011; Lazaroiu and Roscia , 2012), deal with a process that cause a forgetting of information and knowledge on the city leading to forgetting 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 literature review of 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 obvious and simple to answer, the interview was tested before introducing it more widely before the study. This allows identifying points of confusion and problems leading to modifications the last form of the interview. Interviewees which are academic and professional experts of diverse fields and coming from different countries, public leaders, private entrepreneurs, and consultants were chose for contribution in the interview by suggestions of interviewees when asking an already identified interviewee about any person else which might achieve an interview. Then, the findings were re-evaluated and the results were listed on the same page. The data which derived from the interviews was simplified and organized. Through collecting all these experts with all these diverse points of view, the interview permitted the researcher to get a comprehensive information of the current state and prospect of the Smart Cities

4.2.3. Generating indicators of smartness of cities

City indicators are most significant tools for assessing performance of a city that planned to describe something important about the products or services that are being carried (Carli , 2013). Obviously, to assess smart city smartness and to advance its smartness characteristics a smart city requires indicators. Indicators assist and enable stakeholders to make smart decisions to share or exchange performance of the city to the citizens and to make decisions about where to focus resources and time.

Assessing the smartness of a city through development of indicators needs satisfied some principles such as" Specific, Measurable, Achievable, Relevant and Time-bound" (Schomaker, 1997). However, the six common indicators of smart cities are smart people, smart economy, smart governance, smart mobility, smart living, and smart environment (Giffinger, 2007). 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 recognizing the knowledge that able to be implemented 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. Consultation with experts and careful review of the literature were led to build up the indicators of smart cities. Basically, the formulation of indicator has followed the approach developed by UNESCO (2003) to develop a list of potential indicators.

This approach involved five steps as follows:

1. Reviewing all challenges identified through previous step.
2. Implementation very great or intense thinking.
3. Thinking on probable indicators for each problem or challenges.
4. Based on the results from other initiatives and studies.
5. Seeking information or advice from experts.

Taking inconsideration the SMART principles developed by (Schomaker , 1997) 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 a 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. The interview was tested before the starting of study, to ensure that the interviews are obvious and simple to answer. This allows identifying points of confusion and problems , guiding to modifications of the ending form of the interview. 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 by reviewing all challenges identified through previous step, implementation very great or intense thinking, thinking about probable indicators for each problem or challenges, deriving from the results of other initiatives and studies, and seeking information or advice from experts

Basically, the formulation of indicator has followed the approach developed by UNESCO (2003) 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 recognize and distinguishing their stage of smartness that it desires to produce, furthermore a city is able to employ those developed indicators to recognize if the performance they gain goes with the goals of policy 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 a smart city is the advanced step and 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 the first step of development. The most important strength of this research is that it successfully and effectively reviews most of the existing smart city assessment 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 cities and attract the attention of institutions and leaders. Finally, the author believes that the use of the suggested framework in this article might be very helpful since it offers an easy, understandable, extensive, a broad and highly analytical methodology and mechanism.

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