

Towards City Sustainability: An Updated Framework

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Abstract. “City Sustainability” is a relatively new terminology in the field of urban planning and sustainable development. Over the past one decade, a number of scholars have provided different frameworks to create knowledge for city authorities to help them make their cities sustainable. At the same time, some researcher also challenged the idea of using the term “sustainability” along side “city”. However, there is no doubt that cities yield high ecological footprint and having a framework to assist the planners and the policy makers to make the cities more environment friendly is essential. We have conducted a thorough review on the existing works on city sustainability and systematically combined the thoughts of different researchers to develop an updated framework addressing the shortcomings of the existing frameworks.

Keywords: city sustainability, framework, ecological footprint.

1. Introduction

Rapid urbanization is a half century old phenomenon resulted by the rural-urban migration in large number. Although it increases economic activities, it comes at an expense of loss of agricultural land and natural landscape, over exploitation of natural resources, ecosystem destruction and pollution which have high impact on the environment and sustainability of the future generation [1]. The situation is even grimmer for the developing countries. It is projected that cities of the developing world will experience 95% of urban growth in the next two decades [2]. Hence, coupled with high population growth and poverty, unplanned urbanization may have dire consequences by lifting the already existing economical, social and environmental challenges into an alarmingly elevated stage. To acknowledge this issue, it is deemed necessary to incorporate sustainable development as an essential principle in urban master planning. However, to judge city sustainability or its level, it is important to devise a way to measure it. Measuring the sustainability in urban areas so far has been a major challenge for environmental scientist and urban planners. [3] is arguably the first to emphasize the importance of gauging urban sustainability. She recommended that measures of urban sustainability need to provide clear signals as to how urban patterns affect the environment and the natural resource base. To accommodate the intrinsically multisectoral nature of sustainability [4] proposed a holistic or integrated assessment approach encompassing social, economic and environmental factors. [5] employed exergy to analyze the sustainability of urban area taking into account the mean life span of the building. [6] identified 13 indicators covering different aspects including social, economic, environmental and rational land use structure to compare sustainability of urban land use of capital cities and municipalities in China using Principal Component Analysis (PCA). Over the past decade, a common practice has been to employ already existing sustainability indicators from other disciplines to measure city sustainability. [2] conducted a thorough review on such indices in terms of the requirements and discussed the theoretical requirements of a new city sustainability index. However, the review did not focus on the policy implications and the methods followed in developing such an index. In general a substantial number of the users of these indicators are policy makers who may not have sufficient domain knowledge to interpret the outcome and several studies [7, 8] emphasized on the importance of how the

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outcome of the indicator should be understood by multidisciplinary policy makers. Apart from this, having data available for measuring such an index itself is a substantial challenge for the developed world let alone for the developing countries [9]. Being at its infancy, the existing attempts in developing City Sustainability Index (CSI) has been discrete in nature and the concepts itself is not well defined either. This paper illustrate the state of the art in CSI development by a systematically combining the thought of different researchers and identifies its requirements and presents a framework to develop CSI from the view point of the developing countries. More specifically the study i) presents the chronological progress in the development of a CSI (Section 2), ii) proposes a framework to measure CSI for the cities in the developing countries based on the literatures available on its methods and applicability (Section 3). The study uses existing literatures (referred journal papers), which are mainly on policy and practice and methods for developing CSI, as the sources of data.

2. City Sustainability: The Chronology

Though the concept of “sustainable development” has been around for quite a while [10], it took one more decade till its introduction in the fields related to urbanization [11]. At present, it is deemed necessary to incorporate sustainability and modify the existing urban and regional administrative system accordingly so as to cope with the challenges urban planning is being confronted with. This section narrates the chronology of the development in the field of urban sustainability. [3] and [4] can be considered as milestone research studies. While [3] identified the importance of understanding how urban systems work and how they interact with the environmental system, [4] proposed a new index to measure the CSI based on indicators encompassing environmental, economical, social and institutional issues. [3] proposed a three step framework that starts by identifying key variables for urban and environmental systems and their interactions; continues with selecting measurable objectives and criteria enabling us to assess these interrelationships and finally, a response system to gain feedback from the urban community both in individual and collective level. [4] further fulfilled the idea by introducing a Policy Target Index which can appraise the sustainability of a policy or program through projection and trend analysis of different scenarios. Most of the following studies over the past one decade more or less were built around this concept introducing incremental innovation in the different components of the framework. [12] in his thought provoking paper with the growing Asia Pacific cities illustrated that the concept of sustainable cities require revision for the booming cities which are transitioning from a “regional city” into a “world city”. [13] emphasized that the idea of creating world cities may not be sustainable altogether as it uses up a sizable amount of resource from the locality to provide service in the global scale yielding disparity. Rather, they proposed the idea of promoting “great cities” that can sustain local and global development and have enlightened mode of governance coupled with technological and economic advancement. They also developed a set of indicators to benchmark cities of the world. [14] went further disapproving the idea of “sustainable city” as the concept may indicate urban autonomy, self reliance or self sufficiency which should not be used synonymously with a city. With the data from the city of Bath situated in the South West of England, they emphasized that the city center thrives by exhausting the resource within the vicinity and has a 20 times larger environmental footprint than its surroundings. They assert that the concept of sustainability in urban context should be confined within land-use planning only. [15] in their theoretical paper presented a new tool – “Sustainable Solution Space for Decision Making (SSP)” that further complemented the framework by [3, 4] through the utilization of the potential of trans-disciplinary approaches which may fulfill the systemic, normative and procedural requirements of a CSI. During that time, some studies introduced the idea of isolating a component of the city and measure its sustainability. For example, [16] utilized remote sensing data to measure transportation related urban sustainability. [17] focused on measuring the natural capital indicators that exhibit high potential in predicting whether the region is moving towards or away from sustainability path. She introduced a framework where a set of indicators are selected and classified into four groups – Drive, Pressure, State, Impact and Response (DPSIR), where drive represents human factors, pressure translated driving forces into specific impact on natural capital, state stands for the current state, impact demonstrates the influence of the force and response represents society’s reaction to the change. [18] demonstrated how statistical relationships can be formulated to investigate the longitudinal trend for each indicator to judge

sustainability of Taipei city. Then they combined the results based on four categories (environmental, social, economical and institutional) and used equal weighting method to fathom one aggregated index of sustainability. [19] published a policy paper to take up the question regarding what role the global gatherings since the 1992 Earth Summit in Rio de Janeiro, Brazil have played in the pursuit of urban sustainability. The paper emphasized on the necessity to translate research knowledge into policy measures. [20] adopts a two fold approach where first an agent based model tests how residential policy decisions affect urban form, composition and pollution. Secondly, they developed an information index to define the degree of order and sustainability of the urban system in different scenario as recommended by [4] in their recommended framework. [7] calculated the sustainability of a city using indicators of different categories and presented them in a graphical manner which is easy to understand for the policy makers. In [21], the authors improved their previous model [7] by introducing ISO 14031 standard for monitoring the sustainable development. [22] compared the sustainability of 79 Irish localities by developing a single Sustainable Development Index (SDI) encompassing economic, social and environmental dimension through Ecological Footprint (EF) method. Studies like [6, 23, 24, 25, 26, 27, 28, 29] proposed models for urban sustainable development. Among them, [23] also considered the external social, economical and environmental cost benefits; [24] compared the sustainability of 46 Chinese cities employing Data Envelop Analysis (Linear Programming); [25] evaluated the trend rather than measuring a single sustainability indicator; [6] compared the already developed indicators from 17 studies. [26] employed local indicators for measuring CSI. [27] followed an interesting approach by involving two different actors – the environmentalists and the planners. They demonstrated how they can work together to prepare a “red and green plan” which satisfies both economic and environmental requirements. [28]’s approach is similar, however, rather than involving actors, they investigated the coupling between urban and environment related indicators. They also employed high end methods such as System Dynamics and Artificial Neural Network for sustainability measurement. Rather than providing a measuring technique [29] explains how policy makers make complex decisions by considering a large space of indicators. Like [4 and 20], [30] also allows assessment of scenarios. [31] is a very interesting literature arguing that sustainability has a different meaning in different era and different societies. It evaluated 13 Chinese projects and demonstrated that western way of understanding sustainability may not be ported directly into the eastern environment and recommended to use a holistic and hierarchical assessment of sustainability model. [32] does not provide any analytical framework, however, contributes significantly by suggesting the use of separate indicators for sustainability profile, urban performance and monitoring in different phases of a project. [33] amalgamated System Dynamics and GIS to assess sustainability of urban residential development considering sustainability indicators, housing equilibrium and building visualization with data from Stuttgart, Germany. [34] is an enhancement of [22] that has accommodated further policy inputs. [2] conducted a thorough review on different indices such as Ecological Footprint (EF), Environmental sustainability Index (ESI), Dashboard of Sustainability (DS), Welfare Index, Environmental Vulnerability Index (EVI), Environmental Policy Index (EPI), etc. in terms of the requirements and discussed the theoretical requirements of city sustainability index. However, the review did not focus on the policy implications and the methods followed in developing such an index.

3. An Updated Framework for Developing a City Sustainability Index (CSI)

From the discussion in Section 2, it is evident that [3] and [4] jointly have provided a formidable framework and most of the studies later followed it partially or to a great extent. However, some of the new inclusions and innovations as well as issues that have been raised by [7, 12, 13, 17, 18, 20, 23, 25, 28, 30, 32, 33, 34] demand to be considered for an actionable sustainable city framework. We have proposed a new framework for a tool to assist city authorities achieve sustainability as presented in Fig. 1. It commences by classifying cities into three broad categories – “world cities”, “transitional cities” and “regional cities”. We agree with [12, 13] that the values for sustainability in the world cities or transitioning cities may not be shared by the regional cities. Hence, we may have different sets of indicators to measure sustainability or even different set of policies to maintain or improve existing level of sustainability for these cities. Moreover, even among these broad categories, policy makers and city planners may have different specific visions for different cities. A city with economy in the center of attention may have policy and planning strategies quite

different from that with culture at the center of attention. Hence, their indicators defining sustainability or policies for development may be different. After selecting the characteristics of the city and its central planning theme, we recommend to identify the indicators for evaluating sustainability from minimum three aspects – environmental, economic and social. Here, to encompass a full range of influences of factors representing an aspect, we recommend DPSIR method of indicator selection as proposed by [17, 33]. It is also important to ensure that the indicator set is capable of internalizing the external costs of different factors [23]. Next, the city planners can fathom the current level of sustainability of the city using an appropriate modelling method. Here, it is highly desirable that the method will be capable of addressing the recommendation by [28] to consider the interaction among indicators, referred as coupling. Later, to up lift the current state of sustainability, they can choose a set of policies and consider different scenarios to simulate and calculate the trend of sustainability indicators longitudinally for a future year following the steps in [4, 7, 18, 20, 25, 30, and 34]. This will enable them to choose the best policy measure. However, as expressed by [32], it is important to monitor and evaluate the efficacy of a policy measure during its application. For that, a different set of indicators may be needed that can also be translated into the basic indicators for the calculation of CSI, which will eventually lead to measuring CSI [32]. For a CSI value outside the level of expectation, policy makers and planners may evaluate new policies and go through the aforementioned process again to revise their strategies. Also, our framework highly advocates for having easy visualization of the outcomes for all involved stakeholders as exhibited by [7, 8]. For this, graphical modelling methods may be used, or, Geographical Information System (GIS) can be employed [33]. Also, it is necessary to keep the stakeholders involved in throughout the policy, planning and implementation phases.

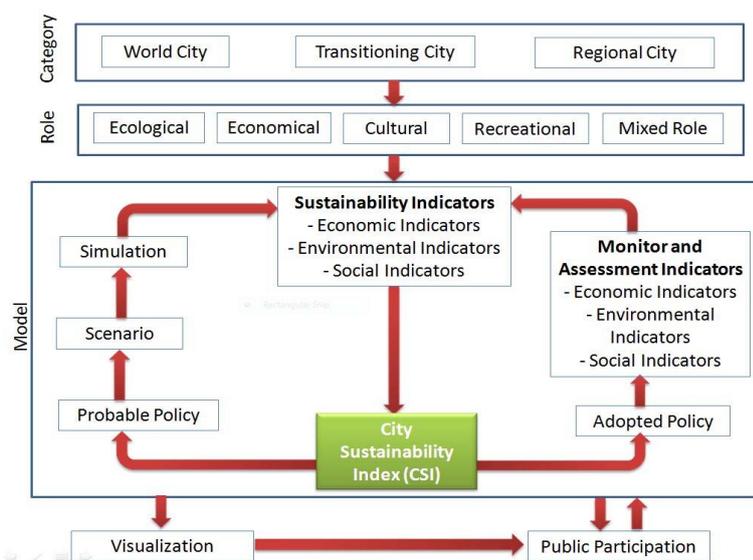


Fig. 1. Proposed Updated Framework for Assessing City Sustainability

4. Conclusion

We have conducted an extensive review on the state-of-the art in assessment of city sustainability and compiled the innovations of the major studies to update the existing frameworks. We expect the outcome of the study to be highly valuable for both the researchers and the practitioners. As part of the future expansion, we look forward to identify an appropriate modelling method to measure CSI and test the performance of the newly proposed framework with real-life data.

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