



Selection and modeling sustainable urbanization indicators: A responsibility-based method



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ARTICLE INFO

Article history:

Received 18 April 2014

Received in revised form 18 March 2015

Accepted 20 March 2015

Keywords:

Sustainability indicators

Sustainable urbanization indicator

Responsibility analysis

Responsibility Assignment Matrix

ABSTRACT

The responsibility borne by governmental departments measured by a set of indicators is a key factor affecting the performance of urban sustainability. Thus, responsibility analysis can guide the selection of sustainability indicators. In line with the principle of Management by Objective (MBO), this paper aims to introduce a responsibility-based method, named Strategic goal-Responsibility department-Response (SRR), for selecting sustainable urbanization indicators. By applying this method, indicators are selected from the perspective of concerned departments' responsibility. In developing the SRR model, the tool of Responsibility Assignment Matrix is used to identify the concerned departments who assume responsibilities in the process of implementing sustainable urbanization. The content analysis is used to analyze the work scope and definitions of the concerned departments and sustainable urbanization indicators that can measure the responsibility performance of the concerned departments are filtered out. A case study of Jinan city in China is used to demonstrate the procedures of using the proposed method. Based on the strategic goals of Jinan city, 20 responsibility departments and 152 initial indicators are identified by using the SRR framework. The case study reveals that the method is a feasible and effective tool in assisting policy makers to select sustainable urbanization indicators.

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1. Introduction

Our world is urbanizing at an unprecedented speed, evidenced by the fact that the population living in megacities has increased from 39 million in 1970 to 359 million in 2011 (United Nations, 2012). Urbanization promoted the adjustment and upgrading of industrial structure as a result of economic growth and more employment opportunities for the mitigations from rural area (Dyson, 2011; Jones, 2003). However, rapid and excessive urbanization in many countries has become a major concern for its detrimental effects on the environment, ecological systems and other aspects (Jaeger et al., 2010). These problems present challenges to achieving sustainable development. Consequently, countries throughout the world have been applying various schemes to mitigate the effects of these challenges and enhance

the sustainability of urbanization. For example, the 2010 Melbourne City Plan launched by Melbourne City Council in 2001 has built up a vision for the city by focusing on shaping a prosperous, innovative, culturally vital, attractive, people focused, and sustainable city. Another strategic tool 'Melbourne 2030' released in October 2002 builds on the similar visions for helping Melbourne remain one of the world's most livable city (Yigitcanlar et al., 2008; Yigitcanlar, 2007). Mexico City government launched the Mexico City's Green Plan in 2007 which was designed to achieve the sustainability targets in seven areas: land conservation, public space, water, mobility, air, waste and climate change and energy (Shen et al., 2011a). There are still other example schemes in improving urban sustainability (Hong Kong Planning Department, 2007; Iskandar Regional Development Authority, 2008).

The application of sustainable development principles in the process of urbanization needs the identification of efficient indicators for assisting policy-makers to identify appropriate policies, monitoring the effectiveness of policy interventions, and coping with emerging problems associated with urbanization (Gustavson et al., 1999; Venturelli and Galli, 2006). In line with this, various indicator frameworks or models have been introduced to

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guide the practice of selecting sustainability indicators, such as the model Pressure-State-Response (PSR), the model Driving force-Pressure-State-Impact-Response (DPSIR), and the model Driving force-State-Response (DSR) (OECD, 2007; Oudenhoven et al., 2012; Wascher, 2000). These frameworks are reported effective in assisting decision-makers to select proper indicators in many disciplines especially in ecosystem (Frederiksen and Kristensen, 2008; Ramos et al., 2004).

However, it is appreciated that the achievement of sustainable urbanization requests for the concerted efforts of all departments who assume responsibility for implementing urbanization. These departments perform their responsibilities for the goal of sustainable urbanization. It appears nevertheless that the responsibility of the concerned departments is not a perspective considered in the existing practice of selecting sustainability indicator. It is therefore considered important to include the responsibilities of concerned departments into the selection model of sustainable urbanization indicators. These indicators presenting the responsibilities of various departments can be filtered from their working scopes and relevant documents. The responsibility-based indicators can link the departments' performance with sustainability performance of urbanization, thus effectively guide the practice of all concerned departments towards sustainable urbanization. Therefore, the aim of this paper is to introduce a responsibility-based method for guiding the selection of sustainability indicators. The validation of the method is conducted through a case study at Jinan in the context of China.

2. Literature review

Indicators are recognized as analytical and interpretive tools and solid basis for policy-making and public communication in a variety of ways (Singh et al., 2009). Sustainability indicators are not only useful for measuring progress but also discovering problems, setting sustainable development goals, and identifying suitable management strategies (Reed et al., 2006). As a result, efforts have been devoted to developing sustainable urbanization indicators, and works about indicator selection have been regarded by some cities as the "indicator industry" (King et al., 2000; Rametsteiner et al., 2011; Steurer & Hametner, 2013). Many institutions and researchers have been proposing and developing sustainability indicators in different perspectives. For example, the European Union proposed a typical sustainable urban development indicator system structured hierarchically consisting of 10 categories, namely, economic development, poverty and social inclusion, ageing society, public health, climate change and energy, production and consumption patterns, management of resources, transport, good governance, and global partnership (Ledoux et al., 2005; Zhang et al., 2011). Shen et al. (2011b) summarized sustainability indicators into four categories: economic, social, environmental, and governance. From the ecological dimension, Valipour (2014c) selected ten indices to examine the status of agricultural irrigation management in Africa, Asian and Oceania. These 10 indices are: permanent crops to cultivated area, rural population to total population, total economically active population in agriculture to total economically active population, human development index, national rainfall index, value added to gross domestic product by agriculture, irrigation water requirement, percentage of total cultivated area drained, difference between national rainfall index and irrigation water requirement, area equipped for irrigation to cultivated area or land use policy index. These socioeconomic indices also are effectively used to predict the future of agricultural water management in the world. The research results show that reduction of rural population and variations of socioeconomic indices leads to decrease of agricultural water management and lack of

sustainable development (Valipour, 2014a,b,d). Other research efforts have been devoted to developing frameworks or models to assisting in selecting sustainable urbanization indicators.

Through the comprehensive content analysis, it is noted that existing research works have included three dimensions when developing the framework of sustainable urbanization indicators, including historical lessons, current problems, and future goals. For example, the Pressure-State-Response (PSR) framework developed by Organization for Economic Co-operation and Development (OECD) organized indicators in the form of a causal chain (Levrel et al., 2009). In this causal chain, the practices of social and economic developments and human activities will exert pressure on the environment. The pressures then lead to changes in the state of environmental conditions and provoke responses by society to change the pressures and the state of the environment (Niemeijer and Groot, 2008). As a result, the indicators are split into three categories: pressure indicators, state indicators, and response indicators (Walmsley, 2002).

The introduction of the PSR model leads to the development of other framework models of sustainable urbanization indicators such as Driving force-Pressure-State-Impact-Response (DPSIR), Driving force-State-Response (DSR), and the improved DPSIR model by integrating it with the analytic network process (ANP) for the assessment of territorial transformations (Bottero and Ferretti, 2010). By applying Multi Attribute Value Theory, Bottero et al. (2014) identified a set of measurable attributes and constructed multi-attribute value functions for assessing the sustainability assessment of urban projects. London Quality of Life Indicator by Commission of Sustainable Development (CSD) follows a goal-oriented framework, which includes fourteen overarching objectives to be considered when selecting sustainability indicators (Nathan and Reddy, 2008). The goal-oriented indicator framework requires users to identify clearly the ultimate goals in social, economic, and environmental dimensions respectively (Johanna et al., 2009).

The research approach of responsibility analysis based on the methodology of Management by Objectives (MBO) is considered applicable for identifying a unique and synthetic sustainability indicator. The methodology MBO proposed firstly by Peter Drucker in 1954 is an embraced management principle about participation in decision-making, goal setting, and objective feedback (Rodgers and Hunter, 1992). The application of the methodology MBO has been extended from performance measurement to strategic planning and managerial control over the work of employees in an enterprise. The application of this methodology includes two important steps: goal setting, responsibility analysis and assignment (Nayab, 2009). Responsibility assignment is a process of identifying participants and determining to what degree they interact with defined activities or objects (Wende, 2007). Through this process, all the responsibility departments are identified and the connections between work that needs to be done and the concerned departments or project team members are built (Yang and Chen, 2009). The performance of responsibility departments can be measured by an appraisal system in which performance appraisal criteria are predetermined and responsibility departments will be judged by a set of indicators (Erdogan et al., 2001). Therefore, a list of indicators based on responsibility is important in assessing responsibility performance. Sustainable urbanization is a complicated system engineering, which involves many responsibility departments assuming various functions, such as political, economic, environmental, cultural, and others (Wu, 2010). Only the functions of responsibility departments are properly performed, the targets of sustainable urbanization can be achieved. Therefore, it is important to understand the sustainability indicators from the perspective of department responsibility, and these indicators are also able to measure the performance of responsibility departments.

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