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An alternative model for evaluating sustainable urbanization

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ABSTRACT

In recent years, there has been rapid urbanization worldwide, resulting in both benefits and problems. Sustainable urbanization has become an important aspect in promoting sustainable development. Existing studies have introduced various methodologies to guide urbanization towards sustainable practices. The application of these methods has contributed to improving urban sustainability. To further support the effective applications of the principles of sustainable urbanization, a tool is needed to evaluate whether a particular process of urbanization is sustainable. In this paper, we introduce an alternative model for evaluating sustainable urbanization by investigating the relationship between urbanization and urban sustainability. The practice of sustainable urbanization is defined as a dynamic process that enables urban sustainability to improve or to maintain a certain level of practice. By employing this definition, we introduce a sustainable urbanization elasticity coefficient e_{SU}, which is defined by two parameters: urbanization velocity ($V_{\mu R}$) and urban sustainability velocity ($V_{\mu S}$). The sustainability of an urbanization process is measured by the value of e_{SU} or read from the $V_{\mu R}$–$V_{\mu S}$ coordinate. A case study demonstrates the application of the measure e_{SU} and the $V_{\mu R}$–$V_{\mu S}$ coordinate. The proposed model is an effective tool to help policy makers understand whether the urbanization processes they support are sustainable and thus whether to correct practices. The model also allows comparison of different urbanization practices and thereby encourages the sharing of successful experiences.

Introduction

Urbanization, which is defined as a movement of people from rural to urban areas with population growth equal to urban migration, has been one of the most prominent trends of the 20th and 21st century (Street, 1997; United Nations, 2010). According to a report by the United Nations (2010), the ratio of urban populations rose from 13% in 1900, to 29% in 1950, to 50% in 2009, and it is projected to be 69% in 2050. Urbanization brings many benefits, such as diversity, market efficiency, jobs, education, and health improvement (Christopher, 2008; Glaeser, 1998). It is these benefits that attract a continuous flow of people from rural to urban areas. However, due to the rapid pace of urbanization, natural ecosystems are increasingly replaced by cities (Attwell, 2000; United Nations Population Fund, 2007). It has been increasingly noted that urbanization leads to many problems, such as air and water pollution, depletion of cultivated land due to urban sprawl, global climate change, and others (Li, Liu, Hu, et al., 2009; Yigitcanlar, 2009). These problems present barriers to achieving sustainable development. Consequently, with the global promotion of sustainable development, the problems created by urbanization have attracted efforts to find solutions from various sectors, including academics.

The principles of sustainable development have been increasingly applied across all sectors, with the development of various management systems. For example, the Building Research Establishment Environmental Assessment Method (BREEAM) (1990), the Leadership in Energy & Environmental Design (LEED) (1993), and Green Star (2003) have been applied to improve environmental performance. Corporate Social Responsibility (CSR) has been promoted as a strategy to improve social sustainability (Mathias, 2005). In line with these developments, sustainable urbanization is promoted as an important component of sustainable development (UN-Habitat/DFID, 2002). An urbanization process that fulfills the principles of sustainable development characterizes sustainable urbanization (Roy, 2009). Governments have advocated various policies on sustainable urbanization, and current research has also introduced various methodologies to assist in promoting sustainable urbanization. Drakakis-Smith and Dixon (1997) developed an integrative framework to understand concerns regarding sustainable urbanization from the perspectives of economic, social, political, demographic, and environmental performances. A report by the UN-Habitat/DFID (2002) identified the main challenges to achieving sustainable urbanization, including potential conflicts

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between economic growth and environmental sustainability, inequity due to lack of political and social inclusion, inadequate governance capabilities, and difficulties in achieving coordinated urban–rural development. Pivo (1996) reviewed the experience of sustainable urbanization in Mainstreet Cascadia and summarized six principles of urban planning for promoting sustainable urbanization, including compactness, completeness, conservation, comfort, coordination, and collaboration. Other studies investigated how various technological methods, such as low carbon emission, air and noise pollution control, and waste management contribute to urban environmental protection and sustainable urbanization (e.g., Brown, 2008; Jenerette & Larsen, 2006; Leach, Bauen, & Lucas, 1997). In recent years, advanced technologies, such as remote sensing, the Cellular Automata model, the SLEUTH model, and the System Dynamics model have been used to monitor the impact of urbanization on the environment and to analyze future scenarios of changes in land use to facilitate policy making for promoting sustainable urbanization (e.g., Encalada & Caceres, 2009; Haase, Haase, Kabisch, et al., 2008; Irwin, Jayaprakash, & Munroe, 2009; Jantz, Goetz, & Shelley, 2003; Ward, Phinn, & Murray, 2000).

Furthermore, various urban models have been introduced to guide the practice of urbanization towards better sustainability. Haughton (1999) suggested four types of urban models to contribute to sustainable development, namely "free market", "redesigning", "self-reliant", and "fair shares" city. Holden (2004) described four models of urban development, namely "urban sprawl", "the green city", "large (monolithic) compact city", and "decentralized concentration", with the model of decentralized concentration favored for better sustainability. Jabareen (2006) discussed the models of "compact city", "eco-city", "urban containment", and "neo-traditional development" and recommended applying the compact city model to promote sustainable urbanization.

The above discussions show that studies have introduced various models and methods to guide the design and practice of sustainable urbanization. Appreciation of these models and methods invites our investigation of how to evaluate their effectiveness. It appears that few studies have addressed this issue, which is important for applying effective methods and for encouraging sustainable urbanization. Therefore, there is a need for a tool to evaluate whether a particular practice of urbanization is sustainable. This tool should be able to incorporate the principles of sustainable urbanization with the characteristics of a particular practice of urbanization. This paper aims to develop such a tool for evaluating the sustainability of urbanization.

Urbanization and urban sustainability

Urbanization

Urbanization is defined by the United Nations as a movement of people from rural to urban areas with population growth equal to urban migration (United Nations, 2010). Urbanization is a dynamic process involving various stages and is usually expressed with the urbanization rate (μ_R). Northam (1975) depicted the urbanization process as an attenuated "S" curve, which includes an *initial stage*, an *acceleration stage*, and a *terminal stage,* as shown in Fig. 1. The *initial stage* has a slow pace until the ratio of urban population reaches about 30%. The *acceleration stage* begins with a pronounced pace. Urbanization reaches the *terminal stage* when the ratio of urban population is over 70%.

Other relevant terms of urbanization include *concentrated urbanization*, *suburbanization*, *counter-urbanization*, and *re-urbanization* (Bind, 1980; Enyedi & Hungary, 1990). *Concentrated urbanization* refers to heavy growth of urban population with similar development of industry in the initial stage of urbanization. *Suburbanization* refers to population growth in the suburbs due to urban expansion. *Counter-urbanization* occurs when urban people emigrate for complex reasons, such as the inability to tolerate urban problems, including air and water pollution. *Re-urbanization* refers to immigration for various reasons, such as a government policy that attracts people to urban areas. According to the urbanization process in Fig. 1, counter-urbanization and re-urbanization are phenomena that occur at the terminal stage of urbanization.

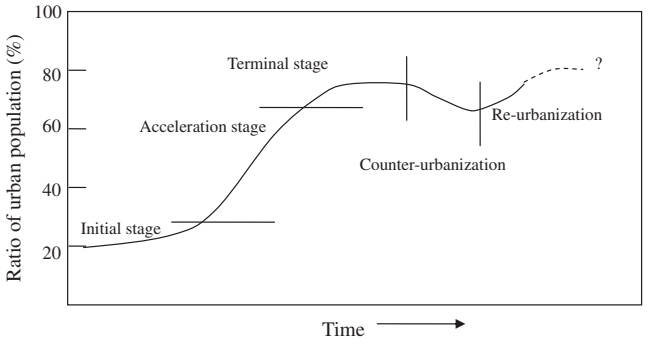

Fig. 1. The urbanization process. *Source*: adapted from Northam (1975) and Bind (1980).

As a dynamic process, urbanization brings changes of physical formation, politics, and culture to a city while satisfying the needs of an increased urban population (Pivo, 1996). Bettencourt, Lobo, Helbing, et al. (2007) argued that urbanization is intimately related to economic development, human welfare, and profound changes in social organization and patterns of human behavior, presenting both opportunities and challenges to achieving urban sustainability. Other studies echo this conclusion, arguing that urbanization presents both benefits and problems in economic, social, and ecological terms (Alberti & Marzluff, 2004; Christopher, 2008; Glaeser, 1998; Li et al., 2009; Yigitcanlar, 2009).

Urban sustainability

Urban sustainability (μ_S) can be considered a measure for assessing the extent to which a city has achieved a desirable state of sustainability (Banister, 1998). This state is described as a practice that uses resources efficiently and improves the quality of life in an excellent environment within the constraints of our earth (Banister, 1998). Therefore, the measure μ_S is often expressed as a stage value to reflect the sustainability of a specific city at any given point in time, as shown in Fig. 2.

Research has been conducted on measuring urban sustainability by means of indicators, flow analysis models, frameworks, and other methods (Oswald & McNeil, 2010; Waheed, Khan, &

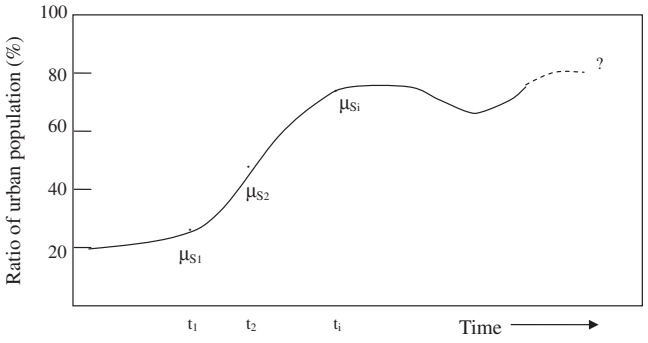

Fig. 2. An illustration of state change of μ_S in the urbanization process.