Cities 66 (2017) 1–9

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities

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Evaluation and prediction of sustainability of urban areas: A case study for Kermanshah city, Iran

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ARTICLE INFO

Article history:
Received 17 July 2016
Received in revised form 3 March 2017
Accepted 12 March 2017
Available online xxxx

Keywords:
IFPPSI
Kermanshah
Shannon's entropy
Urban sustainability

ABSTRACT

Sustainable development is a balance between economic growth, environmental issues and social conditions. In this respect, urban sustainable development is an important challenge, and a considerable part of sustainable development. Therefore, this study was carried out to assess and predict urban sustainability in different areas of Kermanshah city of Iran using an integrated approach, including the improved full permutation polygon synthetic indicator (IFPPSI) and Shannon's entropy methods. Kermanshah is the largest city located in the west of Iran with six main urban areas, which is facing many environmental, economic and social problems. The results showed that among the six urban areas, Areas 1, 3 and 4 have been shown to be at a moderate level, based on the synthetic indicator value (0.25–0.5). According to the synthetic indicator value (<0.25), the levels of the other areas (2, 5 and 6) are quite bad. The IFPPSI results were also compared with common multi-criteria decision-making (MCDM) techniques, ELECTRE of the concordance subgroup, TOPSIS of the compromising subgroup and SAW of the scoring subgroup. The results of the Friedman test showed that there is no significant difference between the MCDM and IFPPSI methods; however, the IFPPSI method is preferred due to its remarkable advantages over the other methods. In a subsequent part, based on the data collected from three time periods, the years 1996, 2006 and 2016, the indicator anticipated for 2026 showing no improvement in the environmental, economic and social indexes compared with the current conditions.

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1. Introduction

At present, around 50% of all urban inhabitants live in cities. Therefore, cities are centers of social and economic development, and consequently are motors for sustainable development (Rotmansa, Asselt, & Vellinga, 2000; Oliver, 2008; Varol, Ercoskun, & Gurer, 2010; Igor, 2014). The challenge of sustainable urban development is now recognized worldwide (Jansen, 2003). The statistics on the urbanization growth rate in the world show a significant increase in the rate from 3% in 1800 to 50% in 2008. On this basis, increases of up to 60% and 70% are respectively forecasted by 2030 and 2050 (Khazaei & Razavian, 2013). Such changes affect the economy and social and environmental conditions. Economic uncertainties and the competition in the attraction of investors are the major results of these changes. Other issues, such as climate change and energy consumption, also affect urban areas (Connelly, 2007; Rasoolimanesh, Badarulzaman, & Jaafar, 2011; Hassan & Lee, 2015). Since the earth's ecosystems cannot tolerate the current levels of economic activities, consumption and their growth trend, the balance of the ecosystem is being upset as a result (Arjmandnia, 2002a, 2002b; Huang, Wu, & Yan, 2015). Hence, the concept of urban sustainable development was advanced to help urban centers cope with these challenges (Whitehead, 2003; Haikio, 2014). The Action Plan outlined in Agenda 21 provided three essential needs (to protect water, soil and biodiversity) for economic development, social justice and cultural issues (Willis, 2006). The sustainable development of urban areas is achieved when the allocation and distribution of spatial units, community services and facilities between cities are conducted on the basis of population needs and geographic equality (Bolay, Yves, Rabinovich, & Catenazi, 2005; Mobaraki & Abdoli, 2013).

Most of the studies related to priority alternatives in urban sustainability have been performed by common methods, such as factor analysis (Zarrabi, 2014) and multi-criteria decision-making (MCDM) methods (Pohekar & Ramachandran, 2004). Kim, Chung, Jun, and Kim (2013) used the TOPSIS technique for the selection of the site of a municipal wastewater treatment plant from among 10 sites in an urban

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http://dx.doi.org/10.1016/j.cities.2017.03.002
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watershed in South Korea. In another study, the environmental sustainability of several metropolitan areas in Canada and the United States was evaluated using MCDM methods (Egilmez, Gumus, & Kuchkvar, 2015). Also, environmental sustainability assessment for different areas of Bandar Turkmen in the north of Iran was conducted by elimination choice translating reality (ELECTRE) and linear assignment (Hosseinzadeh, Khosrobeygi, Istgalday, & Shamsoddini, 2011). Urban sustainable development involves the sustainability levels of different urban areas.

However, few reports are available in the literature that use MCDM methods for this purpose. In this respect, sustainability of some states in India and Weifang urban area in China have been studied by ELECTRE, TOPSIS, preference-ranking organization for enrichment evaluations (PROMETHEE) and analytical hierarchy process (AHP) (Wang & Wang, 2013; Sen, Ghosh, Saha, & Karmaker, 2014). Also, several other studies have been conducted in this field using MCDM methods such as TOPSIS, complex proportional assessment (COPRAS), fuzzy logic and others (Viteikiene & Kazimieras Zavadskas, 2007; Rajak & Vinod, 2015; Liang, Zhang, Chen, & Deng, 2016; Mokhtari Malek-Abadi, Aliakbari, & Khosravi, 2016; Zhang, Xu, Yeh, Liu, & Zhou, 2016). The results showed that the most sustainable area is usually close to the centre of the city. Also, some strategies such as increasing green spaces, well-organized infrastructure, urban harmony, community participation, good ecological environment and economic development were found to be important factors in promoting sustainable urban development.

To assess urban sustainability, a comprehensive, holistic and accurate method is required. Thus, the use of appropriate urban sustainability indicators in combination with scientific methods is of high importance. This approach will lead to the identification and determination or appropriate solutions, strategies and urban planning. In this respect, FPPSI is an appropriate approach to measure sustainability levels. This method uses a set of indicators that reflects the strengths and weaknesses of cities in order to eliminate the existing obstacles and problems. Also, this approach can help researchers and policymakers assess, plan, manage and monitor the cities comprehensively and accurately. Additionally, IFPPSI, as a developed form of the FPPSI method, is more scientific due to the weight added to the indicators.

A few studies in the field of assessment and management of urban sustainable development have been conducted using the FPPSI method. Li et al. (2009) reported an assessment of sustainable development for Jining City in China using the FPPSI method. They applied a system of 52 indicators of urban sustainable development, especially economic, ecological construction, environmental and social progress with the synthetic indicator of 0.24 in 2004. Ranasinghe, Amarawickrama, and Warusavitharane (2016) and Xu, Wang, Zhou, Wang, and Liu (2016) also developed the FPPSI method for the assessment and management of urban sustainable development and achieved beneficial results. Jin et al. (2011) carried out conjugate ecological restoration in Mentougou district, Beijing-China, by adding a new parameter (weight of indicator) to the FPPSI method and introduced it as an improved FPPSI (IFPPSI) method.

Since sustainable urban development is a multidimensional issue with interactive effects of various factors, even the same problems in different cities may require different strategies and actions. However, determination of the city's priorities and knowledge-based urban management are the main factors to implement the strategies for sustainable development.

Kermanshah city, the largest city in the west of Iran, is experiencing rapid urbanization and facing many problems like air, water and noise pollution, solid waste, high traffic density, lack of urban services and optimal facilities distribution, marginalization, and old areas. Owing to the existing problems and the fact that no profound study has been conducted yet in Kermanshah city, accurate understanding of urban areas is required for holistic planning and management. Therefore, this study was conducted to assess and predict the sustainability of urban areas in Kermanshah city using the IFPPSI method and explore necessary

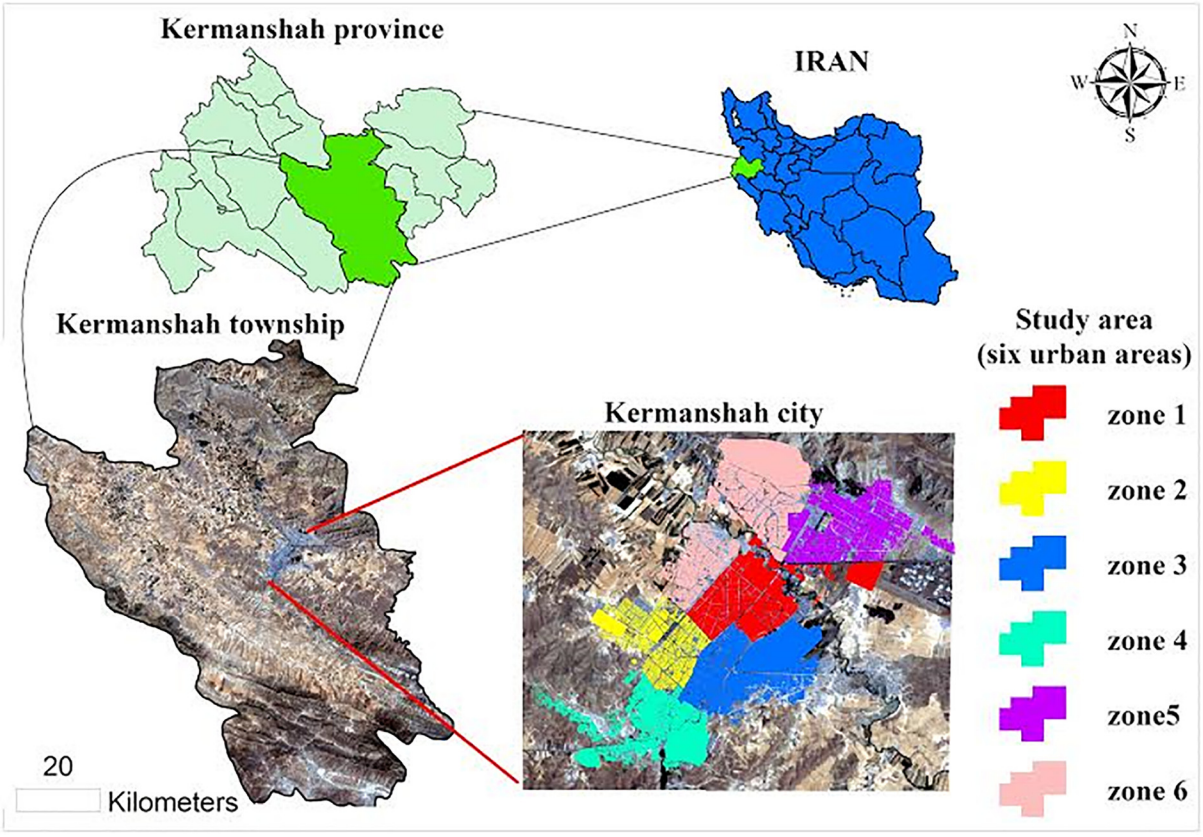

Fig. 1. Location of the study area.

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