A Review of the Indicators for Assessing the Sustainability of Urban Regeneration

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***Abstract*—The prevailing urban regeneration practices have shown the irreplaceable role in solving certain social and urban problems. However, the lack of an overall assessment tool to evaluate the overall sustainability of urban regeneration projects has led to many unsustainable issues during the large-scale urban regeneration around the world. Thus, it is deemed necessary to assess the performance of urban regeneration based on specific indicators. Many indicator-based assessment tools for evaluating urban regeneration have been built, but none of them is applicable to all countries due to social, historic, economic, cultural differences. Based on the literature review about sustainable urban renewal in major databases, this research first presents a critical review of recent studies on sustainable urban renewal, then identifies the main indicators for evaluating the economic, environmental and social sustainability of urban regeneration, and summarizes the common indicators used in evaluating urban regeneration performance. Finally, this paper suggests the establishment of indicator-based sustainability assessment framework which has a wide scope of application.**

Keywords—Indicator, sustainability, urban regeneration

I. Introduction

In the past few decades, many countries have been experiencing large-scale urban regeneration. Urban regeneration is usually regarded as a core mechanism to carry out sustainable development. In a broad sense, all urban regeneration contributes sustainable development by removing the decayed buildings, recycling the resources and reducing the burden on the environment and society [1]. Some successful regeneration projects have become the landmark landscapes, centres of creative industries and popular tourist sites. However, some urban regeneration practics just focused on the economic benefits or physical changes and failed to give sufficient attention to local distinctiveness, traditional arts and culture and the real demand of the local community. Too much emphasis on the economic aspect may lead to the neglect of environmental and social dimensions. In addition, those urban regeneration practices that can't integrate economic, environmental and social aspects in the regeneration process won't achieve an overall sustainable development. In fact, sustainable urban regeneration may have to consider the geographical features of the target area, local economic development, industrial and cultural diversity and many other elements [2,3]. Thus, it is deemed necessary to assess the performance of urban regeneration based on specific indicators. Many indicator-based assessment tools for evaluating urban regeneration have been built, but none of them is applicable to all countries due to social, historic, economic, cultural differences. A brief review of the indicators used in sustainability assessment of urban regeneration can show the common indicators and suggest the focus for future research.

II. Sustainable Development and Urban Regeneration

In 1987, the World Commission on Environment and Development (WCED) published a report entitled *Our Common Future*. According to this report, sustainable development needs to "meet the needs of the present without compromising the ability of future generations to meet their own needs" [4]. There used to be too much research on physical improvements of urban regeneration rather than economic and social sustainability. Urban regeneration, also called urban renewal, urban revitalization or urban redevelopment, has been employed to address many social and urban problems emerging with urbanization. In the context of pursuing an overall sustainable urban development, this research uses the term of urban regeneration, which is considered to include the initiatives of comprehensive urban redevelopment from economic, social, physical and environmental aspects.

Since the end of the last century, relevant studies on urban regeneration and sustainability have been conducted. Scholars have tried to define sustainable urban regeneration from different perspectives. Although there is no unified definition of sustainable urban regeneration, scholars have basically reached a consensus that sustainable urban regeneration should not only focus on physical regeneration, but also on comprehensive sustainable regeneration from economic, social and environmental aspects. For example, Lombardi et al. pointed out that urban regeneration had a substantial impact on social, economic and environmental dimensions [5].

In sustainable urban regeneration, creative industries have played an important role in stimulating economic growth, solving social problems, and promoting urban transformation and economic recovery [6,7]. Culture-led urban regeneration strategies have been widely used to create urban landscapes, promote urban economic growth and enhance the city's competitiveness [8-10]. Miles (2005) pointed out that successful culture-led urban regeneration projects should be closely linked to the sense of belonging

978-1-7281-8169-1/20/$31.00 ©2020 IEEE
DOI 10.1109/BDIEM51022.2020.00009

of local people [11]. In fact, the effective combination of local urban regeneration projects with citizens' sense of belongings can help local communities to preserve and promote regional characteristics so as to reduce social exclusion caused by urban regeneration. In addition, the widespread participation of local communities in the decision-making process helps to create unique urban regeneration projects. Urban regeneration needs to consider the specific characteristics, economic development, and industrial and cultural diversity of the regenerated areas. What's more, urban regeneration is closely related to the development of the local creative economy. A full understanding of local historical heritage, geographic location, trade characteristics, cultural heritage and other factors can help to provide a more effective and sustainable transformation strategy. The involvement of bottom-up decision-making process in urban regeneration practices and effective communication among key stakeholders will surely improve the level of sustainability.

III. Assessment of Sustainable Urban Regeneration

Sustainable urban regeneration strategies and evaluation mechanisms have attracted the attention of many researchers, professionals, and government officials. Some international and regional organizations have proposed a series of urban sustainable development indicators. However, there are still many unsustainable urban regeneration projects that just emphasize the economic and environmental aspects and overlook the social aspects. The issues of unsustainability of many urban regeneration projects mainly lie in the lack of comprehensive recognition of social, economic, cultural and environmental problems and proper evaluation of various stakeholders' interests and expectations. Therefore, an in-depth understanding of the real situation of the regeneration areas and divergent interests and expectations of the key stakeholders is an essential step to achieve economic, environmental and social sustainability in the urban regeneration process.

Since the assessment of the sustainability of urban regeneration projects attracted many researchers' attention, the indicator-based evaluation method has been widely employed to assess the sustainability of urban regeneration practices across the world. Until now, some sets of urban sustainability indicators have been developed, however, none of them can be applied universally due to the social, historic, cultural and political differences of each country. Hemphill et al. (2004) used a hierarchical model and multi-criteria analysis technology to establish a sustainable urban regeneration evaluation framework that includes 52 indicators [12]. Lee and Chan (2008) summarized 30 indicators from environmental, economic and social dimensions and provided an insight to local developers, urban designers, and government officials on sustainable urban regeneration projects [13]. Based on Hemphill's framework and other indicators Langstraat (2006) evaluated the urban renewal project in Leeds of the United Kingdom [14].

IV. Indicator-based Assessment of Urban Regeneration

As mentioned above, indicators have been increasingly used to assess the performance of urban regeneration and sustainable development. Urban regeneration is a complex process and it needs to be evaluated from economic, environmental and social dimensions. Indicators can be used together with benchmarking scales to provide quantitative evaluation of sustainable urban regeneration. The selection of indicators needs to reflect the relationship among economic, environmental and social sustainable development and predict the future trend of urban regeneration. Based on literature research, the main indicators used to assess the sustainability of urban regeneration are summarized as follows (see Table I). Most of the sustainability assessment frameworks are based on three pillars of sustainability: environmental, social and economic sustainability (see Figure 1).

TABLE I. Summary of Main Categories/Indicators to Assess Urban Regeneration Performance

Author	Year	Indicator Categories	No. of Indicators
Hemphill	2004	Economy and work, resource use, buildings and land use, transport and mobility, community benefits indicators [12]	52
Wedding & Crawford-Brown	2007	Environment and health, financial, social and economic, livability indicators [15]	40
Lee & Chan	2008	Environmental, social and economic sustainability indicators [13]	30
Colantonio et al.	2009	Social sustainability indicators [16]	57
Deng	2012	Environmental, economic and social sustainability indicators [17]	26
Turcu	2012	Economic, social, environmental and institutional sustainability indicators [18]	26
Laprise et al.	2015	Environment, sociocultural and economic sustainability indicators [19]	21
Balaban	2015	Economy and work, buildings and land use structure, transportation and mobility, infrastructure and resource efficiency, energy consumption and efficiency, and community-based issues [20]	23
Peng et al.	2015	Building performance, environmental development, social development, economic development [21]	22
Yildiz et al.	2017	Transportation and accessibility, conservation of natural resources and environment, built environment quality, supporting social life, and high density usage [22]	30
Zheng	2017	Social aspect, economy and work, resources and environment, land use form, building form, building condition [23]	27

Fig. 1. Three pillars of sustainable urban regeneration

V. Summary of Criteria and Indicators of Sustainable Urban Regeneration

From the above list of research papers about the assessment indicators for evaluating urban regeneration performance, this paper summarizes the main indicators used to assess the sustainability of urban regeneration from economic, environmental and social dimensions. The detailed explanations of these indicators are also provided.

A. Indicators of Economic Sustainability

The indicators for measuring economic sustainability are related to land use, employment, housing, training, businesses, economic growth, adaptability and compatibility of the regeneration project. The economic benefits brought by sustainable urban regeneration will promote the local employment rate and create more new jobs or business activities. The mixed use of land development for residential and commercial buildings and recreational facilities plays an important role in sustaining the economy. In addition, residential buildings are built for different classes in the society to guarantee the affordability of housing for the public. Different training programs will be provided to increase the employment and reemployment rate and meet the requirements of industrial restructuring and upgrading. What's more, the redevelopment of the buildings and facilities is compatible to local community and can be adapted according to the urban development (see Table II).

TABLE II. Main Indicators Measuring Economic Sustainability of Urban Regeneration

Indicator of economic sustainability	Description
Local employment	Number and range of jobs available locally
Mixed use development	Mix of land use (residential, commercial and recreational buildings and facilities)
Adaptability development	Design of buildings and facilities with adaptability for future development
Local training and skills	Types and availability of training programs
Business activities	Number and diversity of new businesses created
Economic growth	Promoting local economic growth
Housing affordability	House prices, affordability of housing and housing for different classes

B. Indicators of Environmental Sustainability

The indicators in this group focus on the evaluation of the influence of urban regeneration on the environment, ranging from the use of renewable energy sources, recycling of household waste, reuse of building materials to the control of air, noise and water pollution. The accessibility to public facilities and social services such as the walking distance to the nearest educational, medical, entertainment, retail and leisure facilities also shows the performance level of the regeneration. In addition, the convenience, efficiency and safety of public transport are also the main factors which influence the sustainability of urban regeneration. The conservation and preservation of built heritage can add more values to the regeneration projects (see Table III).

TABLE III. Main Indicators Measuring Environmental Sustainability of Urban Regeneration

Indicator of economic sustainability	Description
Waste disposal	Local waste disposal and recycling
Reclamation of building materials	Construction and demolition waste recycled
Energy-efficient facilities	Reduction of non-renewable energy sources and increasing use of renewable energy sources
Built environment	Housing conditions
Services and facilities	Average journey time by foot to leisure, retail, educational, medical, entertainment, cultural facilities; improvements in infrastructure
Pollution control	Reduction of air and noise pollution and water consumption
Green space	Quality and access to green open space
Conservation of built heritage	Maintenance and rehabilitation of built heritage
Use and quality of public space	Accessibility, quality and usage of public space
Convenience and efficiency of public transport	Convenience, efficiency and safety for pedestrians, drivers and public transport users

C. Indicators of Social Sustainability

Sustainable urban regeneration will provide quality social welfare to the public and fulfil their social needs. The demographic information about population status, population growth rate and population density are included as the basic data for assessing the social sustainability. The preservation of social network can enhance the sense of belongings in the community and improve social interaction and integration. One important indicator of this group is the conservation of local geographic, historic, cultural characteristics, which can greatly improve the social sustainability of the regeneration area. What's more, the community safety and social harmony and stability are also significant factors influencing the sustainability level (see Table IV).

TABLE IV. MAIN INDICATORS MEASURING SOCIAL SUSTAINABILITY OF URBAN REGENERATION

Indicator of economic sustainability	Description
Population status	Range of population, population density and population growth rate
Social welfare	Facilities and satisfaction with facilities
Social harmony and stability	Preserving social network, facilitating community harmony and stability
Community group involvement	The degree of public participation, community involvement and satisfaction
Sense of belonging in community	Improvement of sense of community and community network
Crime and safety	Reduction of crime rate, safety perception
Conservation of local distinctiveness	Promotion of local characteristics including culture, history, heritage, etc.
Traveling habits	Work and leisure traveling habits
Social interaction and integration	Improving community interaction and integration of different groups; avoiding gentrification and social exclusion

VI. CONCLUSION

The overall sustainability assessment of urban regeneration can help to provide a guideline for policy-makers, project developers, practitioners, local residents and other stakeholders on urban planning, heritage conservation and community involvement and improve the efficiency of decision-making of urban regeneration. Given the above analysis, the overall assessment of urban regeneration performance needs to follow the principles of sustainable development, emphasizing the ecological protection, economic development, social welfare, cultural transmission and other core elements of sustainable urban regeneration. The future research can focus on the establishment of a framework for evaluating the sustainability of urban regeneration based on regional characteristics.

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