Habitat International 53 (2016) 546–555

Contents lists available at ScienceDirect

Habitat International

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

Assessing the integrated sustainability of a public rental housing project from the perspective of complex eco-system

Li Dezhi [a, *], Chen Yanchao [a], Chen Hongxia [b], Guo Kai [a], Eddie Chi-Man Hui [c], Jay Yang [d]

[a] Department of Construction and Real Estate, Southeast University, PR China
[b] School of Civil Engineering, Sanjiang University, PR China
[c] Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong, China
[d] Science and Engineering Faculty, Queensland University of Technology, Australia

ARTICLE INFO

Article history:
Received 10 November 2015
Received in revised form
9 January 2016
Accepted 11 January 2016
Available online xxx

Keywords:
Sustainability
Public rental housing
Complex eco-system
ANP
China

ABSTRACT

Public rental housing (PRH) projects are the mainstream of China's new affordable housing policies, and their integrated sustainability has a far-reaching effect on medium-low income families' well-being and social stability. However, there are few quantitative researches on the integrated sustainability of PRH projects. Our study tries to fill this gap through proposing an assessment model of the integrated sustainability for PRH projects. First, this paper defines what the sustainability of a PRH project is. Second, after constructing the sustainable system of a PRH project from the perspective of complex eco-system, the paper explores the internal operation mechanism and the coupling mechanism among the ecological, economic and social subsystems. Third, it identifies fourteen indices to represent the sustainability system of a PRH project, including six indices of ecological subsystem, five of economic subsystem and three of social subsystem. Fourth, it qualifies the weights of three subsystems and their internal representative indices. In addition, an assessment model is established through expert surveys and analytic network process (ANP). Finally, the paper carries out an empirical research on a PRH project in Nanjing city of China, followed by suggestions to enhance the integrated sustainability. The sustainability system and its evaluation model proposed in this paper are concise and easy to understand and can provide a theoretical foundation and a scientific basis for the evaluation and optimization of PRH projects.

1. Introduction

In recent years, along with progressive economic growth and acceleration of urbanization, the Chinese real estate industry has been developing rapidly, resulting in the high housing price and the affordability problems faced by low-income groups in many cities in China. For instance, a new phenomenon “ant tribe” has appeared and become well-known among the low-income groups, especially new university graduates, who earns little and live in small residences collectively. It was reported that 8 new university graduates lived together in a small unit of about 40 square meters.[1] In view of this, the Chinese government not only issues a series of stringent readjustment policies but also promulgates various politic documents to reinforce affordable housing, including Economical and Comfortable Housing (ECH) and Cheap Rental Housing (CRH). Most of affordable housing projects are funded by governments, while some government offices and public institutions built ECH and CRH for their employees. Although residents in ECH and CRH must pay for their ownership and tenancy respectively, the prices are both distinctly lower than market level. According to the Ministry of Housing and Urban-Rural Development of China (MOURD), 12.5% of urban residents have benefited from the affordable housing system until the end of2012.[2] However, the ECH projects are designed for urban medium-low income families, and the CRH projects are available for families with the lowest income (Huang & Du, 2015). There are still families who neither meet the application criteria for CRH nor afford ECH. They are commonly called “sandwich layer”.

In order to meet the housing needs of the “sandwich layer” group, seven ministries including MOURD made joint efforts to formulate the *Guidance to Speed up the Development of Public Rental Housing* (PRH) to develop PRH, which is an important measure to

* Corresponding author.
E-mail address: njldz@seu.edu.cn (L. Dezhi).

[1] http://www.china.com.cn/news/local/2009-11/18/content_18912330.htm.

[2] http://www.gov.cn/wszb/zhibo614/content_2614485.htm.

http://dx.doi.org/10.1016/j.habitatint.2016.01.001
0197-3975/

perfect the affordable housing system and meet the basic housing needs of medium-low income households. PRH has been repeatedly declared as the development emphasis and future mainstream of reconstructed affordable housing system in many official documents like The Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China and recognized as an important measure to perfect the affordable housing system and solve the housing difficulties of "sandwich layer" group. Under the overall scheme and vigorous promotion of the Chinese central government, many local governments have started to explore and construct PRH actively. For example, the *Beijing Housing Security Programming in the Twelfth Five-Year* promised to supply PRH projects accounting for 60% of the affordable houses from 2011 through 2015. On December 6, 2013, MOURD, Ministry of Finance and National Development and Reform Commission jointly promulgated *Notice on merger of public rental housing and Cheap Rental Housing* to urge local governments to merge CRH into PRH since 2014.

Under the historical background of PRH projects becoming the national strategy, PRH is developing rapidly throughout the country (Li, Guo, You, & Hui, 2016). Nevertheless, a disturbing and inevitable fact at present is that PRH projects seem hard to develop sustainably in social, economic and environmental terms. For example, due to the remote location, centralized construction and lack of amenities, many PRH projects are rejected by medium-low income families, who prefer severe housing conditions with ample amenities nearby in urban areas (Lin, 2012). In addition, most of the projects have exerted serious influence on ecology and environment using the timeworn designing and constructing technology (Zhao, Zhang, Zhang, & Xie, 2011). The government also suffers from huge financial pressure because PRH construction is almost solely supported by state investment, and very few of private enterprise would like to participate in the provision of PRH (Li, Chen, Huang, & Cui, 2012). Since these problems have seriously undermined the sustainability of PRH projects, this paper aims to propose a scientific approach to assessing and further enhancing the integrated sustainability of PRH, with a view to improving the livelihood of medium-low income families.

2. Literature review

In China, PRH has become a research hotspot with its increasing importance in the affordable housing system and the commencement of a large number of public housing construction projects. A large number of concepts similar to PRH also have been adopted worldwide, including social rented housing, public housing, social housing and affordable housing. Sometimes they are indistinguishable and replaceable. To avoid ignoring PRH-related literature, those concepts are not specifically distinguished herein. Taking the above-mentioned concepts and related terms, such as "sustainability", "energy", "environmental impact", "sustainable", "social" and "stratification", as keywords, it can be discovered that researchers abroad mainly have been carrying out researches related to the sustainability of PRH projects from four aspects, namely ecological, economic, social and integrated (Chen, Li, Deng, & Xie, 2014; Choguill, 2007). Among them, the ecological sustainability of a PRH project is the sustainability behavior of the ecological subsystem, while economic sustainability and social sustainability are the sustainability behavior of the economic and social subsystem respectively. Firstly, as regards ecological sustainability, Hoppe (2012) and Chikamoto, Kobayashi, and Enomoto (2013) explored strategies to effectively reduce carbon emissions by improving energy efficiency. Wong and Kuan (2014) explored the application of building information modeling (BIM) in the evaluation of ecological sustainability. Secondly, researches related to economic sustainability of PRH projects mainly refer to the functions of various forces in the supply of PRH, including for-profit organizations, non-profit organizations and governments. For instance, Arku (2009) and Taiwo (2015) qualitatively proposed policy suggestions to encourage profit organizations to participate in the construction of public houses in Ghana, Nigeria or some other areas through public-private partnerships (PPP). Sedhain (2005) and Blessing (2015) explored the potential roles non-profit organizations play in meeting the housing demand of the poor residents in Nepal, the United Kingdom and Holland. Thirdly, in terms of social sustainability of PRH projects, McCormick, Joseph, and Chaskin (2012) analyzed the impact of social stigma of relocated public housing residents. Ibem and Aduwo (2013) provides an assessment of residential satisfaction of newly designed public low-cost housing dwellers of Kuala Lumpur, Malaysia, with forty-five variables grouped into five components. Lang and Novy (2014) analyzed the effectiveness of housing cooperative society in Vienna on strengthening the social integration. Fourthly, there are few researches done on integrated sustainability of PRH, which mainly focused on sustainable evaluation indices. de Azevedo, Silva, and Silva (2010) proposed to give full consideration to ecological, social and economic aspects and take them as sustainable evaluation indices of social housing projects, while Carter and Chris (2007) considered that weights of the three categories (i.e. ecological, economic and social category) were not reasonable in the process of sustainability evaluation of British social housing projects, failing to reflect the sustainable development policy.

To sum up, there are plentiful researches relating to the sustainability of PRH projects, which are mainly classified into four aspects, namely ecological, economic, social and integrated sustainability. As regards the integrated sustainability of PRH projects, very few publications focus on mechanism analysis and consider the non-linear interaction among the evaluation indices. To fill in this gap, our study constructs a sustainability evaluation system based on the complex eco-system theory, establishes a sustainability evaluation index system and set up a sustainability evaluation model for a PRH project through the analytic network process (ANP). Moreover, this paper carries out an empirical study of Daishan PRH project in Nanjing, China.

3. The sustainability system

3.1. Definition

In 2012, it was made clear in *Management Method of Public Rental Housing*, deliberated and approved by MOHURD, that PRH projects are affordable houses that strictly restricted in construction standards and rental expenses, and limited to medium-low income households, newly-employed workers without houses and migrant workers with stable employment. As regards sustainability, it is a state that can last for a long time and is a description of sustainable development level. Plentiful definitions to sustainable development have been determined internationally from various perspectives (Gan, Zuo, Ye, Skitmore, & Xiong, 2015). The most widely accepted one is from the Brundtland Report which was published by the World Commission on Environment and Development in 1987, referring sustainability development to meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Considering the characteristics of PRH and the concept of sustainability, the sustainability of a PRH project can be defined as a developmental level of PRH project to meet the housing needs of present medium-low income groups without compromising the ability to meet the housing needs of their future groups. It must be reasonable to develop and harness natural resources in pursuit of