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PARADOXICAL PHENOMENON IN URBAN RENEWAL PRACTICES: PROMOTION OF SUSTAINABLE CONSTRUCTION VERSUS BUILDINGS' SHORT LIFESPAN

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ABSTRACT. The current urban renewal programs in some developing countries, such as China, are at the expense of demolishing a huge number of existing buildings without distinction. As a consequence, the buildings' short lifespan due to premature demolition and resultant adverse impacts on environment and society have been criticized for not being in line with sustainable development principles. This study therefore examines impacts of urban renewal practices on buildings' lifespan by referring to a typical urban renewal region in western China – the Gailanxi region of Chongqing city which is considered representative. Findings show in current practices, little consideration is given to the implications of building demolitions across economic, social and environmental horizons collectively. As a result, premature demolition due to requirements of urban renewal has been a major factor leading to the significantly short lifespan of buildings. This is against the core intention of implementing urban renewal, which is promoting sustainability of the cities. Particularly, buildings' short lifespan results in consequences against sustainable construction principles, such as energy and resources waste, construction waste generation, environmental pollution, and higher lifecycle costs of buildings. Furthermore, building demolitions without distinction lead to losses of valuable historic buildings. Therefore, the urban renewal process presents a paradoxical phenomenon: the promotion of sustainable construction versus buildings' short lifespan. The dominance of economic consideration in the decision-making on buildings is considered as the underlying reason to the paradox. The learned experience presented in this study should be built into the decision-making process for carrying out future urban renewal programs.

KEYWORDS: Urban renewal; Buildings' short lifespan; Sustainable construction; China

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1. INTRODUCTION

Many developing countries such as China have been implementing large scales of urbanization and urban renewal over recent years, aiming at improving existing urban residents' living conditions as a whole and providing ac-

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commodations for new residents in the urbanization process. It was reported that by 2009, 46.6% of Chinese people lived in urban areas, demonstrating an increase of 10.2% compared with the proportion in 2000 (NBS, 2010). The growth of urbanization in China has resulted in a large amount of housing demand throughout the country, inducing a huge number of construction projects in urban areas. These housing demands can be commonly met through urban sprawl development and urban renewal. Since urban sprawl development strategies are at the expense of losing agricultural and ecological land space, the sprawl development strategy has limits in application. On this ground, urban renewal has become the major strategy for providing construction space to meet the demands of housings. According to a report by Wang (2010a), the land area that is vacated for new construction projects through demolishing existing buildings in Chinese urban areas annually constitutes about 40% of the total land area used for construction activities. To a certain extent, the Chinese construction industry can be characterized by the substantial demolition and rebuilding works in urban areas. For instance, 120 million m^2 buildings were demolished in Chinese cities and towns in 2002. In 2003, 161 million m^2 buildings were demolished, amounting to 41.3% of the completed construction floor area in that year (Liu et al., 2005). In Chongqing, which is one of the municipal cities in China, 9.1 million m^2 existing residential buildings had been demolished by 2007, and 7.9 million m^2 old residential building would be demolished over the subsequent three years (Chongqing Government, 2008).

Furthermore, the demolition works in China's current urban renewal are to a large extent without distinction. Some demolition works occurred to buildings of a very young age, and some pccured to buildings that still had good cultural or historical value. As a consequence, the demolition works have led to the premature end of life in many buildings; in other words, the physical life of these buildings ceases due to premature demolition. The physical life of a building is the expected period of time for the building to stand physically (Friedman et al., 2004). With appropriate maintenance and refurbishment, a building can last physically for relatively a long time, except for obsolescence factors such as economical or environmental considerations. However, mostly a building's physical life will have to end as a result of the economic consideration on its use. A building's economic life refers to the lifespan during which the building can provide economical benefits. A building's economic lifespan is usually shorter than its physical lifetime. A building can be obsolete if treated purely from an economic perspective although it may be still in good physical condition. This is echoed by O'Connor (2004), asserting that buildings are not necessarily in service as that long as they could physically stand. The Chinese government has appreciated the seriousness of buildings' premature demise during the course of urban renewal. In his keynote speech, Qiu Baoxing (Wang, 2010b), the Vice-minister of the Ministry of Housing and Urban-Rural Development of China, commented that "in recent years, new buildings in China amount to 2 billion m^2 and consume up to 40% the cement and steel of the total consumption in the world every year. Our buildings nevertheless could merely last for 25–30 years on average since they are built. Apparently, the lifespan is much shorter than that as extensively recognized in international standards".

Consequences of buildings' short lifespan are multiple, such as producing a huge amount of construction waste and wasting valuable natural resources. In fact, demolition works generate much more construction waste than that caused by new construction works. According to a recent study, in China, constructing a 10,000 m^2 new building will produce 500–600 tons of construction waste while demolishing a 10,000 m^2 old building will generate 7,000–12,000 tons construction waste (Wang, 2010b). Further, the short building lifespan leads to considerable amounts of energy and resource waste. Buildings' short lifespan contributes to lower resource productivity. As suggested by DeSimone and Popoff

(1998), one way of enhancing resource productivity is to lengthen the useful life of products. Longer building service life was considered as a contributor to sustainable development by John et al. (2002), who opined that when two alternatives with equivalent environmental capacity are compared and examined, the one providing longer service could achieve better sustainability. There are also studies demonstrating that the lifespan of buildings has significant environmental impacts (Hu, 2010; Kohler and Yang, 2007). Many factors affect buildings' lifespan, including the way of using building, the structural failure, and economical obsolete. Bullen and Love (2010), for example, argued that improper use of buildings could result in their premature demise without fully exploiting their residual lifecycle value.

Despite the fact that the importance of buildings' lifespan has been well addressed in previous studies, buildings' short lifespan as a result of urban renewal in China has been hitherto given little attention. China has been implementing a huge scale of urban renewal programs since early 1990s with the purpose of revitalizing the out-dated built environment and accommodating more people induced by the urbanization. However, the implementation of urban renewal has been accompanied by the large-scale premature demise of buildings. It appears that the negative impacts of the premature demise on environment and society have been neglected by the local government. This presents a paradox in its urban renewal practices: promoting sustainable construction versus buildings' short lifespan. As it is intended, urban renewal is launched for improving urban sustainability through embracing and practicing sustainable development principles. Couch and Dennemann (2000) pointed out that urban renewal could contribute to sustainable development through recycling derelict land and buildings, reducing demand for peripheral development and facilitating the development of more compact cities. However, the Chinese urban renewal induces large-scale demolition works, short building lifespan, large amount of construction waste, and considerable social conflicts and ecological damages, which are not in line with the sustainable development principles. It is the aim of this study to investigate this paradox by examining buildings' short lifespan in implementing the urban renewal programs in China. Particularly, the reasons leading to the paradoxical phenomenon are identified and solutions for mitigating the extent of the paradoxical phenomenon explored, so that the urban renewal process can develop toward sustainability.

2. RESEARCH METHODOLOGY

This study employs a hybrid research methodology including literature review, practical survey and statistical analysis. Review of literature helped to capture the fundamental theoretical understanding of urban renewal, building lifespan and sustainable construction. These topics have been well discussed in existing studies. In the present study, relevant previous findings were used for supporting comparative discussions between the Chinese practices and typical practices overseas under the umbrella of buildings' lifespan.

Survey was performed to obtain empirical data for examining the status quo of buildings' short lifespan due to premature demise in the process of Chinese urban renewal. The survey was carried out in Chongqing city of western China, where a large number of urban renewal programs have been underway and are expected to continue in the coming years. Chongqing is considered as representative in the contents of current urban renewal practices in China. It has a territory of 82400 km^2 with a population of approximate 32 million. According to a strategic plan issued by the local government (Chongqing Government, 2008), urban renewal is a major strategy for ameliorating the living condition, providing accommodations for new residents entering urban areas, upgrading city image, and accelerating its economical and social development. In line with this intention, the local government issued a policy entitled 'Guideline to Speeding up Redevelopment of Old and Dilapidated Buildings in Central District in Chongqing' in 2008, according to which

Table 1. Demolished buildings by structure type

Type of structure	Construction area		Number of units	
	m^2	%	No.	%
Brick and concrete (B&C)	198,024.7	58	444	50
Brick and timber (B&T)	53,536.2	16	209	24
Mixed (M)	44,255.8	13	143	16
Timber (T)	8,803.8	3	46	5
Brick (B)	11,125.7	3	29	3
Reinforced concrete (RC)	23,239.1	7	13	2
Total	338,985.3	100	884	100

an area of 7.86 million m^2 will be renewed in the coming years. It was also reported that according to Chongqing Municipal Planning Bureau, the land area for construction in Chongqing would be increased at least by 400 km^2 in the coming years in order to meet the rapid urbanization (Guo, 2010). It is planned that significant proportion of the land needed will be acquired through the urban renewal programs, which involve the demolition of existing buildings.

The data about the demolition works were collected with the assistance of the government agency in the Gailanxi district which is a major urban renewal region in Chongqing. The renewal region is located in Jiangbei District of Chongqing, which is an area of about 2.47 km^2 with a riverbank of 1.8 km. The individual demolished buildings were classified under the headings of construction area, lifespan, primary structural materials (concrete, brick, wood, etc.), and building functions. The data collected comprises information from 884 buildings, reaching a total building area of 338,985.21 m^2. Major statistical analyses were carried out for analyzing the data collected in the survey, including mean value calculation and frequency distribution analysis.

3. DATA ANALYSIS

3.1. Classification of demolished buildings

In the urban renewal area under study, 884 buildings were demolished, including 546 residential buildings (accounting for 62%), 272 industrial buildings (accounting for 31%), and 66 buildings of other functions (accounting for 7%). The total demolished floor area is 338,985.25 m^2, among which 152,608.4 m^2 (accounting for 45%) are occupied by residential buildings, 154,650.5 m^2 (accounting for 46%) by industrial buildings, and 31,726.35 m^2 (accounting for 9%) by the others.

These samples of demolished buildings are also classified according to types of structures, as shown in Table 1. The types of structures mainly include brick and concrete (B&C), brick and timber (B&T), timber (T), brick (B), mixed (M), and reinforced concrete (RC) structure. From the table, the majority of the demolished buildings are brick and concrete (B&C), brick and timber (B&T) and mixed (M) structure.

3.2. Lifespan of the demolished buildings

The lifespan of the demolished buildings is tabulated in Table 2, which shows that the residential buildings have a minimum lifetime of 7 years, an average lifespan of 36.3 years and the maximum life of 80 years. Non-residential buildings achieve an average lifespan of 35.2 years, a minimum lifespan of 11 years and a maximum of 80 years. Table 3 illustrates the distribution of the sample buildings categorized by age (in a 10-year interval). It is evi-

Table 2. Lifespan of demolished buildings

Building life (years)	All building types	Residential buildings	Non-residential buildings
Average life	35.9	36.3	35.2
Minimum life	7	7	11
Maximum life	80	80	80

dent that the largest group of the demolished buildings is within the lifespan between 21 and 30 years.

The average lifespan of demolished residential buildings under study is significantly short compared to those reported in some western countries. According to Song (2004), the average life of residential buildings is 63.8 years in Germany, 71.5 years in Netherland, 77.4 years in Spain, 80.6 years in Austria, 90.0 years in Belgium, 102.9 years in France, and 132.6 years in England. Although the relatively shorter lifespan of residential buildings in China can be related to various factors, such as building technology, construction material reliability, building structure and construction quality, a notable reason is a lack of conservation awareness and policy in the urban renewal process (Wu, 2004; Wu and He, 2005). In other words, the urban renewal process in the country has been largely implemented through forcibly demolishing residential buildings that locate in the planned urban renewal areas. It is therefore considered that enforcing urban renewal greatly causes the premature demise of buildings.

Even though the comparison is given to the statutory life designed for buildings in China, the life of the surveyed buildings is significantly short. The Chinese government introduced 'The Standard for Reliability Design of Building Structures' (GB 50068-2001) in November 2001. According to this standard, a building's working life as designed is divided into four classes, as described in Table 4.

It can be seen that the design life standard for buildings and other common structures is 50 years. However, am-design standard of lifespan before demolition.

Table 3. Distribution of lifespan in demolished buildings

Building lifespan (year)	Residential buildings		Non-residential buildings	
	number	%	number	%
0–10	4	0.7	0	0.0
11–20	64	11.7	19	5.6
21–30	196	35.9	128	37.9
31–40	89	16.3	98	29.0
41–50	74	13.6	83	24.6
51–60	110	20.1	9	2.7
above 60	9	1.6	1	0.3
Total	546	100	338	100

3.3. Comparison of building's lifespan between different structures

The data in Table 5 present the distribution of lifespan of the surveyed buildings with different types of structures. For the demolished buildings, timber structures will stand for longer than those with a concrete structure. Particularly, the former mostly lasts for over 40 years, while the latter lasts for less than 30 years. In addition, there is a big difference between building's service life and the designed durability of the structure; typically the latter will be much longer than the former. Gaston et al. (2001) conducted a survey on expected service life of buildings with different structures in US and Canada, finding that non-residential buildings with concrete structures stand for an average of 87.2 years, compared to timber structures which last for an average of 51.6 years prior to demolition.

Whilst the above comparison does not simply mean that the longer the building's lifespan the better, it is considered that there could be a better balance between the sustainability gains in extending buildings' lifespan and the potential losses from the premature demise of buildings, as suggested by Pearce (2003). In the practice of Chinese urban renewal pro-

Table 4. Building working life designed in standard (GB 50068-2001)

Class	Working life as designed (years)	Examples
1	5	Temporary structures
2	25	Replacement structural parts
3	50	Buildings and other common structures
4	100	Monumental buildings and other special or important structures.

Table 5. Distribution of building lifespan by structure type

Lifespan (year)	B&C		B&T		T		B		M		RC	
	No.	m²	No.	m²	No.	m²	No.	m²	No.	m²	No.	m²
0–10	3	639.4	0	0.0	0	0.0	0	0.0	1	74.0	0	0.0
11–20	70	21182.6	8	2199.9	0	0.0	0	0.0	3	3621.2	2	5140.0
21–30	216	101108.5	68	12013.9	0	0.0	4	5208.1	28	19824.6	8	10988.1
31–40	89	44774.7	57	13056.8	1	73.0	8	1641.9	30	7912.0	2	6882.0
41–50	50	23702.7	37	12606.8	19	2276.0	17	4275.6	33	3616.4	1	229.0
51–60	16	6616.8	32	12000.8	25	6083.8	0	0.0	46	9092.7	0	0.0
above 60	0	0.0	7	1658.0	1	371.1	0	0.0	2	115.0	0	0.0
Total	444	198024.7	209	53536.2	46	8803.8	29	11125.7	143	44255.8	13	23239.1

grams, many buildings are demolished when they are still at a very young age. This demolition-dominant urban renewal practice has been a major contributor to resources waste and emission generation, which in turn results in environmental degradation.

4. DISCUSSIONS

Based on the data presented above, the following sections are focused on discussing three major issues, namely, reasons for building demolition, consequences of demolition works, and potential solutions to the paradoxical phenomenon.

4.1. Reasons for building demolition

Reasons for building demolition have been widely investigated by previous studies (such as Lin, 2010; O'Connor, 2004; Shen, 2008; Golton, 1997). There are various factors causing the short lifespan of buildings, such as functional obsolescence, physical dilapidation and value changes of the land where a concerned building is located. These factors are taken into account when a decision is made on building demolition in the process of urban renewal. According to a survey by the China Youth Daily (Wang, 2010a), 83.5% of the interviewees believed that major reasons leading to building demolition and short lifespan are associated with the decision-making and action of local governments. Regional governments in China are expected to achieve political performance, which is usually measured by Gross Domestic Products (GDP) growth and new construction areas. Urban renewal through means of building demolitions and new construction works appears to be the most effective way for local governments to increase the GDP. Other reasons resulting in building demolitions include poor building conditions due to poor construction quality, poor economic performance of buildings, and land appreciation due to changes in city planning (Wang, 2010a). These reasons are further discussed as follows.

(a) Poor building condition

Poor building condition is caused by various factors, typically including poor construction quality and buildings' physical depreciation. Previous studies revealed that during the period of 1980s-1990s, many buildings were poorly designed and constructed in China. As a result, many of them have to be simply demolished, though they could be renovated for adaptive reuse (Wang, 2010a).

On the other hand, building's depreciation also contributes to poor building condition. However, buildings' physical depreciation is not the overriding reason for demolition. It is appreciated that buildings are often demolished not because they are old or in a bad condition but because building owners want to demolish them (Shen, 2008). The data presented previously show that a considerable number of buildings were very 'young' when their lives ended, many less than 30 years of age.

(b) Poor economic performance

The urban renewal programs in China have been launched since early 1990s aiming at improving conditions of old and dilapidated housings, ameliorating people's living condition, and modernizing urban areas in cities. The consideration about the economic benefits from urban renewal programs is a main motivation for implementing the urban renewal programs.

Since implementation of the unprecedented urbanization programs in China in early 1990s, land value in the Chinese cities has increased at an astonishing speed. The average integrated land price at the national level increased from 993 CNY/m^2 in 2000 to 2882 CNY/m^2 in 2010 (1US$ = 6.3CNY), an increase of 190%. Regional governments normally use land transaction as the major approach to generate income and accomplish the economic growth (measured by GDP growth). Since demolishing existing buildings generates extra land space, it becomes an alternative strategy for regional governments to adopt in the process of urban renewal. In other words, main consideration is given to economic benefits in making decisions on whether demolition works should be taken or not, whilst less attention is paid to environmental and social implications associated with implementing those demolition works.

It is common that economic motivations overweight social and environmental interests in implementing urban renewal programs in China, and massive demolition and replacement activities are underpinned by economic aspiration. Previous studies appreciate that pursuing profits from developing real estate projects is a principal driving force behind urban renewal activities in China (Lu, 1997; Chau, 2008). Since the location of urban renewal areas often has great commercial value, the land concerned for urban renewal is important profit-making resource for real estate developers (Wang, 2010a). Developers are highly tempted to acquire such land resource and they therefore play an important role in driving urban renewal and building demolition. By claiming to support local governments to implement urban renewal programs and improve people's living condition, real estate developers often lobby related government officials for demolishing buildings and building as many as possible luxury apartments and commercial real estate in order to maximize profits (Zhang and Fang, 2004). Commonly the residents who lived in the demolished buildings cannot afford the new replacement buildings after the urban renewal programs. As a consequence, they have to move to some less developed areas. It is obvious that these residents' living conditions are negatively affected by the urban renewal programs. Thus, the urban renewal driven by economic motivation in China is to some extent at the expense of social benefits.

(c) Land appreciation due to changes in city planning

The practice of urban planning in China has been criticized for not responding to ongoing changes in the development of Chinese urban society (Leaf and Hou, 2006). Wang (2010a) opined that current city planning practice in China was less transparent, shortsighted and not performed from a strategic perspective. Many historic buildings with good cultural value are not given proper protection in building demolition. Many buildings are demolished at the young age, which occurs not because of the buildings' safety problems but mainly due to changes in the city planning. For instance, a residential region may be changed into a commercial region with a short-time notification from the local government, which leads to existing residential buildings in the region concerned to be demolished accordingly, in order to make way for development of commercial real estate (Shen, 2008).

Cases are frequently reported that grand new buildings were demolished because of changes in the land planning. The study by Shen (2008) showed that changes in the land planning have resulted in many short-lifespan buildings. An example was a 10-floor residential building located in the studied region, named Longsheng Building. The building was demolished in 2004 only after half a year of being completed. The reason for the demolition was reported as the change of the city planning, in which the site of the building was requisited for developing a new Yangtse River Bridge. The affected homeowners were shocked that their houses were to be demolished before they had moved in. They were reluctant to settle in another place even though they were given compensation by the local government. The conflict between the residents and the government presented a social consequence. Eventually the government spent a great deal of money to demolish the existing buildings and settle affected residents. In addition, a significant amount of construction waste was produced by the demolition.

4.2. Consequences of buildings' short lifespan

Buildings' short lifespan and demolition without distinction in China's urban renewal process induces various consequences such as loss of social and economic investment, environmental pollution, and loss of city characteristics. These problems have not been appreciated and addressed in the government's decision-making. An urban area is usually described as a system comprising subsystems of resources, environment, economy, and society. All these dimensions can be affected by implementing urban renewal programs. Therefore, the consequences of buildings' short lifespan in the urban renewal process are investigated from four aspects, which are energy and resources waste, environmental pollution, higher lifecycle cost, and social and cultural impacts.

(1) Energy and resources waste

Construction and operations of buildings are all energy-intensive activities. Existing buildings have embraced a great amount of embodied energy including initial embodied energy and recurring embodied energy. The initial embodied energy is consumed in the process of acquiring raw materials, processing and manufacturing materials, transporting materials to construction sites, and assembling on site. The recurring embodied energy is consumed to maintain the function of buildings through repairing, refurbishing or replacing materials/components during buildings' lifecycle. However, if buildings are demolished, most of the embodied energy would be wasted irreversibly in the form of solid or liquid waste. Extra embodied energy will be consumed when constructing new buildings. Previous studies found that embodied energy of a building generally accounts for 10–15% of the total energy used in its lifecycle, and this proportion will increase if the building's lifespan shortens (Thormark, 2002). This implies that buildings' short lifespan due to their premature demise can cause significant energy and materials waste. Therefore, the waste of embodied energy should be taken into consideration when assessing the feasibility of demolishing existing buildings. However, although 'energy saving and emission reduction' is advocated in the Chinese construction industry for years, main emphasis is largely placed on measures for energy saving in constructing new buildings. There seems a misconception that energy saving and green building are only effective and achievable in constructing new buildings.

(2) Environmental pollution

Construction waste is a major part of industrial waste. The waste generated from building demolition activities is much more than that from new building construction. In China's current practices, the demolition of a $10000m^2$ old building will create 7000–12000 tons construction waste. Thus the construction waste produced by the Gailanxi demolition program which has a total demolition area of $338,985.25m^2$ would be about 237,000–407,000 tons. Furthermore, the practice of sorting out demolished construction materials is not well developed in China. The mixed waste, which mainly contains concrete, masonry, timber, stone, lightweight materials, insulating materials and chemical materials, is usually disposed of at landfills. Consequently, handling demolition waste in landfills has consumed significant amount of land space.

Although various construction waste recycling techniques have been introduced to the Chinese construction sector, their application is limited (Liu et al., 2005). The illicit transaction of demolished construction materials are prevalent across the country. Waste materials from demolition are usually collected manually. The poor construction waste handling not only deepens environmental pollution, but also presents the danger of unhealthy and harmful substances to the safety of construction workers and nearby residents. There is a serious lack of regulations against this ruthless practice of handling construction waste by demolition.

Furthermore, building demolition activities in urban renewal areas generate various pollutants, such as noise, dust, greenhouse gas and sewage waste. It is commonly appreciated that these pollutants affect people's life and health. Many demolition works are undertaken around-the-clock (Lin, 2010). The residents around the sites normally live in very poor conditions. For example, they cannot open windows because of the dust generated from nearby demolition activities.

(3) Higher lifecycle cost

Buildings' lifecycle costs typically include land acquisition cost, material and construction costs, operation cost, repair and maintenance costs, and salvage (residual) value (Dong et al., 2005). It is evident that new building construction costs much more for land acquisition and material purchase than that required for refurbishing or renovating an existing building. Dong et al. (2005) further compared the lifecycle costs of building retrofit and replacement options, suggesting that over a 40-year lifecycle, the retrofit option has lower lifecycle costs than the option of demolition-and-rebuilding. This is echoed by other studies such as Kohler and Yang (2007). Therefore, the large-scale demolition and rebuilding activities in Chinese urban renewal has added a large amount of extra costs to buildings' lifecycle costs.

(4) Social and cultural impacts

Buildings do not only provide certain functions to meet people's basic living needs but also record people's living culture and its evolution over a particular period. For example, in China's capital of Beijing, people has used to live in quadrangle dwellings (SiHeYuan in Chinese) for several decades. The architectural feature of SiHeYuan has a history of more than 3000 years and represents Beijing people's traditional living custom. It has been an essential part of the social wealth in Beijing. Similarly, in the area under study, there are many buildings that possess social and cultural values. They were demolished and replaced by new and high-rising buildings, resulting in certain loss of social and cultural wealth.

Furthermore, demolition works involve complicated negotiation processes between residents affected, developer and the local government. The residents concerned usually receive much less compensation than what they expect or what they are told. Investigation of the urban renewal case in this study demonstrates that the residents affected are reluctant to rehabilitate. The conflicts between the residents, the developer and the local government occur as a result.

4.3. Paradoxical phenomenon

Urban renewal is unarguably needed, but the current urban renewal practice of demolishing-and-rebuilding is arguable. In line with its good intention, urban renewal is expected to contribute to the promotion of sustainable construction and sustainable development of society. Rothenberg (1965) opined that there are three major benefits from urban renewal. Firstly, from an individual resident's perspective, urban renewal will bring internalization of the externalities to a real estate building. The value of the internalized externalities is measured as an increase in the value of the land vacated from demolition between acquisition and resale. Secondly, spillover effects are generated on the values of the land adjacent to the renewal area, measured by the changes in land values. Thirdly, urban renewal contributes to reduction of slum-generated social costs, such as crime and disease. The benefit of the land value increase through urban renewal has been well appreciated by regional governments in China, which drives implementation of urban renewal across the country with a dramatic speed.

For the controversial part, the demolishing-and-rebuilding in large-scale has attracted wide attention. Langston et al. (2008) pointed out that energy efficient design should be associated with the specified purpose and reality, therefore focused on retrofit of existing buildings rather than demolition and new construction. Teo and Lin (2011) argued that urban renewal program consists of remedial responses to building deterioration and obsolescence. Thus, making decision on the level of adaptation for a given building is actually to choose an appropriate building adaptation action, other than the most extreme action such as demolishing or rebuilding.

According to the Chongqing government (Chongqing Government, 2008), urban renewal has contributed to mitigating the problem of housing shortage for low-income families, ameliorating people's living condition, upgrading the city image and driving the economic development in the city. In the Gailanxi renewal program under study, the use of land has been changed significantly, with obvious reduction in industrial area and increase in land used for residential and green space, commercial area, and infrastructure upgrade, such as road and bridge upgrades. These changes have significantly improved the sustainability of the city.

Nevertheless, the current urban renewal practices in China, exemplified by the Gailanxi case, also results in various problems such as high degree of buildings' short lifespan due to premature demise. This causes poor sustainability performance in urban areas. Therefore, both benefits and problems are resulted from urban renewal programs in China from the perspective of sustainable development. The two dimensional consequences are largely contradictory. This presents a paradox: the promotion of sustainable construction versus buildings' short lifespan. This paradox would continue if no proper actions are taken to address it. Suggestions are thus presented in the next section to mitigate this paradoxical phenomenon.

4.4. Solutions for mitigating the paradoxical phenomenon

There are different reasons leading to the paradox described above. Solutions for mitigating this paradoxical phenomenon are explored based on discussions of trade-off between economic benefits, environment protection and social benefits.

(1) Transparency in the decision-making regarding urban renewal

Before launching an urban renewal program, feasibility studies should be conducted in full consultation with residents that will be affected. The opinions and interests from all groups of communities should be taken into account, which can help minimize the social costs. In particular, feasibility study should be carried out from an integrative perspective of improving urban sustainability. Decisions on urban renewal could only be effective if the process of decision-making is transparent, which fully takes the public's opinions into consideration (Wang, 2010a). The decision-making associated with urban renewal program implementation in China's current practice are of very limited transparency. Experience from some developed countries suggests that regulations are in need to clearly specify how the public can participate in major decision-making regarding urban renewal and city planning programs. A stronger role for public participation and more involvement of non-governmental organizations and agencies in the decision-making can be placed, for instance, through the procedures of public hearing, seminars or public exhibitions (Stead et al., 2004). It is considered necessary for the Chinese government to introduce similar regulations to enable participation of the public in the decision-making about major urban renewal issues.

(2) Maintenance and utilization of existing buildings

In China the decision to demolish an existing building is usually made when the building dilapidates. Less attention is given to other solutions such as appropriate maintenance instead of direct demolition. In fact, adequate maintenance scheme can reduce building dilapidation thereby extending the lifespan. In this regard, the adoption of regular maintenance scheme to existing buildings is suggested as a solution to prolonging building lifespans. Yang and Kohler (2008) pointed out that building maintenance is given insufficient attention in China, where new building developments usually dominate.

Demolition is not the only option when a building is obsolete or in poor conditions. Comparison among demolition and other options has been extensively conducted previously (such as Dong et al., 2005; Itard and Klunder, 2007; Trusty and Meil, 2000). In many cases, demolition-and-rebuilding is much less cost effective than utilizing existing buildings through methods such as proper maintaining, refurbishing and adaptively reuse. For example, adaptive reuse is considered more effective compared with demolition. Increasingly, adaptive reuse of buildings has been promoted as an effective strategy for improving building sustainability (Bullen, 2007; Bullen and Love, 2010; Shen and Langston, 2010; Wilkinson et al., 2009). This strategy is regarded as effective in ameliorating the economical, environmental and social performance of buildings (Bullen, 2007; Langston et al., 2008). Bullen and Love (2010) introduced a building viability process model to guide decision-makers in making decisions on whether a building should be demolished-and-rebuilt or changed to other functions through proper refurbishment. Langston et al. (2008) proposed a method for assessing the potential of the adaptive reuse for buildings. These studies are effective guidelines for promoting maintenance and adaptive reuse of buildings.

(3) Recycling of construction waste

There is a large volume of construction waste generated in China's urban renewal. Recycling of construction waste has been considered as effective in reducing waste and mitigating its impacts on environment (Yuan and Shen, 2011). A study by Thormark (2002) suggested that recycling waste materials from demolished works has the potential of saving about 15% of the total energy used during an assumed building lifetime of 50 years. The benefits of recycling construction waste have been increasingly appreciated in recent years. However, the current construction waste recycling practice in the Chinese construction sector is far from effective (Lu and Yuan, 2011). A large proportion of construction waste is simply open piled, buried, and burned without any pretreatment (Yuan, 2011).

5. CONCLUSIONS

It is found from the present study that buildings' lifespan has been significantly reduced due to demolition works in China's urban renewal process. By referring to the urban renewal context of Chongqing city in western China, it shows that the average lifespan of residential buildings is only 36.3 years, which is far shorter than those in major European countries, ranging from 63.8 years to 132.6 years.

Ambitious urban renewal is implemented in China with the aim of improving people's living condition, upgrading the city image, inducing urban revitalization, and increasing land value. However, this urban renewal practice has resulted in many negative consequences from the perspective of sustainable development, such as buildings' short lifespan due to premature demise. The consequence is contrary to the intended objective of the urban renewal programs, which is to promote sustainability in cities. Buildings' short lifespan causes energy and materials waste, construction waste generation and environmental pollution, and increase buildings' overall lifecycle costs. This indicates that the current urban renewal practice in China is not in line with sustainable development principles. The consequence of the current urban renewal practice diverts from its expectation of contributing to urban sustainable development. A paradoxical phenomenon occurs accordingly: on one hand, urban renewal aims for promoting sustainability; but on the other hand, it results in significant buildings' short lifespan that affects the sustainability of the city.

The paradoxical phenomenon discussed in this study presents the urgent need for solutions to improve the urban renewal practice in China and make contributions to sustainable urban development. Opportunities exist for making the contributions if effective measures are taken. These solutions include establishing more transparent decision-making procedures, implementing regular building maintenance scheme, effective utilization of existing buildings and promoting construction waste recycling. Whilst the data used in this study are from a local region in China, the findings provide valuable references for other economies with similar urban renewal practices. More research work in the future could lead to comparative studies between different practices, thus good experience can be shared and promoted accordingly.

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