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Neighborhood Sustainability in Urban Renewal: An Assessment Framework

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ABSTRACT

It is widely accepted that urban renewal provides valuable opportunities for sustainable development. Sustainability assessment is regarded as a useful tool to ensure sustainable development in practice. Although a number of studies have been conducted to investigate the evaluation of urban renewal potential, studies on sustainability assessment in urban renewal at a neighborhood scale are often ignored. Urban renewal, however, is normally accompanied with many social, economic and environmental conflicts among various stakeholders. This paper proposes a framework for assessing neighborhood sustainability to support urban renewal decision-making in high density cities such as Hong Kong. This framework includes two components: (1) sustainability and building condition, and (2) a decision-making matrix for urban renewal strategies. A case study was conducted to illustrate how this framework can be applied in the decision-making process of urban renewal projects. The results are expected to provide references for urban renewal decision-making in high density cities.

Key words: decision-making, urban renewal, sustainability assessment, neighborhood

1. INTRODUCTION

A considerable amount of studies have been focusing on sustainable development in urban renewal (or urban regeneration) recently (e.g., Burrage, 2011; Chan & Lee, 2008; Evans & Jones, 2008; Hunt et al., 2008; Winston, 2009; Yung & Chan, 2012; Zheng et al., 2014). The two concepts, namely urban renewal and sustainable development, interact with each other closely. Urban renewal is a process of reusing resources and rebuilding urban environment. It has the potential of contributing to sustainable development if it follows sustainable approaches (Zheng et al., 2014). It is regarded as an effective approach to solving the urban decay problem,

increasing land values and enhancing environment (Adams and Hastings, 2001). Similarly, Lee and Chan (2008) argued that it can alleviate the urban decay problem and enhance different socioeconomic objectives. Though there is criticism on urban renewal practice, urban renewal projects could provide valuable opportunities for achieving sustainable development if they are delivered well. It is generally accepted that sustainable development should be integrated into urban regeneration or renewal, and be included in recent government agenda (Alker and McDonald, 2003).

The concept of sustainable development is favorable, but not always well applied in practice (Hunt et al., 2008). To better apply sustainability in urban renewal, it is necessary to assess whether development policy, decision and practice could promote sustainable urban renewal. From a policy perspective it is widely accepted that early, continuous and rigorous evaluation of regeneration activities is crucial because current programs can be enhanced or be terminated when a problem exists (Hemphill et al., 2004) . Identifying potential areas for urban renewal requires prior focus since it is an indispensable prerequisite for regional policies (Greig et al., 2010). The potential for those previously used sites needs to be evaluated on site-based factors and adapted to different contexts (Alker and McDonald, 2003). For example, in Hong Kong, the Dilapidation Index was developed to assess the building conditions, which reflects the need for renewal projects (Ho et al., 2011). In the UK, there is a national metric, the index of multiple deprivations, which serves for measuring the need for initiating regeneration activities (Greig et al., 2010).

However, most assessment tools tend to focus on the scale of the urban renewal project, rather than on a broader context. Research on urban neighborhoods, an intermediate scale, is often ignored (Blum, 2007; Hurley and Horne, 2006). ‘Neighborhood’ generally implies an area with some building blocks in a city (Sawicki and Flynn, 1996; Searfoss, 2011). Our cities are comprised of these neighborhoods or districts spatially (Rohe, 2009). If the components of a city are not sustainable, the city cannot realize overall sustainability (Choguill, 2008). A neighborhood is the frontline for promoting sustainable development (Choguill, 2008; Sharifi and Murayama, 2013), because activities of land development and building construction often take place at the neighborhood level (Sharifi and Murayama, 2013). Neighborhood planning, since its earliest theory of the Neighborhood Unit theory by Perry (1929), it has a great influence on planning theories and practice afterwards. Decision-making for neighborhood development is complex, involving various issues and stakeholders. It is directly related with residents in the community. Neighborhood Sustainability Assessment (NSA) tools are developed to improve decision-making for sustainable development (Sharifi and Murayama, 2013). There have been some NSA tools such as Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND) in the USA, the Australian Housing and Urban Research Institute (AHURI) indicators, and Green Mark for Districts in Singapore. But there is scant research on

sustainability assessment focusing on urban renewal neighborhoods or specifically serving for urban renewal strategies.

This research therefore aims at developing a systematic framework of neighborhood sustainability assessment to support urban renewal decision-making in high density cities. Literature review and expert interviews are applied to develop this framework. Since spatial considerations are to be included in the framework, spatial analysis in geographic information system (GIS) is used to facilitate spatial assessment. Hong Kong is selected as the case study area because of its unique characteristics. Firstly, Hong Kong, like many developed cities in Europe, has been facing urban decay problems in recent decades. There are approximately 4,000 buildings aged 50 years or above in Hong Kong. This figure will increase by 500 each year over the next decade (Development Bureau, 2011: 1). To solve urban problems in Hong Kong, urban renewal was proposed as a crucial policy agenda after the establishment of the Land Development Corporation (LDC), which was later replaced by the Urban Renewal Authority (URA). Criticism is given to both LDC and URA on their renewal projects. Specifically, criticism include profit-driven projects, destruction of local culture, negative influence on community network, and social exclusion. It is necessary to balance different voices by providing some quantitative references in the decision-making process. Secondly, decision-making for urban renewal projects takes place at the local level in Hong Kong, on which the proposed framework focuses. Thirdly, Hong Kong, with its feature of high density, experiences the phenomena of overcrowding, scarcity of serviced and buildable land, and intensification of land-use. It will probably walk in a direction that is not sustainable if it does not follow a proper path. Redevelopment, rehabilitation, revitalization and heritage conservation are adopted by URA as its core strategies to improve urban renewal (Development Bureau, 2011: 1-2). This assessment tool is not only to provide implication for the evaluation of current states, but also to evaluate the potential for implementing different strategies including redevelopment, rehabilitation, revitalization and conservation.

2. RELATED WORK

2.1 The Definition of Neighborhood

The terminology *neighborhood* is commonly used in different contexts especially in the field of urban studies though there is not a consensus on its definite meaning. Neighborhoods are places where people live and are also where urban residents are concerned with most because their daily life is largely influenced by what are and what happens in their neighborhoods (Rohe, 2009). Yet, a consensus on the definition of neighborhood has not been reached. Previous research provides some insights into its inherent characteristics. Mumford (1954) regarded a neighborhood as an essential component of urban life, where people are linked together and live interdependently. Four dimensions in the concept of neighborhood was summarized: “a

physical delimited area having an ecological position in a larger area and particular physical characteristics", "an area containing such facilities as shops, clubs, schools, houses, and transportation that may be used by those living in the area or by outsiders", "an area representing certain values both for the residents and for the larger community", "a field or cluster of forces working in and on an area to give it a special atmosphere."(Keller, 1968: p.91) In anther discussion, a neighborhood is "a bundle of spatially based attributes associated with clusters of residences, sometimes in conjunction with other land uses." (Galster, 2001: p.2112) Even though definitions of neighborhood hold various elements, delineated neighborhoods as communities are one of the most predominant meanings (Martin, 2003). Summarizing a shared understanding, a neighborhood could be qualitatively described as a geographically delineated subarea within city where residents share services, facilities or sometimes common interests. Simultaneously, a neighborhood is not a separated area in city, but is connected with other areas of city. The sizes of neighborhoods may be various due to different contexts and applications.

2.2 Sustainability Assessment at Different Scales in Urban Areas

Ever since the concept of sustainable development (SD) was given in the Brundtland report, it has increasingly become an important policy objective. Although consensus has not been reached on the definition of sustainable urban development, at least three dimensions (environmental, social and economic sustainability) can be regarded as the common principles. With its generous definition, urban sustainability must be discussed in terms of different contexts. Over the past few decades, numerous assessment tools at different scales have been developed to facilitate decision-making and improve the sustainable performance of urban environment and the elements within it.

Urban sustainability assessment

Urban sustainability assessment has become a significant research agenda resulting from a growing number of population moving to cities (Grimm et al., 2008). It is regarded not just as a technical approach to assessing the performance of sustainability, but also a helpful tool for mediating various stakeholders (Thomson et al., 2009). A comprehensive sustainability assessment of urban systems, particularly the one including social, institutional, and cultural aspects, is the research frontier of this field (Chester et al., 2012). Sustainability assessment methods range from single indicator (index) focusing on one particular aspect of sustainability, to more comprehensively composite indicators (Lin et al., 2010).

Human development index (HDI), index for sustainable economic welfare(ISEW), ecological footprint (EF) and environmental pressure indicators (EPI) are examples of single indicators (Nourry, 2008). Most case studies were conducted by integrating these indicators, like the human development index (HDI) and ecological footprint (EF). Lin et al. (2010) proposed a

method of sustainability assessment based on urban eco-efficiency and then applied this method to assess the urban sustainability of Xiamen city in China from 2000 to 2006. Browne et al. (2012) applied energy flow accounting, energy flow metabolism ratio analysis, and ecological foot-printing when measuring urban sustainability in an Irish city, comparing the effectiveness of using different methods to assess urban sustainability.

Most studies tend to use composite indicators. These holistic approaches can offer overall assessment (Lin et al., 2010), which better corresponds to the concept of sustainability. For example, an integrated urban sustainability indicator (USI) model was proposed to evaluate urban sustainability through a hierarchical indices system. The quantification of indicators requires both traditional statistical methods and geospatial techniques (Shen et al., 2013). By clustering indicators into Nature (N), Economy (E), Society (S) and Well-being (W), relating to the four points on a compass, the compass index of sustainability was developed for Orlando, Florida, to assess city sustainability (Atkisson and Lee Hatcher, 2001). In Taipei, Taiwan, an integrated index, including 51 sustainability indicators, was selected for determining city sustainability (Lee & Huang, 2007). By referring to urban sustainability index (USI) (Zhang, 2002), four medium-sized cities in China were assessed on their sustainability (Van Dijk and Zhang, 2005). These integrated models or frameworks focus on several aspects simultaneously, providing references for developing other urban sustainability assessment tools.

Neighborhood (or community) sustainability assessment

Neighborhood is recognized as the scale at which land development and construction of new buildings take place and a favorable point to build a sustainable community (Sharifi and Murayama, 2013). Compared with research on sustainability assessment at the city scale, fewer academic studies focus on neighborhood scale (Blum, 2007; Hurley and Horne, 2006), but some standard tools are developed. The Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND), Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), Building Research Establishment's Environmental Assessment Method (BREEAM), Building Environmental Quality for Sustainability through Time (BEQUEST) etc. are examples of well-known assessment tools for urban communities. These assessment tools were developed based on different contexts worldwide, and locality is regarded as a crucial aspect. Some researchers have examined these tools accordingly. Garde (2009) studied LEED-ND pilot projects to explore the extent of certain planning and design criteria being included and further evaluated the effectiveness of this tool in terms of enhancing sustainability. In a recent study by Haapio (2012), LEED-ND, BREEAM Communities, and CASBEE for Urban Development were examined in terms of their current situations. Two neighborhood assessment tools, Sustainable Community Rating Tool and Enviro-Development, were evaluated on their application for residential estate development (Hurley, 2009).

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Building sustainability assessment

For sustainability assessment applied to construction projects, a considerable amount of research focused on environmental building performance assessment (e.g., Crawley & Aho, 1999; Cole, 1998; Ding, 2008). Performance-based building assessment is an approach focusing on the outcomes (the 'end') (Bragança et al., 2010). The significance of sustainability in the context of building design and subsequent construction work can be reflected in environmental building assessment (Ding, 2008). Examples of methods of green building assessment include Leadership in Energy and Environmental Design (LEED) (US Green Building Council (USGBC), 2014), Green Building Tool (GBTool) (Cole and Larsson, 2002), and the Building Research Establishment Environmental Assessment Method (BREEAM) (Baldwin et al., 1998). These assessment methods tend to assess the building performance based on the performance standards and physical features of a building (Kaatz et al., 2006). What green building assessment methods offer cannot fully meet the requirements of sustainable construction (Kaatz et al., 2006). Sustainable construction requires that sustainability values can be reflected in decisions taken by stakeholders (Kaatz et al., 2006). Sustainable values can be better realized through a life-cycle process. Some building sustainability assessment methods based on processes in construction are consequently produced. Eco-Quantum (Netherlands), Eco-Effect (Sweden), ENVEST (U.K.), BEES (U.S.) and ATHENA (Canada) are examples of life-cycle assessment (LCA)-based tools (Bragança et al., 2010).

2.3 Evaluation of Urban Renewal/Regeneration

In recent years, assessing renewal/regeneration policy and practice has been the focus of numerous studies on urban renewal (e.g. Hemphill, et al., 2002; Hemphill et al., 2004; Langston et al., 2008; Hunt, et al., 2008). It is widely accepted that early, continuous and careful assessment of regeneration activities can promote existing programs and find problems in time (Hemphill et al., 2004).

Before initializing urban renewal practice, it is necessary to assess the potential of urban renewal. Langston et al. (2008) proposed the adaptive reuse potential (ARP) model by which the industry can identify existing buildings with high potential for adaptive reuse in the urban renewal decision-making of Hong Kong. The Dilapidation Index was developed to assess building conditions in Hong Kong in order to find problematic buildings for urban renewal decision-making. In the UK, the index of multiple deprivations, as a national approach, was developed to measure the need for regeneration. This index is comprised of seven categories, which are *income, employment, health and disability, education, skill and training, barriers to housing and services, crime,* and *living environment* (Greig et al., 2010).

Most research focuses on evaluating the impact of urban renewal practice as post-evaluation. Hemphill et al. (2004) developed an indicator-based method to examine the sustainability of

current urban regeneration practice, in which *economy and work, resource use, buildings and land use, transport and mobility,* and *community benefits* are taken into account. In terms of brownfield developments in England, a framework was proposed for evaluating sustainability of brownfield developments. This framework includes two parts: one is identifying involving stakeholders and another is focusing on sustainability objectives that stakeholders should try to reach (Williams and Dair, 2007). Some studies only investigate one aspect of sustainability. Glasson and Wood (2009) paid attention to social sustainability of urban regeneration projects in the UK by defining social sustainability and emphasizing the growing importance of social impact assessment. In another study on urban waterfront regeneration, four dimensions of social impact, including *resources and identity, social status, access and activities, and waterfront experience*, were employed to examine three cases in Helsinki (Sairinen and Kumpulainen, 2006).

3. THE PROPOSED FRAMEWORK

3.1 Methodology

This research is an empirical study for sustainability assessment of neighborhood in Hong Kong, which aims at providing references for land use decision-making of urban renewal. The proposed framework is developed based on several research methods, such as literature review, expert interview, and case study.

Literature review is employed to identify indicators of sustainability assessment and also facilitate proposing the decision-making framework. Through reviewing literature on neighborhood sustainability assessment and evaluation on urban renewal, a preliminary list of indicators were proposed. Tables 1 and 2 summarize important tools or studies on neighborhood sustainability assessment and urban renewal/regeneration evaluation. These tools and studies are the basis of indicator selection and categorization.

Expert interview is applied to enhance and adjust indicators of sustainability assessment, to determine calculation methods and thresholds of each indicator, and to improve the initial decision-making framework. Specifically, three face-to-face interviews were conducted. An interview includes two parts: one is adjusting the initial list of indictors, and another is open-ended questions with the purpose of improving the proposed framework. One interviewee has the experiences of working in a private real estate firm and subsequently in three departments in the Hong Kong SAR Government, including the Lands Department, the Housing Department and the Rating & Valuation Department, and then in universities. Another has the experiences of working as an assistant architect in two renowned architectural firms in Hong Kong, later as a research officer in a NGO for two years, and then as an assistant professor in a university. The third interviewee is the executive director (Planning, Design & Works) of Urban Renewal Authority.

Neighborhood size varies in different contexts. Based on literature mentioned above and local context, this research defines a neighborhood as a sub-area in Hong Kong with several blocks and different land use types where residents share services, facilities or sometimes common interests. To standardize it, tertiary planning units (TPUs), whose features are consistent with the definition given above, are chosen as the neighborhoods since these TPUs are applied by Planning Department of Hong Kong for planning purpose. There are 289 TPUs in the whole territory of Hong Kong. Therefore, case studies are used in this research. Nine TPUs in Kowloon District were selected for analysis. Real data of each neighborhood was used to implement every part in the framework. The details are given in section 4 (CASE STUDY).

Table 1 Summary of important neighborhood sustainability assessment tools

Theme	**Criteria**	**Neighborhood sustainability assessment**						
		LEED-ND	ECC	BREEAM Communities	CASBEE-UD	HQE^{2}R	Ecocity	SCR
Resources and environment	Water	Y	Y	Y	Y	Y	Y	Y
	Energy	Y	Y	Y	Y	Y	Y	Y
	Resources	Y	Y	Y	Y	Y	Y	Y
Social	Housing	Y	Y	Y	N	Y	Y	Y
	Inclusive communities	Y	Y	Y	N	Y	Y	Y
	Community well-being	Y	Y	Y	Y	Y	Y	Y
Economic	Employment, business, economy	Y	Y	Y	N	Y	Y	Y
Land use form	Mixed use	Y	Y	Y	N	Y	Y	Y
	Access, infrastructur	Y	Y	Y	Y	Y	Y	Y

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Note: LEED-ND, ECC, BREEAM Communities, CASBEE-UD, HOE^{2}R, Ecocity and SCR are major neighborhood sustainability assessment tools applied around the world or in different regions. Y means the specific tool applies to this criterion. N means the specific tool does not use this criterion.

Table 2 Summary of studies on urban renewal/regeneration evaluation

Urban renewal/regeneration evaluation		
Theme	**Tool/Method**	**Source**
Income, Employment, Health and disability, Education, Skill and training, Barriers to housing and services, Crime	Deprivation indices in regeneration	Greig et al. (2010)
Building conditions, Building management	The dilapidation index	Ho et al. (2012)
Water and soil resources, Site and architecture, Comfort and health, Land and landscape, Infrastructure, Building concept, Community, Viability, Safety, energy, Domestic water and waste, Operating costs	A multi-criteria approach to compare urban renewal scenarios for an existing neighborhood	Pérez and Rey (2013)
Economy & work, Resource use, Building & land use, Transport & mobility, Community benefits	An indicator-based approach to measuring sustainable urban regeneration performance;	Hemphill et al. (2004)
	An aggregated weighting system for evaluating sustainable urban regeneration	Hemphill et al. (2002)
Social (user comfort, form and space, access, amenity, inclusion), Economy (social benefits and cost, transport, employment, competition effects,	Sustainability indicators in decision-making processes for urban regeneration	Hunt et al. (2008)

viability), Environment (air quality, land use, water, ecology and cultural heritage, design and operation, transport), Natural resources (materials, water, energy, land utilization, waste hierarchy)	projects

3.2 Indicators of Sustainability Assessment

Based on literature on the sustainability assessment of neighborhood, studies on measurement of sustainable urban renewal performance, special considerations on urban renewal in Hong Kong and interview results, a general list of indicators is proposed to assess current condition of land use in neighborhood. These indicators are classified into five categories, which are social aspect, economy and work, resources and environment, land use form, and building condition. For the context of Hong Kong, 25 indicators were initially proposed. Another two indicators ("Density of Small business with local characteristics" and "The fragment level of property rights") were added by expert interviews. As a result of the limited space of this paper, the details of calculating indicators are not displayed. Table 3 gives the modified list of indicators for sustainability assessment and their calculation formulas.

Table 3 indicators of sustainability assessment for neighborhood in urban renewal

No	Category	Indicator	Measurement	Remarks
1 (S1)	Social aspect	Human density	Population/Area of the planning unit	
2 (S2)	Social aspect	Diversity of ages	$\frac{1}{cat}\sum_{i=1}^{cat}(1-\frac{n_{cat\_age\_i}}{n_{cat\_age\_i}^{obj}})^2$	cat means the number of age groups, $n_{cat\_age\_i}$ is the number of people belonging to age group of i category, $n_{cat\_age\_i}^{obj}$ refers to the objective number of people in age group of i category
3 (S3)	Social aspect	Residential floor area	Residential floor	

		per capita	area/Population	
4 (S4)	Social aspect	Diversity of public transport	$\frac{1}{cat}\sum_{i=1}^{cat}(1-\frac{n_{cat\_trans\_i}}{n_{cat\_trans\_i}^{obj}})^2$	cat refers to the number of public transport types, $n_{cat\_trans\_i}$ is the number of transportation points (stops/stations) in type i, $n_{cat\_trans\_i}^{obj}$ is the objective number of transportation points in type i.
5 (S5)	Social aspect	Diversity of facilities	$\frac{1}{cat}\sum_{i=1}^{cat}(1-\frac{n_{cat\_faci\_i}}{n_{cat\_faci\_i}^{obj}})^2$	cat means the number of facility types, $n_{cat\_faci\_i}$ is the number of facility i, $n_{cat\_faci\_i}^{obj}$ is the objective number of facility i.
6 (E1)	Economy and work	Labor force participation rate	Labor force participation rate	Data can be obtained directly from statistics
7 (E2)	Economy and work	Disposable income per capita	Disposable income per capita	Data can be obtained directly from statistics
8 (E3)	Economy and work	Diversity of business activities	$\frac{1}{cat}\sum_{i=1}^{cat}(1-\frac{n_{cat\_busi\_i}}{n_{cat\_busi\_i}^{obj}})^2$	cat means the number of different business groups, $n_{cat\_busi\_i}$ is the number of people belonging to business category i, $n_{cat\_busi\_i}^{obj}$ refers to the objective number of people in business category i

9 (E4)	Economy and work	Density of Small businesses with local characteristics	The trade of small business with local characteristics/the area of planning unit	NA
10 (R1)	Resources and environment	Waste generation	Total waste generation/population	
11 (R2)	Resources and environment	Waste recycling	Number of waste recycling facilities/area the planning unit	
12 (R3)	Resources and environment	Electricity consumption	Total electricity consumption/population	NA
13 (R4)	Resources and environment	Air quality	Air quality index	NA
14 (R5)	Resources and environment	Water consumption	Total water consumption/population	NA
15 (L1)	Land use form	Land use mix	$-\sum_{i=1}^{n} l_i \ln l_i \big/ \ln n$	l_i is the area of land use type i, n means the number of land use types.
16 (L2)	Land use form	Accessibility to cultural facilities	Number of cultural facilities within 300 meters	Spatial analysis in GIS
17 (L3)	Land use form	Accessibility to education services	Number of education facilities within 300 meters	Spatial analysis in GIS
18 (L4)	Land use form	Accessibility to health care services	Number of health care facilities within 300 meters	Spatial analysis in GIS
19 (L5)	Land use form	Accessibility	Number of sport and	Spatial analysis in GIS

		to sport and leisure facilities	leisure facilities within 300 meters	
20 (L6)	Land use form	Accessibility to other facilities	Number of other facilities within 300 meters	Spatial analysis in GIS
21 (L7)	Land use form	Accessibility to public transport	Number of public transport points within 300 meters	Spatial analysis in GIS
22 (L8)	Land use form	Open space coverage ratio	Area of open space/Area of the planning unit	Spatial analysis in GIS
23 (B1)	Building condition	Average building age	$\sum_i^n age_i / n$	
24 (B2)	Building condition	Number of buildings aged above 50 years	Number of buildings aged above 50 years	Data can be obtained directly from statistics
25 (B3)	Building condition	Building maintenance	Number of building repair cases/Number of buildings aged above 50 years	
26 (B4)	Building condition	Building density	Floor area/Area of the planning unit	
27 (B5)	Building condition	The fragment level of property rights	The fragment level of property rights	NA

Note: NA means the data is not available at the study scale. Values of some indicators can be obtained directly from statistics or some data sources, and they are noted as “Data can be

obtained directly from statistics".

3.3 Decision-making Framework

The proposed decision-making framework includes two components. The first component is sustainability values of different neighborhoods and scores of their building conditions respectively. The second one is comparing different neighborhoods in the decision-making matrix with four quadrants, which indicate different strategies for urban renewal.

(1) Sustainability value calculation and building condition measurement

Each indicator has its unique calculation method. After calculating values for indicators, the initial evaluation results of indicators are obtained by using different units and cannot be compared directly, thus requiring standardization. Considering the positive and negative effects of various indicators on overall sustainability value, two equations were applied (Pirrone et al., 2005; Wang et al., 2010).

Positive indicator: $y_{ij} = (x_{ij} - \min x_{ij}) / (\max x_{ij} - \min x_{ij})\ (1 \le i \le m, 1 \le j \le n)$ (1)

Negative indicator: $y_{ij} = (\max x_{ij} - x_{ij}) / (\max x_{ij} - \min x_{ij})\ (1 \le i \le m, 1 \le j \le n)$ (2)

After standardizing values of each indicator, the overall points scoring introduced by Balaban (2013) is applied to calculate the overall sustainability value. The overall points scoring summary is shown in table 4.

Table 4 Overall points scoring

No	Performance categories	Number of indicators	Maximum possible total score
1	Social aspects	5	5
2	Economy and work	4	4
3	Resources and environment	5	5
4	Land use form	8	8
5	Building condition	5	5

Note: this table is adapted from the overall evaluation method by Balaban (2013)

By using this scoring system, the overall sustainability values of each neighborhood are

calculated by summarizing scores of category 1, 2, 3 and 4. The values of building condition are measured independently.

(2) The decision-making matrix

Based on sustainability values and values of building conditions for each neighborhood, the decision-making quadrant is drawn to facilitate decision-making. When both sustainability and building condition have high values, the neighborhood is suggested to be conserved. Conversely, when both of them have low values, it is better to carry out redevelopment projects. When sustainability value is high and building condition value is low, a rehabilitation approach is favored. If sustainability value is low and building condition value is high, revitalizing the neighborhood is strongly recommended.

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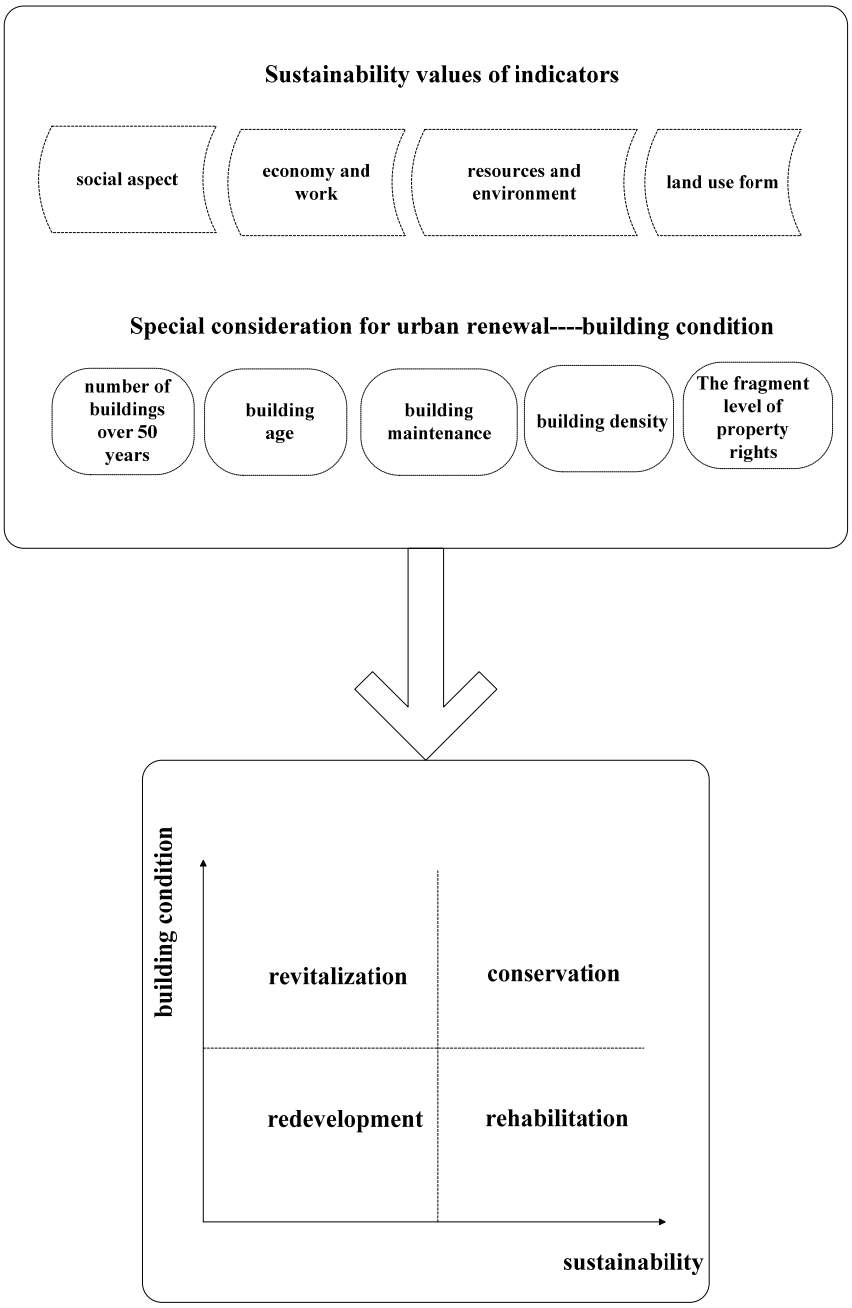

Figure 1 The framework of sustainability assessment for urban renewal decision-making

4. CASE STUDY

4.1 Study Area and Data Preparation

Hong Kong has a population of about 7.2 million and a land are of 1104 km^2. It is one of the world's most densely populated metropolises with only 25% of the land in Hong Kong suitable for urban development. There are three regions including Hong Kong Island, Kowloon and the New Territories. It is always facing issues including land supply shortage, urban decay and

unpleasant living environment. In terms of urban decay issue, there are approximately 4,000 buildings aged 50 years or above in Hong Kong. This figure will increase by 500 each year over the next decade (Development Bureau, 2011: 1). To solve urban problems in Hong Kong, urban renewal was proposed as a crucial policy agenda since the establishment of the Land Development Corporation (LDC), which was later replaced by the Urban Renewal Authority (URA).

Nine tertiary planning units (TPUs)[1] are selected as the case study to employ the proposed framework (See figure 2). Nine TPUs are located in Kowloon, one developed area in Hong Kong with a serious urban decay problem. Five TPUs (2.1.4, 2.2.1, 2.2.5, 2.2.7, 2.2.9) belong to Yau Tsim Mong District where many commercial activities are involved, whist another four TPUs (2.4.1, 2.4.2, 2.4.4, 2.8.5) are located in Kowloon City in which residential buildings are concentrated.

A database for this research is prepared, in which both spatial and non-spatial data are included. Spatial data is comprised of land utilization map, road network map, location map of public facilities, and distribution map of buildings. Non-spatial data covers information of environment and resources and social aspect for nine TPUs. The data is from different governmental departments, thus an integration process in the database is necessary before assessment. In the stage of spatial data processing, the land utilization map was digitalized. The road network and location of facilities were extracted from Hong Kong digital topographic map. Building information was extracted from a building information map. Information of building repairs was manually processed in space, based on addresses of buildings and their spatial orientations.

[1] The territory of Hong Kong is separated into 289 tertiary planning units (TPUs) by the Planning Department for town planning purpose.

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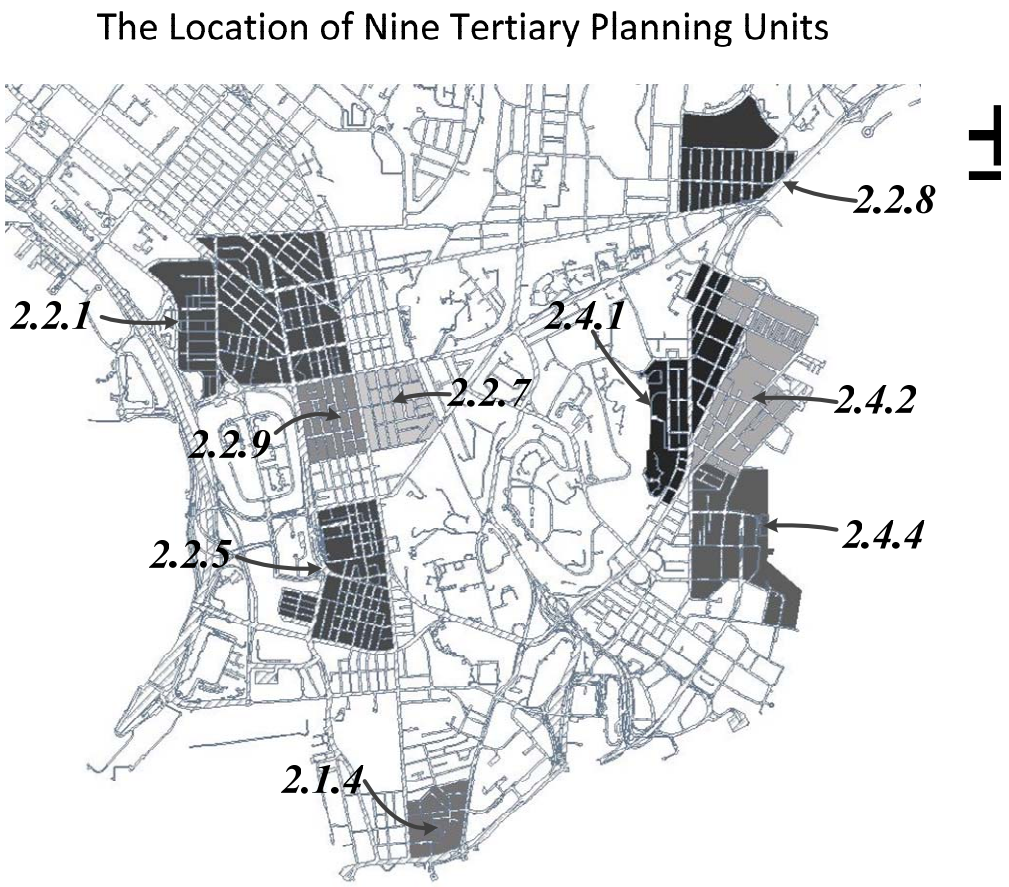

Note: nine tertiary planning units are 2.1.4, 2.2.1, 2.2.5, 2.2.7, 2.2.9, 2.4.1, 2.4.2, 2.4.4 and 2.8.5.

Figure 2 The location of nine tertiary planning units in Kowloon District

Table 5 Data preparation

Information	Raw Data	Source
Land utilization	Hong Kong land utilization map	Planning department
Road network	Hong Kong digital topographic map (1:5000)	Lands department
Location map of public facilities (e.g. hospitals, schools, parks)	Hong Kong digital topographic map (1:5000)	Lands department

Basic information of buildings (e.g. building age, building name, floor)	Building information map	Building department
Building repairs	List of buildings being repaired	Hong Kong Housing society
Information about environment and resources	Statistics and governmental documents	Environmental protection department
Information about social aspects	Statistics and governmental reports	Census and statistics department

4.2 Findings and Discussions

Among 27 indicators, density of small businesses with local characteristics, electricity consumption, air quality, water consumption and the fragment level of property rights are not included for the final results, due to data limitation at the neighborhood scale. For the value of "Social aspect", TPU of 2.2.1 has the best performance while TPU of 2.1.4 has the worst performance. TPU of 2.1.4 has the highest score while TPU of 2.2.9 gets the lowest score for the value of "Economy and work". In terms of "Environment and resources", TPU of 2.2.7 performs best and TPU of 2.1.4 performs worst. As for value of "Land use form", TPU of 2.8.5 gets the highest score. Sustainability value is calculated based on the four categories mentioned above. TPU of 2.2.9 is assessed to be the most sustainable unit while TPU of 2.4.1 is the most unsustainable. Focusing on "Building condition" of different TPUs, TPU of 2.1.4 has the best condition and TPU of 2.8.5 experiences the worst condition.

Figure 3 show the final scores of each planning unit on different categories (social aspect, economy and work, environment and resources, land use form and building condition) by calculating indicators of each category respectively. The purpose of drawing radar figures is to provide decision-makers with more direct results. One the one hand, it clearly compares different TPUs in terms of their performance on a specific category (e.g. Land use form). For example, practitioners can easily capture the information that TPU of 2.1.4 performs best in "Economy and work" from radar figure. On the other hand, practitioners can easily compare the performance of each TPU on the values of different categories. Taking TPU of 2.1.4 as the example, it is obvious that its scores on social aspect as well as environment and resources are very low, while its performance on economy and work is satisfactory, which further indicates the unbalanced development of this neighborhood. By referring to the assessment results, the following information can be extracted for further discussion.

4.2.1 Current issues of TPUs

Some dilemma may exist if we only refer to the final sustainability scores of different planning units, because scores of various indicators can be replaceable. Thus, when referring to assessment results, different aspects must be further compared (see Table 4). For example, TPU of 2.2.9 has the highest score of sustainability. However, the score for its economy and work is the lowest, which provides a reminder for decision-makers to further focus on the issues in this TPU. Referring to the specific scores of each indicator in this category, both disposable income per capita and labor force participation rate have low scores, to which more attention should be drawn.

From the assessment results, issues of each TPU can be found, which can serve as the references for policy makers for the specific unit. Indication can be obtained that there is a certain problem existing, or there are some for each TPU based on the fact that no TPU is in the conservation quadrant. Taking 2.4.1 (the most unsustainable TPU) as an example, it has low values of land use form as well as economy and work. Specifically, the land use form is comparatively simple and residential land use accounts for most areas. For residents living there, they must move to other neighborhoods in order to carry out other activities such as shopping, entertainment, etc. Its diversities of public transport and facilities also present low level performance. Its performance on the accessibility to public transport and other facilities also ranks behind most TPUs, which reminds decision-makers that they need to increase the provision of certain facilities and public transportation points within or near this neighborhood. This area has a low value of diversity of business incomes whilst the level of disposable income per capita is not high, which indicates that it may have a segregation problem with only one income group.

4.2.2 Priority of strategies

Based on the decision-making matrix, no TPU can be categorized into conservation quadrant. TPUs of 2.1.4, 2.2.1 and 2.2.7 are suggested to carry out the revitalization strategy since their sustainability values are comparatively low. TPUs of 2.2.9 and 2.4.4 have the priority of trying the rehabilitation strategy. The rest of the TPUs belong to the redevelopment quadrant. When allocating redevelopment projects, these TPUs could be considered first.

From the decision-making matrix, relevant strategies can be identified for each TPU. For TPUs in the revitalization quadrant, they have comparatively good building conditions. Therefore, initiatives of enhancing the whole neighborhood are recommended by referring to its specific problems. The methods may include upgrading facilities, improving green environment, and enhancing social integration through some community activities. As for TPUs in the rehabilitation quadrant, the whole neighborhood faces a severe problem with building condition. Decision-makers can investigate detailed problems of buildings in the neighborhood. Repairing dilapidated buildings and upgrading building facilities can address the decay problem.

Zheng H.W., Shen G.Q., Song Y., Sun B.X., & Hong J.K. (2017). Neighbourhood Sustainability in Urban Renewal: An Assessment Framework. Environment and Planning B-Planning & Design, 44(5), 903-924, DOI: 10.1177/0265813516655547, June. (SCI, IF=1.65).

Compared with redevelopment, rehabilitation can save economic costs and reduce the impact on environment and residents. Most TPUs belong to the redevelopment quadrant, which implies that redevelopment may be the most appropriate method for long-term development. Comprehensive redevelopment[2] is suggested, because it can address both the problem of building decay and enhancing sustainable performance of the neighborhood by considering every aspect of sustainability. The redevelopment process involves complex aspects and stakeholders. The results here only serve as references for decision-makers. Decision-makers need to consider other factors, such as the feasibility of finance, compensation and resettlement of residents, etc.

[2] Comprehensive redevelopment represents that a redevelopment project includes various land use types, whilst providing facilities and upgrading the surrounding environment are involved in this process.

Zheng H.W., Shen G.Q., Song Y., Sun B.X., & Hong J.K. (2017). Neighbourhood Sustainability in Urban Renewal: An Assessment Framework. Environment and Planning B-Planning & Design, 44(5), 903-924, DOI: 10.1177/0265813516655547, June. (SCI, IF=1.65).

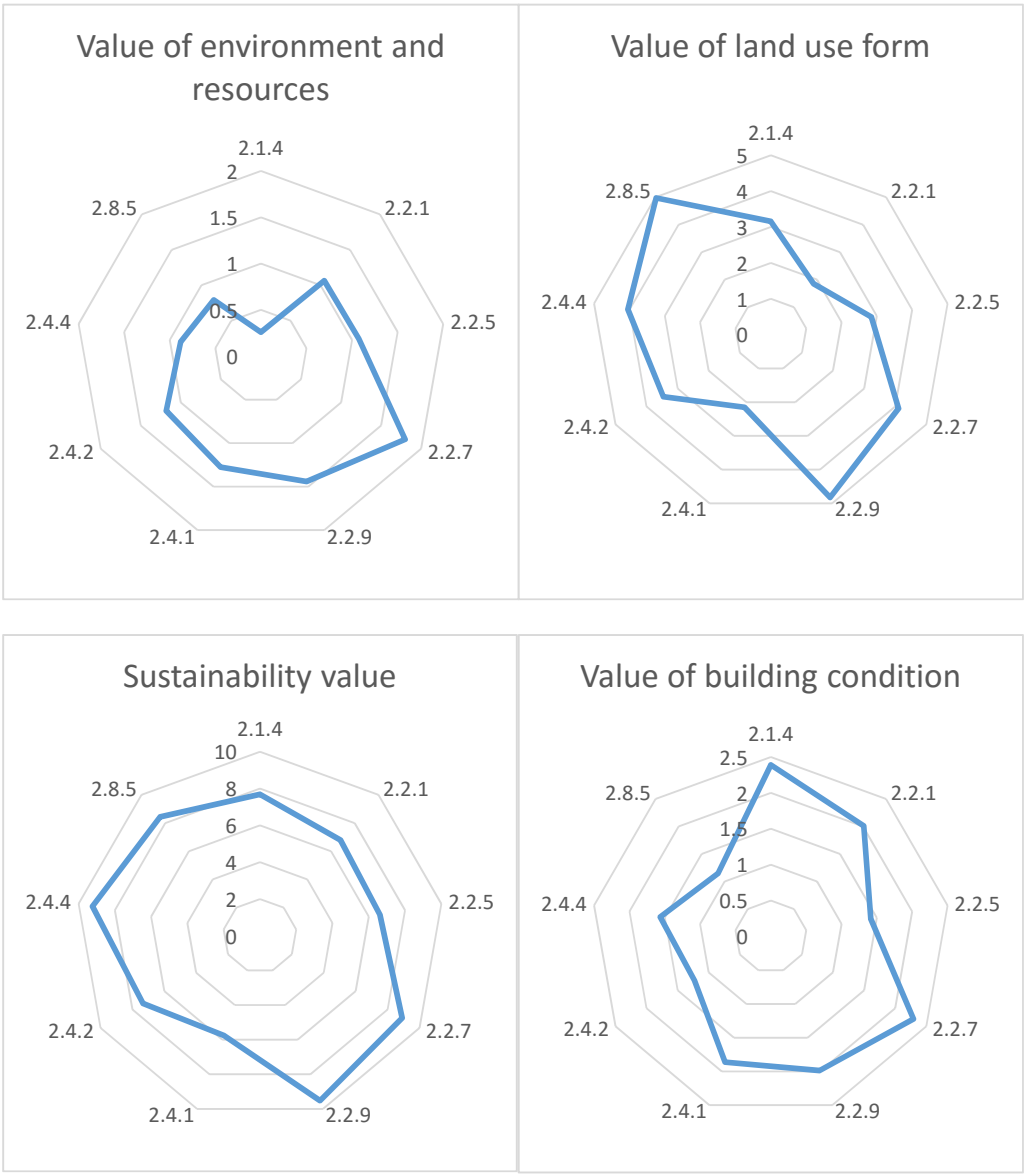

Figure 3 Values of different categories and sustainability value

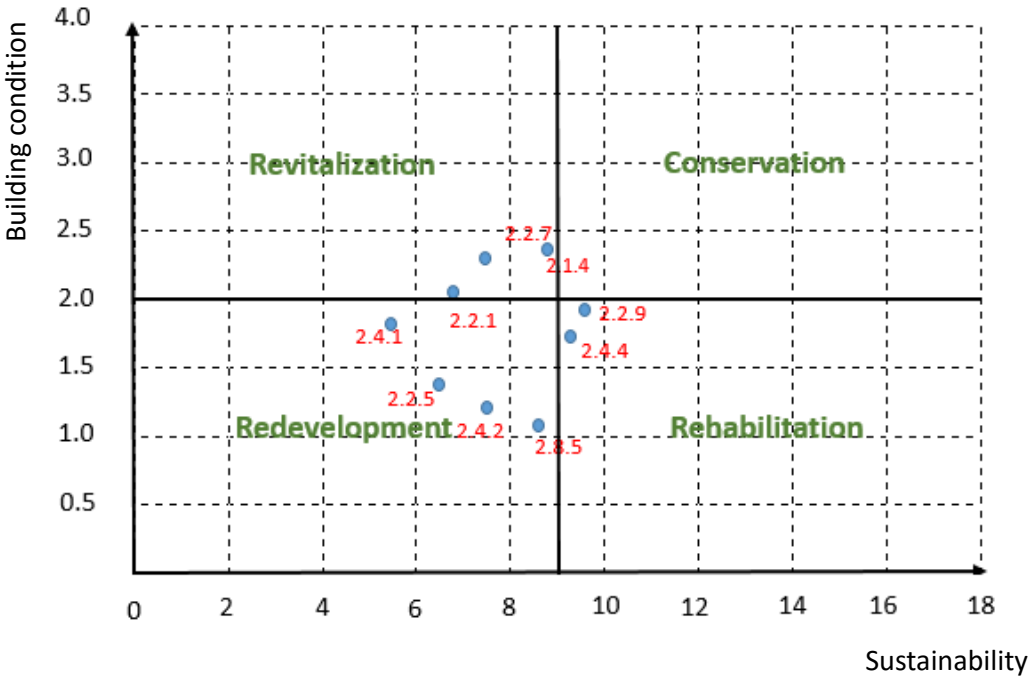

Figure 4 Results of the decision-making matrix

4.2.3 Validation of the Proposed Strategies

The Urban Renewal Strategy (URS) is a governmental stategy by Hong Kong Development Bureau, which suggests a comprehensive and holistic approach through redvelopment, rehabilitation, revitalization and heritage preservation. In our matrix, redevelopment, rehabilitation and revitalizaiton have been included, which further justify the practical advantages of applying the proposed framework.

A comparison between current urban renewal projects initiated by the Urban Renewal Authority (URA)[3] and the proposed strategies can facilitate validating the proposed framework. Table 7 summarizes the urban redevelopment projects and revitalization projects initiated by URA in recent years. Figure 5 shows the boundary of rehabilitation activities by URA. Comparing the proposed strategies with projects by URA, the proposed strategies are mostly consistent with those proposed or developed by URA. For example, the results of assessment suggest redevelopment projects in TPUs of 2.2.5, 2.4.1, 2.4.2 and 2.8.5. URA has already carried out several projects in TPUs of 2.2.5, 2.4.1 and 2.4.2. However, the total GFA of these projects is comparatively small, indicating that more redevelopment projects being required. Assessment results also suggest revitalization projects in TPUs of 2.1.4, 2.2.1 and 2.2.7, whist the revitalization projects by URA have been initiated in TPUs of 2.2.1 and 2.2.7. From the

[3] URA, established in 2001, is an institution to adopt “Redevelopment” and “Rehabilitation” as its core business under the URS.

boundary of rehabilitation activities by URA, most selected TPUs are included. The comparison demonstrates the reliability of the proposed framework to support urban renewal decision-making.

Table 7 Urban redevelopment projects and revitalization projects by URA

Planning Unit	Number of redevelopment projects	Total GFA of redevelopment projects (m^2)	Revitalization projects
2.1.4	1	102625	N
2.2.1	9	122773	Y
2.2.5	1	32012	N
2.2.7	2	46952	Y
2.2.9	2	179933	N
2.4.1	3	27261	N
2.4.2	3	29695	N
2.4.4	2	28666	N
2.8.5	0	0	N

Note: The data is summarized through the information posted in official website of URA. Y means there is a revitalization project in the TPU, N means there is no revitalization project in the TPU.

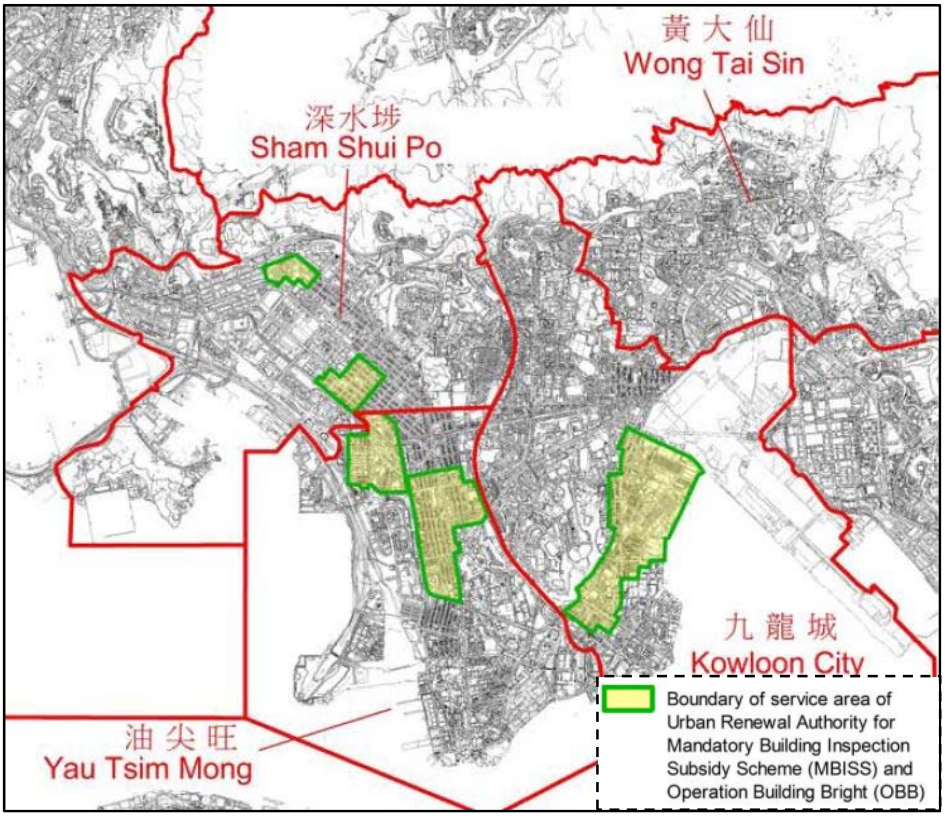

Figure 5 URA building rehabilitation scheme area (adapted from the open information of official website of URA)

5. CONCLUSIONS

Urban renewal provides valuable opportunities for achieving sustainable development. It is accepted that evaluation on urban renewal is necessary for decision-making. Current research rarely touches the neighborhood scale of urban renewal assessment. Considering various stakeholders and problems that have emerged in urban renewal of high density cities such as Hong Kong, this research, therefore with the focus on neighborhood scale, developed a systematic framework of sustainability assessment to support urban renewal decision-making. This framework is mainly comprised of two components. The first component is sustainability values and building condition scores of different neighborhoods. The second component is a decision-making matrix for potential strategies. The proposed framework is a pilot study on sustainability assessment serving urban renewal decision-making at neighborhood scale. It otherwise takes four approaches in urban renewal/regeneration into consideration through a decision matrix, which is a new idea for urban renewal decision-making. The selected indicators for sustainability assessment can be regarded as references for practice whilst they can contribute to theoretical development in sustainability assessment at neighborhood for urban renewal. The indicators and matrix in this framework are not fixed. To better apply it into practice, the conditions of specific contexts must be taken into account. Decision-making is a

complicated process, the proposed assessment framework is not to propose the final strategies for urban renewal, but to provide decision-makers with some more objective references. Their final decisions require consideration of other factors such as those that cannot be quantified.

To further improve this research, it is favorable to develop weights for different indicators based on the context of Hong Kong. Weights can be developed through many methods such as analytic hierarchy process (AHP), analytic network process (ANP), etc. In terms of the data limitation for certain indicators, it is suggested to explore alternatives to include these indicators in the decision-making process. Although validation of the proposed framework has been conducted by comparing existing urban renewal strategies by URA of Hong Kong and the proposed strategies based on assessment results, it would be further improved through focus group meetings or expert interviews. Another validation approach is to conduct more case studies in other TPUs and to compare the results with intergovernmental organization policies.

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