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DFAHP MULTICRITERIA RISK ASSESSMENT MODEL FOR REDEVELOPING DERELICT PUBLIC BUILDINGS

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ABSTRACT. Reusing abandoned public buildings is a positive strategy in sustainable urban development. An appropriate assessment method is needed to reduce the risks of redeveloping derelict public properties. The Delphi method is an optimal group decision-making technique; whereas the analytical hierarchy process (AHP) method is useful for solving multicriteria decision-making problems. In addition, fuzzy logic manages artificial uncertainty and ambiguity, where an explicit number or ratio can express the level of preference. This study uses the Delphi method, fuzzy logic, and AHP (DFAHP) as a risk assessment model to redevelop derelict public buildings. The DFAHP provides an objective reference for investment decisions and is beneficial in reducing the risk of the public sector investing in the reuse of abandoned public buildings, in aiding in reuse cases that revitalize urban economic development, and in appreciating the value of sustainable city development.

KEYWORDS: Derelict public buildings; Sustainable urban development; Delphi method; Fuzzy logic; AHP; Assessment model

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1. INTRODUCTION

Sustainable development is one goal of many redevelopment projects intending to improve older urban spaces (Dale and Newman, 2009). Redeveloping derelict public buildings in urban areas has been a crucial focus of such development. In general, derelict public buildings are either obsolete or unusable and severely affect the appearance of cities. Building demolition projects must consider the economy, culture, alternative usage, urban development, and environmental influences, such as the treatment and management of building pollution (Begum et al., 2009), environmental pollution and damage (Cheng et al., 2006; Moodley et al., 2008), and resource use and pollution control (Briassoulis, 2001). According to Ding (2008), construction may cause environmental problems ranging from excessive consumption of global resources, both in terms of construction and building operations, to the pollution of the surrounding environment. From an environmental perspective, demolishing such buildings is not the best option. Rossi (2003) claimed that reconfiguring existing buildings for entirely new functions and benefits has many positive outcomes.

Among 309 townships in Taiwan, approximately 230 new construction sites may be derelict public buildings. Of these, 119 new construction sites are closed and unused, with 28 failed development projects. Consequently, 147 new construction sites qualify as derelict public buildings. The total construction cost is approximately NTD 47.4 billion (Yao, 2010). According to Taipei County's *Government Ethics Monthly* issued in May 2006, reasons for the disuse of public buildings include failure to pre-assess the use rate, inadequate planning and design, lack of funds for follow-up execution or repair, remote location of facilities, and failure to meet public needs (Taipei County Government, 2006). These buildings waste public resources; they also cause environmental pollution and seriously compromise security. When professional decision-making groups consistently repeat similar mistakes, the construction industry develops a poor ethical reputation in the public eye. It is also generally accepted that the construction industry leads to immoral behavior in society, by engaging in fraud and bribery (Moodley et al., 2008). Before approving public building projects, professional governmental departments, politicians, engineers, and scholars from professional fields must review them. Theoretically, the number of derelict public buildings should be minimal.

Such a serious circumstance demonstrates the lack of an effective risk assessment model during decision-making processes (Hsueh et al., 2007) and indicates substantial professional and ethical defects during the overall review process. When people further obtain ethics-related knowledge, they uphold an ethical attitude (Hungerford and Volk, 1989) and are thus willing to exhibit positive ethical behavior (Glazer and Glazer, 1989). As long as professionals strongly believe in and insist on professional values and emphasize the importance of expertise during implementation, people with more knowledge or who exhibit an aggressive attitude are responsible for their behavior (Hines et al., 1987).

Planning and assessing the development of derelict public buildings is difficult because renewal analysis of such buildings is a complex process (Antucheviciene and Zavadskas, 2008). Pre-assessing risk is highly critical; moreover, risk analysis and management should permeate the entire spectrum of project activities (Jaafari, 2001). Varying concerns among people of different positions cause problems in reuse selection. Solving such problems necessitates an effective knowledge communication tool that enables decision-makers to understand more clearly the complex relationships of the relevant attributes in reuse selection problems. This may subsequently improve the final decision (Wang and Zeng, 2010).

Numerous implemented redevelopment policies have often been ineffective (Kim et al., 2004), because of the difficulty of harmonizing everyone's opinions, the majority of problems addressed by urban renewal (Lee and Chan, 2008), neighborhood renewal (Fung and Yau, 2009), or the development of abandoned public buildings are complex. Additionally, in the urban regeneration process, city planning is an extremely difficult problem (Yau and Chan, 2008). Accordingly, the interests of numerous people are addressed. By contrast, the redevelopment of derelict public buildings is a case of single, independent architectural space or single, independent construction, with limited influence on private interests. In addition, the decision-making teams for the redevelopment of derelict public buildings are typically temporary and infrequently make optimal decisions during the assessment process.

This study combines Delphi's group decision-making technique (Murry Jr. and Hammons, 1995; Ziglio and Adler, 1996) with a fuzzy logic technique for processing quantitative values (Zadeh, 1983; Perng et al., 2005) as well as an AHP multicriteria decision-making technique (Saaty, 1980; Saaty and Takizawa, 1986) to develop a DFAHP (Delphi-Fuzzy-AHP) risk assessment model for redeveloping derelict public buildings. The DFAHP model has the implicit co-research characteristics of Delphi experts and can increase the reliability of the model. Additionally, the DFAHP model includes multicriteria quantitative processing functions, as well as fuzzy inference functions, and is an artificial intelligence model. Although the single AHP analysis method also has quantitative decision-making functions, it lacks inference functions and quantitative functions for processing natural human language. Related studies on applying the DFAHP method include Chen and Wang (2010), who suggested developing global business intelligence.

2. MODEL OVERVIEW

The U.S. RAND Corporation developed the Delphi method as a tool for assisting management in predicting the future; however, it is not restricted to this application (Ziglio and Adler, 1996). Obtaining the latest professional knowledge from expert groups (Hsueh and Yan, 2011) is the best method for increasing research reliability.

Zadeh (1965, 1987, 1988) proposed fuzzy theory as a concept based on set theory. Fuzzy logic can accept the ambiguous information of human natural language, such as uncertainty, complexity, and the tolerance of imprecision (Zadeh, 1976, 1996). Fuzzy set theory applies to a wide range of domains where information is incomplete or imprecise, such as the good, bad, like, dislike, in natural language. Moreover, membership functions help quantify the meaning of linguistic values, denoting the degree of membership of an element in a given set with values between 0 and 1 (Bingul et al., 2000). Various fields have successfully and comprehensively applied fuzzy logic theory. Previous studies have used it to investigate decision-making and evaluate new technology in the construction industry (Chao and Skibniewski, 1998), by selecting an architecture-engineering team (Nguyen et al., 2008), selecting the most efficient maintenance approach (Al-Najjar and Alsyouf, 2003; Mechefske and Wang, 2003; Tahir et al., 2008), and evaluating industrial robotic systems (Kahraman et al., 2007). Fuzzy logic theory is suitable for assessing complicated and hard-to-quantify decision-making problems (Hsueh and Yan, 2011), especially those that involve group decision-making (Hadi-Vencheh and Mokhtarian, 2011; Li and Yang, 2004; Li, 2010; Chen and Lee, 2010; Chen and Niou, 2011).

Saaty was the first to propose AHP, which is currently and widely used in social policy and engineering decision-making (Saaty, 1980, 1990, 1994). Using AHP is considered suitable for solving complex multiobjective decision-making problems with multifactor conditions (Lee and Kim, 2000). Using AHP can investigate multi-criteria decision-making research concerns in the construction industry, such as managing projects (A1-Harbi A1-Subhi, 2001), selecting contractors (Fong and Choi, 2000), evaluating advanced construction technology (Skibniewski and Chao, 1992), and estimating and choosing building investments (Dziadosz, 2008).

Combining the Delphi method, fuzzy theory, and AHP is successful in investigating relevant research concerns, such as performing fuzzy hierarchical analysis (Buckley, 1985), selecting optimum maintenance strategies (Wang et al., 2007), selecting suitable bridge construction methods (Pan, 2008), planning large-scale projects (Chang et al., 1995), selecting managerial talent (Chang et al., 2000), and selecting maintenance strategies (Jafari et al., 2008). This study examined building operations relative to the pollution of the surrounding environment, by combining these three methodologies to develop a DFAHP multicriteria decision-making risk assessment model (Figure 1) as the basis for choosing or assessing the redevelopment projects of derelict public buildings. After obtaining additional professional knowledge and appropriate criteria to understand the effect of each criterion on the hierarchy, a DFAHP figure or ratio can assist decision-making , is highly adaptive, and would be easy to maintain or revise in the future.

The Delphi experts assisting in this study have been practically engaged in relevant fields of industry, government, and academia for more than 15 years. Among these, five served at public departments, five were scholars, three were local public representatives, and three were CEOs of property development companies, comprising 16 Delphi experts. Group decision-making information obtained from these experts was essential in developing the DFAHP model for this study. Selecting the appropriate criteria from complicated affecting factors was necessary. The DFAHP is only effective after completing the hierarchy of each criterion, selecting the membership functions used to quantify natural language, determining the fuzzy sets, fuzzy scale, and linguistic values, and completing the IF-THEN rules base of the fuzzy logic inference system (FLIS).

This assessment model includes two major parts: (1) developing the model and (2) applying the model n (Figure 1). Applying the Delphi-AHP and Delphi-fuzzy models requires four steps:

Step 1: Investigate relevant previous studies and arrange the relevant criteria affecting the redevelopment of derelict buildings. Thereafter, use the Delphi group decision-making method to select the appropriate criteria.

Step 2: Use Delphi-AHP to establish the hierarchical framework of the cause-and-effect relationship among various criteria, confirm the main criterion and subcriterion, and complete the AHP questionnaire.

Step 3: Use Delphi-fuzzy to determine the fuzzy sets and fuzzy scale of the subcriterion, and choose appropriate membership functions to describe the linguistic values.

Step 4: Develop the IF-THEN rules required by the rules base to complete the FLIS.

Applying the model requires four calculation steps:

Step 1: Assess one or several projects.

Step 2: Use AHP to calculate the weighting value (w_i) of the main criterion as the importance parameter for calculating decision-making.

Step 3: Use FLIS to calculate the fuzzy output value, and input the descriptions of uncertainty and ambiguity into the criteria (x_i) us-

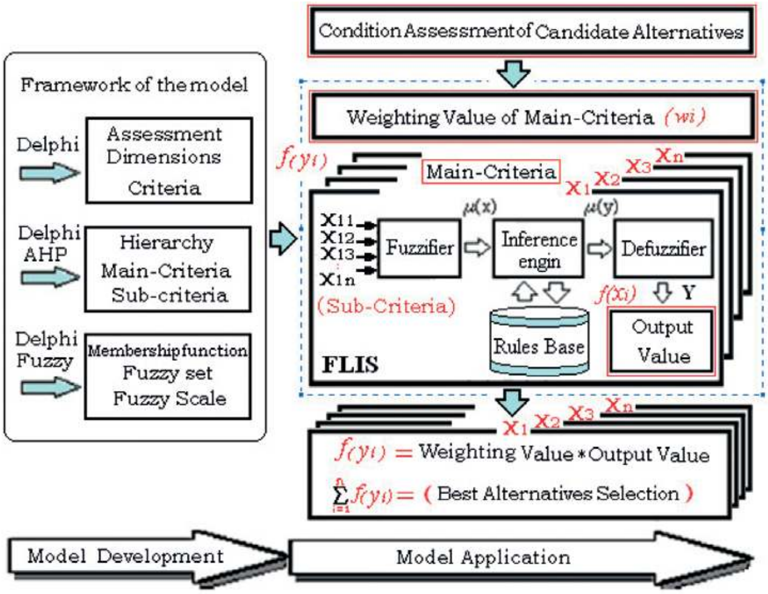


Figure 1. DFAHP Multicriteria risk assessment model

ing natural language to obtain a figure or ratio to denote them. Use the scientific calculation provided by FLIS to obtain the values of *f*(*xi*) and *f*(*yi*) easily.

$f(y_i)$ = Weighting value (w_i)* Output value ($f(x_i)$)

Step 4: Calculate $\Sigma f(y_i)$ as the basis for choosing projects, and determine if the selected project is worthy of redevelopment.

3. THE FUZZY LOGIC INFERENCE SYSTEM

The fuzzy logic inference system (FLIS) involves two output systems, mamdani and sugeno. The output values of mamdani are continuous, whereas those of sugeno are discrete. To understand the change in continuous outputs, this study uses the mamdani system. The establishment process of FLIS requires: (1) inputting the selected criterion and the definition of fuzzy sets; (2) inputting the definition of the fuzzy sets of output values; (3) establishing the rule base of IF-THEN; (4) considering membership functions; and (5) obtaining the corresponding quantitative output value (figure or ratio) after FLIS de-fuzzification (Hsueh and Yan, 2011).

3.1. Selecting initial criteria

Developing public buildings and redeveloping recreational facilities and derelict buildings are intended to serve the public. Effectively distributing and utilizing these services is another concern (Erkip, 1997). Inadequate development may easily lead to derelict buildings, affecting the appearance of cities and leading compromised security. Redeveloping derelict public buildings and abandoned sites is an example of a sustainable urban revitalization alternative. However, such an initiative includes complicated environmental, social, and economic concerns (Zavadskas and Antucheviciene, 2006).

Because derelict buildings are categorized as real estate, real estate project efficiency evaluations (Ginevicius and Zubrecovas, 2009) should be performed before selecting the redevelopment project. For example, factors such as location (Leitham et al., 2000), public facilities (Thisse and Wildasin, 1992; Aitken and Fik, 1998; Jeon and Amekudzi, 2005; Litman, 2007), urban planning and development (Shukla and Waddell, 1991), cultural action (Newman and Smith, 2000; Oakes, 2006; Matarasso, 2007), tourism (Ap and Crompton, 1998), adaptive reuse (Heath, 2001; Rossi, 2003; Bullen and Love, 2011), social interaction (Cattell et al., 2008), rehabilitation costs, and construction time (Campbell, 1996), should be considered. Derelict buildings are useless until they are repaired or partially reconstructed. Refurbishment work involves improvements, upgrades, renovations, retrofits, and repairs (Juan et al., 2009). Refurbishing derelict public buildings also entails financial and follow-up operational and management concerns. Relevant affecting factors include innovative design (Gruber and Imhof, 2007), multidesign (Benford et al., 1998), sustainable development (Dale and Newman, 2009; Zavadskas and Antucheviciene, 2006; Laefer and Manke, 2008), building facility management and maintenance (Taillandier et al., 2009; Thiel, 2008), a reduction in energy consumption (Thiel, 2008), green buildings (Pearce et al., 2007), and green open spaces (Van Herzele and Wiedemann, 2003; Wu and Plantinga, 2003; Choumert, 2010). The purpose of development projects for derelict buildings is to provide the public with accessible spaces. As a result, it is necessary to attach importance to public decisions (Gordon, 2007), to the people closely involved (Grove-White, 2005; Taylor, 2008), and to public-private partnerships (Tang et al., 2010).

Numerous complex factors may affect the redevelopment projects of derelict buildings. The AHP questionnaire data were completed with the assistance of 16 Delphi experts. Based on group decision-making, the Delphi experts assisting in this study suggest considering building conditions first, such as development convenience, high-quality public facilities, and rehabilitation costs. Attaching importance to enhancing sustainable development is necessary; therefore, energy consumption should be considered. Consequently, selected criteria include adopting multidesign, recycling building materials, and developing green buildings. Finally, Delphi experts follow the research of Van Herzele and Wiedemann (2003), who suggested that green spaces attract the public, maintaining that redevelopment projects must have attractive features. Additionally, Delphi experts cite the research of Grove-White (2005), who suggested the influence of the perspective of someone closely involved in society. In addition, Delphi experts cite Owen and Merna (1997) and Heald (2003) in presenting private finance initiative (PFI) projects, which use private funds to engage in public construction. Thus, based on harmonious consensus, the enthusiastic participation of the masses and harmonized opinions can be combined. This is beneficial to creating local characteristics. Therefore, selected criteria include cultural attractions, tourism, and the people closely involved. The model for reviewing the project should be as simple and comprehensible as possible, because professional teams will have discussed the details of derelict buildings (cost, design, the construction process and purpose of use) several times. Therefore, this study assesses the redevelopment process of derelict buildings, investigating the differences in time and space between the past and the present, and thus considers factors different from those for assessing development projects. This study also collected critical affecting factors from relevant studies. The experts in this study added other factors, amended them, and selected appropriate criteria to assess redevelopment of derelict public buildings (Table 1). Table 2 shows calculations of the weighing value of the main criteria. Because this study investigated the overall feasibility assessment of redevelopment, and FLIS can transform different entered scenario mapping into quantified output values, we omitted the subcriteria weighting value calculation. Figure 2 shows the hierarchical framework of the cause-and-effect relationship among various criteria.

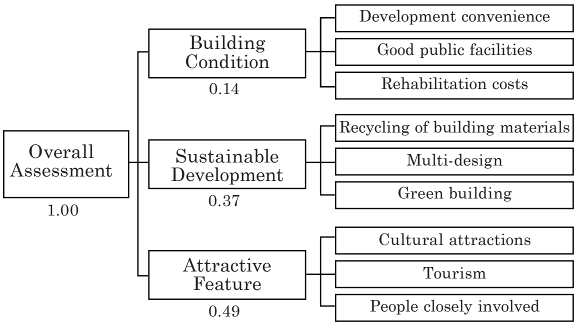


Figure 2. Hierarchy of each criterion and weighting value of the main criteria

Table 1. Consistently agreed upon criteria based on expert group decision-making

Main criteria	Subcriteria
Building condition	Development convenience, good public facilities, rehabilitation costs
Sustainable development	Multi-design, recycling of building materials, green building
Attractive feature	Cultural attractions, people closely involved, tourism

Table 2. Weighting value of main criteria

Comparisons of building condition, sustainable development, and attractive feature			
Attributes	Building condition	Sustainable development	Attractive feature
Building condition	1	1/2	1/5
Sustainable development	2	1	1
Attractive feature	5	1	1
Eigenvector	0.14	0.37	0.49

3.2. Defining the fuzzy sets, fuzzy scale, and membership functions of the subcriteria

The researchers in this study calculated the fuzzy values of the three main criteria (building condition, sustainable development, and attractive features). Fuzzy sets and the membership functions of each criterion of the subcriteria quantified the assessed concerns. Because each factor's effect on redevelopment assessment varied, the researchers in this study defined the fuzzy sets and membership functions of each assessment factor to reflect the corresponding relationships among various scenarios and fuzzy output values.

The quantitative upper and lower values of the fuzzy sets and fuzzy scale of each criterion of the subcriteria and of the output values were defined by obtaining the Delphi-fuzzy experts' consistent approval (Tables 3 to 5). These relevant data result from the Delphi process. In addition, good, ordinary, and poor can be used as input values.The measurement scale defined in fuzzy logic is an artificially established fuzzy scale. Fuzzy logic accepts the complexity and imprecision of natural language. The multidesign criterion of the subcriterion of Table 4 indicates this, in which a score of 90 points and above denotes "very good", 80 points denotes "good", 70 points denotes "ordinary", 60 points denotes "poor", and 50 points and under denotes "very poor". A score of 75 points denotes "good" or "ordinary". In the fuzzy scale, membership functions were used to define a level of "good" or "ordinary". To operate FLIS normally, the rule base had to be completed. Although different calculation units and defined values were used in the fuzzy scale of each criterion, an appropriate figure or ratio presented the assessment result of the input scenario after defuzzifying FLIS to be assessed according to preference level.

Table 3. Fuzzy set of the subcriteria of building conditions and output value

Input scenario			Fuzzy output value	
Subcriteria	Value range	Fuzzy sets	Description	Fuzzy sets
Development convenience	0–100	good ordinary poor	Quantitative value	good (80% ↑) ordinary (60%) poor (40% ↓) (0–100%)
Good public facilities	0–100	good ordinary poor		
Rehabilitation costs	10%–30% (–30)–(–10)	good ordinary poor		

Table 4. Fuzzy set of the subcriteria of sustainable development and output value

Input scenario			Fuzzy output value	
Subcriteria	Value range	Fuzzy sets	Description	Fuzzy sets
Multidesign	0–100	very good good ordinary poor very poor	Quantitative value	very good (90 %↑) good (80%↑) ordinary (70%) poor (60%↓) very poor (50%↓) (0–100%)
Recycling of building materials	0–30%	good ordinary poor		
Green building	0–10	good ordinary poor		

Table 5. Fuzzy set of the subcriteria of attractive features and output value

Input scenario			Fuzzy output value	
Subcriteria	Value range	Fuzzy sets	Description	Fuzzy sets
Cultural attractions	0–10 (Impact; Level)	very good good ordinary poor very poor	Quantitative value	very good (90 %↑) good (80%↑) ordinary (70%) poor (60%↓) very poor (50%↓) (0–100%)
Tourism	0–30% (Expected net income)	good ordinary poor		
People closely involved	0–100%	good ordinary poor		

3.3. Selection of membership function

A membership function characterizes a fuzzy linguistic term by giving its support value or degree of membership. The membership value varies from 0 to 1, representing none to full membership. Common membership functions include triangular and bell-shaped functions (Yu and Skibniewski, 1999). The researchers in this study selected applicable membership functions based on expert group decision-making. The experts in this study suggested that the Taguchi loss function could explain the phenomenon of customer satisfaction with a product. Customer satisfaction decreases when product quality fails to meet the customers' target value (Yacout and Boudreau, 1998). The Taguchi loss function explains individual preferences and feelings based on the changes in a curve. Because a bell-shaped curve can be used to simulate Taguchi loss functions, this study used bell-shaped functions to simulate membership functions. Exploiting the tolerance for imprecision is central to using words in computing (Zadeh, 1996).

3.4. Establishing the rules base of FLIS

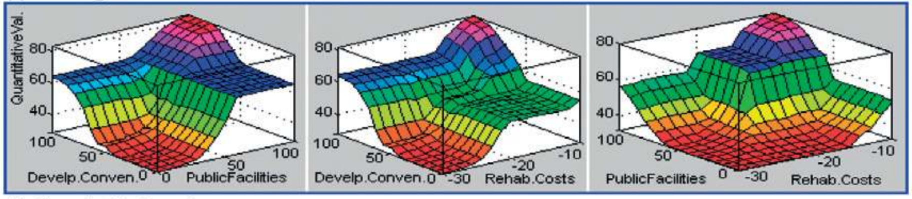
The fuzzy logic inference system quantified the input scenario to be assessed according to the rule base this study established, and yielded distinct quantitative output values after defuzzification. The established rule base completed the systemic and logical mutually-corresponding relationships between the input criterion and the fuzzy output value to complete the definition of the IF-THEN rules.

There were a total of three input criteria: multidesign, recycling of building materials, and green buildings in sustainable development. The fuzzy sets of multidesign were composed of "very good", "good", "ordinary", "poor", and "very poor" using natural language, with five different scenarios. Moreover, three additional scenarios, good, ordinary, and poor, using natural language, represented the fuzzy sets of criteria input from the recycling of building materials and green buildings. Therefore, a total of 5*3*3 = 45 different input scenarios assessed the pros and cons of sustainable development. The rule base resembles a human brain in the overall FLIS. Therefore, FLIS could be used in an inference operation, after using it to complete the If-Then rule base. As long as a decision-maker input a value for each criterion, FLIS could automatically calculate the quantitative assessment value. Because the attractive-feature and sustainable-development criteria shared similar fuzzy sets, there were also 5*3*3 = 45 different input scenarios for attractive features. Therefore, there were three input criteria for building conditions, and three scenarios, "good", and "poor", presented the fuzzy sets of each criterion, using natural language. Therefore, there were a total of 3*3*3 = 27 compositions of the input scenarios.

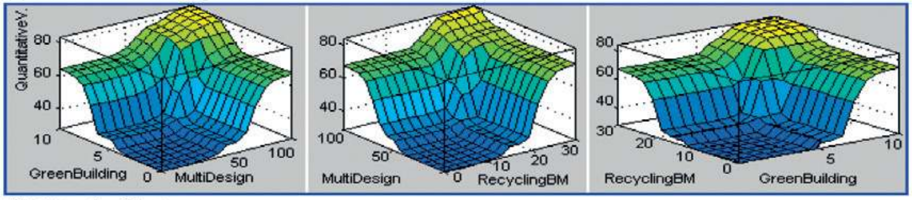
4. INPUT AND OUTPUT MAPPING

For calculation of $\Sigma f(y_i)$, the weighing value w_i of each main criterion and the fuzzy quantitative output value $f(x_i)$ were calculated first. The values of $\Sigma f(y_i)$ were compared and used to select redevelopment projects of derelict public buildings. The larger the $\Sigma f(y_i)$ value is, the higher the quality of the assessed project. Figure 3 is a 3D diagram of the input and output mapping. Tables 4 and 6, respectively, show the largest and smallest quantitative output values. The input scenarios in Table 6 could be either quantitative values or imprecise terms in natural language, such as "good" (high), "ordinary" (medium), and "bad" (low). This model could provide decision-makers with a scientific calculation to compare quantitative values as the basis for decision-making before assessing projects. The model improves the efficiency and effect of decision-making, and reduces the risk of inappropriate decision-making.

(a) Building Condition



(b) Sustainable Development



(c) Attractive Feature

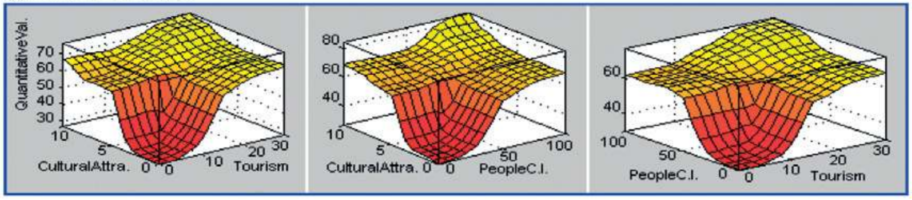


Figure 3. Input and output mapping

Table 6. Each subcriteria optimal and worst output value

Subcriteria	Worst	Optimal	Subcriteria	Worst	Optimal	Subcriteria	Worst	Optimal
Development convenience	Poor	good	Multidesign	poor	good	Cultural attractions	poor	good
Good public facilities	poor	good	Recycling of building materials	poor	good	Tourism	poor	good
Rehabilitation costs	poor	good	Green building	poor	good	People closely involved	poor	good
Output value	27.7	83.8	Output value	25.1	93	Output value	26	86.8

5. CASE STUDY

Local governments usually spend large amounts of money on development projects for derelict public buildings in cities, creating a financial burden. However, redevelopment and reuse of derelict public buildings promotes sustainable urban development, and improves the appearance of cities. Annual government budget restrictions make it difficult to choose appropriate development projects: inadequate development may waste budgets, increase future management and maintenance expenses, and arouse criticism. To reduce public construction investment risk, the government must use a fair, just, open, and efficient assessment procedure. The case study (Table 7) verifies the practicability and reliability of this assessment model. Redevelopment projects were selected based on scientific calculation. Results from the two cases (Table 7) explain how project selection was based on comparing quantitative values, allowing further analysis of whether the selected projects possessed high redevelopment value. For example, Project 1 in Table 7 was a newly-constructed public building that still failed after redevelopment. Calculation of this assessment model demonstrated that the building no longer possessed value for redevelopment. After the project was completed, the usage rate of the building was extremely low. Moreover, although the total score $\Sigma f(y_i)$ of Project N was higher than that of Project 1, their corresponding fuzzy output values in the two criteria of sustainable development and attractive features were both ordinary. Therefore, the model assessed them both as projects with no redevelopment value. The previous case studies shows that this model is applicable in assessing the redevelopment of single derelict public buildings. It is also applicable in selecting assessments of redevelopment projects for multiple derelict public buildings. The output values for each criterion of the case studies listed in Table 7 can be the fuzzy linguistic terms of humans or quantified values, such as good, ordinary, or poor. For the convenient explanation, Table 7 lists numbers as input values.

6. CONCLUSIONS

Urban construction projects are a critical factor triggering economic development. However, inadequate development may lead to formidable problems, such as wasting land resources, governmental budgets, and energy, or environmental damage. However, public construction investment may easily lead to repeated mistakes, and may also lead to public disappointment with regular defects. An effective pre-development group decision-making model may affect assessments of public construction investments. Because reusing derelict public buildings is a positive strategy in sustainable

Table 7. Case study (Project 1- Project N)

Main criteria w_i	Subcriteria	Project 1			Project N		
		x_i	$f(x_i)$	$f(y_i)$	x_i	$f(x_i)$	$f(y_i)$
Building condition ($w_i = 0.14$)	Development convenience	80	81.5	81.5*0.14 = 11.41	85	83.3	83.3*0.14 = 11.662
	Good P. F.	80			90		
	Rehab. C.	–6%			–5%		
Sustainable development ($w_i = 0.37$)	Multid.	65	74.6	74.6*0.37 = 27.602	75	76.1	76.1*0.37 = 28.157
	Rec. B. M.	18%			19%		
	Green B.	6			6		
Attractive features ($w_i = 0.49$)	Cult. A.	5	62.7	62.7*0.49 = 30.723	6	68.5	68.5*0.49 = 33.565
	Tourism	12%			15%		
	People C.I.	60%			75%		
$\Sigma f(y_i)$	$\Sigma f(y_i)$ = 11.41 + 27.602 + 30.723 = 69.753				11.662 + 28.157 + 33.565 = 73.384		

urban development, the DFAHP group decision-making assessment model presented in this study belongs to the artificial intelligence category and can process the assessment of complex and high-risk derelict building redevelopment plans. Additionally, the proposed model has a high degree of objectivity, practicality, and adaptability and can aid in reducing the investment risk of derelict buildings. This study provides practical reference value for policy makers and key decision makers. The proposed model can bring economic benefit to communities and resolve potential problems in the urban environment.

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