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Abstract

Numerous different and sometimes discrepant interests can be affected, both positively and negatively, throughout the course of a major infrastructure and construction (MIC) project. Failing to address and meet the concerns and expectations of the stakeholders involved has resulted in many project failures. One way to address this issue is through a participatory approach to project decision making. Whether the participation mechanism is effective or not depends largely on the client/owner – a particular problem for Asian countries such as China. This paper provides a means of systematically evaluating the effectiveness of the public participation exercise, or even the whole project, through the measurement of stakeholder satisfaction. Since the process of satisfaction measurement is complicated and uncertain, requiring approximate reasoning involving human intuition, a fuzzy approach is adopted. From this, a multi-factor hierarchical fuzzy comprehensive evaluation model is established to facilitate the evaluation of satisfaction in both single stakeholder group and overall MIC project stakeholders.

Keywords: decision making, participation, effectiveness, satisfaction, evaluation, fuzzy mathematics

1. Introduction

Numerous different and sometimes discrepant interests can be affected, both positively and negatively, throughout the course of a major infrastructure and construction (MIC) project [1]. Representatives of these interests are referred to as the *project stakeholders* who can benefit or threaten a project due to their power and intention to influence outcomes in line with their individual concerns and needs [2,3]. Failing to address and meet the concerns and expectations of MIC project stakeholders has resulted in many project failures [4].

Therefore, managing stakeholders is a critical skill for construction project teams [4] and a participatory approach is recommended for construction professionals to better coordinate relationships with diverse stakeholders [5,6]. Through participation, the interests of different stakeholders can be systematically captured and built into the finalized scheme, which should help improve the projects' long-term viability and benefits to the community. However, it is unlikely that the expectations of all the stakeholders involved can be fulfilled as their concerns are rather diverse and often in conflict with each other [1]. On the other hand, authorities can have a cynical attitude towards the value of participation and be concerned that an overactive citizenry may lead to social disorder and conflict. Under these circumstances, they may choose to fast track the participatory process – rendering the whole public participation exercise a mere formality [7]. The effectiveness of public participation in yielding a mutually acceptable solution among different stakeholder groups is still in doubt, especially where participatory levels are relatively low as in such countries as China [7,8].

This study, therefore, aims to provide a means of evaluating the effectiveness of the public participation exercise. This involves the development of a systematic way of measuring stakeholder satisfaction. Since the process of satisfaction measurement is complicated and uncertain, requiring approximate reasoning involving human intuition, a fuzzy approach is adopted. From this, a multi-factor hierarchical fuzzy comprehensive evaluation model is established to facilitate the evaluation of satisfaction in, not only a single stakeholder group, but also the overall MIC project stakeholders.

2. Stakeholder participation

2.1. Stakeholder theory

The stakeholder concept was first developed by academics at the Stanford Research Institute in the 1960s as a straightforward, if highly controversial, idea which defined stakeholders as those groups without whose support the organization would cease to exist [9]. Freeman [10] later widened this definition to include *"any group or individual who can affect, or is affected by, the achievement of the organization's objectives"*. Since then, interest in stakeholder theory has grown considerably and references to stakeholders are commonplace not only in academic texts but also in mainstream media and government communications [4,11].

The application of stakeholder theory has more recently been extended to the field of construction project management, a discipline which focused on the process of planning, coordinating, controlling and managing the complex array of activities required to deliver a functionally and financially viable construction project [12]. The Project Management Institute (PMI) [13] defines project stakeholders as those individuals and organizations who are actively involved in a project or whose interests may be affected as a result of project execution or completion. In this study, stakeholders are defined as "those who can influence the project process and/or final results, whose living environment is positively or negatively affected by the project, and who receive associated direct and indirect benefits and/or losses". These comprise: government/project initiators, the general public/end-users, pressure groups such as the NGOs and mass media[1], and all other project affected people.

2.2. Participation

2.2.1. Background

According to Arnstein [14] participation is a channel for "*the redistribution of power that enables the have-not citizens ... to be deliberately included in the future*". By actively involving *"individuals and groups that are positively or negatively affected by a proposed project"* [15], the chance of project success should increase, as the needs of various sectors of society would be considered before a finalized plan and solution is derived [16]. Stakeholder participation through the MIC project cycle has therefore been advocated by many researchers [5,17].

Despite its merits, stakeholder participation can be challenging to implement as it may lead to social disorder and conflict, as demonstrated in the recent Guangzhou – Shenzhen – Hong Kong Express Rail Link project [7,18]. Decision-makers therefore often try to avoid, or fast

[1] In addition to overseeing the government's roles in promoting environmental friendliness and value-for-money of the project, the mass media plays a vital role in informing and educating the public during the participatory process.

track, the participatory process – an action which, according to Randeree and Faramawy [19], is naive in the extreme as conflict is rooted in the divergence of histories, characters, genders, cultures, values, beliefs, and behaviors of different stakeholder groups, rather than the existence of any public participation exercise. Instead, it is argued that participation provides a good opportunity to resolve conflicts through the engagement of project stakeholders, prioritizing their concerns and maximizing their mutual satisfaction. Through this, the tension between the government and the society can be relieved and required facilities or services delivered smoothly and satisfactorily [20].

2.2.2. Practice in Mainland China and Hong Kong

Participatory practices in advanced economies usually involve the collection and analysis of stakeholders' opinions throughout the project cycle (i.e. the planning, design, construction, operation and demolition stages of MIC facilities) to help decision-makers establish the most apposite solutions to satisfy the broad interests of society [21]. In developing countries such as China, however, the current participatory mechanism at the project level exists only as part of the environmental impact assessment (EIA) process [22]. Li *et al*. [5] identify three major issues in the EIA-based public participation system which could account for the lack of participation in China: (i) uneven progress in the adoption of participatory mechanisms; (ii) the risk of not meeting targets; and (iii) lack of confidence in public competence. The low level of stakeholder participation in China may also be due to the traditional Chinese *culture of compliance* [5,8]. The current participatory practice in China usually takes the form of informing the stakeholders of the finalized plan or design rather than inviting them to express their opinions freely before a decision is made [7], contrary to the true spirit of public participation of respecting the rights of all concerned [23]. Acknowledging the limitations of the current public participation mechanism, the Central Government of China is now developing a more transparent, democratic and comprehensive participatory process to cope with the rapid expansion of MIC projects in the country, the increasing expectations of society [5] and the changing role of the mass media [22]. Gradual deregulation is enabling the mass media to more accurately represent and more thoroughly discuss the issue so as to reflect the diversified voices of society.

The citizens of Hong Kong, on the other hand, are more willing to take part in the decision making process, especially when the issues are related to their living environment and standard of living. This could be due to a more democratic atmosphere in the city and the education levels of Hong Kong citizens [24]. Stakeholder participation is required by the government clients of Hong Kong for a variety of public transactions (e.g. the provisions of MIC projects[2]) to increase the likelihood of project success. Nonetheless, the participatory process in some cases is far from satisfactory, as it is difficult to balance the diverse interests of stakeholders in Hong Kong on issues related to the limited/scarce land resources, the diverse/changing needs of the community, market changes, rapid economic growth, and increasing demand for sustainable city developments [25]. Should stakeholders fail to reach a consensus during the participation process at the early stage of a MIC project (e.g. planning stage), it may not be worthwhile pursuing the project further as this could increase the chance of failure or even lead to confrontation between decision-makers and local citizens [24]. Perhaps the most controversial case is the Guangzhou–Shenzhen–Hong Kong express rail link project (Hong

[2] Several guidance documents on stakeholder participation for MIC projects have been issued by the government of Hong Kong Special Administrative Region, including: (i) Civil Engineering and Development Department's (CEDD) Technical Circular No. 02/2009: Public Consultation/Engagement Guidelines; (ii) Environment, Transport and Works Bureau's (ETWB) Technical Circular (Works) No. 34/2003: Community Involvement in Greening Works; and (iii) ETWB's Technical Circular (Works) No. 4/2006: Delivery of Capital Works Projects.

Kong section), which has generated much debate among different groups over issues of family values, environmental impact, cost-effectiveness and value-for-money [5,26]. These include the affected residents, the younger generation born after the 1980's (referred to as the *after 80's*), politicians, regulators and professionals. Table 1 shows the program and the stakeholder participation process of this project [27]. Here, the issues of stakeholder participation were concerned with (i) the absence of a comprehensive participation process, as stakeholders only had the chance of being involved more extensively at the design stage; and (ii) the relatively short timeframe for participation, as stakeholders only had one month to digest the highly technical information to submit their comments [26,28].

<Table 1>

3. Assessing stakeholder satisfaction with MIC projects

3.1. The concept of stakeholder satisfaction

In recent years, the concept of *customer satisfaction* has been emerged, largely in the production sector and consumer services markets, as being *"a comparison between the customer's pre-purchase expectations and their post-purchase perceptions"* [29,30]. In terms of the construction industry, stakeholder satisfaction can be defined as the achievement of stakeholders' pre-project expectations in the actual performance of each project stage. This concept of construction stakeholder satisfaction has gradually become more important [3,4,29,30,31], especially with the growing tendency of stakeholder groups to try to influence the implementation of MIC projects according to their individual concerns and needs [3]. Yang *et al*. [32] suggest the use of stakeholder satisfaction as a criterion for measuring project success in addition to the traditional measures of time, cost and quality, and this has gained widespread support from academia and the industry [33,34].

3.2. Critical satisfaction factors

One way to measure stakeholder satisfaction is by establishing an evaluation index system which consists of various critical satisfaction factors [31]. Ahmed and Kangari [35] identify six factors leading to client satisfaction in the construction industry, *viz*. time, cost, quality, client orientation, communication skills and response to complaints. Maloney [36], on the other hand, suggests that the assessment of the satisfaction of customers in electrical construction projects should be based on five criteria, namely: contractor/customer relationship, project management, safety, prepared/skilled workforce and cost. Tang *et al*. [37] believe that clients in Hong Kong are satisfied when engineering consulting firms can demonstrate professionalism; competitiveness; timeliness; design quality; innovativeness; support for client; and good supervision during the project. Leung *et al.* [31], however, point out that the satisfaction of construction project participants is determined by management mechanisms (e.g. communication, participation and commitment) instead of the particular project goals (e.g. time, cost and quality). Nkado and Mbachu [38] agree that client satisfaction/dissatisfaction is a subjective phenomenon, which may be based on the client's *perceptions* rather than on reality itself (e.g. delivery of the project within the time, cost and quality targets). Clients can feel dissatisfied if the project team fails to see things from their perspective [39].

3.3. Multi-group multi-objective process

Yu and Li [40] identify the weakness of the current satisfaction evaluation mechanism as its focus on the perceptions of only one or several stakeholder groups (e.g. the client). This can result in an adversarial and confrontational situation between the decision-makers (e.g. government) and other stakeholder groups (e.g. local communities) who are dissatisfied with the project but have been ignored in the evaluation process [18]. Under these circumstances, a MIC project may not be regarded as successful, even if it is completed within the original time, budget and scope [1]. In fact, it is very likely to fail, especially with the increased resources and improved capability that construction project participants have to stop the whole project [4]. It is, therefore, necessary to develop an evaluation system that integrates the needs of all the stakeholder groups and their satisfaction attributes, to form a source of reference for assessing overall stakeholder satisfaction [41]. In this sense, stakeholder satisfaction assessment can be interpreted as a multi-group multi-objective decision process during which different stakeholder groups[3] can contribute to evaluating the degree of achievement of their respective objectives[4].

Measuring the satisfaction of a single stakeholder group with a series of objectives in a MIC project is not necessary very complicated, especially when aided by an established multi-objective decision-making model [42]. However, difficulties arise when the number of stakeholder groups involved in the evaluation process increases, as the objectives of different stakeholder groups in the project can be diverse[5] and are often conflicting [43,44]. The challenge, therefore, is to identify a group decision which satisfies all the participants involved [44].

3.4. Fuzzy approach

Although multi-objective decision-making has been applied to many building and infrastructure development problems [24,42], they seldom have to deal with multiple stakeholders. The solution methodologies adopted for multi-objective, multi-group decision problems are generally based on a straightforward weighted sum model [45]. This approach is, however, incapable of dealing with lexical data such as where stakeholders express their satisfaction in a qualitative way. A fuzzy approach, on the other hand, is more appropriate for measuring stakeholder satisfaction in MIC projects, since it incorporates unquantifiable and incomplete information into the decision model and therefore allows assessments to be made in qualitative and approximate terms [44]. In addition, fuzzy theories can address decision-making problems with conflicting goals [46].

Fuzzy literally means blurred, indistinct in shape or outline, frayed or fluffy [47] and is used to describe concepts with unclear and ambiguous extension boundaries [48]. Its origin in mathematics can be traced back to Zadeh [49], who first proposed the use of fuzzy concepts to deal with ill-defined and complicated problems due to uncertainty and imprecision in the real world. The fuzzy theories were soon recognized as a branch of modern mathematics and have been applied to a number of fields. Lu *et al.* [50] adopt fuzzy techniques to analyze water quality in reservoir. Sadiq and Rodriguez [51], through the fuzzy approach, determine the health risks associated with disinfection by-products. The application of the fuzzy techniques in the area of construction project management has been gaining popularity over the past two

[3] The stakeholder groups of MIC projects can be easily identified, as schemes of this type often have an impact on the public in general [52]. In this study, four stakeholder groups were identified, comprising the government/project initiators, general public/end-users, pressure groups such as the NGOs and mass media, and all other project affected people.

[4] These objectives can be both quantitative (e.g. the compensation provided to those who need to be relocated because of the MIC project) and qualitative (e.g. maintaining the local character of the area) and are often conflicting (e.g. the development of the whole community at the expense of people adversely affected by the project in terms of their quality of life).

[5] Even for a similar objective, different priorities can be assigned by different stakeholder groups [43].

decades [53]. Chen *et al.* [54] develop a hierarchy model based on fuzzy theories to deal with supplier selection. Zhao *et al.* [55] apply a fuzzy approach to assess the risk factors of a project in general. Due to the advantages in dealing with imprecise and qualitative data in a multi-objective multi-participant context involving conflicting goals, the application of fuzzy techniques in construction project decision making appears to be very promising.

4. Research scope and methodology

4.1. Research scope

The stakeholders' favorable, neutral or opposing attitudes towards a MIC project are not invariant since their concerns and expectations of the proposed project can change throughout the whole project cycle[6], based on their observations and experiences, and interactions with other stakeholders. Due to the dynamic nature of stakeholder needs and given that MIC projects usually last for several years, it is necessary to define a specific time frame during which the stakeholder concerns and expectations are identified and weighted, and this can serve as a baseline for comparison with the stakeholders' ultimate perceptions of the project. As a result, this study concentrates on the conceptual stage of a MIC project, during which project stakeholders provide their visions, desires and concepts, as well as sustainability principles and indicators for the development of concept plans [56]. Stakeholder satisfaction is finally evaluated in terms of degree of fulfillment of their concerns and expectations identified at this stage.

4.2. Questionnaire survey

Diverse research methods were employed in the study, including a literature review and content analysis, questionnaire survey, face-to-face interviews, mean score ranking and fuzzy comprehensive evaluation. Figure 1 illustrates the research process in detail. Recognizing the importance of meeting stakeholder expectations throughout the project lifecycle, many government departments and researchers in the world have identified different types of concerns of stakeholders in MIC projects (Table 2). A questionnaire survey was considered to be the most effective means of determining the key concerns involved, as the required data can be captured from a large sample. Therefore, a questionnaire was developed to examine the relative importance of different stakeholder concerns in MIC projects and to measure the satisfaction levels of different stakeholder groups. To facilitate this, a 5-point Likert scale (with 1 representing the 'least important'[7] or 'least satisfied'[8] and 5 denoting the 'most important' or 'most satisfied') was used.

<Figure 1>
<Table 2>

[6] Even for a similar stakeholder concerns or expectations, the relative importance can alter periodically during different project stages.

[7] For the study of the relative importance of different stakeholder concerns in MIC projects.

[8] For the measurement of the satisfaction level of MIC project stakeholders.

A total of 199 valid responses were obtained by means of mail, email, fax or by street survey conducted in Hong Kong[9]. As shown in Table 3, nearly half (49.1%) of the respondents from the general public are with sufficient knowledge of, or previous experience in, public participation. This is not surprising as, despite the generally low participatory level in Hong Kong due to its unique social, political, cultural and environmental background, the Hong Kong Special Administrative Region (HKSAR) Government has provided a large budget and ambitious program for MIC projects in addition to the increased expectations of Hong Kong people today.

<*Table 3*>

The mean scores of the stakeholder concerns as obtained from the questionnaire survey are shown in Table 4. These were used to rank each concern's level of importance, with the scale intervals being interpreted as follows: (i) 'not important' (*mean score* $\leq$ 1.5); (ii) 'fairly important' (1.51 $\leq$ *mean score* $\leq$ 2.5); (iii) 'important' (2.51 $\leq$ *mean score* $\leq$ 3.5); (iv) 'very important' (3.51 $\leq$ *mean score* $\leq$ 4.5); and (v) 'extremely important' (*mean score* $\geq$ 4.51). The validity of the survey results was confirmed through validation interviews with 25 experts representing a cross-section of the community, including representatives from the government, private sector, project affected groups, pressure groups (NGOs), general public, and academia (Table 5). An interview protocol (both in English and Chinese) was carefully crafted and piloted to ensure that the questions were clear, concise and appropriate so all the potential respondents understood them in the way intended. The interview protocol was dispatched to the interviewees in advance to facilitate and expedite the interview process. A brief statement of the research aim and objectives was provided at the beginning of each interview so that the respondents understood the importance of the research and the importance of their participation. To ensure privacy, the specific additional consent of the interviewees was sought at the beginning of each interview for the session to be audio recorded. The interviewees were invited to comment on the 'extremely important' concerns of the MIC project stakeholders[10]. The ways in which the results were interpreted by the interviewees were also explored. Only neutral explanations and feedback were provided during the interviews to minimize the potential influence of the interviewers. The interviewees agreed with most of the survey findings although they proposed that some of the concerns with a mean score between 4.0 and 4.5 should be considered along with those labeled as 'extremely important'. These concerns include: (i) F4 (mean=4.48) and F16 (mean=4.26) for government departments; (ii) F15 (mean=4.47) for the pressure groups; and (iii) F12 (mean=4.49), F14 (mean=4.38) and F7 (mean=4.17) for the project affected groups.

<*Table 4*>
<*Table 5*>

4.3 Interviews

In view of the paucity of published data describing stakeholder satisfaction during the participatory process of MIC projects (and of the need to capture the knowledge and detailed opinions of the stakeholders involved in making project decisions), a semi-structured interview

[9] Respondents from the general public were chosen according to a systematic random sampling approach, i.e., at a fixed location of the central ferry piers, every twentieth passenger was invited to participate in the survey.

[10] The interviewees were invited to rate each 'extremely important' stakeholder concern on a 5-point Likert scale (with 1 representing 'strongly disagree' and 5 denoting 'strongly agree'). The mean scores were calculated and the results showed that all 'extremely important' stakeholder concerns were rated above '4', i.e. 'agree'.

was considered appropriate as it allows the researchers to interact more thoroughly with the experts to identify ways of improving the project decision-making mechanism and therefore maximize the satisfaction of the various stakeholders involved. As a result, five additional experts (Interviewees 26-30 as shown in Table 5), together with the participants of the validation interviews (Interviewees 1-25) were involved. By using a 5-point Likert scale (1 = 'least important' and 5 = 'most important'), they evaluated the importance of a single stakeholder group's satisfaction in comparison with the satisfaction of the stakeholders overall (Table 6). All the thirty interviewees were chosen purposively based on their theoretical knowledge of, and practical experience in, project decision making related to public participation activities[11]. As shown in Table 5, all the interviewees were from a senior management level and with ample hands-on experience in public participation.

< *Table 6* >

5. Fuzzy comprehensive evaluation

Fuzzy comprehensive evaluation (FCE) is a method to facilitate multi-group, multi-criteria decision making [57]. According to Meng *et al.* [58] and Wei *et al.* [59], FCE involves five steps:

(1) To identify a set of basic factors: $U = \{u_1, u_2, \ldots, u_m\}$ with $u_i = (i = 1,2,\ldots,m)$ standing for the evaluation factor *i*;

(2) To establish a set of grades for the factors: $V = \{v_1, v_2, \ldots, v_n\}$ with $v_j = (j = 1,2,\ldots,n)$ being the evaluation grade *j*;

(3) To determine the weight vectors of the evaluation factors and establish a set of weightings: $A = \{a_1, a_2, \ldots, a_m\}$, ($0 \le a_i \le 1$ and $\sum_{i=1}^{m} a_i = 1$) with $a_i = (i = 1,2,\ldots,m)$ denoting the weighting of evaluation factor *i*;

(4) To set up a fuzzy evaluation matrix $R = (r_{ij})_{m \times n}$ with r_{ij} representing the degree to which the grade alternative v_j satisfies the factor u_i in the fuzzy environment; and

(5) To compute and normalize the fuzzy evaluation matrix and the weighting factor sets: $B = A \times R = \{b_1, b_2, \ldots, b_n\}$.

According to Yu and Li [40], stakeholder satisfaction can be quantified by

$$S = B \times V^T \tag{1}$$

where *S, B* and *V* represent the satisfaction of stakeholders during the public participation process, the result of step (5) and the set of grades established in step (2) respectively.

The assessment of stakeholder satisfaction in MIC projects involves different stakeholder groups with a variety of critical concerns. In order to ensure comprehensiveness, each stakeholder group was evaluated in terms of the achievement of its expectations of the proposed project, from which the satisfaction level of the stakeholders overall was identified. Hence, it was more desirable for a hierarchical comprehensive evaluation method to be adopted to solve this multi-factor and multi-level problem. Being an application of fuzzy theories, a fuzzy comprehensive evaluation has been widely adopted in the field of

[11] The interviewees should have a minimum of three years of working or research experience in construction-related industries or in relevant disciplines (e.g. decision making in construction projects or urban planning) or have previously been participants in the public participation activities of at least two projects.

construction project management. Shan and Li [60] establish a multi-layer evaluation index system and developed a fuzzy comprehensive evaluation model for assessing urban development. Zhang and Yang [61] apply the fuzzy comprehensive evaluation approach to assess the risk factors associated with real estate investment. As these previous studies demonstrate, fuzzy comprehensive evaluation (FCE) has the advantage of being able to handle complicated evaluation with multiple factors and layers. In fact, the use of the fuzzy methodology helps to capture the ambiguity of human appraisal and make strategic decisions when uncertain and imprecise data is used. In addition, as humans are comparatively efficient in qualitative forecasting, the fuzzy comprehensive evaluation method is an excellent tool for handling qualitative assessments of stakeholder satisfaction decisions [62]. Since stakeholder satisfaction assessments with MIC projects are often multi-layered and complicated, uncertain and fuzzy in nature and require approximate reasoning involving human intuition and subjective judgment, it was considered appropriate to adopt the hierarchical fuzzy comprehensive evaluation method for developing a fuzzy satisfaction evaluation model in the study.

5.1 Establishment of a fuzzy comprehensive evaluation model

5.1.1 Establishment of the evaluation index systems

Based on the previous findings, the evaluation index systems were established in which the satisfaction of the four stakeholder groups was defined as the first-class index [12] (i.e. $U=\{u_1,u_2,u_3,u_4\}$) [40]. Based on the results of the questionnaire survey and the validation interview, the most important concerns as perceived by each stakeholder group, shown in Table 4, can be identified and represented as the second-class index (i.e. $u_1=\{u_{11},u_{12},u_{13}\}$, $u_2=\{u_{21},u_{22},u_{23},u_{24}\}$, $u_3=\{u_{31},u_{32},u_{33}\}$, $u_4=\{u_{41},u_{42},u_{43},u_{44}\}$). As indicated in Table 4, although the "*compensation and relocation plan/strategy*" (F16) was considered to be the most important by both the government departments (u_{24}) and project affected groups (u_{41}), their starting points can be different as revealed in the validation interviews. The four government representatives stated that *"it is of high risk to start a project without meeting the requirements of project affected people, as their opposition or even confrontation can cause the whole project to fail"*. The project affected people, however, believe they deserve to be compensated as their previous lifestyle is substantially changed.

5.1.2 Determination of the membership function for each major concern

Given that the set of grade alternatives were defined as $V=\{1,2,3,4,5\}$, where 1 = very dissatisfied; 2 = dissatisfied; 3 = basically satisfied; 4 = satisfied; and 5 = very satisfied, the membership function of a specific major concern u_{ik} can be computed by Xu *et al*. [57]

$$MF_{u_{ik}}=\frac{P1_{u_{ik}}}{\text{very dissatisfied}}+\frac{P2_{u_{ik}}}{\text{dissatisfied}}+\frac{P3_{u_{ik}}}{\text{basically dissatisfied}}+\frac{P4_{u_{ik}}}{\text{satisfied}}+\frac{P5_{u_{ik}}}{\text{very satisfied}}$$

$$=\frac{P1_{u_{ik}}}{1}+\frac{P2_{u_{ik}}}{2}+\frac{P3_{u_{ik}}}{3}+\frac{P4_{u_{ik}}}{4}+\frac{P5_{u_{ik}}}{5} \quad (2)$$

[12] For the purpose of conciseness, each of the four stakeholder groups is assigned a group number, i.e. 1, 2, 3 and 4 stand for the general public, government, pressure groups and project affected groups respectively. Sic passim.

where u_{ik} denotes the k^{th} concern of the stakeholder group i ($i = 1,2,3,4$); $MF_{u_{ik}}$ represents the membership function of the major concern u_{ik}; and $Pt_{u_{ik}}(t = 1,2,3,4,5)$ is the percentage of the respondents from the stakeholder group i who choose t for their satisfaction level concerning the factor u_{ik}. Alternatively, the membership function of u_{ik} can also be written as ($P1_{u_{ik}}$, $P2_{u_{ik}}$, $P3_{u_{ik}}$, $P4_{u_{ik}}$, $P5_{u_{ik}}$), where $0 \le Pt_{u_{ik}}(t = 1,2,3,4,5) \le 1$ and $\sum_{t=1}^{5} Pt_{u_{ik}} = 1$.

5.1.3 Development of appropriate weightings for the diverse stakeholder groups and major stakeholder concerns

The mean score ranking technique has been applied to a number of construction management domains, for instance to delineate the common origins of delay from the client, consultant and contractor's perspective [63]. While the stakeholders of a MIC project could have diverse concerns, the mean score ranking technique helps to identify what make a particular group feel satisfied with a MIC proposal. Based on a 5-point Likert scale, the mean score (MS) is

$$MS = \frac{\sum (f \times s)}{N}, \quad (1 \le MS \le 5) \tag{3}$$

where s represents the score from 1 to 5 as assigned by the interviewees of a stakeholder group; f is the frequency of occurrence of each score within a stakeholder group; and N denotes the total number of responses concerning that stakeholder group. This is used to set the weightings for different stakeholder groups in the fuzzy comprehensive evaluation.

The mean score ranking technique was then adopted and the relative importance of each stakeholder group's satisfaction to the overall stakeholder satisfaction was computed by Eq. (3). The mean score of each stakeholder group's satisfaction to the overall stakeholder satisfaction and its ranking are summarized in Table 6. These include the general public (MS = 3.70), government (MS = 3.37), pressure groups (MS = 2.80) and project affected groups (MS = 3.67).

< *Table 6* >

The weighting of a specific stakeholder group is

$$a_i = \frac{MS_i}{\sum_{i=1}^{4} MS_i} \tag{4}$$

where a_i denotes the weighting of the stakeholder group i concerning the importance of its satisfaction to the satisfaction of the overall stakeholders; and MS_i represents the mean score of the stakeholder group i obtained through the interviews.

The weightings of the major concerns of each stakeholder group can be computed in a similar way by using the mean scores obtained through questionnaire survey as shown in Table 4.

5.1.4 Establishing a multi-factor hierarchical fuzzy comprehensive evaluation model

Evaluating stakeholders' satisfaction in MIC projects is a multi-factor hierarchical issue due to the establishment of the hierarchical two-level index system. This necessitates a two-stage fuzzy comprehensive evaluation, during which the satisfaction of a single stakeholder group (i.e. the second-class index) is assessed first, followed by an evaluation of the overall satisfaction of MIC project stakeholders (i.e. the first-class index).

Assessing the satisfaction of a single stakeholder group starts with the establishment of a fuzzy evaluation matrix

$$R_i = \begin{bmatrix} MF_{u_{i1}} \\ MF_{u_{i2}} \\ \cdots \\ MF_{u_{ik}} \\ \cdots \end{bmatrix}$$

for each group where u_{ik} denotes the k^{th} major concern of stakeholder group *i* and $MF_{u_{ik}}$ the membership function of the major concern u_{ik}.

According to Eq. (2), R_i can also be written as

$$R_i = \begin{bmatrix} MF_{u_{i1}} \\ MF_{u_{i2}} \\ \cdots \\ MF_{u_{ik}} \\ \cdots \end{bmatrix} = \begin{bmatrix} P1_{u_{i1}} & P2_{u_{i1}} & P3_{u_{i1}} & P4_{u_{i1}} & P5_{u_{i1}} \\ P1_{u_{i2}} & P2_{u_{i2}} & P3_{u_{i2}} & P4_{u_{i2}} & P5_{u_{i2}} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ P1_{u_{ik}} & P2_{u_{ik}} & P3_{u_{ik}} & P4_{u_{ik}} & P5_{u_{ik}} \\ \cdots & \cdots & \cdots & \cdots & \cdots \end{bmatrix}$$

where $Pt_{u_{ik}}\ (t = 1,2,3,4,5)$ represents the percentage of the respondents from stakeholder group *i* choosing *t* for their satisfaction level concerning the factor u_{ik}. The fuzzy evaluation matrix R_i can be then computed and normalized by considering the weighting matrix of major stakeholder concerns in group *i* (i.e. $A_i = \{a_{i1}, a_{i2}, \ldots, a_{ik}, \ldots\}$), where a_{ik} means the weighting of the k^{th} major concern of stakeholder group *i* through:

$$B_i = A_i \times R_i = \{a_{i1}, a_{i2}, \ldots, a_{ik}, \ldots\} \times \begin{bmatrix} MF_{u_{i1}} \\ MF_{u_{i2}} \\ \cdots \\ MF_{u_{ik}} \\ \cdots \end{bmatrix}$$

$$= \{a_{i1}, a_{i2}, \ldots, a_{ik}, \ldots\} \times \begin{bmatrix} P1_{u_{i1}} & P2_{u_{i1}} & P3_{u_{i1}} & P4_{u_{i1}} & P5_{u_{i1}} \\ P1_{u_{i2}} & P2_{u_{i2}} & P3_{u_{i2}} & P4_{u_{i2}} & P5_{u_{i2}} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ P1_{u_{ik}} & P2_{u_{ik}} & P3_{u_{ik}} & P4_{u_{ik}} & P5_{u_{ik}} \\ \cdots & \cdots & \cdots & \cdots & \cdots \end{bmatrix} = \{b_{i1}, b_{i2}, b_{i3}, b_{i4}, b_{i5}\} \qquad (5)$$

The normalized matrixes $B_i (i = 1,2,3,4)$ constitute another fuzzy evaluation matrix i.e.

$$R = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} \end{bmatrix}$$

where 1, 2, 3 and 4 stand for the general public, government, pressure groups and project affected groups respectively for evaluating overall stakeholder satisfaction. A similar approach is used to normalize *R* considering the weightings of different stakeholder groups in determining overall stakeholder satisfaction (i.e. $A = \{a_1, a_2, a_3, a_4\}$) through:

$$B = A \times R = \{a_1, a_2, a_3, a_4\} \times \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{bmatrix}$$

$$= \{a_1, a_2, a_3, a_4\} \times \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} \end{bmatrix} = \{B_1', B_2', B_3', B_4', B_5'\} \quad (6)$$

The overall stakeholder satisfaction is then finally quantified by taking into account the set of grade alternatives *V* ($V = \{1,2,3,4,5\}$) through Eq. (1) [40]:

$$S = B \times V^T = \{B_1', B_2', B_3', B_4', B_5'\} \times \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{bmatrix}$$

where *S* denotes the overall stakeholder satisfaction involved.

6 A demonstration case

The urban design of the New Central Harborfront in Hong Kong was selected as an example to demonstrate the application of the multi-factor hierarchical fuzzy comprehensive evaluation model for measuring stakeholder satisfaction during public participation in MIC projects. The reasons why this specific case was chosen include: (i) the study area is becoming increasingly important both geographically and economically [64]; (ii) severe debates arose during the design process concerning some controversial issues such as the reassembly of the Queen's Pier [65]; and (iii) a two-stage public participation program was conducted during which public comments were purportedly solicited in an extensive and inclusive manner, as shown in Table 8 [64]. The model was therefore applied to assess how

well the urban design for the New Central Harborfront meets community aspirations, through an open, transparent and collaborative public participation process.

< *Table 8* >

6.1. Determining the membership function of each major concern

The membership function of each major concern of different stakeholder groups is computed according to Eq. (2). For example, take one of the major concerns of general public "Availability of amenities, community and welfare facilities and provision of public open space (u_{11})". Among all the 55 respondents from this stakeholder group (i.e. the general public), 2 (4%) were very satisfied regarding this concern u_{11}, followed by 11 (20%), 29 (53%), 13 (23%) and 0 (0%) in each category of "satisfied", "basically satisfied", "dissatisfied" and "very dissatisfied" respectively. The function membership of u_{11} can be therefore obtained through Eq. (2) as:

$$MF_{u_{11}} = \frac{0.00}{\text{very dissatisfied}} + \frac{0.23}{\text{dissatisfied}} + \frac{0.53}{\text{basically dissatisfied}} + \frac{0.20}{\text{satisfied}} + \frac{0.04}{\text{very satisfied}} = \frac{0.00}{1} + \frac{0.23}{2} + \frac{0.53}{3} + \frac{0.20}{4} + \frac{0.04}{5} \tag{7}$$

which can also be written as (0.00, 0.23, 0.53, 0.20, 0.04). The function membership of the other major concerns of the four different stakeholder groups can be determined similarly as shown in Table 7.

< *Table 7* >

6.2 Developing the weightings of diverse stakeholder groups and major stakeholder concerns

The weightings of the major stakeholder concerns (i.e. the second-class index) and different stakeholder groups (i.e. the first-class index) can be determined according to the mean scores given by the participants involved in either the questionnaire survey or the second-round interviews. For instance, since the top three concerns (F8, F6 and F2) of the general public were given mean scores of 4.95, 4.82 and 4.78 (as shown in Table 3), their respective weightings (i.e. weightings of the second-class index u_{11}, u_{12} and u_{13}) can be calculated through Eq. (4) as:

$$a_{11} = \frac{MS_{u_{11}}}{MS_{u_{11}} + MS_{u_{12}} + MS_{u_{13}}} = \frac{4.95}{4.95 + 4.82 + 4.78} = 0.34 \tag{8}$$

$$a_{12} = \frac{MS_{u_{12}}}{MS_{u_{11}} + MS_{u_{12}} + MS_{u_{13}}} = \frac{4.82}{4.95 + 4.82 + 4.78} = 0.33 \tag{9}$$

$$a_{13} = \frac{MS_{u_{13}}}{MS_{u_{11}} + MS_{u_{12}} + MS_{u_{13}}} = \frac{4.78}{4.95 + 4.82 + 4.78} = 0.33 \tag{10}$$

The weightings of the major concerns of the other three stakeholder groups can be calculated in the similar way as shown in Table 7.

As for the weightings of different stakeholder groups for their importance in determining overall stakeholder satisfaction, the responses of the interviewees can be used (Table 6) and through Eq. (4), the weightings of each stakeholder group (i.e. weightings of the first-class index u_1, u_2, u_3 and u_4) can be computed as:

$$a_1 = \frac{MS_{u_1}}{MS_{u_1} + MS_{u_2} + MS_{u_3} + MS_{u_4}} = \frac{3.70}{3.70 + 3.37 + 2.80 + 3.67} = 0.27 \tag{11}$$

$$a_2 = \frac{MS_{u_2}}{MS_{u_1} + MS_{u_2} + MS_{u_3} + MS_{u_4}} = \frac{3.37}{3.70 + 3.37 + 2.80 + 3.67} = 0.25 \tag{12}$$

$$a_3 = \frac{MS_{u_3}}{MS_{u_1} + MS_{u_2} + MS_{u_3} + MS_{u_4}} = \frac{2.80}{3.70 + 3.37 + 2.80 + 3.67} = 0.21 \tag{13}$$

$$a_4 = \frac{MS_{u_4}}{MS_{u_1} + MS_{u_2} + MS_{u_3} + MS_{u_4}} = \frac{3.67}{3.70 + 3.37 + 2.80 + 3.67} = 0.27 \tag{14}$$

6.3 Evaluating the satisfaction level of each stakeholder group

To evaluate the satisfaction level of a single stakeholder group, a fuzzy evaluation matrix was firstly set up as

$$R_i = \begin{bmatrix} MF_{u_{i1}} \\ MF_{u_{i2}} \\ \cdots \\ MF_{u_{ik}} \\ \cdots \end{bmatrix}$$

for each group where u_{ik} denotes the k^{th} major concern of stakeholder group i and $MF_{u_{ik}}$ stands for the membership function of the major concern u_{ik}. Take the general public (i.e. stakeholder group 1) as an example, a fuzzy evaluation matrix can be established based on the previous results as:

$$R_1 = \begin{bmatrix} MF_{u_{11}} \\ MF_{u_{12}} \\ MF_{u_{13}} \end{bmatrix} = \begin{bmatrix} 0.00 & 0.23 & 0.53 & 0.20 & 0.04 \\ 0.00 & 0.05 & 0.11 & 0.49 & 0.35 \\ 0.00 & 0.09 & 0.42 & 0.36 & 0.13 \end{bmatrix} \tag{15}$$

This can be further normalized by considering the weighting factor matrix of major concerns of stakeholder group 1 as:

$$B_1 = A_1 \times R_1 = \{a_{11}, a_{12}, a_{13}\} \times \begin{bmatrix} MF_{u_{11}} \\ MF_{u_{12}} \\ MF_{u_{13}} \end{bmatrix}$$
$$= (0.34, 0.33, 0.33) \times \begin{bmatrix} 0.00 & 0.23 & 0.53 & 0.20 & 0.04 \\ 0.00 & 0.05 & 0.11 & 0.49 & 0.35 \\ 0.00 & 0.09 & 0.42 & 0.36 & 0.13 \end{bmatrix}$$
$$= (0.000, 0.124, 0.355, 0.349, 0.172) \quad (16)$$

Similarly, the normalized fuzzy evaluation matrixes for stakeholder groups 2, 3 and 4 can be obtained as:

$$B_2 = A_2 \times R_2 = \{a_{21}, a_{22}, a_{23}, a_{24}\} \times \begin{bmatrix} MF_{u_{21}} \\ MF_{u_{22}} \\ MF_{u_{23}} \\ MF_{u_{24}} \end{bmatrix} = (0.000, 0.021, 0.257, 0.3987) \quad (17)$$

$$B_3 = A_3 \times R_3 = \{a_{31}, a_{32}, a_{33}\} \times \begin{bmatrix} MF_{u_{31}} \\ MF_{u_{32}} \\ MF_{u_{33}} \end{bmatrix} = (0.059, 0.322, 0.504, 0.115, 0.000) \quad (18)$$

$$B_4 = A_4 \times R_4 = \{a_{41}, a_{42}, a_{43}, a_{44}\} \times \begin{bmatrix} MF_{u_{41}} \\ MF_{u_{42}} \\ MF_{u_{43}} \\ MF_{u_{44}} \end{bmatrix} = (0.011, 0.155, 0.546, 0.263, 0.025) \quad (19)$$

The level of satisfaction of each stakeholder group can then be quantified through Eq. (1) as:

$$S_1 = B_1 \times V^T = (0.000, 0.124, 0.355, 0.349, 0.172) \times (1,2,3,4,5)^T = 3.569 \quad (20)$$
$$S_2 = B_2 \times V^T = (0.000, 0.021, 0.257, 0.398, 0.324) \times (1,2,3,4,5)^T = 4.025 \quad (21)$$
$$S_3 = B_3 \times V^T = (0.059, 0.322, 0.504, 0.115, 0.000) \times (1,2,3,4,5)^T = 2.675 \quad (22)$$
$$S_4 = B_4 \times V^T = (0.011, 0.155, 0.546, 0.263, 0.025) \times (1,2,3,4,5)^T = 3.136 \quad (23)$$

6.4 Evaluating the overall satisfaction of the MIC project stakeholders

The normalized matrixes $B_i (i = 1,2,3,4)$ constitute another fuzzy evaluation matrix i.e.

$$R = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{bmatrix} = \begin{bmatrix} 0.000 & 0.124 & 0.355 & 0.349 & 0.172 \\ 0.000 & 0.021 & 0.257 & 0.398 & 0.324 \\ 0.059 & 0.322 & 0.504 & 0.115 & 0.000 \\ 0.011 & 0.155 & 0.546 & 0.263 & 0.025 \end{bmatrix}$$

for evaluating overall stakeholder satisfaction. By taking into account the weighting factor sets concerning the relative importance of different stakeholder groups to the overall stakeholder satisfaction, the matrix can be normalized as:

$$\begin{aligned} B = A \times R &= (a_1, a_2, a_3, a_4,) \times \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{bmatrix} \\ &= (0.27, 0.25, 0.21, 0.27) \times \begin{bmatrix} 0.000 & 0.124 & 0.355 & 0.349 & 0.172 \\ 0.000 & 0.021 & 0.257 & 0.398 & 0.324 \\ 0.059 & 0.322 & 0.504 & 0.115 & 0.000 \\ 0.011 & 0.155 & 0.546 & 0.263 & 0.025 \end{bmatrix} \\ &= (0.015, 0.148, 0.414, 0.289, 0.134) \end{aligned} \quad (24)$$

The overall satisfaction of MIC project stakeholders can therefore be quantified through Eq. (1) as:

$$S = B \times V^T = (0.015, 0.148, 0.414, 0.289, 0.134) \times (1,2,3,4,5)^T = 3.379 \quad (25)$$

6.5 Results

The overall satisfaction level of 3.379 indicates the stakeholders in general are satisfied with the urban design of the New Central Harborfront in Hong Kong. However, a significant divergence of satisfaction levels exists among stakeholder groups. While the government are very satisfied with the project (S_2 = 4.025), the satisfaction level of pressure groups falls into the category of "basically satisfied" (S_3 = 2.675). The general public and project affected people, however, believe their expectations are met in the project and therefore are satisfied (S_1 = 3.569 and S_4 = 3.136). Since no one stakeholder group is dissatisfied or very dissatisfied (i.e. $0 \leq S \leq 2$), the participatory exercise of this project is considered as being successful in emphasizing and respecting the rights of all concerned.

7 Discussion

A recurring problem highlighted in the research is the significant divergence of views among stakeholder groups regarding both their expectations in MIC projects and their part in determining overall stakeholder satisfaction. The former phenomenon (i.e. the diversity of concerns held by different stakeholder groups in MIC projects) is a global issue since it is natural for people to want to protect their own interests. However, a consensus cannot be reached among diverse parties if their own interests are overemphasized, irrespective of the existence of any participatory exercise. To overcome this and therefore realize the true spirit of public participation, each stakeholder group needs to comprehensively and thoroughly consider the benefits and costs involved and maintain an effective dialogue with their counterparts in a respectful and inclusive way.

Of course, a consensus can hardly be reached among stakeholder groups regarding their importance in determining their overall satisfaction. Their rankings (in which the general public is ranked first, followed by the project affected people, government and pressure groups as shown in Table 6), however, indicate the significant progress that the Central Government of China and the Government of Hong Kong SAR have made in developing a more transparent, democratic and comprehensive participatory process to cope with the rapid expansion of MIC projects in the territory and increasing expectations of social equality. Controversies can be expected throughout the development of participatory decision making, especially in a country such as China where a culture of compliance and consciousness of "officialdom standards" is deeply rooted. As mentioned by representatives from the general public during the research, *"even if our satisfaction level is considered as the most important when determining overall stakeholder satisfaction in an MIC project or as the most critical standard for measuring project success, it is still the government who decide nearly everything during the process"*.

8 Conclusions

This paper has developed a multi-factor hierarchical fuzzy comprehensive evaluation model to assess stakeholder satisfaction during public participation in major infrastructure and construction projects. The three major steps involved comprise: (i) establishing an evaluation index system; (ii) determining the membership function of each major concern of different stakeholder groups; and (iii) developing appropriate weightings of diverse stakeholder groups and major stakeholder concerns.

Based on the research findings, a two-level evaluation index system was established in which the satisfaction of the four stakeholder groups was defined as the first-class index while the most important concerns of each stakeholder group formed the second-class index. The membership function of each major concern was then determined according to the percentage of the respondents from a certain stakeholder group choosing any of the grade alternatives ($V = \{1, 2, 3, 4, 5\}$, where 1 = very dissatisfied; 2 = dissatisfied; 3 = basically satisfied; 4 = satisfied; and 5 = very satisfied) as their satisfaction level regarding that concern. The technique of mean score ranking was adopted when analyzing the responses obtained from the questionnaire survey and interviews. The mean scores were calculated according to the relative importance of each most important stakeholder concern (i.e. the second-class index) and each stakeholder group (i.e. the first-class index), which then formed a basis when developing the weightings of diverse stakeholder concerns and stakeholder groups.

Instead of evaluating stakeholder satisfaction solely from the viewpoint(s) of a single group or the few selected groups, this multi-factor hierarchical fuzzy comprehensive evaluation model allows a thorough assessment taking the views of all concerned (i.e. the

general public, government, pressure groups and project affected people) into account. Since the concerns of different stakeholder groups are rather diverse, and the roles they play in determining overall satisfaction are rather different, a mismatch may exist among the individuals and between the individual and the whole regarding their satisfaction levels, as demonstrated in the case of the urban design of the New Central Harborfront in Hong Kong. This necessitates effective and persistent communication among all stakeholder groups in a respectful and inclusive manner during participation. In doing this, a balance point can be found where the overall stakeholder satisfaction in MIC projects is maximized while each individual group's satisfaction maintains an acceptable level, helping to engender a harmonious society and a true spirit of public participation.

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TBA

10 References

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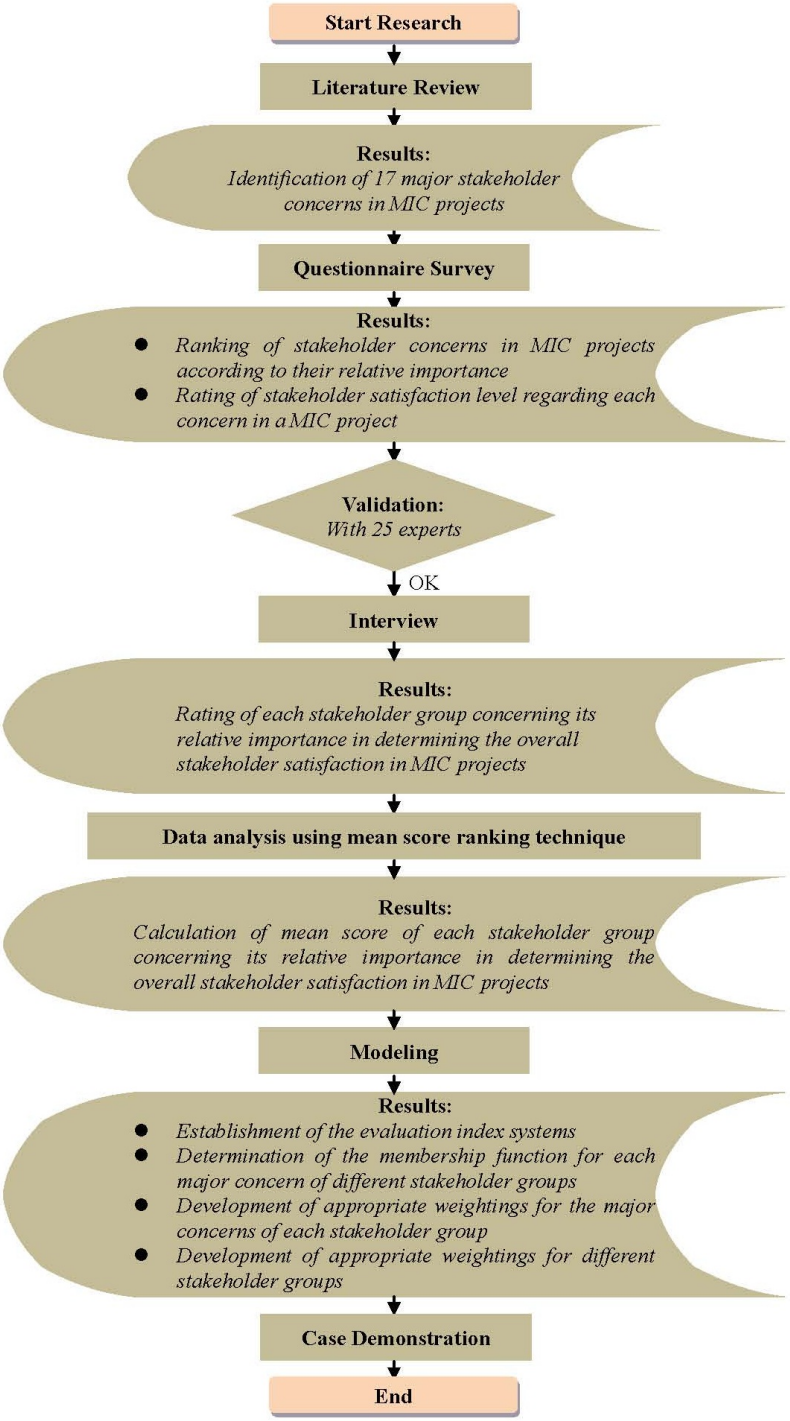

Figure 1: Detailed research process

Table 1: Project program and stakeholder participation activities for the Guangzhou – Shenzhen – Hong Kong Express Rail Link Project (Hong Kong section)

Key dates and duration	***Project program***	***Participatory exercise***	***Duration of stakeholder participation***
10/2007	One of ten major infrastructure projects in policy address	N.A.	
4/2008–11/2008	Preliminary design	District council meetings and rural committee meetings	5/2008–8/2008
		District council meetings, rural committee meetings and exhibition	9/2008–11/2008
11/2008–1/ 2009	Gazettal under the railways ordinance	District council meetings, rural committee meetings and exhibition	12/2008–4/2009
1/2009–4/2009	Detailed design		
4/2009–12/2009	Gazettal amendments under the railways ordinance	District council meetings, rural committee meetings and exhibition	5/2009–9/2009
12/2009–2015	Construction	N.A.	
2015	Completion	N.A.	

Source: [27]

Table 2: Stakeholder concerns in MIC projects

Stakeholder concerns in MIC projects	*PD, 2003*[1] [66]	*PD, 2006*[1] [67]	*CEDD, 2008*[2] [68]	*WKCDA, 2010*[3] [69]	*URA, 2001*[4] [70]	*M-NCPPC, 2001*[5] [71]	*Tang et al., 2008* [72]	*Lu et al., 2002* [73]	*Wang et al., 2007* [74]	*Tanaka, 2005* [75]	*Palerm, 1999* [76]	*Tam et al., 2009* [17]	*Amado et al., 2009* [77]
F1. Adaptability of development to the changing needs	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
F2. Availability of local job opportunities			✓				✓	✓	✓		✓		✓
F3. Economic benefits to government and local citizens	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓
F4. Harmonious development of different local economic activities		✓	✓	✓		✓	✓	✓	✓		✓	✓	✓
F5. Value-for-money of the proposed project(s)				✓		✓			✓	✓	✓	✓	✓
F6. Access to work and locations of activities	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓
F7. Creation of a safe, convenient, comfortable and legible pedestrian circulation and transport network	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓
F8. Availability of amenities, community and welfare facilities and provision of public open space	✓	✓	✓	✓	✓	✓				✓		✓	✓
F9. Being functional and acceptable in terms of tariff to diversified social groups			✓	✓					✓		✓		✓
F10. Green and sustainable design and construction		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
F11. Prevention and mitigation measures against air, water and noise pollution	✓	✓	✓	✓		✓	✓	✓		✓	✓		
F12. Building design in terms of aesthetics, density, height and visual permeability	✓	✓	✓	✓	✓	✓				✓		✓	✓
F13. Harmonization of the proposed project(s) with local natural setting	✓	✓	✓			✓		✓	✓	✓	✓		✓
F14. Unique local characters	✓	✓		✓	✓	✓	✓			✓		✓	✓
F15. Conservation of local cultural and historical heritage	✓	✓	✓	✓	✓						✓		✓
F16. Compensation and relocation plan/strategy				✓	✓		✓		✓		✓		✓
F17. Identity of our city and international reputation				✓		✓	✓	✓	✓	✓		✓	✓

PD[1]*: Planning Department, HKSAR Government*
CEDD[2]*: Civil Engineering and Development Department, HKSAR Government*
WKCDA[3]*: West Kowloon Cultural District Authority, HKSAR Government*
URA[4]*: Urban Renewal Authority, HKSAR Government*
M-NCPPC[5]*: The Maryland-National Capital Park and Planning Commission, USA*

Table 3: Profile of respondents

Group	***No. of respondents***	***Percentage of overall respondents***	***No. of those with sufficient knowledge and practical experience in public participation***	***Percentage of experienced respondents***
General public	55	27.6%	27	49.1%
Government department	46	23.1%	40	87.0%
Pressure groups (NGOs)	45	22.6%	38	84.4%
Project affected groups	53	26.7%	50	94.3%
Total	199	100%	155	77.9%

Table 4: Rankings of respondents' opinions of stakeholder concerns in MIC projects

Stakeholder concerns in MIC projects		***General public***		***Government departments***		***Pressure groups***		***Project affected groups***	
		Mean	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*
F1.	Adaptability of development to the changing needs (u_{22})	4.07	7	4.67*	2	3.27	14	3.38	11
F2.	Availability of local job opportunities (u_{13})	4.78*	3	4.28	4	3.69	6	3.74	6
F3.	Economic benefits to government and local citizens (u_{21})	4.40	4	4.72*	1	3.22	15	2.77	16
F4.	Harmonious development of different local economic activities (u_{23})	3.40	11	4.48**	3	3.49	9	3.21	12
F5.	Value-for-money of the proposed project(s) (u_{32})	2.96	14	3.63	10	4.58*	2	3.15	14
F6.	Access to work and locations of activities (u_{12})	4.82*	2	3.28	12	3.53	8	3.55	9
F7.	Creation of a safe, convenient, comfortable and legible pedestrian circulation and transport network (u_{44})	3.98	8	3.80	8	3.44	10	4.17**	4
F8.	Availability of amenities, community and welfare facilities and provision of public open space (u_{11})	4.95*	1	3.07	15	3.76	5	3.53	10
F9.	Being functional and acceptable in terms of tariff to different social groups	4.36	5	2.80	17	3.69	7	3.87	5
F10.	Green and sustainable design and construction (u_{31})	3.33	13	3.15	14	4.67*	1	3.08	15
F11.	Prevention and mitigation measures against air, water and noise pollution	4.16	6	3.96	6	3.89	4	3.68	8
F12.	Building design in terms of aesthetics, density, height and visual permeability (u_{42})	3.36	12	3.24	13	3.36	12	4.49**	2
F13.	Harmonization of the proposed project(s) with local natural setting	2.07	17	2.98	16	3.42	11	3.19	13
F14.	Unique local characteristics (u_{43})	2.82	16	3.43	11	3.33	13	4.38**	3
F15.	Conservation of local cultural and historical heritage (u_{33})	3.53	9	3.76	9	4.47**	3	3.72	7
F16.	Compensation and relocation plan / strategy (u_{24}) (u_{41})	2.84	15	4.26**	5	3.09	16	4.79*	1
F17.	Identity of our city and international reputation	3.45	10	3.87	7	2.24	17	2.36	17

*Note: * represent those extremely important concerns as rated by the respondents of the questionnaire survey*
*** represent those concerns added to the group labeled as 'extremely important' according to the comments of the interviewees through the validation interviews*

Table 5: Profile of interviewees

Group	***No.***	***Position***	***Organization Type***
Government department	1	Deputy Director	Provincial bureau
	2	Director	Municipal commission
	3	Deputy Director	Municipal commission
	4	Deputy Director	Provincial bureau
	5	Deputy Director	Municipal bureau
General public (*who are currently or have previously been participants in the public participation activities)*	6	The Lay Public	N.A.
	7	The Lay Public	N.A.
	8	The Lay Public	N.A.
	9	The Lay Public	N.A.
	10	The Lay Public	N.A.
Project affected group (*who are currently or have previously been affected by the development of MIC schemes)*	11	Project affected people	N.A.
	12	Project affected people	N.A.
	13	Project affected people	N.A.
	14	Project affected people	N.A.
	15	Project affected people	N.A.
Private sector	16	Project Manager	Real estate corporation
	17	General Manager	Construction company
	26*	Deputy General Manager	Construction company
	27*	Project Advisor	Real estate corporation
	28*	Executive Director	Design company
Professional organizations / universities	18	Associate Professor	Educational institution
	19	Deputy Director	National research centre
	20	Director	Research centre
	29*	Professor	Educational institution
	30*	Director	Provincial research centre
Pressure groups (NGOs)	21	Member	NGO
	22	Director	Environmental group
	23	Member	Environmental group
	24	Member	Environmental group
	25	Director	Environmental group

*Note: * represent those who agreed to participate after the follow up invitation*

Table 6: Importance of a single stakeholder group's satisfaction compared with the satisfaction of stakeholders overall

Group	***Interviewee***	***Importance of a Single Stakeholder Group's Satisfaction compared to the Satisfaction of Overall Stakeholders***			
		General public	*Government departments*	*Pressure groups*	*Project affected groups*
Government departments	1	3	4	3	4
	2	2	5	2	3
	3	3	5	2	3
	4	4	4	2	3
	5	2	5	2	4
General public	6	5	3	3	4
	7	5	2	3	3
	8	5	3	2	2
	9	4	4	3	4
	10	5	4	3	3
Project affected groups	11	3	1	2	5
	12	2	2	2	4
	13	3	2	3	5
	14	3	3	2	5
	15	3	3	3	5
Private sector	16	4	4	2	4
	17	3	4	3	2
	26	3	4	2	3
	27	4	4	1	4
	28	3	3	2	4
Professional organizations / universities	18	5	3	3	4
	19	4	5	3	4
	20	3	4	3	4
	29	4	4	3	3
	30	5	5	2	4
Pressure Groups (NGOs)	21	4	2	4	4
	22	4	1	5	3
	23	4	3	4	3
	24	5	3	5	4
	25	4	2	5	3
Mean score		3.70	3.37	2.80	3.67
Ranking		1	3	4	2

Table 7: Fuzzy comprehensive evaluation model for stakeholder satisfaction with MIC projects

	First-class Index *(U)*	***Weight*** *(A)*	***Second-class Index***	***Weight*** *(a)*	***Membership Function for Each Major Concern*** *Very dis-satisfied* [0,1)	*Dis-satisfied* [1,2)	*Basically satisfied* [2,3)	*Satisfied* [3,4)	*Very satisfied* [4,5)
Overall satisfaction of MIC stakeholders (*S*)	u_1: Satisfaction of general public	a_1=0.27	u_{11}: Availability of amenities, community and welfare facilities and provision of public open space	a_{11}=0.34	0.00	0.23	0.53	0.20	0.04
			u_{12}: Access to work and locations of activities	a_{12}=0.33	0.00	0.05	0.11	0.49	0.35
			u_{13}: Availability of local job opportunities	a_{13}=0.33	0.00	0.09	0.42	0.36	0.13
	u_2: Satisfaction of government departments	a_2=0.25	u_{21}: Economic benefits to government and local citizens	a_{21}=0.26	0.00	0.00	0.15	0.48	0.37
			u_{22}: Adaptability of development to the changing needs	a_{22}=0.26	0.00	0.00	0.28	0.37	0.35
			u_{23}: Harmonious development of different local economic activities	a_{23}=0.25	0.00	0.00	0.24	0.37	0.39
			u_{24}: Compensation and relocation plan/strategy	a_{24}=0.23	0.00	0.09	0.37	0.37	0.17
	u_3: Satisfaction of pressure groups	a_3=0.21	u_{31}: Green and sustainable design and construction	a_{31}=0.34	0.00	0.20	0.58	0.22	0.00
			u_{32}: Value-for-money of the proposed project(s)	a_{32}=0.33	0.09	0.35	0.49	0.07	0.00
			u_{33}: Conservation of local cultural and historical heritage	a_{33}=0.33	0.09	0.42	0.44	0.05	0.00
	u_4: Satisfaction of project affected groups	a_4=0.27	u_{41}: Compensation and relocation plan / strategy	a_{41}=0.27	0.02	0.15	0.60	0.23	0.00
			u_{42}: Building design in terms of aesthetics, density, height and visual permeability	a_{42}=0.25	0.00	0.19	0.55	0.26	0.00
			u_{43}: Unique local characters	a_{43}=0.25	0.02	0.15	0.60	0.23	0.00
			u_{44}: Creation of a safe, convenient, comfortable and legible pedestrian circulation and transport network	a_{44}=0.23	0.00	0.13	0.42	0.34	0.11

Table 8: Public participation program for the urban design of the New Central Harborfront in Hong Kong

Public Participation Program	***Duration of the Participatory Exercise***	***Detailed Public Participation Activities***	***Participatory Techniques***	***Scope of the Involved Public***
Stage 1	3 May 2007 – 30 September 2007	(i) Solicit public views on the urban design objectives and issues, sustainable design assessment frameworks and urban design considerations for the key sites; (ii) Consult the community on the possible locations and design ideas for re-assembling Queen's Pier and reconstructing the Old Star Ferry Clock Tower.	Focus group workshop; community engagement forum; roving exhibition; questionnaire survey	Professional and academic institutions; general public and concerned parties; Town Planning Board, Harbor Front Enhancement Committee; relevant District Councils and other relevant advisory bodies
Stage 2	11 April 2008 – 31 August 2008	Collect public views on the urban design vision and refined urban design framework for the New Central Harborfront as well as the design concepts for the key sites including those for reassembling Queen's Pier and reconstructing the Old Star Ferry Clock Tower.	Public exhibitions; roving exhibitions; focus group workshop; community engagement forum; comment cards; telephone polls; face-to-face interviews; inviting written submissions; briefings; consolidation forum	Legislative Council; the Board, Harbor-front Enhancement Committee (HEC), District Councils (DCs), academic and professional institutes and other relevant public and advisory bodies.

Source: [64]