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An optimization model for managing stakeholder conflicts in urban redevelopment projects in China

Abstract

The rapid urbanization process in China has given rise to a number of sustainability issues, including land shortages, concentrated areas of poverty, inefficient land use, and environmental pollution. Urban redevelopment has been identified as an effective method for addressing these issues and establishing new modes of sustainable urban development. In practice, urban redevelopment projects typically involve a range of stakeholders with competing claims. Managing the conflicting interests of these stakeholders presents a significant challenge to the success of urban redevelopment. In this study, we proposed a model for analyzing stakeholder conflicts in urban redevelopment projects based on the stakeholder salience theory and Pawlak's conflict theory. In this model, the attributes, key concerns, and attitudes of different stakeholders are captured by empirical investigation and salience analysis. Stakeholder conflicts are then quantified using Pawlak's conflict theory with consideration of stakeholder specifics. Finally, an action scheme is generated that mitigates stakeholder conflicts and maximizes project benefits. To evaluate its effectiveness, we applied this model to a real redevelopment project in the Wenzhou Ecological Park. The results indicate that this model can be used to balance the interests of stakeholders and reduce stakeholder conflicts in urban redevelopment projects in China.

1. Introduction

In recent decades, China has experienced rapid urbanization as a result of the reform and easing of policies issued in December 1978. China's urbanization rate reached 58.52% in 2017, which was more than three times that in 1979, with approximately 813.47 million residents currently living in urban areas (China Statistics Bureau, 2018). This rapid urbanization has given rise to a number of sustainability issues, including land shortages (Xue et al., 2015), concentrated areas of poverty (Liu and Wu, 2006), inefficient land use (Tian et al., 2017), uncontrolled urban sprawl, and environmental pollution (Han et al., 2014).

To address these issues, the central government of China began regulating urban redevelopment as a way to establish effective modes of sustainable urban development (Xue et al., 2015; Peng et al., 2015). The reuse and redevelopment of unsustainable urban areas will enhance the efficiency of urban infrastructure (Peng et al., 2015), optimize urban land use, improve environmental quality (Zheng et al., 2014), reduce energy use (Mahzouni, 2018), and mitigate the adverse impacts incurred by climate change (Hou et al., 2018). A series of urban redevelopment projects (URPs) such as the redevelopment of the Dongcheng District in Beijing (Shin, 2009), the "Urban Renewal 365" program in Shanghai (Shih, 2010), and the redevelopment of urban villages in Guangzhou (Chung and Zhou, 2011), have been conducted to achieve multiple goals associated with sustainable development. Incentive policies and laws have been enacted to facilitate these URPs, such as the "Urban Renewal Strategy" in Hong Kong, the "Detailed Rules for the Implementation of Urban Redevelopment in Shenzhen" and the "Rules for the Implementation of Urban Renewal in Shanghai" (Yu et al., 2017a).

With the rapid promotion of urban redevelopment, various stakeholders with competing claims have been deeply affected by URPs (Yu et al., 2017a, 2017b). The conflicting interests of these stakeholders have become a significant challenge to the success of URPs. For example, in the Hongqiao Comprehensive Transport Hub of Shanghai, the economic conflicts between relocated households and local governments has

led to serious and violent resistance, which has adversely affected public opinion regarding this project and caused significant schedule delays. In the redevelopment of the Hung Hom Estate in Hong Kong, sharp conflicts among its developers, the general public, non-government organizations, relocated households, and local governments emerged during the planning stage, which resulted in the termination of the entire project (Chu, 2008). In the URPs of Baizhang Street in Ningbo, 16 group disputes arose due to stakeholder conflicts regarding benefit allocations to more than 2000 households (Zheng, 2005). Courts at various levels in China have received approximately 800,000 cases of administrative dispute cases from 2011 to 2015, more than 40% of which were due to housing demolitions associated with URPs (Beijing Cailiang Law Firm, 2016).

Since URPs play an important role in addressing the sustainability issues associated with the rapid urbanization in China (Peng et al., 2015; Liu et al., 2018), stakeholder conflicts in URPs can adversely affect sustainable urban development in China. According to Yu et al. (2017b) and Dempsey et al. (2011), stakeholder satisfaction is a key indicator for measuring the social dimension of sustainable development. Stakeholder conflicts significantly reduce the level of stakeholder satisfaction in URPs. In addition, the existence of good relationships among different stakeholders has been highlighted as being important social capital for sustainable development (Qiao et al., 2018). Stakeholder conflicts can damage social relationships and adversely affect the accumulation of social capital in urban redevelopment. Furthermore, in China, social harmony has been proposed by the central government as one of the most important strategies for sustainable development. Violent housing demolitions and mass incidents arising from stakeholder conflicts in URPs have a significantly negative impact on the promotion of this strategy (Yu et al., 2017a). Accordingly, there is sufficient evidence that managing stakeholder conflicts is critical in the sustainable development of URPs in China.

Numerous studies have been conducted to identify, quantify and mitigate stakeholder conflicts in URPs, with the majority utilizing questionnaire surveys or basing their analyses on game theory. Questionnaire surveys have been widely used for the identification of conflicts, and can generate comprehensive lists of key stakeholder concerns (Li et al., 2012). For example, Zhuang et al. (2017) investigated the expectations of different stakeholders in URPs and identified potential conflicts arising from the economic, social, and environmental expectations of stakeholders. Wang et al. (2017) examined the key interests of governments, developers, and local residents in urban redevelopment and developed an evaluation system for balancing the interests of different stakeholder groups. Yu et al. (2017b) employed a questionnaire to identify the key concerns of stakeholders during the housing demolition stage of URPs and established an indicator system for assessing the social sustainability of housing demolition.

The game theory approach has been utilized to quantify the economic conflicts among different stakeholders in URPs on the basis of theoretical assumptions, utility analyses, and mathematical derivations (Hu, 2005). The research focus of these game-theorybased studies has been stakeholder conflicts in housing demolition and relocation (HDR), particularly the stakeholder conflicts associated with relocation compensation and violent incidents (Yang and Chang, 2007; Hu, 2005; Peng and Deng, 2009). For example, Hu (2005) applied game theory to investigate the conflicts between local governments and property developers in HDR and argued that local governments should expend more effort in supervising the illegal behaviors of developers who carry out violent demolition and provide inadequate relocation compensation. In the game model established by Liu and Yin (2012), the researchers investigated the dynamic characteristics of stakeholder behaviors in HDR. They found that stakeholder conflicts were typically caused by forced demolition activities and unreasonable claims for relocation compensation. Grounded in evolutionary game theory, Liu et al. (2014) analyzed the conflict between local governments and relocated households that lead to mass incidents. The authors stated that a quantitative approach for evaluating fair compensation should be developed for inclusion in the current URP regulations of China, which would undoubtedly help to reduce the number of mass incidents.

Despite the significant contributions of previous studies, the majority have focused on the general principles of conflict management and provide no action schemes for mitigating stakeholder conflicts or balancing the interests of different stakeholder groups. Questionnaire-based studies typically focus on conflict identification and game-theory-based studies typically focus on the formation and evolution mechanism of stakeholder conflicts. Practitioners may have gained a keen understanding of the factors that can lead to stakeholder conflicts and how stakeholder conflicts develop and emerge in their URPs, but can propose no effective action schemes for addressing these challenges. An effective conflict analysis tool must be developed to help practitioners formulate strategies for mitigating stakeholder conflicts in URPs. To bridge this research gap, in this study, we developed a conflict analysis model based on stakeholder salience theory and Pawlak's conflict theory. This model can be used to quantify stakeholder conflicts with consideration given to stakeholder specifics. Based on the results of an optimization analysis, an action scheme can be designed to mitigate stakeholder conflicts and maximize project benefits. We tested the practical effectiveness of this model in a real urban redevelopment project in the Wenzhou Ecological Park.

2. Research methods and design

2.1. Stakeholder salience theory

As diverse stakeholders play different roles in any given project, when designing management schemes, managers must evaluate the impacts of these stakeholders with respect to their varied attributes (Olander, 2007). In conflict management, the abilities of stakeholders to influence a project can significantly affect the degree of stakeholder conflict as well as the strategies for conflict mitigation (Li et al., 2015). Therefore, for conflict management, stakeholder analysis is essential for quantifying stakeholder attributes and evaluating the ability of each stakeholder group to have an impact on the URP, which we refer to as their 'impact ability.'

Three measurement tools have been widely used for stakeholder analysis in construction projects, including the stakeholder cycle, social network analysis and stakeholder salience (Mok et al., 2015). In qualitative analyses, the stakeholder cycle is used for stakeholder identification, classification, and visualization (Mok et al., 2015). However, this method cannot be used to quantitatively measure the impact abilities of stakeholders, which limits its effectiveness in conflict management. Social network analysis has been widely utilized to analyze the inter-relationships among various stakeholders and to evaluate the impact ability of each stakeholder group (Yu et al., 2017a). In URPs, one stakeholder group can comprise thousands of households or individuals. Therefore, the difficulties of data collection significantly limit the application of this method.

Unlike the stakeholder circle and social network analysis, stakeholder salience can be used to measure stakeholder attributes and to quantitatively assess the impact abilities of stakeholders based on empirical data collected from representative individuals of each stakeholder group. The data used in this method can be easily collected through interviews or questionnaires. Accordingly, in this study, we selected stakeholder salience as our approach for the analysis of stakeholder attributes.

In the salience model, three key attributesdpower, urgency, and legitimacyd are used initially to map the stakeholder characteristics (Mitchell et al., 1997). Based on the distribution of these three attributes, decision-makers can determine which stakeholders may exert a significant impact on the project (Yang, 2010). To define these three attributes, the power of a stakeholder group depends on its ability to mobilize social and political forces and control key resources that determine the survival and development of the organization (Yang, 2010; Aaltonen et al., 2015). Urgency refers to "the degree to which stakeholder claims call for immediate attention (Mitchell et al., 1997)." Legitimacy is defined as "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of

norms, values, beliefs and definitions (Mitchell et al., 1997)." Typically, a high level of legitimacy means that a claim is reasonable or proper. By integrating these three attributes, scholars such as Olander (2007) have developed a "stakeholder index" to reflect the impact abilities of different stakeholders. Compared with the original model developed by Mitchell et al. (1997), Olander's improved model can be used to evaluate the impact abilities of stakeholders using a simple and comprehensive approach based on the final value of a composite index. Therefore, in this study, we utilized this index for our stakeholder analysis.

2.2. Pawlak's conflict theory

Generally speaking, three main theories are used to quantify stakeholder conflicts: game theory (Yang and Zhang, 2012; Xu and Shi, 2012; Hu, 2005; Liu and Yin, 2012), system theory (Shi et al., 2016), and Pawlak's conflict theory (Shi et al., 2016).

Game theory has been widely adopted in analyses of stakeholder conflicts in URPs (e.g., Yang and Chang, 2007; Liu and Yin, 2012; Liu et al., 2014; Hu, 2005; Peng and Deng, 2009). However, the majority of these studies are based on theoretical assumptions that have not been empirically validated. Due to their failure to consider project specifics, the practical value of these studies is relatively limited. In system theory, stakeholders are viewed as subsystems or basic elements of a parent system, and the analysis of conflicts must be based on a holistic understanding of the parent system (Blanchard et al., 1990). This method is a typical dataintensive tool that requires a large amount of information about the parent system. However, due to the lack of any mature URP database, this method has not been widely adopted in fields related to URPs.

Compared with the above two methods, we consider the conflict theory developed by Pawlak to be more applicable here (Pawlak, 1984, 1998, 2005). First, this method can be used to systematically identify conflicts among different stakeholders involved in an activity, as well as to quantify the degrees of stakeholder conflicts (An et al., 2002; Gao et al., 2008). Second, this method can integrate conflict theory with empirical data that can be easily collected from real projects (e.g., Shi et al., 2016). Finally, by calculating the degree of conflict, this method can provide valuable suggestions for balancing and alleviating stakeholder conflicts. For these reasons, we used Pawlak's conflict theory to investigate the conflicting interests of key stakeholders in URPs.

2.3. Research design

Fig. 1 shows a diagram of the research design used in this study. To analyze and manage stakeholder conflicts in URPs, we developed a model based on the theoretical foundation of the stakeholder salience theory and Pawlak's conflict theory. This model comprises three key components: stakeholder analysis, conflict analysis, and decision-making optimization.

We based the stakeholder analysis component on the stakeholder salience theory, as improved by Olander (2007). This theory is based on three traditional stakeholder attributes (i.e., power, urgency, legitimacy) as well as the vested interest impact (i.e., probability of impact and impact level). Based on the examination of these stakeholder attributes, the results of the stakeholder analysis can be used to determine the impact ability of each stakeholder group in a URP.

The conflict analysis component is grounded in the conflict model established by Pawlak (1998), wherein the key concerns of each stakeholder group, the impacts of these concerns, and the stakeholders' attitudes towards these concerns are investigated. The quantification of the degree of conflict is based on Pawlak's conflict analysis model, with which the key stakeholder conflicts in a URP can be identified and the overall degree of stakeholder conflict can be evaluated.

The decision-making optimization component integrates the results obtained from the stakeholder and conflict analyses. Here, the attributes of different stakeholders and the degree of stakeholder conflict are fully reflected. Based on the optimization analysis, the model generates an optimal action scheme that enables decision-makers to maximize stakeholder benefits and minimize stakeholder conflicts. We describe our development of the conflict analysis model in detail in section 3.

After developing the model, we applied it to optimize the conflict management practices of a real case in Wenzhou, i.e., the Sanglangqiao project. Key stakeholders in the project were identified and investigated, and we tested the robustness and effectiveness of the conflict analysis model based on the empirical data collected from interviews and project documents.

3. Model development

3.1. Stakeholder analysis based on stakeholder salience theory

In URPs, diverse stakeholders have different levels of ability to affect the formation and evolution of stakeholder conflict. To determine the impact abilities of different stakeholders, we used an improved stakeholder salience model to quantify the attributes of the key stakeholders.

According to the study conducted by Mitchell et al. (1997), the overall attribute value of a stakeholder group can be expressed as AT ¼ m_1,U_i þ m_2,L_i þ m_3,P_i, where m_i refers to the weight of each attribute ðm_1þ m_2þ m_3 ¼ 1Þ, and P_i; U_i and L_i reflect the power, urgency, and legitimacy of stakeholder i, respectively (Olander, 2007; Li et al., 2015).

In addition to these three traditional attributes, scholars have suggested that the use of a vested interest impact index should be considered when determining the impact abilities of different stakeholders (Olander, 2007; Li et al., 2015; Bourne and Walker, 2005). This index can be measured on a 5-point Likert scale (1 ¼ 'very low' and 5 ¼ 'very high', Bourne and Walker, 2005), and

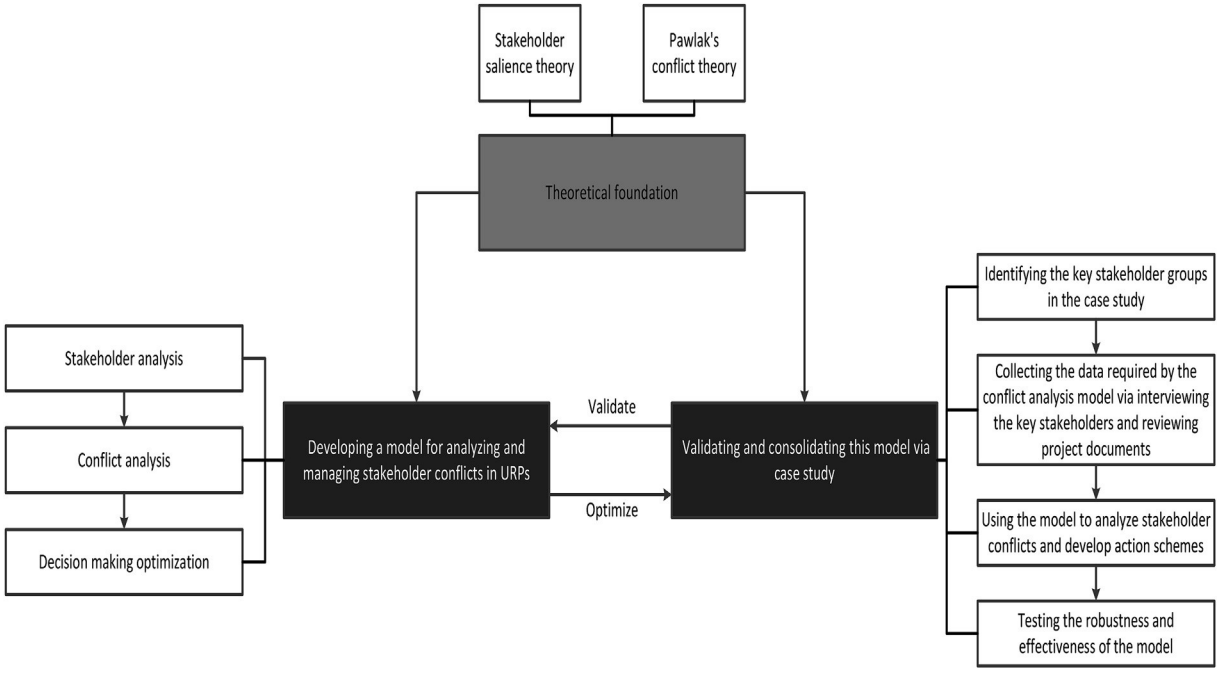

Fig. 1. Research design.

can be expressed as VI ¼ q^{pr}$_{25}$^{im}ffi, where im denotes the potential level of stakeholder impact and pr denotes the probability of impact. By integrating the traditional salience model with the vested interest impact index, the adjusted salience function is expressed as follows:

ðm$_1$,U$_i$ þm$_2$,L$_i$ þm$_3$,P$_i$Þ,VI$_i$

SI$_i$ ¼ ——— (5) ¼ ——— i 2 i 3 i q^{pr,im} 25 / 5 (1)

ðm1,U þm ,L þm ,P Þ

compensation). As in the study conducted by Pawlak (1998), the attitude of stakeholder i toward concern k can be denoted as a_{ik}2 f 1; 0; 1g, where 1 reflects a negative attitude, 0 indicates a neutral standpoint, and 1 denotes a positive attitude. According to Pawlak (1998) and Li et al. (2015), the stakeholder attitude a_{ik} can be calculated using Formula 2. In practice, individuals within the same stakeholder group can hold different viewpoints about a matter of concern. Therefore, the voice of the majority must be captured to reflect the general attitude of this stakeholder group. In Formula 2, a_{ik} is called the Certainty Index (Pawlak, 1998).

8>>< 01;;oovverer5050%%of respondents from stakeholder group i show neutral attitudesof respondents from stakeholder group i show negative attitudes

aik ¼ >>: þRe1; oveervaluate50% of respondents from stakeholder group i show positi; none of the three attitudes receive over 50% of respondentsve attitudes (2)

3.2. Conflict analysis based on Pawlak's conflict theory

3.2.1. Conflicts between stakeholder groups

In this section, we use Pawlak's conflict theory to evaluate the conflicting interests of different stakeholders in URPs. The theoretical foundations and mathematical derivations of this conflict model can be found in Pawlak (1984), Pawlak (1998), and Gao et al. (2008). In these studies, conflict is defined as that occurring between different stakeholders with respect to similar concerns. Stakeholder concerns typically reflect key points that affect the interests of the stakeholders (e.g., the level of relocation The conflict between stakeholder groups i and j (isj) with respect to concern k can be mapped using Formula 3. In this formula, if two stakeholder groups share the same negative or positive attitude toward concern k, then they have a common interest with respect to this concern. If one stakeholder group has this concern whereas the other opposes it, then these two stakeholder groups have conflicting interests toward concern k. If one of the two stakeholder groups holds a neutral viewpoint regarding concern k, then these stakeholders are considered to have a neutral relationship with respect to this concern.

1;if a^{ik},a^{jk} ¼ 1;alliance scði;jÞk ¼ <8 0; if aik,ajk ¼ 0; neutrality$_{1;conflict}$ (3) : $_{1;\ if\ a}$ik,ajk ¼

Based on the logic of Formula 3, Pawlak (1998) proposed a formula for calculating the degree of conflict as the function shown in
Formula 4, where a high value of sc*ði; jÞk indicates a sharp conflict between stakeholder groups i and j with respect to concern k.

sc*ði;jÞk ~~¼1sc2ði;jÞk ¼1a2ik~~,ajk ¼ 8<010:;5;if a;if aif aikik,ik,a,ajkajkjk¼¼¼101 (4) :

3.2.2. Stakeholder conflicts in different action schemes

Previous studies have generally focused on analyzing the inherent conflicts among different stakeholders without giving sufficient consideration to the important role of action schemes. In practice, different action schemes selected by a decision-maker can result in different levels of stakeholder conflict. For example, if an action with respect to concern k can satisfy the demands of the majority of the stakeholders involved, then this action will incur a low degree of stakeholder conflict. Suppose there are sn types of stakeholder groups and n stakeholder concerns in a project. The actions taken that relate to these concerns can incur different levels of stakeholder conflict. In light of the three types of attitude proposed by Pawlak (1998), we assume that the project decisionmaker can take three types of actions to influence each stakeholder concern, i.e., positive, negative, and neutral. A positive action is one that will support stakeholder group(s) having positive attitudes toward concern k, i.e., increase the level of concern k; a neutral action will not significantly affect the level of concern k; and a negative action will support stakeholder group(s) with negative attitudes toward concern k, i.e., reduce the level of concern k. When an action scheme $!_D$ ¼ ð ; d_2;/; d_k;/ ; d_nÞ is carried out, the conflict between this action scheme and stakeholder i toward concern k can be quantified using Formula 5 (derived based on Formula 4). In Formula 5, if the actions support the attitude of stakeholder group i, then the degree of conflict associated with stakeholder group i will be 0. If the actions neither support nor oppose the attitude of stakeholder group i, then the degree of conflict will be 0.5. If the actions oppose the attitude of stakeholder group i, then the degree of conflict will be 1.

sc^dðiÞk ¼ ~~$^{1\ a\_ik,dk\ ¼1}_{2}$~~:<8 $0_1$0:;5;;$_{if\ a}$if aif aik^{ik},ik,$_d$,dkd^k_k¼ ¼¼10_1 (5)

As mentioned in subsection 3.1, the impact abilities of stakeholder groups can modify the degrees of stakeholder conflict in URPs. A stakeholder group with a high stakeholder index value can amplify the effect of conflicts associated with this group (Li et al., 2015). Accordingly, we integrated Formula 5 into these stakeholder indexes, as shown in Formula 6. scd*ðiÞk ¼ SIi,scdðiÞk ¼ SIi,1 a2ik,dk

0; if aik,dk ¼ 1

¼ <8 0:5SIi; if aik,dk ¼10 (6)

: SIi; if aik,dk ¼

A stakeholder concern can also have different levels of impact on different stakeholder groups. For example, in a URP, the amount of relocation compensation can significantly affect the key interests of the relocated residents, but this concern will have no major impact on the general public. If the decision-maker significantly lowers the compensation standard, the stakeholder conflict associated with the relocated residents can be very intense, while the level of stakeholder conflict associated with the general public can be low. Considering the impacts of a concern on the interests of different stakeholder groups, we modified Formula 6 to calculate the degree of conflict (see Formula 7), where b_{ik} denotes the benefit impact of concern k on stakeholder i, where b_{ik} depends on the preferences of different stakeholders (Mostafa and El-Gohary, 2014). A high b_{ik} value indicates that concern k can significantly affect the interests of stakeholder group i. This parameter can be assessed on a 5-point Likert scale in self-evaluations performed by the corresponding stakeholders (Mostafa and El-Gohary, 2014).

scd**ðiÞk ¼ SIi;~~bik,1 a2~~ik,dk ¼ <8 0SI:5iSI,0b;,ikb;if aikif a;ikif a,ikd,kikd¼,kd¼ 1k ¼1 0 i

=

(7)

The total degree of stakeholder conflict arising from decision scheme !D can be calibrated using Formula 8.

SCT!D ¼ XsnXn scd**ðiÞk ¼ XsnXn SIi,~~bik,1 a2ik~~,dk (8)

i¼1 k¼1 i¼1 k¼1

3.3. Optimization of conflict mitigation

Based on the definitions of the three types of stakeholder attitudes (see Pawlak, 1998), we can calculate the variations in stakeholder benefits when an action scheme is carried out. A few rules must be followed, as outlined in the propositions by Pawlak (1998). 1) If stakeholder group i holds a neutral attitude toward concern k, then any actions taken with respect to this concern do not significantly affect the interests of this stakeholder group. 2) If stakeholder group i holds a positive or negative attitude toward concern k, then a variation in concern k can affect the benefit of stakeholder group i. In such cases, if the attitude of this stakeholder group can be supported by the actions taken by the decision-maker, i.e., $a_{ik},d_k ¼ 1$, then they can benefit from this decision. If the actions taken by the decision-maker go against their attitude, i.e., $a^{ik},d^k ¼$ 1, then the benefit of this stakeholder group will be adversely affected. If the decision-maker takes no action with respect to concern k, then the stakeholder benefit is unaffected.

In light of these rules, we propose Formula 9 for calculating the variations in the benefit experienced by each stakeholder group. B_{ik} denotes the variation in the benefit of stakeholder i, when action d_k (toward concern k) is taken. As noted above, b_{ik} denotes the benefit impact of concern k on stakeholder group i. A high b_{ik} value indicates that action d_k can significantly affect the interests of stakeholder group i. B_{ik} is the net effect of action d_k, which reflects the gap between the added revenue and costs incurred by the variation in concern i.

Bik ¼ dk,aik,bik (9)

Accordingly, we can calculate the overall variation in the benefits of stakeholder group i using the following formula:

$$TB_i = \sum_{k=1}^{n} d_k, a_{ik}, b_{ik} \quad (10)$$

In practice, the decision-maker typically cannot treat the interests of different stakeholders absolutely equally. For example, existing laws stipulate that URPs must conform to public interests. Therefore, the decision maker must prioritize the interests of the general public, and weigh the interests of different stakeholders differently. The net value produced by an action scheme is given by

$\sum_{i=1}^{sn} v_i TB_i$, where $\sum_{i=1}^{sn} v_i = 1$ and v_i reflect the relative importance of

stakeholder i to the decision-maker. v_i is used to balance the interests of different stakeholder groups. For example, as URPs must align with public interests, the v_i value of the general public must be higher than those of other stakeholder groups in URPs. $\sum_{i=1}^{sn} v_i = 1$

implies that v_i reflects the relative magnitude of importance. For example, if the general public has a relatively high v_i value in the decision-making process, then other stakeholder groups will have relatively low v_i values. The value of v_i is determined based on the main purpose of the project and the preferences of the decisionmaker. As a result, the value produced by the action scheme can be expressed by the following formula:

$$TB^{*}!D = \sum_{i=1}^{sn} "v_i, \sum_{k=1}^{n} \eth d_k, a_{ik}, b_{ik} \text{Þ}\# \quad (11)$$

Formula 11 is used to calculate the stakeholder benefits generated by an action scheme. However, the losses associated with stakeholder conflicts are ignored. Thus, we adjusted Formula 11 to integrate stakeholder benefits with the costs incurred by stakeholder conflicts. The objective function of the decision-maker is given by Formula 12.
well to solve this optimization model.

4. Case study

4.1. Background information

To verify and demonstrate the practical application of the proposed conflict analysis model, we applied it to an actual case in Wenzhou, i.e., the Sanlangqiao project. The aim of the Sanlangqiao project, the largest URP in Wenzhou, is to protect the nearby wetlands and modernize the ecological functions of the Wenzhou Ecological Park. This planning area covers 1.78 million square meters and involves the relocation of

approximately 1,002 households. The permanent resident population of the Sanlangqiao area totals 7,896, and the majority of residents are villagers who earn their living primarily from traditional farming or hardware processing. This redevelopment project will significantly affect the daily lives of these local residents. The Sanlangqiao project is located at Zhuangyuan Street near the borders of the Longwan District, the Wenzhou Ecological Park, and the Ouhai District. Through comprehensive redevelopment, the Sanlangqiao area will become a new component of the Wenzhou Ecological Park, featuring highquality residential buildings and public facilities such as hospitals and schools.

The Sanlangqiao project was initiated by local governments and the management department of the Wenzhou Ecological Park

Max TB**!D¼ TB*!D g,SC$_T$!D ½Xi^{sn}1"v$_i$, Xk^{n}1ðd$_k$,a$_{ik}$,b$_{ik}$Þ# g,¨ Xi^{sn}1 Xk^{n}1 sc^{d**}ðiÞk#

¼ ¼¼ ¼

^{sn} n 1 a ,d

¼ X"v$_i$, Xðd$_k$,a$_{ik}$,b$_{ik}$Þ# g," X XSI$_i$,b$_{ik}$, sn n sn n

1

i¼1 k¼1 i¼1 k¼1

As discussed, SC$_T$ð!DÞ in Formula 8 reflects the total degree of stakeholder conflict incurred by action scheme !D. In Formula 12, g denotes the sensitivity of the project to stakeholder conflicts. If g has a high value, then the project is highly sensitive to stakeholder

holder conconflicts. gfl,icts.SC$_T$ð!SCDÞ$_{max}$indicates the total losses incurred by stake-represents the maximum degree of con$_{fl}$ict

that can be accepted by the decision-maker. In many cases, the decision-maker cannot accept stakeholder conflicts such as mass incidents because Chinese government authorities regard social stability as an overarching objective. Only in extreme conditions can adverse impacts on social stability be accepted by the decision-

sn n

maker. In such cases, the decision-maker can setsn n SCmax ¼ $_i$P¼1 $_k$P¼1 SI$_i$, b$_{ik}$ (with iP¼1 kP¼1 SI$_i$,b$_{ik}$ being

the maximum value that SC$_T$ð!DÞ can

reach).

The optimization model in Formula 12 can be solved using computer software packages such as Lingo, Lindo, Gurobi, or Cplex. To illustrate the practical implications of this conflict analysis model, we conducted a case study on the Sanlangqiao project in Wenzhou. In this project, we utilized Gurobi software (on the Python

platform) to determine optimal solutions for decision-makers, although other computer software packages can be used equally

$$a2_{ik},d_k\#st^{8}>><\ X i_{¼}1\ X k_{¼}1 S I^{i},\overline{b^{ik},\ 2ik}\ k\ ¼\ SCT!D\ \ SCmax$$

$$>$$

$$>:\qquad d_k 2f1;0;1g;\ k\ ¼\ 1;2;/;n$$

(12)

(MDWEP) in early 2016. The total budget of this project is 11.7 billion yuan, and its expected completion date is 2022. Fig. 2 shows the Sanlangqiao planning area, and the types of land use shown in the figure are explained in Table 1. This project comprises three stages, i.e., planning, HDR, and reconstruction, and the planning and HDR stages have been completed. The reconstruction stage, as noted above, is expected to be completed in 2022. In this case study, our focus was stakeholder conflicts at the HDR stage. At the planning stage, the primary stakeholder groups included the local governments and the MDWEP. With the goal of developing tourism and protecting the local environment, the Wenzhou City government staunchly supported development of the ecological park. Given the positive relationship between the local governments and the MDWEP, there was a minimal degree of conflict during the planning stage. Therefore, we did not subject this stage to conflict analysis. As the reconstruction stage had not yet been completed at the time of writing, data pertaining to this stage could not yet be comprehensively collected nor fully analyzed.

For our case study, we identified six stakeholder groups at the HDR stage, including the MDWEP (the project developer), the Steering Group of Housing Demolition (SGHD, comprising government departments), demolition and consultant companies (DCCs, companies who helped the government design demolition schemes and conduct demolition activities), relocated residents of

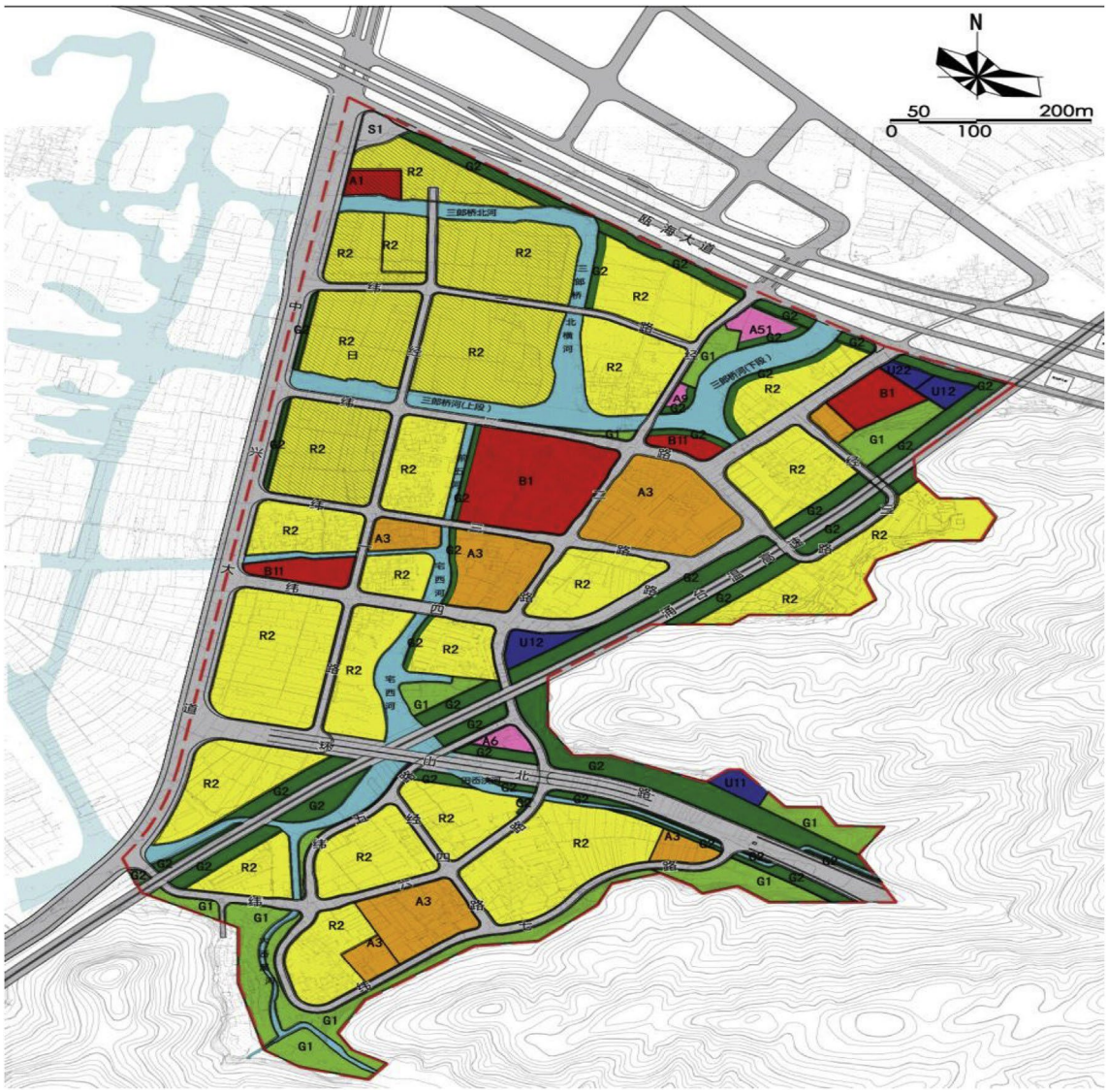

Fig. 2. Planning area of the Sanlangqiao project (enclosed by red dashed lines). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 1
Future land use of the Sanlangqiao project.

Land codes	Types of land use in the future	Land codes	Types of land use in the future
A1	Administrative land	G1	Park green space
A3	Education facilities	G2	Green buffer
A6	Social welfare facilities	R2	The two category of residential land
A9	Religious facilities	R3	The three category of residential land

A51	Hospital	U11	Water supply (municipal utilities)
B1	Commercial land	U12	Power supply (municipal utilities)
B11	Retailing	U22	Sanitation facilities (municipal utilities)

Sanlangqiao (RRS), residents living near the demolished areas (RLNDA), and ordinary residents of Wenzhou (ORW). The SGHD and the MDWEP established an administrative committee to organize, manage, and supervise the major demolition and relocation activities of this stage. Four DCCs were employed to measure the demolition area, evaluate the unit price of the demolished properties, relocate the original residents, and clean up the demolition waste. The RRS were required to leave their original homes and move to other areas, but they became eligible to receive relocation compensation from the government. In addition, the daily lives of the RLNDA may be affected by the urban redevelopment project. For example, nearby transportation may be adversely affected due to the housing demolition activities. After the relocation and demolition work was completed, lands for urban redevelopment were endorsed by the main developer of this project, i.e., the MDWEP, which will upgrade the housing and public facilities in this area. As the redevelopment project must conform to the interests of the public, the ORW is another important stakeholder group.

4.2. Data collection

We performed document analysis and conducted semistructured interviews to gather relevant data. The project documents analyzed in this study included: (1) planning documents such as the master plan of the Sanlangqiao project and detailed planning schemes, (2) policy documents such as the relocation compensation standard and government regulations, (3) routine reports written by key participants in the project, (4) decisions made by the government departments, and (5) minutes of key meetings. All of these materials were highly correlated with this project. Two researchers working on this study read these documents independently to identify potential stakeholder concerns noted in these materials. They focused on the key points that were met with dissatisfaction or debates in this case. For example, in a routine project report, the researchers found the RRS to be dissatisfied with "the level of relocation compensation" established in the relocation scheme. Accordingly, "the level of relocation compensation" was identified as a stakeholder concern.

In the interviews, the primary criteria for selecting interviewees were that each potential interviewee had had a senior position or played an important role in the project. To gain a comprehensive understanding, we interviewed representatives from all of the six identified stakeholder groups in the Sanlangqiao project (Yu et al., 2017b). The profiles of interviewees are listed in S1 of the Supplementary material. The majority of the interviewees from the SGHD, MDWEP, and DCC hold leadership or management positions in their organizations. Accordingly, they had the ability to evaluate the stakeholder conflicts of this project from a macro perspective. During the Sanlangqiao project, the SGHD organized a few rounds of public hearings to learn the viewpoints of key stakeholders. The interviewees from the RRS and RLNDA were representatives from the groups of relocated householders and residents living nearby this project. These interviewees participated in the public hearings and expressed their key concerns regarding the Sanlangqiao project. According to the rule of social justice, a few ordinary residents in Wenzhou were randomly selected to join these public hearings to assess the fairness of the project. We contacted nine of these randomly selected residents who were well aware of this project and had expressed their concerns in the public hearings. Prior to the actual interviews, we sent the interview questions to each interviewee via e-mail and encouraged them to prepare answers. The interview questions mainly focused on key stakeholder concerns about the Sanlangqiao project and the key parameters

required by the conflict analysis model (i.e., parameters in Formula 12). The key interview questions can be found in S2 of the Supplementary material.

4.3. Data analysis and results

4.3.1. Stakeholder attributes, concerns, and attitudes

Table 2 lists the attributes of the key stakeholder groups in the Sanlangqiao project (according to Formula 1), in which we set the

Table 2
Attributes of the six stakeholder groups.

weight of each basic attribute to $\frac{1}{3}$, i.e., $m_1 = m_2 = m_3 = \frac{1}{3}$, which suggests their equal importance. As Table 2 clearly indicates, the SGHD have the highest stakeholder index value, which implies that government officials played the most crucial role in mitigating stakeholder conflicts in this project. In addition, the RRS and MDWEP also have relatively high influencing factor values, since the key interests of these two stakeholder groups were directly and significantly affected by the project.

Table 3 summarizes the key concerns and attitudes of the six stakeholder groups, as determined by our empirical investigation of the Sanlangqiao project (according to Formula 2). We identified a total of 22 critical stakeholder concerns, the majority of which could significantly affect the key interests of the involved stakeholders.

In addition, Table 4 lists the benefit impacts of each concern of the different stakeholder groups. We assessed these parameters based on the preferences expressed by each stakeholder group in the Sanlangqiao project.

4.3.2. Action scheme and sensitivity analysis

To develop an action scheme, the decision-maker (the senior officials in the SGHD) must assign a weight to each stakeholder group, i.e., set the v_i values for each stakeholder group. In this case study, the decision-makers assigned weights based on three basic principles. The first stipulates that public interest be given highest priority. The second principle ensures the protection of the interests of the affected stakeholder groups (relocated residents). The last principle prohibits the local government and developer from pursuing their own economic interests at the cost of the interests of the other stakeholder groups. Accordingly, we assigned the following weights for v_i: RRS (0.15), SGHD (0.075), MDWEP (0.075), DCC (0.1), RLNDA (0.1), and ORW (0.5).

In this case, the maximum potential degree of stakeholder conflict was less than 154.94 ($\sum_{i=1}^{sn}\sum_{k=1}^{n} SI_i, b_{ik}$). The decision-maker set $i=1$ $_k=1$ SC_{max} to 40, which corresponds to an acceptable degree of stakeholder conflict. In addition, the sensitivity of the project to stakeholder conflicts (g) was set to 1, which implies that mitigating stakeholder conflicts was of equal importance as producing project value. We obtained the optimal solution using Gurobi software. The fourth column of Table 5 presents the action scheme.

Most of the parameters in Formula 12 were easily evaluated based on the psychological preferences of the different stakeholder groups (e.g., stakeholder attitudes) and the decision-making principles underlying the project (e.g., the v_i values). However, the parameters SC_{max} (the acceptable degree of stakeholder conflict) and g (the sensitivity of the project to stakeholder conflicts) were difficult to evaluate given the lack of any database

regarding stakeholder conflicts. For example, although decision-makers may attempt to avoid mass incidents, they typically do not know the threshold of SC_{max} at which such incidents will occur. To test the robustness of the action scheme, we conducted a sensitivity

Stakeholder type	Stakeholder group ID.	Basic attributes			Vested interest impact		Stakeholder index (SI_i)
		Power (P_i)	Urgency (U_i)	Legitimacy (L_i)	Probability of impact (pr_i)	Impact level (im_i)	
RRS	SG1	2	5	3	4	3	0.46
SGHD	SG2	5	5	5	5	5	1
MDWEP	SG3	4	4	2	3	3	0.4
DCC	SG4	3	3	2	2	3	0.26
RLNDA	SG5	1	3	2	2	2	0.16
ORW	SG6	3	1	5	1	4	0.24

Table 3

Key concerns and attitudes of the six stakeholder groups.

NO.	Stakeholder concern	Stakeholder attitudes (a_{ik})					
		SG1	SG2	SG3	SG4	SG5	SG6
1	Level of relocation compensation	1	Ratio of in-kind compensation	1	0	1	0	0	0
2	Time spent in relocation and demolition	1			0	1	0	0	0
3	Availability of public facilities in the Sanlangqiao areas	1			1	1	1	1	1
4					1	1	0	1	1
5	Quality of the resettlement houses	1			1	0	0	0	0
6	Distance between the resettlement community and the Sanlangqiao areas	1			0	1	0	0	0
7	Effort levels (by the SGHD, the MDWEP and the DCC) to reduce any adverse impacts on the local transportation system during the	1	redevelopment project		1	0	1	1	1
8	Effort expended (by the SGHD, the MDWEP and the DCC) to protect cultural or historical				1	1	1	1	1
9	heritages during the redevelopment project	0	Effort expended (by the SGHD, the MDWEP and the DCC) to manage safety issues during the redevelopment project	1	1	0	1	1	1
10	Forced demolition and violent incidents	1			1	1	1	1	1
11	Availability of local job opportunities after redevelopment	1			1	1	0	1	1
12	Effort expended (by the SGHD, the MDWEP and the DCC) to protect the community	1			1	1	0	1	1
13	environment during the redevelopment project	1			1	1	0	1	1
	Availability of economic benefits after the redevelopment								
14	Availability of better living conditions after the redevelopment	1			1	1	0	1	1
15	Avoidance of legal disputes	1			1	1	1	1	1
16	Disclosure of key information related to the redevelopment scheme and decision-making	1			1	1	0	1	1
17	processes	0			1	0	1	1	1
18	Effort expended (by the SGHD, the MDWEP and the DCC) to protect the unique local	1			0	1	1	0	0
19	characteristics of Sanlangqiao	1			1	1	0	1	1
20	Control of project cost	1			1	0	0	1	1
21	Degree of public participation	1			1	0	1	1	1

	Occupation of public space during the redevelopment project						
	Timely clearance of demolition wastes						
22	Level of remuneration for employees of the redevelopment project	0	0	1	1	0	0

Table 4
Benefit impacts of each stakeholder concern.

NO.	Benefit impacts (b_{ik})						NO.	Benefit impacts (b_{ik})					
	SG1	SG2	SG3	SG4	SG5	SG6		SG1	SG2	SG3	SG4	SG5	SG6
1	5	2	3	1	1	1	12	3	2	1	3	4	2
2	4	2	3	1	1	1	13	5	5	5	1	5	5
3	3	5	5	4	2	2	14	4	3	3	1	4	3
4	3	3	3	1	5	2	15	3	5	4	4	2	2
5	5	2	1	1	1	1	16	2	2	4	1	2	2
6	5	2	3	1	1	1	17	1	3	1	3	4	2
7	2	2	1	3	4	2	18	3	2	5	4	1	1
8	1	3	3	3	4	2	19	3	4	4	1	2	2
9	3	5	1	5	3	2	20	2	2	1	1	4	2
10	5	5	2	4	2	2	21	2	2	1	3	4	2
11	4	4	2	1	4	3	22	1	1	3	5	1	1

analysis on SC_{max} and g. Table 5 shows that the optimal action in the Sanlangqiao project was robust. As shown in Table 6, only one action (the action regarding Concern 19) was significantly affected by g. This outcome demonstrates that the key interests of the six stakeholder groups were well balanced, in that the maximization of stakeholder benefits was highly consistent with the mitigation of stakeholder conflicts. Therefore, the three decision-making principles were considered to be effective.

4.4. Practical value of the model

Next, we evaluated the practical value of this study based on feedback from the project decision-makers. The senior leaders in the SGHD stated that they modified their redevelopment strategies several times, and to some degree, the final version of their plan was consistent with the action scheme developed by our proposed conflict analysis model. For example, according to the official standards released by the central government of China, the relocation compensation in the Sanlangqiao project (Concern 1) could be anywhere within the given legal range. At the beginning of this project, the relocation compensation was set relatively low (the lower bound of the legal range) due to project cost considerations. However, this decision generated severe conflict between the SGHD and RRS. The majority of the residents to be relocated refused to move and attempted to organize collective resistance. To mitigate the stakeholder conflicts and reduce unnecessary social costs, the SGHD decided to increase the relocation compensation standard. Consequently, every relocated household received an additional compensation of 30,000 yuan (the upper bound of the legal range). Another example was the improvement made to community transportation (Concern 7). Initially, the SGHD took no measures to control the adverse impacts of the project on the local transportation system. These effects subsequently resulted in strong dissatisfaction among nearby residents. A young man in the interview complained that he had to get up earlier every day because his commute time was prolonged due to the terrible

traffic jams. To address these issues, the SGHD added several temporary bus lines during the HDR stage of this project. To some degree, these actions taken by the SGHD were consistent with the findings generated from the conflict analysis model. In summary, because the model developed in this study can be used to investigate the concerns and attitudes of project stakeholders, it has the potential to help practitioners properly modify their initial project plan in the interest of conflict mitigation. However, we note that a single case cannot serve as a comprehensive evaluation of the performance of the method used in this study. The effectiveness of the proposed model

Table 5

Sensitivity analysis on SC_{max}(ᵍ ¼ 1).

Stakeholder concern	The optimal action scheme				
	SCmax ¼ 30	SCmax ¼ 35	SCmax ¼ 40	SCmax ¼ 45	SCmax ¼ 50
1	1	1	1	1	1
2	1	1	1	1	1
3	1	1	1	1	1
4	1	1	1	1	1
5	1	1	1	1	1
6	1	1	1	1	1
7	1	1	1	1	1
8	1	1	1	1	1
9	1	1	1	1	1
10	1	1	1	1	1
11	1	1	1	1	1
12	1	1	1	1	1
13	1	1	1	1	1
14	1	1	1	1	1
15	1	1	1	1	1
16	1	1	1	1	1
17	1	1	1	1	1
18	1 1	1 1	1 1	1 1	1 1
19	1	1	1	1	1
20	1	1	1	1	1
21					
22	1	1	1	1	1

Table 6

Sensitivity analysis on g (ðSCmax ¼ Ì0).

Stakeholder concern	The optimal action scheme				
	g ¼ 0.6	g ¼ 0.8	g ¼ 1	g ¼ 1.2	g ¼ 1.4
1	1	1	1	1	1
2	1	1	1	1	1

3	1	1	1	1	1
4	1	1	1	1	1
5	1	1	1	1	1
6	1	1	1	1	1
7	1	1	1	1	1
8	1	1	1	1	1
9	1	1	1	1	1
10	1	1	1	1	1
11	1	1	1	1	1
12	1	1	1	1	1
13	1	1	1	1	1
14	1	1	1	1	1
15	1	1	1	1	1
16	1	1	1	1	1
17	1	1	1	1	1
18	1	1	1	1	1
19	1	1	1	1	1
20	1	1	1	1	1
21	1	1	1	1	1
22	1	1	1	1	1

must be further tested in other real cases using statistical methods such as the t-test or ANOVA analysis.

5. Conclusions

5.1. Overview of this study

In recent decades, a series of URPs in China have been conducted to address the sustainability issues incurred by rapid urbanization. A number of stakeholders have been significantly affected by these URPs. The conflicting interests of these stakeholders have become a significant challenge to the success of URPs. In this study, we developed a conflict analysis model based on the stakeholder salience theory and Pawlak's conflict theory. This model can be used to investigate stakeholder conflicts with consideration to the key stakeholder attributes of power, urgency, legitimacy, degree of
stakeholder impact, and probability of impact. In addition, this model can consider the key concerns and attitudes of different stakeholder groups. Using Pawlak's conflict analysis, stakeholder conflicts in URPs can be well quantified. More importantly, this model can generate action schemes to help URP practitioners deal with stakeholder conflicts. As a case study, we used the Sanlangqiao project in Wenzhou to validate the effectiveness of the proposed model. The results show that the model can offer effective and robust action schemes for conflict mitigation.

5.2. Theoretical and practical implications

The majority of previous studies related to stakeholder conflicts in URPs used questionnaires or have been based on game theory. Compared with questionnaire-based studies that focus on conflict identification and evaluation (e.g., Li et al., 2012; Wang et al., 2017; Yu et al., 2017b), in this study, we investigated stakeholder conflicts from the decision-making perspective. The optimization model developed in this study can be used to not only evaluate the degree of stakeholder conflict but also generate action schemes to help decision-makers mitigate stakeholder conflicts. In addition, unlike game-theory-based studies (e.g., Hu, 2005; Peng and Deng, 2009), we did not conduct analyses on the basis of general assumptions that typically ignore the unique characteristics of different stakeholders. In our optimization model, we analyzed stakeholder specifics such as attitudes and attributes identified through empirical investigation.

In terms of practical implications, the model developed in this study can help practitioners enhance the effectiveness of their stakeholder management in URPs. Accordingly, practitioners using this model can receive a relatively higher level of stakeholder support and complete their projects with less disruption. In addition, stakeholder satisfaction and social cohesion have been identified as critical indicators for measuring the social sustainability of URPs (Yu et al., 2017b; Dempsey et al., 2011). Therefore, the findings of this study can help practitioners enhance their URP sustainability practices. Furthermore, with a low level of conflict, good relationships among different stakeholder groups can be established, thereby contributing to the accumulation of social capital.

5.3. Limitations

A few limitations must be acknowledged. First, due to the lack of any URP database, we could not determine the effectiveness of the proposed conflict analysis model based on a large data sample. As such, we could only evaluate the performance of the model based on a single case study. Second, this study was conducted in the Chinese context, which may not be applicable to other regions. For example, in the case study, the interests of the general public were considered to be more important than those of other stakeholders due to the Chinese laws stipulating that URPs must conform to public interests. However, in other countries, the protection of private property may have higher priority in URP schemes. In future work, the performance of the proposed conflict analysis model should be evaluated with respect to other URPs so modifications can be made to improve its effectiveness. Statistical methods such as the t-test or ANOVA analysis may be used to quantitatively measure the model performance. Additionally, a scenario analysis could be integrated with the approach adopted in this study to extend the application of the proposed conflict analysis model to URP contexts outside China.

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Appendix A. Supplementary data

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