buildings

MDPI

Article

Regret Theory and Fuzzy-DEMATEL-Based Model for Construction Program Manager Selection in China

Hongyan Yan [1], Yuxuan Yang [2], Xi Lei [1], Qing Ye [1], Wenzhen Huang [1] and Ce Gao [3,4,*]

1 School of Construction Management, Hunan University of Finance and Economics, Changsha 510000, China
2 SWJTU-LEEDS Joint School, Southwest Jiaotong University, Chengdu 610000, China
3 School of Civil Engineering, Guangzhou University, Guangzhou 510000, China
4 School of Civil Engineering and Architecture, Guangzhou City Construction College, Guangzhou 510000, China
* Correspondence: gaoce89@gzhu.edu.cn

Abstract: During the drastic changing process of the construction industry in China, construction program management has been given significant attention. Due to the complexity of construction programs, selecting competent managers is crucially important to its success. Therefore, based on a comprehensive literature review, this paper combines regret theory and the Fuzzy-DEMATEL method to develop a multi-attribute model for construction program manager selection. Firstly, six competence elements are extracted, then the manager selection and evaluation index system are constructed. Secondly, the regret theory is used to simulate the psychological characteristics of the decision makers, combined with Fuzzy-DEMATEL, the comprehensive weights for each element are calculated. Lastly, all alternatives for the selection are sorted and the competent ones are selected. A case study is provided to exam the effectiveness of the developed model. Results shows that the proposed model adopted multi-attribute evaluation and group decision making and took into account the psychological behavior of decision makers as well as influences from the relationships between different attributes. Such results indicate that the proposed model is able to provide more comprehensive and scientific construction program manager selections, which can further improve the management of construction programs.

Keywords: construction program manager selection; group decision-making; multi-attribute evaluation; regret theory; Fuzzy-DEMATEL

Citation: Yan, H.; Yang, Y.; Lei, X.; Ye, Q.; Huang, W.; Gao, C. Regret Theory and Fuzzy-DEMATEL-Based Model for Construction Program Manager Selection in China. *Buildings* **2023**, *13*, 838. https://doi.org/10.3390/buildings13040838

Academic Editor: Maxim A. Dulebenets

Received: 7 February 2023
Revised: 19 March 2023
Accepted: 20 March 2023
Published: 23 March 2023

1. Introduction

In the new journey of the construction industry's development, construction program management, which manages construction projects in groups has gradually become a trend in China [1]. Construction program is more presented in the form of large-scale, complex and groups of "giant projects", such as the West-East Gas Transmission Project, the Yangtze River Three Gorges Project, the Beijing Olympic venues construction project, the South China Sea Petrochemical Project, etc. Construction program management is conducive to enhancing the core competitiveness of enterprises, expanding the market of construction enterprises and realizing enterprises' organization strategy [2]. However, the complexity and uncertainty of different construction projects, especially large-scale projects, has brought great challenges to construction program management, which requires the construction program managers being able to handle rapidly changing programs. As the core personnel in the management process, the construction program manager has a huge impact on the success of the project [3]. Therefore, selecting a competent construction program manager is one of the key factors of the construction program.

However, the current process of selecting and hiring project managers usually uses simple factors in the decision-making process. Such process has significant cognitive limitations while psychological factors and preferences of the decision makers will affect the decision results, thus potentially causing regrets. In such cases, the decision made based on expectation theory is often unable to explain the actual decision-making behavior, and most of the decision makers evaluate alternative construction project managers not in precise numbers, but in fuzzy language, and there are defects such as information loss and poor accuracy of results in the quantification process.

Thus, based on the limitations of currently used construction project manager selection process, this paper combined regret theory, Fuzzy-DEMATEL method, disparity minimization, and multi-attribute group decision making method to quantify, rank, and selects the optimal construction program manager. The proposed model can further improve the scientific nature of the selection of construction program managers for construction enterprises, thus, to improve the overall management effectiveness and efficiency of the programs.

The rest of the paper is organized as follows: (1) a literature review regarding related topics is provided; (2) the data collection process of this study is explained; (3) the competency model of construction program manager is explained; (4) the construction program manager selection model's development process is provided; (5) a case study is provided to prove the feasibility of the proposed model, and (6) the results of the case study as well as main conclusions and future works are presented.

2. Literature Review

The literature review of this paper mainly covered literatures related to methods for construction program (project) manager selection, construction project manager's evaluation indices, language assessment methods, and regret theory.

2.1. Construction Program (Project) Manager Selection

After a comprehensive literature review, only a few studies were found that focused on the selection of construction program managers while most of the documents were aimed at the selection of single project managers. The traditional methods for selecting construction managers in China are mainly achieved through recruitment and open competition [4]. Although organized recruitment method is easy to apply, it is not conducive to innovation and may lead to lack of vitality [5]. Open competition, on the other hand not only selects the best option, but also enhances the competition awareness and the sense of responsibility of the program manager. For open competition, most scholars mainly study the competency of construction project managers [6–8]. In the selection of construction project managers, binary semantic analysis [9], vector angle cosine method [10], analytic hierarchy process [11], support vector basis method [12] are used for selection.

Related research overseas is more in-depth than that in China. Overseas, the selection often requires the application of multi-criteria decision-making (MCDM) methods for robust recruitment [13]. Most foreign scholars also studied the competency of construction managers [14,15], using comprehensive mathematics method [16], analytic hierarchy process [17], Delphi and fuzzy language evaluation method, target programming and topsis [18,19], and other methods. Their main objective was to establish the selection model index system, ranking the alternative construction managers, then selecting the optimal construction managers.

2.2. Construction Project Manager'S Evaluation Indices

For construction project manager's evaluation indices, Skulmoski and Hartman considered that excellent personality charm is one of the strengths of construction project managers to ensure the trust and support of project team members and smooth cooperation with other stakeholders [20]; Krchová's study showed that as the leader of a construction project, the manager must have a convincing personality charm, which plays an important role in mobilizing the team's motivation, uniting the team's fighting force, and successfully implementing the project. Therefore, developing and demonstrating personal charm has become an important challenge for project team managers. Management skills are considered to be a direct reflection of the high level of working ability of project team managers and one of the key hard skills they must master [21]. Considering the characteristics of construction progam managers in practice, most of the time is spent on communication and emotional connection between the program's stakeholders. Therefore, effective communication can help with reducing conflicts between the construction program organization and stakeholders and support the manager to make the right decisions [22]. As a construction program manager, having excellent professional skills is necessary to ensure the program's success [21]. The managers should have the ability to control the risks and discover potential risks of the construction program, to propose effective solutions in a timely manner, and to adopt effective ways to achieve the management goal of the construction program [23]. Furthermore, strategic vision and stress resistance ability are also emphasized as key characteristics of the managers considering the uncertainty and high stress environment of construction program management [22,24,25].

2.3. Language Assessment Methods

Language assessment scale is a prerequisite for group decision making that generally required to select appropriate assessment scale. Levrat and Bordogna et al. [26] used linguistic terms such as "very high", "high", "general", "low", and "very low" to evaluate the scheme. Herrera and Martinez (2000) transformed the evaluation terms into binary groups formed by the values in [−0.5, 0.5]. Dai et al. [27] conducted comparative analysis on the commonly used uniform scale and non-uniform scale. The research shows that the non-uniform language scale is more consistent with people's expression habits as well as the conclusions.

2.4. Regret Theory

For regret theory, it was firstly applied to the choice between two schemes, and Quiggin (1994) extended it to the field of multiple schemes. Bleiehrodt et al. [28] constructed regret-happy function based on exact number and provided its calculation method. On this basis, Zhang, Fan, and Chen [29] used interval number to express the uncertainty of information, while Zhang, Zhu, and Liu [30] used fuzzy number concept to describe it. However, in practice, decision makers tend to use language to evaluate a scheme. Therefore, Zhang and Wang [31] designed a regret-happy function based on language information which shows advantages in language identification.

3. Construction Program Manager Selection Evaluation Index System Based on Grounded Theory

Grounded Theory is a bottom-up qualitative research method based on research questions from field observations by collecting and analyzing data to refine concepts and categories, thus rising to the theoretical level [32]. Grounded theory is able to resolve the differences between traditional quantitative research and qualitative research. At present, academic research on the selection and evaluation index of construction program manager is still in its infancy. Therefore, this paper chooses grounded theory method to construct the selection and evaluation index system of construction program manager selection.

3.1. Data Collection

Considering the number of interviewees available and the purpose of this research, purposive sample is used to select proper interviewees in the data collection process. Purposive sampling, as known as judgment sampling, is typically used to identify and select the information-rich cases for the most proper utilization of available resources [33]. So, managers who have rich experience in construction project/program management and have high credibility in constructing the selection evaluation index system for construction program managers are selected. Based on the literature analysis, this paper prepared a preliminary interview outline. To ensure that the interviewees could accurately understand the purpose of the interview and that the recovered interview data could fully support the study, experts were invited to make preliminary modifications to the interview outline.

On this basis, the first two interviewees were interviewed using the preliminary revised interview outline, and the outline was revised again based on the suggestions of the interviewees to obtain a final interview outline that met the requirements of the study. The interviews were conducted by telephone from January 2021 to March 2021 with 15 interviewees and nearly 20,000 pieces of information were collected, as shown in Figure 1.

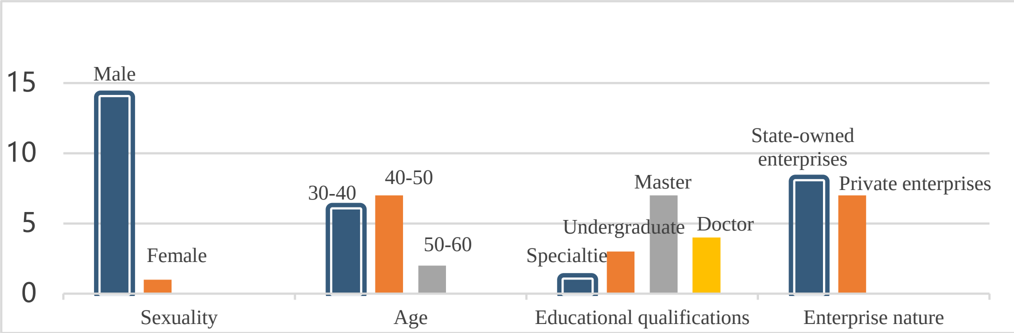


Figure 1. Basic information of interviewees.

Most of the interviewees were males aged between 30 and 50 with considerable experiences. In terms of academic qualifications, the majority of the interviewees had master's degrees or PhDs, reflecting that the interviewees had high level education and social perspective, and could understand the interview questions to give credible responses. In terms of gender, males were significantly more numerous than females in this study's sample. This is mainly caused by the fact that, on the whole, males are more frequently hired in construction project manager positions due to the working condition and intensities. For the employers of the interviewees, the number of state-owned enterprises and private enterprises was equal, reflecting that the work environment was selected in a more balanced manner in this study.

3.2. Development of Construction Program Manager Selection Evaluation Index System Based on Grounded Theory

In this paper, the interview data of 13 construction program manager are used for theoretical modeling, and the rest are used to validate the model. Firstly, the collected raw data are imported into qualitative analysis software, Nvivo11, for spindle and selective coding to identify the characteristic indices and structural dimensions of the managers. Based on the software analysis results and the conducted literature review presented in the previous section, the construction program manager competency model use in this study is shown in Table 1.

Table 1. Competency model of construction program manager.

Serial Number	Index	Secondary Index	Index Connotation
C_1	Personality charm	B_1 Boldness, decisive	Personality charm refers to the manager's ability to attract people in terms of temperament, personality, ideology and morality. In specific work, managers can make decisive decisions and seize key opportunities; managers can communicate with others sincerely and consider problems from the other side's standpoint; managers can solve problems impartially and deal with matters fairly; managers can take responsibility courageously.
		B_2 Sincerity	
		B_3 Responsibility	
		B_4Transpositional consideration	
		B_5 Act fairly	

Table 1. *Cont.*

Serial Number	Index	Secondary Index	Index Connotation
C_2	Management ability	B_6 Whole process management	Management ability refers to the ability of managers to formulate a good plan in advance and execute it according to the plan. Managers can tap the maximum potential of members in team management, build a team culture actively, have rich management experience, and establish a suitable management system to manage the whole process.
		B_8 Team management	
		B_{20} Experience in management	
		B_{21} Establishing management system	
C_3	Communication and coordination	B_7 Arouse the enthusiasm	Communication and coordination means that managers can coordinate and communicate well with all participants in the construction program, and reach a unified strategy, purpose, and path; managers can actively use their own subjective initiative to coordinate well the relationship between the participants in the construction program.
		B_9 Path unification	
		B_{18} Flexible adaptation	
		B_{19} Participant management	
C_4	Professional skills	B_1 Professional knowledge	Vocational skills refer to managers who have a certain level of professional skills, and have sufficient depth and breadth in professional knowledge, so as to be able to guide the team directionally.
		B_{17} Information technology	
C_5	Risk control	B_{13} Policy risk control	Risk control means that managers can predict and control possible risks and establish risk prevention measures.
		B_{14} Market risk control	
		B_{15} Employee turnover risk control	
C_6	Strategic vision	B_{10} Strategic objective	Strategic perspective means that managers have forward-looking strategic thinking based on system thinking and starting from long-term interests. The program manager needs to maintain the sensitivity and attention to the organizational strategy at all times to serve the realization of the long-term organizational strategic goals.
		B_{11} Prospective	
		B_{12} Systematic thinking	

Based on grounded theory, this paper constructs the selection and evaluation indices of construction program managers, namely C = {C_1 = Personality charm, C_2 = Management ability, C_3 = Communication and coordination, C_4 = Professional skills, C_5 = Risk control, C_6 = Strategic vision}.

4. Construction Program Manager Selection Model

4.1. Method Selection

Due to the complexity of construction programs, the competent construction program manager should have multi-factor competencies. In reality, due to the limitation of personal knowledge and experiences, it is often difficult to achieve optimal decisions only judging personal abilities. Therefore, the selection of construction program managers should be a multi-attribute group decision-making process.

In this process, due to the "bounded rationality" characteristics of the decision makers, the psychological factors and preferences will affect the results. When decision makers have the choice to compare the selected results with other alternatives, it may result in regret, which most decision makers prefer to avoid. Considering the cognitive limitations and subjective psychological preferences of the decision makers, "complete rational" decision-making based on expectation theory is often unable to explain the actual decision-making behavior. To solve such problems, Kahneman and Tversk [34], Bell [35], and Loomes and Sugden [36] proposed prospect theory and regret theory, respectively. Prospect theory considers a series of factors such as reference point dependence, loss dependence and subjective probability of the decision makers, while regret theory focuses on the influence of "regret" of decision makers on decision effectiveness. Compared with prospect theory, regret theory has fewer assumptions which can better describe and explain the paradoxes such as Alai paradox and preference reversal effect in actual decision-making behavior, so it is more widely used in decision-making problems. Therefore, this paper chooses regret theory to take the psychological characteristics of decision makers into consideration and obtains the multi-attribute evaluation matrix to calculate the perceived utility value of each alternative construction program manager.

In the multi-attribute group decision-making of construction project group manager selection, determining the weight of the evaluation attributes is the basis for the ranking and selection process. The current methods for attribute weight determination include MCDM (Multi-criteria decision-making) proposed by Linett Montano Guzman [37], and DEMATEL proposed by Gabus and Fontela [38,39] of Geneva Research Center. MCDM refers to an analytical method for making decisions under multiple decision criteria or objectives, and commonly used methods include hierarchical analysis (AHP), fuzzy comprehensive evaluation (FCE), grey correlation analysis (GRA), and entropy weighting. These methods mostly try to obtain the best decision result by assigning weights to decision factors and evaluating them comprehensively. DEMATEL was originally used to solve complex social events, based on graph theory and matrix to construct structural models through analysis to study the causal relationships between attributes of complex events and identify key attributes for better analysis of events. Therefore, MCDM and DEMATEL are slightly different in their scope of application. MCDM is more suitable for scenarios that require selection from multiple decision criteria or objectives, while DEMATEL is more suitable for scenarios that require understanding the interactions between factors in complex systems [40–42]. With the advancement of related techniques, multi-criteria decision analysis method like Ordinal Priority Approach (OPA) have also emerged. The core idea of OPA is to compare the relative importance of different attributes to determine the best decision. The method usually involves assigning different attributes to different importance levels, such as high, medium and low, and scoring and weighting each attribute to calculate a composite score [43]. Compared to DEMATEL, OPA places more emphasis on the comparison and ranking between attributes, instead of the interdependence between the attributes. For the above considerations, DEMATEL is chosen in this paper.

The key to the application of group decision making is the aggregation of decision makers' judgment information. Due to the differences in professional background, knowledge and ability, the evaluation quality and level of each decision maker, the application in this study should be a heterogeneous decision group. The closer the attribute evaluation result of a decision-maker is to the group attribute evaluation result, the more credible the decision-maker is, and the greater its weight. Therefore, this paper uses deviation minimization and attribute weights to obtain the weights of the decision makers. By comparing the attribute weights determined by each decision maker based on Fuzzy-DEMATEL, smaller weights were given to decision makers with larger difference values. Therefore, this paper selects the regret theory to consider the psychological characteristics of decision makers to obtain the perceived utility matrix. The algorithm flow of linguistic multi-attribute selection of construction program managers based on regret theory and Fuzzy-DEMATEL is shown in Figure 2.

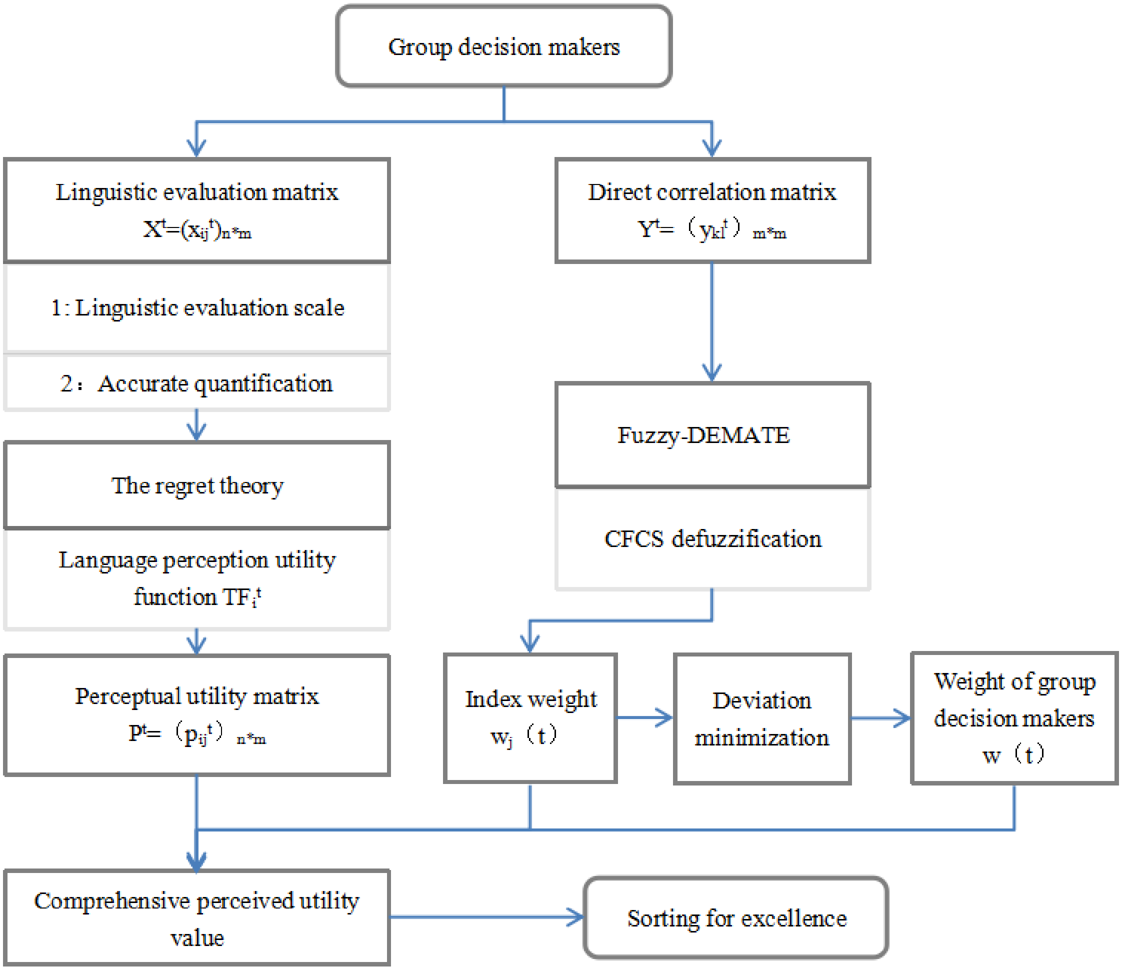


Figure 2. Linguistic Multi-attribute selection of construction program managers based on Regret Theory and Fuzzy-DEMATEL.

4.2. Construction Program Manager Selection

4.2.1. Model Preparation

Assuming the alternative construction program manager set $A = \{A_1, A_2, A_3, \ldots, A_n\}$, where A_i denotes the ith program manager, $i \in N$, $N = \{1, 2, 3, \ldots, n\}$. Property (index) set $C = \{C_1, C_2, C_3, \ldots, C_m\}$, where C_j denotes the j property, $j \in M$, $M = \{1, 2, 3, \ldots, m\}$. The decision maker (expert) set $D = \{D_1, D_2, D_3, \ldots, D_p\}$, where D_t denotes the t_{th} decision maker, $t \in P$, $P = \{1, 2, 3, \ldots, p\}$. The linguistic multi-attribute evaluation matrix $X^t = (x_{ij}{}^t)_{n\times m}$, where $x_{ij}{}^t$ denotes the linguistic evaluation value of decision maker D_t on the selection attribute C_j of construction program manager A_i.

In order to make better use of the knowledge and personal experience of the decision makers, let the decision makers to evaluate the degree of the interaction between the attributes, and then construct an attribute correlation matrix, so the direct correlation matrix $Y^t = (y_{kl}{}^t)_{m\times m}$, where $y_{kl}{}^t$ represents the impact assessment value of the t decision maker on the k_{th} attribute and the l_{th} attribute.

4.2.2. Evaluation Language Based on Regret Theory

(1) Basic definition

This paper uses the non-uniform language scale and are defined as follows:

The linguistic term set of *a* on the right side of numerical zero is

$$S^+ = \left\{ S_a \middle| a = \frac{2(i-1)}{\sigma + 2 - i},\ i = 2, \cdots, \sigma - 1, \sigma \right\} \tag{1}$$

The linguistic term set of a on the left side of numerical zero is

$$S^{-} = \left\{ S_a \middle| a = \frac{2(i-1)}{\sigma + 2 - i}, i = \sigma, \sigma - 1, \cdots, 2 \right\} \quad (2)$$

Therefore, the language assessment scale is

$$\mathrm{S} = \left\{ \mathrm{S_a} \middle| \alpha = -(\sigma - 1), -\frac{2(\sigma-2)}{3}, \cdots, 0, \cdots, \frac{2(\sigma-2)}{3}, (\sigma - 1) \right\} \quad (3)$$

In particular, $S_{-(\sigma-1)}$ and $S_{(\sigma-1)}$ denote the lower and upper limits of the linguistic terms actually used by decision makers, σ is a positive integer, and the number of linguistic terms $(2\sigma - 1)$ is called the granularity of the term set, and S_a satisfies the following properties: If α > β, then $S_\alpha > S_\beta$; there exists a negative operator neg(S_a) = S_{-a}.

For example, when σ is 5, the granularity of the linguistic term set is 9, and then

S = {S_{-4} = extremely poor, S_{-2} = very poor, S_{-1} = poor, $S_{-0.4}$ = slightly poor, S_0 = general, $S_{0.4}$ = slightly good, S_1 = good, S_2 = very good, S_4 = extremely good}.

(2) Utility perception value based on language information

The language identification process used in this study is as follows:

Definition 1. *Let $S_a \in S$ be a term for a language evaluation set, then, a subscript conversion function that converts any language assessment into an exact number is used as shown in function (4).*

$$\mathrm{H(S_a) = a} \quad (4)$$

Definition 2. *Let $V(X)$ be a classical utility function, which is a monotone increasing concave function, namely $V'(X) > 0$, $V''(X) < 0$, indicating that the decision makers are risk aversion, then, a language utility function is formed as shown in function (5), in which, $\sigma - 1$ is called the cardinality and satisfies $0 \leq (a + \sigma - 1)/(2(\sigma - 1)) \leq 1$.*

$$\mathrm{UV(S_a)} = \mathrm{V}\left(\frac{\mathrm{H(S_a)} + \sigma - 1}{2(\sigma - 1)}\right) = \mathrm{V}\left(\frac{\mathrm{a} + \sigma - 1}{2(\sigma - 1)}\right) \quad (5)$$

From Definition 2, when S_a takes the maximum value, the language utility function is also the largest. When S_a takes the minimum value, the language utility function is the smallest. Therefore, it will ensure the accuracy of the results without information loss.

Definition 3. *Let S_a, ${S_a}^*$, ${S_a}^-$, ${S_a}^+$ be the current selected construction program manager, the ideal construction program manager, the negative ideal construction program manager and the positive ideal construction program manager, respectively. R(y) is a classical regret-happy function, which is also a monotone increasing concave function, where $R'(y) > 0$, $R''(y) < 0$, and to meet the intuitive judgment result R(0) = 0, then, there is function (6) that helps the decision maker to chooses the current project construction program manager A_i and abandons the ideal construction program manager A*.*

$$\mathrm{TR_i} = \mathrm{R}\left(\mathrm{V}\left(\frac{\mathrm{a} + \sigma - 1}{2(\sigma - 1)}\right) - \mathrm{V}\left(\frac{\mathrm{a}^* + \sigma - 1}{2(\sigma - 1)}\right)\right) \quad (6)$$

When ${S_a}^* = {S_a}^-$, expressed as the negative ideal construction program manager language evaluation value, namely

$$\mathrm{TR_i}^- = \mathrm{R}\left(\mathrm{V}\left(\frac{\mathrm{a} + \sigma - 1}{2(\sigma - 1)}\right) - \mathrm{V}\left(\frac{\mathrm{a}^- + \sigma - 1}{2(\sigma - 1)}\right)\right) \quad (7)$$

When $S_a{}^* = S_a{}^+$, expressed as the positive ideal construction program manager language evaluation value, namely

$$TR_i{}^+ = R\left(V\left(\frac{a+\sigma-1}{2(\sigma-1)}\right) - V\left(\frac{a^+ +\sigma-1}{2(\sigma-1)}\right)\right) \quad (8)$$

Definition 4. *Suppose that the language utility function of decision maker Dt for the evaluation value S_a of A_i of the selected project construction group manager is $UV(S_a)$, and the language regret-happiness function is TR i, then, decision maker D_t chooses the language perception utility function of the construction program manager A_i.*

$$TF_i^t = UV(S_a) + TR_i = UV(S_a) + TR_i{}^- + TR_i{}^+ = V\left(\frac{a+\sigma-1}{2(\sigma-1)}\right) + R\left(V\left(\frac{a+\sigma-1}{2(\sigma-1)}\right) - V\left(\frac{a^- +\sigma-1}{2(\sigma-1)}\right)\right) + R\left(V\left(\frac{a+\sigma-1}{2(\sigma-1)}\right) - V\left(\frac{a^+ +\sigma-1}{2(\sigma-1)}\right)\right) \quad (9)$$

Through the function TF_i^t, the language perception utility value of any construction program manager of any decision maker can be obtained.

In this paper, we take the function $R(y) = 1 - exp(\delta \cdot y)$, where the parameter $\delta \in [0, +\infty]$ is the regret aversion coefficient of the decision makers. The greater the parameter δ, the greater the regret aversion degree of the decision makers, and vice versa. In addition, the power function $V(x) = X^{\mu}(0 < \mu < 1)$ is used as the utility function, where μ denotes the risk aversion coefficient of decision makers, and the greater the μ, the smaller the degree of risk aversion of decision makers.

4.2.3. Determination of Index Weights Based on Fuzzy-DEMATEL

The key to traditional DEMATEL method is to invite experts to evaluate the mutual influence of each attribute based on their knowledge and experience to form a direct correlation matrix. Due to the uncertainty of practical problems, the complexity of evaluation and the differences between invited experts, most of the evaluations given by experts are not accurate but are similar to fuzzy semantic expressions such as “important” or “satisfied”. Therefore, this paper introduces the triangular fuzzy number method to process the initial matrix to improve the accuracy and the steps are as follows [44]:

Step 1: The construction program manager influencing factors system is constructed, denoted as $F_1, F_2, \ldots, F_6$. The semantic scale assessed by experts is designed and divided into five levels according to the degree of influence, namely: no influence “0”, very weak influence “1”, weak influence “2”, strong influence “3” and very strong influence “4”, as shown in Table 2.

Table 2. Semantic transformation table.

Semantic Variable	Numerical Value	Corresponding Triangular Fuzzy Number
No influence	0	(0, 0, 0.2)
Very weak influence	1	(0, 0.2, 0.4)
Weak influence	2	(0.2, 0.4, 0.6)
Strong influence	3	(0.4, 0.6, 0.8)
Very strong influence	4	(0.8, 1, 1)

Step 2: Invite experts to use language operators to evaluate the influencing factors of the construction program manager, and convert the evaluation semantics into the corresponding triangular fuzzy number $W_{ij}{}^t = (\beta_{1ij}{}^t, \beta_{2ij}{}^t, \beta_{3ij}{}^t)$ according to the semantic transformation table, which means that the t experts believe that the factor i has an effect on the factor j, where $\beta_{1ij}{}^t$ is a conservative value, $\beta_{2ij}{}^t$ is the closest to the reality value, and $\beta_{3ij}{}^t$ is an optimistic value.

Step 3: Using the CFCS method to de-fuzzify the triangular fuzzy number, the direct influence matrix Z is obtained. Z reflects the direct effect between factors, and the steps are the following three steps.

(1) Standardization of triangular fuzzy numbers:

$$x\beta_{1ij}^{t} = \left(\beta_{1ij}^{t} - \min\beta_{1ij}^{t}\right) / \Delta_{\max}^{\min} \tag{10}$$

$$x\beta_{2ij}^{t} = \left(\beta_{2ij}^{t} - \min\beta_{1ij}^{t}\right) / \Delta_{\max}^{\min} \tag{11}$$

$$x\beta_{3ij}^{t} = \left(\beta_{3ij}^{t} - \min\beta_{1ij}^{t}\right) / \Delta_{\max}^{\min} \tag{12}$$

where $\Delta_{\max}^{\min} = \max\beta_{3ij}{}^{t} - \min\beta_{1ij}{}^{t}$, and $x\beta_{1ij}{}^{t}$, $x\beta_{2ij}{}^{t}$, $x\beta_{3ij}{}^{t}$ are calculated in turn.

(2) Standardize left (ls) and right (rs) values:

$$xls_{ij}^{t} = x\beta_{2ij}^{t} / \left(1 + x\beta_{2ij}^{t} - x\beta_{1ij}^{t}\right) \tag{13}$$

$$xrs_{ij}^{t} = x\beta_{3ij}^{t} / \left(1 + x\beta_{3ij}^{t} - x\beta_{1ij}^{t}\right) \tag{14}$$

(3) Calculate the clarity value after defuzzification:

$$x_{ij}^{t} = \left[xls_{ij}^{t}\left(1 - xls_{ij}^{t}\right) + xrs_{ij}^{t} \times xrs_{ij}^{t}\right] / \left[1 - xls_{ij}^{t} + xrs_{ij}^{t}\right] \tag{15}$$

$$Z_{ij}^{t} = \min\beta_{1ij}^{t} + x_{ij}^{t} \times \Delta_{\max}^{\min} \tag{16}$$

Step 4: Standardize the direct impact matrix Z^t to get the standardized direct impact matrix $G^t = (g_{kl})_{m\times m}$, where

$$g_{kl}^{t} = z_{kl} / \max_{1\le i\le m} \sum_{j=1}^{m} z_{kl} \tag{17}$$

Step 5: Measure the comprehensive influence matrix T^t, namely

$$\begin{aligned} T^t &= \lim_{m\to\infty}\left(G^1 + G^2 + \cdots + G^m\right) \\ &= Z(E - Z)^{-1} \end{aligned} \tag{18}$$

where E is the unit matrix, when $m \to \infty$, $G^m = 0$ is satisfied.

Step 6: Calculate the importance of influencing factors ε_j^t.

Note that each row of the elements in T^t is added to the influence degree $r_k{}^t$, indicating the combined influence value. The addition of each column element in T^t is the affected degree $d_i{}^t$, indicating the comprehensive influence value of this element by other elements. Let k = l = j, then the importance of the influencing factor of ε_j^t is

$$\varepsilon_j^t = \sqrt{\left(r_k{}^t + d_i{}^t\right)^2 + \left(r_k{}^t - d_i{}^t\right)^2} \tag{19}$$

Step 7: Determine the attribute weight $w_j(t)$. Normalize the importance of the influencing factor ε_j^t in step 6 to obtain the index weight as

$$w_j(t) = \varepsilon_j^t / \sum_{j=1}^{m} \varepsilon_j^t \tag{20}$$

In the formula, $0 < w_j(t) < 1$, and satisfy $\sum_{j=1}^{m} w_j(t) = 1$, for generality, let $w_j(t) = (w_1(t), w_2(t), \cdots, w_m(t))^T$, $w_j(t)$ represents the attribute weight of the t-th decision maker based on Fuzzy-DEMATEL on the j-th attribute.

4.2.4. Weight Determination of Decision Makers Based on Deviation Minimization

The attribute weights are obtained by Fuzzy-DEMATEL based on the attribute evaluation of each decision maker. Based on the idea that smaller differences mean larger weights, this paper uses the deviation minimization to obtain the weight of decision makers [45].

For attribute weight $w_j(t)$, the difference value of attribute weight between decision maker D_t and other decision makers is $E_j(t)$:

$$E_j(t)=\sum_{t'=1}^{P}\{w_j(t)-w_j(t')\}^2\ (t'=1,2,\cdots,P) \tag{21}$$

Then define the attribute weight difference $E(t)$ of the decision maker D_t with respect to all attributes compared to other decision makers as:

$$E(t)=\sum_{j=1}^{m}\sum_{t'=1}^{p}\{w_jt-w_j(t')\}^2\ (t'=1,2,\cdots,P) \tag{22}$$

The selection of decision maker's weighting vector $\varphi(t)$ should minimize the difference value of the total attribute weight of all decision makers for all attributes. Therefore, an objective weighting model for decision makers is constructed:

$$\min E=\sum_{t=1}^{p}\varphi(t)^2E(t) \tag{23}$$

$$s.t\sum_{t=1}^{p}\varphi(t)=1,\ \varphi(t)>0, t=0,1,\cdots,p$$

Introduce the Lagrange function to solve the above model:

$$L(\varphi(t),\theta)=\sum_{t=1}^{p}\varphi(t)^2E(t)+2\theta\left[\sum_{t=1}^{p}\varphi(t)-1\right] \tag{24}$$

The derivations of $\varphi(t)$ and θ are obtained:

$$\begin{cases}\frac{\partial L}{\partial\varphi(t)}=2\varphi(t)E(t)+2\theta=0\\ \sum_{t=1}^{P}\varphi(t)=1\end{cases} \tag{25}$$

Thus:

$$\varphi(t)=\frac{1}{E(t)}\frac{1}{\sum_{t=1}^{P}\frac{1}{E(t)}} \tag{26}$$

The decision maker weight vector $\varphi(t)$ is normalized to get the decision maker weight:

$$W(t)=\varphi(t)/\sum_{t=1}^{p}\varphi(t) \tag{27}$$

In the formula, $0 < w(t) < 1$, and satisfies $\sum_{t=1}^{p} w(t) = 1$, for generality, let $w(t) = (w(1), w(2), \cdots, w(p))^T$, $w(t)$ represents decision maker D_t is based on the weight of decision maker with minimum deviation.

4.2.5. Comprehensive Perceived Utility Value Calculation and Decision-Making

Let that $p_{ij}{}^t$ ($i \in N$, $j \in M$, $t \in P$) is the perceptual utility value calculated by decision maker D_t for the linguistic assessment value x_{ij} of alternative construction program manager A_i for attribute C_j, $w_j(t)$ is the attribute weight of decision maker D_t to attribute C_j based on Fuzzy-DEMATEL, $w_j(t)$ is the decision maker D_t's decision maker weight based on deviation minimization, then the comprehensive perceptual utility value of alternative construction program manager A_i is:

$$p_i^*=\sum_{t=1}^{p}\sum_{j=1}^{m}[\tau w_j(t)+(1-\tau)w(t)]p_{ij}(t) \tag{28}$$

In the formula, the parameter $\tau \in [0, 1]$ is the weight preference adjustment coefficient, the larger the value of τ, indicating that the group decision makers pay more attention to the attribute weight based on Fuzzy-DEMATEL.

5. Case Study

5.1. Background

In this case of selecting construction program manager, there are five candidates A = {A_1, A_2, A_3, A_4, A_5}, and three decision makers D = {D_1, D_2, D_3}. According to the selection attribute system in this paper, C = {C_1 = Personality charm, C_2 = Management ability, C_3 = Communication and coordination, C_4 = Professional skills, C_5 = Risk control, C_6 = Strategic vision}. Using the language assessment scale S = {S_{-4} = Extreme poor, S_{-2} = Very poor, S_{-1} = Poor, $S_{-0.4}$ = Slightly poor, S_0 = General, $S_{0.4}$ = Slightly good, S_1 = Good, S_2 = Very good, S_4 = Extreme good} to evaluate the five candidates, the linguistic evaluation matrix for the group decision makers can be obtained as shown in Tables 3–5. The significant impact between different attributes, such as personality charm, having a significant impact on communication and coordination, has also been taken into consideration. Then, the three decision makers used {no influence "0", very weak influence "1", weak influence "2", strong influence "3", very strong influence "4"} to analyze the influence relationship between the attributes and use the language assessment scale to get the direct correlation matrix between attributes as shown in Tables 6–8.

Table 3. Linguistic Multi-attribute Evaluation Matrix X_1 of decision maker D_1.

Alternative Construction Program Manager	Evaluation Index					
	C_1	C_2	C_3	C_4	C_5	C_6
A_1	S_4	S_1	S_4	S_2	$S_{0.4}$	S_2
A_2	S_2	S_1	$S_{0.4}$	S_4	S_4	S_1
A_3	S_1	S_4	S_4	$S_{0.4}$	$S_{0.4}$	S_4
A_4	S_2	$S_{0.4}$	S_4	S_2	$S_{0.4}$	S_4
A_5	S_4	S_4	S_1	S_1	S_4	S_0

Table 4. Linguistic Multi-attribute Evaluation Matrix X_2 of decision maker D_2.

Alternative Construction Program Manager	Evaluation Index					
	C_1	C_2	C_3	C_4	C_5	C_6
A_1	S_2	S_4	$S_{0.4}$	S_1	$S_{0.4}$	S_2
A_2	S_4	S_2	S_4	$S_{0.4}$	S_4	S_1
A_3	S_4	S_1	$S_{0.4}$	S_4	$S_{0.4}$	S_4
A_4	S_1	S_4	S_0	S_4	$S_{0.4}$	S_4
A_5	$S_{0.4}$	S_2	S_2	S_1	S_4	S_0

Table 5. Linguistic Multi-attribute Evaluation Matrix X_3 of decision maker D_3.

Alternative Construction Program Manager	Evaluation Index					
	C_1	C_2	C_3	C_4	C_5	C_6
A_1	$S_{0.4}$	S_1	S_4	S_2	S_4	S_4
A_2	S_2	$S_{0.4}$	S_4	S_1	S_4	S_1
A_3	S_1	S_1	S_4	S_4	S_1	S_4
A_4	$S_{0.4}$	S_4	S_4	S_2	S_2	S_1
A_5	S_2	S_4	$S_{0.4}$	S_4	S_1	S_2

Table 6. Direct correlation matrix Y_1 between indicators of decision maker D_1.

Evaluation Index	C_1	C_2	C_3	C_4	C_5	C_6
C_1	0	2	3	0	1	2
C_2	2	0	4	2	3	2
C_3	3	3	0	1	2	1
C_4	1	2	1	0	1	0
C_5	1	3	1	1	0	2
C_6	3	1	1	1	2	0

Table 7. Direct correlation matrix Y_2 between indicators of decision maker D_2.

Evaluation Index	C_1	C_2	C_3	C_4	C_5	C_6
C_1	0	3	2	0	1	1
C_2	2	0	3	2	4	2
C_3	4	3	0	1	2	1
C_4	2	2	1	0	1	1
C_5	1	3	1	0	0	2
C_6	4	2	1	1	2	0

Table 8. Direct correlation matrix Y_3 between indicators of decision maker D_3.

Evaluation Index	C_1	C_2	C_3	C_4	C_5	C_6
C_1	0	3	3	0	1	2
C_2	3	0	4	2	4	3
C_3	4	4	0	0	3	1
C_4	1	3	2	0	1	0
C_5	1	4	2	0	0	3
C_6	3	2	1	0	3	0

5.2. Decision-Making Steps

(1) Given the parameters $\mu = 0.88$ and $\delta = 0.3$ [17,18], Formulas (4)–(9) are used to process the linguistic multi-attribute evaluation matrix X given by each decision maker to obtain the perceived utility function ${p_{ij}}^t$, as shown in Tables 9–11.

Table 9. Perceived utility value of decision maker D_1.

Alternative Construction Program Manager	Evaluation Index					
	C_1	C_2	C_3	C_4	C_5	C_6
A_1	1.0966	0.5752	1.1155	0.7450	0.4603	0.7644
A_2	0.7409	0.5752	0.4603	1.1155	1.1155	0.5891
A_3	0.5543	1.1155	1.1155	0.4603	0.4603	1.1280
A_4	0.7409	0.4603	1.1155	0.7450	0.4603	1.1280
A_5	1.0966	1.1155	0.5752	0.5752	1.1155	0.3966

Table 10. Perceived utility value of decision maker D_2.

Alternative Construction Program Manager	Evaluation Index					
	C_1	C_2	C_3	C_4	C_5	C_6
A_1	0.7450	1.0966	0.4744	0.5752	1.0966	0.5752
A_2	1.1155	0.7409	1.1280	0.4603	0.7409	0.4603
A_3	1.1155	0.5543	0.4744	1.1155	1.0966	0.4603
A_4	0.5752	1.0966	0.3966	1.1155	0.5543	1.1155
A_5	0.4603	0.7409	0.47644	0.5752	0.7409	1.1155

Table 11. Perceived utility value of decision maker D_3.

Alternative Construction Program Manager	Evaluation Index					
	C_1	C_2	C_3	C_4	C_5	C_6
A_1	0.5369	0.5752	1.1155	0.7409	1.0966	1.0966
A_2	0.8176	0.4603	1.1155	0.5543	1.0966	0.5543
A_3	0.6502	0.5752	1.1155	1.0966	0.5543	1.0966
A_4	0.5369	1.1155	1.1155	0.7409	0.7409	0.5543
A_5	0.8176	1.1155	0.4603	1.0966	0.5543	0.7409

(2) The direct correlation matrix Y between indicators is processed according to Formulas (10)–(20), and the attribute weights are obtained as follows.

$$w_j(1) = (0.1737, 0.2083, 0.1950, 0.1118, 0.1647, 0.1464)^T$$

$$w_j(2) = (0.1778, 0.2076, 0.1751, 0.1108, 0.1727, 0.1559)^T$$

$$w_j(3) = (0.1689, 0.2112, 0.1886, 0.0970, 0.1823, 0.1519)^T$$

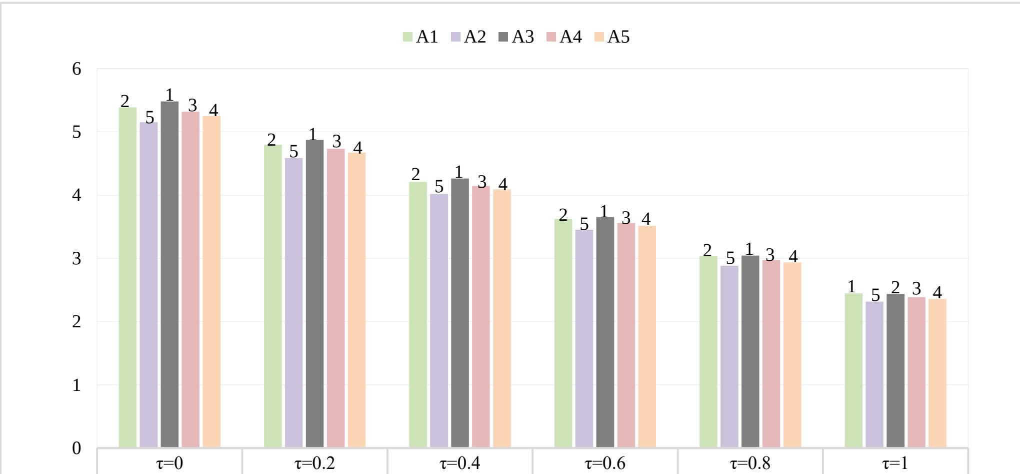
(3) According to Formulas (21)–(27), the attribute weight $w_j(t)$ is processed, and the weight of decision makers is obtained as follows.

$$W(t) = (0.3287, 0.3448, 0.3265)$$

(4) According to Formula (28), the preference coefficient $\tau = 0$, which means the process only focus on the weight of decision makers based on the minimization of deviation. So, the perceived utility value of each alternative construction program manager is $p_i^* = (5.3858, 5.1525, 5.4812, 5.3175, 5.2502)^T$. Thus, the order of construction program managers is $A_3 > A_1 > A_4 > A_5 > A_2$, that is, the construction unit chooses A_3 as the optimal construction program manager.

5.3. Parameter Sensitivity Analysis

When calculating the comprehensive weight, there is a preference adjustment parameter τ. Therefore, in the process of ranking the candidate construction program managers, the comprehensive perceived utility value p_i^* of the construction program managers will be different. This will ultimately affect the ranking of the candidates. The following change parameter τ values $\tau = 0$, $\tau = 0.2$, $\tau = 0.4$, $\tau = 0.6$, $\tau = 0.8$, $\tau = 1$, resulted in different alternative rankings as shown in Figure 3.



	τ=0	τ=0.2	τ=0.4	τ=0.6	τ=0.8	τ=1
A1	5.3858	4.7976	4.2095	3.6217	3.0337	2.4457
A2	5.1525	4.5853	4.0181	3.4511	2.8840	2.3169
A3	5.4812	4.8719	4.2627	3.6537	3.0446	2.4355
A4	5.3175	4.7311	4.145	3.5591	2.9729	2.3867
A5	5.2502	4.6714	4.0926	3.514	2.9354	2.3566

Figure 3. Ranking of alternative construction program managers.

It can be seen from the sensitivity analysis results that large preference adjustment parameter gives larger weight $w_j(t)$ based on Fuzzy-DEMATEL.

When $\tau = 1$, only attribute weights are considered, the first and second rankings in the ranking result will be switched. When $\tau < 1$, it can be found from the figure that as τ decreases to zero, the ranking results of the candidate construction program managers are consistent and do not change. Based on the above results, on the one hand, when $\tau = 1$, due to ignoring the weight of decision makers, the ranking results change greatly, this indicates that the model may have some instability when only attribute weights are considered, suggesting that decision maker weights should be considered in a comprehensive manner in practical applications. For example, in a construction program, an optimal manager candidate needs to be selected from several alternatives. However, different decision makers may have different views on the importance of the characteristics, so the decision maker weights need to be considered together when ranking. If we only consider the attribute weights and ignore the decision maker weights, it may lead to instability in the ranking results and thus bring negative impact to the selection process. Therefore, in practical application, we need to consider both attribute weights and decision maker weights according to the context in order to better stabilize the ranking results and provide a more credible basis for the selection of construction program managers.

On the other hand, the ranking results did not change when $\tau < 1$. Although, theoretically the different values of the parameter may have an impact on the ranking of the alternative construction program managers. However, if sensitivity analysis of the parameters reveals that the ranking results of the alternatives did not change significantly, this indicates that the model is stable when the parameter changes. This stability may enable decision makers to use the model with more confidence. It is important to note that although the model performs well in such cases, in practical applications, decision makers still need to choose the parameters carefully to ensure reliable results.

6. Conclusions and Contributions

Construction program managers are the core personnel in the management process. They need to respond and handle various events flexibly to promote the success of the program. This paper proposed a multi-attribute manager evaluation and selection model based on grounded theory, regret theory and Fuzzy-DEMATEL methods. During the course of completing this study, the following conclusions and contributions were made:

(1) By using grounded theory and semi-structured interview, this paper proposed a construction program managers selection and evaluation index system that is able to take various attribute into consideration, including personality charm, management ability, communication and coordination, professional skills, risk control, and strategic vision, which comprehensively reflects the competency requirements for construction program managers.
(2) In the process of decision-making, this study identified that the decision makers have "bounded rationality", and their psychological factors and preferences will have an impact on the decision results. Therefore, this paper introduces the idea of "regret theory" to make the decisions more practical.
(3) The method based on Fuzzy-DEMATEL attribute weight determination method used in this paper is found more efficient for complex situations as it considered both fuzzy language evaluation and the mutual influence between attributes.
(4) Based on the analysis of attribute weights, the decision makers' weights are analyzed using deviation minimization method. Their weights and attribute weights are effectively combined to propose more comprehensive and reasonable weights compared to traditional single weight methods.
(5) The case study shows that the construction program manager selection model proposed in this paper takes into account the psychological behavior of decision makers and group rationality and considers the mutual influence relationship between attributes. This provides a new effective way to solve the problem of construction program manager selection.
(6) Compared to past studies, the proposed study took into account the "limited rationality" of decision makers, which is different from the traditional assumption of "perfect rationality". In order to reflect the actual decision-making situation more accurately, this paper introduces "regret theory" to consider the risk attitude and decision pref-

erences of decision makers. This approach makes up for the shortcomings of past studies, and also helps to improve the accuracy and practicality of the selection model of construction program managers.

7. Future Works

This paper used fuzzy numbers to construct the construction program manager evaluation and selection model. In the future, the use of other data forms such as interval numbers and incomplete information can be attempted. In addition, hybrid approaches have been used frequently in personnel, supplier, and key factor selection problems in different industries, so combining different methods such as ANP, TOPSIS, MCDM, and MEMATEL can also be attempted in the future.

Author Contributions: Conceptualization, H.Y.; Software, W.H.; Investigation, Y.Y.; Data curation, C.G.; Writing—original draft, X.L. and Q.Y.; Writing—review & editing, H.Y.; Supervision, H.Y. and C.G. All authors have read and agreed to the published version of the manuscript.

Funding: The present study was supported by the Social Sciences Fund of Hunan Province (22ZDB089, 22JD076) and the National University Student Innovation and Entrepreneurship Project (202111532010).

Data Availability Statement: Some or all data, models, or code that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Bai, L.; Zhen, K.; Shi, H.; Guo, W.; Du, Q. Construction of collaborative management organization mode of enterprise project group. *J. Eng. Manag.* **2019**, *33*, 91–96. (In Chinese)
2. Jia, G.; Chen, Y.; Xue, X.; Chen, J.; Cao, J.; Tang, K. Program management organization maturity integrated model for mega construction programs in China. *Int. J. Proj. Manag.* **2011**, *29*, 834–845. [CrossRef]
3. Guo, F.; Shi, B.; Chen, Y. Research on the coupling interaction structure between project group construction and enterprise growth of large construction enterprises. *J. Railw. Sci. Eng.* **2015**, *12*, 449–454. (In Chinese)
4. Hong, Y.; Xu, Y. Analysis of project manager selection based on competency model. *China Bus.* **2013**, *18*, 35–37. (In Chinese)
5. Jian, S. Analysis of enterprise youth management personnel training mechanism from the perspective of governance modernization. *China Youth Res.* **2019**, *5*, 37–41. (In Chinese)
6. Liu, H.; Cao, Q. Research on the competency of large-scale project managers. *Sci. Technol. Dev.* **2017**, *13*, 540–546. (In Chinese)
7. Shui, Z.; Fei, K. Analysis on the difference of project manager's competency under the construction mode of DBB and DB/EPC. *J. Civ. Eng.* **2014**, *47*, 129–135. (In Chinese)
8. Sun, C.; Song, H.; Zhai, X.; Zhang, H. Construction of professional ability index system for construction project managers. *Prediction* **2018**, *32*, 72–76. (In Chinese)
9. Li, J.; Zhang, F.; Zhang, W.; Wang, J. Selection method of construction project manager based on capability characteristic analysis. *J. Railw. Eng.* **2019**, *36*, 94–100. (In Chinese)
10. Chen, W.; Wang, H.; Yan, H.; Li, M. Competency evaluation of construction project manager based on cosine of vector angle. *J. Civ. Eng. Manag.* **2018**, *35*, 32–38+84. (In Chinese)
11. Dong, X. Project manager selection system model based on analytic hierarchy process. *J. Pu'er Univ.* **2016**, *32*, 53–55. (In Chinese)
12. Shui, Z.; Fei, K.; Xiang, L. Competency evaluation of construction project manager based on support vector machine. *China Soft Sci.* **2013**, *11*, 83–90. (In Chinese)
13. Ceran, T.; Dorman, A.A. The Complete Project Manager. *J. Archit. Eng.* **1995**, *2*, 67–72. [CrossRef]
14. Sina, M.; Kalle, K.; Jonny, K.O.; Kirsi, A. A Competency Model for the Selection and Performance Improvement of Project Managers in Collaborative Construction Projects: Behavioral Studies in Norway and Finland. *Buildings* **2020**, *11*, 4. [CrossRef]
15. Alvarenga, J.C.; Branco, R.R.; Guedes, A.L.A.; da Silveira e Silva, W. The project manager core competencies to project success. *Int. J. Manag. Proj. Bus.* **2020**, *2*, 277–292. [CrossRef]
16. Hanna, A.S.; Ibrahim, M.W.; Karim, A.W.L. Modeling Project Manager Competency: An Integrated Mathematical Approach. *J. Constr. Eng. Manag.* **2016**, *142*, 04016029. [CrossRef]
17. Kumar, S.K.; Anup, K. Facilitating quality project manager selection for Indian business environment using analytical hierarchy process. *Int. J. Qual. Reliab. Manag.* **2018**, *6*, 1177–1194.
18. Afshari, A.R. Selection of construction project manager by using Delphi and fuzzy linguistic decision making. *J. Intell. Fuzzy Syst.* **2015**, *6*, 2827–2838. [CrossRef]
19. Afshari, A.R. Methods for Selection of Construction Project Manager: Case Study. *J. Constr. Eng. Manag.* **2017**, *143*, 06017003. [CrossRef]

20. Skulmoski, G.J.; Hartman, F.T. Information systems project manager soft competencies: A project-phase investigation. *Proj. Manag. J.* **2010**, *41*, 61–80. [CrossRef]
21. Alshammari, F.; Yahya, K.; Haron, Z.B. Project Manager's Skills for improving the performance of complex projects in Kuwait Construction Industry: A Review. *IOP Conf. Ser. Mater. Sci. Eng.* **2020**, *713*, 012041. [CrossRef]
22. Wu, G.; Hu, Z.; Zheng, J. Role stress, job burnout, and job performance in construction project managers: The moderating role of career calling. *Int. J. Environ. Res. Public Health* **2019**, *16*, 2394. [CrossRef] [PubMed]
23. Wang, C.M.; Xu, B.B.; Zhang, S.J.; Chen, Y.Q. Influence of personality and risk propensity on risk perception of Chinese construction project managers. *Int. J. Proj. Manag.* **2016**, *34*, 1294–1304. [CrossRef]
24. Ghorbani, A. A Review of Successful Construction Project Managers' Competencies and Leadership Profile. *J. Rehabil. Civ. Eng.* **2023**, *11*, 76–95.
25. Shehu, Z.; Egbu, C. The skills and competencies of programme managers. In Proceedings of the RICS-COBRA 2007 Annual Conference, Atlanta, GA, USA, 6–7 September 2007; pp. 6–7.
26. Levrat, E.; Voisin, A.; Bombardier, S.; Brémont, J. Subjective evaluation of car seat comfort with fuzzy set techniques. *Int. J. Intell. Syst.* **1997**, *11–12*, 891–913. [CrossRef]
27. Dai, Y.; Xu, Z.; Li, Y.; Da, Q. New scale of language information assessment and its application. *China Manag. Sci.* **2008**, *2*, 145–149. (In Chinese)
28. Bleichrodt, H.; Cillo, A.; Diecidue, E. A quantitative measurement of regret theory. *Manag. Sci.* **2010**, *56*, 161–175. [CrossRef]
29. Zhang, X.; Fan, Z.; Chen, F. Risk based multiple attribute decision making method based on Regret Theory. *Syst. Eng. Theory Pract.* **2013**, *33*, 2313–2320. (In Chinese)
30. Shi, Z.; Jian, Z.; Xiao, L. Group decision making method based on Regret Theory under multi-dimensional preference information of scheme pair. *China Manag. Sci.* **2014**, *22*, 33–41. (In Chinese)
31. Fa, Z.; Wei, W. Linguistic multiple attribute decision making method based on Regret Theory and DEMATEL. *China Manag. Sci.* **2020**, *28*, 201–210. (In Chinese)
32. Glaser, B.G.; Strauss, A.L.; Strutzel, E. The discovery of Grounded Theory; strategies for qualitative research. *Nurs. Res.* **1968**, *17*, 377–380. [CrossRef]
33. Etikan, I.; Musa, S.A.; Alkassim, R.S. Comparison of convenience sampling and purposive sampling. *Am. J. Theor. Appl. Stat.* **2016**, *5*, 1–4. [CrossRef]
34. Kahneman, D.; Tversky, A. Prospect Theory: An Analysis of Decision under Risk. *Econometrica* **1979**, *2*, 263–291. [CrossRef]
35. Bell, D.E. Regret in Decision Making under Uncertainty. *Oper. Res.* **1982**, *30*, 961–981. [CrossRef]
36. Loomes, G.; Sugden, R. Regret Theory: An Alternative Theory of Rational Choice Under Uncertainty. *Econ. J.* **1982**, *92*, 805–824. [CrossRef]
37. Guzman, L.M. *Multi-Criteria Decision Making Methods: A Comparative Study. Applied optimization. Evangelos Triantaphyllou*; Kluwer Academic Publishers: Alphen am Rhein, The Netherlands, 2001; p. 288.
38. Gabus, A.; Fontela, E. *World Problems, an Invitation to Further thought within the Framework of DEMATEL*; Working Paper; Battelle Geneva Research Centre: Geneva, Switzerland, 1972.
39. Fontela, E.; Gabus, A. DEMATEL: Progress achieved. *Futures* **1974**, *6*, 361–363. [CrossRef]
40. Baykasoglu, A.; Durmusoglu, Z.D. A hybrid MCDM for private primary school assessment using DEMATEL based on ANP and fuzzy cognitive map. *Int. J. Comput. Intell. Syst.* **2014**, *7*, 615–635. [CrossRef]
41. Chen, Y.S.; Chuang, H.M.; Sangaiah, A.K.; Lin, C.K.; Huang, W.B. A study for project risk management using an advanced MCDM-based DEMATEL-ANP approach. *J. Ambient. Intell. Humaniz. Comput.* **2019**, *10*, 2669–2681. [CrossRef]
42. Göncü, K.K.; Çetin, O. A Decision Model for Supplier Selection Criteria in Healthcare Enterprises with Dematel ANP Method. *Sustainability* **2022**, *14*, 13912. [CrossRef]
43. Ataei, Y.; Mahmoudi, A.; Feylizadeh, M.R.; Li, D.-F. Ordinal priority approach (OPA) in multiple attribute decision-making. *Appl. Soft Comput.* **2020**, *86*, 105893. [CrossRef]
44. Li, R.-J. Fuzzy method in group decision making. *Comput. Math. Appl.* **1999**, *38*, 91–101. [CrossRef]
45. Hong, Y.; Fei, Z.; Wen, T.; Yong, D. ANP group decision making model for project group selection of construction enterprises. *Sci. Technol. Prog.* **2011**, *28*, 38–42. (In Chinese)