Development of a Contractor Failure Prediction Model using Analytic Network Process

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ABSTRACT

Contractor failure is one of the most critical and costly risks to the employer. Despite the ability of the employer to terminate the construction contract due to the contractor’s failure to achieve crucial contractual objectives, employer still suffers adverse impacts on time, cost and goodwill. Under price-driven selection, construction contracts are usually awarded to the lowest bidder with little attention to bidder’s capabilities. Therefore, this study attempted to develop a model to assist construction professionals in selecting the bidder with the lowest failure potential. Analytic network process (ANP) was used to analyse the data collected from the fuzzy questionnaire. The results concluded a ranking for the reasons of contractor failure, which were initially identified from the literature and categorized to five categories. The results showed that ‘corporate governance’ and ‘financial position’ are the most and second influential categories towards contractor failure potential respectively. Furthermore, ‘cost control’, ‘tender approach’ and ‘technical competency’ are ranked as the third, fourth and least influential categories respectively. Construction practitioners can utilize the model developed by this study to evaluate bidders to minimize the probability of contractor failure and consequently maximize the probability of successful project delivery.

Keywords: Contractor Failure, Analytic Network Process (ANP) and Fuzzy Questionnaire

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INTRODUCTION

Construction projects are exposed to numerous risks which may hinder its success. Al-Sobiei, Arditi and Polat (2005) pointed out that the contractor failure is one of the most critical risks to the employer. They defined contractor failure as the inability to discharge further its contractual obligation due to cease of business operation (e.g. bankruptcy). Contractor failure incurs additional construction expenditures, prolongs construction period, losses of rental income, and negatively impact the goodwill. Procurement to complete the remaining works after the initial contractor was terminated takes time and the employer incurs additional expenditures. Al-Sobiei, Arditi and Polat (2005) and Russell (1991) identified the additional time and professional fees incurred for the procurement of a completion contract, including, survey of works executed, and preparation of procurement and contract document for the leftover works. Furthermore, the employer has to bear higher total construction cost due to the inflated construction costs and risk premium. Legal fees may also be incurred on the dispute resolution with the contractor who failed to deliver the works. In terms of loss of profit, the employer would also suffer losses of the rental income during the extended construction period (Sobel, 1984). Apart from quantifiable impacts on time and cost, Russell (1991) pointed out that employer would also have a negative impact on the goodwill and reputation because of the late handover and even late accomplishment of the flagship development.

De Loach (2006) believed the risk of contractor failure is unavoidable. This is because the external third party has to be engaged to execute construction work unless an in-house project team is formed (Al-Sobiei, Arditi and Polat, 2005). Ideally, De Loach (2006) suggested that risks which could not be fully eliminated should be reduced or transferred to external parties. Despite the contractual provision of a performance bond may cover part of direct financial losses, it does not manage the risk of contractor failure. Denicol, Cassel and Pryke (2016) criticised that the industry adopts price-driven selection that awarding the contract to the lowest bid. However, the price-driven assessment does not evaluate the failure potential of a contractor. Agroudy et al. (2009) observed the employers' realization of the fact that awarding contracts to the lowest bidder is not the best strategy in terms of value. The bidder with the lowest bid may have high failure potential. Consequently, the employer may incur higher total construction cost than the cost of awarding the construction contract to a capable contractor due to due to cost of termination and appointment of another contractor to take up remaining works (Afsath and Linjesh, 2015; Tserng et al., 2011).

As discussed above, contractor failure brings critical and harmful impact to the development project. Accordingly, the objectives of this study are 1) identification of critical factors that cause contractor failure 2) and, development of contractor failure prediction model to support construction practitioners in selecting the contractor with low potential of failure to deliver the works. Three steps of research are carried out. First is the identification and categorization of the reasons behind the contractor failure. Second is building a simplified fuzzy questionnaire to collect the opinion of experts. The third is analysing the results using ANP to develop prioritization for the causations of contractor failure to achieve the project objectives.

LITERATURE REVIEW

The literature on predicting the failure of the contractor can be classified into three categories. First is the prediction of contractor failure by relying on data of failed businesses (Tserng et al., 2011). Conversely, general business failure models may not be applicable to the construction contracting business (Chava and Jarrow, 2004). The second category is related to evaluation of contractors in the procurement stage. Russell and Skibniewski (1988) conclude that bidder’s experience and past performance are critical factors of evaluation. They also revealed in 1990 that the employers in the private sector would also evaluate bidder’s corporate governance and safety record. Contractor evaluation and pre-qualification models are common in literature (Afsath and Sebastian, 2016; Agroudy, Elbeltagi and Razek, 2009; Bendana, Cano and Cruz, 2008; Tang et al., 2014). It revealed that past performance, experience on relevant projects, knowledge on concerned project, competency of senior management, technical competency, and financial performance are critical contractor evaluation criteria. Others included health and safety performance, reputation, resource availability and price realisticity. The methodology used among these models is mainly Analytic hierarchy process (AHP) to systematically compute weightings among factors. However, these evaluation models do not analyze the potential of failure for the contractor during evaluation.

The third and final category is the contractor failure prediction models, which is the closest category to this research. Al-Sobiei, Arditi and Polat (2005) developed a contractor failure prediction model by retrieving financial data of contractors from a surety in the United States and identified that poor financial performance in terms of liquidity, profitability, liability ratio and business volume, is critical to their failure potential. Although their study only considered past financial performance of contractors, it achieved 88% and 78% of accuracy in evaluating the contractor failure potential. In the same context, Tserng et al. (2011) and Jang et al. (2019) developed contractor failure prediction models by considering the financial performance of both failed and sustained listed contractors published in stock exchange markets of United States. Apart from common financial variables, Jang, Jeong and Cho (2020) introduced few variables regarding construction sector market condition and macroeconomic into their contractor failure prediction model and concluded that this increased predictability by 4%.

Existing models mainly considered financial data of bidders but did not evaluate other critical factors that have strong indication on contractor failure potential. It is hypothesized that considering a wider range of factors would enhance the predictability of the developed contractor failure prediction model. Furthermore, previous contractor failure prediction models were developed using AHP which neglects the interrelationship among factors. Similarly, data of existing contractor failure prediction models were collected through a questionnaire on a Likert scale, which fails to capture imprecise rating between two defined options. The problems identified in literatures form a gap that could be addressed by providing a more holistic model that can predict the failure potential of contractors through exploring and assessing on wider range of failure causations. In addition to ‘financial performance’, this study also considers critical factors that have a strong influence on ‘contractor failure potential’, including, ‘corporate governance’, ‘tender approach’, ‘technical competency’ and ‘cost control’. The interrelationship between factors is taken into account in this study through the application of ANP. Furthermore, fuzzy questionnaire is adopted to solve the imprecise rating problem found in previous studies. Respondents have to enter their ratings in ranges. Therefore, transition rating between two defined options can be captured.

METHODOLOGY

Figure 1 illustrates the structure of this study. This study started with the identification of critical factors that contribute to the contractor failure to deliver project based on existing literature. Then, the questionnaire survey is conducted to collect industry practitioners' rating on the identified factors. Afterwards, the results of the questionnaire are analyzed using ANP. Finally, the results are discussed and recommendations are concluded. In the remainder of this section, a brief description is furnished for each research technique used in this research.

Fuzzy Questionnaire

Fuzzy questionnaire is an advanced questionnaire survey to capture imprecise magnitude on factors by incorporating the fuzzy process (Bouchon, 1981). Questionnaire in likert scale requires only a single answer to respond to a question. In contrast, fuzzy questionnaire requires respondents to rate their opinion using two numerical ranges to indicate their perception. First range describes the respondent's rating according to the respondent's opinion, while the second range is a boarder range to describe respondent's acceptable extent (University of Oviedo, 2014). Fuzzy questionnaire has been adopted in wide range of contexts (Angeles Gil et al., 2015). They obtained reasonable response from the fuzzy questionnaire survey from nine-year-old students after fifteen minutes of face-to-face instruction on how respondents shall answer the fuzzy questionnaire. De La Rosa de Saa et al. (2014) carried out a fuzzy questionnaire survey with the public on dining experience. Therefore, the fuzzy questionnaire is suitable to adopt in a questionnaire survey on the general public.

Quantitative Analysis Technique

Analytic hierarchy process (AHP) is the most used mathematic tool for multi-criteria decision-making (Kahraman et al., 2004). AHP is a systematic procedure to rank factors for decision-making proposed by Saaty in 1980. For example, the decision on bidder selection can be made by ranking the important factors of comparison, followed by evaluating bidder's performance based on these factors. Sets of pairwise comparison are carried out to capture respondents' perception, thought and judgment to rank factors systematically.

AHP is carried out through sequential steps. First, a complex decision problem is transformed into a multi-level hierarchy as per Figure 2. The highest level of the hierarchy in Figure 2 is the required decision to make. Second-level and subsequent level of the hierarchy are factor categories and sub-factors for each category respectively for the evaluation. Then, multiple sets of pairwise comparisons are drawn to evaluate importance among factors by gathering the respondent's rating on how two elements at the lower level influence the criteria at the upper level. Next, weightings are calculated with the aid of matrices. In addition, Saaty (2005) proposed to calculate the relative weight of each factor by normalization. Analytic hierarchy process (AHP) is adopted to derive weighting among factors in contractor evaluation models (Bendana, Cano and Cruz, 2008; Agroudy, Elbeltagi and Razek, 2009; Tang et al., 2014; Afsath and Sebastian, 2016). Questionnaire surveys in the form of pairwise comparisons were carried out to capture views of respondents. Weights of factors were then calculated for their influence to the subject. Bidders are ranked by a total score calculated from the model. Notably, the score is an implication of suitability of the bidder to the project.

A more enhanced quantitative approach is the Analytic network process (ANP), proposed by Saaty in 1996 which is an advancement of AHP. Similar to AHP, ANP transforms complicated decision problem into a multi-level hierarchy. Then, multiple sets of pairwise comparisons are adopted to rank relative importance among factors subjectively. In addition to pairwise comparisons between factors' influence on the criteria, ANP also considers the influence between factors within the same level, i.e., categories of factors, by comparing how two factors influence other factors within the same level. Therefore, ANP outperforms AHP by considering the interrelationship between factors within the same level, which is why in this research ANP was adopted. To perform ANP on the results of the data collected from the fuzzy questionnaire, series of steps must be followed. These steps are defuzzification, creation of pairwise matrix, developing relative weights in a pairwise matrix, developing weighted supermatrix, developing overall limited priorities, calculating the local and global weight of factors, and finally, evaluating the contractors' failure potential. The ANP model was developed on SuperDecision software for easier computation. Details of each step are explained as follows;

1. First, physical scale is adopted on questionnaire survey to minimize the perception on the absolute numerical scale between respondents. However, ratings in the form of physical scale were converted to numerical scale to calculate the weightings of each factor (Saaty, 2005), where "1" is equivalent to "Equal important", "3" is equivalent to "Moderate", "5" is equivalent to "Strong", "7" is equivalent to "Very Strong", and "9" is equivalent to "Absolute". Second, defuzzification is carried out. Defuzzification is the process of converting aggregated values into a single value (Mamdani, 1974). Mean-max membership, which is known as the middle of maxima, was adopted to defuzzify aggregated rating obtained from the questionnaire survey [Eq. (1)],

   $$\mathrm{DR}_i = (\mathrm{Min}\ \mathrm{I}_i + \mathrm{Max}\ \mathrm{I}_i) \div 2 \quad (1)$$

   where DR_i is the defuzzified rating of factor *i* while Min I_i and Max I_i are the minimum and maximum importance of factor *i* among two factors in a pairwise comparison towards the category.

2. Pairwise comparison matrix (Table 1) is drawn by inputting defuzzified ratings for subsequent computation of relative importance among factors. Value in each cell is the ratio of factors associated with the cell's row against the column, as per [Eq. (2)]. Raji (2013) suggested that only values on the first row have to be obtained from a questionnaire survey while the rest of the value can be computed accordingly. Furthermore, Saaty (2005) suggested that computation on relative weighting only requires values on the last column. Value of the last column is obtained by dividing the first value on the last column by rating of respective factors on the first row by [Eq. (3)]. Therefore, questionnaire survey only enquires for

comparisons on the first row (i.e. comparsions of subject with rest of factors within the same category) and while value on last column can be calculated accordingly.

Considering Value A_{ij} is the value in Row '*i*' and Column '*j*' in the matrix.

$$A_{ij} = i \div j \qquad (2)$$

From Eq. 2,

$$A_{ij} = i \div j$$

$$A_{ij} = \frac{i}{j} \times \frac{i_1}{i_1}$$

$$A_{ij} = \frac{i_1}{j} \times \frac{i}{i_1}$$

$$A_{ij} = \frac{i_1}{j} \div \frac{i_1}{i}$$

$$A_{ij} = (i_1 \div j) \div (i_1 \div i)$$

$$A_{ij} = A_{1j} \div A_{1i} \qquad (3)$$

where the value on the first row of the last column is labeled as A_{1j} and value on the first row of column i is labeled as A_{1i}.

3. The relative weight of factors in a pairwise comparison matrix is also known as vector of priorities (Saaty, 2005). Instead of calculating for eigenvector by complicated mathematical computation, Saaty (2005) pointed out that relative weight can also be obtained by normalization of rating. Normalization is the process of dividing any values in a column by the sum of the whole column as per [Eq. (4)]. In this study, the relative weight of factors is obtained by normalizing ratings on the last column of the pairwise comparison matrixes. Alternatively, the tedious computation can be carried in an excel spreadsheet or with the aid of SuperDecisions (an ANP analysis computer software). Relative weight within a pairwise comparison matrix can be generated by entering weightings among factors into the matrix. Screenshot of SuperDecisions on computation for the relative weight is captured in Figure 4.

$$\text{Local relative weight: } a_{ij} \div \Sigma\, a_{ij} \qquad (4)$$

where a_{ij} is the value in a cell and $\Sigma\, a_{ij}$ is the sum of all values on the column

4. Unweighted supermatrix is a matrix holding relative local weights among factors based on all pairwise comparisons. Apart from manual entry, unweighted supermatrix can be generated by SuperDecisions. Afterwards, weighted supermatrix is drawn by normalizing every column in the unweighted supermatrix (El Chanati, 2014). Weighting in a cell is divided by the sum of that column as per [Eq. (5)]. Weighted supermatrix can be generated by SuperDecisions.

$$\mathrm{W}_i = \mathrm{w}_i \div \sum \mathrm{w} \tag{5}$$

where W_i is weighted weighting of factor i, w_i is local weight of factor i obtained from unweighted supermatrix and $\sum \mathrm{w}$ is the summation of weights from a category.

5. A limited matrix was built by powering up the weighted supermatrix until values within the same row are identical. Limited priorities, values computed from the limited matrix, are used to calculate factors' weighting. The limited matrix for all questionnaire responses is developed by repeating this step. Then, limited priorities from all questionnaire responses are extracted to calculate the overall limited priorities. The overall limited priority of a factor is the mean of limited priority of that particular factor associated with all questionnaire responses as per [Eq. (6)].

$$\mathrm{LP}_i = \Sigma\, \mathrm{lp}_i \div n \tag{6}$$

whereas LP_i is the overall limited priority of factor i, lp_i is the the limited priority of factor i from single questionnaire respond while n is number of questionnaire response.

6. Local weight of factors associated with the same pairwise comparison matrix can be calculated by normalization of limited priority. In [Eq. (7)], the local weight of a factor is calculated by dividing the limited priority of a particular factor by the sum of limited priorities in a pairwise comparison matrix.

$$\mathrm{LW}_i = \mathrm{LP}_i \div \Sigma\mathrm{LP} \tag{7}$$

Where LW_i is the local weight of factor i, LP_i is the limited priority of factor i within the cluster, and $\Sigma\mathrm{LP}$ is the summation of limited priority among factors within the cluster.

On the other hand, the computation of the global weight of sub-factors for each category eliminates the additional timesing of sub-factors local weight against its category weight when applying the model (Mosleh, 2014). Global weight of sub-factor is calculated by multiplying sub-factor's local weight with the local weight of its category as per [Eq. (8)].

$$\mathrm{GW}_i = \mathrm{LW}_i \times \mathrm{LW}_c \quad (8)$$

Where GW_i is the global weight of factor i, LW_i is the local weight of factor I and W_c is the local weight of category c. Repeat this step to calculate the global weight of all sub-factors in the model.

7. Proposed contractor failure prediction model evaluates bidder's failure potential by scoring bidder's performance on each factor. Each category or factor shall be scored according to the same scale, i.e., 100 or 1 for meeting the requirement, 50 or 0.5 for meeting only half of the requirement, 0 for not meeting the requirement and other numerical scores in between can be awarded to factors accordingly. Index of a factor can be calculated by multiplying the weighting calculated by ANP to its score as per [Eq. (9)]. 'Contractor Failure Potential index' of a bidder is proposed as the sum of indexes as per [Eq. (10)].

$$\mathrm{I}_i = \mathrm{W}_i \times \mathrm{S}_i \quad (9)$$

$$\mathrm{CFPI}_a = \sum \mathrm{I} \quad (10)$$

Where I_i is the index of factor i, W_i is the weighting of factor i among factors in a category, S_i is the score of factor i, CFPI_a is the capability index of bidder a, and $\sum \mathrm{I}$ is the summation of indexes among factors.

MODEL DEVELOPMENT

Factors Identification from Literature

Corporate Governance

Business performance of a contractor can be affected by its management (Lee, Lee and Park, 2018). Al-Sobiei, Arditi and Polat (2005) point out that inadequate, incapable and inexperience managers may not be able to steer the business in the right direction leading to failing of business. Senior management of a contractor is personnel that are at the highest level of management. Chief officers, such as chief executive officer (CEO), chief finance officer (CFO) and chief technical officer (CTO), are common positions of the senior management. Organization chart and resume of senior management could be reviewed to evaluate bidder's corporate governance system. A few parameters regarding the senior management can be assessed to give an indication about the robustness of the company. First, the number of senior management staff, in case of an insufficient number of staff at such critical positions it would mean excessive workload that may affect their decision-making abilities. Second, the experience of the senior management staff, this affects their strategic management skills in operating the company. Third and lastly, academic and professional qualification of senior management, this affects their technical and soft skills, consequently, affecting their capabilities to discharge their duties.

Tender Approach

The over-aggressive tender approach leads to contractor failure (Russell, 1991). Royal Institution of Chartered Surveyors (2016) suggested that projects are underbid because of bidder's insufficient knowledge of tendered project such that project complexity and risks are underestimated. It pointed out that tenderers may carry out cost estimate without a thorough understanding of project scope. In addition, Russell (1991) pointed out that bidders may not fully acknowledge additional costs imposed by project constraints. Underassessment of inherent project risks would lead to contractor failure. The contractor did not allocate costs for managing risks that may arise when delivering construction projects, such as, shortage of labour and materials. Furthermore, over-estimated profitability also leads to contractor failure by failing to achieve the expected profit to settle overheads. Conclusively, tendered price and risk management approach of bidder shall be evaluate to identify its failure potential.

Technical Competency

A contractor may fail because of its inadequate technical competency (Russell, 1991). He observed that the failure of the contractor is due to lack of technical expertise and knowledge in dealing with the variation in type, scale and geographic location of projects. The contractor is more likely to fail when undertaking project which is two times larger in scale than those projects its successfully delivered (Russell, 1991). In addition, contractors having inadequate in-house construction professionals are more likely to fail. Without sufficient technically competent engineers and construction managers, the contractor fails to carry out extensive design and management duties (Russell, 1991). Therefore, the technical competency of contractors can be projected from their past performance in similar projects, i.e. quality works, on time completion and testimonial from previous projects recoginize the competency of contractors. Further documents indicating idling resources owned by the bidder can indicate its technical competency.

Cost Control

Inadequate cost control measures may lead to contractor failure (Russell 1991). Severson, Russell and Jaselskis (1994) revealed that 98% of contractors who failed do not have a formal cost control system. Systematic cost control system aims to record expenditures and monitor cost status of a particular project. Accurate and up-to-date accounting information enables the construction manager to make well-informed decision to optimise profitability (Severson, Russell and Jaselskis, 1994). Corrective actions can be taken if a desirable financial outcome cannot be achieved. In contrast, a contractor without effective cost control system cannot identify early symptoms of budget slippage. The remedial decision may not be formulated promptly to maintain profitability. Accordingly, the cost control system of the contractor and cost control personnel are critical aspects in predicting the contractor’s failure potential.

Financial Position

Contractor with weak financial position is more vulnerable to failure. Russell (1991) pointed out that uncontrolled liabilities and lack of working capital are major causes of failure. Al-Sobiei, Arditi and

Polat (2005) mentioned that a business is defined as bankrupted if the business cannot settle its outstanding debts by assets and capital of the business. In particular, a contractor with high liability profile and few working capitals has hardship on applying for loans. Hence, more likely to go bankrupt. Ineffective and inefficient billing procedure develops a higher potential for business failure (Severson, Russell and Jaselskis, 1994). The long timeframe of receiving payments from the employer would reduce the contractor’s working capital. Hence, the contractor has a higher potential to fail. The contractor with profit that does not grow in line with business volume growth, may have a higher potential of failure (Russell, 1991). Construction contracting is a volume-driven business that relies on business volume to be sustained. However, large contractors incur higher overheads. Therefore, continuity of the unproportioned growth of profit and business volume may result in a worse situation where the profit margin could not settle the growing overheads leading to financial loss.

The financial position of a contractor is the resourcefulness of the contractor. Financial ratios computed from the financial statement can evaluate tenderer’s financial position. A set of financial parameters are indicative of the financial position of contracting companies. First, profitability, which can be evaluated through the ratio of net profit against business volume, assets and capital as illustrated in Table (2) (Tserng et al. 2011). Return on sales is the financial ratio between net profit and business. Profitability ratios evaluate bidder’s financial return from existing resources. Second, liquidity, which can be indicated by the relationship between assets and liabilities (Jang et al. 2019; Lee, Lee and Park, 2018). The current ratio and debt ratio evaluate contractor’s liquidity by evaluating ratios of assets against liabilities as illustrated in Table (2). Third, ease of finance. Bidder’s ease of finance represents bidder’s financial situation (Tserng et al., 2011). Bank credit line is the maximum amounts of borrowing from financing institutions. Remaining bank credit indicates contractor's ease of finance. Surety rating is a rating given by the surety company regarding the financial capacity of the contractor. Contractor with a low credit rating has stronger risk of bankruptcy due to failure in turnover. Fourth, the timeframe to realize earnings (Tserng et al., 2011).

The contractor with a shorter timeframe of realization, has shorter billing and effective debt collection procedure. Therefore, a contractor with a shorter timeframe of realization has stronger cash flow hence better financial position and lower failure potential. Fifth, financial reserve (Jang, Jeong and Cho 2020). It is the accumulation of net profit over the life of a business excluding dividends. Contractor with more financial reserve, is less likely to fail as financial reserve serves as a contingency to reduce contractor's reliance on loans from a financial institution.

Factors Considered in this study

Conclusively, five categories and associated sub-categories, namely, 'corporate goverance', 'tender approach', 'technical competency', 'cost control' and 'financial position' that contribute to the assessment of contractor's failure potential have been identified from the literatures. Figure 3 illustrates the hierarchy of the identified factors.

Data Collection Using Fuzzy Questionnaire

A fuzzy questionnaire is designed to calculate the weighting among factors in the contractor failure prediction model. Part 1 of the questionnaire screens eligibility of respondents to participate in the questionnaire survey by the background of respondents, such as knowledge, experience, and profession. Only respondents who have over two years of industrial experience and knowledge or experience on construction procurement are invited to participate in subsequent parts of the questionnaire survey.

Part 2 of the questionnaire is the pairwise comparisons between factor categories. For example, how 'corporate governance' and 'tender approach' impact 'contactor failure potential'. Part 3 of the questionnaire is the pairwise comparisons among sub-factors in each category. For example, how 'number of senior management staff' and 'experience of senior management' impact 'corporate governance'. Part 4 of the questionnaire is the pairwise comparisons among factor categories on how two-factor categories influence another factors category. For example, how 'tender approach' and 'technical competency' impact 'corporate governance'.

This study simplifies the fuzzy questionnaire by only requiring the respondent to enter his/her minimum and maximum rating on the questionnaire. In other words, the respondent does not have to indicate his/her acceptable ranges. In each pairwise comparison, two factors are presented. First, the respondent has to indicate which factor is more important towards the category. For example, Factor X 'number of senior management staff' is more important than Factor Y 'experience of senior management' towards category 'corporate governance'. Then, the respondent rates the magnitude of importance by using the scale of 'absolute', 'very strong', 'strong', 'moderate' and 'equal important'. A range consists of two ratings shall be entered. For example, Factor X 'number of senior management staff' is more important than Factor Y 'experience of senior management' towards category 'corporate governance' between 'very strong' and 'strong'.

This study adopts a paper-based questionnaire, Microsoft Word-based questionnaire, and web-based questionnaire. The paper-based questionnaire is the hard copy of the Microsoft Word-based questionnaire. Web-based questionnaire is hosted in the mySurvey, which is the online survey platform owned by the Hong Kong Polytechnic University. Questionnaire survey invitations are sent via emails. Directories of relevant government departments, organizations and business entities are reviewed to identify construction practitioners who are qualified to participate in the questionnaire survey. Email invitations are sent accordingly with a dedicated link to the web-based questionnaire and the Microsoft Word-based questionnaire as an attachment. In addition, face-to-face interviews are carried out in some occasions to introduce and assist the respondent in filling in the fuzzy questionnaire.

Respondent Background

Construction practitioners with diverse background participated in the questionnaire, including quantity surveyors also known as cost engineers (35%), building surveyors (35%), engineers (18%), architects (6%), project managers (6%). Respondents with different level of experience, took part in the questionnaire survey, as 23% of respondents had two to four years industrial experience, while 18% and 23% of respondents have ten to nineteen and twenty to twenty-nine years industrial experience, respectively. In addition, 18% of respondents have thirty to thirty-nine, and 18% of respondents have above forty years of industrial experience. Another classification for the respondents' organization was carried out, where it was found that 35% of respondents practised in government organizations, 23% of respondents practised in non-governmental organizations, 12% of respondents practised in consultants, 12% practised in facility management service providers, 12% of respondents practised in contractors, and 6% of respondents practised in developers took part in the questionnaire survey. In total, 69 practitioners were contacted and 41 replied, which achieved 59.42% response rate. The topic understudy here is very sensitive, some people may spend their whole career and not come by the incident where the contractor fails to complete the project. Accordingly, people who have the enough knowledge to repond are not so many, as this requires experienced professionals not early career ones. The years of experience classification for reflects the hypothesis that younger professionals may not be able to participate much, 77% of the repondents have more than ten years of experience.

Applying ANP on Collected Questionnaire Data

Table (3) extracts one group of pairwise comparisons from Questionnaire no. 6. This sample will be used as an example of how ANP was applied to the data collected from the fuzzy questionnaire. The table shows how physical scales were converted from the questionnaire response to the numerical scale. In addition, pairwise comparison on how 'corporate governance' and 'tender approach' influence towards 'contractor failure potential' is rated between 'moderate' and 'equal important'. It is converted to 3 and 1. Numerical Rating from a pairwise comparison in Table (3) is defuzzied to the value "2" by applying [Eq. (1)] on two numerical scales, 1 and 3. Defuzzied rating between 'corporate governance' and 'tender approach' on influence towards 'contractor failure potential = $(1 + 3) \div 2 = 2$

After defuzzification, the pairwise comparison matrix is created for subsequent calculation of weight among factors. The value "2" on the second column of Table (4) indicates that 'tender approach' is two times more influential than 'corporate governance' towards 'contractor failure potential', i.e., between ‘moderate’ and ‘equal important’. Similarly, the value “4” indicates that ‘technical competency’ is four times more influential than ‘corporate governance’ towards ‘contractor failure potential’, i.e., between ‘moderate’ and ‘strong’. In other words, it indicates that ‘corporate governance’ has only one-fourth influential over ‘technical competency’ towards ‘contractor failure potential’. In addition, the relative weights of factors within a pairwise comparison matrix were calculated, as shown in Tables (4). The column of ‘financial position’ (FP) was normalized. Sum of column FP is 2.071, i.e., 1/7 + 1 /14 + 4/7 + 2/7 + 1 = 29/14. Normalized relative local weight of ‘corporate governance’ is 0.069 which is calculated by dividing the influence of ‘corporate governance’ over ‘financial position’ towards ‘contractor failure potential’ (1/7 or 0.143), against a sum of entries in the column of ‘financial position’ (FP) (29/14 or 2.071), i.e., 0.143/2.071 = 0.069. The aforesaid calculations were carried out on SuperDecision, where data from pairwise comparisons were entered into the software as per Figure (4). Factor pointed by the arrow has stronger implication to the subject over alternative in the concerned set of pairwise comparison and the number next to arrow describes respondent’s view on how the factor is more influential to the subject over alternative factor. Right-hand side of the interface shows the weighting among factors towards contractor failure potential (subject). The factor which has a higher influence on the subject would have a higher weighting. In Figure (4), factor category ‘financial position’ has the strongest influence on ‘contractor failure potential’ while factor category ‘tender approach’ has the least influence on ‘contractor failure potential’. Take a pairwise comparison between ‘corporate governance’ and ‘financial position’ as illustration, arrow pointing to the financial position with digit 7 next to arrow shows that respondent believed that financial position is seven times more influential to contractor failure potential (subject) over corporate governance.

The next step is to develop the unweighted and weighted supermatrices for the same example. In particular, the relative weight of factor categories’ influence towards ‘contractor failure potential’ calculated in Table (4) is entered to the first column of the unweighted supermatrix. In Figure 5, the first row of matrix lists out 5-factor categories of this study. The first column of matrix lists out

5-factor categories and sub-factors under each category. The last column of the matrix shows the factor categories' influence towards 'contractor failure potential' (subject) where 'financial position' (0.48276) has the strongest influence on 'contractor failure potential'. First to fiifth rows of data are the local relative weight among factor categories. In the first column of data, 'cost control', 'financial position' and 'technical competency' (0.30000) have equal influence towards 'corporate governance' (subject factor category). In the last and second last rows of number under the column of 'tender approach',' realistic price' (0.8333) has stronger influence to 'tender approach' (subject factor category) than 'risk management' (0.16667). The unweighted matrix is then converted to a weighted matrix by normalizing every column in the unweighted supermatrix. Table (5) represents the established weighted supermatrix along with Figure (6) from the software used. Weightings on the Column 'contractor failure potential' remain unchanged since the sum of the column is one in the unweighted supermatrix. In contrast, 0.0500 on column 'corporate governance' and row 'tender approach' is obtained by dividing the local weight of factor 'tender approach' towards 'corporate governance' from the unweighted supermatrix (0.1000), by sum of that column under the same unweighted supermatrix [(0.3000+0.3000+0.3000+0.1000)+(0.14286+0.14286+0.71429)=2 (rounded)], i.e., 0.100/2 = 0.050.

The following step is to develop the limited supermatrix is shown in Figure (7) by powering up the supermatrix until values within the same row are identical. Values obtained from all questionnaires are then entered into Table (6) to compute the overall limited priorities of factor. Afterwards, the local weight of categories is calculated through normalizing the limited priority. Then, the global weight is calculated by multiplying sub-factor's local weight with the local weight of its category. Tables (7) illustrates the local weight of factor categories towards 'contractor failure potential'. 'Corporate governance' contributes to 'contractor failure potential' by 0.273 out of 1. It is calculated by dividing the factor's overall limited priority (0.118) by the sum of limited priority among categories (0.433). Next, weighting among the identified factors is calculated based on all questionnaire responses. Weighting indicates how respondents ranked the impact of identified factors towards 'contractor failure potential'. In general, all factor's categories have a similar impact on 'contractor failure potential' as indicated by similar weighting. On the other hand, Table (8) illustrates the computation of the global weight of sub-factors for Category 'corporate governance'. Global weight of sub-factor 'number of senior management' associated with Category 'corporate governance' (0.099) is calculated by multiplying sub-factor's local weight (0.3636) by category's local weight (0.273).

DISCUSSION

The results reveals that 'corporate governance', which is related to the senior management of the bidder has strongest influence towards bidder's failure potential. This result can be linked to the segmentation of the respondents by years of experience. More than 41% of the respondents have more than 10 years of experience. It indicates that this significant portion of respondents believe that competency of senior management is the most important factor in preventing the failure of contractors. In other words, more experienced practitioners tend to believe that competent senior management team of contractor in terms of experience, qualification and number will be able manoeuvre through difficult times to deliver the project. This result is interesting as previous scholars tended to focus on the financial position of contractors as the main cause for contractor failure in their analysis. However, the 'financial position' of bidders came in second place with category weighting 0.201, which indicates that practitioners still value bidders' financial position on selection.

The developed model has captured interesting results from industry practitioners. The results can change if the constitution of respondents' background changed. For instance, higher proportion of respondents with longer experience may increase the influence of 'corporate governance' towards 'contractor failure potential' by. In addition, category 'financial position' may gain higher importance when the sample includes larger portion of respondents with commercial background. This cannot be asserted without carrying out a questionnaire that is targeting a particular segment of practitioner to capture their point of view exclusively.

In broader extent, the developed model can then be transformed into the respondents' own contractor failure prediction model. The responses collected from a team or group of construction practitioners within an organization capture the extent of how the identified factors impact contractor failure potential from team's and organization's perspective. Similarly, it can be transformed into the contractor failure prediction model for the team or organization. Contractor failure prediction model for different job natures, i.e., scale and trade, can be obtained by rating factors according to the context of the particular job nature. Geographically, the result of the questionnaire survey from a particular city, i.e., Hong Kong, represents how local construction practitioners interpret the relationship between the identified factors and contractor failure potential. Local contractor failure prediction model can be set up based on the response of construction practitioners from a particular city. In addition, questionnaire survey responses from a particular profession, i.e., architect, engineer, surveyor and project manager, can capture their views on the relationship between factors and contractor failure potential. Contractor failure prediction model developed from a questionnaire survey carried out by respondents of a particular construction profession can be adopted be as guidance issued by relevant professional bodies.

Causations of contractor failure identified in this study enable construction practitioners to react accordingly when they observe any symptoms on the contractor. Construction practitoners can adopt the contractor failure prediction model developed to evaluate bidder's failure potential. It is believed that the application of the model developed in this study could avoid to award of the construction contract to contractors with observable failure potential. Therefore, construction projects can be successfully delivered.

CONCLUSION

Employer suffers from impacts on time, cost and goodwill due to contractor failure to deliver the project. However, it is not a common practice to evaluate the failure potential of a contractor during procurement. Instead, construction industry adopts price-driven selection which construction contracts are usually awarded to the lowest bid. On the other hand, existing failure prediction models may not effectively predict contractor failure potential. Existing models only consider the factors associated with the financial position of a contractor. This study identifies a wider range of critical factors that contribute to the contractor failure based on existing literatures. Apart from the 'financial position', this study consolidated that 'corporate governance', 'tender approach', 'technical competency', and 'cost control' of bidders also have an influence towards its failure potential. The fuzzy questionnaire was set to collect respondents’ rating on factors. Unlike questionnaire commonly set with Likert scale requiring respondents to select a single rating, fuzzy questionnaire requires respondents to indicate their rating by ranges to collect respondents’ imprecise ratings on factors. Prediction model of this study was then developed by the analytic network process (ANP). ANP considers interdependence among factors to enhance predictability over Analytic hierarchy process (AHP) adopted by existing models. The result of the analysis concluded that ‘corporate governance’ (0.228) has the highest influence on ‘contractor failure potential’. ‘Financial position’ (0.201) and ‘cost control’ (0.196) are second and third influential factors towards ‘contractor failure potential’. ‘Tender approach’ (0.194) and ‘technical competency’ (0.182) are fourth and fifth influential factors on ‘contractor failure potential’. Causations of contractor failure identified in this study enable construction practitioners to take action to safeguard the employer’s interest when they observe any symptoms on the contractor during the execution of the project. Furthermore, the incorporation of several categories that were not considered in this matter before boardens the perspective of practitioners regarding various causes of contractor failure other than the contractor poor financial position. Construction practitioners can adopt the contractor failure prediction model developed to evaluate bidder’s failure potential during prequalification and tender evaluation stages to avoid awarding the construction contract to the contractor with observable failure potential. Therefore, construction projects can be successfully delivered, and reduce the occurrence of risk that the employer has to suffer adverse impact on achieving time, cost and quality of a construction project as a result of contractor failure. Similarly, contractor’s surety, supplier, creditors, financial institution, and investors can apply the model developed to evaluate contractor’s failure potential to make an objective decision on doing business with the contractor to minimize their financial loss from contractor failure. In addition, the reader can repeat the steps involved in this study to develop a failure prediction model of other business by respective factors.

LIMITATIONS AND FUTURE DIRECTIONS

This study only considers criteria that are directly related to contractor failure potential. Weightings calculated in this study does not represent the opinion of a small sample of construction professionals. Consequently, this study serves as a preliminary study for developing contractor failure prediction model. This study identified the feasibility of further research in developing more representable weightings from a more diversified and larger group of respondents. In addition, the questionnaire survey of this study may be too complicated to respond since both pairwise comparisons and fuzzy questionnaire are too tedious. On the other hand, large number of factors may also lengthen the questionnaire survey hence weakening its attractiveness to respondents. It is suggested to design the questionnaire in a more appealing manner and organise it in a less complex way in future studies. Questionnaire should be more user-friendly and understandable to attract larger group of respondents to participate in the self-administrated questionnaire survey.

Further study can be carried out to validate the factors ranking obtained in this study. Data on both business-as-usual and default contractor can be entered into the contractor failure prediction model to evaluate whether the developed model can identify construction contractor failure potential. Further studies can also be carried out to evaluate the predictability of the model developed through different statistical methods.

DATA AVAILABILITY STATEMENT

Some or all data, models, and codes that support the findings of this study can be furnished through contacting the corresponding author upon reasonable request.

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List of Figure Captions

Tables

Table 1: Illustration of values in a pairwise comparison matrix

	A	B	C	D	E
A	A/A	A/B	A/C	A/D	A/E
B	B/A	B/B	B/C	B/D	B/E
C	C/A	C/B	C/C	C/D	C/E
D	D/A	D/B	D/C	D/D	D/E
E	E/A	E/B	E/C	E/D	E/E

Table 2: Terms and Financial Ratio

Category	Financial Ratio / Terms	Computation
Profitability	Net Profit	Income – Total Costs
	Return on Sales	Net Profit / Income
	Return on Assets	Net Profit / Total Value of Assets
	Return on Capital	Net Profit / Total Value of Equity
	Working Capital	Current Assets – Current Liabilities
	Return on Working Capital	Net Profit / Total Value of Working Capital
Liquidity	Current Ratio	Current Assets / Current Liabilities
	Debt Ratio	Total Value of Assets / Total Value of Liabilities

Table 3: Response on the pairwise comparison between factor categories with respect to the goal (Questionnaire no. 6)

	X is more important						Y is more important					
	Numerical Scale	Physical Scale					Physical Scale				Numerical Scale	
		A	VS	S	M	EI	M	S	VS	A		
Corporate Governance	1,3				X	X						Tender Approach
							X	X			3,5	Technical Competency
	3				X			X			5	Cost Control
									X X		**7,7**	Financial Position

Table 4: Pairwise comparison matrix and Relative weight between factor categories with respect to the goal (Questionnaire no. 6)

	CG	TA	TC	CC	FP	Normalized Relative Weight
Corporate Governance (CG)	1	2	1/4	1/2	1/7	0.069
Tender Approach (TA)		1			1/14	0.034
Technical Competency (TC)	4		1		4/7	0.276
Cost Control (CC)	2			1	2/7	0.138
Financial Position (FP)	7				1	0.483
					29/14	1.000

Table 5: Weighted supermatrix of Questionnaire no. 6

	Failure Potential	CG	TA	TC	CC	FP
Corporate Governance (CG)	0.069		0.054	0.063	0.063	0.050
Tender Approach (TA)	0.034	0.050		0.063	0.063	0.150
Technical Competency (TC)	0.276	0.150	0.018		0.188	0.150
Cost Control (CC)	0.138	0.150	0.268	0.188		0.150
Financial Position (FP)	0.483	0.150	0.161	0.188	0.188	
Number		0.071				
Experience		0.071				
Qualification		0.357				
Realistic Price			0.417			
Risk Management			0.083			
Past Performance				0.399		
Experience				0.044		
Resource				0.057		
System					0.438	
Personnel					0.063	
Profitability						0.066
Liability Ratios						0.066
Ease of Finance						0.022
Realization						0.332
Reserve						0.013
Sum	1.000	1.000	1.000	1.000	1.000	1.000

Table 6: Overall limited supermatrix for this study

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Mean
Corporate Governance	0.181	0.180	0.192	0.118	0.060	0.075	0.111	0.113	0.030	0.197	0.044	0.040	0.073	0.086	0.099	0.054	0.058	0.101
Tender Approach	0.132	0.070	0.149	0.106	0.103	0.094	0.089	0.079	0.094	0.141	0.088	0.072	0.094	0.095	0.014	0.014	0.019	0.085
Technical Competency	0.062	0.083	0.039	0.064	0.103	0.103	0.104	0.078	0.101	0.054	0.089	0.126	0.079	0.149	0.014	0.054	0.058	0.080
Cost Control	0.063	0.083	0.047	0.100	0.149	0.119	0.104	0.093	0.138	0.053	0.109	0.161	0.110	0.085	0.020	0.027	0.012	0.087
Financial Position	0.062	0.083	0.073	0.112	0.085	0.110	0.093	0.137	0.137	0.054	0.171	0.102	0.144	0.085	0.020	0.018	0.019	0.088
Number	0.036	0.060	0.137	0.027	0.042	0.011	0.037	0.016	0.003	0.141	0.006	0.004	0.008	0.052	0.100	0.028	0.071	0.046
Experience	0.108	0.060	0.027	0.009	0.011	0.011	0.037	0.065	0.023	0.028	0.019	0.026	0.040	0.017	0.033	0.028	0.024	0.033
Qualification	0.036	0.060	0.027	0.082	0.007	0.053	0.037	0.032	0.003	0.028	0.019	0.009	0.024	0.017	0.033	0.111	0.071	0.038
Realistic Price	0.106	0.012	0.134	0.088	0.086	0.078	0.022	0.016	0.085	0.117	0.058	0.062	0.082	0.019	0.143	0.083	0.139	0.078
Risk Management	0.026	0.058	0.015	0.018	0.017	0.016	0.067	0.063	0.009	0.023	0.029	0.010	0.012	0.076	0.024	0.083	0.028	0.034
Past Performance	0.037	0.050	0.030	0.050	0.077	0.082	0.062	0.047	0.009	0.039	0.030	0.010	0.013	0.028	0.127	0.053	0.119	0.051
Experience	0.012	0.017	0.004	0.007	0.013	0.009	0.021	0.008	0.028	0.008	0.030	0.039	0.003	0.112	0.021	0.009	0.024	0.021
Resource	0.012	0.017	0.004	0.007	0.013	0.012	0.021	0.023	0.064	0.008	0.030	0.078	0.063	0.009	0.018	0.105	0.024	0.030
System	0.050	0.063	0.039	0.075	0.124	0.104	0.069	0.047	0.069	0.047	0.054	0.138	0.014	0.017	0.143	0.143	0.139	0.078
Personnel	0.013	0.021	0.008	0.025	0.025	0.015	0.035	0.047	0.069	0.007	0.054	0.023	0.097	0.068	0.024	0.024	0.028	0.034
Profitability	0.031	0.017	0.041	0.035	0.038	0.015	0.031	0.017	0.013	0.035	0.016	0.014	0.009	0.009	0.106	0.018	0.081	0.031
Liability Ratios	0.008	0.017	0.005	0.012	0.019	0.015	0.015	0.017	0.002	0.005	0.016	0.007	0.044	0.003	0.015	0.003	0.016	0.013
Ease of Finance	0.008	0.017	0.008	0.018	0.009	0.005	0.015	0.017	0.013	0.005	0.047	0.027	0.062	0.035	0.015	0.004	0.016	0.019
Realization	0.008	0.017	0.006	0.012	0.009	0.073	0.015	0.068	0.094	0.005	0.047	0.027	0.026	0.035	0.015	0.035	0.027	0.031
Reserve	0.008	0.017	0.014	0.035	0.009	0.003	0.015	0.017	0.013	0.005	0.047	0.027	0.003	0.003	0.015	0.106	0.027	0.021
Sum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 7: Local weight of categories towards ‘contractor failure potential’

	Limited Priority	Local Weight
Corporate Governance	0.101	0.228
Tender Approach	0.085	0.194
Technical Competency	0.080	0.182
Cost Control	0.087	0.196
Financial Position	0.088	0.201
	0.441	1.000

Table 8: Global weight of sub-factors in this study

Categories	**Local Weight**	**Sub-factors**	**Local Weight**	**Global Weight**
Corporate Governance (Senior Management)	0.228	Number	0.390	0.089
		Experience	0.284	0.065
		Qualification	0.326	0.074
Tender Approach	0.194	Realistic Price	0.698	0.135
		Risk Management	0.302	0.058
Technical Competency	0.182	Past Performance	0.497	0.090
		Experience	0.210	0.038
		Resource	0.293	0.053
Cost Control	0.196	System	0.697	0.137
		Personnel	0.303	0.060
Financial Position	0.201	Profitability	0.269	0.054
		Liability Ratios	0.112	0.022
		Ease of Finance	0.165	0.033
		Realization	0.267	0.054
		Reserve	0.187	0.038
	1.000			1.000

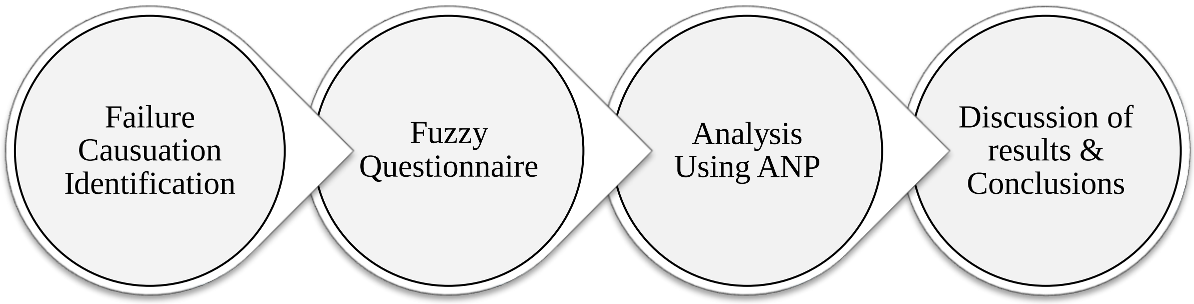


Figure 1: Research flow of this study

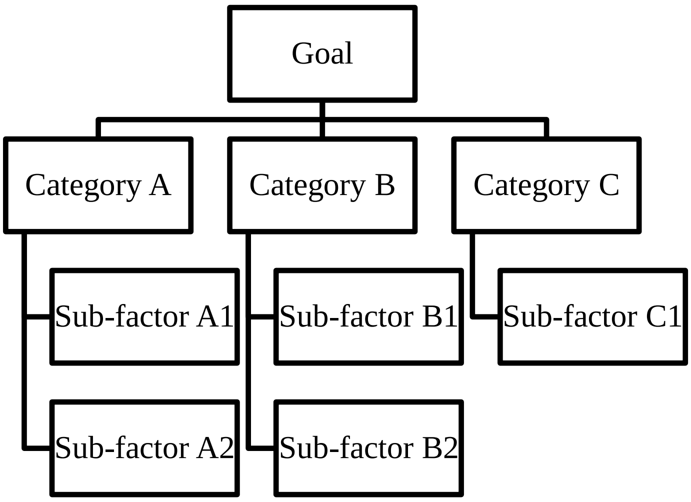


Figure 1: A three-level hierarchy (Saaty, 1980)

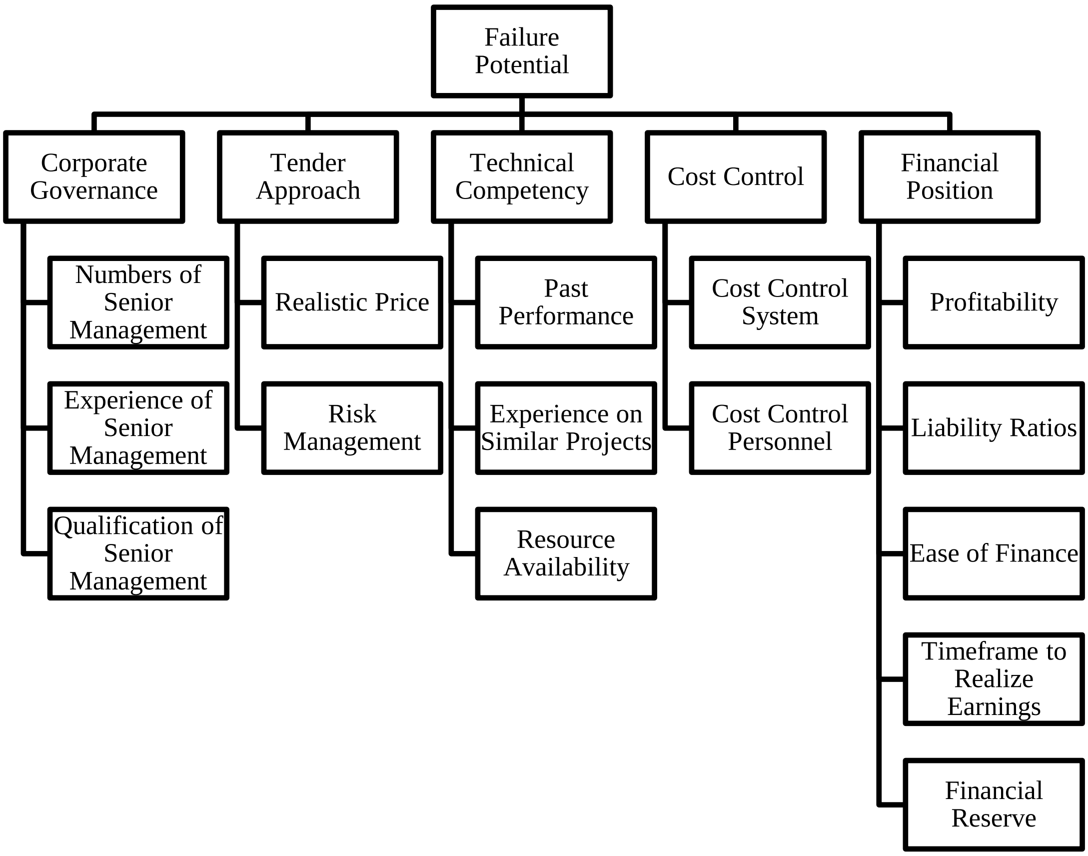
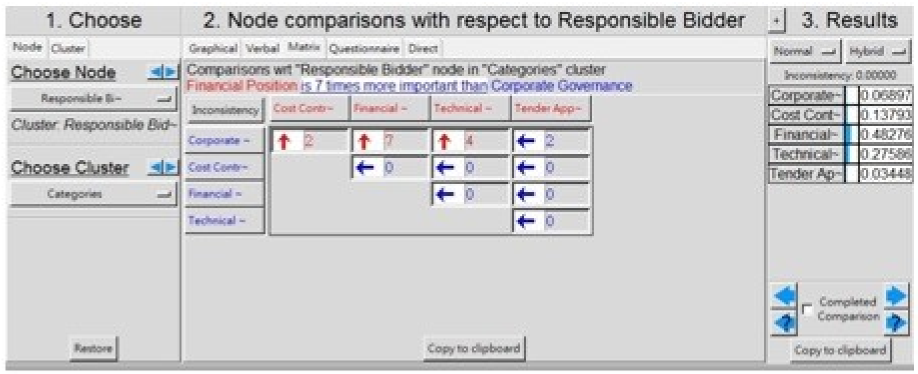


Figure 3: Hierarchy of proposed contractor failure prediction model


1. Choose
2. Node comparisons with respect to Responsible Bidder
3. Results
Node
Cluster
Choose Node
Responsible Bi~
Cluster: Responsible Bid~
Choose Cluster
Categories
Restore
Graphical
Verbal
Matrix
Questionnaire
Direct
Comparisons wrt "Responsible Bidder" node in "Categories" cluster
Financial Position is 7 times more important than Corporate Governance
Inconsistency
Cost Contr~
Financial ~
Technical ~
Tender App~
Corporate ~
Cost Contr~
Financial ~
Technical ~
2
7
4
2
0
0
0
0
0
0
Copy to clipboard
Normal
Hybrid
Inconsistency: 0.00000
Corporate~
0.06897
Cost Cont~
0.13793
Financial~
0.48276
Technical~
0.27586
Tender Ap~
0.03448
Completed Comparison
Copy to clipboard

	Corpora~	Cost Co~	Financi~	Technic~	Tender ~	Respons~
Corpora~	0.00000	0.12500	0.10000	0.37500	0.10714	0.06896
Cost Co~	0.30000	0.00000	0.30000	0.12500	0.53571	0.13793
Financi~	0.30000	0.37500	0.00000	0.12500	0.32143	0.48276
Technic~	0.30000	0.37500	0.30000	0.00000	0.03571	0.27586
Tender ~	0.10000	0.12500	0.30000	0.37500	0.00000	0.03448
Experie~	0.14286	0.00000	0.00000	0.00000	0.00000	0.00000
Numbers~	0.14286	0.00000	0.00000	0.00000	0.00000	0.00000
Qualifi~	0.71429	0.00000	0.00000	0.00000	0.00000	0.00000
Cost Co~	0.00000	0.12500	0.00000	0.00000	0.00000	0.00000
Cost Co~	0.00000	0.87500	0.00000	0.00000	0.00000	0.00000
Ease of~	0.00000	0.00000	0.04425	0.00000	0.00000	0.00000
Financi~	0.00000	0.00000	0.02655	0.00000	0.00000	0.00000
Liabili~	0.00000	0.00000	0.13274	0.00000	0.00000	0.00000
Profita~	0.00000	0.00000	0.13274	0.00000	0.00000	0.00000
Timefra~	0.00000	0.00000	0.66372	0.00000	0.00000	0.00000
Respons~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Experie~	0.00000	0.00000	0.00000	0.08861	0.00000	0.00000
Past Pe~	0.00000	0.00000	0.00000	0.79747	0.00000	0.00000
Resourc~	0.00000	0.00000	0.00000	0.11392	0.00000	0.00000
Realist~	0.00000	0.00000	0.00000	0.00000	0.83333	0.00000
Risk Ma~	0.00000	0.00000	0.00000	0.00000	0.16667	0.00000

	Corpora~	Cost Co~	Financi~	Technic~	Tender ~	Respons~
Corpora~	0.00000	0.06250	0.05000	0.18750	0.05357	0.06896
Cost Co~	0.15000	0.00000	0.15000	0.06250	0.26786	0.13793
Financi~	0.15000	0.18750	0.00000	0.06250	0.16071	0.48276
Technic~	0.15000	0.18750	0.15000	0.00000	0.01786	0.27586
Tender ~	0.05000	0.06250	0.15000	0.18750	0.00000	0.03448
Experie~	0.07143	0.00000	0.00000	0.00000	0.00000	0.00000
Numbers~	0.07143	0.00000	0.00000	0.00000	0.00000	0.00000
Qualifi~	0.35714	0.00000	0.00000	0.00000	0.00000	0.00000
Cost Co~	0.00000	0.06250	0.00000	0.00000	0.00000	0.00000
Cost Co~	0.00000	0.43750	0.00000	0.00000	0.00000	0.00000
Ease of~	0.00000	0.00000	0.02212	0.00000	0.00000	0.00000
Financi~	0.00000	0.00000	0.01327	0.00000	0.00000	0.00000
Liabili~	0.00000	0.00000	0.06637	0.00000	0.00000	0.00000
Profita~	0.00000	0.00000	0.06637	0.00000	0.00000	0.00000
Timefra~	0.00000	0.00000	0.33186	0.00000	0.00000	0.00000
Respons~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Experie~	0.00000	0.00000	0.00000	0.04430	0.00000	0.00000
Past Pe~	0.00000	0.00000	0.00000	0.39873	0.00000	0.00000
Resourc~	0.00000	0.00000	0.00000	0.05696	0.00000	0.00000
Realist~	0.00000	0.00000	0.00000	0.00000	0.41667	0.00000
Risk Ma~	0.00000	0.00000	0.00000	0.00000	0.08333	0.00000

	Corpora~	Cost Co~	Financi~	Technic~	Tender ~	Respons~
Corpora~	0.07454	0.07454	0.07454	0.07454	0.07454	0.07454
Cost Co~	0.11853	0.11853	0.11853	0.11853	0.11853	0.11853
Financi~	0.10989	0.10989	0.10989	0.10989	0.10989	0.10989
Technic~	0.10313	0.10313	0.10313	0.10313	0.10313	0.10313
Tender ~	0.09391	0.09391	0.09391	0.09391	0.09391	0.09391
Experie~	0.01065	0.01065	0.01065	0.01065	0.01065	0.01065
Numbers~	0.01065	0.01065	0.01065	0.01065	0.01065	0.01065
Qualifi~	0.05324	0.05324	0.05324	0.05324	0.05324	0.05324
Cost Co~	0.01482	0.01482	0.01482	0.01482	0.01482	0.01482
Cost Co~	0.10371	0.10371	0.10371	0.10371	0.10371	0.10371
Ease of~	0.00486	0.00486	0.00486	0.00486	0.00486	0.00486
Financi~	0.00292	0.00292	0.00292	0.00292	0.00292	0.00292
Liabili~	0.01459	0.01459	0.01459	0.01459	0.01459	0.01459
Profita~	0.01459	0.01459	0.01459	0.01459	0.01459	0.01459
Timefra~	0.07293	0.07293	0.07293	0.07293	0.07293	0.07293
Respons~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Experie~	0.00914	0.00914	0.00914	0.00914	0.00914	0.00914
Past Pe~	0.08224	0.08224	0.08224	0.08224	0.08224	0.08224
Resourc~	0.01175	0.01175	0.01175	0.01175	0.01175	0.01175
Realist~	0.07826	0.07826	0.07826	0.07826	0.07826	0.07826
Risk Ma~	0.01565	0.01565	0.01565	0.01565	0.01565	0.01565