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Identification and Evaluation of Risk Allocation Criteria and Barriers: A Malaysian Public Private Partnership Project Case Study

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Abstract: Risk allocation is a key to managing risks associated with the public private partnership projects. Optimal risk allocation between the parties involved, namely public and private, is the essence of successful PPP project implementation. This study intends to identify and prioritize significant risk allocation criteria and barriers preventing the optimal allocation of risk to PPP projects in Malaysia. Due to interaction among criteria and barriers, this research has adopted analytic network process in order to decompose decision model into meaningful network and weight decision elements. Data has been collected through literature review, questionnaire and interview with PPP project experts. This study reveals that "Bear the risk at lowest price", "Control the chance of risk" and "Risk attitude" are three major optimal risk allocation criteria. "Different sets of information about project risk", "Lack of efficient risk allocation mechanisms" and "Lack of understanding the benefits of optimal allocation" are of three major optimal risk allocation barriers identified throughout the study. The outcome can be used to improve the implementation of PPP project in Malaysia by more rationally allocating risks between parties involved.

Key words: Optimal risk allocation, risk allocation criteria, risk allocation barriers, ppp project, analytic network process

INTRODUCTION

Policymakers today prefer to choose Public Private Partnership (PPP) for the implementation of public mega projects, especially when the government is short of financial resources (Terry, 1996; Alfen *et al*., 2009). Following the successful implementation of a PPP model in a number of countries including the UK, Hong Kong, Singapore and Australia, the rate at which PPP based projects have been adopted in Malaysia has increasingly risen. Malaysia is striving to become a modern and industrialized country by 2020 and Vision 2020 has been set up by the government to help achieve this target. One aspect of development is the win-win delivery of public projects, hence, a number of policies have been set up in order to strengthen the relationship between the public and private sectors which play important roles in project delivery (Nambiar, 2007; Rusmani, 2010). The government has emphasized in the 10th Malaysian plan that the pivotal role of PPP is in forming a successful partnership between the public and private sector. As a result, 52 recent PPP based projects worth an estimated of RM63 billion have been initiated (EPU, 2010). Such projects result in the active involvement of the private sector which contributes hugely to the economy (Leong, 2010).

The need to manage risk in PPP projects has been highlighted by many authors. Successful completion of PPP projects depends highly on the quality of risk assessment. It has been found that many construction projects that adopted PPP in Western countries have not successfully achieved the project objectives although it is more than a decade since a PPP project was adopted and implemented there (Thomas *et al*., 2003). The need to design a mechanism which systematically allocates risk to PPP in order to manage PPP project risk is tangible. It is a fact that construction project delays directly impose extra costs which are mainly due to uncontrolled risk. Risk is inherent with construction projects (Kartam and Kartam, 2001) and PPP projects are no exception as stakeholders need to manage complexities associated with documentation, capital budget, taxation, technical details, policies and market conditions. Grimsey and Lewis (2002), Heravi and Hajihosseini (2011). According to AS/NZS ISO 31000 (2009), risk management is a project management tool. Risk management process in PPP project contains four main steps that are namely identification of risk, risk assessment, allocation of risk and replies to reduce risk (Shen *et al*., 2006). Risk in PPP project cannot be removed completely. Probably the word management is more appropriate when dealing with PPP project risk

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(Ng and Loosemore, 2007). Malaysia PPP guidelines define optimal risk sharing as essential features of risk management. It has been indicated that risk should be allocated to the party who is best able to manage it. Hence, risk allocation is considered a significant component of the risk management process of PPP projects.

Hashim (2010) describes how improper risk allocation has a negative impact on time, cost and PPP project quality. While the risk allocation process is complex, it is very flexible as it depends on many parameters such as participants' risk attitude and the ability to manage risk and risk premiums (Zhang *et al*., 2002; Lam *et al*., 2007). In addition to Hashim (2010) findings, inappropriate risk allocation in PPP projects leads to disagreement, disputes, claims and eventually distorts relationships among the project parties (Kumaraswamy, 1997). For the past ten years, several studies have been conducted on how to optimally allocate the risk of PPP projects in order to minimize the aforementioned adverse impacts. Notable among these studies are those of (Rahman and Kumaraswamy, 2005; Akintoye and Main, 2007; Bing and Tiong, 1999; Erikson, 1979) who worked on joint risk management, collaborative relationships in construction, joint ventures and risk sharing, respectively. Optimal risk allocation is defined as not transferring all risk to one party (Ke *et al*., 2011). According to Gao and Jiang (2008), it is better to pairwise compare the parties management capabilities and then allocate risk based on these abilities because the public sector is used to allocating risk to the private sector due to the inability to manage risk or unwillingness to take responsibility.

The risk assessment process begins with the identification of risk and it is the responsibility of those who create the risk (Loosemore and McCarthy, 2008). Risk should then be analyzed in terms of the likelihood (Thomas *et al*., 2003) and severity of the impact on the project target (Lam *et al*., 2007). One who can accurately assess risk is more capable to handle risk (Loosemore and McCarthy, 2008) manage and control the consequence of risk (Loyd, 2001; Lam *et al*., 2007). Resources to compensate the consequences of risk must be available when risk occurred (Abednego and Ogunlana, 2006). Moreover, handling risk requires access to instruments based on the enlargement of risk (Loosemore and McCarthy, 2008), authority (Loyd, 2001) and expertise (Abednego and Ogunlana, 2006) to use these instruments. If an individual attempts to secure additional revenue or provides special security measures, it could be more capable to bear the risk (Abrahamson, 1973). Xu *et al*. (2010) identified and evaluated risk allocation criteria in a Chinese PPP project which identified 23 criteria for risk 3 allocation. There are several barriers and basic general factors associated with risk allocation in the construction industry such as cooperation, negotiation, teamwork, collaboration, trust and communication. Negotiation is actually "a social decision-making procedure through which two or more people confirms how to allocate scarce resources" (Thompson, 2001). Loosemore and McCarthy (2008) explained that risk allocation takes place by means of negotiation regarding contract clauses between project partners. Communication is a vital factor of negotiation. Open communication in risk management allows a corporation to evaluate its risk management towards related organizations which may present relative feedback (Tang *et al*., 2006).

Insufficient negotiation and lack of good communication among construction project sectors could be a barrier to optimal risk allocation. Trust can be explained as a disposition and attitude regarding readiness depending on the actions of or the susceptibility towards another party using the potential for cooperation (Smyth *et al*., 2010). A lack of trust can be a major barrier to the collaborative connection between project partners (Akintoye and Main, 2007). Risk attitudes and risk awareness of the various participating parties in a construction project could be a barrier to optimal risk allocation (Alsalman, 2012). Therefore it is necessary to broadly consider the criteria of risk allocation and barriers to allocate the risk fairly. The objective of this study is to identify and rank the optimal risk allocation criteria and barriers which guarantee equitably and optimal allocation of risk for PPP projects in Malaysia. Analytic network process which is able to see dependence and feedback, is used in order to rank the importance of barriers and criteria. The results of this study, which focuses on assigning priority to allocation criteria and barriers contributes to the existing body of knowledge and can be used in PPP projects, especially in the construction sector.

MATERIALS AND METHODS

For the sake of data collection, this study reviews journal papers and reports in the area of PPP projects. Review of such literature guides the research work to identify criteria and barriers to decision making for optimal allocation of risk to PPP projects.

Questionnaire: Following the development of a list of criteria and barriers, a questionnaire was designed and experts were asked to verify the identified factors. Less significant factors were disregarded in this step. Careful respondent selection is made for the purpose of knowledge acquisition. All respondents are selected based on expertise and experience in Malaysia PPP projects in order to get more realistic data. The main objective of this stage is to identify significant criteria and barriers of optimal risk allocation for the PPP projects in Malaysia. The questionnaire for this study is designed in three sections. The first section explored general demographical information about the survey respondents, the second section was the main section of the questionnaire (criteria and barriers to optimal risk allocation in the PPP project) and in the final section, respondents were given the opportunity to add criteria and barriers that not otherwise addressed in this survey.

Analytic network process: The next important step is to rank decision elements. Optimal risk allocation of PPP projects can be viewed as a decision making problem. Analytic network process is used to derive priority for decision elements. The Analytic Network Process (ANP) is a multi-criteria decision making (MCDM) approach which is able to solve complex decision problems (Saaty and Vargas, 2006). It is a generalized form of analytic hierarchy process in which a decision problem is decomposed in a network instead of hierarchy order. In the real world, decision making using ANP is more preferable since it is able to see dependence and feedback among decision elements and derive alternative priorities when decision alternatives themselves influence the criteria (Saaty, 1996). In contrast to AHP where additive synthesis is employed to derive overall priority of decision alternatives, ANP uses super matrix approach. A well-structured super matrix needs clear problem decomposition. In order to fill the necessary elements of super matrix, with the aid of questionnaire, expert judgments are elicited by asking the experts to compare the relative dominance of a pair of elements.

Saaty's fundamental 1-9 scale is used during questionnaire design where 1 indicates the equal importance of two elements and 9 indicates element i overpowering j. With respect to the fact that no judgment is perfect, especially when it is being performed by humans, during or reasonably after knowledge elicitation, the consistency of judgments should be tested and evaluated against Saaty's consistency index (Saaty, 2005). In order to achieve accurate results, experts who made inconsistent judgments should be asked to correct their judgment. Next, local priority vectors of pairwise matrix is estimated by solving equation $Aw = \lambda\ max.w$ where, A is the positive reciprocal matrix of pairwise comparisons, w is the principal eigenvector (priority vector) and λmax is the largest eigenvalue of A. Subsequently, super matrix is formed by entering estimated local priority vectors. In order to determine the final priority of decision alternatives, unweighted supermatrix which is obtained right after entering vectors should be transformed first into the stochastic column or weighted super matrix. Weighted super matrix is a matrix in whose columns sum to unity. In order to synthesis all interactions, the stochastic matrix column are raised to large power (Saaty, 2005). In this study, a "Super Decisions" special software for decision making with dependence and feedback is used in order to facilitate decision making and minimize error during the matrix manipulation process. The flow of the research methodology for this study is schematically illustrated in Fig. 1.

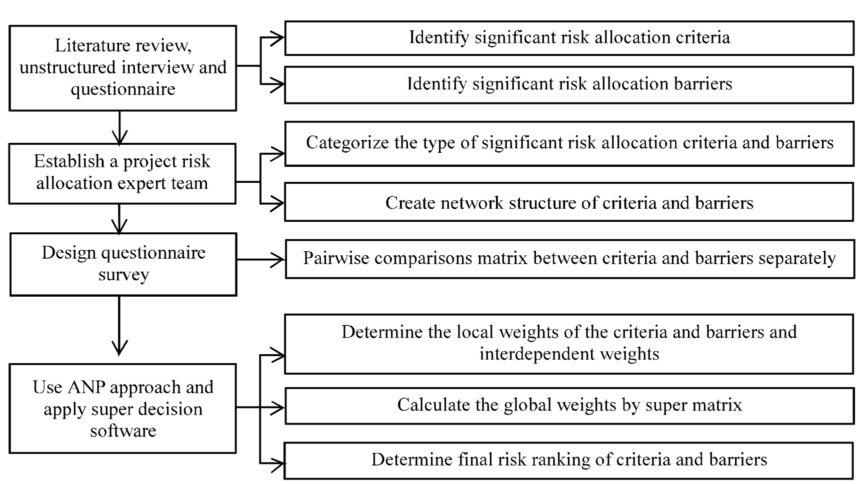

Fig. 1: Schematic diagram of research methodology

DATA ANALYSIS OF CASE STUDY

Identify risk allocation criteria and barriers: The first step of this study was to identify risk allocation criteria and barriers. Hence, a group of experts including representatives from the design team, project management team, contractors and the most contributing stockholders and clients were gathered and asked to brainstorm a list of criteria and barriers of optimal risk allocation. In addition, library based mechanisms such as a detailed review of relevant journal papers and books, interviews with PPP experts and questionnaire survey were also adopted to collect necessary data. Concerning the questionnaire survey, a total of 120 sets of questionnaires were distributed among the respondents. Among them, a total of 74 valid questionnaires representing 61.67% of the total number of design questionnaires were returned by the correspondents, of which 28 were obtained from the private sector and 46 from the public sector. The results show that the experts have identified 15 significant criteria and 11 barriers for the optimal risk allocation in PPP projects (Table 1 and 2).

Application of ANP method: Saaty's fundamental scale was used and respondents were asked to rank 11 identified risk allocation barriers and 15 criteria based on their experience expertise. Moreover, expert judgments were aggregated by applying geometric mean equation.

A network structure of risk allocation criteria and barriers: Following the identification of criteria and barriers, decision problems were decomposed into a meaningful network with the aid of seven experts. Experts identified inner and outer dependencies among decision elements and the network of connections were, respectively formed. Indirect comparison of components in arranged B_i was performed matching to their influence on C_{ij} by considering component set B_i (i = 1, 2, 3) as the main step for the group criteria and criteria components set C_j (j = 1, 2, . . ., 10). The ANP network structure of the criteria is shown in Fig. 2. This is then followed by indirect comparison of components in set D_i matching to their influence on E_{ij} by considering component set D_i (i = 1, 2, 3) as primary standard for group of barriers and barrier factors set E_j (j = 1, 2,...,5) as a secondary step, that

Table 1: Significant risk allocation criteria in Malaysia PPP project

Criteria	1	2	3	4	5	6	7	8	9	10	11
B1: Risk management competency											
C11: Identification of risk					*						
C12: Foreseeing risk	*	*	*	*	*						
C13: Evaluation of risk	*	*		*	*						
C14: Bear the risk at the lowest price						*	*				
C15: Capability of control risk				*	*	*		*	*		
C16: Resources of risk control				*	*	*		*	*		
C17: Control the chance of risk	*	*	*	*		*	*				
C18: Minimize loss if risk occurs	*		*			*	*				
C19: Sustain the consequence	*	*		*	*						
C110: Expertise of control risk					*		*				
B2: Incentive mechanism											
C21: Obtain reasonable						*	*				
C22: Obtain intangible assess						*					
C23: Level of governmental support	*					*					
B3: Risk preference											
C31: Assume the direct						*				*	
C32: Risk attitude			*	*	*	*					*

1: Thomas *et al.* (2003), 2: Lam *et al.* (2007), 3: Gao and Jiang (2008), 4: Loosemore and McCarthy (2008), 5: Khazaeni *et al.* (2012), 6: Xu *et al.* (2010), 7: EU (2003), 8: Zhu *et al.* (2007), 9: Jin and Doloi (2008), 10: Zhang *et al.* (2002), 11: Wang *et al.* (2007)

Table 2: Significant risk allocation barriers in Malaysian PPP projects

Barriers	1	2	3	4	5	6	7	8	9	10
D1: Behavioral barriers										
E11: Aversion to risk by project participants						*	*			*
E12: Imbalance and abuse of power										*
E13: Lack of understanding benefits of optimal allocation										*
E14: Lack of trust among project participants				*	*	*				*
E15: Competitive attitude	*									*
D2: Technical barriers										
E21: Lack of efficient risk allocation mechanism		*			*					*
E22: Complexity of contracts								*	*	
E23: Static risk allocation										*
E24: Staging involvement of project participants										*
D3: Organizational barriers										
E31: Different sets of information about project risk										*
E32: Poor risk management communication	*	*	*							

1: Tang *et al.* (2006), 2: Loosemore and McCarthy (2008), 3: COSO (2004), 4: Smyth *et al.* (2010), 5: Akintoye and Main (2007), 6: Zaghloul and Hartman (2003), 7: Wu and Wei (2009), 8: Meng (2012), 9: Rahman and Kumaraswamy (2002), 10: Alsalman (2012)

Table 3: Fundamental comparison scale

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Judgment slightly favour one activity over another
5	Strong importance	Experience and judgment strongly favour one activity over another
7	Very strong importance	An activity is favoured very strongly over another
8	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	For compromise between the above values	Compromise judgment between the above values because there is no good word to describe them

Table 4: Pairwise comparison matrix for C22

Criteria	C11	C12	C14
C11	1	5	1/3
C12	1/5	1	1/8
C14	3	8	1
CR	0.0423		

Table 5: Pairwise comparison matrix for E21

Criteria	E22	E23	E24
E22	1	3	1/2
E23	1/3	1	1/5
E24	2	5	1
CR	0.0035		

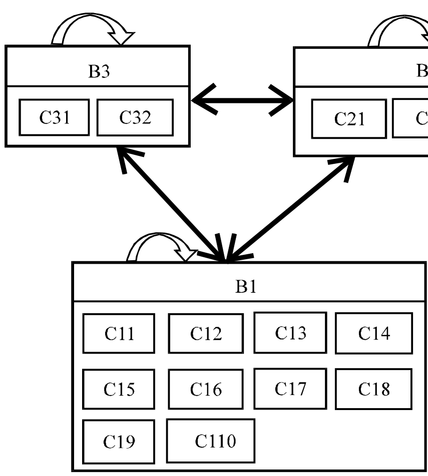

Fig. 2: Network criteria process

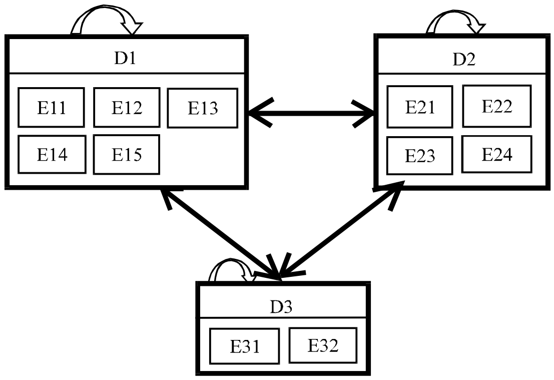

Fig. 3: Network barrier process

is, to create judgment matrix for barriers. The ANP network structure of the barriers is illustrated in Fig. 3.

Determination of pairwise comparison matrix: Following the development of the network model, pairwise comparisons are conducted to derive weight and importance of various criteria and barriers involved in decision model. Experts were asked to pairwise compare the dominance of each criterion with respect to other criterion according to the decomposed model and connections. They were asked to answer this question: given two elements of i and j, with respect to node k, which of i or j are more influential on k? The 1-9 scale as shown in Table 3 was used in order to acquire this knowledge.

In this study, a group pairwise comparison was employed. A total of 21 experienced and knowledgeable experts were involved into decision making process. Consequently, for each set of pairwise comparisons, 21 answers have been obtained. In order to aggregate 21 sets of pairwise comparisons into a single answer, geometric average of answers were acquired. A Consistency Ratio (CR) of less than 0.1 demonstrates that judgments were consistent (Saaty, 2005). For comparison matrices with a value greater than 0.1, experts are asked to evaluate their judgment and make necessary corrections. In this study, experts made consistent judgments and the aggregated values were then entered into super decisions software in order to estimate the weight vector of each decision criteria. It is noteworthy that aggregations of consistent judgments are still consistent. The estimated CR after entering aggregated judgments into super decisions software proves the consistency of judgments. Two examples of pairwise comparison matrices and CR obtained for the given matrices are shown in Table 4 and 5.

Determination of the unweighted, weighted and limit super matrix: After estimating the priority of decision elements, a super matrix should be formed. A super matrix starts with an unweighted super matrix and merges into a powered super matrix. Local priorities are directly entered into a matrix of the unweighted supermatrix. When there is no influence from one element to other elements, a value of "zero" has been assigned (Saaty, 2005). The unweighted super matrix was then transformed into a weighted super matrix where the summation of each column is equal to one. The final priority of a decision

Table 6: Weighted super matrix for barriers

Barriers	E11	E12	E13	E14	E15	E21	E22	E23	E24	E31	E32
E11	0.000	0.000	0.333	0.000	0.167	0.083	0.000	0.083	0.070	0.040	0.250
E12	0.075	0.000	0.000	0.333	0.333	0.000	0.000	0.000	0.062	0.106	0.000
E13	0.224	0.000	0.000	0.000	0.000	0.250	0.000	0.250	0.136	0.186	0.083
E14	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.000	0.036	0.000	0.000
E15	0.033	0.333	0.000	0.000	0.000	0.000	0.167	0.000	0.026	0.000	0.000
E21	0.000	0.224	0.266	0.000	0.000	0.000	0.000	0.250	0.216	0.158	0.208
E22	0.000	0.000	0.000	0.000	0.333	0.103	0.000	0.000	0.076	0.058	0.000
E23	0.250	0.033	0.066	0.000	0.000	0.036	0.000	0.000	0.040	0.031	0.045
E24	0.083	0.075	0.000	0.333	0.167	0.193	0.500	0.083	0.000	0.084	0.079
E31	0.250	0.250	0.250	0.000	0.000	0.266	0.000	0.267	0.250	0.000	0.250
E32	0.083	0.083	0.083	0.333	0.000	0.067	0.000	0.067	0.083	0.333	0.083

Table 7: Limit super matrix for barriers

Barriers	E11	E12	E13	E14	E15	E21	E22	E23	E24	E31	E32
E11	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112
E12	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
E13	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
E14	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
E15	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
E21	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139
E22	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
E23	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
E24	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103
E31	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184	0.184
E32	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124

element is derived by increasing the weighted super matrix into power. The computation process has been done with the aid of super decisions software version 2.2.4. Weighted super matrix and limit barrier matrices are shown in Table 6 and 7. The outcomes of the priorities were then obtained from the limit matrix.

RESULTS AND DISCUSSION

Table 8 and 9 show the final priority of each risk allocation barrier and criteria estimated by limit super matrix of ANP. In this study with the aid of literature review and questionnaire survey, 11 significant barriers of optimal risk allocation in PPP projects in Malaysia were identified. These barriers have been categorized into three main groups namely, behavioral, technical and organizational barriers. The final priority of risk allocation barriers showed the respondents concurred "Different sets of information about project risk" (E31) is the most significant barrier for optimal risk allocation with the score of 0.1842. In a competitive environment with a lack of trust between the construction parties, each party tends not to share his/her information with the other party in the construction project. Accurate and up-to-date information are necessary to identify, assess and manage project risks. The second significant barrier is "Lack of efficient risk allocation mechanisms" (E21) with a score of 0.1395. "Lack of understanding of the benefits of optimal allocation" (E13) is the third barriers factor with a score of 0.1338. On the other hand, "Lack of trust among project participants" (E14), "Competitive attitude" (E15) and "Contract complexity" (E22) are the least significant barriers to optimal risk allocation with a score of 0.0183, 0.0306 and 0.0434, respectively. Accurate and up-to-date information is necessary to identify, assess and manage project risks. Meanwhile, it is suggested that for PPP

Table 8: Weight of each risk allocation barriers

No.	Barrier	Weight
E31	Different sets of information about project risk	0.1842
E21	Lack of efficient risk allocation mechanisms	0.1395
E13	Lack of understanding of the benefits of optimal allocation	0.1338
E32	Poor risk management communication	0.1245
E11	Aversion to risk by project participants	0.1122
E24	Staging involvement of project participants	0.1035
E23	Static risk allocation	0.0594
E12	Imbalance and abuse of power	0.0509
E22	Contract complexity	0.0434
E15	Competitive attitude	0.0306
E14	Lack of trust among project participants	0.0183

Table 9: Weight of each risk allocation criteria

No.	Criteria	Weight
C14	Bear the risk at the lowest price	0.1527
C17	Control the chance of risk	0.1274
C32	Risk attitude	0.1099
C21	Obtain reasonable	0.1088
C23	Level of governmental support	0.0815
C16	Resources of control risk	0.0769
C22	Obtain intangible assets	0.0741
C11	Identification of risk	0.0684
C18	Minimize the loss if risk occurs	0.0616
C31	Assume the direct loss	0.0371
C13	Evaluation of risk	0.0337
C110	Expertise of control risk	0.0203
C19	Sustain the consequence	0.0160
C12	Foreseeing risk	0.0156
C15	Capability of controlling risk	0.0153

projects, a mechanism should be made in order to more rationally allocate risks to the parties and to overcome this barrier.

In this study, after reviewing literature and conducting questionnaire survey, 15 significant criteria of optimal risk allocation have been identified. Similar to the barrier stage, a set of criteria have been categorized as risk management competency, incentive mechanism and risk preference. The final weights of elements of these categories shows that “Bear the risk at lowest price” (C14) is the most important criteria with a score of 0.1527. Among the other risk allocation criteria, “Control the chance of risk” (C17) and “Risk attitude” (C32) were the most important criteria with scores of 0.1274 and 0.1099, respectively. On the contrary, “Capability of controlling risk” (C15) and “Foreseeing risk” (C12) are the least important with scores of 0.0153 and 0.0156, respectively. The final weight of each risk allocation criteria are presented in Table 9. Risk allocation criteria and barrier rankings could be applied in the optimal risk allocation mechanism.

CONCLUSION

Successful implementation of public private partnership projects depends highly on optimal allocation of risk among the interested PPP parties. Identification and weight determination of optimal risk allocation barriers and criteria in Malaysia PPP projects was investigated in this study. The 11 significant barriers and 15 significant criteria were identified through literature review and questionnaire survey. In order to weigh barriers and criteria of optimal risk allocation, the problem has been viewed as multi-criteria decision making with dependence and feedback. ANP has been adopted as a decision making tool. With the aid of super decisions software, weights of each decision element were obtained. The result shows that “Different sets of information about project risk”, "Lack of efficient risk allocation mechanisms" and “Lack of understanding of the benefits of optimal allocation" are placed among the top three optimal risk allocation barriers in Malaysia PPP projects. On the other hand, the top three of optimal risk allocation criteria were identified as "Bear the risk at lowest price", "Control the chance of risk" and "Risk attitude”. Identifying and ranking these barriers and criteria could help PPP projects overcome these barriers and criteria to achieve optimal risk allocation easier and faster.

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