Assessment of Risk Allocation Criteria in Malaysian PPP Projects

Alireza Valipour[1], Hadi Sarvari[2]

1- RESA group Faculty of Civil Engineering, Universiti Teknologi Malaysia, valipour1802@gmail.com
2- RESA group Faculty of Civil Engineering, Universiti Teknologi Malaysia, sarvari.hadi@gmail.com

Abstract

Risk allocation is a key to controlling risks related the public private partnership projects. Risk allocation between parties included, namely private and public, is the essence of successful PPP project implementation. This research intends to identify and assessment significant risk allocation criteria preventing risk allocation to PPP project in Malaysia. Because of interaction among criteria, this research adopts Analytic Network Process in order to decompose decision model into meaningful network and weight decision elements. ANP approach is used to overcome the problems of interdependence and feedback between various criteria ranking alternatives for simulation of the imprecision of man's judgment. Data has been collected through literature review, questionnaire and interview with PPP project experts. This study concludes that "bear the risk at lowest price", "control the chance of risk" and "risk attitude" are of three major optimal risk allocation criteria in Malaysian PPP project.

Keywords: Optimal risk allocation, Risk allocation criteria, PPP project, Analytic Network Process (ANP)

1. 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 and 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 the pivotal role of PPP in forming a successful partnership between the public and private sector. As a result, 52 recent PPP based projects worth an estimated RM63 billion have been initiated (10th Malaysian plan, 2011). Such projects result in the active involvement of the private sector which contributes hugely to the economy (Leong, H.Y, 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 ISO 31000(2009), risk management is a project management tool. The PPP risk management process includes four main sections namely, risk identification, assessment stage, responses to reduce risk and the allocation of proper contingencies (Shen et al., 2006). Generally, PPP project risk cannot be eliminated. Probably the word management is more appropriate when dealing with PPP project risk (Ng and Loosemore, 2007). Malaysia PPP guidelines also 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. Hisham (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 Hisham (2010) findings, inappropriate risk allocation in PPP projects leads to disagreement, disputes, claims and eventually distorts relationships among the project parties (Kumaraswamy M, 1997). For the past 10 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 C. A, 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 effect on the project goal (Lam et al., 2007). One who can accurately assess risk is more competent to manage risk (Loosemore and McCarthy, 2008), control risk (Loyd, 2001) and manage the consequence of risk (Lam et al., 2007). When risk events happen, the sequence must be maintained and resources must be available to compensate for the probability of loss on behalf of others (Abednego and Ogunlana, 2006). Also, handling risk requires access to tools based on the magnitude of risk (Loosemore and McCarthy, 2008), expertise (Abednego and Ogunlana, 2006) and authority (Loyd, 2001) to utilize these tools. If an individual attempts to secure additional revenue or provides special security measures, it will be more able to bear a certain risk (Abrahamson, 1973). Xu et al (2011) identified and evaluated risk allocation criteria in a Chinese PPP project which identified 23 criteria for risk allocation. Therefore it is necessary to broadly consider the criteria of risk allocation to allocate the risk fairly. The objective of this study is to identify and rank the optimal risk allocation criteria 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 criteria. The results of this study, which focuses on assigning priority to allocation criteria contributes to the existing body of knowledge and can be used in PPP projects, especially in the construction sector.

2. Research method

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

2.1. Questionnaire

After developing a list of criteria, 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 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 to optimal risk allocation in the PPP project), and in the final section, respondents were given the opportunity to add criteria that not otherwise addressed in this survey.

2.2. Analytic network process

Next 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 et al., 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 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 λ_{max} 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. Finally to synthesis all interactions, the stochastic matrix column are raised to large power (Saaty, 2005). In this study "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 Figure 1.

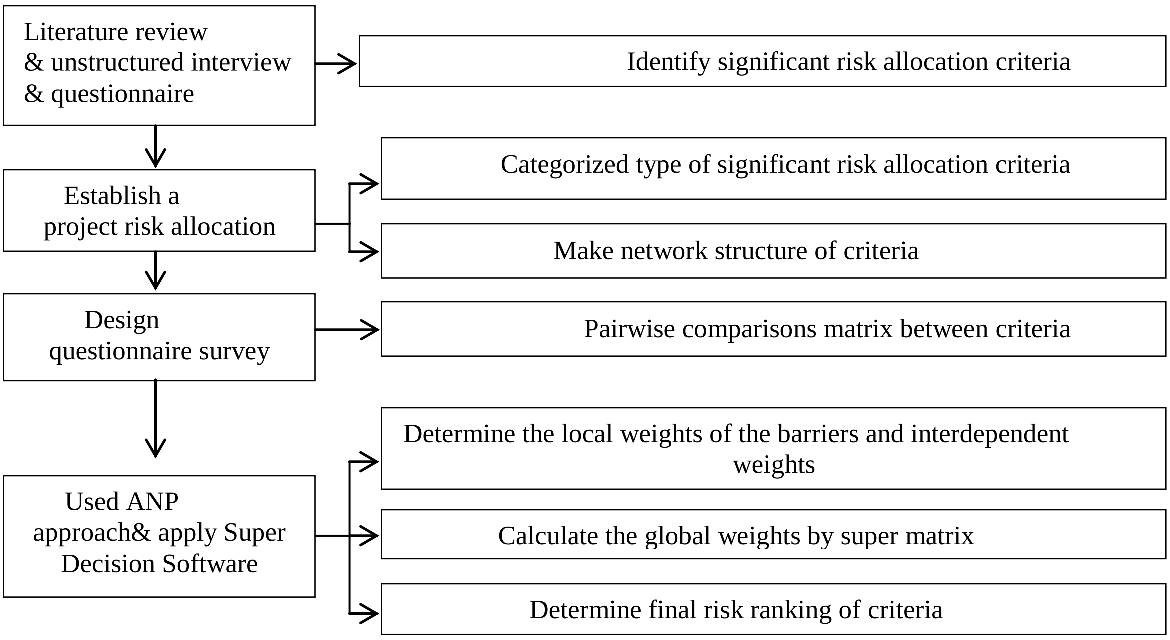


Figure1. Schematically of Research Methodology

3. Data analysis of Case study

3.1. Identify risk allocation criteria

The first step of this study was to identify risk allocation criteria. Hence, a group of experts including representatives from the project management team, design team, contractors and of course the most contributing stockholders and clients were gathered and asked to brainstorm a list of criteria to 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. We tried to distribute questionnaires personally where possible in order to get more valid answers; however, email distribution was also applied. Among them, a total of 74 valid questionnaires representing 61.67% of the total number of design questionnaires were obtained, of which 25were obtained from the private sector and 49 from the public sector. The results show that experts identified 15 significant criteria for the risk allocation in PPP projects (Table1).

3.2. Application ANP method

Saaty's fundamental scale was used and respondents were asked to rank 15 identified risk allocation criteria based on their experience and expertise. Moreover, expert judgments were aggregated by applying geometric mean formula.

3.2.1. A Network Structure of Risk allocation criteria and barriers

Following the identification of criteria, 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 dominance comparison of factors in set Bi is carried out according to their influence on Cij by considering factor set Bi (i = 1, 2, 3) as primary standard for group of barriers and barrier factors set Cj (j = 1, 2, . . ., 10) as a secondary standard, that is, to construct judgment matrix for barriers. The ANP network process of the barriers is shown in Figure 2.

Table1. Significant risk allocation criteria in Malaysia PPP project

Group of criteria	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) Khazaieni et al., 2011, (6) Xu et al., 2010 , (7) Hong Kong Efficiency Unit, 2003b, (8) Zhu et al., 2007, (9) Jin and Doloi, 2008, (10) Zhang et al. 2002., (11) Wang et al., 2007												

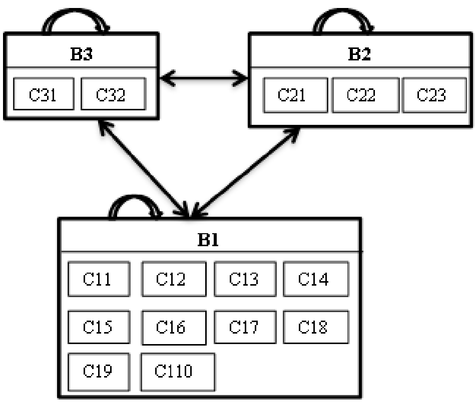


Figure2. Network criteria process

3.2.2. **Determine pairwise comparison matrix**

Following the development of the network model, pairwise comparisons are conducted to derive weight and importance of various criteria 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 2 was used in order to acquire this knowledge.

Table.2. 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

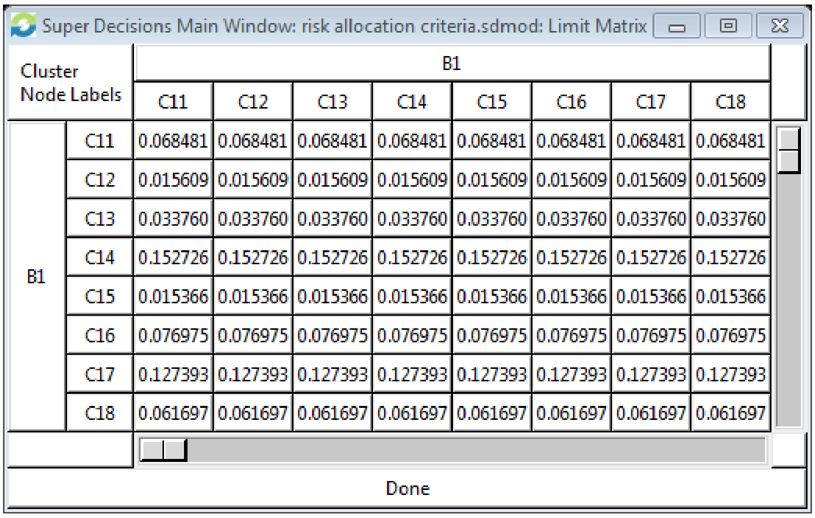
In this study group pairwise comparison was employed. A total of 21 experienced and knowledgeable experts were involved into decision making process. Consequently, for each set of pairwise comparisons, 21 answers have been obtained. In order to aggregate 21 sets of pairwise comparisons into a single answer, geometric average of answers were obtained. However before aggregation of answers consistency test were performed. A consistency ratio (CR) of less than 0.1 indicates 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. The examples of pairwise comparison matrices and CR obtained for the given matrices are shown in Tables 3.

Table 3. Pairwise comparison matrix for C_{22}

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

3.2.3. **Determine the Un-weighted, Weighted and Limit Super Matrix**

After estimating the priority of decision elements, a super matrix should be formed. A super matrix starts with an un-weighted super matrix and merges into a powered super matrix. Local priorities are directly entered into a matrix of the un-weighted supermatrix. When there is no influence from one element to other elements, a value of "zero" has been assigned (Saaty, 2005). The un-weighted 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 element is derived by raising the weighted super matrix into power. The computation process has been done with the aid of Super Decisions software version 2.2.4. Sample Limit super matrix for criteria is shown in Figure 3. The results of the priorities are extracted and obtained from the limit matrix.



Super Decisions Main Window: risk allocation criteria.sdmod: Limit Matrix

Cluster	Node Labels	B1							
		C11	C12	C13	C14	C15	C16	C17	C18
B1	C11	0.068481	0.068481	0.068481	0.068481	0.068481	0.068481	0.068481	0.068481
	C12	0.015609	0.015609	0.015609	0.015609	0.015609	0.015609	0.015609	0.015609
	C13	0.033760	0.033760	0.033760	0.033760	0.033760	0.033760	0.033760	0.033760
	C14	0.152726	0.152726	0.152726	0.152726	0.152726	0.152726	0.152726	0.152726
	C15	0.015366	0.015366	0.015366	0.015366	0.015366	0.015366	0.015366	0.015366
	C16	0.076975	0.076975	0.076975	0.076975	0.076975	0.076975	0.076975	0.076975
	C17	0.127393	0.127393	0.127393	0.127393	0.127393	0.127393	0.127393	0.127393
	C18	0.061697	0.061697	0.061697	0.061697	0.061697	0.061697	0.061697	0.061697

Done

Figure3. Sample Limit Super Matrix for Criteria

4. Result

Tables 4 show the final priority of each risk allocation criteria estimated by limit super matrix of ANP. In this study with the aid of literature review and questionnaire survey, 15 significant criteria of optimal risk allocation in PPP projects in Malaysia were identified. These criteria have been categorized into three main groups namely, ‘Risk management competency (B_1)’, ‘Incentive mechanism (B_2)’ and ‘Risk preference (B_3)’. The final weights of elements of these categories shows that “bear the risk at lowest price” (C_{14}) is the most important criteria with a score of 0.1527. Among the other risk allocation criteria, “control the chance of risk” (C_{17}) and “risk attitude” (C_{32}) were the most important with scores of 0.1274 and 0.1099 respectively. On the contrary, “Capability of controlling risk” (C_{15}) and “Foreseeing risk” (C_{12}) are the least important with scores of 0.0153 and 0.0156 respectively. Accurate and up-to-date information is necessary to identify, assess, and manage project risks. Meanwhile, it is suggested that for PPP projects, a mechanism should be made in order to more rationally allocate risks to the parties and to overcome this criteria.

Table 4. Weight of each risk allocation criteria

Number	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

5. Conclusion

Successful implementation of public private partnership projects depends highly on allocation of risk among the interested PPP parties. Identification and weight determination of optimal risk allocation criteria in Malaysia PPP projects was investigated in this study. 15 significant criteria were identified through literature review and questionnaire survey. In order to weigh risk allocation criteria, 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 'bear the risk at lowest price', 'control the chance of risk' and 'risk attitude' are placed among the top three optimal risk allocation criteria in Malaysia PPP projects. Identifying and ranking these criteria could help PPP projects overcome these criteria to achieve proper risk allocation easier and faster.

6. References

Abednego, M.P., Ogunlana, S.O. (2006), Good project governance for proper risk allocation in public–private partnerships in Indonesia. International Journal of Project Managemen,t 24, 622–634.

Abrahamson, M. (1973) Contractual risks in tunneling: how they should be shared. Tunnels and Tunneling, pp. 587–598 (Nov.).

Akintoye, A., and Main, J. (2007), Collaborative relationships in construction: the UK contractors' perception. Engineering. Construction and Architectural Management, 597- 617.

Alfen, H.W., Kalidindi, S.N., Ogunlana, S., Wang, S., Abednego, M.P., Jungbecker, A.F., Jan, Y.A., Ke, Y., Liu, Y, Singh, B., and Zhao, G. (2009), Public-private partnership in infrastructure development: Case studies from Asia and Europe. Germany: Publisher of Bauhaus-Universitat Weimar

Bing, L., and Tiong, R. L. (1999), Risk Management Model for International Construction Joint Ventures. Journal of Construction Engineering and Management, 377-384.

Erikson, C. A. (1979), Risk Sharing in Construction Contracts. Urbana: Dept. of Civil Engineering. Univ. of Illinois.

Gao, Y. L., and Jiang, L. (2008), The risk allocation method based on fuzzy integrated evaluation of construction projects. International Conference on Risk Management and Engineering Management, IEEE, Piscataway,N.J., 428–432.

Grimsey, D. and Lewis, M. K. (2002), Evaluating the risks of public private partnerships for infrastructure projects. International Journal of Project Management, 20(2), 107-118.

Hashim, N.H. (2010), Practical Risk Management Framework in Project Development, Seminar on Malaysia's PPP.

Heravi, G. and Hajihosseini, Z. (2011), Risk Allocation in Public–Private Partnership Infrastructure Projects in Developing Countries: Case Study of the Tehran–Chalus Toll Road. Journal of Infrastructure Systems, 18(3), 210-217.

Hong Kong Efficiency Unit. (2003), Serving the community by using the private sector: An introductory guide to public private partnerships PPP. Hong Kong SAR Government, http://www.info.gov.hk/eu/ english/psi/psi_materials/psi_materials.html#3 Jan. 2007.

ISO 31000 (2009), Risk Management Principles and Guidelines.

Jin, X. H., and Doloi, H. (2008), Interpreting risk allocation mechanism in public-private partnership projects: An empirical study in a transaction cost economics perspective. Construction Management Economy, 267, 707–721.

Kartam, N. A. and Kartam, S. A. (2001), Risk and its management in the Kuwaiti construction industry: a contractors' perspective. International Journal of Project Management, 19(6), 325-335.

Ke, Y., Wang, S., and Chan, A. (2011), Equitable risk allocation of projects inside China: analysis from Delphi survey studies. Journal of Chinese Management Studies, 298-310.

Khazaeni, G., Khanzadi, M., and Afshar, A. (2012), Fuzzy adaptive decision making model for selection balanced risk allocation. International Journal of Project Management, 30(4), 511-522.

Kumaraswamy, M. (1997), Common categories and causes of construction claims. Construction Law Journal, 21-34.

Lam, K., Wang, D., Lee, P. T. and Tsang, Y. (2007), Modeling risk allocation decision in construction contracts. International Journal of Project Management, 25(5), 485-493.

Leong, H.Y. (2010), RM82bil construction projects in M'sia this year. Retrieved May 5th, 2010, from Star Property: http://www.starproperty.my/PropertyScene/TheStarOnlineHighlightBox/6263/0/0

Loosemore, M., and McCarthy, C. S. (2008), Perceptions of contractual risk allocation in construction supply chains. J. Profl. Issues Eng. Educ. Pract., 1341, 95–105.

Loyd, L.H. (2001), the background to the conference on whose risk, The Grove Report. International Construction Law Review, 18 (2), 302–311.

Nambiar, S. (2007), Public private partnerships for innovation and export development: The Malaysian model. Retrieved August 5, 2011, from http://ww.cepal.org/comercio/noticias/paginas/7/29947/Nambiar_Malaysia_Sevilla.pdf

Ng, A. and Loosemore, M. (2007), Risk allocation in the private provision of public infrastructure. International Journal of Project Management, 25(1), 66-76.

Rahman, M. M., and Kumaraswamy, M. M. (2005), Assembling integrated project teams for joint risk management. Construction Management and Economics, 365-375.

Rusmani, N. (2010), Public private partnership in New Zealand and Malaysia. Unpublished master thesis, Victoria University of Wellington, Wellington.

Saaty, T. L. (1996), Decision making with dependence and feedback: The analytic network process.

Saaty, T. L. (2005), Theory and applications of analytic network process, RWS publications Pittsburgh.

Saaty, T. L. and Vargas, L. G. (2006), Decision making with the analytic network process: Economic, political, social and technological applications with benefits, opportunities, costs and risks, Springer.

Shen, L.-Y., Platten, A. and Deng, X. (2006), Role of public private partnerships to manage risks in public sector projects in Hong Kong. International Journal of Project Management, 24(7), 587-594.

Tenth Malaysia Plan. (2010), Tenth Malaysia Plan (2011-2015). Retrieved April 12, 2011, http://www.pmo.gov.my/dokumenattached/speech/files/RMK10_Speech.pdf

Terry, F. (1996), The private finance initiative-overdue reform or policy breakthrough? Public Money and Management, 16(1), 9-16.

Thomas, A. V., Kalidindi, S. N., and Ananthanaryanan, K. (2003), Construction Management Economy, 214, 393–407.

Wang X. Q., Yu G., and Bing, X. G. (2007), The analysis of risk allocation on the PPP financing model. Soft Science, 216, 23–27 in Chinese.

Xu, Y., Chan, A.P.C., and Yeung, J.F.Y. (2010), Developing a fuzzy risk allocation model for PPP projects in China. Journal of Construction Engineering and Management, 136 (8), 894–903.

Zhang, X. Q., Kumaraswamy, M. M., and Zheng, W. (2002), Concessionaire selection for build-operate-transfer tunnel projects in Hong Kong. Journal of Construction Engineering Management, 1282, 155–163.

Zhu, L., Yuan, J. F., and Du, J. (2007), the study of administration right of government base on PPP contract. Construction Economics, 10, 54–57 in Chinese.