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A Risk Allocation Model for Construction Projects in Yemen

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Abstract
Construction projects in Yemen always experience high levels of risk due to their complex and dynamic environments. This, in turn, impacts projects in both time and cost. Obviously, risk allocation is usually poorly assigned to project parties; leading to terrible disputes among them. Moreover, there are no suitable risk allocation models that suit the nature of Yemen's construction industry. This work endeavors to propose and apply a Risk Allocation Model (RAM), based on a simple mechanism for allocating critical risks to the responsible party in the project. In addition, the RAM aims to compare among projects, which is more risky. The construction of RAM is based on Delphi method by the expert's judgment of construction projects. Fifty four risk factors, over ten groups, are identified and used in the model development. All factors are analyzed and weighted by deploying Weighted Risk Factor (WRF) which combines the effect of a risk factor probability and its effect on time and cost. The model results identified the most important risk factors to be allocated to owner, contractor or shared between them, as well as the suitable risk action for each factor. The model is applied on a real case study through two construction projects in Yemen to test the validation. A complete comparison between the two projects is presented and a decision is introduced for contractor based on projects time and cost overruns, WRF, and risk allocated to contractor. The results emphasized that the model is easy to understand and use by the parties involved in construction projects. Further, it is characterized by flexibility in the event of variables. The RAM outcomes thus help decision-makers to come to the appropriate decision during the trade-off among different projects.
Keywords: Risk allocation, Delphi method, Construction projects, Decision-making, Yemen.

1. Introduction

Project risk management is one of the important aspects in the project management. Because of the uncertainty of construction risks, the losses due to risk directly impact all project participants' benefits. Risk allocation is explicitly one of the causes that raise significant concerns by practitioners and researchers well as. Risk allocation is the process of allocating risk events with related and responsible project participants. It also provides another way for project participants to identify and classify risk issues. The concept of risk allocation is the process that allocates the potential risk loss or return to each project participant in order to promote them for improving the enthusiasm of risk controlling and reducing the cost of risk-taking. One of the main aims of risk allocation is to minimize disputes in construction contracts. Also, risk allocation is very important for project success (Odunusi & Bajracharya 2014).

The risk allocation process can be performed qualitatively and quantitatively (Rouhparvar *et al.* 2014). In recent years, the researches for risk allocation were mostly focusing on project risk allocation principles as well as problems in contracts (Hartman & Snelgrove 1996; Hanna & Swanson 2007; Zhenyu *et al.* 2003; and Dingjun *et al.* 2007). Allocating project risks is always a difficult problem that project risk management couldn't solve (Gao *et al.* 2008). Traditionally, in construction projects, owner seeks to pass almost of the risks to contractor. Due to the one-sided attitude to the risk allocation and unfair transfer of risks, the parties that these risks are imposed on adopt defensive strategies such as lowering the work quality, imposing extensive contingency charges, conservative design and eventually resort to claims, disputes and litigation. Such defensive strategies may lead to project delays and project cost overruns (Nasirzadeh *et al.* 2013). The Construction Industry Institute (1993) points out that the risks during the construction of a project can be allocated by the predictability of risks. The risks, which could be forecasted by the experienced contractors, should be undertaken by the contractor; whereas risk that couldn't be forecasted should be undertaken by the owner (Construction Industry Institute 1993; Chuang 2002). "Construction Risks and Liability Sharing", published by American Society of Civil Engineering, proposes a manageable risk allocation principle: the risk should be assigned to the participant who can best manage and reduce the risk (Chuang 2002).

2. Problem Statement

One of the main problems of construction projects in Yemen is that there is no available simple risk allocation model to support risk allocation and minimize disputes in Yemeni construction industry. In fact, the owner tends to transfer risk to the primary contractor, who in turn pushes it to the subcontractors. As a result, risk is not necessarily allocated to the proper party that is best able to manage it efficiently and effectively. Rather, risk is re-allocated to parties with the least amount of control and influence over risk to manage it. Therefore, the hypothesis of this research is basically based on the need for either tools or a mechanism that can be used throughout the construction projects in Yemen; in order to effectively conduct efficient allocation of the most critical risk factors to reduce the problems and consequences of risks that impact construction projects in Yemen.

3. Risk Allocation Model (RAM)

The proposed Risk Allocation Model (RAM) is simply based on the appropriate party in the project, which can undertake the risk impact and is able to respond to and manage risk factors. The methodology that can be used for developing RAM proposed a mechanism consists of several steps as follows: Risk factors identification, analysis, and weighing by deploying WRF. The allocation process of these risk factors in a later step will be performed using the Delphi method, onto the stage of decision-making. Making such decisions is done via the comparison among different projects to help decision makers such as the contractor to determine the most risky project. Through developing RAM, four categories can be used for risk allocation; namely: (1) owner, (2) contractor, (3) sharing between both owner and contractor, and (4) risks that should be ignored. Figure (1) shows the RAM methodology.

3.1 Risk Identification

Risk identification is tackled by investigating the most significant risks related to the construction projects in a form of a Hierarchical Risk Breakdown Structure for various levels. 54 risk factors are selected for this study. They have been screened from both the literature review and a survey that has been conducted to construction practitioners in Yemen. These factors are divided into ten groups, in order to match the specific nature of construction projects in Yemen as shown in figure (2), (Ahmed *et al*. 2013).

3.2 Risk Analysis

Through this step, risk is analyzed. Risk analysis is the determination of the quantitative and qualitative value of risk for construction projects, which is important for calculation. Three indices are used in this research: Probability Index (PI), Impact index for Time (IIT) and Impact index for Cost (IIC). These indices are used as introduced by Ahmed *et al*. (2013).

3.3 WRF Calculation

The WRF is a technique that combines the effect of risk factors on both time and cost. It considers risk factor probability, risk factor index for time $RF_{(time)}$ and risk factor index for Cost $RF_{(cost)}$. It also takes project priorities into account (John 2001). In this research, for any risk factor, the relationship function between $RF_{(time)}$ and $RF_{(cost)}$ can be calculated as follows:

$$WRF = W1 * RF_{(time)} + W2 * RF_{(cost)} \qquad \text{Equation (1)}$$

Where:

$W1 * RF_{(time)}$: Weighted Risk Factor for Time.
$W2 * RF_{(cost)}$: Weighted Risk Factor for Cost.

W1 and W2 are valued 0 through 1 depending on the priorities of the stakeholders' project, and together must sum to one. In this study, the values of W1 and W2 are taken as 0.60 and 0.40; as calculated from a field survey by Ahmed *et al*. (2013).

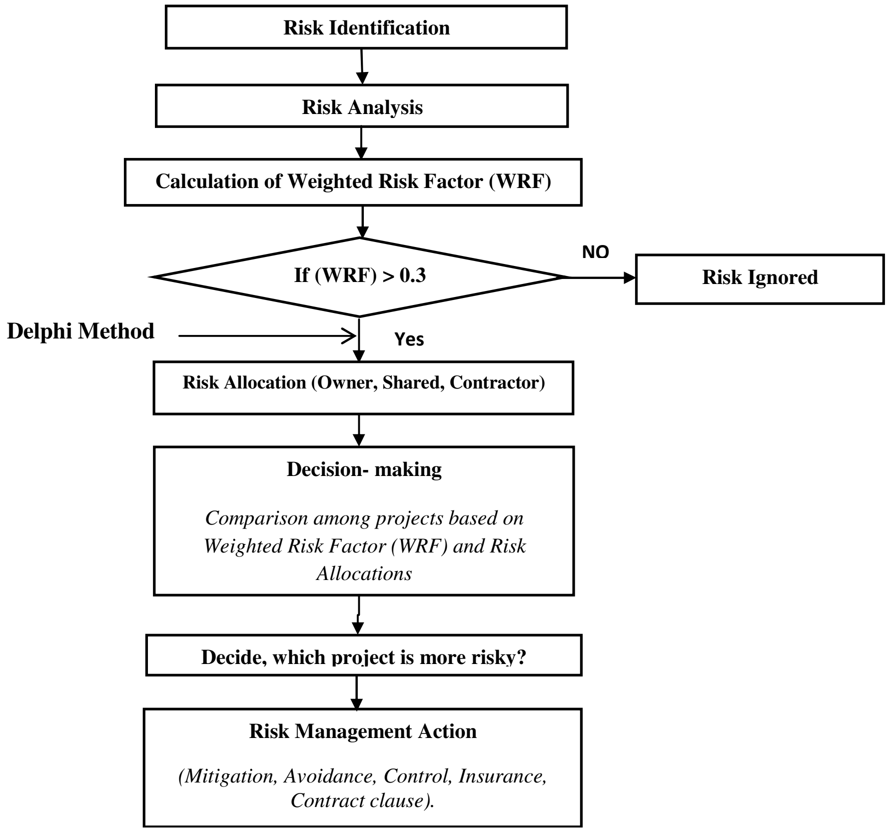

Figure (1): Proposed Risk Allocation Model (RAM)

Figure (3) shows the calculated WRF for the identified 54 factors. The risk factors, with WRF less than or equal to 0.3, will be ignored (very low and low); while the most critical risk factors that cause time and cost overruns are selected to have WRF value more than 0.30 (medium , high and very high). Table (1) shows risk factors ranked in descending order according to their WRF values. Such factors which have WRF more than 0.3 will be considered in risk allocation step using the Delphi Method as will be explained in next sections.

3.4 Delphi Method

The Delphi method is a formalized technique of communication designed to obtain the maximum amount of unbiased opinions from a panel of experts. Its method is beneficial where there is no historical data of adequate communication (Chan *et al*. 2001). The strength of the Delphi method is to collect data from individuals or relevant specialists who may contribute diverse backgrounds with respect to expertise and experience. It is also one of the best known methods for dealing with open ended and creative aspects of a problem because it motivates independent thought and gradual formation of group solutions. The technique is also relatively inexpensive and simple. Design, implementation and analysis of a Delphi do not require advanced mathematical skills (Salleh & Kajewski 2009). Recent researches have been used Delphi technique in many construction projects. Pulipati & Mattingly (2013) used it in evaluating transportation funding alternatives while Alyami *et al.* (2013) used it in developing sustainable building assessment scheme for Saudi Arabia. Markmann (2013) introduced a Delphi-based risk analysis in global supply chains through identifying and quantifying risks and analyzing stakeholder perceptions in addition to stimulating a global communication process. Other examples for using Delphi techniques in construction projects include Xia& Chan (2012) and Vidal *et al.* (2011) who used it to identify the key parameters that measure the degree of project complexity. Also, Toole (2011) employed Delphi method in risk minimization for relationship between project managers.

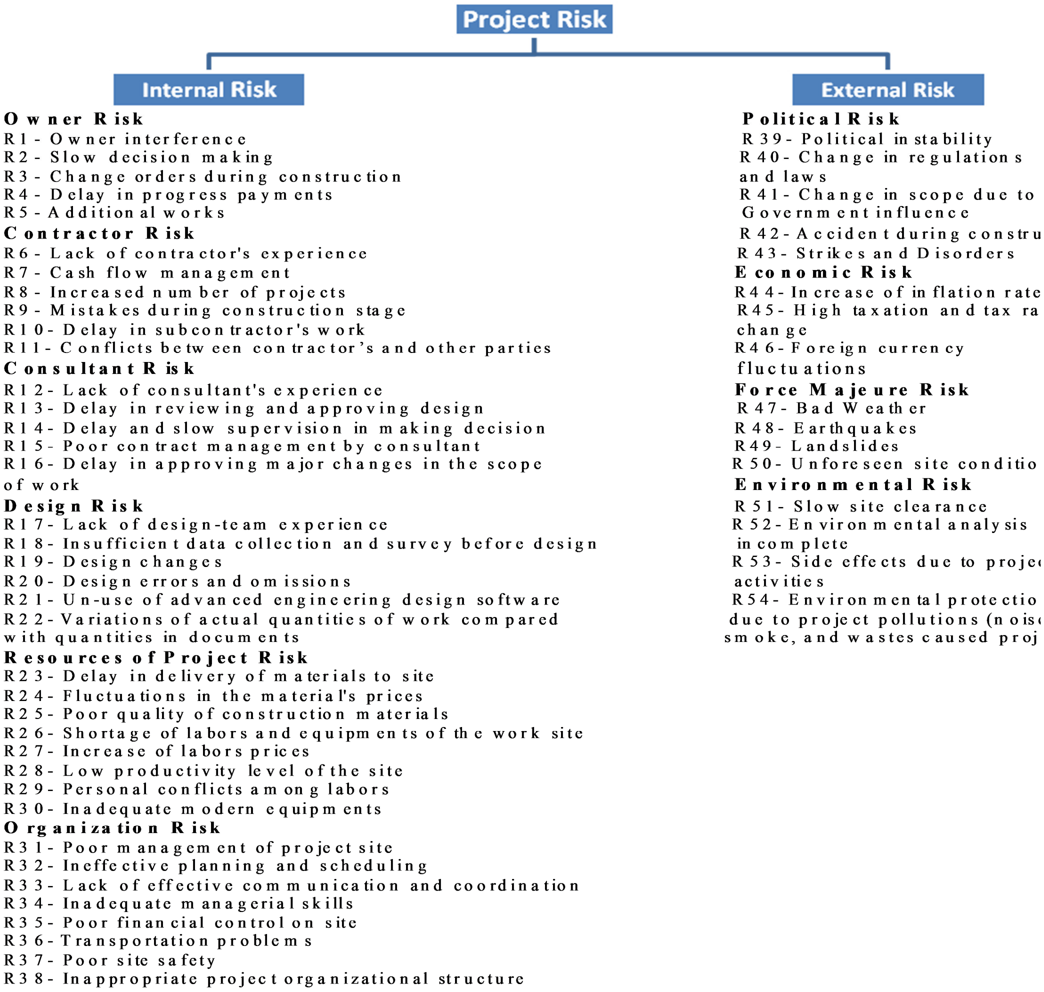

Figure (2): Risk identification breakdown structure

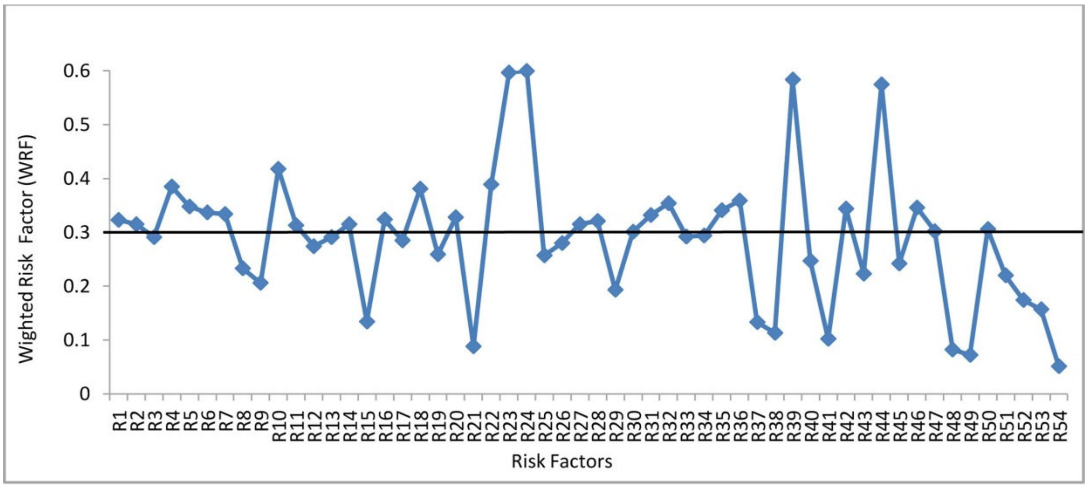

Figure (3) Weighted Risk Factors (WRF)

Table 1. The most critical risk factors based on their WRF

Risk NO.	Risk Factor	WRF
R24	Fluctuations in the material's prices	0.6
R23	Delay in delivery of materials to site	0.597
R39	Political instability	0.584
R44	Increase of Inflation rates	0.575
R10	Delay in subcontractor's work	0.418
R22	Variations of actual quantities of work compared with quantities documents	0.389
R4	Delay in progress payments	0.385
R18	Insufficient data collection and survey before design	0.381
R36	Transportation problems	0.359
R32	Ineffective planning and scheduling	0.354
R5	Additional works at owner's request	0.348
R46	Foreign currency fluctuations	0.346
R42	Accident during construction	0.344
R35	Poor financial control on site	0.341
R6	Lack of contractor's experience	0.337
R7	Cash flow management	0.334
R31	Poor management of project site	0.332
R20	Design errors and omissions	0.328
R16	Delay in approving major changes in the scope of work	0.324
R1	Owner interference	0.323
R28	Low productivity level of the site	0.321
R2	Slow decision making	0.315
R14	Delay and slow supervision in making decision	0.315
R27	Increase of labors prices	0.315
R11	Conflicts between contractor and other parties	0.313
R50	Unforeseen site conditions	0.306
R47	Bad weather	0.302
R30	Inadequate modern equipments	0.301

For this study, experts were selected from a population of experienced practitioners in the field of construction projects in Yemen. Fifteen experts participated in the Delphi questionnaire survey in this study. The experts were (5 Owner representatives, 5 Contractors, 3 Consultants, and 2 Academic professionals). The experts represent a wide spectrum of construction professionals and they can provide a balanced view for the Delphi study. Furthermore, over 90% of the experts had more than twenty years of experience in construction projects in Yemen. The Delphi method adopted in this study consists of two rounds and all experts participated in the two rounds. The results of each round of the Delphi study were analyzed, presented, and the final Delphi results presented in tabulated format for better visualization as shown of table (2). The preferred risk allocation in the RAM is referred to as the "perceived party best capable to manage the risk" which is the party which has more than 50% of vote for the critical risk factors. Table (2) presents the experts judgment of construction projects in Yemen for risk allocation of the most critical risk factors to the party that is best able to manage it efficiently and effectively and also investigates the various preventive and mitigated risk Action (Risk Mitigation, Risk Avoidance, Insurance, Control, and Contract Clause).

From table (2), the purpose of round two is to reach a consensus on the input of round one. In round two, panelists were given the opportunity to change their responses in round one in light of the calculated group's values of round one and/or provide clarification for their answers. As shown in table (2), stability is reached in round two and no additional rounds are needed. A satisfactory degree of consensus was achieved in round two. The risk factors to be allocated to owner in table (2) include :(Fluctuations in the material's prices, Political instability, Increase of Inflation rates, Variations of actual quantities of work compared with quantities documents ,Delay in progress payments, Insufficient data collection and survey before design ,Additional works at owner's request ,Foreign currency fluctuations, Design errors and omissions ,Delay in approving major changes in the scope of work, Owner interference ,Slow decision making and Delay and slow supervision in making decision). Risk factors to be allocated to share between the owner and the contractor in table (2) include: (Unforeseen site conditions and Bad weather). While, risk factors to be allocated to contractor as mentioned in table (2) include: (Delay in delivery of materials to site, Delay in subcontractor's work, Transportation problems, Ineffective planning and scheduling, Accident during construction, Poor financial control on site, Lack of contractor's experience, Cash flow management, Poor management of project site, Low productivity level of the site, Increase of labors prices, Conflicts between contractor and other parties and Inadequate modern equipment).

Risk response is to take the actions to control the risks which were allocated. Risk management actions which have been proposed by the expert judgment are appeared also in table (2). The risk management actions are (Risk Mitigation, Contract Clauses, Risk Avoidance, Control, and Insurance). As shown in figure (4), the risk mitigation represents the most proposed risk actions and represents more than 50%, while the insurance received the less provided risk action solutions.

4. Case study and Model Application

In order to test the effectiveness of using the RAM, the model is applied to two construction projects in Yemen for the purpose of identifying which of them is more risky. Based on the most critical risk factors, data was collected from the practitioners of the case study projects about risk factors using structured interviews. The practitioners identified the expected probability of occurrence for the risk factors, and the impacts of risk factors on the time and cost of the two projects are based on their opinions. The two projects may be sufficient to test the reliability of the model.

4.1 Project (1): Industrial and Vocational Institute – Thamar governorate, Yemen.

This project consists of classrooms, administration building, laboratories building, educational workshops, student accommodation, teacher's accommodation, Dean Accommodation, security rooms, generator room and water tanks.

The planned duration for this project was (840) days and the budgeted cost was (446.127.220) Yemeni Rial (YR), (1$ = 214 YR), while the actual duration and actual cost was (1780) days and (486. 847.168) (YR), respectively.

4.2 Project (2): Industrial and Vocational Institute–Al Qurashia-Al Bayda Governorate, Yemen.

The project consists of classrooms, laboratories building, educational workshops, administration building, student accommodation, Dean Accommodation, teacher's accommodation, security rooms, generator room and water tanks.

The planned duration for this project was (707) days and the budgeted cost was (469.710.090) Yemeni Rial (YR), while the actual duration and actual cost was (1739) days and (546. 266.851), (YR) respectively.

Both projects illustrate time and cost overruns. The two projects faced many critical risk factors due to various obstacles and problems encountered by different project parties with different degrees of responsibility. Table (3) summarizes WRF values for risk factors calculated due to the expected probability of occurrence for risk factors, and the impacts of risk factors on time and cost based on contractors' opinions in the two projects. Data is used for calculating WRF to be used in the RAM. Table (3) also includes the risk allocation for each risk factor in both projects. Moreover, figure (5) summarizes and compares the percent of risk allocation for both projects. Figure (6) compares WRF for risk factors in the two projects.

Table 2. The final Delphi method results of risk allocation and risk management action

Risk No.	Risk Factor	Delphi Round One (Risk Allocation)			Delphi Round Two (Risk Allocation)			Allocated	Risk Action
		Owner	Shared	Contractor	Owner	Shared	Contractor		
R24	Fluctuations in the material's prices	46.70%	20%	33.30%	53.30%	26.70%	20%	Owner	Contract Clause
R23	Delay in delivery of materials to site	20.00%	20%	60.00%	26.70%	6.60%	66.7 %	Contractor	Mitigation
R39	Political instability	66.70%	13%	20.00%	66.70%	13.30%	20%	Owner	Contract Clause
R44	Increase of Inflation rates	53.30%	33%	13.40%	60.00%	33.30%	7%	Owner	Contract Clause
R10	Delay in subcontractor's work	13.30%	20%	66.70%	6.70%	13.30%	80%	Contractor	Mitigation
R22	Variations of actual quantities of work compared with quantities documents	46.70%	40%	13.30%	66.70%	20.00%	13%	Owner	Contract Clause
R4	Delay in progress payments	73.30%	20%	6.70%	73.30%	20.00%	7%	Owner	Mitigation
R18	Insufficient data collection and survey before design	53.30%	27%	20.00%	66.70%	20.00%	13%	Owner	Mitigation
R36	Transportation problems	26.70%	33%	40.00%	20.00%	26.70%	53%	Contractor	Mitigation
R32	Ineffective planning and scheduling	13.30%	20%	66.70%	13.30%	20.00%	67%	Contractor	Control
R5	Additional works at owner's request	66.70%	20%	13.30%	80.00%	13.30%	7%	Owner	Contract Clause
R46	Foreign currency fluctuations	46.70%	33%	20.00%	53.30%	26.70%	20%	Owner	Contract Clause
R42	Accident during construction	13.30%	20%	66.70%	13.30%	20.00%	67%	Contractor	Insurance
R35	Poor financial control on site	6.70%	20%	73.30%	6.70%	6.70%	87%	Contractor	Mitigation
R6	Lack of contractor's experience	20.00%	13%	66.70%	6.70%	20.00%	73%	Contractor	Mitigation
R7	Cash flow management	20.00%	33%	46.70%	20.00%	26.70%	53%	Contractor	Mitigation
R31	Poor management of project site	20.00%	27%	53.30%	6.70%	20.00%	73%	Contractor	Mitigation
R20	Design errors and omissions	73.30%	20%	6.70%	6.70%	6.70%	87%	Owner	Mitigation
R16	Delay in approving major changes in the scope of work	66.70%	20%	13.30%	53.30%	26.70%	20%	Owner	Mitigation
R1	Owner interference	73.30%	20%	6.70%	73.30%	20.00%	7%	Owner	Avoidance
R28	Low productivity level of the site	20.00%	27%	53.30%	6.70%	20.00%	73%	Contractor	Control
R2	Slow decision making	40.00%	27%	33.30%	53.30%	26.70%	20%	Owner	Mitigation
R14	Delay and slow supervision	53.30%	27%	20.00%	66.70%	13.30%	20%	Owner	Mitigation
R27	Increase of labors prices	40.00%	27%	33.30%	53.30%	20.00%	27%	Contractor	Mitigation
R11	Conflicts between contractor and other parties	13.30%	20%	66.70%	13.30%	20.00%	67%	Contractor	Avoidance
R50	Unforeseen site conditions	26.70%	40%	33.30%	20.00%	66.70%	13%	Shared	Mitigation
R47	Bad weather	20.00%	53%	26.70%	13.30%	66.70%	20%	Shared	Avoidance
R30	Inadequate modern equipment	6.70%	20%	73.30%	6.70%	6.70%	87%	Contractor	Avoidance

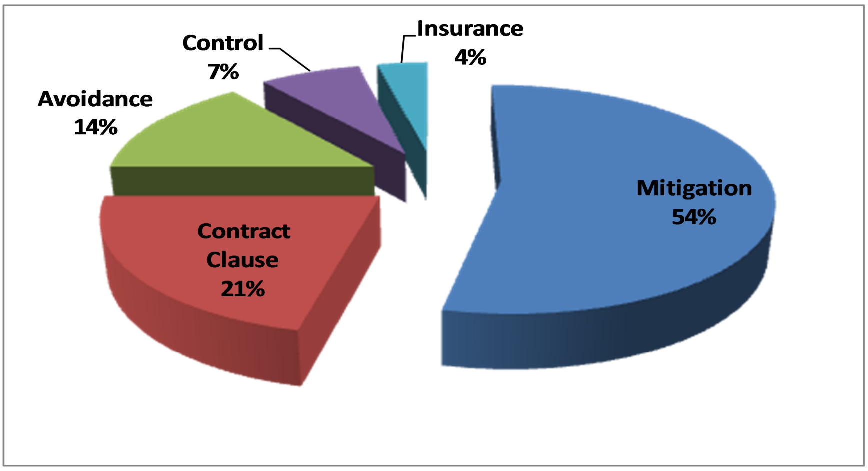

Figure (4): Risk management action

The equations used to calculate the time and cost overruns percentage for projects (1) and (2) are shown below:
Actual Time overrun % *= (Actual duration – Planned duration) / Planned duration * 100* Equation (2)
Actual cost overrun % *= (Actual cost – Budgeted cost) / Budgeted cost * 100* Equation (3)
Applying the last two equation on the real data from the two projects, it is found that time overrun of project (1) is (12 %) and (46 %) for project (2); whereas cost overrun for project (1) is (9.1 %) and (16.3 %) for project (2).

5. Decision making
As explained previously, the main aim of the RAM is to support the decision of selecting a project among many projects, based on which project is more risky. Based on time and cost overruns calculations and the results from table (3) and figures (5) and (6), if the contractor would like to select one of the projects (1 and 2), the decision can be provided to select project (1) because project (2) is more risky for the following reasons:

- Number of risk factors in project (2) which has (WRF) > 0.3 is 18 factors versus 16 in project (1) as shown table (3) and figure (6).
- For risk factors with WRF > 0.3, the mean value of WRF in project (2) is 0.409 compared to 0.344 in project (1); which indicates that project (2) is more risky.
- As shown in figure (5), the percent of risks which will be allocated to contractor in project (2) is (50 %), compared to 31 % in project (1).
- Both time and cost overruns in project (2) are higher than time and cost overruns in project (1), which confirms that project (2) is more risky.

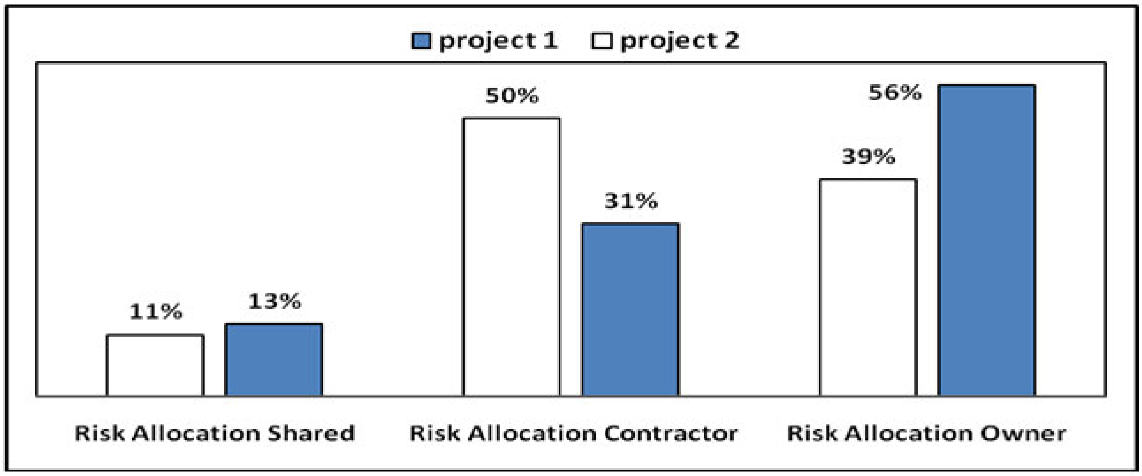

Figure (5): Percentage of risk allocation for projects (1) and (2)

Table 3. WRF and risk allocation for project (1) and project (2)

Risk No.	Risk Factor	Project 1		Project 2	
		WRF	Risk Allocated to	WRF	Risk Allocated to
R24	Fluctuations in the material's prices	0.501	Owner	0.57	Owner
R23	Delay in delivery of materials to site	0.467	Contractor	0.536	Contractor
R39	Political instability	0.467	Owner	0.467	Owner
R44	Increase of Inflation rates	0.407	Owner	0.501	Owner
R10	Delay in subcontractor's work	0.467	Contractor	0.467	Contractor
R22	Variations of actual quantities of work compared with quantities documents	0.358	Owner	0.358	Owner
R4	Delay in progress payments	0.333	Owner	0.501	Owner
R18	Insufficient data collection and survey before design	0.358	Owner	0.259	Neglected
R36	Transportation problems	0.259	Neglected	0.383	Contractor
R32	Ineffective planning and scheduling	0.333	Contractor	0.363	Contractor
R5	Additional works at owner's request	0.358	Owner	0.309	Owner
R46	Foreign currency fluctuations	0.333	Owner	0.398	Owner
R42	Accident during construction	0.259	Neglected	0.363	Contractor
R35	Poor financial control on site	0.111	Neglected	0.156	Neglected
R6	Lack of contractor's experience	0.333	Contractor	0.309	Contractor
R7	Cash flow management	0.111	Neglected	0.383	Contractor
R31	Poor management of project site	0.259	Neglected	0.383	Contractor
R20	Design errors and omissions	0.309	Owner	0.284	Neglected
R16	Delay in approving major changes in the scope of work	0.156	Neglected	0.185	Neglected
R1	Owner interference	0.185	Neglected	0.26	Neglected
R28	Low productivity level of the site	0.333	Contractor	0.383	Contractor
R2	Slow decision making	0.259	Neglected	0.185	Neglected
R14	Delay and slow supervision in making decision	0.156	Neglected	0.235	Neglected
R27	Increase of labors prices	0.235	Neglected	0.235	Neglected
R11	Conflicts between contractor and other parties	0.111	Neglected	0.259	Neglected
R50	Unforeseen site conditions	0.309	Shared	0.383	Shared
R47	Bad weather	0.309	Shared	0.309	Shared
R30	Inadequate modern equipments	0.259	Neglected	0.235	Neglected

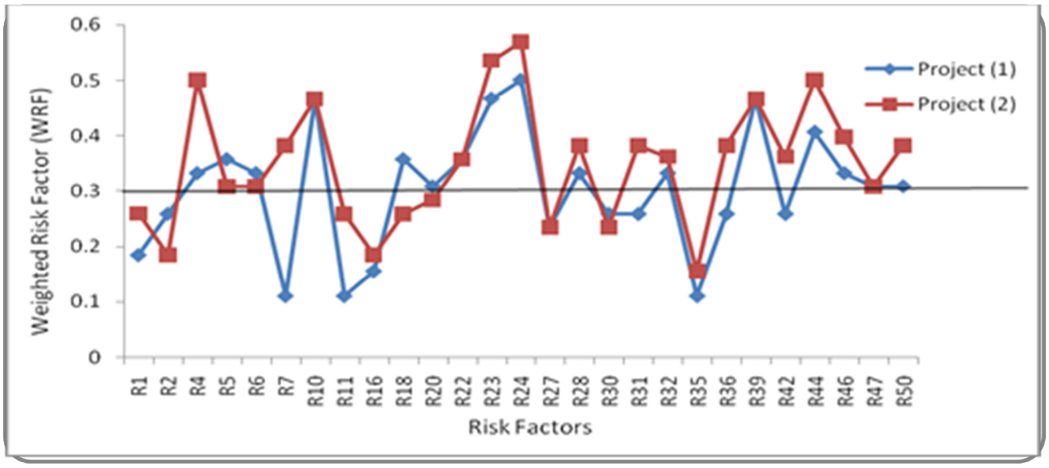

Figure (6): A comparison between risks affecting project (1) and project (2) based on WRF

6. Conclusions

The main conclusions drawn from applying the RAM on the available data and case study can be summarized as follows:

- The RAM addresses the highest and most important risks associated with construction projects in Yemen.

- The study presents the experts' judgment of construction projects in Yemen for risk allocation of the most critical risk factors to the party that is best able to manage it efficiently and effectively. Also, the study investigates the various preventive and risk mitigation actions.
- Based on the results of the RAM applications, the risk factors to be allocated to owner include:(Fluctuations in the material's prices, Political instability, Increase of Inflation rates, Variations of actual quantities of work compared to quantities documents, Delay in progress payments, Insufficient data collection and survey before design, Additional works at owner's request, Foreign currency fluctuations, Design errors and omissions, Delay in approving major changes in the scope of work, Owner interference, Slow decision making and Delayed/slow supervision in making decision).
- Risk factors to be allocated to contractor include: (Delay in delivery of materials to site, Delay in subcontractor's work, Transportation problems, Ineffective planning and scheduling, Accidents during construction, Poor financial control on site, Lack of contractor's experience, Cash flow management, Poor management of project site, Low productivity level of the site, Increase of labors prices, Conflicts between contractor and other parties and Inadequate modern equipment).
- Risk factors to be shared between the owner and the contractor include: (Unforeseen site conditions and Bad weather).
- The RAM shows risk management actions which have been proposed by the expert judgment. The risk management actions are (Risk Mitigation, Contract Clauses, Risk Avoidance, Control, and Insurance). The risk mitigation represents more than 50%, while the other risk actions represent less than 50%.
- The RAM is easy to understand and use by the parties involved in construction projects in Yemen and is characterized by flexibility in the event of variables.
- The RAM Helps decision-makers to take the appropriate decision during the trade-off among projects, particularly at the stage of bidding and tenders.

References

Ahmed S. A., Issa U. H., Farag M. A., & Abdelhafez L. M., (2013), " Evaluation of Risk Factors Affecting Time and Cost of Construction Projects in Yemen", *International Journal of Management (IJM),* 5(4), 168-178.

Alyami S. H., Rezgui Y., & Kwan A., (2013), " Developing sustainable building assessment scheme for Saudi Arabia: Delphi consultation approach" , *Renewable and Sustainable Energy Reviews*, 27, 43-54.

Chan A. P., Yung E., Lam P., Tam C. M., & Cheung S., (2001), "Application of Delphi Method in Selection of Procurement Systems for Construction Projects", *Construction Management Economy*, 19 (7), 699-718.

Chuang Q., (2002), "Contract Principle and Business for International Project",*Beijing: China Building Industry Press.*

Construction Industry Institute (CII), (1993), "Allocation of Insurance Related Risks and Costs on Construction Projects", *University of Texas at Austin*, Austin.

Dingjun L., Shirong L., (2007), "The Research on Risk Allocation between the Government Client and Agent", *Construction economy*, (7), 105-108.

Gao Y. L., & Jiang L., (2008), " The Risk Allocation Method based on Fuzzy Integrated Evaluation of Construction Projects*." Int. Conf. on Risk Management and Engineering Management*, IEEE, Piscataway, N.J., 428-432.

Hanna A. S., & Swanson J., (2007), "Risk Allocation by Law-Cumulative Impact of Change Orders", *Journal of construction engineering and management*, 133(1), 60-66.

Hartman F., & Snelgrove P., (1996), " Risk Allocation in Lump-Sum Contracts-Concept of Latent Dispute", *Journal of construction engineering and management*, 122(3), 291-296.

John M., (2001), "Project Management for Business and Technology", Upper Saddle River, Second Edition, NJ, 312-317.

Markmann, C., Darkow I., & Gracht H., (2013), " A Delphi-based risk analysis — Identifying and assessing future challenges for supply chain security in a multi-stakeholder environment", *Technological Forecasting and Social Change*, 80(9), 1815-1833.

Nasirzadeh F., Khanzadi M., & Rezaie M., (2013), "System Dynamics Approach for Quantitative Risk Allocation" , *International Journal of Industrial Engineering & Producttiion Research* , 24(3) , 237-246

Odunusi G.H., & Bajracharya B., (2014), " The Role of Risk Allocation in Minimizing Disputes in Construction Contracts", MSc.Thesis, the British University, Dubai.

Pulipati S. B., & Mattingly S. P., (2013) "Establishing Criteria and their Weights for Evaluating Transportation Funding Alternatives Using a Delphi Survey", *Social and Behavioral Sciences*, 104(2), 922-931.

Rouhparvar M., Zadeh H. M., & Nasirzadeh F., (2014) " Quantitative Risk Allocation in Construction Projects: A Fuzzy-Bargaining Game Approach", *International Journal of Industrial Engineering & Producttiion Research* , 25(2), 83-94.

Salleh R., & Kajewski S., (2009), "Critical Success Factors of Project Management for Brunei Construction

Projects: Improving Project Performance", Ph.D. Thesis, School of Urban Development, Faculty of Built Environment and Engineering, Queensland University of Technology.

Toole T. M., (2011), " Minimizing Communication Risk in Construction: A Delphi Study of the Key Role of Project Managers", *Proceedings Engineering Project Organizations Conference*, Colorado August 9-11.

Vidal L. A., Marle F. & Bocquet J., (2011), "Using a Delphi process and the Analytic Hierarchy Process (AHP) to evaluate the complexity of projects", *Expert Systems with Applications*, 38(5), 5388–5405.

Xia B. & Chan A. P.C., (2012), "Measuring complexity for building projects: a Delphi study", *Engineering, Construction and Architectural Management*, 19(1), 7 – 24.

Zhenyu Z., Wei J., &Wenjie H., (2003), "Contractor's Risks in the FIDIC 1999 Conditions of Contract for Construction ", *China Civil Engineering Journal*, 36(9), 34-37.