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RISK ASSESSMENT FOR CONSTRUCTION OF DAM PROJECT IN MYANMAR

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ABSTRAK

Di Myanmar, pembangunan proyek bendungan penting untuk alasan kebutuhan pertanian sektor, pasokan listrik tenaga air, pemeliharaan lingkungan dan perlindungan terhadap banjir. Di sisi lain, proyek bendungan tipikal memiliki sifat dan karakteristik khusus yang melibatkan banyak risiko dan ketidakpastian yang bila tidak diidentifikasi, dianalisis, dan direspon secara memadai dapat berakibat pada kenaikan dan keterlambatan proyek. Untuk mendukung dan meningkatkan pengelolaan kegiatan pembangunan proyek bendungan, dilaksanakan penilaian risik. Sebanyak 78 risiko berkaitkan dengan risiko konstruksi berhasil diidentifikasi. Dari sejumlah tersebut, 45 risiko berkaitan dengan proyek bendungan proyek bendungan. Survei melalui kuesioner dikirim ke Departemen Irigasi Myanmar dan itu direspon oleh 31 ahli yang sudah berpengalaman di bendungan dikirim ke Departemen Irigasi Myanmar dan itu direspon oleh 31 ahli yang sudah berpengalaman di bendungan. Berdasarkan hasil analisis, faktor risiko yang paling signifikan adalah cuaca tak terduga buruk. Hal ini berkaitan dengan kelompok risiko alami. Tiga risiko yang signifikan berikutnya adalah "masalah tak terduga teknis dalam konstruksi", " Buruknya kualitas kerja", dan "Inflasi dan perubahan mendadak dalam harga". Risiko tersebut mengenai kelompok risiko ekonomi, kelompok risiko konstruksi dan kelompok risiko operasi. 42 risiko harus dimitigasi dan 3 risiko dihindari dan diterima.
Kata Kunci: Myanmar, Risiko, Penilaian Risiko, Manajemen Risiko Dam

ABSTACT

In Myanmar, the construction of dam project is essential for agriculture sector, hydro power supply, environment and flood protection. On another front, typical dam project has specific nature and characteristics that constitute a great deal of riskst that, if not thoroughly identified, analyzed, and responded, can result in cost and time overrun. To support and improve the management of construction activities of dam projects, project risks need to be assessed. A total of 78 risks asssociated with construction risks were sucessfully identified. Of which, 45 risks are related to dam projects. A questionnaire survey was undertaken and addressed at Myanmar Irrigation Department. It was responded by 31 experienced officials. Based on the analysis, the most significant risk factor is the unexpected inclement weather classified under natural risk group. The next three significant risks are “Unpredicted technical problems in construction”, “Poor quality of work”, and “Inflation and sudden changes in prices” under economic construction and operation groups. A total of 42 risks should be mitigated and 3 risks should be avoided and accepted.
Key Word: Myanmar, Risk, Risk Assessment, Dam Risk Management

Introduction

In Myanmar, over 230 projects, construction of dams, reservoirs, sluice gates and river pumping stations have been developed to fill the required gap for agricultural sector. Myanmar is an agro-based country and agricultural sector is 43% of Gross Domestic Product (GDP).The purposes of dams are to develop the new fallow lands, to supply enough water for irrigation and to prevent the regional people from the flood. For all old and new dam projects, the most important thing is to control the dam safety. A project involves processes, procedures, goals, objectives, both human and other resources, expectations, promises, contracts, schedules, budgets, plans, coordination, supply chains and stakeholders (Furst, 2010) and it varies in size and complexity in project life cycle structure (as shown in Figure 1.1): starting the project, organizing and preparing, carrying out the project work and closing the project (Project Management Institute (PMI), 2008).

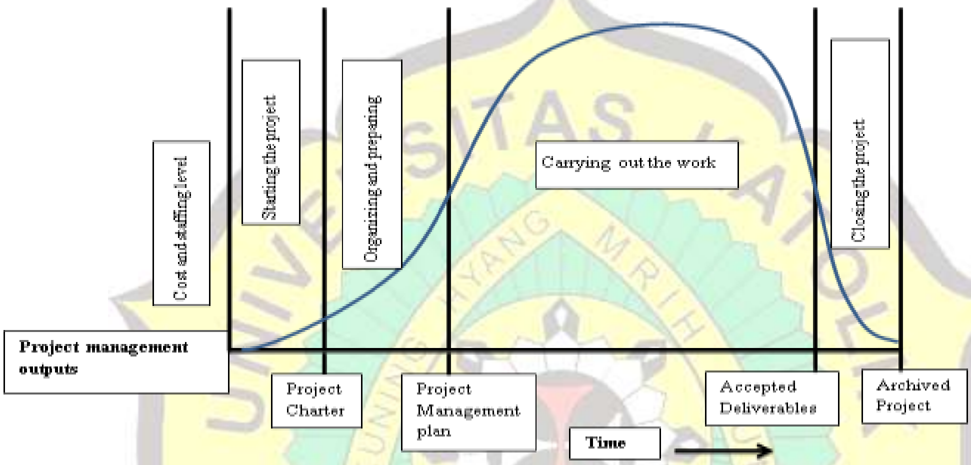

Figure. 1 Typical cost staffing levels across the project life cycle (PMI, 2008)

As shown in Figure 1, the time and cost will be spent at the most in carrying out the work stage among the stages of the project life cycle due to the complexities. To tackle the project's construction successfully, the possible events are required to consider or to predict at the beginning of the project. This research paper is to perform the first stage of risk management, the implementing risk assessment prioritizing the construction stage.

With regard to the construction industry, risk management is not commonly used (Klemetti, 2006) in models and techniques aimed for managing risks. Risks differ between projects due to the fact that every project is unique, especially in the construction industry (Gould and Joyce, 2002). However there are still many practitioners that have not realized the importance of including risk management in the process of delivering the project (Smith et al., 2006). Successful project managers recognize that risk management is important, because achieving a project's goals depends on planning, preparation, results and evaluation that contribute to achieving strategic goals (Duggan, 2013).

The problem statements for this dam construction are identified with regarding to the reason of a very unique project, lack of upgrading on the previous design, techniques, tools and management support, using risk assessment method and management and lack of sharing the construction knowledge area to all participants. The four research questions and the four objectives are developed concerning the identification and evaluation of risk factors for probability and impact assessment, the allocation and mitigation of these factors.The scope of the study starts with the selection of the identification factors from the feasibility study of the occurred events and accidents in past, the documentation review and investigation data from site or workplaces. In the second step, the identified risk factors are sent to the address of Ministry of Agriculture and Irrigation, Irrigation Department, Construction (1), Hlegu

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Township, Myanmar to collect data by questionnaire survey via email. After collecting data, the qualitative analysis approach is developed with the assessment of probability and impact. The final stage is to monitor and control the analysis results.

Literature Reviews

Construction projects represent a unique set of activities that might take place to produce a unique product. A project has to meet the criteria of cost, time, safety, resource allocation, and quality to achieve goals. The construction manager must control, deflect, or mitigate the effects of any occurrence or situation that could affect project success (Muir, 2005). The challenges for construction workplace might be the following: (1) Nature of the work, (2) Work force Consideration, (3) Safety, (4) Time Constraint, (5) Environmental Issues, and (6) Legal Issues. If risks cannot be totally eliminated or transferred, it will be necessary to monitor and minimize or mitigate as soon as possible to succeed throughout the project lifecycle. Risk management is concerned not only with identifying risks, but also with reducing risks to an acceptable level. It includes maximizing the probability of positive events and minimizing the probability and consequences of adverse events (Alvarez et al, 2009). The possible risks in construction projects are summarized as below: (1) technical risk, (2) schedule risk, (3) cost risk and (4) documentation requirement. From the standpoint of project management styles, uncertainty can be categorized as the following to be considered: (1) Variation, (2) Foreseen Risks, (3) Unforeseen Risks and (4) Chaos.

Risk Identification

Risk identification is the critical first step of the risk management process. Risk identification defines the set of the future events that, if any occur, could have an unwanted impact on an engineering system project's cost, schedule, technical performance or any other evaluation criteria defined by the engineering team. Risks factors are identified by the negative events occurring at projects and negative impacts of projects to achieve performance or capability outcome goals. Risk identification is best performed as a team because it might be serviced under the guidance of a professional facilitator. Working sessions are regularly held with key team members and experienced personnel to review and validate all identified risks. Throughout the risk identification process, dependencies among risks must also be identified (Garvey, 2009).The 45 risk factors are selected for this research from the 78 risk factors which are sub the international references of construction projects from the various construction fields such as construction of building, construction of highway, failures of dam construction, cost overrun projects and etc. The 45 possible risks are picked up as the sensitive and vulnerable risk factors for construction projects with author name and the year mentioned together.

The output of identifying risk is risk register including list of identified risks and list of potential responses (PMI, 2008). The purpose of identifying risks is to obtain a list with potential risks to be managed in a project (PMI, 2004). Handling potential threats is not only a way to minimize losses within the project, but also a way to transfer risks into opportunities, which can lead to economical profitability, environmental and other advantages. If the causes of the risks have been identified and allocated before any problems occur, the risk management will be more effective (PMI, 2004). The aim is to highlight the potential problems, in order for the project team to be aware of them.

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Table. 1 Selected Identification Risk Factors

No	Identified Risks	Name of Authors						
		Odeyinka & Lowe (2001)	McMullen (2004)	El-Sayegh (2007)	Alnuaimi (2010)	Creedy et al (2010)	Chan et al (2010)	Chan et al (2011)
1	Owners's delayed payment to contractors.	*		*		*		*
2	Owners's unreasonably imposed tight schedule.			*				
3	Lack of scope of work definition by owner.			*				
4	Owner's breach of contracts and disputes.			*				
5	Adequate inspections independent of the owner/contractor were absent during the Dam's construction.		*					
6	Contractors' incompetence			*	*			
7	Subcontractors' poor performance			*	*			
8	Subcontractors' breach of contracts and disputes.			*				
9	The contractor misuses variations instructions.				*			
10	Contractor bears any unforeseen design development risks.						*	
11	Did not meet prevailing dam designs.		*					
12	Defective design			*	*			
13	Frequent changes in design by designer.			*				
14	Deficiencies in drawings and specifications .			*				
15	Drawings and documents are not issued on time .			*				
16	Delays in approval			*				
17	Deficient documentation						*	*
18	Changes in laws and regulations							*
19	Imperfect law and supervision system							
20	Failure by the consultant to provide adequate and clear information in the tender documents.				*		*	*
21	Unproven Enigineering Techniques							*
22	Unpredicted technical problems in construction.		*					
23	Delay of material supply by supplier.		*					
24	Delays in resolving disputes.		*					*
25	Delays in resolving contractual issues	*	*					*
26	Shortage in material supply and availability.			*	*	*		*
27	Shortage in manpower supply and availability.			*	*	*		*
28	Shortage in equipment availability.			*	*	*		
29	Unexpected inclement weather.	*		*		*		*
30	Unforeseen site conditions.			*				*
31	Poor quality of work.			*	*			
32	Low productivity of labor and equipment.			*				
33	Lack or departure of qualified staff			*				
34	Corruption and bribes			*				

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No	Identified Risks	Name of Authors						
		Odeyinka & Lowe (2001)	McMullen (2004)	El-Sayegh (2007)	Alnuaimi (2010)	Creedy et al (2010)	Chan et al (2010)	Chan et al (2011)
35	Inflation and sudden changes in prices	*		*		*		*
36	Operation cost overrun				*			*
37	Organization and coordination risk							*
38	Estimating error.	*						
39	Invalid calculation changes against the planned estimate's specifications.		*					
40	Project from beginning to end was achieved with very little public scrutiny.		*					
41	Project from beginning to end was achieved with very little public scrutiny.				*			
42	Natural growth of the project was not anticipated at the design stage.			*				
43	Accidents during construction							*
44	Lack of supporting infrastructure				*			
45	Poor communication between relevant government units and the owner.					*		

Methodology

For this research study, the risk factors identified will be used by questionnaire method. The data collection for survey is taken via email and the results are analyzed by qualitative risk analysis method. And the results of analysis can be controlled by risk mitigation process. This study consists of three main sections. In the first section, the stage of the research's method will be illustrated by flow chart diagram. In second section, the questionnaire method and data collection will explain with respect to the likert scale, probability and impacts. In the third section, qualitative analysis method, risk identified factors and risk response mitigation will be explained. Risk appraisal will be asked for the skilled engineers and specialists who had experienced in dam construction. The steps of study method are as shown in Figure 2.

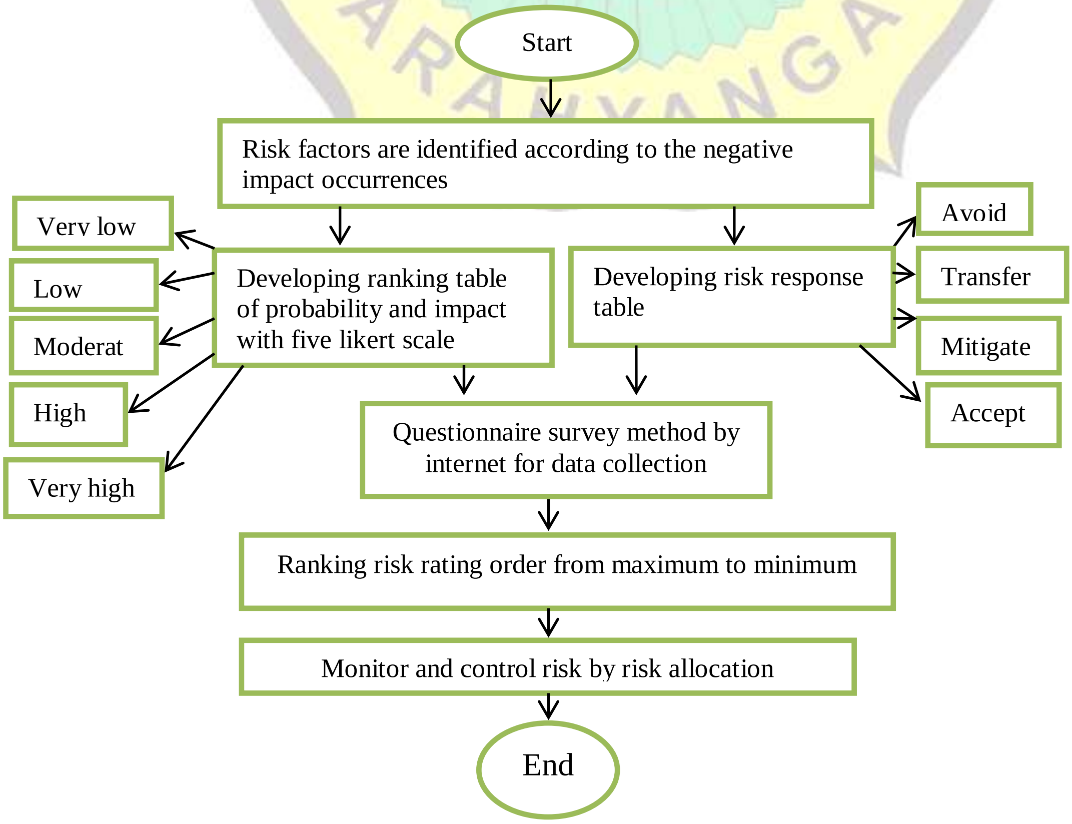

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Figure. 2 Research Method

For this research study, the questionnaire form of probability and impact were sent to the Construction (1), Irrigation Department in Myanmar via email and 31 copies of questionnaire were evaluated by 31 engineering government staffs of their experience and opinions. Their background profile can be studied in Table.2 and their feedback percentages are shown in Figure 3. For data collection analysis, questionnaire consists of two sections. One section is intended to define the respondents who will evaluate this appraisal. Respondents are selected from Myanmar Irrigation Department and their profiles are arranged with their experiences, position, number of respondents and the type of construction. Second section is to evaluate the probability, impact and risk response.

To evaluate the probability and impact , the five likert scale method is used with the agreement of (1) very low, low, moderate, high and very high level. To evaluate the response table, the respondents will answer the identification factors to (1) avoid, (2) transfer, (3) mitigate and (5) accept.

Table 2. Background Profile of Respondents

No	Position	Service experience	Number of respondents	Types of work experienced
1	Project Engineer (or) Director	35 years	1	Construction and maintenance of dams, canals , polders and embankment systems
2	Deputy Director	22 years	1	Construction of Dams
3	Assistant Directors	20 years	2	Construction of Dams and irrigation networks
4	Assistant Engineers	from 10 years to 35 years	17	Construction of Dams, canals, irrigation networks, design branch and irrigation technology center
5	Sub-assistant Engineers	from 7 years to 31 years	8	Construction of Dams, canals, irrigation networks
6	Engineering Drawing (1)	11 years and 20 years	2	Construction of Dams, canals, irrigation networks
	Total number of respondents		31	

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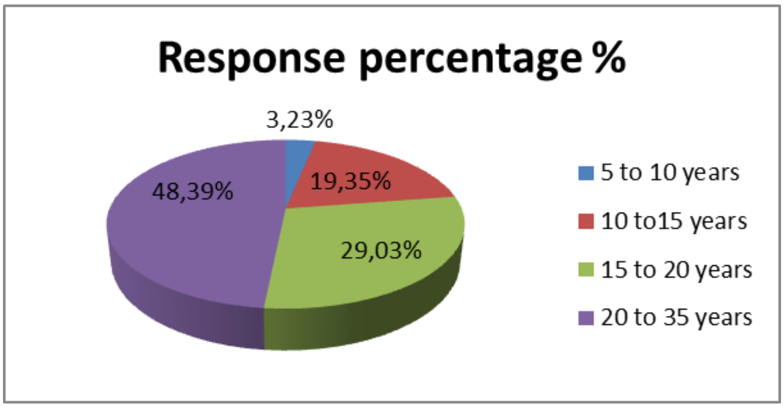

Figure.3 Group of respondents and their feedback

Analysis Results

Data collection results are divided into three parts: analysis results of probability, analysis results of impact and risk allocation response results. The total risk score for each identification factor is produced by multiplying the mean probability value and the mean impact value. The results of total risk are ranked from maximum significant to minimum significant. To compute the mean result of risk, the mean value of probability and impact are multiplied. The results of risk score are show in Table 3.

Risk = Probability x Impact

Table.3 Risk Ranking of all identification factors

Risk factor no	Identified Risk Factors	Mean value of probability (P)	Mean value of impact (I)	Risk = P X I	Rank of Risk
X1	Owners's delayed payment to contractors.	1.42	2.06	2.9	31
X2	Owners's unreasonably imposed tight schedule.	1.55	1.81	2.8	33
X3	Lack of scope of work definition by owner.	1.23	1.97	2.4	44
X4	Owner's breach of contracts and disputes.	1.33	1.93	2.6	40
X5	Adequate inspections independent of the owner/contractor were absent during the Dam's construction.	1.48	2.07	3.1	24
X6	Contractors' incompetence	1.74	2.29	4.0	12
X7	Subcontractors' poor performance	1.93	2.29	4.4	8
X8	Subcontractors' breach of contracts and disputes.	1.45	2.10	3.0	27
X9	The contractor misuses variations instructions.	1.67	1.97	3.3	20
X10	Contractor bears any unforeseen design development risks.	1.48	2.87	2.8	34
X11	Did not meet prevailing dam designs.	1.77	2.26	4.0	13
X12	Defective design	1.58	2.16	3.4	18
X13	Frequent changes in design by designer.	1.48	1.87	2.8	35
X14	Deficiencies in drawings and specifications .	1.42	1.87	2.7	39

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Risk factor no	Identified Risk Factors	Mean value of probability (P)	Mean value of impact (I)	Risk = P X I	Rank of Risk
X15	Drawings and documents are not issued on time .	1.71	2.23	3.8	14
X16	Delays in approval	1.55	1.94	3.0	28
X17	Deficient documentation	1.52	1.81	2.8	36
X18	Changes in laws and regulations	1.50	2.03	3.0	29
X19	Imperfect law and supervision system	1.32	1.97	2.6	41
X20	Failure by the consultant to provide adequate and clear information in the tender documents.	1.55	1.90	2.9	32
X21	Unproven Engineering Techniques	1.32	2.00	2.6	42
X22	Unpredicted technical problems in construction.	1.94	2.45	4.8	2
X23	Delay of material supply by supplier.	1.77	2.29	4.1	11
X24	Delays in resolving disputes.	1.55	2.06	3.2	23
X25	Delays in resolving contractual issues	1.52	2.23	3.4	19
X26	Shortage in material supply and availability.	1.65	2.26	3.7	15
X27	Shortage in manpower supply and availability.	1.65	2.20	3.6	16
X28	Shortage in equipment availability.	1.87	2.23	4.2	9
X29	Unexpected inclement weather.	2.03	2.48	5.0	1
X30	Unforeseen site conditions.	1.65	2.16	3.6	17
X31	Poor quality of work.	1.87	3.55	4.8	3
X32	Low productivity of labor and equipment.	1.90	2.42	4.6	5
X33	Lack or departure of qualified staff	1.29	2.00	2.6	43
X34	Corruption and bribes	1.50	2.23	3.3	21
X35	Inflation and sudden changes in prices	1.87	2.55	4.8	4
X36	Operation cost overrun	1.90	2.37	4.5	7
X37	Organization and coordination risk	1.94	2.39	4.6	6
X38	Estimating error.	1.48	2.10	3.1	25
X39	Invalid calculation changes against the planned estimate's specifications.	1.16	1.87	2.2	45
X40	Project from beginning to end was achieved with very little public scrutiny.	1.53	1.93	3.0	30
X41	Natural growth of the project was not anticipated at the design stage.	1.50	1.87	2.8	37
X42	Accidents during construction	1.61	1.94	3.1	26
X43	Lack of supporting infrastructure	1.77	2.35	4.2	10
X44	Poor communication between relevant government units and the owner.	1.42	2.00	2.8	38
X45	Insufficient investigations and latent conditions.	1.52	2.19	3.3	22

The results of the mean value of probability and impact are plotted in risk matrix in Figure 4.2. The Y-axis can be represented as the mean probability value and the X-axis can be represented as the mean impact value. The matrix shows that the most significant factor is the unexpected inclement weather and its level is in moderate level.

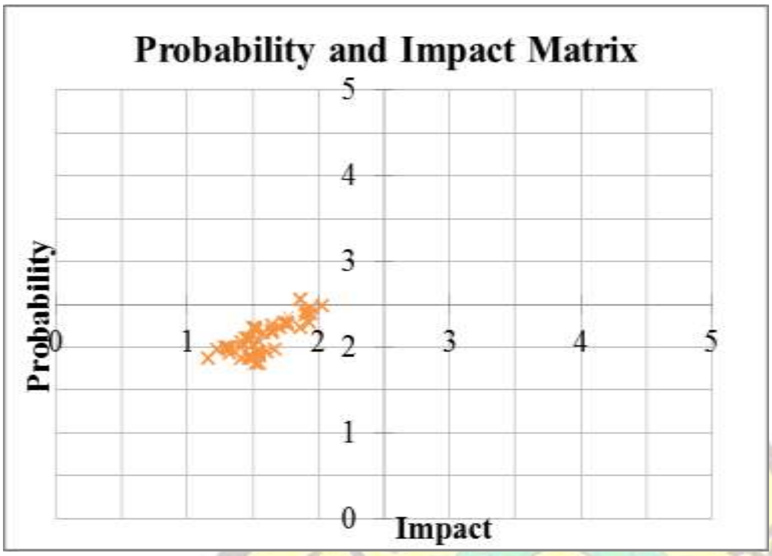

Figure .4.2 probability and impact matrix

The 27 factors are classified as moderate risk (both the values of risk probability and impact are greater than 2 and lower than 3), which accounts for 60 % of all the 45 risk factors. They are (1) unexpected inclement weather, (2) unpredicted technical problems in construction, (3) poor quality of work, (4) inflation and sudden changes in prices, (5) low productivity of labor and equipment, (6) organization and coordination risk, (7) operation cost overrun, (8) Subcontractors' poor performance, (9) shortage in equipment availability, (10) Lack of supporting infrastructure, (11) delay of material supply by supplier, (12) contractors' incompetence, (13) did not meet prevailing dam designs, (14) drawings and documents are not issued on time, (15) shortage in material supply and availability, (16) shortage in manpower supply and availability, (17) unforeseen site conditions, (18) defective design, (19) delays in resolving contractual issues, (20) Corruption and bribes, (21) insufficient investigations and latent conditions, (22) delays in resolving disputes, (23) adequate inspections independent of the owner/contractor were absent during the Dam's construction, (24) Estimating error, (25) subcontractors' breach of contracts and disputes, (26) owner's delayed payment to contractors and (27) changes in laws and regulations.

The 42 factors are determined to mitigate and the 3 factors are determined to avoid and accept by the respondents as shown in Table 4.

Table 4 Risk Response

Risk factor no	Identified Risk Factors	Avoid	Transfer	Mitigate	Accept	Total number of respondents	The risk allocation
X1	Owners's delayed payment to contractors.	8	0	20	3	31	mitigate

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Risk factor no	Identified Risk Factors	Avoid	Transfer	Mitigate	Accept	Total number of respondents	The risk allocation
X2	Owners's unreasonably imposed tight schedule.	9	0	20	2	31	mitigate
X3	Lack of scope of work definition by owner.	11	0	18	2	31	mitigate
X4	Owner's breach of contracts and disputes.	13	1	16	1	31	mitigate
X5	Adequate inspections independent of the owner/contract or were absent during the Dam's construction.	14	5	10	1	30	avoid
X6	Contractors' incompetence	6	9	15	1	31	Mitigate
X7	Subcontractors' poor performance	7	2	21	1	31	Mitigate
X8	Subcontractors' breach of contracts and disputes.	15	1	15	0	31	Avoid and mitigate
X9	The contractor misuses variations instructions.	8	2	19	2	31	Mitigate
X10	Contractor bears any unforeseen design development risks.	1	4	25	1	31	Mitigate
X11	Did not meet prevailing dam	12	2	16	1	31	Mitigate

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Risk factor no	Identified Risk Factors	Avoid	Transfer	Mitigate	Accept	Total number of respondents	The risk allocation
	designs.						
X12	Defective design	4	2	24	1	31	Mitigate
X13	Frequent changes in design by designer.	11	2	17	1	31	Mitigate
X14	Deficiencies in drawings and specifications .	4	1	25	1	31	Mitigate
X15	Drawings and documents are not issued on time .	4	2	24	1	31	Mitigate
X16	Delays in approval	3	1	26	0	30	Mitigate
X17	Deficient documentation	5	0	25	1	31	Mitigate
X18	Changes in laws and regulations	6	3	10	11	30	Accept
X19	Imperfect law and supervision system	11	2	17	1	31	Mitigate

According to the result of risk ranking order, the most significant ten risk factors are selected to allocate the responsibilities of owner or contractor. The effects of each factor are required to reduce or to mitigate with the strategies. Firstly the selected most significant factors are allocated to owner and contractor as shown in Table 5.

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Table 4.7 Risk Allocation to Owner and Contractor

Risk Rank	Identified Risks	Risk rating = P X I	Owner (Government)	Contractor (Company)	Response
1	Unexpected inclement weather.	5	*	*	Mitigate
2	Unpredicted technical problems in construction.	4.8	*		Mitigate
3	Poor quality of work.	4.8		*	Mitigate
4	Inflation and sudden changes in prices	4.8	*	*	Mitigate
5	Low productivity of labor and equipment.	4.6	*	*	Mitigate
6	Organization and coordination risk	4.6	*	*	Mitigate
7	Operation cost overrun	4.5		*	Mitigate
8	Subcontractors' poor performance	4.4		*	Mitigate
9	Shortage in equipment availability.	4.2	*	*	Mitigate
10	Lack of supporting infrastructure	4.2	*		Mitigate

The most significant factor is "Unexpected inclement weather" and it is allocated to mitigate by owner and contractor. The broadcasting of weather forecast should be aware and distributed to know all participants. The second risk is "Unpredicted technical problems in construction" and it may occur because of the uniqueness of the project or unfamiliarity of the contractor with this type of project. To mitigate this risk, the technical requirements should be prepared in design stage and this should be undertaken by the owner. The third risk is "Poor quality of work" which is directly related to the performance and supervision of contractor. Therefore the contractor should undertake to mitigate this risk and to reduce the unawareness and the uncertainty of the operation work. The contractor have to study the machine norm which is including the project estimate and perform to get the specified outputs according to the standard specifications of estimate for each machine such as tractor, backhoe, dump truck, tipper and so on.

The fourth risk is "Inflation and sudden changes in prices"and this risk can be found in Myanmar every year therefore the cost of estimate has to be revised every year. Labor price changes, material price changes and fuel price changes are the major effects to change the estimate's cost. Therefore the mitigation of this risk has been undertaken by the owner and contractor. The fifth risk is "Low Productivity of labor and equipment". Maintenance of machines and equipment make the activity delay. The lack of the labor's perseverance, the lack of labor's experience and knowledge with the project and lack of supervision by contractor cannot produce the required output. The contractor has the full responsibility to mitigate (1) by using the skilled labor, (2) by substituting the new labor instead of the labor that are tired or cannot work due to the loss of energy and (3) by the observation of contractor.

The sixth risk is "Organization and coordination risk" which may occur among the government organization participants or among the company's participants or among the government organization and the companies. To mitigate this risk, the government organization and the companies have to cooperate. The "operation cost overrun" risk and the "subcontractors' poor performance" are directly related to the contractor's lack of proper training and experience on project management, unskilled manpower and complexity of works. These are economic risk and it has to be only mitigated by contractor. The ninth risk is "shortage in equipment availability". The type of dam construction is completely depending on the workability of equipment through the whole project life cycle. To mitigate this risk, the owner and contractor have to help each other in construction site and the cooperation of owner and contractor is easy to tackle it. The final risk is "Lack of Supporting Infrastructure" and it is the fully responsibility of the owner or the departmental organization. The owner has to create the suitable infrastructure for the contractors.

Conclusion

Depending on the documentation reviews and site reports and historical data, 45 risks are issued to identify probability and impact, and to response the significant risk factors. According to the experts' response, the most significant factor is "Unexpected inclement weather" and their mean probability value and impact value are 2.03 and 2.48. The most significant factor for dam construction project in Myanmar is the natural risk group and the total score of risk is 5. As the result of risk response, the 45 risk factors are allocated by the views of academic engineers. Except three factors, the other 42 factors are agreed to mitigate by respondents. The first stage of risk assessment has been done by questionnaire survey method. For performing construction activities, this risk assessment can be used as a tool. The prioritized risks that have been analyzed in the qualitative risk analysis process can be carried out to perform quantitative risk analysis process because the quantitative risk analysis is the process of numerically analyzing the effect of identified risks on overall project objectives.

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