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An Assessment Model for Risk Management Capabilities in Infrastructure (RMC Model)

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ABSTRACT: Infrastructure projects are crucial to the economy of any country, especially developing ones such as Egypt and most African countries. According to the World Bank, a 10 % rise in infrastructure assets directly increases GDP by up to 1 percentage point. There are many aspects to consider when dealing with infrastructure projects such as unique characteristics, complexity, risk, public safety, financial difficulty etc. The main issue is the contractor is burdened by and carries the risks involved in this type of project. The contractor's risk management capability (RMC) reflects his team's expertise of risk understanding and how he can manage those risks. Hence, proper assessment of RMC may contribute to the probability of achieving project objectives. In addition, assessment of the client's risk management capability (client risk sharing) can support the RMC. The objectives of this study are: (1) to identify appropriate indices to assess the RMC of the contractor's infrastructure project; (2) to develop appropriate weightings for each index; (3) to develop an RMC assessment model for infrastructure project contractors and (4) to assess the current overall RMC of infrastructure project contractors. The contractor risk management capabilities (RMC) are categorized in three categories: (1) risk identification and assessment approaches, (2) risk response approaches (3) risk control strategy. Each RMC in the three categories is assessed with respect to each project's objective including cost, duration, quality, scope and any additional objective according to the client, project characteristics. These objectives reflect the client's capacity and willingness to share the risk.

KEYWORDS: Risk Management; Contractor Capabilities; Assessment; AHP; Infrastructure

I. INTRODUCTION

Worldwide, construction works are considered a major sign of economic growth. For example, in developing countries, investments into the transportation infrastructure (construction and maintenance of roads, railways, etc.) vary from 0.5% to 1.5% of the GDP; by Beckers, et al., [1], U.S. Department of transportation [2] and International Transport Forum – OECD [3]. In developing countries, the share of the GDP may be significantly higher, up to 6% by UN ESCAP, [4]. When including also water, energy and communication infrastructure, the global investments to infrastructure are assessed roughly as 2.5% of the world GDP in [5]. According Beckers, *et al.*, [1] "the World Bank estimates that Africa needs to invest US $93 billion per year to close its infrastructure gap, of which just under half is currently financed, with major sources being African governments, multilateral and bilateral sources of finance". According to the World Bank [6] the term infrastructure comprises a range of facilities, from public utilities such as water supply, sanitation and sewerage, solid waste collection and disposal, piped gas, and telecommunications; to public works such as urban transport, roads, railways, canal works, ports and waterways, and dam and airports. Infrastructure projects are the kind of projects which gain public support, in which government policy has an important role to influence the effects of the project on economic development and social needs by Liyin [7]. The World Bank estimates that a 10 % rise in infrastructure assets directly increases GDP by up to 1 percentage, Calderon, *et al.*, [8]. Hence, developments of infrastructure projects play a significant role in economic development and advancement in any country. Failure to achieve project objectives and failure to efficiently execute the project affects the project's stakeholders as well as policy makers, lenders, executing agencies, consultants and contractors directly involved in the project as well as the country's GDP. All projects involve risk—the zero risk projects are not worth pursuing as

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illustrated by Chris and Stephen [9]. Large infrastructure construction projects are prone to risks according to Feng, *et al.*, [10]. The basic issue in risk assessment is to identify who owes the risk or whom risks are being identified with and assessed. Infrastructure projects as construction projects have different parties take part in risks with different percentages of the share. Generally, project owners or consultants take responsibility for some of the risks, but the contractor is responsible for most of the risk. Irrespective who owns the risks, the most important issue is to have an accurate and effective risk assessment.

II. INFRASTRUCTURE PROJECTS AND RISKS ASSOCIATED

The construction industry is facing more and high risks compared with many other industries, due to the its private complexities, unique features of construction activities, such as long period, complicated processes, abominable environment, financial intensity and dynamic organization structures by Naumani and Tsegay [11]. These complexities and unique features of construction activities are more recognized in infrastructure projects. These complexities create multiple risks that have a great effect on achieving project objectives. For example, the occurrence of unexpected events such as natural disasters, uncertainty about weather conditions, unforeseen site conditions, material and equipment delivery delays and equipment breakdown are typical risk variables that exist in the most of construction projects. As a result, many projects fail to achieve their objectives such as time, cost, quality and scope. Hence, taking effective risk management techniques to manage risks associated with variable construction activities has never been more important for the successful delivery of a project. Volker, et al., [12] illustrates the main characteristics of infrastructure and implications for the asset management system by eight characteristics.

The main characteristics that are related to risk include: (1) a very long lifespan which has uncertainty about future directions as system implication and (2) owners, manager and operators usually not users which has different interests and responsibilities, (3) widely distributed which make the identification of all risks very hard. In addition, owners, manager and operators usually not users as well as, users often anonymous which lead to different interests and responsibilities and very little control over use.

The major problem in large infrastructure projects is the high level of misinformation about costs and benefits that decision makers face in deciding whether to build, and the high risks such misinformation generates, Flyvbjerg, *et al.* [13]. Omar, *et al.*, [14] showed those infrastructures projects have been identified as a major factor that are contributing in the growth of economies for many countries. The growing complexities of modern construction projects consume a huge amount of construction capital and efficient coordination. Thus, the facilitation of project management aspects should be handled with great care. Otherwise, infrastructure project will tend to be cost overruns and benefit shortfalls. Frank Beckers, et al., [1] reported that large infrastructure projects suffer from significant under management of risk in practically all stages of the value chain and throughout the life cycle of a project. In particular, poor risk assessment and risk allocation.

Large scale infrastructure construction projects are associate with a lot of uncertainties. This is due to the fact that unforeseen and unrecognizable changes in the project environment will cause the result to be unanticipated [15]. In addition, according to Akkirajul, *et. al.,* [20] the riskiness is more severe in the cases where projects are one-off, large and complex due to high level of technical uncertainties. Loves P. E., *et al.*, [16] illustrated in his study that infrastructure projects are prone to cost and time overruns and often fail to meet stakeholder expectations.

III. RISK IDENTIFICATION OF INFRASTRUCTURE PROJECTS

From the perspectives of AI-Bahar [17] and Craciun [18] there are nine categories of risks that confront any construction and infrastructure development projects. They are follows, technical risks, construction risks, operation risks, revenue risks, financial/expenditure risks, force majeure risks, regulatory/political risks, environmental risks, and project default risks. Expenditure and financial risks are very crucial from the beginning to end of the entire stages of infrastructure development projects.

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Askar, & Gab-Allah, [19] surveyed the major risks that are facing the infrastructure projects and they identified these risks which include: Political risks, Termination of concession by government, Increase in taxes, Changes in law, Construction risks; Cost overrun, Land expropriation, Increases in financing costs, Variations, and time and quality risks, operating risks; Termination by project company, Government department default, and Project company default and market and revenue risks; Monopoly, insufficient tariff, and insufficient income.

El-Dash, and Abdul Monem, [20] in infrastructure projects, identified the source of risks by three risks. The first was the capital flow that controls the progress of the project. Where, the investors are willing to provide capital for the project if the owner include compensation for the expected level of risks during the investment period. The second source of risk is the long term financing which is dependent on the allocated budget mainly from the government. Medium and long term financing represents a great risk that intimidates most of large projects and infrastructure projects. The third source of risk in this set is the delayed payment which is related to government as well as private sector.

Keith. *et al*. [21] conducted a program study to identify practices that might be evaluated and applied in the United States to improve construction management. Their report was developed as part of the scan implementation plan to help raise awareness of risk management techniques and to begin the process of incorporating elements of risk management into the institutional structures of Department of Transportations. They identified the sources of risks which included:

(i) Performance, scope, quality, or technology issues,
(ii) Environment, safety, and health concerns,
(iii) Scope, cost, and schedule uncertainty, and
(iv) Political concerns.

Akkirajul, *et al.* [22] argued that enterprise RMC means the process, data, tools and the culture in the organization that enables one to manage risks. Hopkinson, [23] indicated that assessing RMC can help identify the strengths and weaknesses of the organization and can also identify areas needing improvement.

IV. CONTRACTOR RISK MANAGEMENT CAPABILITIES

Wang, *et al.*, [24] indicated that RM is a formal and orderly process of systematically identifying, analyzing and responding to risks throughout the lifecycle of a project to obtain the optimum degree of risk elimination, mitigation and/or control. Contractor's risk management capability (RMC) reflects the sophistication of contractor's understanding of risk portfolio and how to manage those risks [25]. Assessing the current RMC of construction organizations can be used to identify the priority or weakest areas needed for improvement and actions can be taken to increase the performance [26].

The Risk management capabilities of a contractor in infrastructure projects can be identified via proper review and analysis of critical factors which contribute to the achievement of a project's objectives. Revision and analysis of these critical factors are carried out to develop measures for assessment of the contractor's risk management capabilities. An evaluation model to assess the contractor's risk management capabilities is developed in this study incorporating the developed measures and other criteria which impact the evaluation process and are related to the project's characteristics. These criteria should be implemented for each project separately according to the common role of construction projects which indicate that any construction project is unique. (PMI definition). Analytical Hierarchy Process (AHP) [27] technique is used to develop the RMC assessment model.

CRITICAL FACTORS CONTRIBUTING IN THE ACHIEVEMENT OF PROJECT'S OBJECTIVES

Tentatively, risks can be measured by their potential effect on achievement of project objectives where, there is logically an intimate link between risk management capability and projects' success. Risk management capability (RMC) reflects the sophistication of an organization's understanding of its risk portfolio and how to manage those risks (Zou et al, 2010). An assessment of the contractor's risk management capabilities and modeling them can provide a framework for defining and selecting procedure to which extent a project owner can share in project's risks.

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CONTRACTOR WILLINGNESS TO HANDLE RISK

The highest ranked factor for project failure was poor project planning which means that risks were not or inadequately addressed as part of the project planning process, or the risk management plan was weak. The contractor willingness may be assessed either during the tendering stage or during the mobilization of the project. The key elements of risk management planning which measure the contractor willingness to handle risk may include:

- Have intention to take part in sharing risks
- Define risk parameter.
- Introduce risk management Plan.
- Team members are familiar with RM process and methods
- Introduce RM control policy

CONTRACTOR'S RISK MANAGEMENT RESOURCES

- Naming risk's team members
- Resources devoted to projects in accordance to the severity of risk events identified.
- Allocate risk management responsibilities.
- Top management support and encourage risk management (basically every member is responsible for managing risk).

CONTRACTOR'S Risk Identification Policy and Procedure

- Have risk register plan for previous projects
- Introduce risk checklist for project under consideration
- Risk identification approach (which common method is used)
- Potential risks could be identified for project under consideration
- Actual risks found are compared against initial identified risks

CONTRACTOR'S RISK ASSESSMENT AND ANALYSIS TOOLS AND PROCEDURE

- The probability and severity of all risks could be assessed
- A systematic quantitative and qualitative assessment and analysis method are used
- Every member grasps risk assessment and analysis skills
- An automated system is used for risk assessment and analysis

CONTRACTOR'S RISK RESPONSE CAPABILITIES

- Response plan for negative risk impacts (avoided, transferred, mitigated, accepted)
- Response plan for positive risk impacts (exploited, enhanced)
- A systematic response method is used
- Every member grasps effective risk response method
- Appropriate measures are taken for reducing different risks

RISK MONITOR AND CONTROL POLICY

- Periodic evaluation is carried out
- RM process is standardized
- Risks are consistently identified, assessed, analyzed, and responded via the project life cycle.
- RM process is merged into daily management process of the organization
- RM process is often reviewed to ensure its applicability

The objectives of this paper are: (1) to identify appropriate indices to assess the RMC of contractor's infrastructure project; (2) to develop appropriate weightings for each index; (3) to develop a RMC assessment model for infrastructure project contractors and (4) to assess the current overall RMC of infrastructure project contractors.

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V. PROJECT'S OWNER CAPABILITIES TO SHARE RISK

Most previous studies in construction project risk management have been focusing on the factors contributing to the success of risk management, but little attention was given to factors significantly affecting decision makers' risk attitudes in construction projects by Wang, and Yuan [28]. Muhammad N. and Awetahgn [11] in their study of Clients' Capabilities to managing Major Infrastructure Construction Projects in Sweden, illustrated that public clients are considered to have poor management skills, risks handling, and over dependency on contract documents and adversarial relationship with other participants in the projects. Infrastructure projects are prone to cost and time overruns and often fail to meet stakeholder expectations ([11], [28], [29], [30], [31], [32] and [33]). Practically, not all clients are considered equal in their willingness to handle their project risks. Some clients have engineers with professional management skills or have project management consultant. This means that such clients can share in their project's risks.

To what extent the client may share in their project risks? This question should be answered before the assessment of contractor risk management capability for deciding the relative important of CRCM elements in achieving project objectives. For example, in case of incomplete design, the client or his consultant will select remunerable contract to avoid the risk of varied work items quantities and hence it will have reflected in the relative importance of the contractor risk management capability element that is related to project cost, time, quality, scope and other objectives. Another example, financial risks are the focus when discussing a contractor's risks capability. Buying insurance risks are the instruments of contractor varied risk management. Hence, in the basis of the client financial capability and strategy, the contractor's financial capability and its risk is assessed. Therefore, all contractor risk management capabilities are assessed and their relative of importance can identified for each project with respect to each project objective accordingly.

VI. ASSESSMENT MODEL FOR CMRC WITH RESPECT TO PROJECT OBJECTIVE

The concept of the assessment model for contractor risk management capability (RMC) as shown in Figure 1 is based on:

1. Performing the assessment of project objectives to identify their relative of importance from the client prospective, as shown in Figure 2. This will reflect the client risk share according to his capabilities and project conditions.

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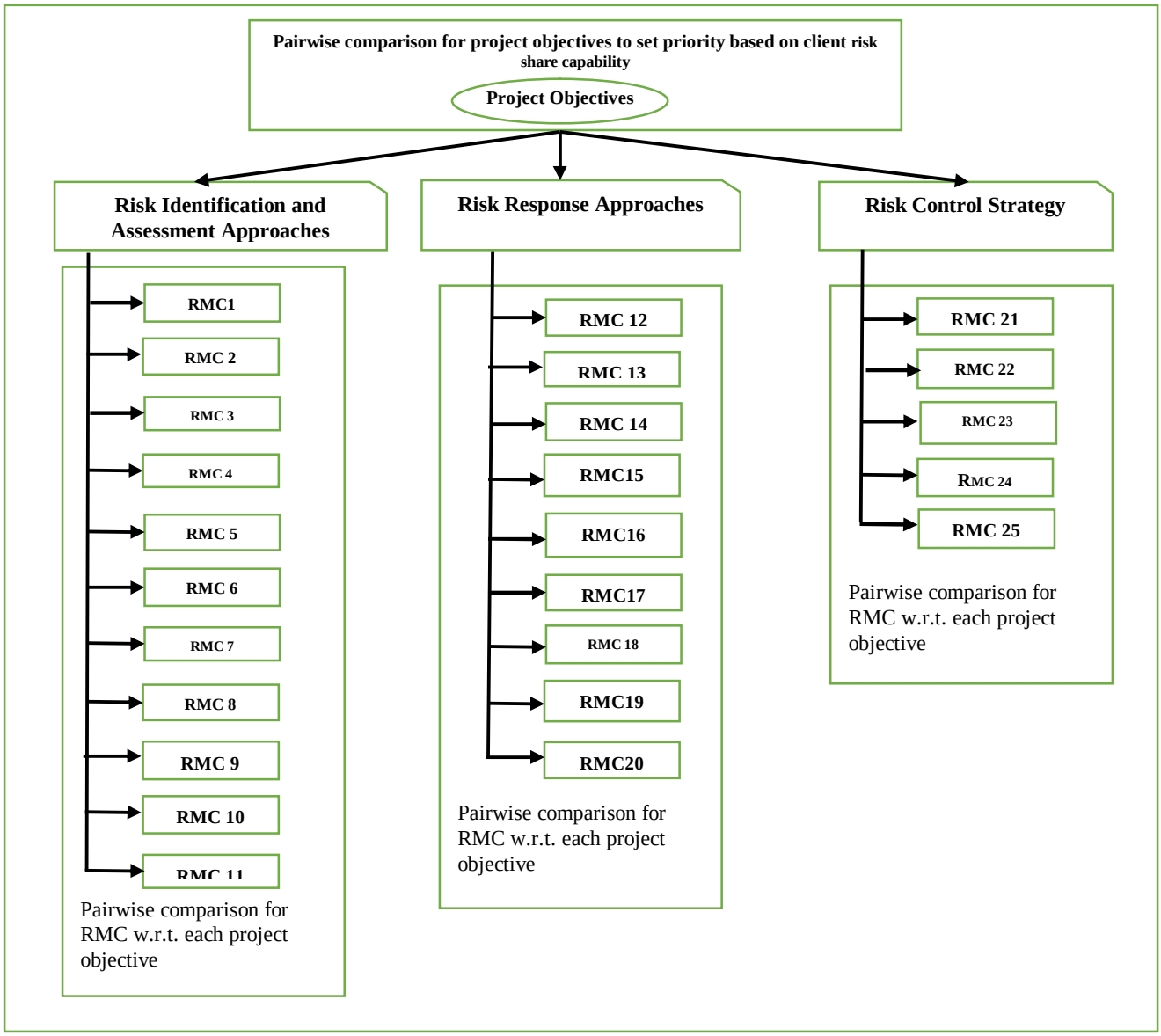

2. Each RMC element included in each category as shown in Tables 1, 2 and 3, is assessed with respect to each project objective. This step is carried out, for example in the first category of Table 1, by performing pair comparison of the 11 RMC with respect to cost objective using AHP method, then for time objective and so on. The AHP models are developed using EXCEL. Sample of pairwise comparison for project objectives to set their priorities is shown in Figure 2.

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Element No.	Contractor Risk Management Capability Elements	Index Measures				
		5	4	3	2	1
RMC 1	Identification of important project success parameters	Done/ List	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 2	Use of Checklists/Forms/Risk Registers	Done/ List	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 3	Develop Plan to Manage Risk	Done/	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 4	Formation of Risk Quantification Team	Done/	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 5	Rating relevance of every risk with all selected success	Done/	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 6	Expert Input	Done/ List	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 7	Analytical or Descriptive Statistics Methods for the probability	Done/	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 8	Decision Tree Analysis and/or Expected Monetary Value	Done/	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 9	Simulation with Team	Done/	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 10	Formal Brainstorming with Team	Done/ List	Will do	Recorded in similar	Aware/ Not	Nothing
RMC 11	Risks screening for selection of critical/ significant risks	Done/ List	Will do	Recorded in similar	Aware/ Not	Nothing

Table 1: ***Contractor Risk Management Capability Elements***

Table 2: RMC for RISK RESPONSE APPROACHES

Element No.	Contractor Risk Management Capability Elements	Index Measures				
		5	4	3	2	1
RMC 12	Contingency Planning	Done/ Plan	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 13	Regular Risk Meetings within project progress meetings	Done/. Minutes	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 14	Tracking Risk Indices in construction phase as a part of project control system	Performed	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 15	Risk Prioritization	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 16	Special Teams to Monitor	Done/ Team	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 17	Mitigate Risk throughout Project Lifecycle	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 18	Transfer Risk throughout Project Lifecycle	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 19	Exploit or Enhancement of Risk throughout Project Lifecycle	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 20	Continuity of Risk Management throughout Project Lifecycle	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done

Table 3: RMC for RISK CONTROLSTRATEGY

Element No.	Contractor Risk Management Capability Elements	Index Measures				
		5	4	3	2	1
RMC 21	Periodic evaluation is carried out	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 22	RM process is steady	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 23	Risks are consistently identified, assessed, analyzed, and responded throughout the project life cycle.	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 24	RM process is merged into daily management process of the organization	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done
RMC 25	RM process is often reviewed to ensure its applicability	Done/ Reports	Will do	Recorded in similar Projects	Aware/ Not done	Nothing done

Project	Project	Project	Project	Project	Additional
Project Cost	1.00	2.00	1.00	4.00	5.00
Project Time	0.50	1.00	0.70	2.50	4.00
Project Quality	1.00	1.43	1.00	5.00	4.00
Project Scope	0.25	0.40	0.20	1.00	1.25
Additional Objective	0.20	0.25	0.25	0.80	1.00
COL. TOTAL	2.95	5.08	3.15	13.3	15.25
COL. TOTAL	34%	21%	32%	8%	6%

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Project Cost	34%
Project Time	21%
Project Quality	32%
Project Scope	8%
Additional Obj.1 Objective	6%

Figure 2: Example for Pair comparison of Project Objectives to set their relative importance

3. Sum up the assessment of each RMC w.r.t. each project objective to set out the RMC priority list which has great significant on project success, as shown in Figures 3.a to 3e.

Then, the RMC elements per each category as shown in Tables 2, 3 and 4 are assessed using AHP method for each project objective. The AHP models are developed using Excel. Sample of pairwise comparison for project objectives to set their priorities is shown in Figure 2.

The relative importance of project objectives is identified according to the client and project conditions using pair comparison as shown in Figure 2.

Project Cost	RMC 21	RMC 22	RMC 23	RMC 24	RMC 25
RMC 21	1.00	0.50	1.25	0.80	0.75
RMC 22	2.00	1.00	2.50	2.00	2.00
RMC 23	0.80	0.40	1.00	1.50	1.60
RMC 24	1.25	0.50	0.67	1.00	0.80
RMC 25	1.33	0.50	0.63	1.25	1.00
COL. TOTAL	6.38	2.90	6.04	6.55	6.15
COL. TOTAL %	16%	34%	18%	15%	17%

RMC 21	RMC 22	RMC 23	RMC 24	RMC 25	
0.157	0.17	0.21	0.12	0.12	16%
0.313	0.35	0.41	0.31	0.33	34%
0.125	0.14	0.17	0.23	0.26	18%
0.196	0.17	0.11	0.15	0.13	15%
0.209	0.17	0.10	0.19	0.16	17%
					100%

Figure 3.a: Pairwise comparison for RMC of third category w.r.t. Project Cost's objective

Project Time	RMC 21	RMC 22	RMC 23	RMC 24	RMC 25
RMC 21	1.00	0.80	2.00	3.00	5.00
RMC 22	1.25	1.00	2.50	4.00	6.00
RMC 23	0.50	0.40	1.00	2.00	3.00
RMC 24	0.33	0.25	0.50	1.00	2.00
RMC 25	0.20	0.17	0.33	0.50	1.00
COL. TOTAL	3.28	2.62	6.33	10.50	17.00
COL. TOTAL %	30%	38%	17%	10%	6%

RMC 21	RMC 22	RMC 23	RMC 24	RMC 25	
0.31	0.31	0.32	0.29	0.29	30%
0.38	0.38	0.40	0.38	0.35	38%
0.15	0.15	0.16	0.19	0.18	17%
0.10	0.10	0.08	0.10	0.12	10%
0.06	0.06	0.05	0.05	0.06	6%
100%	100%	100%	100%	100%	100%

Figure 3.b: Pairwise comparison for RMC of third category w.r.t. Project Time's objective

Project Quality	RMC 21	RMC 22	RMC 23	RMC 24	RMC 25
RMC 21	1.00	1.25	3.00	2.00	4.00
RMC 22	0.80	1.00	4.00	3.00	5.00
RMC 23	0.33	0.25	1.00	2.50	2.00
RMC 24	0.50	0.33	0.40	1.00	5.00
RMC 25	0.25	0.20	0.50	0.20	1.00
COL. TOTAL	2.88	3.03	8.90	8.70	17.00
COL. TOTAL %	31%	34%	14%	15%	6%

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RMC 21	RMC 22	RMC 23	RMC 24	RMC 25	
0.347	0.41	0.34	0.23	0.24	31%
0.277	0.33	0.45	0.35	0.29	34%
0.116	0.08	0.11	0.29	0.12	14%
0.173	0.11	0.05	0.12	0.29	15%
0.087	0.07	0.06	0.02	0.06	6%
100%	100%	100%	100%	100%	100%

Figure 3.c: Pairwise comparison for RMC of third category w.r.t. Project Quality's objective

Project Scope	RMC 21	RMC 22	RMC 23	RMC 24	RMC 25
RMC 21	1.00	1.00	1.25	2.00	3.00
RMC 22	1.00	1.00	1.50	2.00	4.00
RMC 23	0.80	0.67	1.00	1.60	5.00
RMC 24	0.50	0.50	0.63	1.00	7.00
RMC 25	0.33	0.25	0.20	0.14	1.00
COL. TOTAL	3.63	3.42	4.58	6.74	20.00
COL. TOTAL %	26%	28%	22%	18%	6%

RMC 21	RMC 22	RMC 23	RMC 24	RMC 25	
0.28	0.29	0.27	0.30	0.15	26%
0.28	0.29	0.33	0.30	0.20	28%
0.22	0.20	0.22	0.24	0.25	22%
0.14	0.15	0.14	0.15	0.35	18%
0.092	0.07	0.04	0.02	0.05	6%
100%	100%	100%	100%	100%	100%

Figure 3.d: Pairwise comparison for RMC of third category w.r.t. Project Scope's objective

Additional	RMC 21	RMC 22	RMC 23	RMC 24	RMC 25
RMC 21	1.00	1.00	1.00	1.00	1.00
RMC 22	1.00	1.00	1.00	1.00	1.00
RMC 23	1.00	1.00	1.00	1.00	1.00
RMC 24	1.00	1.00	1.00	1.00	1.00
RMC 25	1.00	1.00	1.00	1.00	1.00
COL.	5.00	5.00	5.00	5.00	5.00
COL.	20%	20%	20%	20%	20%

RMC 21	RMC 22	RMC 23	RMC 24	RMC 25	
0.20	0.20	0.20	0.20	0.20	20%
0.20	0.20	0.20	0.20	0.20	20%
0.20	0.20	0.20	0.20	0.20	20%
0.20	0.20	0.20	0.20	0.20	20%
0.20	0.20	0.20	0.20	0.20	20%
					100%

	Project Cost	Project Time	Project Quality	Project Scope	Additional Objective1	
	34%	21%	32%	8%	6%	
RMC 21	16%	30%	31%	26%	20%	25%
RMC 22	34%	38%	34%	28%	20%	33%
RMC 23	18%	17%	14%	22%	20%	17%
RMC 24	15%	10%	15%	18%	20%	14%
RMC 25	17%	6%	6%	6%	20%	10%
	100%	100%	100%	100%	100%	100%

RMC Elements	
RMC 22	33%
RMC 21	25%
RMC 23	17%
RMC 24	14%
RMC 25	10%

Figure 3.e: Setting the RMC list of priority with respect to all project objectives and Priority List of RMC in 3rd Category

CONTRACTOR'S RISK MANAGEMENT CAPABILITIES INDICES

RMC FOR WILLINGNESS TO HANDLE, IDENTIFY AND ASSESS

Different risk identification and assessment approaches may have implemented by the contractor. Indices that may be used for RMC to identify risk and in their assessment approaches include the following:

- Identification of important project success parameters
- Use of Checklists/Forms/Risk Registers

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- Develop Plan to Manage Risk
- Formation of Risk Quantification Team
- Rating relevance of every risk with all selected success parameters
- Expert Input
- Analytical or Descriptive Statistics Methods for the probability and consequence of each risk with Team
- Decision Tree Analysis and/or Expected Monetary Value Analysis (EMV) with Team
- Simulation with Team
- Formal Brainstorming with Team
- Risks screening for selection of critical/ significant risks

RMC for RISK RESPONSE APPROACHES

- Contingency Planning
- Regular Risk Meetings within project progress meetings
- Tracking Risk Indices in construction phase as a part of project control system
- Risk Prioritization
- Special Teams to Monitor/Mitigate Risk throughout Project Lifecycle

The second sets of measures to assess the risk response approach which can illustrate the risk management capabilities for the contractor are illustrated in table 3.

RMC for RISK CONTROL STRATEGY

Last set of measures to assess the contractor risk management capability to control risk is illustrated in Table 1.

RMC INDICES MEASURES

Different measurements can be implemented to assess the risk indices as illustrated in table 2 for the contractor risk management capabilities (RMC) for risk identification and assessment approaches. Tables 2, 3 and 4 have different measures for each risk management capability. Done measure means that the capability is done by the contractor and he introduces either a list, or a report or any approval for that action done. Will do means that the contractor has the intention to do and support his intention with plan, report or strategy. Records in similar project for that work which are done in project similar to project under consideration. If the contractor is not doing anything and has no record in previous similar projects, the measure is low or 1. The last measure is that the contractor has nothing to do and have no awareness about risk management.

SETTING PRIORITIES FOR RMC USING ANALYTICAL HEIRARCHY PROCESS

Decision of setting priorities to the contractor risk management capabilities (RMC) with respect to the project's objectives involve many intangibles that need to be traded off, Ibrahim, *et al* [33]. To do that, they have to be measured alongside tangibles whose measurements must also be evaluated as to, how well; they serve the objectives of the decision maker. The Analytic Hierarchy Process (AHP) is a theory of measurement through pairwise comparisons and relies on the judgements of experts to derive priority scales by Saaty [27]. It is these scales that measure intangibles in relative terms. The comparisons are made using a scale of absolute judgements that represents how much more; one element dominates another with respect to a given attribute [27]. A scale of numbers is required to make comparisons that indicate how many times more important or dominant one element over another element with respect to the criterion or property with respect to which they are compared. Likert style rating questions, using a five-point scale, were used to elicit respondents' opinions of the importance of each nominated variable. The scale intervals are interpreted as shown in table 4. Table 4 indicates the Likert scale that can use as measure scale While, Table 5 illustrate the fundamental scale of absolute numbers that are used for AHP method. This scale is showing the intensity of importance. Then, another set of pairwise comparison for all element of RMC in each category with respect to each project objective, sample of RMC assessment with respect to project objectives, using EXCEL© are shown in Figure 3.a, to Figure 3.f.

Table 4: Likert Scale

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Intensity of Importance	Likert Scale
Not important	1
Fairly important	2
Important	3
Very important	4
Extremely important	5

VII. CONCLUSIONS

The contractor's risk management capability (RMC) can reflect the contractor's understanding of risk and the expertise how he will manage those risks. Therefore, proper assessment of the contractor's risk management capacity (RMC) can contribute to the increase of the probability of achieving project objectives. Proper assessment of client risk share capability is important to determine the extent of which RMC can be assessed. This means that the probability of achieving project objectives increases when the client and his consultant assess the contractor's capability rather than simply delegating the risk or exposure to the contractor. Classifying the RMC into three categories and carrying out the assessment according to the model in Figure 1 leads to setting the standard of capabilities that a contractor should meet in order to manage the project risks properly. The contractor's risk management capabilities (RMC) are categorized into three categories: (1) risk identification and assessment approaches, (2) risk response approaches (3) risk control strategy. Each RMC in the three categories is assessed with respect to each project objective such as cost, duration, quality, scope and any additional objective according to the client and project conditions and characteristics. These objectives reflect the client's capacity and willingness to share the risk. The model developed can be implemented in the evaluation of RMC either during project delivery and procurement or during the construction. This process can be carried out by assessing the level of importance of RMC with respect to objectives according to the project life cycle phase.

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