Evaluation of Risk Management Practices in Construction Projects in Rwanda

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Abstract*: *This research found that the Rwanda construction Industry is faced with critical risk management practices on construction projects. This evaluation has identified the high likelihood of construction failures that fall under logistics, physical, construction, subcontractors, and design related factors. Risks wither remedial or by mitigation associated with the criteria of risk factors are frequently averaged, and certainly used to identify some risk factors it does not identify all of the problems that can result in failure. Similarly, the findings indicate that the most common used analysis techniques were expert systems which include software package, decision support system and computer-based analyses techniques, direct judgement using experience and personal skills, transfer or sharing risk to/with other parts and comparing analysis which means comparing similar projects with similar conditions.

Index Terms*: *Risk management, Risk remedial, Risk Mitigation, Risk analysis techniques.

I. INTRODUCTION

Rwanda is one of the least urbanized countries in the world, with an urbanization rate of 29% in 2015. However, the urban population is rapidly growing (5.9% annually), making it above average in Sub-Saharan Africa(4.2%) and globally(2.1%), resulting in a shortage of housing [1]. The study shows that, since 2010-2015, the construction industry is the fastest growing industry sector accounting for 7.1% of GDP. This sector grew at an average of 9.3% annually, outperforming the overall economy at 7% [2]. Every construction project certainly has risks, and that is true of the Rwandan's construction industry, as the majority of the projects fail to meet deadlines, cost and quality targets due to inadequate risk management [3]. This failure is often caused by risk factors that are not anticipated. Thus, evaluating risk management practice will make the project managers recognize risk occurrence, risk influence and the level of their impacts in managing and controlling the most dominant risks as recommended in the report done by REMA[4].

Earlier observation shows that risk management protocols are not widely implemented in the Rwandan construction industry [5]. Normally in project planning to deal with unexpected events there will be an allocation of about 10% of the estimated budget for the proposed construction project as a reserve sum for unexpected threats[3]. But for effective and efficient time management of construction projects it is [4] recommended to evaluate the quality of available data and key data gaps, to establish the level of certainty for decision making. Thus, it is necessary for stakeholders to identify and analyse the main factors influencing risk management that are most likely to be encountered in their running project before starting a construction project[6].

II. BACKGROUND

This research was initiated based on research[5] previously carried out by Sibomana Amaible, under the title of "Effects of risk management methods on project performance in Rwandan construction industry. This research is conducted for a case study of multi-story building construction projects of RSSB. Under recommendations he suggested further research to be conducted on how using the risk management process impacts delays on public building projects. Additionally, the research project study carried out by Lawrence Mwangi Gitau, titled "The Effects of Risk Management at Project Planning Phase on Performance of Construction Project in Rwanda revealed the level of skills in construction related fields needed to be high, with 85% of the respondents having a degree, however most respondents had not studied risk management. The process of risk management was not adequate and no measures were put in place to mitigate the risks. Consequently, there was an 85.7% occurrence of identified risks. The impact of these risks was quite high and resulted in 10 % to 40% cost variation in 72% of the projects surveyed. To overcome the risks that can occur in a construction project, it is necessary to institute project management protocols that start by identifying risk factors and creating an action plan for handling found risks[7]. This research aims to evaluate risk factors, their level of impact and the frequency of occurrences in construction projects, as well as to evaluate remedial methods used in risk management to assess the mitigation methods, and evaluate risk analysis techniques used in risk management on Rwandan construction project.

Revised Manuscript Received on July 05, 2019.

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III. LITERATURE REVIEW

A. *Construction projects*

The author of [8] indicated that construction projects are projects involving the principles and methods to build a building facilities (office buildings, hospitals, residences and schools) and infrastructure (bridges, roads, and others). A viable construction industry is necessary to continue development and to maintain and meet the needs of facilities and infrastructure. According to [9], every construction project involves a risk. Many construction projects can fail. While the author of [10] insisted that most of the failures or losses in the construction industry are caused by inaccurate decision made or the failure to evaluate the attendant risks.

B. *Risk in Construction projects*

According to [4], risk is can occur because of a series of unfortunate conditions, financially and physically, as a result of decisions taken or as a result of environmental conditions in an activity or project. Risks occur when deviations arise outside of the plan or when something has not been planned for. Furthermore, [11]defines risk as events or factors that the event will increase the likelihood of archiving the project's objectives which are not in accordance with the time, cost and performance. While, the author of [3] defines risk as an uncertain event, if the case has a negative or positive impact on the goals and objectives of the project.

C. *Understanding Risk management*

According to National Research Council [12], Risk management is the process of measuring or assessing risks and developing management strategies. The strategy starts by identifying risks, measuring and determining the amount of risk, then finding ways to deal with these risks. The study of [13] defines Risk management as process carried out by project stakeholder, applied strategically and implemented throughout the project, designed to identify potential events that can affect the project, and implemented to provide adequate assurance, about achieving project goals. Similar to the research [14] that explains project risk management as the process of planning, identifying, analysing, implementing and controlling the risks involved in a project. While the purpose of risk management is to increase the probability of positive influence, and reduce the threat[15].The use of risk management practice that do not use best practices can result in workplace accidents, that can cause disruptions that affect the project in both time and cost and even result in the cessation of all work activities on the project. Current work accident related problems in Rwanda in general are still often overlooked[7].

Risk Identification

Accordingly to[16], Risk Identification consist of Identification and documentation of the risks that may affect the project. While the author of

[17] defines risk identification as assessment process of risks and uncertainties that are carried out systematically and continuously, so that they could be managed in effective manner.

Project risk are marked by factors:

1. Risk impact (events that can happen to the project)
2. The probability of an event (or frequency)
3. Depth (severity) of negative impact of the risks that may result in negative consequences to the project and require risk mitigation[18].

Based on literature review:[16] [19],Most of risk in construction project fall under category of Logistic risks, Technology risks, Physical risks, Construction/implementation risks, Pemissions, Sub-contractor risks, Environmental risks, Legal risks, Design risks, Management risks, Financial and Political criteria for risk factors [19]. The next part described risks categories or criteria and their factors associated with abbreviated letter, V1, V2, V3, V4, V5, V5 and V7 that will represent risk factors under their categories in findings.

***Logistics risks*:** Risk associated with materials

V1: Unavailability of sufficient materials that are needed
V2: Mobilization of resources (materials, tools, personnel's
V3: Submission of samples materials by the contractor is not scheduled
V4: Poor material quality control.

Technology risks: Risk associated with technology.

V1: Knowledge of equipment
V2: Service for damaged equipment
V3: Loss of data of computer software/hardware

Physical risks

V1: Occurrence of accidents because of poor safety procedures
V2: Supplies of defective materials
V3: Varied labour and equipment productivity

Construction risks

V1: Disputes between labours
V2: Changing sequences in construction activity
V3: Non availability of resources
V4: Contractor qualifications and experience
V5: Revision of design
V6: Availability of camp for labours
V7: Change in quantities of work, change in quality of work

Permission risks

V1: In Time work permissions for executing work

Sub-contractor risks

V1: Chances of sub-contractor walk out
V2: Delay in work execution of sub-contractor
V3: Revision of prices

Environmental risks

V1: Adverse weather conditions
V2: Difficulty to access the site
V3: Acts of God

Legal risks

V1: Difficulty to get permits
V2: Ambiguity of work legislations
V3: Legal disputes during the construction phase
V4: Delayed disputes resolutions
V5: No specialized arbitrators to help settle disputes

Design risks

V1: Defective design
V2: Inaccurate quantities
V3: Not coordinated design
V4: Rush design
V5: Awarding the design to unqualified designers

Management risks
V1: Ambiguous planning due to project complexity
V2: Resource management
V3: Changes in management ways
V4: Information unavailability
Financial risks
V1: Financial failure of the contractor
V2: Monopolizing of materials due to closure and other unexpected political conditions
V3: Unmanaged cash flow
V4: Delayed payments on contract
V5: Inflation
Political risks
V1: New government act or legislation
V2: Change of government
V3: Change of government policy
Remedial Method
Accordingly to [10], remedial methods aimed at minimizing the effects of risks through the construction phase. The study presents seven remedial measure actions. These measures were generated based on related research work on risk management practice in construction projects.
V1: Utilize quantitative risk analyses techniques for accurate time
V2: Depend on subjective judgment to produce a proper program
V3: Produce a proper schedule by getting updated project information
V4: Plan alternative methods as stand-by
V5: Consciously adjust for bias risk premium to time estimation
V6: Transfer or share risk to/with other parties
V7: Refer to previous and ongoing similar projects for accurate results.
Risk mitigation
Accordingly to [16] Risk mitigation: identification and documentation of the risks that may affect the project. The author claimed that Risk mitigation is carried out in order to reduce risk. While [20] insisted that Risk mitigation is something that should be done in dealing with risks. For that reason, various types of risk mitigation methods associated with construction projects in Rwanda are identified from previous research and field study.
V1: Increase manpower and/or equipment
V2: Increase the working hours
V3: Change the sequence of work by overlapping activities
V4: Coordinate closely with subcontractors
V5: Close supervision to subordinates for minimizing abortive work
Risk Analysis Techniques
According to [21]Analysis includes methods for prioritizing the identified risks for further action, the results of risk analysis.
Determine the appropriate course of action to pursue. Similar to statement of [22] analysed result are converted into numerical values and analysed to give the required results for the purposes of risk management and improving project delivery among contractors involved in the construction project.
V1: Expert Systems
V2: Probability analysis
V3: Sensitivity analysis
V4: Simulation analysis
V5: Direct judgment using experience and personal skills
V6: Transferring Risk
V7: Comparing analysis

IV. RESEARCH METHODOLOGY

Research methods applied to this study is survey research. Survey research techniques are carried out by capturing opinions or perceptions, experiences, and attitudes of respondents towards factors influencing the construction project cycle to identify and address concerns.

D. *Data collection*

Data collection in this study use the questionnaire method with Likert scale measurement. On part one, the respondents were queried about their characteristics and in part two, they were queried to rate the impact and the probability of risk occurrence which can affect the quality of project performance. Both impact and probability were rated as none, very low, low, average, high, very high, never, rarely, sometimes, averagely, frequently and certainly. The third part was about remedial methods used in management of risk under construction projects while the fourth and fifth parts were concerned with mitigation methods and techniques respectively used in risk management. For remedial, mitigation, and risk analysis techniques the scale was rated as never, rarely, lowly, averagely, frequently and certainly.

E. *Sample Size*

The sample size for the study was found using Taro Yamane's formula 1973 that is used in determining the sample size when the number of a target population is known. The sample size in each stratum was proportionately determined.

According to Yamane, (1973):

$$n = \frac{N}{\left[1 + (Ne^2)\right]}$$

Where n = is the sample size
N = is the population
e = is the error limit (0.05 on the basis of 95% confidence level)

Therefore, $= 120 / [1 + 120(0.05)^2]$

n=120/1.3 n= 92.3

A sample size of 93 respondents was used within an error limit of 5%. The questionnaires were sent to reputable professionals selected from contractors, client/owners, consultants and professionals that are considered familiar with the construction industry in Rwanda. Purposively, sampling technique was used to select study participants with a non-response rate of 5%, of 93 respondents 88 questionnaires were completed and returned.

F. *Reliability and validity of questionnaire.*

In order to ensure the reliability of questionnaire, the pilot study was done in Huye construction project, a sample size of 11 study participants (12% of sample size) was used for pre-testing.

To ensure reliability of the instrument, scale reliability coefficient so-called Cronbach's alpha coefficient was calculated using SPSS version 21 and it was 0.928(above 0.7), meaning that the instrument was reliable. To ensure its validity in Rwanda construction project context, researcher took suggestions from experts, lecturers and advisors that looked at its relevance, consistency and clarity to the study and the questionnaire was amended after the pilot according to respondents' answers.

V. RESULTS AND DISCUSSION

G. Characteristics of respondents

Variable	Frequency N (%)
Respondent company/organization	
Client	10(11.4)
Consultant	31(35.2)
Contractor	34(38.6)
Other	13(14.8)
Respondent position	
Director	14(15.)
Site Manager	20(22.7)
Project Manager	41(46.6)
Engineer/ Designer	13(14.8)
Respondent experience	
0-5	26(29.5)
6-10	18(20.5)
11-15	44(50.0)
Company experience	
0-5	13(14.8)
5-10	42(47.7)
10-15	27(30.7)
15-20	6(6.8)
Number of projects	
7-10	20(22.7)
>10	68(77.3)
Project type	
School	10(11.4)
Hospital	4(4.5)
Civil Eng. project	29(33.0)
Hotel /business	9(10.2)
Officer	24(27.3)
Other	12(13.6)
Type of contract	
Traditional	36(40.9)
Turnkey	22(25.0)
Design-build	30(34.1)
Contract price	
<500 million	30(34.1)
5ooM-1 billion	12(13.6)
1-5 billion	5(5.7)
>5 billion	41(46.6)
Project duration	
<12 months	7(8.0)
12-18	44(50.0)
18-24	25(28.4)
24-30	5(5.7)
30-36	7(8.0)
Actual Time spends	
<12 months	7(8.0)
12-18	21(23.9)
18-24	14(15.9)
24-30	34(38.6)
30-36	6(6.8)
>36	6(6.8)

Contractors and consultants were predominant among 88 respondents, with percentage of 38.6 and 35 while clients and others were 11.4% and 14.8% respectively. For respondents 'experience the majority had more than 5 years of working experience in area of construction projects. The majority were involved in more than 10 projects. Civil engineering projects were predominant with 33% followed by office construction project at 27% while school, hospital and hotel were less frequent at 11.4%, 4.5% and 10.2% respectively. Other types of construction projects are 13.6%. The majority of contracts were traditional and design-build and the contract price was below 500 million for 34.1% of respondent and above 5 billion in 46.6% and 19.3% in between that range. With regard to project duration the majority were more than 12 months and spent more than 12 months in construction project.

H. Impact and probability of risk factors

Level of impact for risk factors

The risk factors with high impact fall Under logistic related factors such as unavailability of sufficient needed materiel with median of 5.0 while for physical related factors, only occurrence of accident because of poor safety procedure was found to yield with median of 5.0. For construction and subcontractor related factors, non-availability of resource and revision of prices were also found to yield high impacts with median of 5.0. other remaining risk factors were found to yield a low impact and their median were below overall average median of 4.1.

Variables	Median	Impact
Logistic		
V1	**5.0**	**High**
V2	3.5	Low
V3	4.0	Low
V4	5.0	Low
Technology		
V1	4.0	Low
V2	3.5	Low
V3	4.0	Low
Physical		
V1	**5.0**	**High**
V2	4.0	Low
V3	4.0	Low
Construction		
V1	2.0	Low
V2	3.0	Low
V3	**5.0**	**High**
V4	4.0	Low
V5	4.0	Low
V6	2.0	Low
V7	4.0	Low
Workpermission		
V1	4.0	Low
Subcontract		
V1	4.0	Low
V2	4.0	Low
V3	**5.0**	**High**
Legal		
V1	4.0	Low
V2	4.0	Low
V3	4.0	Low
V4	4.0	Low
V5	4.0	Low
Design		
V1	**5.0**	**High**
V2	4.0	Low
V3	**5.0**	**High**
V4	4.0	Low
V5	**5.0**	**High**
Management		
V1	4.0	Low
V2	4.0	Low
V3	4.0	Low

Finance		
V1	4.0	Low
V2	4.0	Low
V3	4.0	Low
V4	4.0	Low
V5	4.0	low
Politics		
V1	4.0	Low
V2	3.0	Low
V3	3.0	low
Overall average median	**4.1**	

Probability (frequency)of risk factors

The majority of respondents assumed that under logistics related factors, poor material quality control had a high chance for occurrence and 38.8% of respondents responded that the same factors averagely occurs, 20.5% of respondents said that it frequently occurred and 8% of respondents said that it certainly occurred. However, under construction related factors, unavailability of camp for labour averagely, frequently and certainly occurred while for subcontractor, revision of prices, and majority of respondents agreed that it occurred. Under design and finance related factors, awarding the designs to unqualified designer and delayed payment of contract occurred in construction projects

Variables	1	2	3	4	5	6
Logistics						
V1	0	0	79.5	5.7	14.8	0
V2	10.2	25.0	38.6	18.2	8.0	0
V3	0	34.1	23.9	42.0	0	0
V4	0	27.3	4.5	**39.8**	**20.5**	**8.0**
Technology						
V1	6.8	25.0	29.5	38.6	0	0
V2	6.8	25.0	31.8	5.7	20.5	10.2
V3	38.6	51.1	0	10.2	0-	0
Physical						
V1	11.4	58.0	20.5	10.2	0	0
V2	6.8	29.5	19.3	44.3	0	0
V3	0	28.4	52.3	5.7	0	13.6
Construction						
V1	6.8	52.3	25.0	19.9	0	0
V2	0	38.6	25.0	15.9	20.5	0
V3	0	35.2	30.7	34.1	0	0
V4	0	38.6	25.0	15.9	20.5	0
V5	31.8	37.5	30.5	0	0	0
V6	27.3	6.8	4.5	**12.5**	**38.6**	**10.2**
V7	16	28	31.2	24.8	0	0
Permission						
V1	0	42.0	34.1	10.2	13.6	0
Subcontract						
V1	6.8	30.7	48.9	6.8	6.8	0
V2	6.8	6.8	15.9	26.1	28.4	15.9
V3	27.3	13.6	0	**30.7**	**28.4**	0
Environnent						
V1	0	33.0	40.9	20.5	5.7	0
V2	13.6	25.0	37.5	13.6	0	10.2
V3	29.5	12.5	34.1	4.5	19.3	0
Legal						
V1	14.8	11.4	53.4	20.5	0	0
V2	14.8	47.7	37.5	0	0	0
V3	23.9	40.9	30.7	4.5	0	0
V4	13.6	40.9	17.0	18.2	10.2	0
V5	23.9	40.9	14.8	20.5	0	0
Design						
V1	27.3	6.8	27.3	18.2	20.5	0
V2	6.8	27.3	6.8	**20.5**	**28.4**	**10.2**
V3	13.6	11.4	26.1	48.9	0	0
V4	13.6	25.0	22.7	8.0	20.5	10.2
V5	13.6	12.5	35.2	8.0	20.5	10.2
Management						
V1	13.6	20.5	47.7	18.2	0	0
V2	6.8	21.6	58.0	13.6	0	0
V3	0	25.0	23.9	20.5	6.8	23.9
V4	6.8	36.4	21.6	4.5	30.7	0
V5	0	6.8	6.8	**38.6**	**47.0**	0
Finance						
V1	20.5	6.8	29.5	12.5	30.0	0
V2	13.6	68.2	13.6	4.5	0	0
V3	0	27.3	44.3	20.5	8.5	0
V4	0	13.6	17.0	**18.1**	**51.1**	0
V5	0	54.5	11.4	34.1	0	0
Politics						
V1	20.5	40.9	18.2	0	0	0
V2	25.0	64.8	10.2	0	0	0
V3	12.6	36.1	29.5	20.5	0	0

I. *Remedial methods*

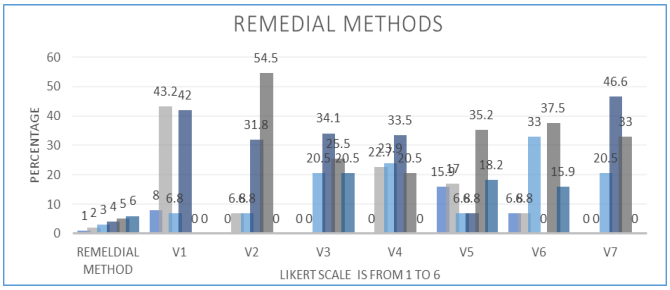
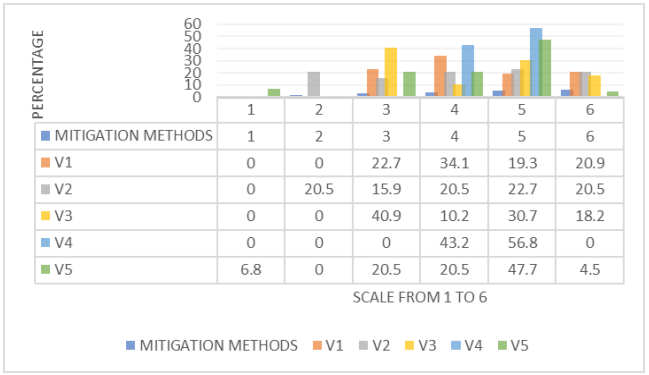


Figure 4. 1 Descriptive result of used Remedial method

Respondents frequently agreed that subjective dependence for producing a proper program was used with percentage of 54,5%, while proper schedule by getting updated information was averagely, frequently, and certainly used with percentages of 34.1%, 25,5%, and 20.5% respectively. Respondents confirmed that consciously adjustment for bias risk premium to time estimation was frequently and certainly used with a percentage of 35.2% and 18.2% respectively. And reference to previous and ongoing similar projects were agreed averagely with 46.6% and frequently with 33% by respondents. The other remedial methods mentioned in Index Questionnaire, respondents agreed that they were never, rarely and lowly used in Rwanda construction projects

J. *Mitigation methods*



MITIGATION METHODS	1	2	3	4	5	6
V1	0	0	22.7	34.1	19.3	20.9
V2	0	20.5	15.9	20.5	22.7	20.5
V3	0	0	40.9	10.2	30.7	18.2
V4	0	0	0	43.2	56.8	0
V5	6.8	0	20.5	20.5	47.7	4.5

Respondents agreed that changing sequences of work by overlapping activities was averagely, frequently and certainly used with percentages of 10.2%, 30.7% and 18.2% respectively. Respondents agreed that close coordination with subcontractors was frequently adopted with percentages of 56.8%, While close supervision to subordinate for minimizing abortive work was averagely, frequently and certainly adopted with a

percentage of 20.5,47.7 and 4.5% respectively.

K. *Risk analysis techniques*

Respondents agreed that expert system was averagely, frequently and certainly used with a percentage of 20.5%,47.7% and 4.5% respectively. Direct judgement was averagely, frequently, and certainly used with a percentage of 25%, 48.9% and 26.1% respectively. Transfer or sharing risk was averagely and frequently used with a percentage of 38.6% and 34.1% respectively. And Comparing analysis was frequently and certainly used with a percentage of 60.2% and 10.2 %

TECHNIQUES	V1	V2	V3	V4	V5	V6	V7
Series1	1	6.8	14.8	26.1	22.7	0	6.8	6.8
Series2	2	0	15.9	8	33	0	20.5	0
Series3	3	20.5	47.7	13.6	29.5	0	0	0
Series4	4	20.5	11.4	30.7	8	25	38.6	22.7
Series5	5	47.7	10.2	21.6	6.8	48.9	34.1	60.2

Figure 4. 2 Descriptive result of used risk analysis technique

L. *Recommendation*

It is recommended the Rwanda construction industry must consider risk management practice as an integral part of overall construction project management.

- To focus on how to remedy those found factors with high impact and probability of occurrence in this research as an effort to increase work productivity by
- increasing the performance of the construction project's stakeholders.
- Consider that not all remedial measures have the same ranking, some remedial techniques have a higher likelihood of reducing the risk impact, construction project stakeholders should consider various remedial alternative for achieving construction project goals.
- Risk mitigation methods should be executed to address high-risk threats to project objectives.

VI. CONCLUSION

This research found that the construction Industry of Rwanda is facing critical risk management practices in construction projects due to the identification of the risk factors with high impact and high chance for occurrence which fall under the criteria of logistics, physical, construction, subcontractors and design related factors. For Risk Analysis Techniques, the findings indicate that a major portion of construction companies in Rwanda deal mostly with expert systems which includes software package, decision support system and computer-based analyses techniques, direct judgement using experience and personal skills, transfer or sharing risk to/with other parts and comparing analysis which means comparing similar projects with similar conditions. However, Project risk monitors should seek more Risk analysis techniques that may change the project team's assessment of the risk that fall under Logistics, Technology, Physical, construction, Sub contractor, Environmental, Legal, Design, Management, Financial and Political criteria for risk factors.

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