The Identification and Management of Major Risks in Sri Lankan Construction Industry

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Abstract:
Background: The construction industry plays a vital role in the Sri Lankan economy and it contributes 7.6% to Gross Domestic Product (GDP). The construction sector varies from individual houses to major infrastructures such as roads and multiple storied buildings. The research aims to identify the major risks associated with the Sri Lankan construction industry and to evaluate the practical measures that the various local construction industry players would take to manage and respond to those risks. A mixed-method of questionnaire and interviews was used to investigate the risks and the trend of risk management implementation in the Sri Lankan construction industry.
Materials and Methods: In this study, a mixed-method of questionnaire and interviews was used to investigate the Sri Lankan construction industry.Using convenient sampling, data from 275 professionals in Sri Lankan Construction Industry was collected through a questionnaire. Descriptive and Correlational Analysis were used to analyze those data.Interviews were used as a follow-up procedure to further investigate the responses of surveys.
Results: Financial Risk and Time risk are found to be the major risks in terms of occurrence and impacts. The construction stage has the highest level of risk in the construction project life cycle because it involves a high investment of money, time and effort. The most popular risk management tool used is brainstorming, which relies on highly subjective experiences and the most popular risk response method to handle the risk in the Sri Lankan construction industry is Risk Reduction.
Conclusion: The awareness, knowledge of risk management is still at a relatively low level in the Sri Lankan construction industry therefore local players in the construction industry lag behind in implementing risk management in their practices. Effective risk management brings greater rewards to project performance by enhancing productivity.
Key Word: Risk Identification, Risk Management, Risk Responses, Sri Lankan Construction industry, Risk Impact, Risk Occurrence.

I. Introduction

Construction projects are initiated in complex and dynamic environments, and gather together hundreds of stakeholders. The process of planning, executing and maintaining all construction project activities is complex and time-consuming. To complete the projects under the given time, quality and cost, proper risk identification and management systems are crucial.

Risk refers to the future uncertainty about deviation from an expected outcome and it is the possibility of losing something of value. Risk identification is the process of determining risks that could potentially prevent the firm from achieving its objectives. Risk management involves forecasting and evaluating and addressing risks to make sure organizations achieve their objectives. A construction project converts designers' drawings to a physical structure after following a set of procedures and processes. Larson & Gray (2011) illustrated 4 stages of the project life cycle as the Initiation stage, Planning stage, Executing stage, Closing stage.

Based on the literature it was found that there is a lack of information about the risk identification and risks management of the Sri Lankan construction projects. Accordingly, this research focus on the "Identification and Management of major risks in the Sri Lankan Construction Industry. The current study aims to achieve the following objectives.

1. To identify the major risks associated with the Sri Lankan Construction Industry.
2. To understand the preferred risk management tools used by the players of the Sri Lankan Construction Industry.

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3. To evaluate the measures that various local construction industry players would take to respond to those risks.

II. Material and Methods

This is an Inductive type of research where the researcher begins by gathering detailed information from participants and then forms this information into categories or themes. The study is designed with both qualitative and quantitative data so a mixed method was used. In this study open-ended data is taken in the case of qualitative and closed-ended data is taken in the case of quantitative to get different types of information. The population relevant to the study is all players related to the construction projects in Sri Lanka. Although there are many construction projects the research focuses mainly on building construction, road construction and irrigation.

Study Duration: January 2019 to October 2019.
Sample size: 275 professionals in the construction industry of Sri Lanka.
Sample size calculation and sample selection: The sample size was estimated on Krejcie & Morgan's formula and when selecting a sample from described population convenience sampling was used. The convenience in approaching the employees in the construction companies and the willingness by these different roles to provide information was also considered when selecting different construction industries and different roles for the sample.

Procedure methodology

First, a literature survey is to be carried out in order to understand the global situation. Then a pilot test will be performed with a draft questionnaire with academics and practitioners to ensure the questionnaire is practical. The first draft of the questionnaire will be derived from the literature review. Several revisions will be made to construct an applicable and understandable questionnaire. The improved questionnaire then subsequently sent to the respondents. Interviews were used as a follow-up procedure to further investigate the responses of the surveys. Interview questions will be derived from the analysis results of the questionnaires and interviews will be done with a small number of selected participants.

The questionnaire comprises 24 questions. Out of those, 18 questions are close-ended and 6 questions are open-ended. The first part of the questionnaire gets the background of the respondent and the type of construction project. The next part of the questionnaire gathers information about the risks identified during the construction projects. The latter part of the questionnaire gathers information on the risk management methods that are practiced in the construction industry.

The questionnaire was distributed to 1420 professionals targeting consultants, Site engineers, Architects, Quantity surveyors, Technical Officers. The number of responses received was 298 out of 1420 making the response rate 20.98% Out of them, 23 responses had to be removed due to data discrepancies.

Interviews were carried out as a follow-up procedure to further investigate the responses of the surveys. Face to face interviews with open-ended questions was used to increase the quality of the information gathered. In this study, 12 interviewees were selected from different disciplines to reduce bias and to achieve higher accuracy. They include 2 Consultants, 4 Site Engineers, 2 Architects, 2 Quantity surveyors, and 2 Technical Officers.

The research uses two types of analytical methods in order to achieve the research objectives. Descriptive analysis is used to describe the characteristics of a population or phenomenon being studied. Microsoft Excel and SPSS Statistics 25 software was used for this. Correlation analysis was used to measure the strength of association between two variables and the direction of the relationship. For the purpose of analysis, a weighting of 4,3,2 and 1 was assigned to represent "Very High", "High", "Low" and "Very Low" respectively.

Statistical analysis

The research uses two types of analytical methods in order to achieve the research objectives. Descriptive analysis is used to describe the characteristics of a population or phenomenon being studied. Microsoft Excel and SPSS Statistics 25 software was used for this. Correlation analysis was used to measure the strength of association between two variables and the direction of the relationship. For the purpose of analysis, a weighting of 4,3,2 and 1 was assigned to represent "Very High", "High", "Low" and "Very Low" respectively. Chi-square and Fisher exact tests were performed to test for differences in proportions of categorical variables between two or more groups. The level $P < 0.05$ was considered as the cutoff value or significance.

III. Result

Descriptive Analysis

When considering the management level of the respondents most of the respondents are from lower management. Figure no 1 shows the role which the respondents are performing in the construction industry.
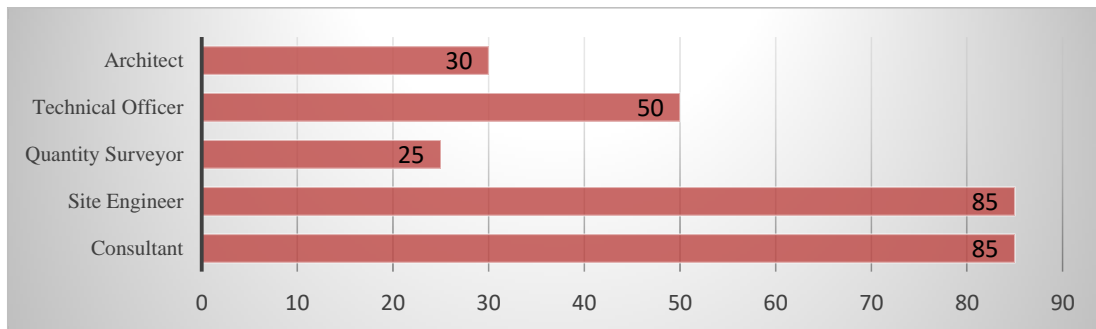

Figure no 1: Categorization of respondents according to the role in the construction industry

When considering the experience of the participants most of the respondents have experience around 2 years to 5 years. As most of the participants are having experience of more than 2 years, even past project data are also considered. Further, the responses show that 54% of the respondents are from the private sector, 33% are from the semi-government sector and 13% of them are from the government sector.
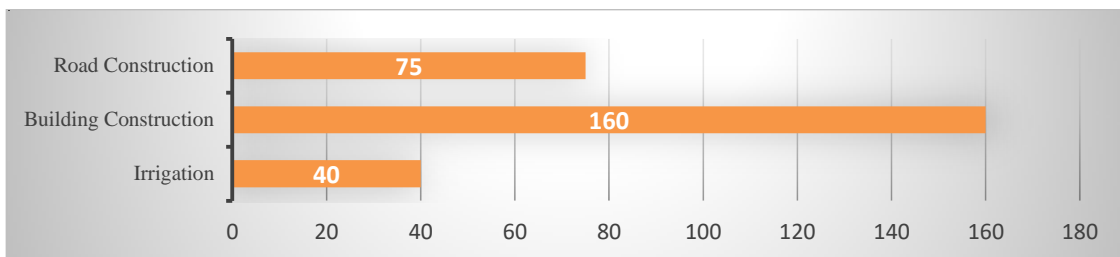

Figure no 2: Categorization of respondents according to the constructions carried out by the organization

According to figure no 2, the majority of the respondents are from the Building construction. This is because many parties including all government, semi-government and private sectors are involved in the building construction sector in Sri Lanka.

The questionnaire required the respondent to rank the risk impacts and risk occurrences according to the experience, job role and the type of construction that their company carrying out.

Table no 1: Frequency of Risks according to Impact

	Impact of Financial Risk	Impact of Time Risk	Impact of Design Risk	Impact of Faults Risk	Impact of Political Risk	Impact of Safety Risk
Mean	3.13	3.11	2.60	2.53	2.71	2.31
Median	3.00	3.00	3.00	2.00	3.00	2.00
Mode	3	3	2	2	2	2
Std. Deviation	.834	.706	.888	.761	1.058	1.009

According to the mean in table no 1, the highest mean (3. 13) is for the Impact of Financial Risk and Impact of Time Risk (3.11). Therefore, the highest impacting risks are Financial and Time Risks while the political risk is also comparatively high to the remaining risks.

Table no2: Frequency of Risks according to Occurrence.

	Occurrence of Financial Risks	Occurrence of Time Risks	Occurrence of Design Risks	Occurrence of Faults Risks	Occurrence of Political Risks	Occurrence of Safety Risks
Mean	2.80	2.95	2.51	2.49	2.45	2.18
Median	3.00	3.00	2.00	2.00	2.00	2.00
Mode	3	3	2	2	2	2
Std. Devi.	.819	.842	.761	.712	1.008	.918

According to the mean in table no 2 the highest mean is for Occurrence of Time Risk (2.95) and Occurrence of Financial Risk (2.80). Therefore, the highest occurring risks are Financial and Time Risks.

When considering both the impact and the occurrence of the risks of the collected data, the highest impact is from the Financial Risk while the highest occurring risk is the Time Risk. Safety Risk can be identified as the risk which is having a very low impact and very low occurrence according to the results of the respondents. When means are compared in impact and occurrence of the risks the means are high in risk impacts than occurrence showing that practitioners have rated that the impact of the risks is significant than the occurrence of the risks.
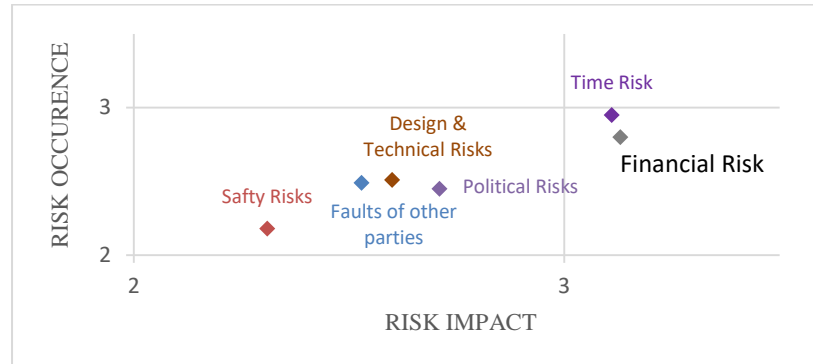

Figure no 3: Risk Probability/ Impact Matrix

The above figure no 3 shows the critical risks, medium level risks and low-level risks in the construction industry according to the understanding of the respondents. this figure confirms that the most critical risks in the construction industry are Financial risks and Time Risks.

Construction projects have different stages in the project life cycle and the number of risks varies with the stage of the project. The ranking of the risk with the stages in the project life cycle is shown in figure no 4.
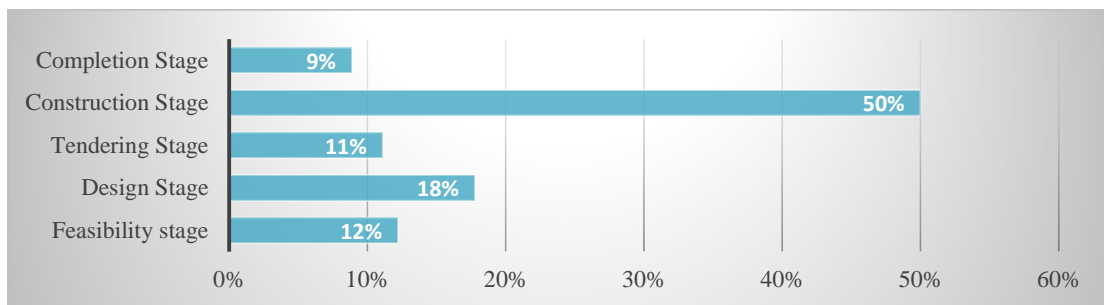

Figure no 4: Stages of the Project Life Cycle with Risks

According to the respondents, the risks in the construction stage is significantly higher than the other stages of the construction project life cycle while the least risk is found in the completion stage. Different tools and techniques are being used in order to identify and manage risks. The rating of these tools and techniques used by the practitioners are shown in figure no 5.
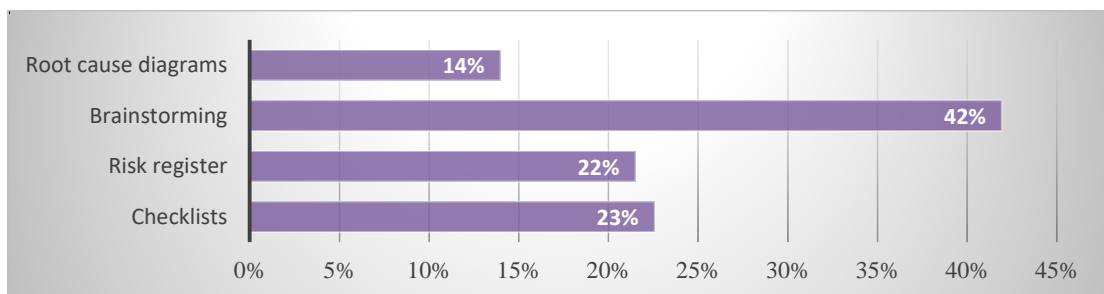

Figure no 5: Rating Tools and Techniques for Risk Identification and Risk management

Brainstorming is the most frequently used tool in order to identify and manage the risks in the Sri Lankan construction industry. Although Checklists and Risk registers are also used Root cause diagrams are being used occasionally by the practitioners.

There are different risk responses used by the practitioners in order to manage the financial risks and time risks that they face throughout the project life cycle. Many of the respondents working in the Sri Lankan Construction Industry are using Risk Reduction in order to manage financial risks. The other risk responses are used by the occasionally but in a similar percentage. According to the data collected Risk reduction is used most often to manage the time risks. Risk avoidance and Risk acceptance are also practiced while the most rarely used risk response tool is the risk transfer.

When all risks are taken as a whole more than 50% of the respondents have been using Risk Reduction as the risk response method in order to manage risks in the Sri Lankan Construction Industry. Least used risk response method is the risk acceptance method as the impact and occurrence of risks in construction industry are high to accept.

Correlation Analysis

In the correlation analysis, the relationship between 2 variables is identified. When considering p values between variables all the p values were less than 0.05 and in most of the cases it is 0.00 so variables are independent in the entire population.

When the role of the respondent in the Construction Industry and Impact of Financial Risk and the Impact of Time Risk is considered using SPSS crosstab 47% of the consultants have considered the Impact from financial risk as very high risk while the impact from the time risk is not very much high (35.3%) for consultants compared to the impact of Time Risk. The site engineers, quantity surveyors & architects, and technical officers have identified both the impact from the financial risk and the time risk as a high risk. Out of all the practitioners the 16.7% of the architects have identified that the impact from the financial risk is very low and it is the highest percentage that has identified the impact from the financial risk is very low. Only consultants (5.9%) have marked the impact of time risk as a very low impact risk.

When the role of the respondent in the Construction Industry and Occurrence of Financial Risk and the Occurrence of Time Risk is considered using SPSS crosstab, most of the consultants (35.3%) have marked the Occurrence of Financial Risk as low occurring risk. Moreover, 11.8% of the consultants have identified the Occurrence of Financial risk as a very low occurring risk. For the other players in the construction industry the Financial Risk is a high occurring risk. When considering the Occurrence of Time Risk, it is a very high occurring risk only for the Quantity surveyors (65%) and 11.8% Consultants have identified the time risk as a very low occurring risk.

The relationship between the type of the construction carried out by the respondents' organization and Impact of Financial Risk and the Impact of Time Risk was observed and it was seen that in irrigation industry the impact of financial risk is very high then (50%) the impact of time risk (25%) and even for irrigation many of the respondents (25%) have stated that the time risk is very low. When the same was done to the occurrence of Financial Risk and Time Risk 50% of the respondents have stated that Occurrence of Financial Risk in Irrigation is low while 25% have stated that Occurrence of time Risk is very low in irrigation. In the building construction industry more than half of the respondents have stated that financial risk as high occurring risk while 47% stated that the time risk as a high occurring risk. For road construction majority (47%) have stated that the financial risk as a low occurring risk while majority (40%) have stated that the time risk high occurring risk.

When the relationship between the role of the respondent in the Construction industry and the stage of project life cycle with highest risk levels is considered all the respondents have identified the construction industry as the highest risk level out of all the stages in the project life cycle. For the respondents except consultants' project completion stage has been the stage with lowest risk in the construction projects. Moreover, the Role of the respondent in the Construction Industry and Tools to identify and manage risks is considered and it was found all the practitioners have been using brainstorming as the main tool to identify and manage the risks in the local construction industry. All the responded technical officers (100%) have been using the brainstorming as a tool to identify and manage the risks. Less amount of practitioners has been sing Root Cause Diagrams in order to identify and manage the risks.

In order to manage risks Risk reduction was used by the respondents more frequently. Consultants are the respondents who have been using Risk Acceptance (23.5%) more frequently than any of the other practitioners. Technical officers are the respondents who have been using Risk Transfer (35%) in a repeated manner. Meanwhile, the construction stage has the highest risk in all the related fields in the construction industry. According to the respondents in Irrigation has identified the construction stage only half of the respondents (50%) have identified that the construction stage is having the highest risk.

It is also important to know how different tools used to identify and manage risks have been used by different sectors of the construction industry. Irrespective of the type of construction checklists have been used by many of the respondents' construction sectors, Irrigation (75%), Building Construction (72%) and Road Construction (67%). For Irrigation, Building Construction, Road Construction and Landslide Mitigation the second-highest tool used to identify and manage risks is Brainstorming and for Construction Chemicals and Water Treatment Plant sectors the second-highest tool used is Root Cause Diagrams.

When considering the relationship between type of the construction carried out by the respondents' organization and Risk Responses to handle the risks. Irrigation sector has been using risk avoidance (50%) oftentimes but Building construction (56%) and road construction (60%) have been using risk reduction method frequently in order to manage their risks. With the experience, the risk response methods have been varying according to the situation but the most preferred risk responses used by all the respondents is Risk reduction method. When the respondents' experience is more than 10 years the professionals have been moved away from the risk acceptance. That means the respondents of that category have been doing something to remove the risk than absorbing the risk.

Interview Findings

According to the consultant who was in building construction the impact of the financial risk is high while the occurrence of the time risk is high because the severity of the impact of the time risk can be reduced through the manipulation of other resources. In the case of occurrence all the time in all projects the time risk occurs due to faults of any party or due to environmental conditions than the occurrence of the financial risks. In order to avoid these risks financial solutions are taken and then the financial risks occur.

The other consultant who was in road construction said that the impact of the time risk is higher than the impact of the financial risk in the road construction and the occurrence of the time risk is also higher than the occurrence of the financial risk because funding for road construction is normally done by the government through the loans and any financial cost overrun is beard by the government. The impact for the Road Development Authority due to the impact of the financial risk is not much high. But in the case of not delivering the roads on time will be a huge impact for them due to the public involvement in road development projects.

Engineers and Technical Officers selected from the building construction, road construction explained the same while the engineer from irrigation stated Impact of the financial risk is high while the occurrence of the time risk is high because the government does not give a high priority for the irrigation projects and the funding for these might be not done on time. Due to bad environmental conditions there may be time delays most of the time.

Two architects and Two Quantity Serve yours were selected from the building construction. As per all, the impact due time risk is high occurrence due to the faults of other parties is high. The impact due time risk high because of the high occurrence of the other parties lead to delay the project.

All the two consultants, four site engineers, two quantity surveyors, two architects, and two technical officers said that the construction stage has the highest risk level. The reasons for them for this as below.
• 	High cost and more time are spent to complete the construction stage of a project.
• 	Disagreements occur as many parties of different knowledge; skill capacities are involved in construction.
• 	Construction depends on environmental condition, equipment efficiency, productivity, material delivery.
• 	A high amount of investments for construction.
• 	Many unexpected events happen during constructions stage than other stages.

Interviewees responded that they have been using brainstorming in order to identify and manage risks. The reasons behind their answer were,
• 	As a team, disusing related parties to manage the risk will give good results than identifying alone with another tool.
• 	Lots of risks can be recognized quickly when brainstorming.
• 	The high amount of generated ideas. At best, participants with different knowledge and different experiences come together.
• 	Newcomers to the project can get an idea how problems are solved so knowledge will be shared during brainstorming.

All the two consultants, four site engineers, two quantity surveyors, two architects, and two technical officers said that risk reduction is the most commonly used risk response to manage their risks which are having high impact and high occurrence. According to the following are the reasons behind their answer.
• 	Risk reduction is limiting the impact of a risk, so that if it does occur and it is easy than other methods.
• 	This strategy decreases the severity of the risk

- Taking early action to reduce the probability and/or impact of a risk is often more effective than trying to repair the damage after the risk has occurred.
- Risk mitigation may require resources or time and thus presents a tradeoff between doing nothing versus the cost of mitigating the risk.

IV. Discussion

The construction industry plays an important role in Sri Lanka. In all the construction projects there are risks associated with it which make that project complex. By achieving the objectives of the study complexity of the project will be reduced and will increase the GDP.

Objective 1: To identify the major risks associated with the Sri Lankan Construction Industry.

Out of the risks identified through the literature review, the respondents ranked the risks impact and occurrence wise. Table no 3 shows the ranking of the impact and table no 4 shows the ranking of the occurrence.

Table no3: Records the Percent Change in Lipids profile after treatment given.

Ranking	Risk	Mean
1	Financial Risk	3.13
2	Time Risk	3.11
3	Political Risk	2.71

Table no4: Records the Percent Change in Lipids profile after treatment given.

Ranking	Risk	Mean
1	Time Risk	2.95
2	Financial Risk	2.80
3	Design and Technical Risk	2.51

The findings demonstrate that the Financial Risk and Time Risks are the major risks in the Sri Lankan Construction Industry. It was found that the emergence of the financial and time risk is frequent because of frequent late payments and poor planning that plague the performance of the local construction industry. Both types of risks have a considerable impact on the project performance in terms of time, cost and quality. Greater performance in construction projects is more likely to achieve by focusing on the management of these two risks rather than handling a large number of minor risks.

Objective 2: To identify the preferred risk management tools used by the players of the Sri Lankan Construction Industry.

The construction stage has the highest level of risk in its project life cycle because it involves a high investment of money, time and effort in the project. Therefore, more attention should be given to the construction stage during risk management. Lack of proper risk management practices is one of the reasons the local construction projects are experiencing schedule and time overruns.

The most popular risk management tools used are brainstorming and checklists, which rely on highly subjective experiences. The results of the questionnaire demonstrate that many organizations in the local construction industry do not practice formal risk management. The interview findings suggest a low level of risk management knowledge among local construction practitioners as a factor for local contractors lagging behind their foreign counterparts in the risk management application. A systematic risk management application is significant because informal risk management fails to provide useful risk-reporting for future project reference.

Objective 3: To evaluate the measures that various local construction industry players would take to respond to those risks.

In view of the unique characteristics of different risks, different countries adopt different strategies in dealing with different types of risk, to manage them more effectively.

The players in the Sri Lankan construction industry have been using Risk Reduction as the risk response method in order to handle both the financial and time risks. All the risk responses have used by all the professionals belong to different experience categories. But with the experience of the professionals' increases, they are avoiding risk acceptance and use the other methods to manage the risks to reduce the impact and the occurrence of the risks in the Sri Lankan construction industry.

V. Conclusion

There are benefits of Identification and Management of major risks to any industry such as removal of potential mistakes at the beginning of the project, Project team can achieve the required quality productively, ensure that projects run smoothly within the expected time and budget etc. These benefits can be enjoyed by the Construction Industry in Sri Lankan Construction Industry through knowing risks, risk management techniques before initiating a project. As per the 80/20 rule, greater performance in construction projects can be achieve by the management of financial risks and rime risks rather than handling a large number of minor risks.

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