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Apportionment and Ranking of Risk Elements in Construction Industry of Sri Lanka-Contractors' Perspective

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Abstract: This study provides the results of a survey of major contractors engaged in the Sri Lankan construction industry. It is aimed at identifying common risk elements affecting construction industry projects, determining how they are apportioned between the owner and the contractor, and quantifying and ranking their significance. The previous studies provided a list of 52 risk elements and with the help of a pilot study it was reduced to manageable 25 risk elements having a great relevance to the Sri Lankan construction industry. Altogether 72 respondents selected from among major contractors in Sri Lanka (C1 to C4) were involved in the questionnaire survey of the study.

The analysis of the results show that only some risk elements are apportioned more to one party (apportionment of at least 65%) either contractor or owner. *Shortage of labor, materials, tools and equipment (82%), Low productivity of labor and equipment due to complexity of work (78%), Labor disputes & trade union action (76%), Delays due to sub-contractors, suppliers and other bodies (74%), Difficulty to coordinate with sub- contractors (74%), Corruption (70%), Delayed payment by owner (68%),* and *Accidents (66%)* are apportioned more to contractors whereas, D*elay in approvals and permits (70%),* is apportioned more to the owner than to the contractor. The risk elements were ranked according to their significance and the most significant risk elements are, in descending order of significance are; *Shortage of labor, materials, tools and equipment, inaccurate and incomplete design, Financial failure resulting from owner and contractor, Substandard quality of work.* The results indicate that contractors perceive that risks are apportioned disproportionately more towards them. The implication of this is that naturally contractors tend to quote higher bid prices to cover their potential risks.

Key words: Construction Risks, Risk Management, Sri Lankan Construction industry

1. Introduction

The construction industry is exposed to a lot of predictable and unpredictable risks that could have a greater impact on the productivity, performance, quality and the budget of the project. Risk management is a relatively new discipline in the construction industry of Sri Lanka. However, it is gradually becoming prominent owing to increased construction activity, increased complexity and sophistication in the end products and stiff competition. A better understanding of significance of risks and how they are apportioned is needed to arrive at a realistic bid price.

The main objective of this study is to identify common risk elements affecting construction industry projects, determine how they are apportioned between the owner and the contractor, and quantify and rank their significance.

2. Literature Review

Risk is defined in Webster's dictionary as a chance of injury or damage or loss.The construction industry is increasingly fraught with high levels of risks and uncertainties. Kartam and Kartam (2001) defined risk as the probability of occurrence of some uncertain, unpredictable and even undesirable event(s) that would change the prospects for the profitability on a given investment. Over the past decade, many projects have experienced large variations in cost and/or schedule turning these projects into unsuccessful endeavors (Abdelgawad and Fayek, 2010). Systematic risk management allows the early detection of risks. Therefore, there is no need for contingency plans to cover almost every eventuality (Dawood, 1998).

Yusuwan *et al.* (2008) have explored a number of risks faced by the construction industry, namely political risk, economic risk, technology

risk and social risk. These risks having a bearing mainly on the cost and duration of project completion may push up the tender price. Flanagan and Norman (1993) state the construction industry participants (client, consultants and contractors) are heterogeneous having different roles and tasks to perform. In order to survive in a risky environment the participants should show a desire to share risk. This process termed risk apportionment is an important component of risk management. Risk management is a critical part of project management as unmanaged or unmitigated risks are one of the primary causes of project failure (Royer, 2000).

Nummedal *et al*. (1996) suggested a five step procedure for risk management which are; risk identification, risk estimation, risk evaluation, risk response and risk monitoring. Baker *et al.*(1999) have suggested a simple circular procedure fitting these five steps, which is lustrated in Figure 1. The adherence to this procedure will yield a controlled risk environment. The first two steps, namely risk identification and risk estimation jointly forms the process of risk analysis. Risk analysis followed by risk evaluation together forms the risk assessment. Risk response and Risk monitoring constitutes the risk controlling process.

Kartam and Kartam (2001) have conducted a study to identify common risk elements affecting construction industry projects and to assess the degree of risk apportionment between owner and contractor for the Kuwaiti construction industry. In Sri Lanka, evidently, no study has been carried out on the same aspect.

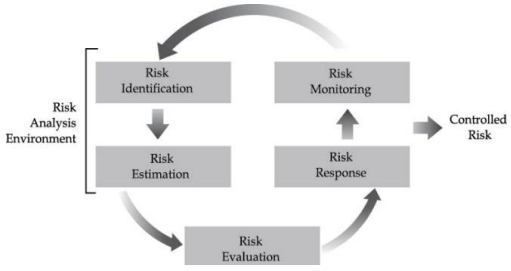

Figure 1: Steps in Systematic Risk Management

3. Methodology

3.1 Questionnaire Design

The past studies revealed 52 risk elements related to construction industry and with the help of 5 industry experts these risk elements were short listed to manageable 25 risk elements. Their inputs were useful in the questionnaire design, too. In order to ensure obtaining complete and meaningful response to the questionnaire, an interview based questionnaire was conducted with each respondent. This also gave an opportunity to explain the objectives of the study to the respondents.

The main questionnaire consists of three parts. The first part seeks background information of respondents. The second and the third parts contain the same 25 short statements eliciting perceptions on apportionment and significance of risk elements. The layout of the questionnaire is presented in Figure 2.

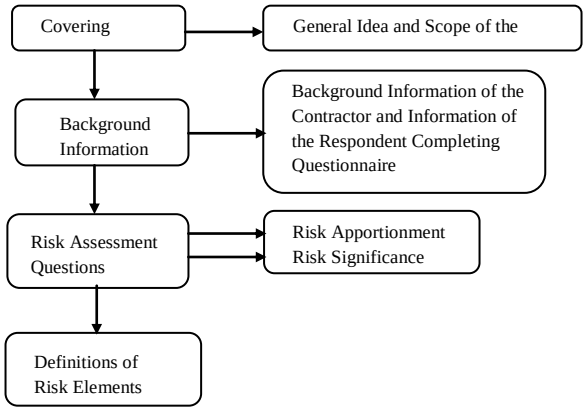

Figure 2: Layout of the Questionnaire

3.2 Sample Selection

Selection of the most suitable sample for the survey from a long list of contractors was a major task in making the research more effective and representative. In order to maintain the precision of study it was decided to consider only the construction contractors for the survey. The contractors for the sample survey were selected from the list obtained from the directory published by ICTAD -2011. Only medium (C4) to large scale construction contractors (C1) working in the Western Province were included in the survey. The questionnaires were

distributed to 80 respondents and a response rate of 62.5 per cent was achieved.

3.3 Approach to Analysis

The first part focused on getting information regarding respondent's employers and their experience. The second part of the questionnaire solicits information to evaluate the risk apportionment between contractor and owner. As against each risk element the respondents indicated their perception about how the risk is shared between owner and client. In order to facilitate the respondent to indicate the perceptions on risk apportionment between owner and contractor (as a percentage) five uniform ranges were decided namely; 0-20, 20-40, 40-60, 60-80 and 80-100. The third part is to get contractors' observations and judgements in determining the relative significance of the each risk element.

A Likert-Type Scale ranging from 1 to 5 was adopted to gauge people's perception. Although the degree of significance of a particular risk element could vary from project to project, the questionnaire is expected to elicit a general assessment of the significance of each risk element. Weightings were assigned to different levels of significance as follows;

Most significant - 5 points
More significant - 4 points
Significant - 3 points
Less significant - 2 points
Least significant - 1 points

The principle is that the risk with the highest significance would be assigned with the largest weight. Risk Significance Score (RSS) for each risk element was calculated as follows:

$$RSS= 5X_5 +4X_4 +3X_3 +2X_2 +1X_1$$

Where X_1, X_2, X_3, X_4 and X_5 denotes number of respondents indicating most significant, more significant, significant, less significant and least significant respectively.

4. Results and Discussion

4.1 Analysis of Sample

Distributions of respondents based on ICTAD grading of the constructing firms where they are employed at are shown in Table 1. The level of experience of respondents is shown in Table 2.

Table 1: Distribution of Respondents

Classification of the Contractor	Number of respondents (Frequency)	Percentage
C1	40	80
C2	08	16
C3	02	04
Lower than C4	00	00
Total respondents (N)	50	100

It was found that 80 per cent of the respondents are from C1 contracting firms (those qualified to undertake projects worth more than Rs 600 million), 16 percent of the respondents are from C2 contracting firms (those qualified to undertake projects worth more than Rs 300 million and less than 600 million).

Table 2: Experience of Respondents

Experience (Years)	Number of respondents	Percentage
1 – 5	06	12
6 – 10	08	16
> 10	36	72
Total respondents (N)	50	100

4.2 Construction Risk Apportionment

The frequencies of responses on the perceptions on the risk apportionment between the owner and the contractor were counted under the five ranges, with respect to each risk element. In order to enable easy interpretation, the number of responses in the ranges 0-20 and 20-40 were amalgamated under the range 0-40. Similarly, responses in the ranges 60-80 and 80-100 were grouped under the range 60-100. The results have been summarized and presented in Table 3. In similar studies by Kangary (1995) in the USA and by Kartam and Kartam (2001) in Kuwait, an apportionment of 70% or beyond to one party is

considered as full apportionment to that party. In this study this value was lowered to 60 so that more risks elements can be apportioned to one party. Accordingly, the following risk elements are considered to be fully apportioned to the contractor:

- Shortage of labor, material, tools & equipment
- Low productivity of labor and equipment due to complexity of work
- Labor disputes & trade union action
- Delays due to sub contractors, suppliers and other bodies
- Difficulty to coordinate with sub contractors
- Corruption
- Delayed payment by owner
- Accidents

Beside these, there were other risk elements which are apportioned neither to contractor nor to owner. If the apportionment of a risk element is less than 60 per cent to any party (except for shared elements), it is considered as an 'undecided' apportionment. Risk elements which were categorized as 'undecided' are listed below:

- Issues related to right of way and site access to vehicles
- Unexpected site conditions (soil, underground pipes, etc)
- Unpredictable weather conditions
- Noncompliance of materials to standards and specifications
- Delayed dispute resolutions
- Substandard quality of work
- Financial failure resulting from owner and contractor
- Errors in project program
- Increasing actual quantity of work
- Delayed payment by the owner
- Change to scope, plans and specifications
- Capacity issues of contractor to handle the given job
- Price increase due to inflation

If a risk element is equally apportioned to either part it is considered a 'shared risk'. As such the following risk elements are considered as 'shared risks';

- Scope limitation & insufficient definition of work
- Inaccurate & incomplete design
- Natural disaster & human violence

Beside these, the risk element 'Delay in approvals and permits' is fully apportioned to the owner instead of the contractor.

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4.3 Significant risk elements

Table 4 depicts the summary of both frequencies of different significant levels and RSS of risk elements according to the perceptions of engineers and project managers employed by the contractors. The RSSs and ranks in relation to all risk elements are summarised in Table 4. The figures in parentheses in Table 4 are the ranks of risks based on RSSs. The following six risk elements have RSS greater than 200 and carries ranks from one to six.

- Shortage of labour, materials, tools and equipment
- Inaccurate and incomplete design
- Financial failure resulting from owner and Contractor
- Substandard quality of work
- Lower productivity of labour & equipment due to complexity of work

The most significant risk element (Shortage of labour, materials, tools and equipment) is also the one apportioned most to the contractor.

Table 3: Apportionment of Risk between Owner and Contractor- Percentage

s/n	Risk Elements	Owner (%)			Contractor (%)		
		0-20 & 20-40	40-60	60-80 & 80-100	0-20 & 20-40	40-60	60-80 & 80-100
01	Delays in approvals and permits	8	22	70	70	18	12
02	Issues related to right of way and site access to vehicles	36	22	42	32	36	32
03	Scope limitation & insufficient definition of work	26	40	34	30	36	34
04	Shortage of labour, materials, tools and equipment	80	6	14	6	12	82
05	Lower productivity of labour & equipment due to complexity of work	76	14	10	4	18	78
06	Inaccurate and incomplete design	28	32	40	24	38	38
07	Unexpected site conditions (soil, underground pipes, etc)	34	34	32	26	34	40
08	Unpredictable weather conditions	54	18	28	28	28	44
09	Natural disasters and human violence	34	34	32	22	48	30
10	Noncompliance of materials to standards and specifications	34	30	36	22	30	48
11	Ad-hoc revision in government policies and regulations	26	24	50	40	34	26
12	Labour disputes and trade union actions	84	8	8	10	14	76
13	Accidents	70	22	8	12	22	66
14	Price increases due to inflation	22	26	52	36	30	34
15	Capacity issues of contractor to handle the given job	30	14	56	40	22	38
16	Changes to scope, plans and specifications	18	18	54	44	34	22
17	Delays due to sub contractors, suppliers and other bodies	62	16	22	4	22	74
18	Difficulty to coordinate with subcontractors	66	22	12	0	26	74
19	Delayed dispute resolutions	48	22	30	20	24	56
20	Delayed payments by the owner	48	20	32	18	14	68
21	Substandard quality of work	40	24	36	24	22	54
22	Financial failure resulting from owner and contractor	10	44	46	22	44	34
23	Increasing actual quantities of work	24	26	50	34	44	22
24	Errors in project program	38	22	40	26	22	52
25	Corruption (bribery/theft/burglary and & pilferage)	48	20	32	14	16	70

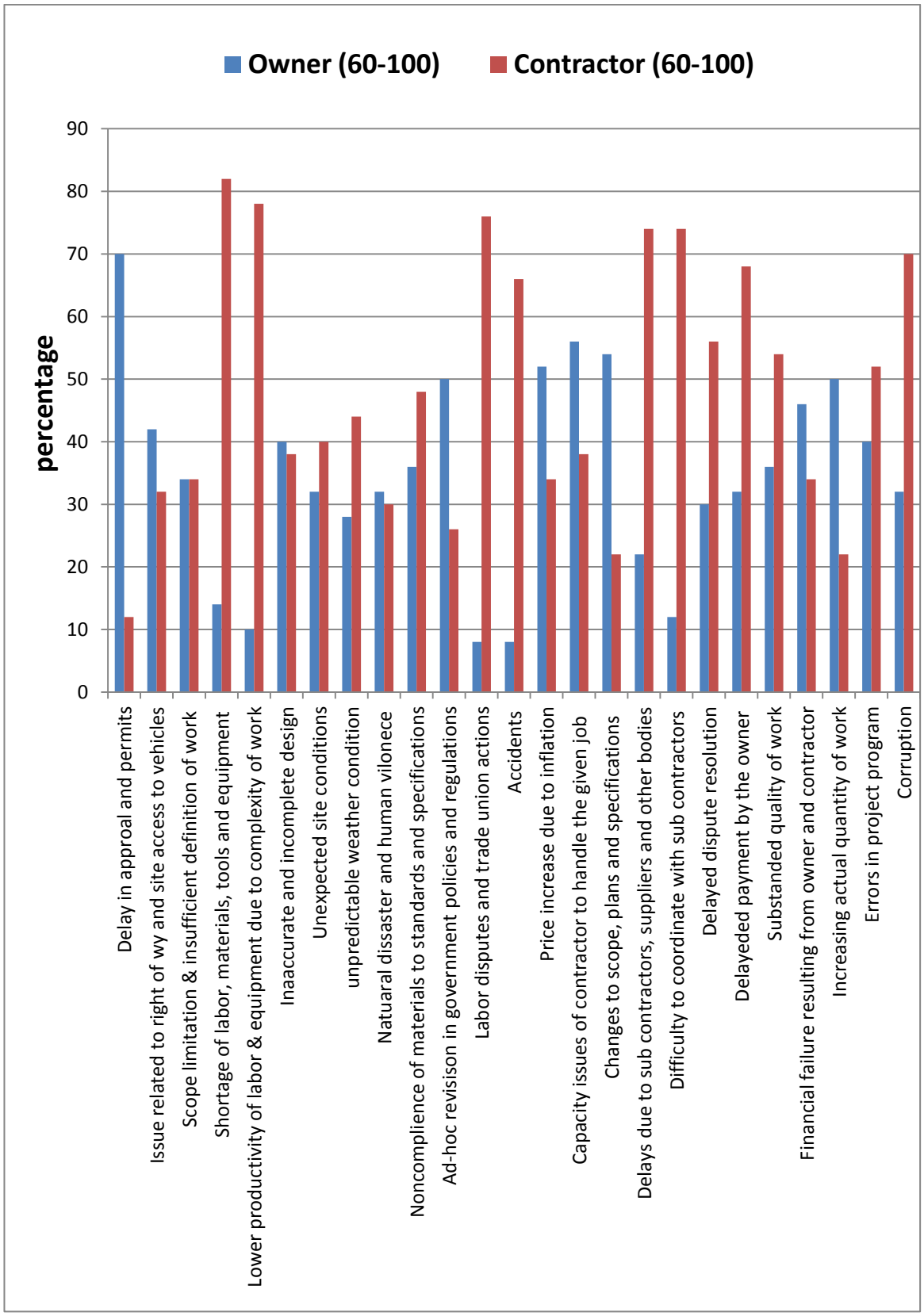

Figure 3: Risk Apportionment between Contractor and Owner

Table 4: Weighted scores of importance of risk elements

s/n	Risk elements	Least Significant (1)	Less Significant (2)	Significant (3)	More Significant (4)	Most Significant (5)	Risk Significance Score and [rank]
01	Delays in approvals and permits	0 (0)	1(2)	16(48)	16(64)	17(85)	199 [06]
02	Issues related to right of way and site access to vehicles	0(0)	1(2)	26(78)	13(52)	10(50)	182 [12]
03	Scope limitation & insufficient definition of work	0(0)	1(2)	24(72)	17(68)	8(40)	182 [12]
04	Shortage of labor, materials, tools and equipment	0(0)	1(2)	6(18)	27(108)	16(80)	208 [01]
05	Lower productivity of labor & eqpt due to complexity of work	0(0)	3(6)	12(36)	30(120)	5(40)	202 [05]
06	Inaccurate and incomplete design	0(0)	1(2)	13(39)	19(76)	18(90)	207[02]
07	Unexpected site conditions (soil, underground pipes, etc)	0(0)	9(18)	23(69)	12(48)	6(30)	165 [18]
08	Unpredictable weather conditions	0(0)	16(32)	22(66)	10(40)	2(10)	148 [23]
09	Natural disasters and human violence	0(0)	20(40)	19(57)	8(32)	3(15)	144 [24]
10	Noncompliance of materials to standards and specifications	0(0)	1(2)	14(42)	22(88)	13(65)	197 [08]
11	Ad-hoc revision in government policies and regulations	2(2)	10(20)	23(69)	21(84)	4(20)	195 [09]
12	Labor disputes and trade union actions	0(0)	17(34)	24(72)	7(28)	2(10)	144 [24]
13	Accidents	1(1)	9(18)	21(63)	11(44)	8(40)	166 [17]
14	Price increases due to inflation	0(0)	10(20)	22(66)	14(56)	4(20)	162 [20]
15	Capacity issues of contractor to handle the given job	0(0)	4(8)	16(48)	21(84)	9(45)	185 [10]
16	Changes to scope, plans and specifications	0(0)	2(4)	19(57)	21(84)	8(40)	185 [10]
17	Delays due to sub contractors, suppliers and other bodies	0(0)	0(0)	23(69)	23(92)	4(20)	181 [14]
18	Difficulty to coordinate with subcontractors	0(0)	8(16)	21(63)	17(68)	4(20)	167 [16]
19	Delayed dispute resolutions	1(1)	8(16)	22(66)	17(68)	2(10)	161 [21]
20	Delayed payments by the owner	0(0)	0(0)	14(42)	19(76)	16(80)	198 [07]
21	Substandard quality of work	0(0)	0(0)	10(30)	26(104)	14(70)	204 [04]
22	Financial failure resulting from owner and contractor	0(0)	1(2)	14(42)	13(52)	22(110)	206 [03]
23	Increasing actual quantities of work	0(0)	12(24)	21(63)	12(48)	5(25)	160[22]
24	Errors in project program	1(1)	9(18)	18(54)	15(60)	7(35)	168 [15]
25	Corruption bribery/theft/ burglary and & pilferage)	1(1)	11(22)	16(48)	17(68)	5(25)	164 [19]

5. Conclusions

Although the number of construction risk elements found in the literature could be well over 50, they can be summarised into 25 manageable risk elements. The results prove that the evaluation of current practice of risk apportionment between contractor and owner is a measurable task. Except for one risk element all risk elements are apportioned to contractors. Only the risk ‘a delay in approvals and permits’ is apportioned to the owner. It must be stressed that this is the perspective of the engineers’ employed by the contractors. Hence, naturally, there could

be a tendency for them to believe that risks have been apportioned, unfairly, more to them. Although the technique of interview based surveys minimised the possibility for this, it is prudent to examine the risk element from the perspective of owners of construction projects in future studies.

The risk, 'shortage of labour, materials, tools and equipment' is the most significant risk and also it is the one which is perceived to be most apportioned to the contractor. The study also revealed the next five most significant risks as follows; Inaccurate and incomplete design, Financial failure resulting from owner and Contractor, Substandard quality of work, Lower productivity of labour & equipment due to complexity of work.

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