

COST OVERRUN FACTORS IN PRE-CONTRACT AND POST-CONTRACT STAGES: A CRITICAL ANALYSIS

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ABSTRACT

“Cost overrun” is considered as an unavoidable phenomenon in the construction industry. Despite the professional effort and adaptation of advanced technologies, still the construction industry experiences cost overruns. Especially, among many stakeholders, contracting organizations are one of the key stakeholders that would be highly affected by the construction cost overrun. Poor coordination between the pre & post-contract stages in the contracting organizations has been a critical issue over many decades which leads to cost overruns. Professionals involved in the pre-contract stage have not possessed the knowledge regarding the significance of the cost overrun factors that may appear in the post-contract stage and vice versa. Therefore, this research aims to comparatively analyze the significance of cost overrun factors in the pre & post-contract stages in Sri Lankan construction projects from the perspective of industry professionals. A total of 5 semi-structured interviews were conducted among professionals who have experience in cost estimation and post-contract cost management in contracting organization to categorize the selected cost overrun factors into pre-contract and/or post-contract stages. Then, a questionnaire survey was conducted to evaluate the significance of those categorized cost overrun factors. A total of 80 responses were collected from the questionnaire survey and the data were analyzed using statistical analysis. Then the quantitative data was analyzed using the Mann-Whitney U-Test. The results of the Mann-Whitney U test concluded that there is a statistically significant difference between the perspective of professionals involved in the pre & post-contract stage.

Keywords: Construction cost; Cost Overrun; Post-Contract Stage; Pre-Contract Stage.

1. INTRODUCTION

Among many other industries and sectors in the world, the construction industry contributes and stimulates economic growth as the construction industry is highly dynamic and it is considered to possess the enormous potential of contributing to the economy due to the creation of linkage between many other sectors and industries (Durdyev and Ismail, 2012). The construction industry provides a wide range of necessary infrastructure inclusive of hospital buildings, roads, school buildings and many other projects (Rahman, et al., 2013). According to Raftery, et al (1998), there are major 3 aspects on which the Asian construction industry focuses. They are more involvement in foreign participants, potential private sector involvement in infrastructure development and improving vertical integration in projects. The incredible transformation of Singapore

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to a highly developed nation is one of the best examples of the impact of the construction industry as Singapore emphasized infrastructure development as a crucial sector (Ofori, 1998).

Numerous reasons have been identified over the last years which affect the success of the project. Such reasons include effective monitoring and feedback by the project manager, timely decisions, regular budget updates, construction control meetings, delegating authority to project manager by top management and monitoring and feedback by the client (Iyer and Jha, 2005). Among numerous factors, researchers have emphasized that exceeding budgets and cost overrun attribute to the success of the project. Therefore, this shall be carefully managed to achieve the intended targets of a project (Ahady, Gupta and Malik, 2017). According to the authors, the employees who work in different phases of a certain project (i.e., pre-contract and post-contract) have proper knowledge in their particular stage however not the other stage of the project which might lead to certain issues as the communication in between these two stages are considerably less. The establishment of cost estimation of a particular project is quite difficult and associated with a higher level of risk in project management as it must be done prior to the work being commenced (Oberlender, 2014).

Many studies such as Akanni, et al. (2014) have been carried out regarding the factors affecting the cost overrun in both pre-contract and post-contract stages and several studies have analyzed their significance based on the respective research methodologies. However, the recent study of Mahmud, et al. (2021), emphasized that still the cost overrun issue has not been properly addressed and requires an in-depth investigation. According to certain studies, pre-contract and post-contract management are not well-combined and managed in the construction industry (Akanni, et al., 2014). As Igwe, et al. (2020) stated that proper management is required in both the pre-contract and post-contract stages in order to have better cost performance from the contractors' perspective. The authors further argued that conducting several kick-off meetings would not develop a proper linkage between the pre-contract stage and the post-contract stages. It is not clear whether the estimation team is focusing on the most significant cost overrun factors that affect in both stages.

The problem has been drastically affected for a long period as some cost overrun facts have less concern during the estimation period however has a significant impact during the physical construction stage as well as the pre-contract stage, ultimately affecting the overrun cost of the project. The opposite also might occur in the industry. It is therefore important to fill the knowledge gap by examining the relationship of cost inhibit factors and providing a guideline and better platform to estimators to focus on more significant cost items when carrying out the price estimation. Moreover, it requires statistical analysis to compare the opinion on the cost overrun factors in pre-contract and post-contract stages of the professionals who are engaged in those two stages to critically review whether they have a similar perspective in terms of the significance of cost overrun factors. Therefore, this research aims to conduct a comparative analysis on the cost overrun factors in the pre- and post-contract stages of the construction projects.

2. LITERATURE REVIEW

2.1 COST OVERRUN IN CONSTRUCTION PROJECTS

The variance between the actually incurred cost and the baseline cost would be referred as the cost overrun in a construction project (Amoa-Abban and Allotey, 2014). Thus, cost overrun is the exceeding of finally incurred cost at the completion stage of the project compared to initial cost estimation (Ullah, et al., 2017). This figure of final cost indicates the total expenditure encountered at the completion stage of the project whereas initial cost figure indicates the planned and determined cost during the initiation of the project (Lee, 2008). Table 1 depicts the cost overrun factors along with the frequency count of previous studies.

Table 1: Cost overrun factors

Factor	Source	Frequency
Factors related to project financier/owner		
Owner's financial crisis	[1], [4], [5], [8], [9], [10], [11], [12], [14], [17]	10
Delayed payments	[1], [2], [3], [4], [5], [7], [10], [12], [13], [15], [17], [21]	12
Discrepancy in details and incomplete briefing regarding the project	[3], [4], [6], [7], [8], [9], [10], [11], [12], [13], [14]	11
Rapid and unrealistic alterations in client's requirements	[4], [11], [18], [19], [20], [23]	6
Delay in decision making and management	[1], [2], [3], [5], [6], [9], [10], [14]	8
Allowing unrealistically shorter time periods for design, approvals and tendering process to get delivered the project as earliest as possible.	[6], [11], [15], [17]	4
Factors related to designers and consultants.		
Lack of experience of design team related to the project	[7], [10], [12], [13], [19], [20]	6
Misinterpretation of client's design requirements and other information	[3], [8], [13], [16], [19], [22], [26]	7
Discrepancies in tender document	[9], [11], [14], [15], [16], [17], [19], [22], [23], [24]	10
Delay in issuing instructions and information to the contractor	[10], [11], [12], [18], [20]	5
Inappropriate procurement approach	[10], [12], [13], [17]	4
Deficiencies in communication and negotiation with stakeholders	[11], [15], [16], [19], [21]	5
Inaccurate cost estimations	[10], [11], [12], [15], [16], [17], [19], [20], [21], [23]	10
Lowest bid might not be the most technically feasible bid	[12]	1

Factor	Source	Frequency
Factors related to contractor		
Inaccurate cost estimation	[13], [15], [16], [18], [19], [20], [24], [25], [26]	8
Poor cost planning at the initial stage of the project	[12], [14], [17], [21]	4
Ineffective post contract cost controlling and management	[7], [13], [18], [21], [24],	5
Errors in prepared documents and schedules	[4], [6], [8], [9], [11], [16], [23]	7
Incompetence in technical aspects and lack of experience	[9], [10], [12], [14], [15], [26]	6
Cost of reworks	[15], [16], [17], [19], [20], [21], [22], [26], [27], [28]	10
Contractor's bidding strategies such as front-end loading	[1], [5], [8], [10], [13], [28]	6
Delay payments to suppliers and subcontractors	[2], [6], [7], [17]	4
Assignment of incompetent and inexperienced subcontractors	[4], [5], [9], [10], [28]	5
Delay in supply of material, plant & equipment	[1], [3], [8], [11], [15], [18], [23]	7
Previous experience on the projects of the contractor	[13], [14], [15], [19], [26], [27]	6
Cost of testing and commissioning and approval for samples	[17], [25], [28]	3
Factors related to external environment		
Market condition and the level of competition	[2], [4], [5], [7], [10], [13], [24]	7
Taxes and duties on imported materials and import restrictions on material	[16], [18], [19], [20], [22], [27]	6
Culture of conflicts and lack of trust	[2], [3], [6], [7], [12], [14], [17], [18], [21], [23]	10
Increase in cost of workmanship	[3], [4], [5], [8], [9], [10], [13], [15], [19], [22], [24]	11
Adverse weather impacts an unrealistic site condition	[3], [9], [17], [28]	4
Weather conditions	[1], [2], [4], [6], [7], [11], [14], [18], [19], [21], [26]	11
Unrealistic site conditions	[2], [4], [6], [8], [9], [12], [13], [17], [19], [23], [25]	11
Labour nationality and social impacts	[2], [3], [5], [8], [10], [12], [16], [19], [21], [27]	10
Material, plant & equipment shortage	[5], [9], [11], [28]	4

Factor	Source	Frequency
Price fluctuation in material, plant & equipment	[1], [3], [15], [24], [26], [27]	6
Economic stability and market conditions in the country	[2], [5], [7], [10], [15],[25]	6
Impact on foreign construction companies to the local industry	[17], [18], [19], [22]	4
Fluctuation in foreign currency exchange rates	[3], [5], [7], [9], [16], [27], [28]	7
Site safety and likelihood of accidents faced by the workers	[3], [11], [14], [17], [19], [20], [21]	7
Absence of construction cost data	[11], [12], [14]	3
Site constraints based on the location and several other factor (access, storage, services)	[1], [4], [6], [10], [14], [25], [26]	7
Epidemic and pandemic	[29], [31], [32]	3

[1] (Sohu, et al., 2020); [2] (Haslinda A. N., Xian, Norfarahayu, Hanafi, & Fikri, 2018); [3] (Alinaitwe, et al., 2013); [4] (Jayalath, 2019); [5] (Frimpong, Oluwoye, & Crawford, 2003); [6] (Olubunmi & Olukanyin, 2015); [7] (Vu, et al., 2016); [8] (Rajakumar, 2016); [9] (Cantarelli, et al., 2012); [10] (Park & Papadopoulou, 2012) [11] (Ameh, et al., 2010) [12] (Tan & Suranga, 2008) [13] (Mahamid & Dmaid, 2013) [14] (Rosenfeld, 2014) [15] (Forcada, et al., 2017) [16] (Aljohani, et al., 2017); [17] (Ahady, Gupta, & Malik, 2017); [18] (Rodrigo & Malkanthi, 2018); [19] (Fagbenle, et al., 2018); [20] (Azhar, et al., 2008); [21] (Adedokun, et al., 2019); [22] (Baloi & Bekker, 2011); [23] (Akanni, et al., 2014); [24] (Aziz R. F., 2013); [25] (Famiyeh, et al., 2017); [26] (Hatamleh, et al., 2017); [27] (Mahamid & Dmaid, 2013); [28] (Amoa-Abban & Allotey, 2014); [29] (Hesna, et al., 2021); [30] (Larsen, et al., 2016); [31] (Abdullah, et al., 2020); [32] (Isa, et al., 2021)

Table 1 presents the cost overrun factors that are common to most of the aspects in the construction industry from the findings of the literature with the frequencies out of 32 references. According to the findings, the cost overrun factors can be categorized mainly into 4 categories such as related to project financier/owner, related to designers and consultants, related to contractor and related to external environment.

In most of the research papers, owner-related cost overrun factors have been elaborated as crucial in most of the segments in the construction industry such as civil & infrastructure development, building construction, Mechanical, Electrical & Plumbing (MEP), and rehabilitation as well as renovation works. According to Alinaitwe, et al. (2013), cost overrun factors would relate to the financier of the project have made a critical impact on the overall cost overrun of the project as the project is supposed to finance and lead by the owner. If any error occurs in virtue of the client's fault such as delay in decision making, faulty documents and inaccurate briefing the significance would be quite considerable (Olubunmi and Olukanyin, 2015).

The designers and consultants would manage the project on behalf of the owner of the project throughout the project period from initiation to completion (Rajakumar, 2016). Therefore, in any segment of the construction industry the management, consultation to the employer and coordination of the project would be done by the consultants. As explained by Park and Papadopoulou (2012), designer and consultant related cost overrun

factors may affect in the whole life cycle of the project as design and consultation are of utmost important attributes that requires competence and careful attention.

Amoa-Abban and Allotey (2014) found that the cost overrun is crucially affected by the factors relating to the contractor. From the submission of the bid to the handing over of the project to the employer, there are numerous aspects in which the cost overrun may occur in relation to the contractor (Baloi and Bekker, 2011). Among many cost overrun factors, inexperience, incompetence and delays cause a major role in cost overruns in construction projects.

Apart from the major three parties (i.e., Owner, Consultant, and Contractor) involved in a construction project, there are certain other factors attribute that may lead to cost overruns (Amoa-Abban and Allotey, 2014). Those factors can be categorized as external factors which inclusive of different stakeholders to the construction projects such as sub-contractors, labors, public, government, and suppliers. Moreover, there are certain other aspects relating to the external environment such as the economic condition of the country, weather conditions, man-made and natural disasters, and epidemics and pandemics which may have a massive impact on cost overrun in construction projects.

3. METHODOLOGY

A comprehensive literature synthesis has been carried out to gather information regarding the key components of the research such as cost overrun factors, cost overrun, and issues related to the construction industry around the world. This research then adopts a mixed research approach in order to investigate the cost overrun factors in the pre-contract and post-contract stages of construction projects in Sri Lanka. The mixed research approach diminishes the limitations associated with monomethod and enhances the rationality and reliability of collected data by assisting complementarity, and the advancement, initiation and expansion of study findings. Furthermore, this type of methodological triangulation allows to distinguish the variances or similarities among the results that can remain unexplored when one research approach is applied.

3.1 SEMI-STRUCTURED INTERVIEWS

The face-to-face interviews were conducted 5 Qs occupied in the construction industry who have the experience in both pre-contract stage and post-contract stage, working in contracting organizations (refer Table 2).

Table 2: Details of the interviewees

Interviewee	Organization Type	Designation	Experience (Years)
IP-1	Consultant/Contractor	Director	27 Years
IP-2	Contractor	General Manager- Contracts	16 Years
IP-3	Contractor	Assistant General Manager - Estimation and Contracts	15 Years
IP-4	Contractor	Quantity Surveyor and Estimator	12 Years
IP-5	Contractor	Contracts Manager and Quantity Surveyor	17 Years

The interviewees were chosen through convenient sampling. The industry professionals, who were having experience in post-contract cost management and technical aspects of

cost estimation were selected as per the role they performed. Accordingly, industry practitioners, who were involved in cost management and cost estimation were selected. Categorize the pre-contract related and post-contract related cost overrun factors according to the Sri Lankan context based on how often those factors can occur in either stage, were the main roles considered, for selecting the respondents.

3.2 QUESTIONNAIRE SURVEY

The questionnaire survey was carried out targeting professionals in the construction industry who had knowledge of the construction cost and involved in either pre-contract stage or post-contract stage. Hence, non-random convenient sampling was selected as the sampling technique. Data were collected from 40 pre-contract involved professionals and 40 from post-contract involved professionals out of distributed 93 questionnaires obtaining a response rate of 86%.

A questionnaire survey was conducted among professionals who have experienced in contracting organizations in order to evaluate the significance based on their perspective. The collected data were then analyzed using Mann-Whitney U test. The rankings of the individual values in two groups are determined and then those ranks add up and derive the rank sum which usually denotes by T. Then the U-values are calculate using formulas (Eq. 01).

$$U_1 = n_1 * n_2 + \frac{n_1(n_1+1)}{2} - T_1 \quad U_2 = n_1 * n_2 + \frac{n_2(n_2+1)}{2} - T_2 \quad (Eq. 01)$$

n_1 – Number of cases in group 1

n_2 – Number of cases in group 2

T_1 – Rank sum in group 1

T_2 – Rank sum in group 2

Once the U numbers are calculated, then minimum U number is taken for further calculations. $U = \min(U_1, U_2)$. The minimum U number is taken from the minimum value of U_1 and U_2 . Then the expected value of u (μU) and standard error of U (σU) is taken by applying the following formulas (Eq. 02).

$$\mu U = \frac{n_1 * n_2}{2} \quad \sigma U = \sqrt{\frac{n_1 * n_2 * (n_1 + n_2 + 1)}{12}} \quad (Eq. 02)$$

Once these calculations are done then the Z value is derived by using the following formula (Eq. 03).

$$Z = \frac{U - \mu U}{\sigma U} \quad (Eq. 03)$$

Once the Z value is calculated then the related P-value of that Z -value can be derived by using Z -value tables. Then it can be determined whether to reject or retain the null hypothesis.

Null hypothesis - There is no difference in difference between two groups in the population.

Alternative hypothesis - There is a difference between two groups in the population.

4. RESEARCH FINDINGS AND ANALYSIS

4.1 FINDINGS OF THE SEMI-STRUCTURED INTERVIEWS

Findings of the semi-structured interviews are presented below.

4.1.1 Cost Overrun Factors Directly Related to Pre and Post-Contract Stages

According to the interviews carried out, the above cost overrun factors are sorted as the most probable of occurring in pre-contract stage and/or post-contract stage. Thus, it has higher likelihood of appearing in the respective stage/s and impact to the cost overrun in the Sri Lankan construction industry. The thematic analysis of the qualitative data reveals that the majority of the interviewees believe these factors have a relevance to the respective stage/s and even stated certain factors as “*highly related*” and “*definitely related*”, which convince that these factors have the top priority when consider the relevance for pre-contract stage and post contract stage.

4.1.2 Cost Overrun Factors Partially Related to Pre and Post-Contract Stages

The above cost overrun factor have less relevance according to the majority of the respondents. These factors cannot be completely eliminated by stating these factors are irrelevance in either stage for cost overrun. They have a certain likelihood of occurring and impact to the cost. The majority of the interviewees stated these factors as “*partially related*” and “*may be related*” which emphasize the weak relevance to their respective stage.

4.1.3 Cost Overrun Factors Not Related to Pre or Post-Contract Stages

The aforementioned factors are more likely to occur in the opposite stage in which they have been mentioned. Thus, the effect of cost overrun will not be there as these factors are more likely to not appear in the particular stage and interviewees reason out why they do not cause any cost overrun in that particular stage. IP-1 argued regarding the delayed payments factor as “*usually, the interim payment application happens in the post-contract stage so only in that stage delay can be occur if any. So, no relevance to the pre-contract stage as no payment is done in that stage since that stage is prior to award the contract*”. Moreover, IP-1 expressed that the reason for non-relevance of the lowest bid might not be the most technically feasible bid as “*this can happen in tender evaluation phase which is happened in pre-contract stage*”.

4.1.4 Cost Overrun Factors Not Related to Both Pre and Post-Contract Stages

As per the perspective of the interviewees, the factors shown in Figure 1 have been eliminated for further analysing as they are not related to cost overruns in construction projects. These factors also confirmed by at least 3 members out of 5. Different reasons have been identified for denying those factors and some factor has their unique feature in order to get eliminated from this initial analysis.

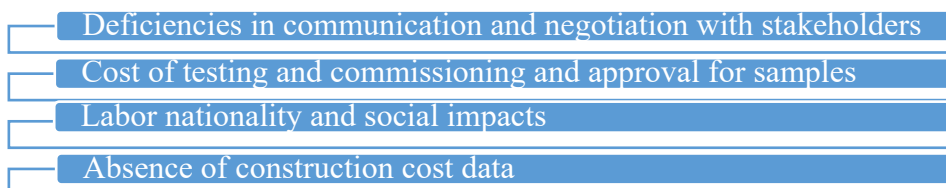


Figure 1: Cost overrun factors not related to both pre and post-contract stage

Excluding the factors mentioned in Figure 1, all the other factors have been categorized into pre-contract and/or post-contract stages and further proceed to questionnaire survey to evaluate the significance. Hence, in the pre-contract stage, there were 35 factors and in the post-contract stage, 39 factors have been categorized as related factors.

4.2 FINDINGS OF THE QUESTIONNAIRE SURVEY

A questionnaire survey was carried out among the professionals involved in cost estimation and controlling in Sri Lankan construction projects. The professionals were asked to indicate the significance of the cost overrun factors using 10-point Likert scale. The collected quantitative data were analysed using SPSS software. Figure 2 depicts the data distribution histogram and Figure 3 shows the results of Mann-Whitney U-test.

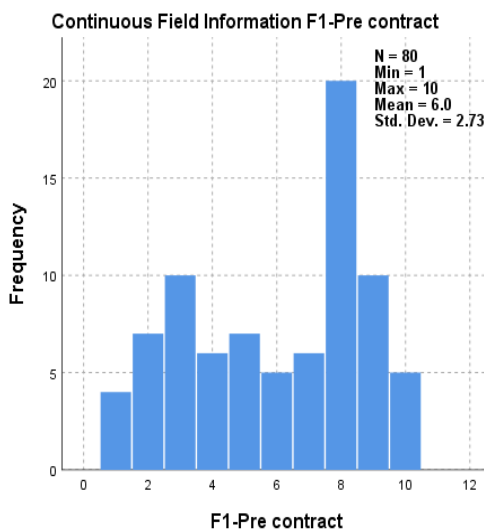


Figure 2: Data distribution histogram

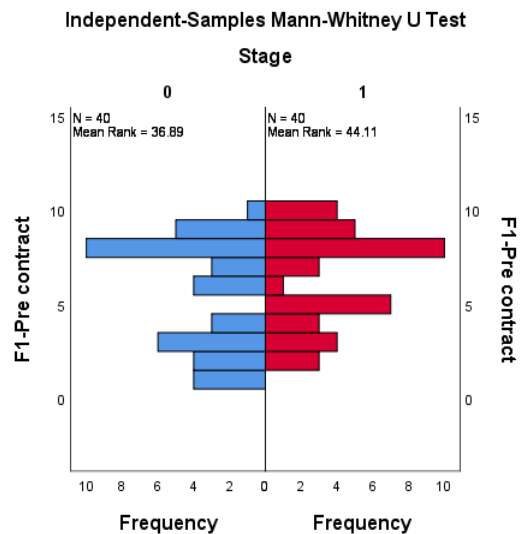


Figure 3: Mean rank distribution graph

The above histogram of frequency demonstrates the numerical data set (significance of the particular cost overrun factor in Likert scale) is not normally distributed. Therefore, the parametric t-test cannot be applied due to non-normality of data, and Mann-Whitney U-test needs to be adopted as these numerical data are non-parametric.

As demonstrated in Figure 3, there is a sizeable difference in mean rank for two stages (36.89 in the pre-contract stage and 44.11 in the post-contract stage). However, by referring to the above graph alone cannot come to a conclusion that there is a statistically significant difference is there. To determine it, the results of the Mann-Whitney U test need to be referred and analyzed. If the test result shows that the p-value of the corresponding Z-value is less than 0.05 (alpha value), then only it can be stated as those two groups have a statistically significant difference. When the p-value is less than 0.05, it means that the standard error of rejecting the null hypothesis is less than 0.05(5%). Thus, the result supports that there is more than 95% confidence of rejecting the null hypothesis which is, there is no difference between pre-contract and post-contract stages in terms of the significance of the factor.

4.2.1 Hypothesis test

Once the Z-value is calculated corresponding p-value (0.160) has been denoted as Asymptotic significance in 2-tailed test. Since the sample size is greater than 20, the p-value (Asymptotic significance) can be taken or otherwise the significance value is derived from U value. This will be further confirmed by the hypothesis test summary which was generated from the SPSS software as shown in Table 2.

Table 2: Hypothesis test summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of F1- Pre contract is the same across categories of Stage.	Independent-Samples Mann-Whitney U Test	0.160	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is 0.050

SPSS reports that the 2-tailed p-value is 0.160 which is quite higher than the 0.05 (the standard alpha level) and it is therefore, concluded that the null hypothesis cannot be rejected as the null hypothesis can be rejected only if the p-value is less than the alpha value (0.05). Therefore, the null hypothesis shall be retained based on the available data.

4.2.2 Hypothesis Test Results

Thus, there is no statistically significant difference in mean rank between the pre-contract stage and post-contract stage in terms of the significance of factor F1(owner’s financial crisis) in pre-contract stage. The above results demonstrate the results of F1 in pre-contract stage. To obtain the conclusion of whether there is a difference in perspective of the cost overrun factors between professionals in pre & post stages, it was required to carry out 74 number of Mann-Whitney U tests (35 in pre-contract and 39 in post-contract) for each cost overrun factors and results are then summarized. Out of 74 tests, 45 tests resulted in rejecting the null hypothesis as in all those tests, the p-value is less than 0.05. Thus, all cost overrun factors that come under those 45 tests, have a different perspective in professionals between pre-contract stage and post-contract stage. It is 60.81% out of total tests. Therefore, it can be stated that 60.81% cost overrun factors have been rated as significantly different by the professionals involved in the two phases of the projects.

4.3 DISCUSSION

One of the major issues of the construction industry is that no proper management and knowledge is sharing between pre-contract stage and post-contract stages in contracting organizations. This was the reason for carrying out this research specifically and to statistically evaluate the view of the industry professional’s perspective on the significance of cost overrun factors, based on the stage in which they are involved. The output of the tests can be interpreted as it supports the statement which means professionals involved in the pre-contract stage view the cost overrun factors in a way different to professionals involved in post-contract stage. Usually, estimators are carrying out price estimation based on their perspective and the way they incorporate certain risk measures and activities to mitigate cost overrun would be completely based upon their assumptions and perspective. When it comes to the physical construction of the project, post-contract involved professionals provide the priority to the cost-related activities

based on their opinion and they have limited knowledge on the perspective of the estimation team. This can lead to allocate time, money and other resources by the post-contract team, which might have been forecasted as unnecessary by the pre-contract team.

For instance, when there are two cost overrun factors (F1 & F2) occurring in the construction phase and the post-contract team view F2 as the most significant cost overrun factor and allocate resources to mitigate the cost overrun. However, the pre-contract team has a different perspective and they have prepared the estimation by viewing F1 as the most significant cost overrun factor and therefore, there is an unnecessary cost overrun can be occurred due to this poor understanding of these two phases. Therefore, this situation needs to be avoided by proper coordination and conducting frequent meetings and knowledge-sharing sessions in the construction projects.

5. CONCLUSION AND RECOMMENDATIONS

The current research well-identified that the poor pre-contract and post-contract management and coordination have a massive impact on this cost overrun. The professionals working in one phase have less knowledge and concern on what other professionals concerned about the significance of cost overrun factors. The responses on each factor have been tested by using the Mann-Whitney U test to examine whether there is any statistically significant difference in significance of the cost overrun factor in the particular stage in terms of the perspective of pre-contract stage involving professionals and post-contract stage involve professionals. Therefore, this statistical analysis further confirmed the discussion on the problem statement which is the poor coordination between pre-contract and post-contract is also happening in the Sri Lankan construction industry. Immediate attention requires for this issue and proper coordination between pre-contract stage and post-contract stage shall be established rather than limited to several kick-off meetings in order to minimize the cost overruns of construction projects.

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