Contractor-related Cost Overrun Causes, Controlling Tools and Techniques: Study on Selected Building Construction Projects in Colombo District

KKK Hansika[1#], GPMCM Bandara[1] and AP Karunaratne[2]

[1]*Department of Quantity Surveying, University College of Kuliyapitiya (University of Vocational Technology), Sri Lanka*

[2]*Central Expressway Section 2 Project, Deputy Director's Office, Gattuwana, Kurunegala, Sri Lanka*

[#]hkrishani15@gmail.com

Abstract– Construction projects in Sri Lanka often fail completion within the specified time and cost allotted for the projects. Hence, cost overrun and delays are major problems that construction projects frequently experience. Many stakeholder-related causes affect cost overrun in construction projects despite their attempt to minimize cost overrun using various methods. Among them, there is a considerable proportion of Contractor-related causes. Therefore, this study attempted to find significant Contractor-related cost overrun factors and apposite cost controlling techniques that can be used to minimize the likely impact of cost overrun on building construction projects in Sri Lanka. This study primarily focused on completed or ongoing building construction projects between the years 2010 to 2019 located in Colombo District. First, a literature review was carried out and Contractor-related cost overrun causes and cost controlling techniques in general were identified. Then, a questionnaire survey was conducted among eighty professionals who worked in building construction projects in the Colombo district belonging to contracting companies with above C3 level Construction Industry Development Authority (CIDA) grade. Sixty-two of them were responded to and considered as valid for further analysis. The ultimate result was obtained through the Relative Importance Index (RII) technique, and the results revealed 'poor project management skills' as the most significant contractor-related cost overrun cause. Besides, the results disclosed the implementation of the labour controlling mechanism as the most prominent cost controlling method that can be utilized for minimizing contractor-related cost overrun causes.

Keywords: *cost overrun, contractor causes, cost controlling techniques, cost controlling tools*

I. INTRODUCTION

A. Background to study

The construction industry can be considered as the mighty pioneer of the country's economy which allocates a substantially higher percent for Gross National Product (Navon, 2005). Hence, the construction industry consists of a complex stakeholder network that defines the growing success of a nation worldwide. Similar to the other countries in the world, the Sri Lankan construction industry also contributes to the country's Gross Development Product by 7.1% (Jayasuriya, 2019). Hence, managing construction projects in Sri Lanka is extremely important in terms of economical perspective.

The fundamental controls required for managing a construction project are cost, time, and quality controls. According to the price indexes issued by the Institute of Construction Training and Development, a total construction project cost is increased by 12.2% annually, though it was 5.4% in 2011 (Jayamaha, 2019). Therefore, cost control is important for the success of every construction project. However, most of the construction projects suffer from budget overrun and the Contractors significantly cause the factors behind construction cost overrun (Zewdu and Aregaw, 2015). Mainly, the insufficient lowest bidding method used for the selection of potential Contractors affects project cost overrun in Pakistan (Azhar et al., 2008). As a result of poor planning for managing the construction projects,

Contractors often lead to many budget issues (Vafaiee et al., 2010). Therefore, it is required to keep the "S" curve, a monitoring tool for the construction projects, as it is without any major deviations for protecting the employer's requirements and project value.

All construction companies in the world attempt to provide profit from any project as their final objective. To successfully achieving this objective, all stakeholders should work within the employer's requirements and especially within the estimated project value. Moreover, the project should not be delayed (Polat et al., 2014). According to Doloi (2011), over-budgeting can be identified as one of the severe problems faced by civil and building projects at the time of their completion. Due to the excess stakeholder engagement, high administration cost also evident in construction projects (Doloi, 2011). Rahman et al., (2013) also state the cost overrun as one of the most regularly affected problems in global construction projects. Moreover, if the contractor or other stakeholders did not manage construction project cost without saving, it directly affects the construction project progress, changes the financial savings of the company, and abuse the national budget as well. According to Ali et al. (2010), if the stakeholders perform with the utmost care and provide clear advice and make correct decisions for the construction works, the employer's budget can keep at the expected margin. Cost overrun always affects the project progress and it is a common problem in almost all construction projects. Therefore, all stakeholders should be aware of the causes behind the cost overrun of construction projects and how to mitigate them in a practical situation.

This study mainly examines the causes behind the contractor-related cost overrun causes and tries to identify relevant cost controlling tools and techniques to mitigate the cost overrun issues.

In Indian construction projects, various factors affect cost overrun such as material shortage, shortage of labour, late delivery of materials and equipment, unavailability of competent staff, the low productivity level of labours, quality of equipment and raw materials, etc. (Tejale et al., 2015). Reddy, Raya & Prakash (2016) also mention lead factors of cost overrun such as; frequent design changes risk associated with projects, inaccurate evaluation of project period, tax liabilities, and the complexity of works and, further suggest the methods for mitigating cost overrun. Apart from the cost categorization, Subramani (2014) also studies mainly the leading cost overrun factors. Rathi & Khandve (2016) analysed time extension and cost overrun causes concerning Indian construction projects and further provides mitigation methods for cost overrun.

According to the literature review findings, various local and international researchers have identified numerous causes behind cost overrun, as cited in Table 1.

Table 1. Causes behind cost overrun

No	Cost overrun causes	Citations
1	Poor project management skills and practices	Malkanthi, et al (2017), Okpala and Aniekwu (2016), Mansfield et al. (1994), Memon et al. (2014)
2	Inaccurate Quantity Take-off (Lump sum /Design & build)	Ramabodu and Verster (2013)
3	Insufficient project planning and scheduling	Akram et al. (2017), Memon et al. (2014), Vaardini (2016), Nega (2008), Memon et al (2011), Wanjari & Dobariya (2016)
4	Poor time management	Sriram (2018), Ramabodu and Verster (2013)
5	Poor analysis of site condition	Alinaitwe et al. (2013)
6	Poor site management and supervision	Alinaitwe et al. (2013), Hoai et al. (2008), Mansfield et al. (1994), Vaardini (2016), Memon et al (2011), Memon et

		al. (2014), Okpala and Aniekwu (2016),
7	Obscurity in the contract documents	Ramabodu and Verster (2013)
8	Poor financial control on-site	Azhar et al., (2008), Vaardini (2016)
9	Wrong method of cost estimation	Akram et al. (2017), Gundaz and Maki (2017), Bekker and Baloyi (2011), Vaaedini (2016), Mansfield et al. (1994)
10	Not decided on the construction materials	Polat et al., (2014), Okpala and Aniekwu (1988), Nega (2008), Pirabahar et al., (2017), Salah and Shibnai (2015), Malkanthi, et. al (2017)
11	Lack of relationship between the management and labor	Memon et al (2011)
12	Shortage of skilled labor	Azhar et al., (2008), Gundaz and Maki (2017), Memon et al. (2014),
13	Services available on site not sufficiently exposed	Jackson (2002), Ramabodu and Verster (2013)
14	The fluctuation of prices	Mansfield et al., (1994)
15	Unplanned weather Conditions	Vaardini (2016)
16	Unnecessary storage of material, labour or machinery	Insaj (2017), Mansfield et al., (1994), Okpala and Aniekwu (1998)
17	Political instability	Alinaitwe et al. (2013)
18	Government legislations	Sriram (2018)
19	The high cost of transportation	Pirabahar et al., (2017), Gundaz and Maki (2017)
20	Variations	Nega (2008)
21	Mistakes during construction	Pirabahar et al., (2017), Memon et al (2011), Mansfield et al. (1994)

In addition, there are different types of cost controlling techniques that can use to mitigate cost overrun in construction projects as Earn value management, Cash Flow Forecasting, To-Complete index, Variance Analysis, and Performance reviews (Project Management Institute, 2004). Moreover, several records to be maintained such as unit cost sheets, subcontractor's payments, weekly statements of labour, and machines/ material cost for controlling the costs. Since cost controlling is somewhat difficult for professionals in the construction industry, they have to have a thorough understanding of cost controlling techniques (Malkanthi et al., 2017).

II. METHODOLOGY

The methodology includes investigation methods for objectives, research scope, research limitations, sampling technique, methods for data gathering, and analysis. Rajasekar et al. (2006) state that research methodology is the plan that introduces the researcher's actual work-study that explains and forecasts.

Data collection limited to a sample of 20 building construction projects in the Colombo district that belongs to C3 or above CIDA classified contractors. Snowball sampling technique was used for project selection. A detailed questionnaire was developed and distributed among 80 different construction industry professionals who worked on the selected projects. Out of them, 62 professionals were

responded and considered as valid for further analysis.

As a result of a detailed literature review, 25 numbers of contractor related cost overrun causes, 4 numbers of cost controlling tools, and 12 numbers of cost controlling techniques were identified and tested the same with the use of a detailed questionnaire concerning their applicability for building construction projects in Colombo district. The questionnaire consisted of four sections namely; demographic responses, Identification of contractor related cost overrun causes, cost controlling tools, and cost controlling techniques. As Ikechukwu et al. (2017) suggested, frequency values obtained to analyze demographic data.

Collected data referred to the subsequent sections of the questionnaire analyzed with the use of the Relative Importance Index (RII) method.

$$\text{Relative Importance Index(RII)} = \frac{\sum W}{AN}$$

W = Weight given to each attribute by the respondent

A = Frequency of response

N = Total number of responses

Here, "N" is constant since the total number of responses for this research equals 62. Besides, "A" and "W" are variables. A five-point Likert scale also used to support RII calculations as shown in Table 2.

Table 2. Likert Scale

Level of Importance	Scale
Extremely important	5
Very important	4
Important	3
Less important	2
Not important	1

III. RESULTS AND DISCUSSION

A. Demographic responses

The total number of respondents epitomized Client, Contractor, and Consultant categories as in Table 3. 85.5% among them represented contractors' party.

Table 3. Respondents' categories

Respondent category	Respondent %
Client	1.6%
Contractor	85.5%
Consultant	12.9%

According to designation categories, 50% of respondents were Quantity Surveyors (QS). Hence, it can be considered as a good rate of response since the QSs are the experts who directly monitor cost sequences of construction projects and who often use cost controlling tools and techniques. Besides, more than 60 % of them had a degree or more qualifications and, 64.5% of them had at least ten years of experience in the construction industry.

B. Contractor related causes behind cost overrun

Though there were other causes for cost overrun, this study was limited to contractor's causes behind cost overrun. Tabulated results of RII values and the rankings of contractor-related cost overrun factors are summarised as in Table 4. Accordingly, the most significant contractor-related cost overrun factors can be identified.

Table 4. Contractor-related causes behind cost overrun

Contractor-related causes behind cost overrun	RII	Rank
Poor project management skills	0.871	1
Inaccurate Quantity Take-off (Lump sum /Design & build)	0.823	2
Insufficient project planning and scheduling	0.816	3
Poor time management	0.813	4
Poor analysis of site condition	0.806	5

Poor site management and supervision	0.790	6
Problems with sub-contractors	0.777	7
Obscurity in the contract documents	0.774	8
Poor financial control on site	0.765	9
Wrong method of cost estimation	0.758	10
Not decided on the construction materials	0.739	11
Lack of relationship between the management and labour	0.735	12
Shortage of skilled labour	0.729	13
Services available on site not sufficiently exposed	0.703	14
Proposed services not fully followed	0.700	15
The fluctuation of prices	0.687	16
Unplanned weather Conditions	0.677	17
Unforeseen tasks	0.677	17
Late delivery of material and equipment	0.677	17
Unnecessary storage of material, labour or machinery	0.613	20
Political instability	0.603	21
Government legislations	0.590	22
High cost for transportation	0.587	23
Variations	0.529	24
Mistakes during construction	0.484	25

As per the tabulated RII values, the most significant contractor-related cause behind cost overrun was the poor project management skills though it is not significantly dominated by Malkanthi et al. (2017). Moreover, Mahawatte (2021) also indicated the impact of poor project management skills on contractor's cost overrun in Sri Lankan building construction projects and highlighted the skills improvement requirement in stakeholder management, schedule management and communication management areas of project management. Inaccurate Quantity Take-off (Lump sum /Design & build) reached the 2nd position of the causes list with the recording of 0.823 RII value. As Nega (2008), Memon et al. (2011), Jayamaha (2019), and Wanjari & Dobariya (2016) identified, insufficient project planning and scheduling can be considered as a highly prominent contractor relate cost overrun factor which was at the 3rd rank in this research resulted with 0.816 RII value. Moreover, poor time management reached 0.813 RII amount and positioned at 4th position among the top-rated contractor-related cost overrun causes. Also, poor analysis of site conditions and site management/ supervision hold 5th and 6th positions of the causes list respectively.

Though Omotayo et al. (2017) stated poor contractor-subcontractor relationship as a less prevalent factor to cost overrun; it was among the top ten causes with its 0.777 RII value in this research. The cause of poor detailed drawings and specifications was ranked among the uppermost three causes by Alumbugu et al. (2014) in their research. However, according to the tabulated results in this research, the cause of obscurity in the contract document was at the 8th position with a 0.774 RII value.

Poor financial control on-site was positioned at 2nd in Omotayo, et al.'s (2017) findings, though it was in the 9th position with a 0.765 RII value. According to Jayamaha (2019), poor financial status was not highly influenced to cost overrun, despite its importance in managing a construction project. As justified by Omotayo et al. (2017) and Malkanthi et al. (2017), the 'selection of wrong cost estimation methods' can be considered as somewhat influential contractor-related cost overrun factor due to its RII value of 0.758. 'Shortage of material, labour, or mechanical Plants' was the topmost cause identified by Malkanthi et al. (2017), though it was not a prominent contract-related cause in this research.

Besides, political instability, government legislation, high cost of transportation, variation, and mistakes during construction are the other factors that comparatively less prevalent due to their low RII values.

C. Cost controlling tools

As shown in Table 5, BOQ items, unit rates, S curve, and engineering estimate stated as significant cost controlling tools that can be used to mitigate contractor-related cost overrun causes.

Table 5. Cost controlling tools

Cost Controlling Tools	RII	Rank
BOQ items	0.884	1
Unit rates	0.865	2
S curve	0.794	3
Engineering estimate	0.790	4

Due to the highest RII value, 'BOQ items' can be considered as the topmost cost-controlling tool. Then, 'Unit rates' can also be deployed as a tool owing high RII value of 0.865 RII. Abobakr (2018) also indicated the importance of unit rate as a cost-controlling tool. Moreover, the S-curve was at 3rd place with a 0.794 RII value. Compared to the other cost-controlling tools, there was the least response rate for using engineering estimates as a cost-controlling tool.

D. Cost controlling methods

By considering the results indicated in Table 6, the most effective cost controlling method to mitigate contractor-related cost overrun causes was the labour control due to the highest RII value of 0.861. It was the 2nd best cost controlling technique identified by Malkanthi et al. (2017). Otim et al. (2011) also stated that work programming is the most widely used cost controlling technique with a 16.3% portion of responses. However, accurate work programming (including MS project work) and record-keeping equally shared 2nd highest value of 0.855 for RII in this study. Besides, 'regular inspection of Works' was at the 3rd place while 'cost value reconciliation' reached the 4th position with an RII value of 0.809. However, cost value reconciliation was the widely used cost controlling method in world construction projects (Abobakr, 2018). Otim et al. (2011) also exaggerated the importance of regular inspections and record-keeping as cost-controlling methods.

Variance analysis, as a method for cost controlling, was placed 6th in the list. Earned value management, Forecasting, and Evaluation of works carried out equally obtained RII value of 0.794. However, Earned value management was the 3rd highly responsive cost controlling technique in the research conducted by Malkanthi et al. (2017). Though Otim et al. (2011) stated the importance of evaluating works carried out for cost control purposes in Uganda; it was in the 7th position in this research. Though Site meetings, To-Complete Performance Index (TCPI), and performance reviews are important to mitigate cost overrun, those methods respectively obtained insignificant RII values in this research. Malkanthi et al. (2017) also denoted no significance of TCPI and performance reviews as cost controlling techniques. However, regular site meetings were somewhat influential for accurate cost controlling (Otim et al., 2011).

Tabulated results of cost controlling techniques can be summarized as shown in Table 6.

Table 6. Cost controlling methods

Cost controlling methods	RII	Rank
Labour controlling	0.861	1
Work programming	0.855	2
Record keeping	0.855	2
Inspection of works	0.813	4
Cost value reconciliation	0.810	5
Variance analysis	0.800	6
Earned value management	0.794	7
Forecasting	0.794	7
Evaluation of works carried out	0.794	7
Site meetings	0.781	10

To-complete performance index (TCPI)	0.690	11
Performance reviews	0.681	12

IV. CONCLUSIONS

Cost overrun is one of the critical issues associated with building construction projects in Sri Lanka. Though there are substantial ways and means available for cost controlling in present-day building construction projects, Sri Lankan contractors often experience cost-over run issues in their building construction projects. Therefore, this study primarily attempted to identify the actual contractor-related cost overrun causes, aiming to propose a mechanism to minimize the impact of cost overrun for the contractors. Among the prominent contractor-related cost overrun causes associates with building construction projects in the Colombo district, the study indicates poor project management skills substantially impact cost overrun in building construction projects. Therefore, it is apparent that thorough improvements of contractor side project management skills in areas such as stakeholder management, communication management, and schedule management are essentially required to minimize the contractor-related cost overrun issues. However, further researches need to be conducted, by covering different types of construction projects all over the country, to generalize the research findings.

The study further proved inaccurate quantity take-offs in lump sum/ design and build contracts as one of the prominent causes behind cost overrun in building construction projects. Meantime, theoretical and empirical investigations in this research suggested that the building contracting professionals extensively need to use BOQ items and unit rates as cost control tools. Hence, there is a crucial responsibility for contractor's quantity surveyors to minimize the cost overrun in building construction projects in Sri Lanka since they are the experts in quantity take-offs and preparation of BOQs and unit rates.

Moreover, improved labour controlling mechanisms and accurate work programs supported by modern project planning software can be utilized as effective cost controlling techniques to minimize the contractor-related cost overrun causes of building construction projects in the Colombo District. However, more research gaps still exist to investigate to produce a sound framework for minimizing the contractor's cost overrun issues. Taking this into account, the most effective cost control tools and techniques suit for each identified cost overrun cause are essential to be identified & analysed separately. Further, specific project management areas that need to analyse skills to be improved are also required to find in further researches. Besides, analysing the existing level of modern technology used for cost controlling purposes and required technology advancements are among the future research avenues.

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AUTHOR BIOGRAPHIES

Ms. K.K.K. Hansika is an undergraduate standing at Higher National Diploma in Quantity Surveying NVQ level 6 course of Department of Quantity Surveying, University College of Kuliyapitiya attached to University of Vocational Technology, Sri Lanka.

Mr. G.P.M.C.M. Bandara is a Masters in Quantity Surveying degree holder at Birmingham City University, United Kingdom. He is currently serving as the internal academic and research coordinator of the Department of Quantity Surveying at the University College of Kuliyapitiya attached to University of Vocational Technology, Sri Lanka.

Mr. A. P. Karunaratne is a Chartered Quantity Surveyor having thirteen years of experience in the construction industry. He holds a BSc. Quantity Surveying (Hons) degree from the University of Moratuwa and serving as an external supervisor to the Department of Quantity Surveying, University College of Kuliyapitiya attached to University of Vocational Technology, Sri Lanka.