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THE IMPACT OF MATERIAL AND LABOUR COST VARIABLES ON CONTACTORS' BUDGETED COST

R.D.W.W. Jayathilaka[1], K.G.A.S. Waidyasekara[2] and D.C. Sirimewan[3]

ABSTRACT

An accurate budget is important for all construction stakeholders, but it is difficult to maintain the budget within the initial estimation. The contractors' financial stability tends to complete the projects within the budgeted cost without destructing the contractors' cash flow. The major impact for the contractors' budgeted cost overrun in construction projects has happened with the material and labour costs. Therefore, it is necessary to find the contribution of material cost and labour cost to the contractors' budgeted cost in construction projects to minimise contractors' budgeted cost overruns. This research aims to analyse the impact of material and labour costs on contractors' budgeted costs in building construction projects, Sri Lanka. Hence, three-building construction projects were selected, and documentary review was the main data collection tool to find the required data. Sensitivity Index (SI) in Sensitivity Analysis was adopted for data analysis. As research outcomes, the average contribution of material cost to the cost of civil work was assessed as 60%, whereas the cost of labour was indicated as 35%. Moreover, plastering, tiling and painting works were identified as the main civil work categories that can highly influence the material and labour cost overruns in Sri Lankan building construction projects and ultimately would impact the contractors' budgeted cost. Therefore, contractors should pay special attention to the budgeted cost of these work categories when preparing the initial budget.

Keywords: *Contractors' Budget; Cost Overrun; Labour; Material.*

1. INTRODUCTION

The construction environment is characterised by a high level of competition, complex operations, high-risk conditions, stressful and well knowledgeable clients (Tarawneh, 2014). According to the findings of Mokhtariani, et al. (2017), time, cost, and quality represent the main attributes of a construction project, which cannot be accurately determined or evaluated before contracting and cease of the project. Deferment in payments and overestimation of investment opportunities are the reasons behind the absence of money for maintaining a business (Anysz and Rogala, 2019). The loss of financial liquidity is a reason for most of the construction companies' bankruptcy (Alavipour and Arditi, 2018). Liu and Zhu (2007) suggested that accurate prediction of construction costs is heavily depending upon the availability of historical cost data and the level of professional expertise. Moreover, a clearer understanding of the cost

[1] Department of Building Economics, University of Moratuwa, Sri Lanka, jayathilakardww.21@uom.lk
[2] Department of Building Economics, University of Moratuwa, Sri Lanka, anuradha@uom.lk
[3] Department of Building Economics, University of Moratuwa, Sri Lanka, dianis@uom.lk

determinants is vital to achieving the desired level of accuracy of anticipated costs of labour, material, plant, and equipment in total cost estimation (Enshassi, et al., 2009). Flyvbjerg, et al. (2007) mentioned that the misallocation of insufficient resources can be happened due to the inaccurate budget. The involvement of subcontractors, suppliers, and manufacturers during the estimation process will positively affect having an accurate budget (Arif, et al., 2015). Many types of research focused on factors affecting budget overruns, but there is an insufficient number of researches that focused on how to minimise the impact of those factors (Olawale and Sun, 2010). Consequently, there is a need to predict cost overruns, reasons for cost overruns, as well as the impact of variables that can influence cost overruns (Annamalaisami and Kuppuswamy, 2019). Hence, the paper presents how the material and labour cost can influence the contractors' budgeted cost adopting sensitivity index. The adjacent topics of the paper present literature review, research methodology, research findings and discussion and conclusions.

2. COST OVERRUN IN THE CONSTRUCTION INDUSTRY

As stated by Memon, et al. (2010), the cost is one of the major considerations and an important parameter of a construction project. Traditionally, the client and the contractor have a high influence on project cost performance as the main stakeholders of a construction project (Deshmukh and Menkudle, 2019). In most instances, the actual cost of a construction project can differ from the agreed contract amount concerning clients' decisions, project attributes, and contractual aspects (Skitmore and Ng, 2003).

2.1 COST OVERRUN IN CONSTRUCTION PROJECTS

The term 'cost overrun' in the construction industry is used, where the expected project cost is increased or the estimated budget of a project is exceeded (Al-Hazim, et al., 2017). Also, an accurate budget ensures that the design of the project is in line with the original scope (Odeyinka, et al., 2010). According to Potts and Ankrah (2014), most project owners are not working with flexible cost plans in construction projects. Therefore, if the budget is exceeded, the total arrangement of the project will be unsuccessful (Feng and Li, 2014). Huo, et al. (2018) reported that the average cost overrun in the Hong Kong construction industry is 39%, and it is nearly 34% for retail projects, 32% for road projects, and 37% for projects like bridges, tunnels. Cost overrun in Portugal construction projects is nearly 12% (Moura, et al., 2007).

2.2 CONTRACTORS' BUDGETED COST OVERRUN

The poor cost performance has become a major concern for the clients as well as the contractors in construction projects (Xiao and Proverbs, 2002). Most construction projects do not have satisfactory records regarding project completion within the budget (Aljohani, et al., 2017). Therefore, budget overrun is treated as a 'regular feature' in the construction industry (Morris, as cited in Aljohani, et al., 2017). Azis, et al., (2012) stated the budget as "a financial evaluation of the future courses of action set out in a business plan" (p. 626). According to Flyvbjerg, et al. (2003), contractors' budgeted cost overrun can define as the difference between initial budgeted cost and the actual cost of a project at completion. Dakhli and Lafhaj (2019) stated that there is a considerable difference between contractors' budgeted cost and the actual cost at completion in many construction projects. According to Shrestha, et al. (2013), large sized, and long duration projects have a higher percentage of budget overrun compared to the small sized, and

short duration projects. Researchers stated that it is important to identify the factors that contribute to budget overrun to avoid and reduce the problems (Ali and Kamaruzzaman, 2012). The confined records available at the early stages of construction projects imply that the quantity surveyor must make assumptions on the design details of a project, which may not eventuate as the design, planning, and construction evolve (Liu and Zhu, 2007).

2.3 CRITICAL COST VARIABLES RELATE TO THE CONTRACTORS' BUDGET

According to Rashid (2020), material and human resources (labour) are critical cost variables that can highly influence the contractors' budget in construction projects. As mentioned by Ullah (2020), even small change in labour-related cost or material related cost can highly influence the cost overrun or time overrun in construction projects. Supporting the above statement, Norul Izzati, et al. (2019) have found that variables such as material related issues and labour related issues are affecting contractors' budget heavily. Joukar (2016) mentioned that the price volatility of material and labour is a prominent cause of contractors' budgeted cost overruns. A proper management of these two variables is essential to maintain the project budget within the expected amount (Rashid, 2020). Burke (as cited in Albtoush, et al., 2020) mentioned that the material cost and labour cost in construction projects should be well managed and controlled. Further, there is a necessity to investigate the level of contribution of material cost and labour cost to the contractors' budgeted cost in construction projects.

3. METHODOLOGY

To achieve the aim of the research, the case study was selected as the research strategy. Case studies are generally proceeding with organisational, institutional, geographical, provisional, or similar contexts that have boundaries around the cases (Cohen, et al., 2007). The cases for the study were selected based on the research problem and aim of the study. Accordingly, the case studies were limited to three cases due to the unavailability of required data to conduct the research, confidentiality of the cost data of contractor organisations and the ethical rules that they are following. Moreover, the selected projects have been faced with contractors' budgeted cost overrun due to several variables. Table 1 summarises the profile of the selected cases.

Table 1: Profile of selected projects

Case Code	Project Details
Case A (Organisation A)	Original Contract Amount is Rs. 6.0 Billions 13 Storey Apartment Complex The Construction Period - The year 2016 to 2019 Duration is 30 Months
Case B (Organisation B)	Original Contract Amount is Rs. 2.6 Billions 8 Storey Educational Building The Construction Period - The year 2016 to 2019 Duration is 36 Months
Case C (Organisation C)	Original Contract Amount is Rs. 3.1 Billions 8 Storey Educational Building (Laboratory) The Construction Period - The year 2018 to 2020 Duration is 22 Months

All organisations have higher gradings (CS2) for building works according to the gradings given by the Construction Industry Development Authority (CIDA) in Sri Lanka. Greener and Martelli (2018) stated that case studies included "more than one way of deriving data about the case or organisation under the study" (p. 119). Therefore, it includes methods of data collection such as referring documents, interviews, observations, consumer research about the case. Archival documents and records used to collect quantitative data from those projects such as Project progress reports, Project final reports, Profit analysis reports, Project final bill statements, Actual Cost Work Performed (ACWP) records and Budgeted Cost Work Performed (BCWP) records, Material cost records and labour cost records and cost records from ERP systems. "Sensitivity is the ability of research instrument to capture the variability in responses" (Adedokun, et al., 2019). Wong et al. (as cited in Adedokun et al., 2019) used sensitivity analysis as a better measuring instrument to analyse research data.

Sensitivity Index was the measure used to present the impact of key variables (material and labour costs) to the contractors' budget and the project cost and measured using Eq. 01.

$$\textit{Sensitivity Index (SI)} = \frac{\textit{\% Change in Cost Outcome}}{\textit{\% Variation in Estimating Variable}} \qquad \textit{(Eq. 01)}$$

As mentioned by Yeo (1991), the cost outcome has a major impact from variables that cause lesser SI than variables that cause higher SI.

4. RESEARCH FINDINGS AND DISCUSSION

All the projects were different from each other by their features. Two projects were government funded projects and the other project was funded by a private sector organisation within Sri Lanka. According to the available data and to get an accurate figure, the costs related to budgeted cost and the actual cost were taken only for the civil works of the project and the cost of variations was not considered for the analysis. Hence. six civil work categories such as 1) excavation and earth work (V1), 2) concrete work (V2), 3) masonry work (V3), 4) plastering (V4), 5) tiling (V5) and 6) painting (V6), and all other balance civil works considered as "other works". The main work categories are listed in Figure 1.

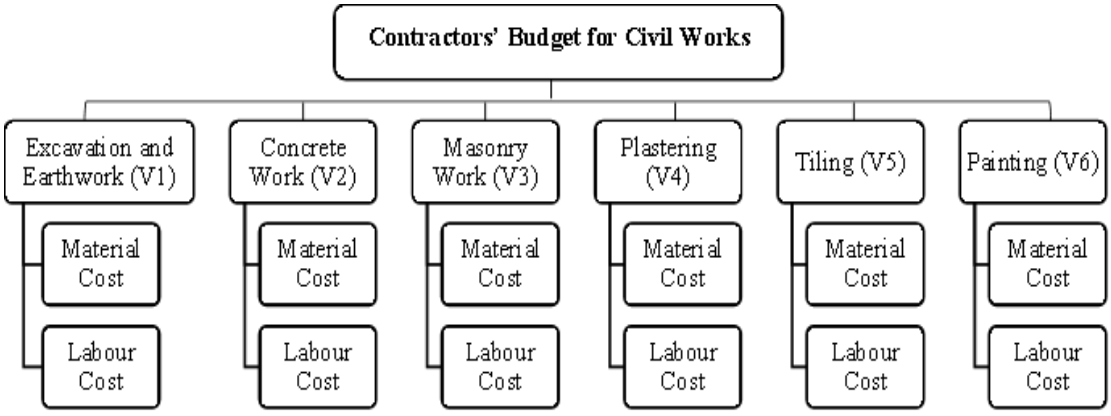

Figure 1: Levels of work categories

Figure 2 illustrates the cost contribution of individual categories from the total cost of civil works.

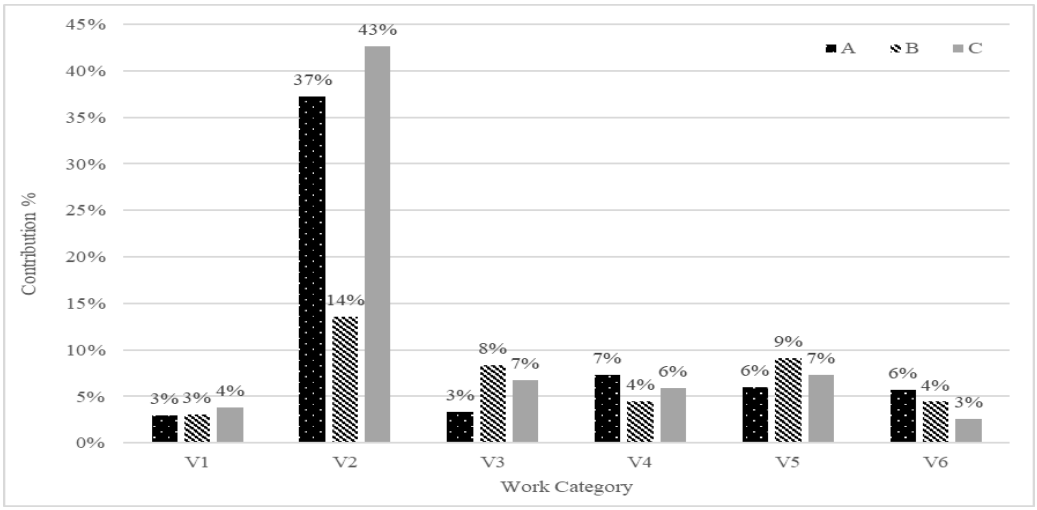

Figure 2: Contribution of work categories to the total cost of civil work

The highest contribution to the budgeted cost is from concrete work (V2) in three cases.

4.1 IMPACT OF COST OVERRUN OF WORK CATEGORIES ON CONTRACTORS' BUDGETED COST OVERRUN

Since the selected cases were remeasurement contracts, the impact on the cost from budgeted quantity changes can be ignored. The Overhead and profit component was not taken to account. Based on Actual Cost Work Performed (ACWP) and Budgeted Cost Work Performed (BCWP), the Sensitivity Index (SI) was calculated. Based on the Sensitivity Index formula, suitable equations were adapted (Refer Eq. 02) to present the impact of material cost and labour cost on the contractors' budgeted cost. The variables which have lesser SI can influence the contractors' budgeted cost significantly.

$$\textbf{Sensitivity Index (SI) for Work Categories} = \frac{\%\ Change\ in\ Cost\ Outcome}{\%\ Variation\ in\ Estimating\ Variable} = \frac{\dfrac{[\ ACWP\ of\ Civil\ Work - BCWP\ of\ Civil\ Work]\ x\ 100}{[\ BCWP\ of\ Civil\ Work]}}{\dfrac{[\ ACWP\ of\ Work\ Category - BCWP\ of\ Work\ Category]\ x\ 100}{[\ BCWP\ of\ Work\ Category]}} \quad (Eq.\ 02)$$

Table 2 presents SI values of overrun of work categories on contractors' budgeted cost overrun in Case A, B and C adopting Eq. 02. The impact of cost overrun of work categories on contractors' budgeted cost overrun was also calculated based on collected Actual Cost Work Performed (ACWP) and Budgeted Cost Work Performed (BCWP) data. In Case A, SI values of V1, V4, V5, and V6 were less than 0.5. In Case B, SI values of work categories are comparatively high and compared to other work categories SI values are low in V5 and V6. In Case C, results are almost similar to Case A and SI values of V5 and V6 are less than 0.5. Accordingly, V5 (Tiling) and V6 (Painting) work categories show smaller SI in all cases compared to the other four work categories.

Therefore, according to SI interpretation, the cost overrun from those work categories significantly influence the contractors' budgeted cost overrun.

Table 2: Distribution of budgeted cost overrun among work categories

Case	Description	Budgeted Cost Work Performed (BCWP)	Actual Cost Work Performed (ACWP)	%Change in Cost Outcome	%Variation in Estimating Variable	SI
A	**Total Cost of Civil work**	**3,986,185,883.90**	**4,068,867,733.72**	**2.07**		
	V1	111,216,916.00	125,675,115.08		13.0	0.16
	V2	1,492,578,856.00	1,504,347,745.03		0.8	2.63
	V3	134,722,080.00	137,416,521.60		2.0	1.04
	V4	287,455,088.25	301,827,842.66		5.0	0.41
	V5	235,190,526.75	246,950,053.09		5.0	0.41
	V6	221,522,206.00	235,921,149.39		6.5	0.32
	Other Works	1,503,500,210.90	1,516,729,306.87		0.9	2.36
B	**Total Cost of Civil work**	**1,257,180,902.23**	**1,476,430,889.29**	**17.44**		
	V1	40,280,051.12	42,375,416.43		5.2	3.35
	V2	182,984,319.28	185,247,720.75		1.2	14.10
	V3	110,952,593.63	115,979,893.90		4.5	3.85
	V4	59,532,997.53	61,135,037.19		2.7	6.48
	V5	115,635,656.54	134,125,505.72		16.0	1.09
	V6	56,547,568.28	64,287,516.69		13.7	1.27
	Other Works	691,247,715.85	873,279,798.61		26.3	0.66
C	**Total Cost of Civil work**	**777,281,350.04**	**808,189,970.68**	**3.98**		
	V1	29,715,973.34	30,148,410.13		1.5	2.73
	V2	336,551,945.33	338,691,881.98		0.6	6.25
	V3	51,975,682.19	55,247,891.21		6.3	0.63
	V4	45,192,123.55	48,657,232.40		7.7	0.52
	V5	55,507,899.39	60,844,822.55		9.6	0.41
	V6	16,931,572.38	24,272,833.56		43.4	0.09
	Other Works	241,406,153.85	250,326,898.85		3.7	1.08

Even though, V2 (Concreting) work category contributed to the contractors' budget significantly, the contribution to the budgeted cost overrun is extremely low because SI value is high compared to the other categories. The 'other works' category is also significantly influencing the contractors' budgeted cost overrun.

4.2 IMPACT OF MATERIAL AND LABOUR COST OVERRUNS ON THE CONTRACTORS' BUDGETED COST OVERRUN

The contribution of material and labour costs to the total cost of civil work is also evaluated and presented in Table 3. Therefore, the cost of material for the civil works and the cost of labour for the civil work was compared with the cost of civil work based on data availability. Furthermore, Eq. 02 has been adopted for the SI calculation for material and labour cost overruns. Accordingly, the impact of total material and labour cost overruns based on the collected data in Cases A, B and C are presented in Table 3.

Figure 4: Impact of material cost and labour cost overruns on the contractors' budgeted cost overrun

Case	Description	Budgeted Cost Work Performed (BCWP)	Actual Cost Work Performed (ACWP)	Average Contribution to the Civil Work	% Change in Cost Outcome	% Variation in Estimating Variable	SI
A	**Cost of Civil Work**	**3,986,185,883.90**	**4,068,867,733.72**		**2.07**		
	Material	2,683,031,028.87	2,739,374,680.47	67%		2.10	0.99
	Labour	1,055,581,333.55	1,076,692,960.23	26%		2.00	1.04
B	**Cost of Civil Work**	**1,257,180,902.23**	**1,476,430,889.29**		**17.44**		
	Material	678,877,687.20	797,272,680.22	54%		17.4	1.00
	Labour	528,456,409.97	620,618,214.88	42%		17.4	1.00
C	**Cost of Civil Work**	**777,281,350.04**	**808,189,970.68**		**3.98**		
	Material	449,212,710.51	466,120,263.12	58%		3.8	1.06
	Labour	276,745,337.86	287,665,431.56	36%		3.9	1.01

The average contribution was calculated for both material and labour costs and results are presented in Figure 3.

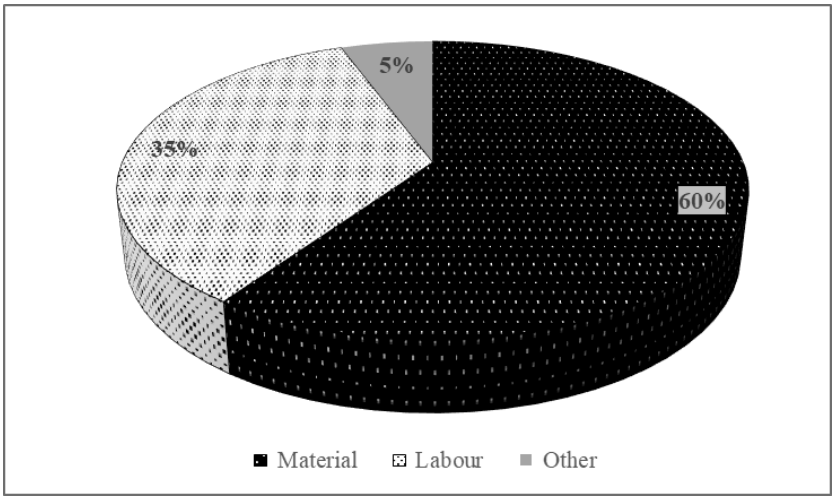

Figure 3: Average contribution of material cost and labour cost to the total cost

Accordingly, the contribution of material cost remains around 60 % and the contribution of the labour cost remains around 35 % of the total civil works. As per Table 3, the SI values of both material and labour cost overruns are around 1.0 in Case A, B and C. When considering the interpretation of SI, the cost outcome has a high impact from the variable which gives lower SI values. Therefore, in Case A contractor's budgeted cost overrun has a high impact from material cost overrun which has lower SI (0.99) than the SI of labour cost overrun (1.04) while Case C has the opposite results of Case A. In Case C contractor's budgeted cost overrun has a high impact from labour cost overrun which has lower SI (1.01) than the material cost overrun which has a 1.06 SI value. According to the calculations, the impact from material cost overrun and labour cost overrun is almost the same in Case B.

4.3 IMPACT OF MATERIAL COST IN EACH WORK CATEGORY ON TOTAL MATERIAL COST OVERRUN

Furthermore, the same analysis was done using Eq. 02 for each work category. Further, the impact of each work category on the total material cost overrun was analysed using Eq. 02 and presented in Figure 4. Accordingly, the work categories which were highly influenced the total material cost overrun in three cases can identify based on SI values.

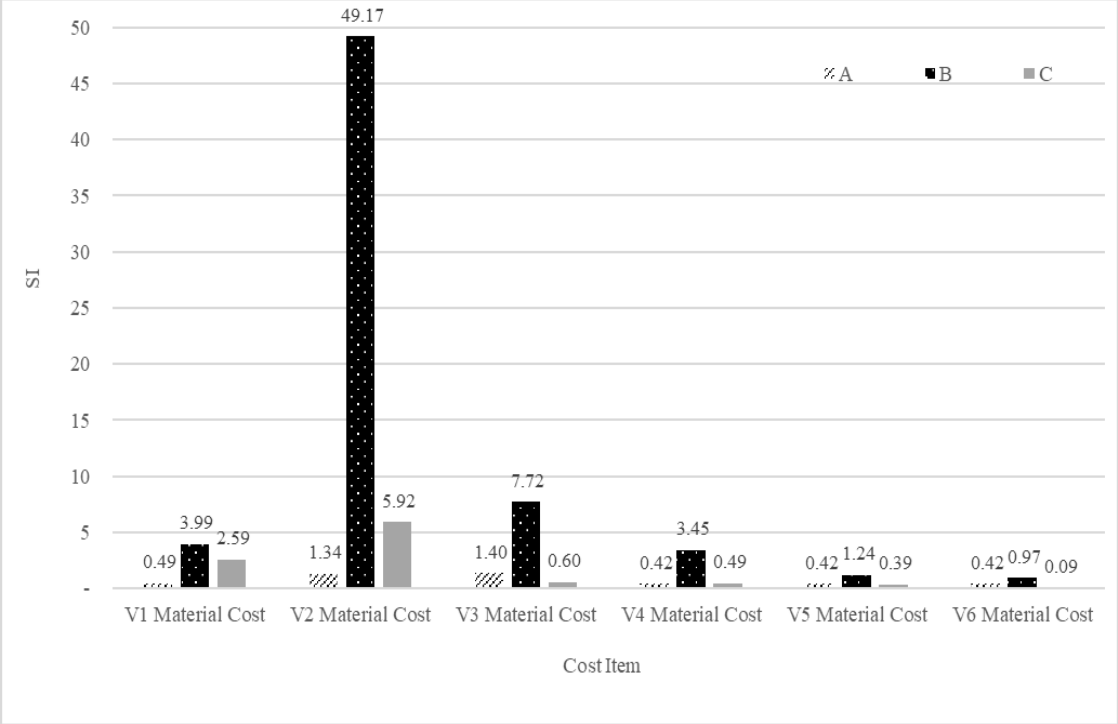

Figure 4: SI of material cost in each work category on total material cost overrun

In Case A, the calculated SI values using material costs of V1 (Excavation and earthwork), V4 (Plastering), V5 (Tiling), and V6 (Painting) were less than 0.5. In addition, the SI values of V4, V5 and V6 were almost the same (0.42). The highest SI value in Case A was found under V3 (Masonry work).

In Case B, the SI values of work categories are comparatively high compared to the other two cases. Also, V2 (Concrete work) has a significantly higher value (49.19) than other SI values from any work category in selected three cases. It is because the material cost overrun of concrete work in Case B is considerably a low amount. Therefore, the contribution of the material cost overrun of V2 to the total material cost overrun is ignorable. SI values of V5 (1.24) and V6 (0.97) are lower than the SI values of existing work categories in Case B.

In Case C, SI values of V4, V5, and V6 were less than 0.5 and V3 (Masonry work) has 0.60 SI value. The highest SI value was found under V2 (5.92) in Case C. When considered the SI values of three cases, it is clear that there are lower SI values for V4 (Plastering), V5 (Tiling) and V6 (Painting) work categories in the selected three cases. It was evident that the major impact for the material cost overrun has happened under V4, V5, and V6 categories and the minor impact for the material cost overrun has happened under V2.

4.4 IMPACT OF LABOUR COST IN EACH WORK CATEGORY ON TOTAL LABOUR COST OVERRUN

Similarly, the same analysis was done to find the impact of labour cost in each work category on total labour cost and results are presented in Figure 5.

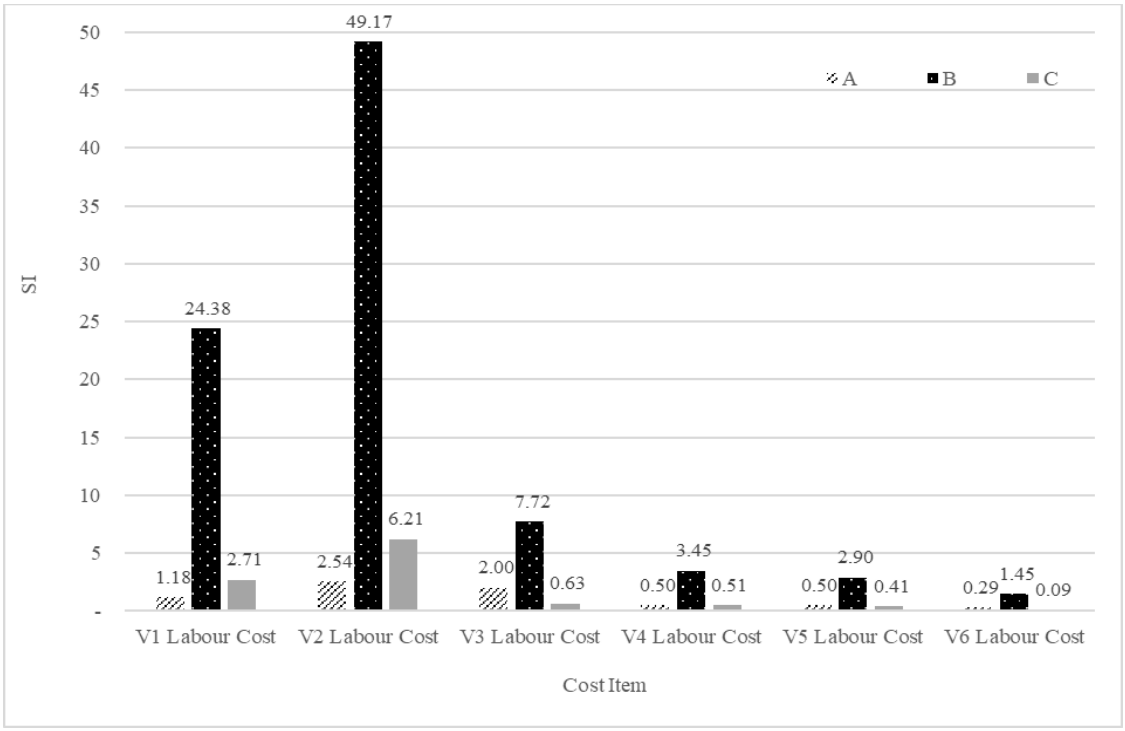

Figure 5: SI of labour cost in each work category on total labour cost overrun

The work categories which were highly influenced the total labour cost overrun in three cases can identify based on SI values. In Case A, the calculated SI values using the labour costs of V6 (Painting) was less than 0.5. In addition, the SI values of V4 and V5 were almost the same (0.5).

In Case B, the SI values of work categories are comparatively high compared to the other two cases. Also, V2 (Concrete work) has a significantly high value (49.17) than other SI values from any work category in selected three cases. It is because the labour cost overrun of concrete work in Case B is a considerably low amount. Therefore, the contribution of labour cost overrun of V2 to the total labour cost overrun is ignorable. SI values of V5 (2.90) and V6 (1.45) are lower than the SI values of existing work categories in Case B.

In Case C, SI values of V5, and V6 were less than 0.5. The SI value of V4 is 0.51 and V3 has a 0.63 SI value in Case C. Further, the highest SI value was found under V2 in Case C. When considered the SI values of three cases, it is clear that there are lower SI values for V4 (Plastering), V5 (Tiling) and V6 (Painting) work categories in the selected three cases. It was evident that the major impact for the labour cost overrun has happened under V4, V5, and V6 categories and the minor impact for the labour cost overrun has happened under V2.

5. CONCLUSION AND RECOMMENDATIONS

Use In the current construction industry project cost overrun is treated as a regular feature because all projects which were completed resulted in cost overruns. An accurate budget is a prominent requirement for all stakeholders in construction projects. To maximise the profit within contracting firms it is essential need to be aware of the budgeted cost overrun aspects. Even though there are many cost variables related to construction cost, the material and labour costs can ensure as critical cost variables that can influence the contractors' budgeted cost overrun heavily.

Basically, this research is limited to building construction projects in Sri Lanka. Further, this study was focused on two main variables, material cost and labour cost in building construction projects. The case studies were limited to three cases due to the unavailability of required data to conduct the research, confidentiality of the cost data of contractor organisations and the ethical rules that they are following.

When considered the findings, it was evident that a major impact for the contractors' budgeted cost overrun is happening due to the material cost and labour cost overruns. According to the analysis and findings of case studies, the average contribution of material cost to the cost of civil work was assessed as 60%, whereas the cost of labour was indicated as 35%. Even though the contribution of the cost of concrete work has a high contribution to the total cost of civil work, it has a lesser contribution to the contractors' budgeted cost overruns in building construction projects. Plastering work, tiling work and painting work are the major work categories that can highly influence the material cost and labour cost overruns in building construction projects. Therefore, contractors should pay special attention on the budgeted cost of plastering work, tiling work and painting work when preparing the initial budget to maximise the profit through minimising the budgeted cost overrun.

Future research can be conducted to develop a methodological framework to monitor the impact of material cost and labour cost on the construction supply chain and predetermine the financial situation of the contractors adopting Sensitivity Analysis technique.

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