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Research Article

Perspectives of Construction Supervisory Workers on the Project-level Causes Affecting the Efficiency of Labour Operations in Sri Lankan Building Projects

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Abstract

The construction industry thrives on productive-based project-level operations, which help businesses to realise their anticipated profitability and long-term viability. Past studies draw attention to the subpar project-level procedures that reduce productivity in numerous developing nations, including Sri Lanka. Construction supervisors are one of the key resources who provide blood circulation for a wide range of project-level practices. This study sought to quantify the effects of project-level causes on the efficiency of construction operations in Sri Lankan building projects based on the viewpoint of construction supervisors. First, a comprehensive literature review was used to qualitatively identify the project-level determinants. A questionnaire survey was then conducted among construction supervisors working from 64 Sri Lankan building construction firms. The effects of the project-level determinants on construction productivity were evaluated using the Relative Importance Index (RII) approach. The findings highlight the need for construction management teams to strengthen their current planning and monitoring practices with a focus on construction methods, working conditions, scheduling and sequencing of construction tasks, health and safety procedures, quality control procedures, reworks, labour skill development and workforce over time. The statistical evaluations guaranteed the validity and dependability of the findings. In addition, a series of industry consultation seminars and discussion sessions were held among construction specialists to identify future actions in the planning procedures for construction projects. The validity of the aforementioned results was also guaranteed by these debate outcomes. The findings of the study will encourage construction management practices to lessen conflict situations between

project-level activities at various phases, resulting in the accomplishment of organisational objectives. Although the study findings are restricted to the building construction sector of the Sri Lankan setting, some of them might be evaluated in similar situations in other developing nations.

Keywords: *Building projects, construction supervisors, labour efficiency, Sri Lanka*

1. Introduction and Background Study

The enhancement of construction industry practices is essential for a developing nation like Sri Lanka to achieve its national socioeconomic objectives (Silva et al., 2018). According to Manoharan et al. (2022a), Sri Lanka is one of many developing countries where the construction industry has grown quickly. Numerous jobs have been created as a result for a number of occupational sectors, and it is anticipated that this tendency will continue for some time (Manoharan et al., 2022a). The key to obtaining the anticipated profitability from any building project is the productivity enhancement in various construction operations (Ghate and Minde, 2019). The parameters at the project level that affect the productivity of construction operations should generally be well under control (Hughes and Thorpe, 2014; Nourhane et al., 2018; Shahab and Audrius, 2018). According to Manoharan et al. (2022c), many of the project-level elements are primarily dependent on labour-related operations, while some of these elements are outside the scope of job site management's control.

The effectiveness of labour operations in the global construction sector has recently been the subject of various studies. Studies show that the types of construction operations (Ghoddousi et al., 2015; Saravanan and Surendar, 2016), project size (Nourhane et al., 2018), site conditions (Hughes and Thorpe, 2014; Shahab and Audrius, 2018) and site locations (Paul, 2002) all affect labour efficiency. Changes in site configurations and locations lead to irrational project timelines (Hickson and Ellis, 2013) and force contractors to adopt unconventional construction techniques (Ghate and Minde, 2019).

Poor building practices and unfavourable working conditions have been an issue for construction companies in many nations when attempting to increase the efficiency of labour operations (Patel et al., 2017; Onyekachi, 2018; Ghate and Minde, 2019; Mistri et al., 2019). Workplace conditions and healthy construction practices have a big impact on employee morale (Manoharan et al., 2021c). These lessen the likelihood of job injuries, the associated financial obligations and the requirement

for time off (Manoharan et al., 2022b). Throughout the construction process, the construction personnel must adhere to appropriate health and safety procedures (Dharani, 2015; Oseghale et al., 2015; Saravanan and Surendar, 2016). Previous studies have stated that many nations, including Australia (Hughes and Thorpe, 2014), Egypt (Nourhane et al., 2018), India (Shashank et al., 2014; Singh et al., 2017), Nigeria (Okoye et al., 2016) and South Africa (Windapo, 2016), lack health and safety regulations in the construction sector. In several building projects in Australia (Hughes and Thorpe, 2014), India (Shashank et al., 2014; Thiyagu et al., 2016) and South Africa (Oke et al., 2018), a notable number of cases were documented due to accidents and labour injuries.

In various building projects in Sri Lanka, Praveen et al. (2011) discovered that time and cost overruns significantly impacted the efficiency of labour operations. Additionally, studies from South Africa (Oke et al., 2018) and Iran (Shahab and Audrius, 2018) also reported the same. The inappropriate working time of labour operations is caused by the time overrun, which may also be one of the causes of the underwhelming efficiency of labour (Ailabouni et al., 2009). According to Oke et al. (2018), a significant contributing element to the South African construction industry's low productivity has been the relatively small number of labourers employed in construction projects. On the other side, Shahab and Audrius (2018) stated that too many workers working in construction projects adversely hampered labour efficiency in Iranian construction projects. Rework and workforce overtime were two other crucial issues that Shahab and Audrius (2018) identified. Durdyev et al. (2013) reported the same issues when taking into account Turkmenistan's business procedures. Alcohol consumption and body mass index may rise as a result of working overtime, which may result in a variety of additional health issues (Wong et al., 2019). Long hours of labour might be detrimental to workers' mental health (Wong et al., 2019).

The degree of variation in design complexity/changes had a major impact on the effectiveness of construction project operations in many countries, including India (Sangole and Rani, 2015) and Kuwait (Jarkas and Bitar, 2012). Other project-level characteristics that have a substantial impact on construction work efficiency include the clarity of the plans and project documents (Hickson and Ellis, 2013; Mahamid, 2013; Hughes and Thorpe, 2014, Robles et al., 2014), high mobility (Oseghale et al., 2015), quality inspection delays (Soekiman et al., 2011; Hughes and Thorpe, 2014; Shashank et al., 2014) and the absence of utilities (Murari and Joshi, 2019).

Overall, as indicated in Table 1, the current study has comprehensively evaluated earlier studies that looked into the project-level variables influencing building operations in various nations.

Table 1: Past studies that investigated the labour productivity and efficiency in different countries

Country	Studies
Egypt	Shehata and El-Gohary (2011); Nourhane et al. (2018)
India	Soham and Rajiv (2013); Dharani (2015); Sangole and Rani (2015); Saravanan and Surendar (2016); Thiyagu, et al. (2016); Dixit et al. (2017); Patel et al. (2017); Saurav et al. (2017); Singh et al. (2017); Ghate and Minde (2019); Mistri et al. (2019); Murari and Joshi (2019); Agrawal and Halder (2020); Saurav and Kaaraayaarthi (2020)
Indonesia	Soekiman et al. (2011); Adi and Ni'am (2012)
Iran	Shahab and Audrius, (2018); Ghoddousi et al. (2015)
Kuwait	Jarkas and Bitar (2012)
Malaysia	Karim et al. (2013); Mohammed et al. (2020)
Nigeria	Ayegba and Agbo (2014); Oseghale et al. (2015); Okoye et al. (2016); Zannah et al. (2017); Onyekachi (2018)
Palestine	Enshassi et al. (2007); Mahamid (2013)
Qatar	Jarkas et al. (2012)
South Africa	Windapo (2016); Oke et al. (2018); Orando and Isabirye (2018)
Sri Lanka	Halwatura (2015); Wickramasinghe (2015); Fernando et al. (2016); Silva et al. (2018); Manoharan et al. (2020)
Trinidad & Tobacco	Hickson and Ellis (2013)
Turkey	Kaya et al. (2014); Kazaz et al. (2016)
Turkmenistan	Durdyev et al. (2013)
United Arab Emirates	Ailabouni et al. (2009)
Vietnam	Dinh and Nguyen (2019)

1.1. Sri Lankan Context

Only a few research have looked into the variables influencing labour efficiency in the construction industry in Sri Lanka (Halwatura, 2015; Wickramasinghe, 2015; Fernando et al., 2016; Silva et al., 2018; Manoharan et al., 2020). Among these, the results of Manoharan et al. (2020) are important for comprehending the state of the industry's practices at the moment. Using comprehensive approaches, Manoharan et al. (2020) have determined the variables that have a substantial impact on the effectiveness and productivity of project operations in the Sri Lankan construction industry. The study (Manoharan et al., 2020) offered 24 parameters in total when taking into account project-level construction processes. The current study displays the mapping of those 24 characteristics with additional studies from other contexts, as indicated in Table 2.

Table 2: Project-level causes influencing construction labour productivity and efficiency: Mapping with other previous studies from different nations

Code	Project-level Causes	Past Studies from the Countries (shown in Table 1)														
		Egypt	India	Indonesia	Iran	Kuwait	Malaysia	Nigeria	Palestine	Qatar	South Africa	Sri Lanka	Tritad & Tobacco	Turkev	Turkmenistan	United Arab Emirates	Vietnam
P1	Project size	X															
P2	Poor site layout				X												
P3	Site location											X					
P4	Type of construction process		X		X												
P5	Unrealistic schedule		X	X	X		X		X				X		X		
P6	Sequence of the work		X		X												
P7	Poor construction methods		X		X			X									
P8	Poor working conditions		X					X									
P9	Lack of health and safety practices	X	X					X			X						X
P10	Accidents and labour injuries		X								X	X					
P11	Work at heights	X	X														

P12	Excessive number of labourers			X												
P13	Less number of labourers	X								X	X					X
P14	Workforce overtime	X		X							X			X	X	
P15	Rework	X	X	X		X		X	X	X				X		
P16	Improper working time	X									X					
P17	Time overrun			X						X	X					
P18	Cost overrun										X					
P19	Extent of variation	X			X											
P20	Design complexity and changes	X			X					X						
P21	Clarity of the drawings and project documents		X									X				
P22	High mobility						X									
P23	Poor quality assurance and quality control in	X	X					X								
P24	Unavailability of utilities	X														

Source: (Manoharan et al., 2020)

1.2. Importance of this Study

Overall, studies show that there is a significant need to upgrade the current project-level methods and procedures in order to improve the efficiency of the work operations for building in many developing nations. Building construction is an important part of the Sri Lankan construction industry due to the enormous number of current building projects on a large scale and high investment. On the other hand, construction supervisory workers are the working resources who supply the lifeblood for construction project operations by directly involving project-level operations (Shehata and El-Gohary, 2011). Considering these aspects, this study emphasises the importance of the viewpoint of construction supervisors on the project-level practices that influence construction efficiency. Consequently, this study aims to quantify the effects of project-level elements that affect the effectiveness of labour operations in the current stage of Sri Lankan building construction projects based on the perspectives of construction supervisors. This will be very helpful to the construction industries in many developing nations as they make the necessary changes to their present project-level operating procedures.

2. Materials and Methods

Based on the viewpoint of construction supervisors, quantitative methods were employed to quantify the impact levels of the project-level elements (given in Table 1) on the effectiveness of labour activities. The study also used extensive methodologies to check the accuracy and dependability of the results. These are covered in the sections that follow.

A questionnaire survey was conducted among 64 building contractors in Sri Lanka, where the construction supervisors responded on behalf of their companies based on their current project-level procedures. For identifying the impact levels of the determinants on labour productivity and efficiency, the survey questions used a Likert scale of five ordinal measurements from 1 to 5 (very low effect to very high effect). At the beginning of the survey, 5-6 construction supervisors participated in the interviews to verify the questions that had been created in the questionnaire design.

As recommended by Showkat and Praveen (2017), the snowball sampling method was used to select survey respondents because it was difficult to determine the exact sample size given the desired features. The practice of increasing the sample size from the beginning of the survey through a small population is known as the snowball sampling approach. Only contractors with the highest level of registration with Sri Lanka's Construction Industry Development Authority (CIDA) were eligible for the survey. CIDA is the official body in Sri Lanka that approves the registration of contractors in the construction industry. According to the national registration and grading scheme for construction contractors of CIDA, the building contractors are classified under 11 grades based on their financial capability, technical proficiency and work experience. The minimum financial need to get the middle level of CIDA registration (C4 grade) is 50 million Sri Lankan Rupees.

Table 3 presents a complete description based on the survey respondents' expertise in the building construction industry and their CIDA registration grades. Notably, all the survey respondents had at least five years of work experience, with the majority (about 55%) falling between five and ten years. On the other hand, the majority of respondents were from C4 grade contractors, which corresponds to the CIDA registration ratings.

The Relative Importance Index (RII) technique was used to calculate how much each project-level element affected worker productivity and efficiency. According to earlier studies (Jarkas and Bitar, 2012; Kesavan et al., 2014), equation (1) was used to determine RII.

$$\mathrm{RII} = \frac{\sum \mathrm{W}}{\mathrm{A} * \mathrm{N}} \qquad (1)$$

- W is the weight that response ranges have given each element (1 – Very low, 2 – Low, 3 – Medium, 4 – High, 5 – Very high).
- A stand for the maximum weight permitted (A equals 5).
- The total number of responses is shown as N.

Table 3: Detailed profile of survey respondents

Profile	Variables	No. of Responses	Percentage
Experience in the construction field	Less than 5 Years	00	00%
	5–10 Years	35	55%
	11–15 Years	18	28%
	16–20 Years	04	06%
	21–25 Years	05	08%
	More than 25 Years	02	03%
CIDA Grade of Contractors (X: Financial Limit of the Projects - LKR in Million)	CS2 / CS1 (X > 1500)	00	00%
	C1 (1500 >= X > 600)	08	13%
	C2 (600 >= X > 300)	06	09%
	C3 (300 >= X > 150)	14	22%
	C4 (150 >= X > 50)	34	56%

The greater RII value shows how much of an impact the corresponding element has on the effectiveness of labour operations. The associated element/cause had to have a minimum RII value of 0.7 to be determined as critical. To assess the accuracy of the findings, the coefficient of variation (CV) values were also computed for each cause. The ratio between the standard deviation and RII values can be used to define the CV value (Solly and Gezani, 2017). Here, the lower CV value shows that the respondents' values are roughly in line with the mean values. For the result to be reliable, the CV value should not be greater than 0.3, according to Statistics Canada (Statistics Canada, 2020).

Construction specialists from various working categories participated in a series of discussion sessions and workshops to discuss the levels of impact of the identified essential elements on the efficiency of labour operations. In order to decide the activities that need to be made in the construction management processes, problem-based communication approaches were mainly applied in the discussion sessions. These discussion results served to further validate the findings.

3. Results and Discussion

The degrees of the project-level elements' effects on the efficiency of labour in building construction projects are presented in Table 4 based on the viewpoint of construction supervisors. Almost half of those elements/causes were found to be critical based on their RII scores (more than 0.7). Importantly, this section discusses the current condition of those characteristics, how they are connected to other aspects and the necessary measures in the industry operations. This section also compares those essential causes to earlier studies conducted in Sri Lankan and other international contexts.

Table 4: Impact levels of the project-level causes on labour efficiency in construction

Codes of Causes	Mean (M)	Relative Importance Index (RII)	Standard Deviation (SD)	Coefficient of Variation (CV)	Ranking (R)	Level of Impact (LI)
P8	3.86	0.77	0.15	0.19	1	High
P13	3.8	0.76	0.14	0.18	2	High
P6	3.77	0.75	0.15	0.20	3	High
P7	3.77	0.75	0.13	0.17	3	High
P5	3.75	0.75	0.18	0.24	5	High
P9	3.69	0.74	0.14	0.19	6	High
P4	3.67	0.73	0.14	0.19	7	High
P15	3.61	0.72	0.13	0.18	8	High
P23	3.55	0.71	0.12	0.17	9	High
P14	3.53	0.71	0.12	0.17	10	High
P17	3.53	0.71	0.12	0.17	10	High
P16	3.52	0.70	0.13	0.18	12	High
P18	3.44	0.69	0.10	0.15	13	Medium
P20	3.42	0.68	0.11	0.16	14	Medium
P21	3.38	0.68	0.11	0.16	15	Medium
P3	3.34	0.67	0.15	0.22	16	Medium
P11	3.31	0.66	0.12	0.18	17	Medium
P19	3.31	0.66	0.13	0.20	17	Medium
P10	3.27	0.65	0.12	0.18	19	Medium

P22	3.27	0.65	0.10	0.15	19	Medium
P24	3.20	0.64	0.14	0.22	21	Medium
P2	3.19	0.64	0.15	0.24	22	Medium
P1	3.17	0.63	0.14	0.22	23	Medium
P12	2.41	0.48	0.11	0.23	24	Low

According to the study, the efficiency of labour operations in Sri Lanka is significantly impacted by the construction methods and working conditions in various major construction projects. Other nations, like India (Soham and Rajiv, 2013; Patel et al., 2017; Ghate and Minde, 2019; Mistri et al., 2019), Nigeria (Onyekachi, 2018), and New Zealand (Durdyev et al., 2011), have similarly seen lower labour productivity levels as a result of the subpar building practices and working conditions. The industry consultation specialists specifically highlighted the following concerns relating to materials/tools that result in subpar building processes and working conditions in many construction activities, taking into account the Sri Lankan construction environment.

- Material shortages and delivery delays
- Improper material selection and changes in material types
- Costs of some materials
- Poor quality and maintenance of materials and working tools
- Equipment delays and breakdowns
- Equipment shortages
- Poor skills of equipment operators

Kesavan et al. (2014) also mentioned the aforementioned problems, which led to subpar construction practices and construction delays. This demonstrates how a lack of attention has been paid by the construction firms in Sri Lanka to enhancing procedures for managing materials and tools in current situations. According to Kesavan et al. (2014), the main contractors' financial difficulties, poor communication between parties, unclear or inadequate details in drawings, frequent changes of subcontractors, lack of technical skills of contractors' staff and delays in site mobilisation are the causes of the poor construction methods and working conditions.

The study emphasises the value of scheduling and sequencing building tasks using planning procedures to increase the efficiency and productivity of construction labour operations. Previous studies have also revealed that unrealistic project timetables in construction projects across various nations have a negative impact on

the efficiency of labour operations (Soekiman et al., 2011; Durdyev et al., 2013; Kesavan et al., 2015a; Shahab and Audrius, 2018). In order to have a successful operational process, projects must be scheduled properly. It increases productivity, facilitates efficient material management and ensures that resources are distributed effectively, which lowers expenses and saves time.

The industry consultation experts also indicated that the changes in government rules and the delays in receiving permits/approvals from the relevant authorities also contribute to unrealistic project planning and scheduling based on the current construction business practices in Sri Lanka. The issues with subcontractors, namely frequent subcontractor changes, scheduling conflicts and delays in subcontractors' work, were highlighted by Kesavan et al. (2014) as the significant factors that affect project schedules. Kesavan et al. (2014) cited rework due to construction errors as a factor that affected project schedules and the order of construction jobs.

The results further highlight that labour shortages significantly contribute to the reduction of the efficiency of building projects in Sri Lanka. The construction sector of many other nations, including India (Mistri et al., 2019, Murari and Joshi, 2019), South Africa (Windapo, 2016, Oke et al., 2018) and Vietnam (Dinh and Nguyen, 2019), have been facing productivity-related challenges in more recent times due to labour shortages. The shortage of labour has been a major issue for the contractors and caused construction delays in the Sri Lankan context (Kesavan et al., 2015b). The industry consultation specialists highlight that the lack of skilled labourers working in various construction operations is mostly attributable to this issue in Sri Lanka. Consequently, numerous building projects in Sri Lanka use unskilled labourers in place of skilled labourers (Fernando et al., 2016; Silva et al., 2018; Manoharan et al., 2022c), which has a negative impact on the efficiency and quality of construction work. The experts also emphasised a list of elements, such as salary delays and low salaries, lack of job security for labourers, no labour rewarding mechanisms, lack of proper incentives, improper promotion opportunities and fewer welfare facilities for labourers, influencing the motivation, interest and job satisfaction of Sri Lankan construction workers.

This study draws attention to the subpar quality assurance and control procedures used in building construction projects in Sri Lanka. Many Sri Lankan construction companies do not adhere to adequate quality assurance and control procedures. Construction quality assurance and control techniques are not sufficiently covered in

school curricula or vocational training programmes, according to industry consultation experts and previous studies (Manoharan et al., 2021a). Additionally, they noted that those training programmes lacked sections on construction procedures linked to health and safety. Notably, numerous workplace injuries occurred during the construction processes in Sri Lankan building projects as a result of poor health and safety procedures (Manoharan et al., 2021b). Furthermore, Kesavan et al. (2014) revealed that construction delays in Sri Lanka have been significantly impacted by workplace injuries.

3.1. Reliability and Validity of the Findings

Based on the CV values of the causes, the accuracy and reliability of the results were guaranteed. The CV values of all the causes were within the permissible range (less than 0.3) according to the range indicated in the Labour Force Survey Guide 2020 of Canada (Statistics Canada, 2020). The outputs of the problem-based conversations among specialists in the field also helped to guarantee the legitimacy of the study findings.

4. Conclusions

Based on the viewpoint of construction supervisors, the study has determined the crucial project-level variables that influence the efficiency of labour operations in Sri Lankan building construction projects. To increase the efficiency and productivity of construction operations, it is necessary to give the appropriate amount of consideration to each element of project-level practices, as indicated by the components' impact levels. The study also discussed the importance of such characteristics and how they affect the different project-level activities during the construction stage. In-depth comparisons have been made between the significant findings of this study and earlier studies from Sri Lanka and other overseas environments. Through comprehensive procedures, the validity and reliability tests were performed on the study findings and produced favourable outcomes.

The study has highlighted the project-level techniques used during the building phase where the construction management team must adopt better practices. The study report also emphasises the critical need to strengthen the learning components linked to quality assurance and control, health and safety, material handling and equipment handling in the nation's vocational training programmes. The overall study findings will help construction management teams to lessen conflict between project-level

duties at various phases and to guide the sector's actions toward long-term sustainability. The study suggests that future research should concentrate on enhancing quality control and safety management procedures. The study findings are restricted to project-level construction procedures in Sri Lankan building construction. However, some of these insights might also help other developing industries to enhance their present project-level procedures.

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