

LABOUR PRODUCTIVITY OF LARGE-SCALE BUILDING CONSTRUCTION PROJECTS IN SRI LANKA: PERSPECTIVE OF PROJECT MANAGEMENT STAFF

DHR Lakshan^{1*}, RP Kumanayake²

^{1,2}Faculty of Engineering, General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka

¹lakshandhr@kdu.ac.lk, ²ramyak@kdu.ac.lk

ABSTRACT

As construction projects play an important role in a country's economy, it is vital to improve their productivity. Labour productivity is considered one of the major measures of construction productivity. Therefore, improving labour productivity in construction industry is recognized as critical for the national economy of Sri Lanka. This research is conducted to identify the critical factors affecting labour productivity of large-scale building construction projects in Sri Lanka. Thirty-nine factors that affect the construction labour productivity were identified from reviewing the literature. These factors were modified and thirty-two factors were short listed to match the Sri Lankan context with the help of experts in the industry. In order to collect the data required for the study, a questionnaire was distributed among the selected sample of project management professionals in the Sri Lankan construction industry. The Relative Importance Index (RII) method was used to analyse the data and to identify the critical factors affecting labour productivity. The top five critical factors were identified as shortage of experienced labourers, insufficient skill level of labourers, shortage of materials, rework, and unavailability of suitable tools and equipment. The main recommendations of the study include enhancing training and development opportunities for workers, developing policies to improve the skill levels of the workforce, focusing on target-based wage system instead of a daily wage system, maintaining continuous information sharing among stakeholders, and providing the appropriate tools and equipment for construction work through effective equipment management plans. The recommendations of this study are expected to contribute to improving the labour productivity of future building construction projects in Sri Lanka.

KEYWORDS: *Labour productivity, Construction projects, Critical factors, Relative Importance Index*

1. INTRODUCTION

The construction industry is one of the most significant industries that impact the economy of a country. This scenario is even more relevant for a developing country like Sri Lanka. Therefore, developing the Sri Lankan construction industry is very important for reinforcing the national economy and social development. Improving productivity plays a vital role in developing the construction industry.

In general, "productivity" is defined as the ratio of input to output [1]. Among various measures of construction productivity, "labour productivity" is crucial as it considerably impacts the overall productivity of a construction project. Labour productivity mainly concerns the direct labour force and in most countries, the cost of construction labour is found to be 30% to 50% of the total project cost [2].

This study aimed at investigating the factors affecting labour productivity of large-scale building construction projects in Sri Lanka and providing recommendations to enhance the labour productivity of building construction projects.

2. LITERATURE REVIEW

The poor productivity of construction labour was found to be the main reason for cost and time overrun in a construction project as it directly affects the performance and cost effectiveness [3]. Although there are many studies conducted globally on construction labour productivity, only a limited number of such research can be found in the context of Sri Lanka.

Much research is currently available on construction labour productivity [4], [5], [6], [7], [8]. A study carried out in Trinidad and Tobago identified the top five factors for poor labour productivity as lack of labour supervision, unrealistic expectations for labour performance, shortage of experienced workers, lack of leadership skills of construction managers, and low skill level of workers [4].

Hughes and Thorpe [5] identified the top ten critical factors affecting construction productivity in Australia from the perspective of project managers and developing a formal structure responsible for improving construction productivity was recommended. A similar study conducted in the USA suggested improving labour

*Corresponding Author: Email Address: lakshandhr@kdu.ac.lk (DHR Lakshan)

productivity through appropriate and continuous training. Also, identifying a planned approach to overcome conflicts during the construction process was recommended [8].

Durdyev and Mbachu [7], in a study carried out in New Zealand recommended conducting further studies to investigate the factors affecting construction labour productivity during all phases of a construction project. Further, it was recommended to consider the views of clients, designers, and other stakeholders of the projects as well as those of consultants, contractors, and subcontractors. A study conducted in UK identified the need for conducting further research taking into account the perceptions of project management personnel such as designers and engineers [6].

A number of studies on construction labour productivity are available in the context of developing countries. In India, many such studies have been conducted [9], [10], [11], [12]. One study identified the critical factors for low labour productivity as poor decision making, improper planning, poor logistics and supply chain management, ineffective site coordination, and lack of labour skills. A detailed study to further investigate these critical factors and to identify the appropriate measures for improving labour productivity was recommended [9]. The need for extending the scope of research to include different regions of the country was emphasized [10].

Dixit et al. [11] pointed out that construction productivity can be improved by comprehensively revising the management process for project execution and appropriately changing the organizational environment. Further, they identified that insufficient time allocation for project planning as one of the main factors which lead to poor labour productivity. A study conducted in Pakistan [13] identified rough outdoor environment during project execution, poor management, as well as unskilled and inexperienced workers as the main causes for low labour productivity. In another study, the factors influencing labour productivity in construction projects in Pakistan were investigated and ranked based on severity level [14].

A study conducted in Iraq from the perspective of construction contractors highlighted that most of the issues related to labour productivity can be mitigated by proper planning of construction work [15]. In a similar study based in Yemen, it was identified that one of the main reasons for cost and time overrun in construction projects is poor labour productivity, which significantly affects the performance and profitability [16]. In a study conducted in Ethiopia, the top five factors affecting construction labour productivity were identified [17].

A similar study conducted by Howlader and Rahman [18] identified the most critical factors affecting construction productivity in Bangladesh. The findings of this research can be used to guide the stakeholders of construction projects in enhancing construction productivity. According to a study carried out in Indonesia, the overall performance of a construction project can be improved by developing a detailed understanding of various factors affecting construction labour productivity [19]. It was recommended to identify the critical factors affecting construction productivity in both positive and negative aspects and thereby, to formulate suitable strategies to improve construction productivity. In a study conducted in Thailand, the five most significant factors affecting construction productivity were identified as shortage of materials, incomplete drawings, incompetency of supervisors, shortage of tools and equipment, and absenteeism [20].

A limited number of research studies have been conducted related to the construction labour productivity in Sri Lanka. These research mainly focused on identifying the factors affecting labour productivity [21], [22], [23]. In his study to identify the critical factors affecting the motivation of construction workers, Halwatura [3] found out that enhancing worker motivation significantly contributes to improving labour productivity. Another study highlighted the importance of factor ranking in order to identify measures to improve worker productivity [21]. The critical role of skilled labour in improving construction labour productivity was emphasized and the need for providing training focusing on productivity improvement was identified as an appropriate strategy for Sri Lankan construction industry [22].

In their study, Santoso and Gallage [23] identified the vital role played by the contractors in effective project performance when compared to the clients. They highlighted the limited efforts taken so far to study the labour productivity in Sri Lankan construction industry as a main reason for labour productivity remaining a critical issue [3]. Many of the previous research identified the need for further studies on construction labour productivity in the Sri Lankan context.

3. METHODOLOGY AND DATA

The methodology of the research is summarized in Figure 1.

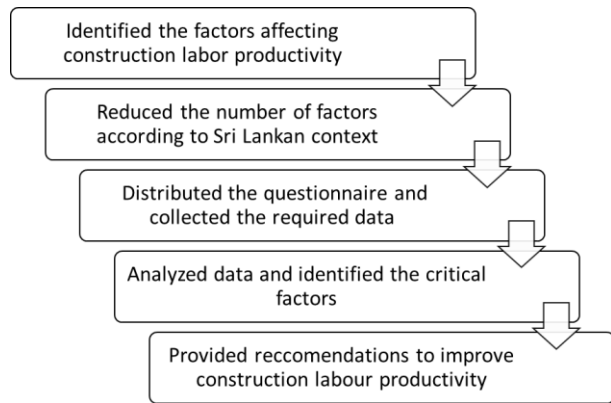


Figure 1: Summary of research methodology

3.1 REVIEW OF LABOR PRODUCTIVITY FACTORS

Initially, a total of 39 factors affecting labour productivity were identified from literature [4], [8], [14], [15], [16], [17], [21]. These factors were modified to match the Sri Lankan context and a total of 32 factors were identified for the current study. This was done based on the views of experienced professionals from the Sri Lankan construction industry. These factors were then classified into four groups: (1) technological related factors, (2) human/labour related factors, (3) management related factors and (4) external factors. This categorization was done based on previous research studies related to construction labour productivity [4], [15], [16].

3.2 SAMPLE SELECTION

The minimum sample size required was estimated statistically by using the Cochran formula considering the confidence level and margin of error for which Equation 1 and Equation 2 were adopted from past studies [4], [16].

$$n = \frac{m}{1 + \left(\frac{m-1}{N}\right)} \quad \text{Equation 01}$$

$$m = \frac{z^2 \times \hat{p} \times (1 - \hat{p})}{e^2} \quad \text{Equation 02}$$

where:

n = Minimum sample size

m = Sample size of the unlimited population

N = Sample size of the available population

z = Statistical value for the confidence level

e = Margin of error (Sampling error)

\hat{p} = Population proportion

The population of the study was the total number of project management professionals in large-scale building construction projects in Sri Lanka including project managers, civil engineers, quantity surveyors, construction supervisors, and technical officers. In determining the sample size, a 90% confidence level was considered. Further, previous studies suggested the value of \hat{p} as 0.50 for estimating the minimum sample size [4], [16]. Therefore, by using the above values in Equations 1 and 2, the minimum sample size was estimated as 36 for the study.

3.3 DEVELOPMENT OF QUESTIONNAIRE

The questionnaire was developed using relevant references and guidelines [24]. The structured questionnaire consisted of three sections A, B, and C. Section A included background information of respondents such as job title, experience in construction, experience in large-scale building construction projects, and educational qualifications. This section was used to justify the suitability of the selected sample and to ensure the reliability of the results.

Section B included the identified factors affecting construction labour productivity in Sri Lanka. The respondents were asked to rate these factors according to a Likert scale. This section was used to obtain data, in order to identify the critical factors affecting construction labour productivity in Sri Lanka.

Section C was used to gather suggestions from respondents including the proposed improvements to enhance construction labour productivity. The purpose of this section was to incorporate the practical experience of respondents in recommending improvements for construction labour productivity.

3.4 DATA COLLECTION

A pilot survey was conducted to identify the practical issues that can occur in responding to the questionnaire and to improve the relevance of questions before distributing the final questionnaire.

In order to ensure the data collection from the required minimum sample size, a total of 135 questionnaires were distributed to the project management professionals through email, LinkedIn, and also using direct personal contacts. A total of 51 completed questionnaires were received, from which nine were rejected and 42 questionnaires were used for the study.

The composition of respondents was analysed considering the job titles, educational level, and experience. Figure 2 illustrates the composition of respondents based on job titles.

3.5. DATA ANALYSIS

For data analysis, the Relative Importance Index (RII) was used. This method was selected because it can be used to identify the critical factors affecting construction labour productivity [21], which is one of the objectives of this research. Furthermore, Cronbach's Alpha coefficient was calculated using Statistical Package for the Social Sciences (SPSS) software in order to ensure the internal consistency of the collected data and the reliability of the questionnaire. To determine the RII values, the calculations were performed and the data was compiled using Microsoft Excel spreadsheet software. RII for each factor was calculated using Equation 3 adopted from previous studies [4], [16], [17].

$$RII = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{N} \quad \text{Equation 03}$$

Where:

n = Number of responses for each scale

N = Total number of responses collected

In Section B of the questionnaire, a Likert scale was used to rate each of the factors affecting labour productivity considering a scale of 1 to 5 (1 representing very low effect and 5 representing very high effect). The factors were ranked and critical factors affecting construction labour productivity were identified by considering the RII values. The factors were ranked for each category, the overall ranking of factors and overall ranking of productivity categories were determined and the top five critical factors affecting labour productivity were identified. As the final objective of this study, improvements to enhance the construction labour productivity were recommended.

4. RESULTS AND DISCUSSION

This study investigated the factors affecting labour productivity in large-scale construction projects in Sri Lanka. Initially, a total of 39 factors affecting labour productivity in global building construction industry were identified from the literature. Then, these factors were screened and short listed to match the Sri Lankan construction industry, by considering the views of professionals in the field. Hence, 32 factors were incorporated into the questionnaire for data collection.

4.1. COMPOSITION OF RESPONDENTS

A total of 135 questionnaires were distributed to the professionals in the construction industry and a total of 42 responses were used for the data analysis, as shown in Table 1.

Table 1: Details of data collection

	Total Number
Questionnaires sent	135
Questionnaires received	51
Rejected responses	9
Selected for the study	42

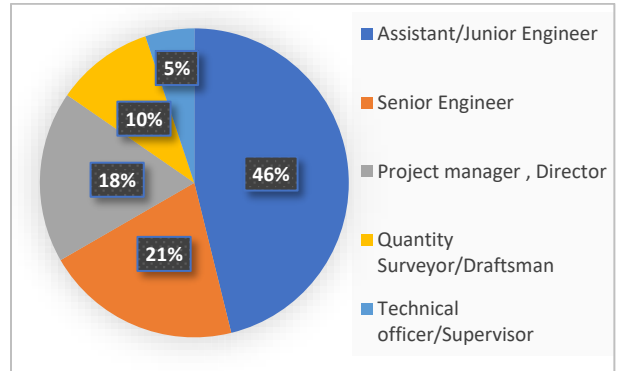


Figure 2: Job titles of respondents

The number of respondents based on their work experience and education level are shown in Figure 3 and Figure 4 respectively.

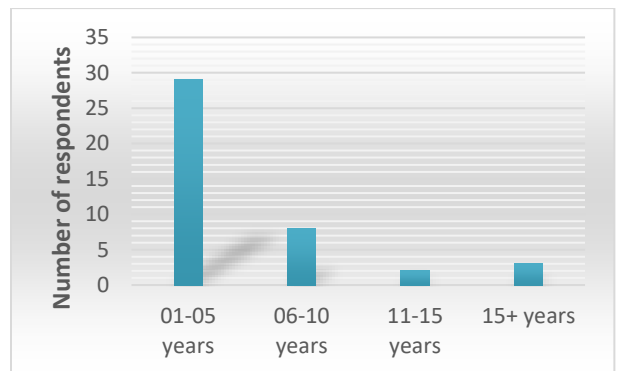


Figure 3: Work experience of respondents

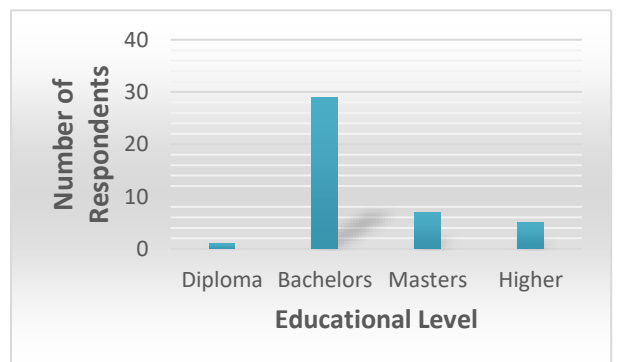


Figure 4: Educational level of respondents

Reliability analysis was done by calculating the Cronbach's Alpha coefficient in order to measure the internal consistency between responses collected for

the study. This test was done by using SPSS and the value of Cronbach's Alpha coefficient was found to be 0.814. Therefore, the reliability of the questionnaire was considered sufficient for the study.

4.2. OVERALL RANKING OF FACTORS AFFECTING LABOUR PRODUCTIVITY

The overall ranking of 32 labour productivity factors investigated in this study, which were ranked based on

Journal of Advances in Engineering, 1(1) their Relative Importance Index (RII) are given in Table 2. The top five factors that affect construction labour productivity in Sri Lanka were identified as the critical factors. These are (1) shortage of experienced labourers, (2) low skill level of labourers, (3) shortage of materials, (4) rework, and (5) unavailability of suitable tools.

Table 2: Overall ranking of factors

Category	Factor	RII	Overall Rank
Human/Labour	Shortage of experienced labourers	4.3095	1
Human/Labour	Skill of labourers	4.2855	2
Management	Shortage of materials	4.2145	3
Technological	Rework	4.1905	4
Management	Unavailability of suitable tools	4.1430	5
Human/Labour	Motivation of labourers	4.0715	6
Management	Unrealistic scheduling and expectation of labour performance	3.9760	7
Management	Payment delays	3.9525	8
Technological	Poor site layout and organization	3.9050	9
Human/Labour	Physical fatigue	3.9050	9
Management	Lack of labour supervision	3.9050	9
Management	Construction manager's lack of leadership	3.9050	9
Management	Communication problems between site management and labourers	3.9050	9
External	Extreme weather conditions (rainy/dry seasons)	3.9050	9
Technological	Coordination level among design disciplines	3.8810	15
Technological	The extent of variation/change orders during execution	3.8810	15
Technological	Clarity of technical specification	3.8570	17
Management	Inspection delay by site management	3.7855	18
Management	Lack of training offered to operatives	3.7620	19
Technological	Delay in responding to requests for information	3.7380	20
Technological	Design complexity level	3.7380	20
External	Delays in getting service approval	3.6905	22
Management	Lack of incentive scheme	3.6665	23
Technological	Inspection delay by the engineer	3.6190	24
Management	Accidents as a result of poor site safety program	3.6190	24
External	Site location, environment around project site and the neighbourhood	3.5475	26
Management	Proportion of work subcontracted	3.5240	27
Management	Lack of periodical meetings	3.5000	28
External	Extreme temperatures in the working environment	3.4050	29
Management	Lack of suitable rest area offered to labourers on site	3.2855	30
Management	Working over time	3.2620	31
Human/Labour	Education level of labourers	3.1905	32

4.3 RANKING OF PRODUCTIVITY CATEGORIES

The ranking of productivity categories was determined based on their average RII values as shown in Table 3.

The results demonstrate that human/labour group was ranked first with the highest average RII value of 0.7905. This reveals the impact of experience, skill, motivation, and individual characteristics of workers to the productivity at the work site. The technological group

was ranked second with an average RII value of 0.7702, illustrating the significant effect of construction practices and equipment to the labour productivity.

Table 3: Ranking of productivity categories

Group	Average RII	Rank
Human factors	3.9525	1
Technological factors	3.8510	2
Management factors	3.7605	3
External factors	3.6370	4

5. CONCLUSION

This study investigated the factors affecting labour productivity of large-scale building construction projects in Sri Lanka. The factors were ranked according to their RII values and the critical factors were identified as: (1) shortage of experienced labourers, (2) low skill level of labourers, (3) shortage of materials, (4) rework, and (5) unavailability of suitable tools. Shortage of experienced labourers may occur due to the lack of a proper employment hierarchy for the experienced workers within local construction companies in Sri Lanka. Therefore, experienced workers tend to move to other companies in the expectation of better prospects. Lack of appropriate material management system, the economic condition of the country as well as the contractor related factors can be identified as the main reasons for the shortage of materials at the site. This can result in time and cost overrun and increase the workers' unproductive time. Rework is caused by various reasons including inexperienced labour, poor workmanship, and poor construction methods. The main reasons for the unavailability of suitable tools at construction site can be identified as lack of proper maintenance, poor handling of tools, and ineffective tool and equipment planning.

The following measures are recommended in order to enhance the labour productivity of building construction projects in Sri Lanka. These are expected to contribute in improving labour productivity of future building construction projects in Sri Lanka.

- 1) Organizations should focus on providing more training and development opportunities for workers, in order to enhancing the necessary skills of construction labour force.
- 2) Necessary steps should be taken to improve the existing National Vocational Qualification (NVQ) system of Sri Lanka by developing appropriate policies to enhance the skill levels of workforce, focusing on

maximizing access to assessment and evaluation at work site.

- 3) Organizations should focus on target-based wage system for the workers, instead of a daily wage system.
- 4) A suitable combination of skilled and unskilled labour should be maintained in order to ensure a smooth and effective workflow.
- 5) Organizations should identify strategies for improving the quality of life of the construction workers.
- 6) Supervisors should be advised to assign daily targets to workers and to review the worker performance on site. Individuals with necessary skills, knowledge, and leadership qualities should be assigned for work supervision.
- 7) A systematic approach should be implemented for the registration of construction workers in Sri Lanka. This should include providing them with job security and lifelong benefits such as ETF and EPF, which will lead to attracting youths of the country to the construction industry.
- 8) Project managers should focus on maintaining continuous information flow among the stakeholders. This would support minimizing rework during the construction.
- 9) The necessary measures should be taken for effective planning and scheduling of material, by paying extra attention to material availability at site in order to avoid idling of labourers.
- 10) Organizations should provide the required number of necessary tools, equipment and machinery for construction work through effective planning. Further, necessary steps should be taken to maintain tools, equipment and machinery in good working condition as well as to prevent poor handling of tools.

6. FUTURE DIRECTIONS

This study was limited to large-scale building construction projects in Sri Lanka. Therefore, future studies can be conducted focusing on small-scale and medium-scale projects as well as the other areas of the construction such as the roads, bridges, and hydraulic structures.

Only the perspective of project management personnel was considered in the study. As the input of labourers is extremely important in identifying the current issues related to labour productivity, focusing on construction workers in future studies is recommended.

7. REFERENCES

1. S. P. Dozzi and S. M. AbouRizk, Productivity in Construction, Institute for Research in Construction, National Research Council Canada, 1993.
2. C. G. Bitar and A. M. P. D. Jarkas, "Factors Affecting Construction Labor Productivity in Kuwait," *Journal of Construction Engineering and Management*. 2012, doi: 10.1061/(ASCE)CO.1943-7862.0000501
3. R. U. Halwatura, "Critical Factors which Govern Labour Productivity in Building Construction Industry in Sri Lanka," *PM World Journal*, vol.4, no.4, 2015.
4. B. G. Hickson and L. A. Ellis, "Factors affecting Construction Labour Productivity in Trinidad and Tobago," *The Journal of the Association of Professional Engineers of Trinidad & Tobago*, vol. 42, no. 1, pp. 4–11, 2014.
5. R. Hughes and D. Thorpe, "A review of enabling factors in construction industry productivity in an Australian environment," *Construction Innovation*, vol. 14, no. 2, pp. 210–228, 2014, doi: 10.1108/CI-03-2013-0016.
6. S. G. Naoum, "Factors influencing labor productivity on construction sites: A state-of-the-art literature review and a survey," *International Journal of Productivity and Performance Management*, vol. 65, no. 3, pp. 401–421, 2016, doi: 10.1108/IJPPM-03-2015-0045.
7. S. Durdyev and J. Mbachu, "On-site labour productivity of New Zealand construction industry: Key constraints and improvement measures," *Australasian Journal of Construction Economics and Building*, vol. 11, no. 3, pp. 18–33, 2011, doi: 10.5130/ajceb.v11i3.2120.
8. M. M. Gundecha, "Study of factors affecting labour productivity at a building construction project in the USA: web survey," MSc Thesis, North Dakota State University of Agriculture and Applied Sciences, USA, pp. 1–76, 2012.
9. S. Dixit, A. K. Pandey, S. N. Mandal, and S. Bansal, "A study of enabling factors affecting construction productivity: Indian scnerio," *International Journal of Civil Engineering and Technology*, vol. 8, no. 6, pp. 741–758, 2017.
10. S. Dixit, S. N. Mandal, J. V Thanikal, and K. Saurabh, "Critical analysis of factors affecting the on-site productivity in Indian construction industry," *Creative Construction Conference 2018*, 30 June- 3 July, Ljubljana, Slovenia, pp. 38–45, 2018, doi: 10.3311/cc2018-006.
11. S. Dixit, S. N. Mandal, J. V. Thanikal, and K. Saurabh, "Study of Significant Factors Affecting Construction Productivity Using Relative Importance Index in Indian Construction Industry," *E3S Web of Conferences*, vol. 140, 2019, doi: 10.1051/e3sconf/201914009010.
12. A. Madhan and G. I., Gunarani, "Factors Affecting Construction Labour Productivity using Questionnaire Survey," *Interntional Journal of Engineering and Technology*, vol. 7, pp. 309- 313, 2018, doi: 10.14419/ijet.v7i3.12.16048.
13. M. Anees, M. Saqib, and D. Memon, " Identification of Factors Affecting Construction Productivity in Pakistan Industry," *Sir Syed Research Journal of Engineering and Technology*, vol. 6, no. 1, 2016, doi: 10.33317/ssurj.v1i1.50.
14. I. A. Rahman, A. H. Memon, A. Q. Memon, M. A. Shaikh, and F. Siddiqui, "Factors Affecting the Labour Productivity in Construction Projects of Pakistan," *MATEC Web of Conferences*, 2019, doi: 10.1051/matecconf/201926605010.
15. S. Al-tmeemy and W. Amer, "Critical factors affecting construction productivity in Iraq," *International Journal of Project Organization and Management*, vol.5, no.2, pp. 87-93, 2014.
16. W. Alaghbari, A. A. Al-Sakkaf, and B. Sultan, "Factors affecting construction labour productivity in Yemen," *International Journal of Construction Management*, vol. 19, no. 1, pp. 79–91, 2019, doi: 10.1080/15623599.2017.1382091.
17. A. Alyew, "A Study on Factors Affecting Labour Productivity on Construction Projects in Wolaita Zone, Ethiopia," *International Journal of Engineering Research and Technology*, vol. 8, no. 12, pp. 817–822, 2020, doi: 10.17577/ijertv8is120385.
18. M.F.H. Rakib, S. Howlader, M. Rahman, and A. Hossain, "Factors affecting the construction productivity in the context of Khulna city of Bangladesh," *5th International Conference on Civil Engineering for Sustainable Development*, Khulna, Bangladesh, 7-9 February 2020.
19. A. Soekiman, K. S. Pribadi, B. W. Soemardi, and R. D. Wirahadikusumah, "Factors relating to labor productivity affecting the project schedule performance in Indonesia," *Procedia Engineering*, vol. 14, pp. 865873, 2011, doi: 10.1016/j.proeng.2011.07.110.
20. A. Makulsawatudom, M. Emsley, and K. Sinthawanarong, "Critical Factors Influencing Construction Productivity in Thailand," *Construction*, vol. 14, no. 3, pp. 1–6, 2004.

21. N. Karunaratna and C. Siriwardana, "Evaluating the Factors Affecting Construction Worker's Productivity," *Technology Driven Sustainable Development in Science and Technology*, vol. 77, no. 12, November, 2018.
22. K. Manoharan, P. Dissanayake, C. Pathirana, D. Deegahawature, and R. Silva, "Assessment of critical factors influencing the performance of labour in Sri Lankan construction industry," *International Journal of Construction Management*, pp. 1–35, 2020, doi: 10.1080/15623599.2020.1854042.
23. D. S. Santoso and P. G. M. P. Gallage, "Critical factors affecting the performance of large construction projects in developing countries: A case study of Sri Lanka," *Journal of Engineering, Design and Technology*, vol. 18, no. 3, pp. 531–556, 2020, doi: 10.1108/JEDT-05-2019-0130.
24. Harvard University Program on Survey Research, "Questionnaire Design Tip Sheet", 2007 [Online]. Accessed 4 July 2021. Available : <https://psr.iq.harvard.edu/book/questionnaire-design-tip-sheet>.