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Development of a New Strategic Framework for Improving the Productivity Benchmarking Practices in Road Project Operations

M. Kesavan, P.B.G. Dissanayake, C.K. Pathirana, M.M.D.R. Deegahawature and K.D.R. Silva

Abstract: Primarily, this study highlights the knowledge gaps in the field for implementing systematic techniques to benchmark and improve productivity levels of critical construction activities in road projects. Accordingly, the study aims to develop a new strategic framework that can enhance the benchmarking practices related to the assessment of labour productivity compared to labour performance with the use of potential apprenticeship tools and systems in road construction operations. A series of literature reviews and expert consultations were conducted to build a new framework with the collection of potential models/tools/systems related to labour training, performance evaluation and productivity measures. The mechanism associated with the developed framework was systematically executed in nine road construction projects in Sri Lanka. The findings show the precise patterns of significant changes in labour productivity and performance index values, which have inspired new approaches in the planning procedures for construction projects. The results assure that proposed mechanisms can be applied with reliable, generalisable and sustainable aspects in their use. The study offers a fresh road map with constructive approaches for project managers, planners and engineers to raise the bar for benchmarking labour productivity and performance levels across a wide range of tasks. The results of the study will have considerable impacts on how other emerging countries and enterprises need to operate their workflows to achieve productivity-related benefits in the future circumstances.

Keywords: Construction planning, Performance improvement index, Productivity benchmarking, Road project, Work-based training

1. Introduction

The contribution from the construction industry is significant to a country's economic framework [1-2]. Although a variety of resources are used in a wide range of construction projects, the construction industry relies heavily on labour productivity in general because labour resources are essential for processing a number of operations related to other resources [3]. Significantly, 30-50% of the costs in the total funding of a typical construction project are related to labour [2]. It is vital to note that the stakeholder initiatives, financial processes and the levels of competition are heavily dependent on the labour productivity [4-7].

Studies highlight that productivity is about how resources are efficiently used to accomplish organisational goals linked with the quality of input, output and process [4, 8-9]. On the other hand, the term 'labour productivity' is defined by Shoar and Banaitis [2] as the proportion of output amounts to labour hours. Further, Murari and Joshi [10] emphasise that the primary factor driving productivity increases in construction operations is labour performance. Importantly, the term 'labour performance' is defined as the process outcomes of labour competencies [9-10]. The lower levels of productivity of labour lead construction firms to face challenges related to time overruns, cost overruns, low quality and poor safety aspects [1, 4]. According to recent studies, numerous construction organisations have been facing such challenges due to the low productivity of labour work in many

Eng.(Dr.) M. Kesavan, *AMIE(SL), BSc Eng (Hons) (Peradeniya), PhD (Peradeniya), AMSSE(SL), GREENSL®AP, Senior Lecturer, Department of Construction Technology, Faculty of Technology, Wayamba University of Sri Lanka. Email:kesavan@wyb.ac.lk;*
https://orcid.org/0000-0002-1985-348X
Eng.(Dr.) P.B.G. Dissanayake, *AMIE(SL), BSc Eng (Hons) (Peradeniya), PhD (Hong Kong), MIE(Aust), Senior Lecturer, Department of Civil Engineering, Faculty of Engineering, University of Peradeniya. Email:pujithad@gmail.com;*
https://orcid.org/0000-0002-8586-5307
Eng.(Dr.) C.K. Pathirana, *C.Eng, MIE(SL), BSc Eng (Peradeniya), MSc Eng (Peradeniya), PhD (Peradeniya), MSSE(SL), Senior Lecturer, Department of Civil Engineering, Faculty of Engineering, University of Peradeniya.*
Email: chinkupathi@gmail.com ;
https://orcid.org/0000-0002-0920-9738
Prof. M.M.D.R. Deegahawature, *BSc (Business Administration) (Jayewardenepura), MBA (Colombo), MBA (Technology Management) (AIT), PhD (Huazhong), MIM(SL), Professor, Department of Industrial Management, Faculty of Applied Sciences, Wayamba University of Sri Lanka.*
Email:dharsana@wyb.ac.lk;
https://orcid.org/0000-0001-6586-0464
Prof. K.D.R. Silva, *BSc (Agric) (Sri Lanka), PhD (UK), RNutr, Director, Centre for Quality Assurance, Wayamba University of Sri Lanka. Email:renuka.silva@wyb.ac.lk;*
https://orcid.org/0000-0002-8252-5331

developing countries, including Sri Lanka [2, 4-6, 11]. The crucial cause behind this is the industry's knowledge gaps in the application of productivity benchmarking approaches linked with apprenticeship and performance evaluation practices at construction sites [12-14]. Noticeably, productivity benchmarking is the process of setting the target achievements, measuring key metrics and performing comparison analysis between the variations in the metrics, which provides ways for upgrading the usual practices.

Within the direct focus on the significance of the above-stated knowledge gap, this study intends to freshly develop a strategic framework with the use of potential apprenticeship tools and systems that can generalise and upgrade the benchmarking procedures associated with the evaluation of labour productivity in relation to labour performance in road construction projects. Notably, the consultations with industry experts highlighted the primary importance of addressing this knowledge gap in road construction projects since such types of projects make a crucial contribution to strengthening the economic structure of a developing nation like Sri Lanka. The study also assesses the satisfaction levels of organisations, trainers and labourers on the productivity enhancement practices and outcomes associated with labour training components. This may lead to providing new productivity enhancement strategies in construction planning and management practices. Based on the above-stated aims and scope, the study focused on the following objectives.

- Identifying potential apprenticeship tools and systems associated with the major intention of this study
- Applying the components of the identified tools and systems for the execution of labour apprenticeship components and the measurement of labour performance and productivity levels in road construction operations
- Finding out the ways for determining the baseline productivity, productivity index and performance improvement index values
- Constructing a new roadmap containing a mechanism of enhancing the productivity benchmarking practices by comparing the productivity and performance index variation patterns within a framework
- Evaluating the validity, reliability and generalisability of the developed framework and its mechanism

2. Literature Review

Poor effectiveness and productivity in construction processes have had a significant impact on the industrialised outcomes, especially in the Indian [1], Vietnamese [4], Nigerian [6], Sri Lankan [11] and South African [15] construction sectors, and these issues are related to a lack of systematic skill development and performance improvement procedures. Accordingly, the literature review of this study mainly focuses on identifying potential apprenticeship tools and systems that can be used to evaluate labour performance and productivity aspects.

A competency framework model is an assemblage of competencies that collectively characterise effective performance within a certain work environment. Importantly, human resource operations, including hiring and recruitment, apprenticeship and development and performance management, are built on competency framework models [16-21]. Uwakweh and Maloney [16] developed a forward-thinking model for personnel planning in expanding construction sectors, emphasising the necessity to develop a pool of supervisory strategies and paths through enhancing training implementation practices. The major flaw of this model is the lack of productivity enhancement characteristics connected with supervisory attributes/strategies. On the other hand, it is important to take into account the results of Serpell and Ferrada [17], who suggested a practical competency framework for supervisors of construction sites engaged in developing countries. Serpell and Ferrada [17] place significant emphasis on the work characteristics among the supervisory job positions in order to coordinate and organise the completion of crucial operational activities in line with project plans towards achieving higher productivity benefits. Despite the framework of Serpell and Ferrada [17] discussing productivity enhancement aspects, the major shortcoming of this framework is the absence of labour competency traits and labour performance evaluation processes connected to the supervisory attributes. Furthermore, Akyazi et al. [18] have produced a model that emphasises competent and multi-skilled workforces in light of the construction sector in the European Union countries to recover from

the effects of the global financial crisis and overcome the challenges associated with digitalisation, sustainability and environmental requirements. But, the detailed review of the contents of this model highlights some limitations of the applicability of this model in numerous developing countries like Sri Lanka, considering the current practices associated with technological and financial aspects. Similar limitations were identified by reviewing some other workforce competency framework models [19-21].

Considering the flaws, limitations and research gaps associated with the use of the above-discussed competency framework models, more reviews of potential apprenticeship models highlight the significance of the tools/models/systems produced by Kesavan et al. [5, 14]. Importantly, the findings and outcomes of Kesavan et al. [5, 14] provide some useful mechanisms that can be suitable and applicable to the current study's aim. It is important to note that Kesavan et al. [14] included a set of developed labour training exercises (LBEXs), whereas Kesavan et al. [5] developed a set of labour training elements of outcomes (LBEOs) with the relative weights based on the objectives of labour training exercises to guide the training delivery and assessment components relating to work operations. As part of their extensive investigation into these LBEXs and LBEOs, Kesavan et al. [5] also presented a labour performance score system (LBPS), which provides a systematic framework for performance assessments and performance-based classifications for construction labourers. Kesavan et al. [5] further recommend assessing the physiological measure of labour performance through continuous measurements of the work productivity of the trained labourers at job sites. Accordingly, these systems can assist in altering behavioural construction practices to increase effectiveness and productiveness in relation to work outputs. It is also significant to note the absence of the flaws, limitations and gaps highlighted in the above paragraph in the models/systems produced by Kesavan et al. [5, 14].

3. Research Methodology

The study mechanism was designed based on the identified knowledge gap and the study's aims, as shown in Figure 1. Importantly, the expert discussions and reviews validated this mechanism by assessing various factors associated with practicality, applicability and organisational aspects for addressing the knowledge gap highlighted. Potential academic experts and industry professionals (project directors, project managers, civil engineers and senior technical officers) were involved in these discussions and validation process. A series of processes were sequentially carried out with the use of potential tools based on the mechanism shown in Figure 1, as described in the following paragraphs.

3.1 Execution of Labour Apprenticeship Components; Measuring the Labour Performance Scores

A total of nine road projects were selected for the implementation of labour apprenticeship components within the mechanism shown in Figure 1. This was accomplished by assessing the organisational policies, current and past working practices, working patterns, problematic locations and the project team's focus on performance and productivity enhancement of project tasks. More than 30 construction site supervisory staff members delivered the labour training components to nearly 100 labourers on those selected projects. It is notable that the supervisory staff had a minimum of five years of prior work experience. The labour training components mainly focused on the following seven elements, as per the guidelines provided by Kesavan et al. [14].

- Enhancing the soft skills required for construction labourers in work-related tasks
- Enhancing the knowledge and use of fundamental scientific and technological principles by construction labourers
- Enhancing the knowledge and use of basic engineering and technological concepts by construction labourers in work-related tasks
- Enhancing the performance of construction labourers in terms of their knowledge and usage of the technological methods/procedures utilised in construction tasks
- Enhancing the performance of construction labourers in handling materials and tools associated with construction operations
- Enhancing the performance of construction labourers on applying green concepts in work-related tasks
- Enhancing the needed skills/abilities of construction labourers associated with fundamental level management processes

Consequently, monthly performance evaluations were carried out under each of the seven categories mentioned above, as per the instructions provided by Kesavan et al. [5] connected with the level descriptors of the National Vocational Qualification Framework of Sri Lanka. As a result, the monthly performance scores were calculated for each labourer using the weights of LBEXs and LBEOs produced by Kesavan et al. [5]. The unit weights of the above-listed seven LBEXs are 0.23, 0.1, 0.1, 0.18, 0.24, 0.1 and 0.06, respectively. These weights were determined by Kesavan et al. [5] using Analytical Hierarchy Process (AHP) method.

3.2 Measuring Labour Productivity Levels

Throughout the delivery of labour apprenticeship components at the chosen projects, the labour productivity levels for the ensuing tasks were regularly assessed. Only the tasks where trained construction labourers were primarily employed in the chosen projects during the apprenticeship period were the subjects of the productivity measurements. Even while some other workers outside the labour apprenticeship circle participated in specific tasks repeatedly, the majority of the tasks that were documented were completed by workers who adhered to the labour apprenticeship components. Accordingly, continuous productivity measurements were taken for the following tasks associated with road construction.

- Aggregate base course laying
- Asphalt (wearing course) laying
- Concrete pavement laying
- Road marking
- Shoulder work

As per the types of above-highlighted tasks, the necessary productivity measurement tools and sheets were designed and executed through discussions with the construction project management team (CPMT) of each selected project.

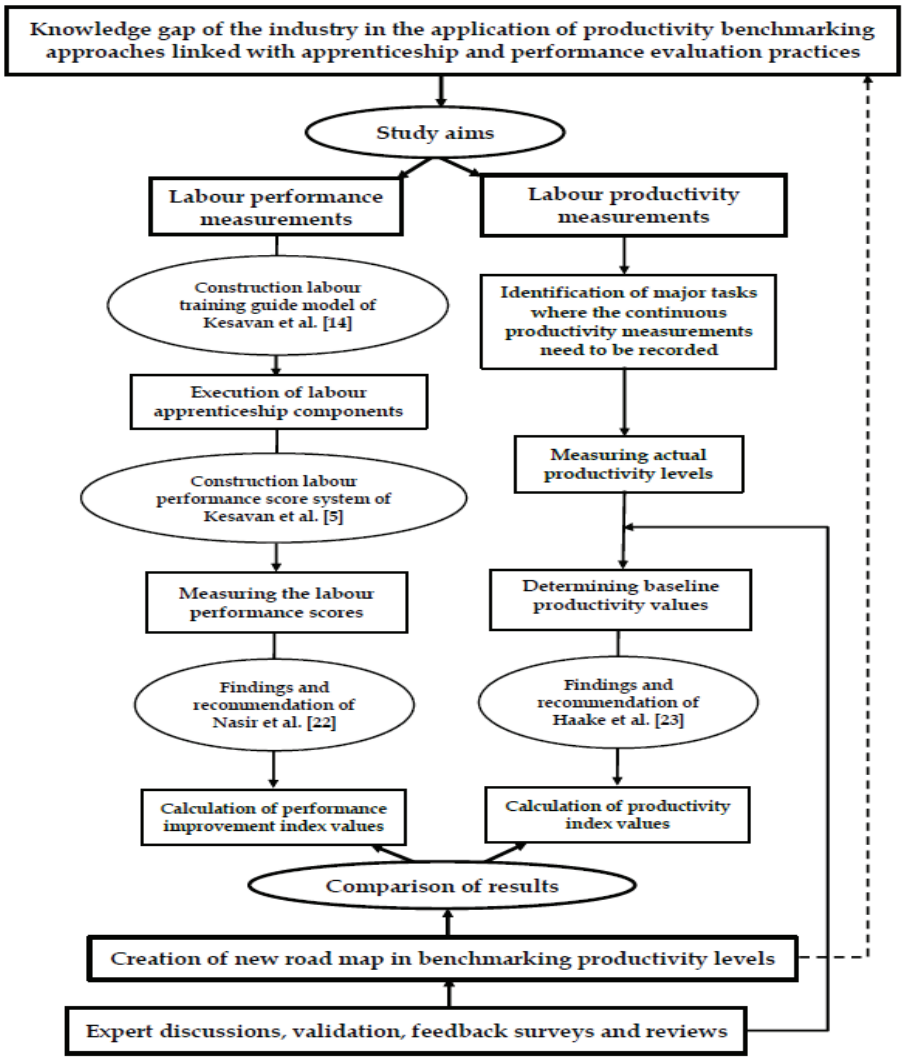

Figure 1 – Flow Diagram of the Study Methodology

3.3 Determining Baseline Productivity, Productivity Index and Performance Improvement Index Values

The productivity measurements in the aforementioned labour-intensive tasks were contrasted with the enhanced labour performance. As recommended by Nasir et al. [22], the productivity index values were determined for each type of construction task using Equation (1). It was identified that there have never been any productivity benchmarks or baseline values used before by the CPMTs of all the chosen projects. Through the discussions with the CPMTs, it was chosen to use the baseline productivity values as the mean values of the prior monthly average productivity levels. The baseline production figures were consequently revised each month. As recommended by Haake et al. [23], similar methods were employed to determine the values of the labour performance improvement index.

$$\text{Productivity Index} = \frac{\text{Actual Productivity}}{\text{Baseline Productivity}} \quad (1)$$

3.4 Expert Discussions, Validation, Feedback Surveys and Reviews

In addition to the discussions and assessment processes associated with the validation of the study mechanism shown in Figure 1, the academic and industry experts were involved in assessing the final results and outcomes of the study applications in the selected nine projects. Moreover, after the completion of the labour apprenticeship project delivery, interviews were also conducted among the trained labourers to assess their feedback on the impacts of labour apprenticeship outcomes. Furthermore, the satisfaction levels of the supervisors and organisations on the labour apprenticeship project delivery and its outcomes were assessed through a feedback survey under the items/statements shown in Table 1 within the five levels of responding, which are 'Strongly agree / Very satisfied', 'Agree / Satisfied', 'Neutral', 'Disagree / Dissatisfied' and 'Strongly disagree / Very dissatisfied'.

Table 1 – Survey Contents for Assessing the Satisfaction Levels of the Construction Supervisors and Organisations on the Labour Apprenticeship Project Delivery and its Outcomes

Item Codes	Statements
Satisfaction Level of Construction Supervisors (Labour Trainers)	
Item S1	The labourers' involvement in apprenticeship tasks at the worksite
Item S2	The support from the organisation/CPMT in running the labour apprenticeship tasks at the worksite
Item S3	The guidance from the CPMT for carrying out labour apprenticeship tasks at the worksite
Item S4	The workload of the labour apprenticeship components
Item S5	The design of labour apprenticeship components and the methods of deliveries
Item S6	The labour apprenticeship components resulted in significant changes in labour behavioural patterns and motivation.
Item S7	The labour apprenticeship components have played a significant role in solving various problems of labourers and increasing the fulfilment levels of their life needs.
Item S8	The labour apprenticeship components have played a significant role in developing new competencies among construction supervisory workers as well as upgrading supervision practices considering long-term aspects and new normal situations of the industry.
Satisfaction Level of Organisations	
Item O1	The labour apprenticeship components delivered a smooth and systematic mechanism to apply skill development practices for labourers at the worksite.
Item O2	The labour apprenticeship components resulted in a significant improvement in the performance of labour at the worksite.
Item O3	The labour apprenticeship components resulted in a significant improvement in the productivity levels of labour operations at the worksite.
Item O4	The labour apprenticeship components resulted in labour rewarding opportunities at the worksite.
Item O5	The labour apprenticeship components provide proactive approaches to supervision practices at construction sites.
Item O6	The labour apprenticeship components play a significant role in upgrading the construction management practices against evolving challenges faced by the industry.

4. Results and Discussion

Table 2 displays the list of the chosen projects and the monthly involvement of labourers in the apprenticeship components. The interviews and discussions held between CPMTs and the labourers employed on those projects before the commencement of apprenticeship applications revealed a variety of issues with their practices that were related to the effectiveness and productivity of labour work. It is noteworthy that their companies had not taken any appropriate activities or processes to provide apprenticeship facilities and evaluate how the labourers performed in construction-related duties. There had also been no mechanisms used in those projects in order to monitor productivity measurements. The CPMTs of the selected projects, except for R2, R7 and R9, agreed to perform productivity measurements for the relevant tasks in their project operations.

The casual appointment of labourers and the temporary shutdowns of some projects due to material shortages, weather effects, seasonal holidays and covid pandemic issues were found to be the reasons for the fluctuations in the number of labourers who participated in the apprenticeship components, as shown in Table 2. Regular meetings and discussions with the CPMTs, supervisors and labourers of the selected construction sites revealed that the goals and objectives of the apprenticeship, the training materials, the strategies for delivering the training, the participation of the labour force, the performance of the supervisors and the organisational management support were all found to be at a satisfactory level towards assuring the applied components of the apprenticeship as intended.

Table 2 – List of the Chosen Nine Projects and the Monthly Participation of Labourers in the Labour Apprenticeship Components

Project Name and Code	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022
iRoad Project TR2, Trincomalee (R1)	15	12	10	14	12	11
iRoad Project AM5, Ampara (R2)	16	12	9	15	12	12
iRoad Project BT1, Batticaloa (R3)	11	11	12	12	12	12
Implementation of 100,000 km Alternative Road System – Road Segments of Batticaloa (R4)	21	16	13	14	14	12
Rehabilitation of Punnakudah Road, Batticaloa	8	8	7	7	7	7
Rehabilitation / Improvements of Roads for Thiraimadu Housing Project (R5)	17	14	12	14	12	12
Construction of Road and Bridge, Mee Oya (R6)	10	8	0	7	6	6
Rehabilitation of Sembiyampatru – Thalaiyadi Road, Kilinochchi (R7)	7	7	8	7	6	6
Implementation of 100,000 km Alternative Road System: Road Segments of Peradeniya – Delthota – Rikillagaskada (R8)	8	7	7	7	6	6
Total	**113**	**95**	**78**	**97**	**87**	**84**

Table 3 illustrates the monthly mean productivity levels at the starting point (which is the earliest stage of the training period) in the chosen projects for the works mentioned in the methodology. Moreover, Figure 2 displays the percentage of growth in the monthly average productivity levels of those works compared to the starting point.

The study finds that the productivity levels of the labour workers significantly increased during the labour apprenticeship period in the chosen projects. Early on in most projects, there was a noticeable decline in productivity for the majority of the tasks, especially in November and December. Labour and material shortages had been faced by most of the projects throughout this time (as described above). In addition, the bad weather conditions forced task discontinuity in some projects during the period. These can be the major causes for the low levels of productivity throughout the initial stages of the time of labour apprenticeship. However, throughout the middle and end of the labour apprenticeship in the vast majority of the projects, the productivity levels of all work categories gradually and significantly increased. No additional particular procedures were added to the construction practices during the labour apprenticeship phase, according to the discussions with the CPMTs of all the chosen projects. The site supervisors reported that they had seen a marked improvement in both the quality and speed of the labour work

outputs. They emphasised that the labour apprenticeship elements contributed significantly to raising labourers' abilities in a variety of areas, which had a noticeable impact on the productivity levels of different labour tasks. However, the factors on the following list may also have some bearing on productivity levels.

- Quantity and quality of materials
- Facilities for material supply and storage
- Dimensions of structures and other features
- Usage of tools and their capacities and qualities
- Size of work outputs
- Weather conditions
- Site management policies/practices

Table 3 – Monthly Average Productivity Levels at the Starting Point

Work Type	Projects					
	R1	R3	R4	R5	R6	R8
Aggregate base course laying (m^3 per labour hour)	3.125	3.781	2.896	2.537	2.667	2.128
Asphalt (wearing course) laying (m^2 per labour hour)	3.462	2.819	2.292	2.310	-	2.847
Concrete pavement laying (m^3 per labour hour)	-	1.406	1.183	-	1.077	-
Road marking (m^2 per labour hour)	2.124	3.757	-	-	-	2.250
Shoulder work (m^3 per labour hour)	4.257	1.360	2.015	-	-	-

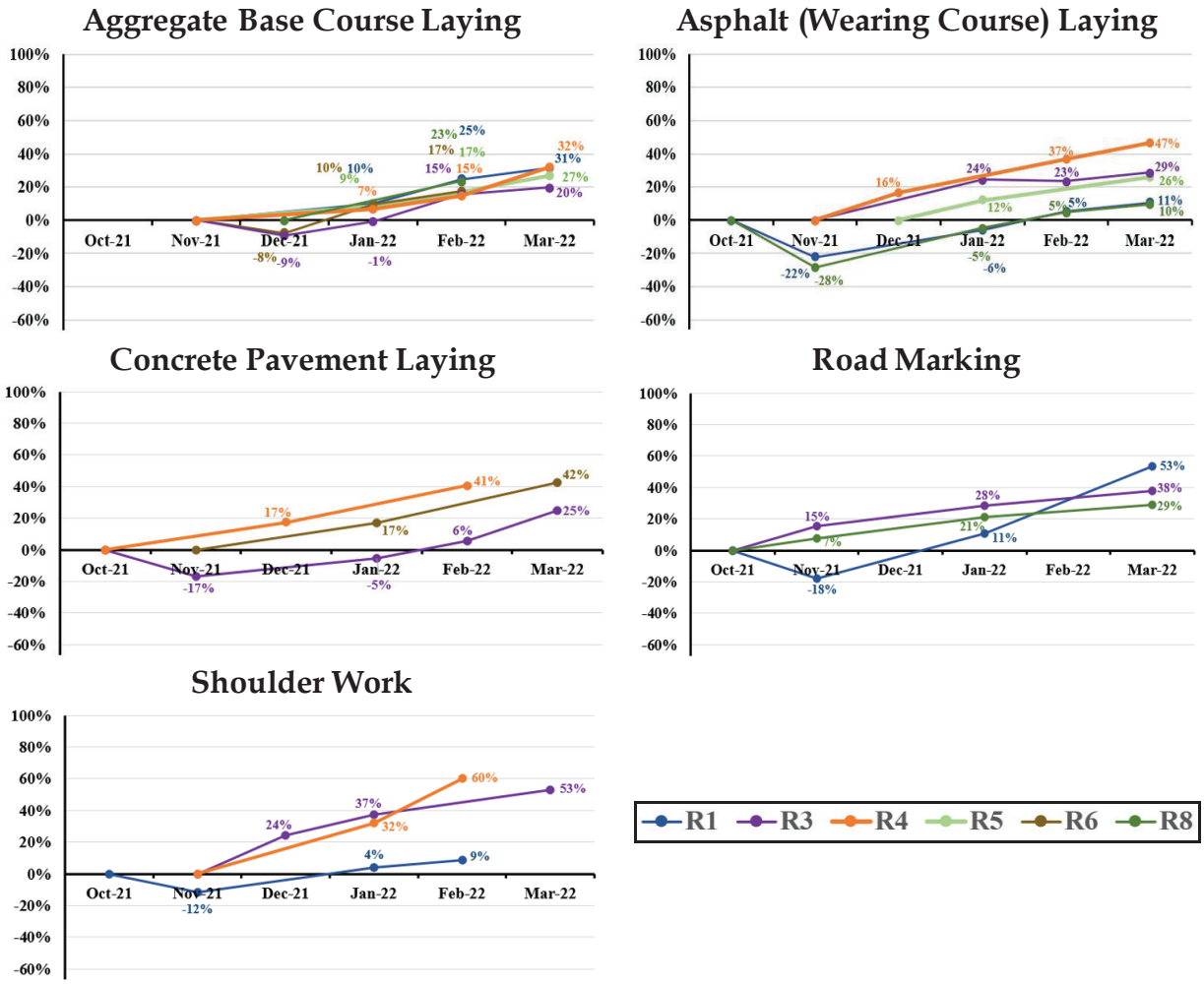

Figure 2 – Percentage of Growth in the Monthly Average Productivity Levels Compared to the Beginning Point

Figure 3 displays the fluctuations in productivity index values and performance improvement index values. The baseline productivity values for each task each month increased in line with the rise in the majority of the construction tasks' monthly average productivity levels. Lower productivity index values can be seen in the results for earlier phases of labour apprenticeship (lower than 1 in most of the work tasks). However, the findings demonstrate a significant rise in the productivity index values of all tasks throughout the middle period (higher than 1 in all the work tasks). The productivity index values peaked and then began to decline as the labour apprenticeship process came to an end. The research suggests that productivity measuring procedures be carried out consistently until the productivity index values for each work approach 1. For each activity/task in each project, the productivity benchmark values can be finalised using the updated baseline productivity values (obtained when the productivity index values hit 1). The variances in the labour performance improvement index values show that there are still opportunities to boost labour productivity in the majority of projects. The research accentuates that the differences between productivity index and performance improvement index values reflect the effects of the factors that affect productivity levels, as stated above.

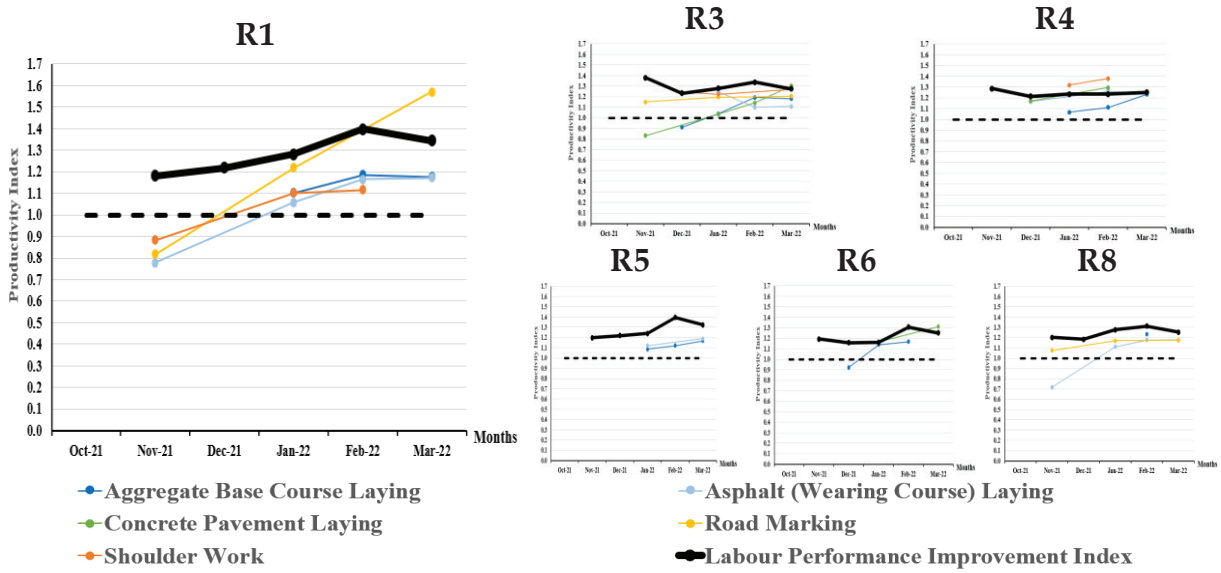

Figure 3 – Variations in Productivity Index Values and Performance Improvement Index Values

The expert assessments/reviews on the above-discussed results and outcomes revealed positive feedback overall. Importantly, the expert reviews highlighted that the proposed applications provide generalisable and reliable approaches that can be highly effective in assuring the efficiency, productivity, profitability and sustainability of various construction organisational outcomes, leading to strengthening the economic structure of the industry.

Additionally, the results of the survey conducted on the satisfaction levels of both the labour trainers (construction site supervisors) and the organisations with the labour apprenticeship project delivery and its outcomes (based on the items and statements described in Table 1) are shown in Table 4.

Table 4 – Results of the Feedback/Satisfaction Survey Conducted among Labour Trainers and Organisations on the Labour Apprenticeship Project Delivery and its Outcomes

Item Codes	SD/ VD	D	N	A/S	SA/ VS
Satisfaction Level of Construction Supervisors (Labour Trainers)					
Item S1	0%	5%	9%	68%	18%
Item S2	0%	0%	27%	68%	5%
Item S3	0%	0%	0%	23%	77%
Item S4	0%	0%	18%	73%	9%
Item S5	0%	0%	5%	50%	45%

Item S6	0%	0%	0%	41%	59%
Item S7	0%	0%	9%	55%	36%
Item S8	0%	0%	0%	36%	64%
Satisfaction Level of Organisations					
Item O1	0%	0%	11%	77%	11%
Item O2	0%	0%	0%	22%	77%
Item O3	0%	0%	0%	66%	33%
Item O4	0%	0%	11%	55%	33%
Item O5	0%	0%	0%	22%	77%
Item O6	0%	0%	0%	44%	55%

SD/VD: Strongly Disagree / Very Dissatisfied; D: Disagree/ Dissatisfied; N: Neutral; A/S: Agree/ Satisfied; SA/VS: Strongly Agree / Very Satisfied

A total of 22 construction site supervisors responded to the survey of labour trainers from all the selected construction projects, whereas the project manager/site-in-charge responded to this survey of organisations from each selected construction project. Overall, the results confirm that very good feedback was obtained among both work categories on the labour apprenticeship project and its outcomes. Considering the viewpoint of labour trainers, more than 70% of the labour trainers expressed 'Satisfactory' or above the level for all items (S1 – S8), where it was more than 95% for S3, S5, S6, S7 and S8. Only 5% of the labour trainers expressed their dissatisfaction with the labourers' involvement in training tasks (S1). This does not need to be seriously taken since the majority expressed their satisfaction with those items. When it comes to the viewpoint of organisations, all the organisations almost expressed 'Satisfactory' or above the level for all items. Additionally, the trained labourers' high levels of satisfaction with the effects of applying apprenticeship components on their requirements, job standards, lifestyles, financial situation and career enhancement opportunities were made clear in the interviews with them.

Considering the discussion on the current study findings with past studies, the current study describes the systematic solution mechanism to achieve significant improvement in various competency traits of workforce through the use of apprenticeship components, addressing the requirements highlighted by many studies [1, 3-6, 24-27] for productive apprenticeship systems. Similar to the findings of Ojha et al. [12], Syafiatun [28] and Gao et al. [29], the results of the current study highlight the significant advantages of apprenticeship approaches over conventional methods. When it considers the deficient methods used by industrial firms to evaluate labour abilities, run performance reviews and measure productivity, the need for the systematic procedures emphasised by earlier studies [1-2, 4-6, 11, 13, 19] has been satisfactorily addressed in the current research. As per the recommendation of recent studies [30-31] to use videography and photography techniques in apprenticeship components, the training components presented in this research can be upgraded with those digitalised methods in the future stages. Further, the current research outcomes will contribute to filling the gaps highlighted by recent studies in the curricula of numerous training programmes in the vocational education sector [3, 5-6, 13]. Importantly, the study outcomes will lead to upgrading the benchmarking levels of various industry operations to address the challenges highlighted by recent studies [5, 11, 13] on the growth of foreign labour in the Sri Lankan construction sector.

Moreover, the current study findings open a gate to determine the key performance indicators (KPIs) in performance benchmarking since the findings show sets of quantifiable metrics to assess the overall long-term performance of an organisation towards the improvement in productivity, profitability and the satisfaction of the employees and employers. In particular, the proposed mechanism and systems can also be helpful in identifying the uses associated with performance measurements, action strategies, employee motivations and opportunities, as well as the risks related to inappropriate indicators, distraction, manipulation, dissatisfaction aspects and non-measurable areas. This may lead to the implementation of sustainable and productive systems and well-enhanced strategies for performance evaluation, progress tracking systems, time analysis and organisational health monitoring aligning with the organisational culture, values, vision and mission aspects.

5. Conclusions

Overall, the study has addressed the gaps in knowledge of the industry for executing methodical approaches to benchmark and upgrade productivity levels of important construction tasks in road projects. The initial phase of this study has explored prospective apprenticeship structures, tools and systems to lay a platform for the achievement of this intention. In its mid-phase, the study tested the key variables associated with labour performance and productivity through the applications of such tools and systems in selected road construction projects. This led to the construction of a new functional roadmap for the enhancement of productivity benchmarking procedures within a framework with generalisability and reliability assurance at the end stage of the study.

The study deliverables highlight notable theoretical, practical and social implications and new values, connecting with the industrial and institutional practices in present and future circumstances. Taking on the theoretical implications of this study, work process, learning demand and job responsibilities can be considered as the major categories in the performance assessment procedures. This can lead to the development of meaningful performance measurement formulas, connecting with productivity measurement and benchmarking approaches. Accordingly, the study outcomes add new attributes to the role of supervisors, linking to this theoretical implication. This theoretical implication adds new values to the construction management and planning practices, connecting with some practical implications, especially in preparing the organisations to identify KPIs and potential action plan frameworks towards achieving their goals and sustaining them in the next normal circumstances. The results demonstrate the behavioural shifts in the work patterns of the workforce and the site supervision practices that resulted in the curtailing of the disparities between the organisational policies and labour characteristics. Accordingly, the study outcomes lead to the way of healthy communication practices between supervisors and labourers on construction sites, strengthening the bonds between different work chatagories and promoting the long-term viability of construction firms. The study outcomes could also lead to a rapid rise in the number of skilled workers in the industry within a short time, as well as a rise in the number of labourers switching from casual to permanent employment in industrial firms, raising the standard of living for workers and providing them with benefits like job security, salary increment, opportunities for advancement/promotion and other benefits for career development. This may uplift the motivation and work qualities of labour at construction sites, leading to removing any roadblocks to hiring more local workers while reining in local enterprises' overseas preference for hiring foreign workers. In its way, the practical and social implications connected to the current study findings are expected to make sustainable-based impacts on re-building and re-structuring the industry practices to achieve the expected economic outcomes of the nation.

Although the study applications and outcomes are restricted to road construction, similar methods can be applied to other kinds of projects to achieve outcomes that are comparable. The research findings are anticipated to have a substantial impact on the industrial processes in other developing countries, despite the fact that the study's scope and applications are restricted to the Sri Lankan context. The research outcomes may also push the other emerging industrial sectors to consider similar methods and procedures to upgrade the benchmark levels of efficiency and productivity in work operational flows. As a result, this research advises that future studies concentrate on developing new apprenticeship tools as well as evaluating the outcomes of apprenticeships and reviewing the characteristics of particular professions or industrial sectors in diverse contexts.

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