Evaluating the Performance-Based Grading of Construction Labour in Road Project Operations Through a New Apprenticeship Framework

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Abstract: The main issues facing the construction industry in many nations have been poor labour performance in work operations, leading to significantly influencing the quality, safety and productivity of construction processes/outcomes. By implementing efficient apprenticeship components, this study attempts to evaluate the effectiveness/performance of labour in road project operations through a case study. With action-oriented and problem-focused communication approaches, an exhaustive academic review and expert consultations were carried out to design a collection of methods/tools/systems linked to labour apprenticeship and performance assessment inside a framework. Through a newly established site supervisory apprenticeship programme, the developed procedures were implemented with more than 100 construction labourers engaged in nine Sri Lankan road projects. The results display the specific patterns of substantial changes in labour performance levels with the quantified values, which aid in the planning and formation of crew mixes for various project jobs, as well as proactive methods for managing and controlling labour in the construction industry. The findings ensure the generalisation of the developed practices/tools/mechanisms towards the sustainability of its applications. The study further adds advanced attributes to construction supervision job roles. The study findings/outcomes can make significant impacts on the practices of other developing nations and industries.

Keywords: Labour skills, Performance measurement, Road construction, Supervision, Sri Lanka

1. Introduction

The construction sector plays an indispensable part in the economic structure of a nation [1-2]. When compared to other businesses, the construction industry employed the largest portion of workers for many years [3-4]. The effectiveness of construction organisations, which is part of a nation's broader economy, is significantly influenced by the performance of labour [2, 4], whereas work-related labour skills are the primary determinants of labour performance [5-6]. The poor practices of the vocational institutional sector of many countries have been the major cause of the low performance and work outputs of labour [1, 3]. Recent studies spotlight the lack of awareness among many construction firms on the need for the application of proactive labour apprenticeship and performance evaluation systems at construction sites in numerous developing nations like Sri Lanka [2, 4-8].

1.1 Labour Skill Shortage in Sri Lankan Context

The rise of the construction industry has drawn numerous investments from the public and private sectors since the end of the protracted war in Sri Lanka. As a result, there are numerous infrastructure development projects underway right now in the country [9]. However, recent studies report that numerous construction firms have been experiencing a wide range of challenges in many of those construction projects due to low levels of performance of labour work [3, 8]. The skill shortage has been the key factor that critically influences the productivity and performance levels of labour [3, 8]. The cognitive, self-management and transferrable abilities of labourers fall short of the norms needed to improve labour performance in the Sri Lankan construction sector [9]. The industry's requirements are not sufficiently addressed in

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the secondary and vocational education sector of the country [3, 6, 9]. Tertiary and Vocational Education Commission [9] reveals that unskilled labourers are employed in place of skilled workers at a large number of Sri Lankan construction projects resulting in poor work quality in construction operations. Recent studies [3, 8] and discussions with the skill sector authorities and vocational training institutions state that no proper systems are used by firms to examine labour skills at job sites, and there is a mandatory requirement for effective apprenticeship programmes for construction labourers connected with the assessment on the labour performance levels. Recent studies highlight similar requirements and scenarios for the construction industry of numerous other developing nations too [2, 4-8, 10].

1.2 The Intention and Significance of the Research

Based on the above-stated needs and gaps, this research aims to evaluate the performance-based classification of construction labour in road project operations by implementing methodical labour apprenticeship practices. Notably, the discussions with the Sri Lankan Construction Industry Development Authority (CIDA) and industry experts have stated that the impacts of the above-stated problems are much higher in road construction projects than in other types, also stressing the essential role that the construction of roads makes as a crucial contribution to the infrastructure development of a developing country like Sri Lanka. The research also engages the ways of implementing effective labour-rewarding mechanisms on project sites. This may lead the construction firms to find out better ways to direct construction practices towards maximising efficiency, quality, safety and productivity of labour work.

2. Literature Review

In the last decade, studies have highlighted the poor labour skills in various categories that resulted in low levels of construction labour efficiency in numerous nations, namely Australia [11], Egypt [12-13], India [1], Nigeria [5], Sri Lanka [8] and Vietnam [4]. Construction labourers' cognitive abilities in construction technological application methods and health and safety practices were highlighted as one of the major factors affecting construction efficiency in India [1], Egypt [13], Iran [14] and New Zealand [15]. Moreover, studies reveal

that labourers' inadequate self-management skills in commitment, attendance and punctuality affected the progress of a large number of construction projects in numerous nations, namely Egypt [12], India [16] and Trinidad and Tobacco [17]. Such self-management abilities are very significant for labourers to develop a reputation as trust worthy and reliable employees [17]. In addition to these self-management abilities, the need for improving self-motivation and problem-solving skills among labourers is accentuated by Nwosu [5] and Kesavan et al. [6], as per the current practices of most construction firms in numerous developing nations. Further studies highlight the inadequate cognitive competencies of Sri Lankan construction labourers in taking measurements and estimations and manipulating materials, tools and technologies [15, 18].

Effective supervision of labour contributes greatly to higher levels of labour motivation as well as the quality and quantity of labour work outputs [4-5, 13]. The delivery of work-based training components for labourers through supervision practices can result in better ways for the smooth implementation of skill enhancement practices at construction project sites [4]. Interestingly, an apprenticeship guiding model has been produced by Kesavan et al. [10] to constructively develop advanced training programmes for construction site supervisors towards handling the industry's challenges in future circumstances. Importantly, this guide model specifies a package of construction site supervisory competencies that are crucial for the efficient delivery of apprenticeship practices for construction labourers with the assessment of labour competencies and performance in all types of construction project operations. Accordingly, the guide tool of Kesavan et al. [10] recommends designing occupational-based diploma-level training programmes for construction site supervisors consisting of job-integrated learning practices using the detailed steps.

Furthermore, studies highlight the significance of apprenticeship methods, which generate well-improved cognitive, transferable and self-management skills in construction workers compared with other traditional methods [19-21]. However, most industrial and institutional firms have been familiar with the use of traditional training methods, which are lecture-based sessions/talks and not on-the-job

training approaches [13]. Additionally, based on an apprenticeship programme conducted on concrete works among 30 construction workers in Medan City, Indonesia, Syafiatun [20] states that how the trainees note explanations from the instructor, ask questions, show self-confidence, communicate/participate in group work, share their own thoughts, respond to the thoughts of others and make summarised learning contents need to be considered in the delivery of apprenticeship components and evaluations.

Recent studies recommend the application of various technologies like 360-degree panorama and virtual gaming methods to develop environments digitally for promoting the sensory awareness and interaction of workers in apprenticeship elements [22-24]. The real surrounding views can be generated using photography and videography techniques for training assessment purposes [25]. But, the main barrier to the training sectors in many developing nations adapting their current practices to the digital environment has been the requirements for technological innovation and the high costs associated with using these digital technologies.

Despite some practices being recommended by past studies for apprenticeship delivery, further guiding models are required for industrial firms to implement apprenticeship components within a methodical framework. Accordingly, the academic investigation of this research highlights the significance of the construction labour apprenticeship guiding tool presented by Kesavan et al. [26] and the labour performance score and grade systems of Kesavan et al. [6] for the industry sector. With the specific goal of raising labour performance levels, the labour apprenticeship guiding tool of Kesavan et al. [26] comprises a package of labour training exercises (LBEXs) that can be systematically applied to the labourers by site supervisory staff. Based on the aims of these LBEXs, Kesavan et al. [6] have exhaustively developed the labour training elements of outcomes (LBEOs), which provide the base to direct and control the delivery of labour apprenticeship components. Table 1 illustrates those LBEXs and LBEOs, including their unit weights. Importantly, these LBEXs and LBEOs cover the common elements that can be applied in all types of construction projects. The investigation extended by Kesavan et al. [6] on the LBEXs and LBEOs has introduced new constructive systems, namely the labour performance score (LBPS) system and labour grading scheme (LGS), which provide a methodical framework for assessing the performance of labour. Importantly, the elements included in the above-specified models/systems/schemes are well-connected to addressing the needs and characteristics highlighted by many other past studies based on the perspectives of developing countries, as indicated by Kesavan et al. [6, 26].

3. Research Methodology

Based on the study aims, the methodology was developed, as described in Figure 1. Throughout the processes, a number of discussion sessions, workshops and reviews was held with academic experts and industry professionals, including project directors, project managers, civil engineers and senior technical officers, with a focus on the steps that need to be taken in the project planning and site management practices to meet the industry's changing challenges and opportunities in future circumstances. Throughout the study's processes, problem-focused communication techniques were employed, particularly for comprehending the problems, exchanging information, creating ideas and coming up with solutions. Importantly, the generalised training guide models and systems mentioned in this study's literature review were taken into account as the base for the study's methodology. The assessments and discussions of the experts also suggested using those models and systems to accomplish the objectives of the study.

Table 1 – Objectives and Elements of Outcomes of Labour Apprenticeship Exercises

Exercise Code Nos. and Aims/Objectives in Performance Enhancement [Relative Weights] (Kesavan et al. [26])	Labour Apprenticeship Elements of Outcomes (LBEOs) [Relative Weights] (Kesavan et al. [6])	
LBEX1 - Soft skills required for construction labourers in work-related tasks [0.23]	LBEO1.1	Performing activities with the needed transferable skills [0.4]
	LBEO1.2	Performing activities with the needed self-management skills [0.6]
LBEX2 - Fundamental scientific and technological principles by construction labourers [0.10]	LBEO2.1	Assisting with the tasks associated with measuring and estimating in the construction [0.6]
	LBEO2.2	Carrying out work-related tasks with a fundamental-level understanding of construction drawings aspects [0.3]
	LBEO2.3	Using relevant information and communication technology applications for simplifying regular work operations [0.1]
LBEX3 - Basic engineering and technology concepts by construction labourers in work-related tasks [0.10]	LBEO3.1	Carrying out work-related tasks with a fundamental-level understanding of simple architectural and structural concepts [0.3]
	LBEO3.2	Assisting with the tasks associated with soil testing, flow measurements and surveying practices [0.4]
	LBEO3.3	Following safety regulations in using electrical sources [0.3]
LBEX4 - Technological methods/procedures utilised in construction tasks [0.18]	LBEO4.1	Following health and safety guidelines in all types of work-related tasks at construction sites [0.3]
	LBEO4.2	Carrying out work-related tasks with the required cognitive and manual abilities in using technologies [0.5]
	LBEO4.3	Handling equipment and tools effectively in machinery operations [0.2]
LBEX5 – Handling materials and tools associated with construction operations [0.24]	LBEO5.1	Using materials in work-related tasks with a fundamental-level understanding of the behaviour and properties of construction materials [0.4]
	LBEO5.2	Handling tools by following the required instructions and procedures in material testing tasks [0.6]
LBEX6 - Applying green concepts in work-related tasks [0.10]	LBEO6.1	Following green practices in work-related tasks (eg. waste disposal, water supply, usage of material and resources, etc.) with an understanding of the need for environmental sustainability [0.6]
	LBEO6.2	Explaining the significance of the uses of energy conservation approaches and other sustainable practices to other workers [0.4]
LBEX7 - Fundamental level management processes [0.06]	LBEO7.1	Following the instructions and procedures associated with quality assurance and control in construction tasks [0.6]
	LBEO7.2	Managing regular activities to strengthen financial status for sustaining the fulfilment of human needs [0.3]
	LBEO7.3	Following the labour laws and relevant aspects for career enhancement benefits [0.1]
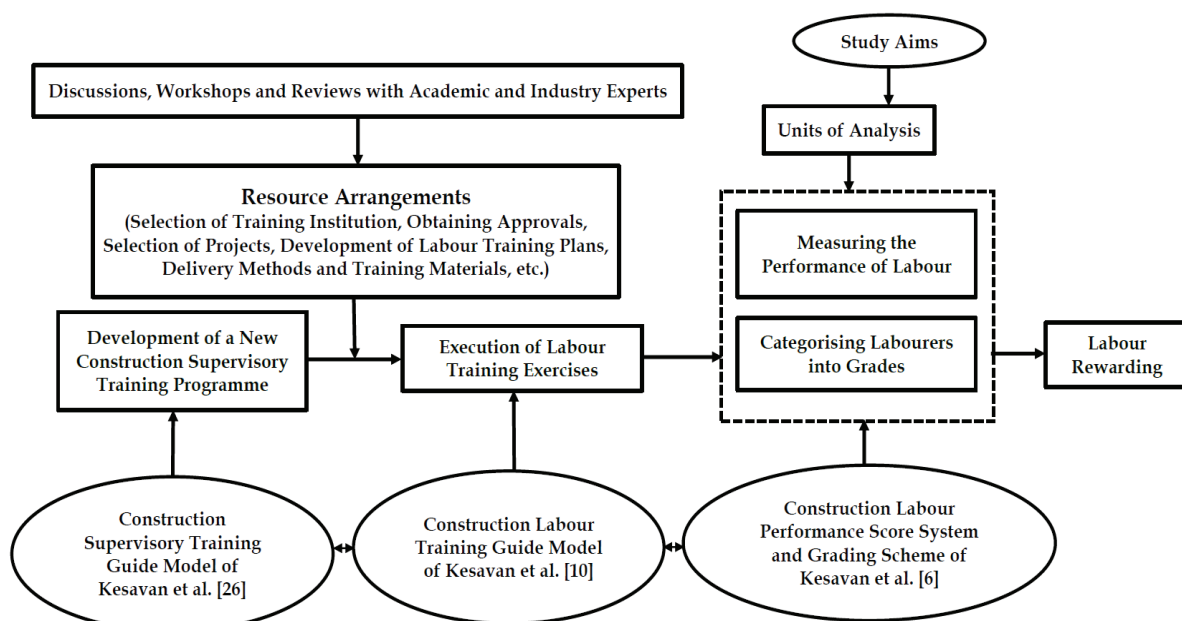
Figure 1 – Flow Mechanism of the Study Methodology

3.1 Development of an Advanced Training Programme for Construction Site Supervisors

The guidelines of Kesavan et al. [10] were followed to develop a new training programme for applying proactive approaches in labour supervision practices with a direct focus on improving the effectiveness of labour work. The training institution for the implementation of the construction site supervisory training components was chosen by following expert discussions using the SWOT analysis. Through a series of discussions with the boards/committees of the chosen institution relevant to academic planning, curriculum development, ethics, finance and scholarships, the required approvals were taken for commencing the supervisory training programme. With the focus on the need for systematic and long-term training delivery, the by-laws were designed, the human resources were appointed for the programme's Board of Study, teaching panel and other necessary resources were arranged within the institution. The training promotion activities importantly consisted of a series of awareness sessions, considering the current/recent apathetic behaviour and poor practices of many construction firms and their inability to adopt new approaches. The construction site supervisory training encompassed lecture-based sessions, interactive talks and project discussions for the execution of labour apprenticeship elements at the job sites based on the following elements of competencies specified by Kesavan et al. [10].

- Describe the significance of a training needs analysis for construction workers
- Apply the procedures required to prepare for the implementation of worker apprenticeship at construction sites
- Describe how to evaluate the training needs of construction labourers
- Design training materials, assessments and delivery plans for the construction site workers
- Apply brainstorming techniques to enhance labour skills at construction sites
- Apply competency-based training methods to enhance labour skills at construction sites
- Apply fundamental concepts and theories of construction operations to the labourers at construction sites

- Execute experiential learning approaches among labourers at construction sites
- Maintain records of the applications and outcomes of labour apprenticeship components
- Examine the labour performance in construction operations
- Execute relevant rewarding mechanisms for the career enhancement of labourers at construction sites

3.2 Execution of Labour Training Exercises

According to the by-laws of the newly designed construction site supervisory training programme, the site supervisors were selected among the applicants by conducting interviews and assessing their qualifications unbiasedly. In total, nine road projects were chosen for the delivery of labour apprenticeship components by taking into account the projects where the chosen supervisory workers were employed. This was done by evaluating the projects' background information, organisational policies, present/past practices, working patterns, problematic areas and skill levels of labourers. There were around 100 labourers continuously trained by more than 30 construction site supervisory staff in the chosen projects. Noticeably, all of the supervisory staff had a minimum of five years of prior work experience.

According to the task schedule illustrated in Figure 2, the labour apprenticeship components were delivered at the selected projects. The training materials were designed based on the characteristics of LBEXs and LBEOs presented in Table 1. For each LBEX component, brief manuals and video clips were created in the primary language of the labour force, outlining the fundamental ideas, steps and strategies to accomplish the corresponding LBEOs. A group of specialists vetted the manuals and video clips before sharing them with the workers to guide them to become better self-learners. Based on the developed training materials, the labourers were involved in essential field exercises, interactive discussions, brainstorming sessions and demonstrations during the delivery of apprenticeship components.
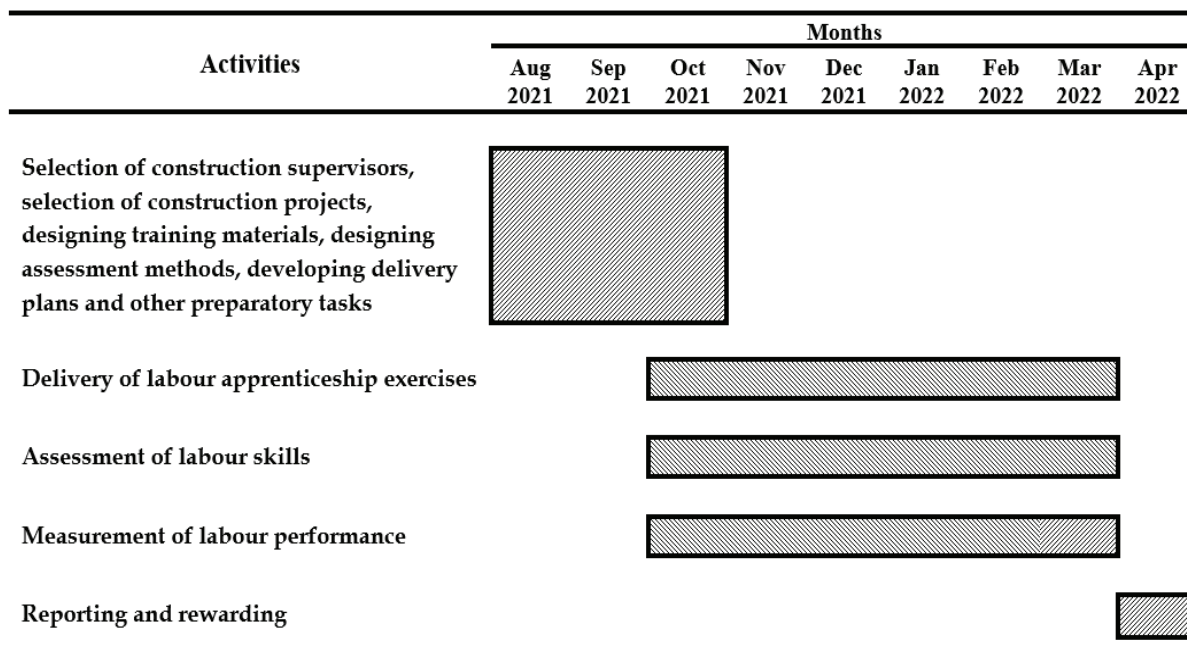
Activities	Months								
	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022	Apr 2022
Selection of construction supervisors, selection of construction projects, designing training materials, designing assessment methods, developing delivery plans and other preparatory tasks	▨	▨	▨						
Delivery of labour apprenticeship exercises			▨	▨	▨	▨	▨	▨	
Assessment of labour skills			▨	▨	▨	▨	▨	▨	
Measurement of labour performance			▨	▨	▨	▨	▨	▨	
Reporting and rewarding									▨

Figure 2 – Labour Apprenticeship Activity Schedule

3.3 Assessing Labour Skills, Measuring Labour Performance and Grading Labourers

The levels of descriptors listed in the National Vocational Qualification (NVQ) framework of Sri Lanka under the areas of the process [P], learning demand [L] and responsibilities [R] were primarily taken into consideration to assess the labourers' competencies. Every month, the construction site supervisors were instructed to continuously observe each labourer's participation in the given activities to determine the degree of each category under each LBEO.

Throughout the execution of the labour apprenticeship elements, labour performance, and labour grades were thought of as the main units of analysis. According to the instructions provided by Kesavan et al. [6], the following steps were used to determine the labour performance score (LBPS) values and labour grade for each labourer in each month.

- Determine the level descriptor for each LBEO within each category indicated in the Sri Lankan NVQ framework by ongoing observations of a worker's participation in assigned tasks.
- Take into account the scores listed below, one for each level of descriptor within each category.
  Process (P): P1-25; P2-50; P3-75; P4-100
  Learning Demand (L): L1-25; L2-50; L3-75; L4-100
  Responsibilities (R): R1-25; R2-50; R3-75; R4-100

- Based on the scores indicated above and assuming equal weights for each category (P, L, and R), get the average score for each labourer under each LBEO.
- Use the following formulas to calculate each labourer's performance score for each LBEX.
  $LBEX1 = 0.4*LBEO1.1 + 0.6*LBEO1.2$
  $LBEX2 = 0.6*LBEO2.1 + 0.3*LBEO2.2 + 0.1*LBEO2.3$
  $LBEX3 = 0.3*LBEO3.1 + 0.4*LBEO3.2 + 0.3*LBEO3.3$
  $LBEX4 = 0.3*LBEO4.1 + 0.5*LBEO4.2 + 0.2*LBEO4.3$
  $LBEX5 = 0.4*LBEO5.1 + 0.6*LBEO5.2$
  $LBEX6 = 0.6*LBEO6.1 + 0.4*LBEO6.2$
  $LBEX7 = 0.6*LBEO7.1 + 0.3*LBEO7.2 + 0.1*LBEO7.3$
- Calculate the labour performance score (LBPS) value for each labourer using the following formula.
  $LBPS = 0.23*LBEX1 + 0.10*LBEX2 + 0.10*LBEX3 + 0.18*LBEX4 + 0.24*LBEX5 + 0.10*LBEX6 + 0.06*LBEX7$
- Consider the following criteria to classify each labourer with a grade according to his/her LBPS value.
  Range of LBPS: 75–100; Grade: 'A'; Color code: 'Green'
  Range of LBPS: 50–74; Grade: 'B'; Color code: 'Yellow'
  Range of LBPS: 25–49; Grade: 'C'; Color code: 'Orange'
  Range of LBPS: 0–24; Grade: 'D'; Color code: 'Red'

3.4 Reinforcement of Apprenticeship Components

Regular discussions and meetings were held among the construction project management

team (CPMT) members, supervisors and labourers with a focus on the delivery of training contents, use of training methods, achievement of training objectives, participation of labourers, capabilities of supervisors, policies of organisational management and other needed actions in order to evaluate whether the labour apprenticeship components are carried out in the desired direction.

3.5. Labour Rewarding and Reporting

The labour incentive mechanisms were implemented in the chosen projects using the Recognition for Prior Learning (RPL) approach. RPL is a rapid method for assessing whether a person has attained the necessary abilities in accordance with the NVQ framework's national skill requirements [6]. Each labourer was assigned to a suitable NVQ level according to the LBPS value and labour grade obtained by him/her at the conclusion of the apprenticeship period. As per the recommendation of Kesavan et al. [6], the NVQ levels rising from 1 to 4 were compared to the labour grades D to A, correspondingly. The CPMTs and career development units were shown the overall variances in the monthly labour performance score values and grading details, which helped them in taking the necessary actions for the RPL implementation.

4.   Results and Discussion

The list of the selected projects is shown in Table 2. The interviews and discussions conducted among CPMTs and labourers working on those projects unveiled a wide range of problematic areas associated with the efficiency of labour work in their practices and verified the importance and suitability of the application of the labour apprenticeship components for those nine projects. The

majority of labourers working on those projects lacked the necessary NVQ certifications and qualifications in addition to not finishing their school education. Though such labourers were working in skilled and unskilled categories in those projects, no systematic mechanisms were found for this categorisation. Notably, the labourers working on those projects revealed that their organisations had not previously given them suitable apprenticeship facilities. The majority of them further expressed their willingness to follow the labour training exercises to upgrade their skills and qualification levels. No proper actions/steps had been taken by their firms to assess how the workers perform in construction tasks.

In the chosen projects, 113 labourers in total were involved with the labour apprenticeship components during the first month, and this was significantly reduced to 78 by the third month. The majority of the labourers were working with casual appointments at the selected projects. Some labourers did not report to work for some weeks/months due to the seasonal holidays and Covid-19 pandemic issues. Further, some projects experienced temporary shutdowns for some days/weeks due to material shortages and bad weather conditions. This led to very slow progress in the planned activities in some projects and resulted in some labourers leaving their workplaces temporarily or permanently. In addition, the labour training exercises were not conducted in project R7 for the third month due to lengthy shutdowns during this period. However, the labour training exercises were resumed fourth month onwards and processed smoothly in project R7. However, due to the decrease in the aforementioned effects, the number of labourers who were involved in the apprenticeship exercises climbed to 97 by the end of the fourth month and decreased to 84 by the completion of the sixth month.

Table 2 – List of the Chosen Projects

Project Name	Code
iRoad Project TR2, Trincomalee	R1
iRoad Project AM5, Ampara	R2
iRoad Project BT1, Batticaloa	R3
Implementation of 100,000 km Alternative Road System – Road Segments of Batticaloa	R4
Rehabilitation of Punnakudah Road, Batticaloa	R5
Rehabilitation / Improvements of Roads for Thiraimadu Housing Project	R6
Construction of Road and Bridge, Mee Oya	R7
Rehabilitation of Sembiyampatru – Thalaiyadi Road, Kilinochchi	R8
Implementation of 100,000 km Alternative Road System: Road Segments of Peradeniya – Delthota – Rikillagaskada	R9

Regular meetings, talks and discussions with the CPMTs, supervisors and labourers of the chosen construction sites revealed that the apprenticeship's goals and objectives, training materials, training delivery strategies, participation of labourers, supervisory performance, organisational management support and other needed actions were all met to a satisfactory level. This made sure that the apprenticeship components were carried out in the intended manner.

Figure 3 illustrates the monthly changes in the LBPS values, as per the LBEXs, projects and overall category. The overall findings demonstrate a remarkable improvement in labour performance across all LBEXs and projects. Since the labour training projects mainly focused on LBEX 1, the soft skills of the labourers in all the projects dramatically improved in the first two months and then showed gradual improvement over the next four months of the apprenticeship period. Overall, the average labour performance score has risen from 33.44 to 62.77 for LBEX 1 during the labour apprenticeship delivery. This quantitative variance shows that the applied apprenticeship procedures contributed to improving the soft skills of the labourers by about 90% from the baseline. The meetings with the experts stated that the job environment and working conditions have notable influence on workers' soft skills. Considering the labourers' competencies in applying scientific and technological principles (LBEX 2), the labour performance score values gradually increased from 35.96 to 57.79 during the six-month duration of the apprenticeship, representing a 50% increase in LBEX 2 characteristics from the baseline. On the other hand, a gentle improvement was observed in labourers' abilities in understanding basic engineering and technology concepts (LBEX 3), implementing green concepts in work-related tasks (LBEX 6) and their skills/abilities associated with fundamental-level management processes (LBEX 7) throughout the apprenticeship period. The quantitative variance in the score values of LBEX 3, LBEX 6 and LBEX 7 demonstrates around 40% enhancement in the attributes associated with such LBEXs. When it considers the labourer competencies in using technological methods/procedures in construction activities (LBEX 4) and their material manipulating abilities (LBEX 5), a steady improvement was identified in the labour performance score values midway through the apprenticeship period. Notably, the training delivery mainly focused on the LBEX 4 and LBEX 5 contents from the mid-stage of the apprenticeship period, and this might be the cause for the improvement. Overall, the results indicate a 60% increase in the performance characteristics of LBEX 4 from the inception level of the apprenticeship, whereas it was around 80% when it considers LBEX 5. The study reveals a progressive increase in monthly average LBPS values for the nine projects it chose, with only slight variations between them (R1 – R9). At the completion of the apprenticeship, R5 reported the highest monthly LBPS average value (62.06), and R3 reported the lowest value (50.89). According to Figure 3, the overall monthly average LBPS value increased from 33.80 to 56.30 within the six months of labour apprenticeship, which implies a 67% increase in the overall labour performance quantitatively.
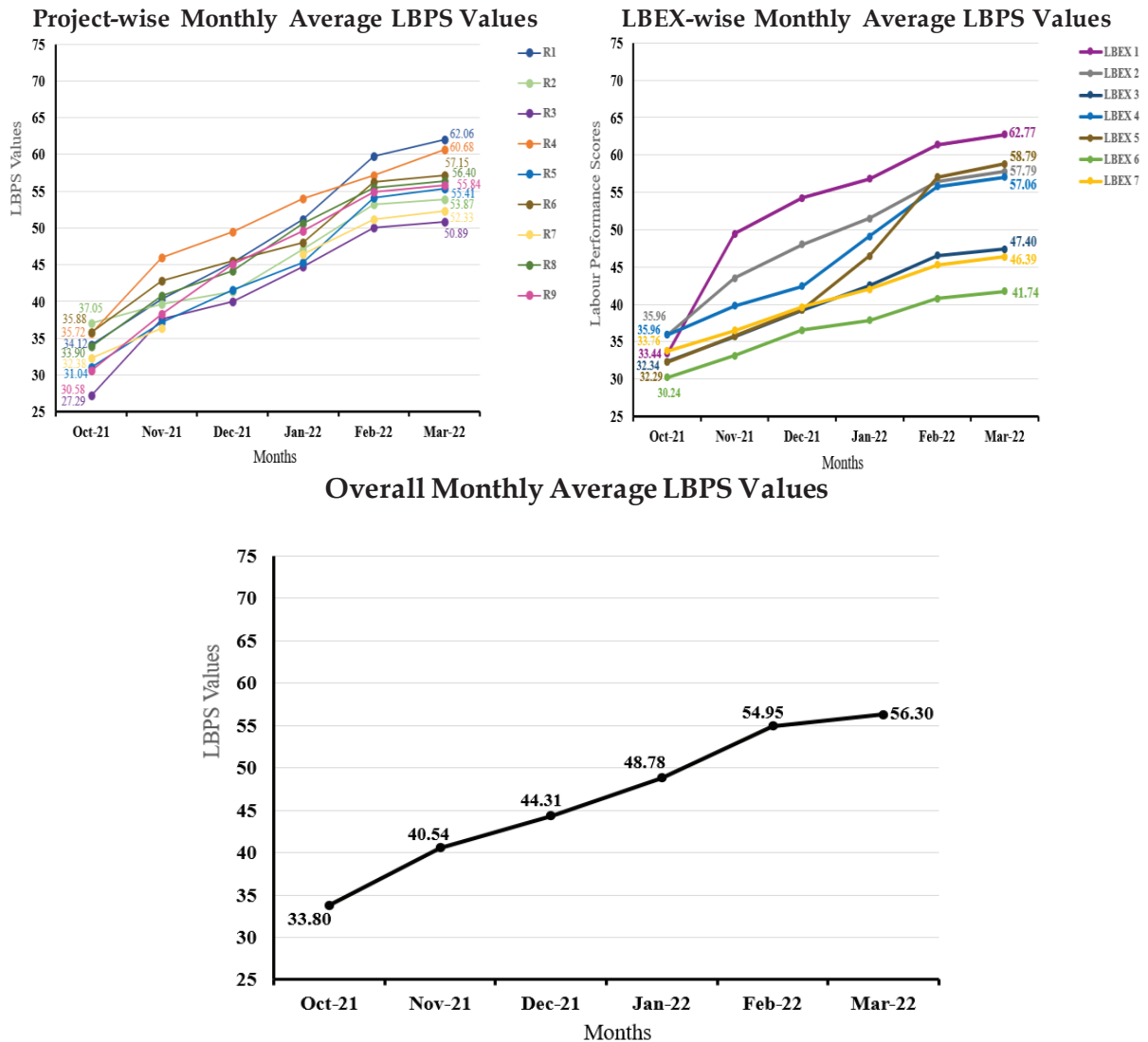
Project-wise Monthly Average LBPS Values

LBEX-wise Monthly Average LBPS Values

Overall Monthly Average LBPS Values

Figure 3 – Variations in Monthly Average LBPS Values

The bulk of the labourers had a limited range of knowledge and skills at the start of the apprenticeship, and they had a weak ability to come up with their own thoughts. Close supervision was required to carry out their job tasks. The majority of trained labourers have polished their work qualities to operate under general supervision with some autonomy and little responsibility after completing their six months of apprenticeship. They have developed the capacity to do job-related activities using a broad variety of theoretical knowledge and practical abilities and also to come up with their own thoughts and mentor less-experienced workers on construction sites up to a certain level.

After the first month, there were 107 labourers in grade 'C' and a total of 6 labourers in grade 'B', but no labourers in grade 'A' or grade 'D'. In terms of grade 'C' labourers, a rapid decline was observed up until the third month's end

and a gentle decline over the following three months. The number of labourers gradually climbed until it reached 47 for grade 'B' by the end of the fourth month, and it then began to decline over the course of the following two months as several labourers were promoted to grade 'A' due to their better performance scores. At the conclusion of the apprenticeship session, the number of labourers who were in grades 'A', 'B' and 'C' was 10, 48 and 26, respectively, with an approximate ratio of 2:10:5 between those three grades. Notably, no labourers in grade 'D' were discovered during any of the months.

A number of workshops and discussions were held with the participation of CPMT members and career development mentors (CDMs) of the firms for each chosen project to report the above-stated changes and improvements in the performance and grading levels of labour. The detailed records of the labour apprenticeship

delivery, labour skill evaluation and labour performance measurements were checked by the CPMTs and CDMs and revealed their contentment with the improved levels of labour performance. All the CDMs and CPMTs consented to revise/update their management policies and regulations to consider the labourers for the possible salary increment and prospects for advancement according to their LBPS values and grades. The CDMs also indicated their willingness to carry out the RPL evaluations required to issue the NVQ certifications to those labourers in accordance with the stages outlined in NVQ Circular No. 02 of the Tertiary and Vocational Education Commission.

5.   Conclusions

This research has displayed the systematic ways of apprenticeship and performance evaluation practices for achieving significant improvement in the performance of labour work. The performance of labour and labour grading were assessed in this study as the crucial units of analysis by the application of labour apprenticeship components, and the results ensure significant improvement in all categories. This has resulted in reporting the training outcomes to the organisation level and then taking the necessary steps to reward labourers within a methodical framework.

The research provides productive mechanisms to display the cross-section of labourers working on road construction projects for determining their strengths, values and weaknesses based on their performance score levels under a wide range of competency element categories. It shows a template to grade labourers based on their performance levels, which provides ways to make efficient crew mix designs among the project activities, enhancing the resource utilisation and levelling procedures in site planning and project management.

The results report similar patterns in the variations of labour performance values with minor variations in each of the chosen projects, despite the wide variations in organisational policies, resource availability and financial capabilities among the organisational firms where the labour apprenticeship components were applied. This substantiates the generalisable characteristics of the developed labour apprenticeship components for the construction industry.

The study emphasises that the shape of labour performance can be viewed by the assortment of the range of learning demands, work processes and responsibilities together. This concept provides the standard base for reinforcing the supervisors' observation skills on labour work outputs towards carrying out the performance evaluations methodically. Accordingly, the research adds new characteristics to construction site supervisory procedures that can be momentous in increasing the efficiency of labour work. This may lead to enhancing the values of the supervisors' job roles in the construction industry, also providing effective ways for them to become certified NVQ assessors within a framework. This may further influence work attributes and qualities of construction managers and engineers for strengthening the application of the work-based labour training components. As a result, the study's findings may encourage the upgrading of the training curricula presently offered by universities and technical institutes in order to better meet the demands and problems of the industry.

The study accentuates that the labourers' cognitive, conceptual and operational abilities are the key elements to determining the features of the practices used for supervision. The findings affirm that the labour apprenticeship components applied in this research have made considerable influences in transforming the working patterns of labourers to the new normal situations. Most of the trained labourers have been changed to perform their job duties with well-enhanced self-management and transferable abilities. They have become familiar with the necessary application of fundamental practices related to science, technology and engineering in their work operations. The proposed apprenticeship components can be the key elements in reinforcing the labourers' capability to perform processes with some autonomy, particularly in obtaining dimensions and estimates, using health and safety regulations, manipulating materials and tool operations and performing other operations with the proper knowledge and manual abilities in technologies used. The study outcomes further contribute to enabling workers to come up with little suggestions for environmentally friendly construction methods and adjusting them to adhere to quality control and assurance procedures. Particularly, the research outcomes enforce the training practices with the importance of encouraging workers to learn on their own for lifelong

learning to face the challenges in the new normal situations.

The overall research findings offer a bridge that connects industrial and institutional policies and practices, promoting the improvement of the entire quality of labour capacity involving vocational, technical and professional competence in the sector. Though the research findings were limited to road projects, comparable approaches can be used to get similar results in other types of projects too. Despite the fact that the study applications and scope are limited to the Sri Lankan setting, the research outcomes are expected to significantly impact the industrial processes in other developing nations. Moreover, this research suggests that future investigations concentrate on creating new apprenticeship tools as well as assessing the apprenticeship outcomes and evaluating the traits of various vocations or industrial sectors in various circumstances. The research further recommends future investigations test the application of digital technologies in the labour training components for further reinforcement of apprenticeship delivery methods to the next normal characteristics. This research further opens a new window to designing new tools for digitalised applications to broaden the suggested mechanisms towards getting more users internationally, leading to further strengthening of the generalisation of the proposed practices.

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