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A Study on the Evaluation of Construction Supervisors' Competencies in Applying Construction Planning and Management Approaches

İnşaat Planlama ve Yönetim Yaklaşımlarının Uygulanmasında Şantiye Şeflerinin Yetkinliklerinin Değerlendirilmesi Üzerine Bir Çalışma

ABSTRACT

Productivity growth is associated with competitiveness, profitability and sustainability in the construction sector, whereas studies underline that poor supervisory characteristics and training resources are the leading causes of construction productivity loss. This study employs a case study to evaluate the capabilities of construction supervisors to apply planning and management approaches for enhancing the effectiveness of construction operations. A new training programme for construction supervisors was designed using meticulous sequential methods, and 59 construction supervisors were trained and assessed under seven elements of competencies and the relevant learning domains. An assessment guide with varying degrees of descriptions and criteria was accomplished through literature reviews and professional interviews. The study has produced a new generalised guideline that shows the cross-section of what levels of skill/ability can be taken into account in supervisory attributes as a result. Using pertinent statistical evaluations and expert assessments, the reliability of the results, as well as the generalisation of the study's applications and outcomes, were guaranteed. The study has opened a valve that allows new values of highly practicable supervision features to flow into the site management structures, filling the industry's knowledge vacuum in the methodical execution of apprenticeships. Though the study's conclusions/findings are particularly applicable to a developing country's construction environment analogous to the Sri Lankan context, they will have a significant impact on current/future industrial practices in a variety of other countries and rising industries.

Keywords: Competence development, construction supervision, performance assessment, planning and management, productivity enhancement, training

ÖZ

Verimlilik artışı inşaat sektöründe rekabet gücü, kârlılık ve sürdürülebilirlik ile ilişkilendirilirken, araştırmalar inşaat verimliliği kaybının başlıca nedenlerinin zayıf denetim özellikleri ve eğitim kaynakları olduğunun altını çiziyor. Bu çalışma, inşaat operasyonlarının etkinliğini artırmak için inşaat denetçilerinin planlama ve yönetim yaklaşımlarını uygulama yeteneklerini değerlendirmek için bir vaka çalışması kullanmaktadır. İnşaat denetçileri için titiz ardışık yöntemler kullanılarak yeni bir eğitim programı tasarlandı ve 59 inşaat denetçisi, yedi yeterlilik unsuru ve ilgili öğrenme alanları kapsamında eğitildi ve değerlendirildi. Literatür taramaları ve profesyonel görüşmeler yoluyla, farklı derecelerde açıklamalar ve kriterler içeren bir değerlendirme kılavuzu oluşturuldu. Çalışma, sonuç olarak denetleyici niteliklerde hangi beceri/yetenek seviyelerinin dikkate alınabileceğinin kesitini gösteren yeni bir genelleştirilmiş kılavuz üretmiştir. İlgili istatistiksel değerlendirmeler ve uzman değerlendirmeleri kullanılarak sonuçların güvenilirliği ve çalışmanın uygulamalarının ve sonuçlarının genelleştirilmesi garanti altına alındı. Çalışma, son derece uygulanabilir denetim özelliklerinin yeni değerlerinin saha yönetim yapılarına akmasına olanak tanıyan bir yol açtı ve çıraklık eğitimlerinin metodik yürütülmesinde endüstrinin bilgi boşluğunu doldurdu. Çalışmanın sonuçları/bulguları Sri Lanka bağlamına benzer şekilde gelişmekte olan bir ülkenin inşaat ortamına özellikle uygulanabilir olsa da, diğer çeşitli ülkelerdeki ve yükselen endüstrilerdeki mevcut/gelecekteki endüstriyel uygulamalar üzerinde önemli bir etkiye sahip olacaktır.

Anahtar Kelimeler: Yetkinlik geliştirme, inşaat denetimi, performans değerlendirmesi, planlama ve yönetim, verimliliğin artırılması, eğitim

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Introduction and Background

By generating various employment and investment opportunities, the construction sector makes a substantial contribution to the achievement of a nation's wealth and socioeconomic goals (Hai & Tam, 2019; Berkani & Köymen, 2023). Noticeably, a country's global domestic product is significantly impacted by productivity enhancement in the construction industry (Anilvd., 2019; Hatem & Kassem, 2023). Principally, recent investigations spotlight that the construction business is labour-intensive since it employs the most people in the long term compared to other industries (Victor, 2018). Accordingly, the efficiency of labour operations significantly impacts the safety, quality and productivity outcomes of construction processes (Anilvd., 2019). However, due to poor labour efficiency, the construction sector of numerous developing countries has been facing numerous difficulties related to financial flows and competitiveness (Victor, 2018; Silvavd., 2018; Hai & Tam, 2019). Consequently, construction companies experience issues with overrunning costs and time (Anilvd., 2019; Hatem & Kassem, 2023).

A number of countries, including Australia, New Zealand, Nigeria, Sri Lanka, Trinidad and Tobago and Vietnam have seen low levels of construction productivity in numerous construction projects (Serdar & Jasper, 2011; Hickson & Ellis, 2013; Hughes & Thorpe, 2014; TVEC, 2017; Victor, 2018; Hai & Tam, 2019; Manoharan vd., 2023). The efficiency and productivity of labour are affected by a variety of circumstances in construction operations (Victor, 2018). In spite of the fact that the elements like lack of motivation (Hickson & Ellis, 2013), labour skill shortage (Victor, 2018), poor material handling and tool maintenance practices (TVEC, 2017) and other evolving challenges related to technological advancement (Victor, 2018; Windapo, 2016) substantially impact the efficiency, quality and productivity of construction labour, improving supervision techniques can have a substantial positive impact on work productivity by providing effective solutions and connections between these aspects to handle efficiency and productivity related issues. Construction supervisors' abilities are the main determining variables in how well labour is directed to perform, and they play a significant role in bridging the gap between labour and organisations (Victor, 2018). Noticeably, contemporary contexts of emerging nations like Sri Lanka have very high-level influences of supervision techniques on work productivity (Victor, 2018; Manoharan vd., 2020, 2023). Recent studies demonstrate that construction supervisors from those countries need to practice honing their abilities so they can manage labour operations involving handling tools, materials and equipment more effectively (Victor, 2018; Manoharan vd., 2021a).

On the other hand, it is crucial to note that competence is the outcome of cognitive, manual/psychomotor and affective/emotional skill elements because they directly affect the components related to the process of work operations, the demand of learning aspects and obligations associated with work practices (Manoharan vd., 2021b). Accordingly, recent research (Victor, 2018; Manoharan vd., 2021a, 2023) and meetings with construction industry specialists highlight that the construction supervisors' abilities in applying efficient project planning and management procedures have a significant impact on improving the effectiveness and productivity levels of project activities. Taking on this important fact, this study emphasises the need for upgrading the characteristics of construction supervision practices in order to ensure the expected levels of efficiency, quality, productivity and safety in the work outputs of construction operations. It is important to understand that on-the-job apprenticeship elements are the essential learning components that need to be linked to regular job tasks to boost career readiness and employability towards solving the challenges related to the characteristics of the construction supervisory job role (Manoharan vd., 2021a).

The Construction Sector in the Sri Lankan Setting

Construction infrastructure development is significant to Sri Lankan national plans (TVEC, 2017). The rise of the Sri Lankan construction industry following the end of the protracted war has drawn considerable investments from governmental and private bodies, and this has led to a large number of construction projects under the nation's infrastructure development scheme (Silvavd., 2018). However, poor approaches to supervision practices have been significantly contributing to many Sri Lankan construction firms facing productivity issues in several of those projects (Silvavd., 2018). In the Sri Lankan setting, the deliverables from the secondary education and vocational training sectors are significantly out of sync with the requirements of the industrial sector (TVEC, 2017). The industrial firms' poor emphasis on job-based skill enhancement practices has further been an influencing component in this regard (TVEC, 2017; Manoharan vd., 2020, 2023).

Problem Statement

Connecting with the above-discussed aspects, recent studies and interviews/meetings with industry specialists and skill enhancement authorities revealed that there have been numerous emerging countries like Sri Lanka that lack suitable methods and practices to assess the construction supervisory abilities in applying necessary construction planning and management approaches in project operations. Addressing this problem is significant because it impacts the reformation of the connection of insufficient apprenticeship facilities, gaps in supervisory competencies and skill-shortage of labour, which are the primary elements resulting in efficiency loss in construction operational practices in numerous developing countries like Sri Lanka (Windapo, 2016; Victor, 2018; Anilvd., 2019; Manoharan vd., 2020). This study highlights the fact that these needs were not sufficiently addressed in earlier studies. Accordingly, this study identifies the knowledge gap on how apprenticeship development, skill evaluations and performance measurement tasks need to be methodically processed in construction supervisory characteristics for enhancing the supervisory attributes related to planning and management approaches with a specific scope of enhancing efficiency, productivity and safety of operational flows in construction.

The Study's Aim and Significance

As per the above-mentioned problems and need analysis, this research intends to test the construction supervisory work characteristics in comprehending the planning and management theories as well as in executing their applications/functions for the enhancement of the efficiency of construction operations. It is noticeable that the Sri Lankan context was specifically focused upon in this study since the above-highlighted background analysis highlights that the stated problems cause operational practices in construction to become less efficient in numerous developing nations that are similar to the Sri Lankan context. The study engages with a variety of competency element characters in supervisory practices connected to the aim of this study. This study thus highlights the industry's knowledge gap regarding the

formation of advanced frameworks to evaluate the competence of construction supervisory workers and measure their performance outcomes within this context. The study aims to create a channel for the influx of cognitive attributes to the industrial views, comparing the pertinent competency characteristics and their weightages to comprehend what levels of competence capacities can be conceptually and practically used in supervisory practices. As a result, this could lead to more up-to-date procedures for technical comprehension and scientific authentication of the industry's regulations and agreements to employment limitations.

Literature Review

By generating various employment and investment opportunities, the construction sector makes a substantial contribution to the achievement of a nation's wealth and socioeconomic goals (Hai & Tam, 2019; Berkani & Köymen, 2023). Noticeably, a country's global domestic product is significantly impacted by productivity enhancement in the construction industry (Anilvd., 2019; Hatem & Kassem, 2023). Principally, recent investigations spotlight that the construction business is labour-intensive since it employs the most people in the long term compared to other industries (Victor, 2018). Accordingly, the efficiency of labour operations significantly impacts the safety, quality and productivity outcomes of construction processes (Anilvd., 2019). However, due to poor labour efficiency, the construction sector of numerous developing countries has been facing numerous difficulties related to financial flows and competitiveness (Victor, 2018; Silvavd., 2018; Hai & Tam, 2019). Consequently, construction companies experience issues with overrunning costs and time (Anilvd., 2019; Hatem & Kassem, 2023).

The perceptions of the industry sector state that low productivity and a significant skills gap will endanger the processes of construction businesses to compete globally. It is claimed that the early recessions were the cause of this gap (Victor, 2018). Many investigations spotlight the scarcity of methodical practices that have resulted in construction organisations experiencing a wide range of productivity-related difficulties in numerous countries, including Australia, India, Nigeria, South Africa, Sri Lanka and Vietnam, in recent decades (Hughes & Thorpe, 2014; Windapo, 2016; Victor, 2018; Silvavd., 2018; Hai & Tam, 2019; Anilvd., 2019).

Useful Models and Techniques to Evaluate the Construction Supervisory Practices and the Efficiency of Construction Labour Operations

More than 30 years ago, Uwakweh & Maloney (1991) developed a theoretical model for effectively planning manpower in the construction sector that accentuates the need to enhance job-based training procedures in order to produce a better-qualified group of construction supervisors with a range of abilities. Uwakweh & Maloney (1991) emphasised the importance of cooperative abilities of supervision practices along with the proper path that should be followed when doing tasks and using tools. Furthermore, Dickinsonvd. (2018) developed a group of digital tools with a specific focus on encouraging construction supervisors' awareness and adaptation in job-based training and skill evaluation procedures using a variety of technologies, including technologies related to virtual gaming and 360-degree panorama. Additionally, recent investigations have presented some useful practical apprenticeship models, tools and systems that have a specific focus on enhancing the efficiency of construction workflows, particularly a labour apprenticeship guide tool of Manoharan vd. (2021a), a supervisory apprenticeship guide tool of Manoharan vd. (2021b) and a new system of Manoharan vd. (2022) for labour performance measurements and grading. The apprenticeship model presented by Manoharan vd. (2021a) comprises a number of labour apprenticeship exercises (LAEXs) that can be applied to labourers by supervisory workers, while Manoharan vd. (2022) methodically created the required labour apprenticeship outcomes (LAOs) according to the aims of each LAEX component. In their comprehensive examination of these LAEXs and LAOs, a labour performance score (LBPS) system connected with a new labour grading scheme (LGS) was built by Manoharan vd. (2022) to assess the efficiency of construction operations inside a systematic generalised mechanism. For the systematic execution of the required tasks associated with these LBEXs, LBEOs, LBPS and LGS, this study accentuates the significance of upgrading the attributes of construction supervision in the application of the planning and management theories and functions.

Critical Supervisory Skills Influencing the Efficiency and Quantity of Construction Work Outputs

A strong understanding between supervisory staff and construction labourers is essential for increasing worker motivation as well as better quality and quantity of job outputs (Hickson & Ellis, 2013; Victor, 2018). Supervision approaches are the primary driving force for the execution of job-based apprenticeship elements among construction labourers at workplaces (Manoharan vd., 2021b). Strong decision-making, planning, leadership, communication and site management abilities of supervisors help their workers perform at their best (Hickson & Ellis, 2013; Victor, 2018). Noticeably, a survey conducted among 84 industrial organisations in Qatar revealed that leadership abilities are a deciding element in construction supervisors' site management techniques (Jarkasvd., 2012). However, one of the key performance factors that significantly affect the efficiency of construction operations in many Indian building projects has been found as the planning abilities of supervisors (Anilvd., 2019). Planning approaches effectively boost output, efficiency management and resource utilisation strategies to reduce costs and delays in project activities (Manoharan vd., 2020; Gündüz, 2023; Berkani & Köymen, 2023). Moreover, effective site coordination is essential for combining a variety of resources for construction operations, especially to optimise resource usage (Serdar & Jasper, 2011; Kocalar, 2022). This results in a reduction of expenses, productivity increase and time-saving (Manoharan vd., 2020).

Poor cognitive abilities of site supervisory staff in quality controlling techniques were identified as a major impacting factor on productivity outcomes in various building projects in Australia (Hughes & Thorpe, 2014). By improving quality control systems, project activities can be made safer, and the likelihood of costly mistakes can be decreased (Hughes & Thorpe, 2014). Another significant issue that inhibited contractors' focus on boosting productivity in Australian construction projects was the inadequate cognitive domains of site supervisors' understanding of health and safety regulations (Hughes & Thorpe, 2014). Similar issues associated with construction supervision were found to affect the progress of many Nigerian construction projects too (Victor, 2018). Additionally, Manoharan vd. (2020) highlight the significance of boosting construction supervisory staff's research skills so they can identify problems at worksites and respond quickly.

Taking into account the construction environment in Sri Lanka, only a little number of research investigated the enhancement of supervision methods. The cognitive skills of supervisory staff in the application of health and safety protocols and their capacity for examining the skills of labourers need to be improved in Sri Lanka (Silvavd., 2018). Importantly, Manoharan vd. (2020) identified the main issues related to supervisory practices that have severe impacts on work efficiency in the construction sector of Sri Lanka. These issues include poor site management, poor decision-making skills, poor labour management and lack of participation in project activities. In addition, Manoharan vd. (2020) identified 20 crucial behaviours for site supervision that need to be considered while developing new training programmes for construction supervisors. These lead to producing 20 training programme outcomes (POs), adding a reinforcement layer in developing new effective courses and training for construction supervisors (See Table 2). Importantly, these POs display a distinct sectional view of the industry's anticipation of construction supervisory procedures in a wide range of project activities.

Overview of the Flaws, Restrictions and Gaps Shown by the Research Findings

In summary, despite the fact that the current study's literature review widely identifies the competency elements of construction supervisory workers affecting job productivity, a few studies only have offered a limited number of tools and models to upgrade skill-development processes and evaluate work productivity at project sites. However, the usage of such instruments in accordance with industrial needs and characteristics has significant drawbacks and limits that have been revealed by the current study. Despite the fact that such tools and models barely touch on the topic of work productivity enhancement. The main flaws are their lack of specific competency traits and performance evaluation processes. The present research identifies the inability of a large number of industrial organisations in emerging nations to adapt to the use of such cutting-edge technological methods and their financial status as the primary concerns for these flaws at this time. Dickinsonvd. (2018) presented digitalised models that are largely limited to the industrial flows of developed nations. Another significant flaw in these produced models/tools is their neglect of strategies for enhancing the efficiency and safety of construction operational flows and outputs.

In addition, the literature review of this study shows that there are still some substantial knowledge gaps that must be filled to enhance efficiency and work productivity in construction through the performance evaluation of construction supervision procedures. The industry has difficulty in determining what standards or levels of competence can be practically considered and conceptually used in supervisory characteristics due to the cognitive gap regarding the formation of application methodologies and protocols necessary to evaluate the competence of supervisory workers and measure their levels of performance in the construction field.

The Importance of the Applicability and Suitability of the Guiding Tool of Manoharan vd. (2021b) to the Aim of the Present Research

More specifically, Manoharan vd. (2021b) provided a paradigm for developing advanced construction supervisory courses and training components that provide efficient ways to face the industry's evolving productivity-related challenges. The apprenticeship model of Manoharan vd. (2021b) significantly comprises sixty four elements of competencies (ECs) under twelve competency units (CU) within a specific scope of enhancing the work productivity in industrial site activities, whereas the application of planning and management approaches is emphasised in one of those competency units. Notably, a total of seven ECs among those addressed the required supervision characteristics to enhance the efficiency of construction operational flows through the execution of efficient planning and management practices. As indicated in Table 1, the distributed weights of such ECs in regard to learning domains of Bloom's taxonomy are also supplied in the apprenticeship model of Manoharan vd. (2021b). Noticeably, this weighting scheme displays a distinct sectional view of the ECs, offering a means for developing competency assessment approaches.

On the other hand, the mapping levels of the seven ECs against the POs of supervisory apprenticeship (produced by Manoharan vd. (2020)) were indicated in Table 2 using the descriptions of levels shown below.

- Introduced (IN): The learnt contents give an overview of the intended outcomes.
- Emphasised (EM): The learnt contents assert the needed results or outcomes.
- Reinforced (RE): The learnt contents act as pillars for strengthening the materials in the direction of the desired result.
- Advanced (AD): The learnt materials represent a vigorous level of interaction with the resources in order to achieve the desired results.

During the mapping process, the capabilities of the supervisors, the industry's requirements, expectations and practicalities were all carefully taken into account. The results of mapping the whole competency unit (CU) with the POs were established in accordance with the following statements, taking into account the mapping levels that emerged between the POs and ECs.

The mapping level denotes that the CU is prominently (P) or considerably (C) or moderately (M) or slightly (S) accomplishing the required characteristics of the respective PO.

Table 1. Mapping and Distributed Weights of Relevant Elements of Competencies (ECs) along with Learning Domains of Bloom's Taxonomy, Produced by Manoharan vd. (2021b)

Elements of Competencies (ECs) / Competency Unit (CU)	Weight (%)	Levels of Learning Domains															
		Cognitive/ Knowledge Levels (CD)				Psychomotor/ Skill Levels (PD)							Affective/ Attitude Levels (AD)				
		CD1	CD2	CD3	CD4	PD1	PD2	PD3	PD4	PD5	PD6	PD7	AD1	AD2	AD3	AD4	AD5
EC1: Applying the theoretical elements of project management practices into construction tasks	20	2	9			3	1						4	1			
EC2: Performing the supervision tasks with an understanding of labour laws and policies	10	5				3							2				
EC3: Planning and scheduling the construction project tasks effectively	25	2	3			3	1	6	6				2	2			
EC4: Maintaining the quality assurance and control procedures in construction activities	20	2	2			1	2	2	4				5	2			
EC5: Working with decent understanding of contract laws in construction	5	3				2											
EC6: Involving in cash flow analysis tasks at construction sites	10	4	4			2											
EC7: Preparing plans and training materials for the enhancement of labour skills associated with fundamental levels of financial processes, managing tasks and quality control aspects of construction	10	2	2			1	1	2					2				
Competency Unit (CU)	100	20	20	0	0	15	5	10	10	0	0	0	15	5	0	0	0

CD1: Remembering and Understanding; CD2: Applying; CD3: Analyzing and Evaluating; CD4: Creating; PD1: Perception; PD2: Set; PD3: Guided Response; PD4: Mechanism; PD5: Complex Over Response; PD6: Adaptation; PD7: Origination; AD1: Receiving Phenomena; AD2: Responding to Phenomena; AD3: Valueing; AD4: Organzation; AD5: Characterization

Table 2. Levels of Mapping between the Elements of Competencies (ECs) of Manoharan vd. (2021b) and the Programme Outcomes (POs) of Manoharan vd. (2020)

Elements of Competencies (ECs) / Competency Unit (CU)	Programme Outcomes (POs)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
EC1	EM	EM	EM	EM	EM	IN	EM		IN	IN	IN	IN	IN	IN	EM	EM		EM	EM	EM
EC2		IN	IN			IN						IN	IN							EM
EC3	EM	EM	EM	EM	EM	IN	IN							IN	IN	EM		EM	EM	IN
EC4	EM	EM	EM		IN		IN				IN				EM	EM	IN	EM	EM	
EC5		IN		IN												IN		IN		
EC6		EM		EM										IN		EM				
EC7			IN			IN	IN	IN	IN	IN	IN						IN	IN	IN	IN
Competency Unit (CU)	MO	CO	MO	MO	MO	SL	SL	SL	SL	SL	SL	SL	SL	SL	MO	CO	SL	MO	MO	MO

POs of Manoharan vd. (2020): Monitoring the storage, delivery and usage of construction materials and tools in project operations (PO1), Planning the resources at project sites efficiently (PO2), Applying productive-based supervision approaches on the construction labour operations (PO3),

Assisting in estimating and budgeting for the construction operational flows effectively (PO4), Following the site regulations associated with overcoming health, safety and environmental related problems during the project tasks (PO5), Implementing the constructive practices on enhancing labour performance in project operations (PO6), Applying self-learning approaches to learn modern concepts, advanced technologies and theories associated with construction works (PO7), Applying brainstorming approaches/techniques to enhance the labour skills in construction (PO8), Applying competency-based apprenticeship approaches to enhance the labour skills in construction (PO9), Instruct fundamental concepts, principles and applications to enhance the labour skills in construction (PO10), Providing experimental training exercises to the construction labourers for their skill enhancement (PO11), Assessing the labour performance at construction project sites (PO12), Implementing labour rewarding mechanisms at construction project sites (PO13), Applying suitable mathematical principles and theories to solve real problems at construction project sites (PO14), Conducting field surveys, investigations and tests associated with feasibility studies on construction project works (PO15), Maintaining the records of the project activities and assisting to prepare the relevant reports (PO16), Applying green concepts and sustainable development practices on construction project tasks (PO17), Performing tasks as a very good team player and communicator among construction workers (PO18), Performing tasks with positive thinking to effectively address the evolving challenges (PO19), Performing as a good guider for construction labourers in project sites (PO20)

Methodology

The flow diagram shown in Figure 1 demonstrates how the research plan associated with the study's methodologies was designed to achieve the research aims. A series of discussions, workshops, interviews and review sessions were held among industry and academic specialists. Importantly, project directors, civil engineers, project managers, team leaders, institutional directors/heads and senior academicians were involved throughout the process, focusing on the needed action-based procedures in the industrial planning and construction site management practices to handle the industry's growing obstacles and opportunities in next normal situations. Problem-focused strategies and communication methods were applied in all the stages of the study's methodology, specifically for identifying potential challenges and difficulties, exchanging knowledge and thoughts as well as finding out solution methods. In particular, the apprenticeship model of Manoharan vd. (2021b) served as the base for the study approach. The implementation of this model while taking the aims of the present research and other important factors into consideration was validated by expert discussions, evaluations and reviews.

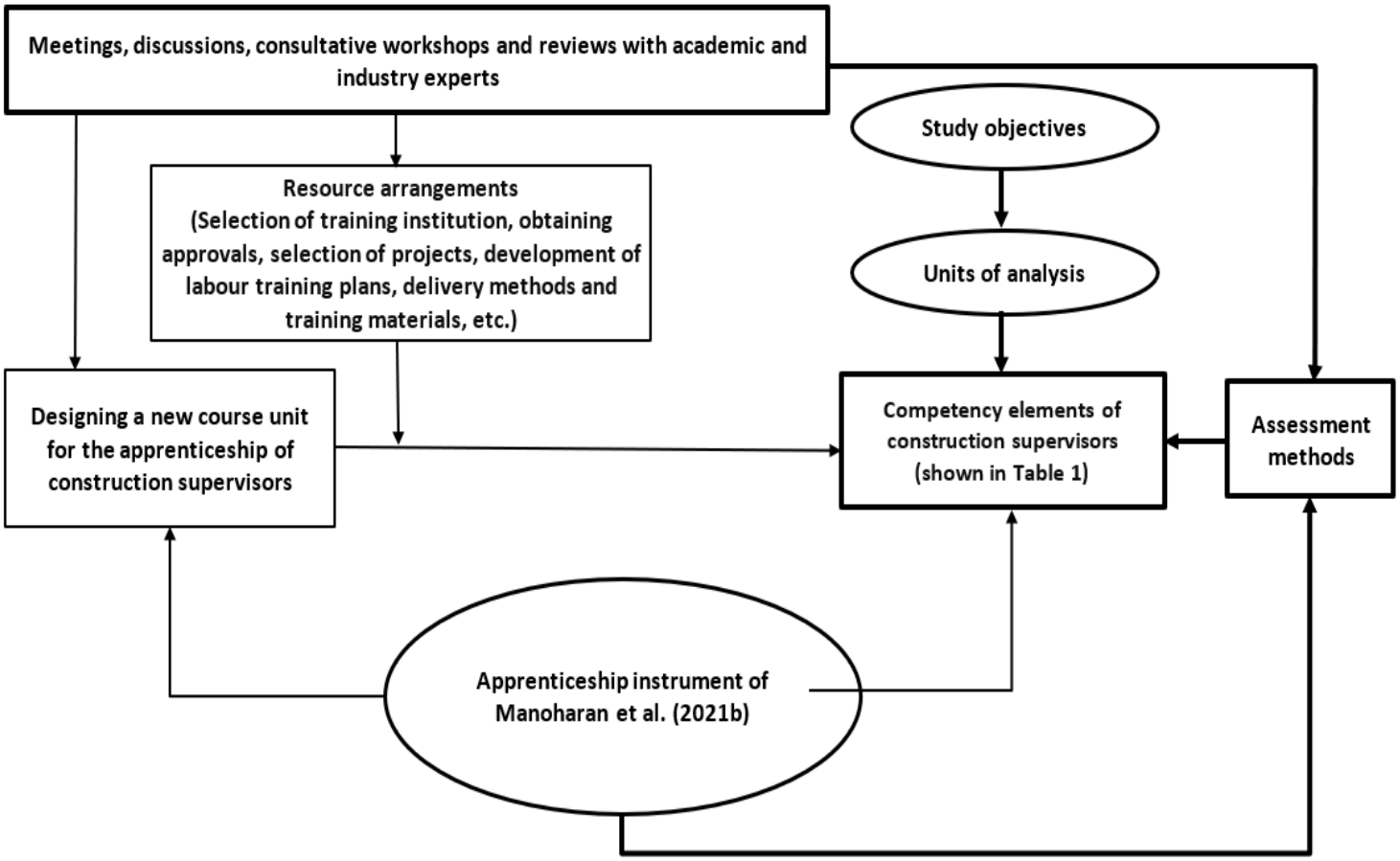


Figure 1. Study Methodology

Development of a New Course Unit in a Training Programme for Construction Supervisors

As per the competency factors produced in the model of Manoharan vd. (2021b), an occupational-based vocational training programme was methodically developed for construction supervisory workers to achieve the qualification level of diploma of the Sri Lankan National Vocational Qualification (NVQ)

framework. The criterion for this qualification level served as the basis of the eligibility requirements for the candidate selections. In Sri Lanka, the Tertiary and Vocational Education Commission authorises the certification under the NVQ framework, which is a consistent and national protocol that upholds the legitimacy of certificates, diplomas and degrees awarded in the Sri Lankan vocational education sector according to the internationally benchmarked procedures and norms (TVEC, 2021).

A set of processes were sequentially carried out during the training development practices considering novel characteristics in the new normal conditions of the industry. The SWOT (Strength, Weakness, Opportunities and Threats) analysis approach was applied through discussions with experts to select the potential institution for the delivery of the developed apprenticeship programme. The relevant approvals were secured for the start of the proposed supervisory apprenticeship through a series of consultations with the relevant committees and administrative divisions of the chosen institution that were relevant to academic planning, curriculum, finance and ethics. The formation of a new Board for the programme, the nomination of academic resources and further arrangements of crucial human resources and services were established to ensure the methodical training delivery for a long-term emphasis. It is important to look on that the developed supervisory apprenticeship comprised a special course unit that includes a collection of job-integrated learning techniques to upgrade supervision skills based on the primary objectives of the current study. Noticeably, the relevant course unit covered all the aspects shown in Table 1 and Table 2.

The detailed curriculum components of the relevant course unit were examined by an expert panel consisting of two institutional authorities, two academic directors and three industry specialists. These evaluators were chosen according to their level of work experience in the construction field and current involvement in apprenticeship development techniques. Notably, they all have been employed in the academic or industry sector with more than 10 years of job experience. In particular, the necessary documentation, observations and discussions were held during the review process focusing on the title of the course unit, academic credit weight, time breakdown, the course aims, learning outcomes, learning contents, methods for teaching, learning and assessments, weights of assessment components and the requirement of the resources, within a specific consideration on the applicability and practicality of those components with the aspects shown in Table 1 and Table 2.

Delivery of the Academic Components of the Course Unit

The method of snowball sampling approach was employed to locate construction site supervisory staff. Notably, this approach is a strategy that can be applied when it is challenging to obtain samples with the desired features. The sample was first expanded through a small group of well-known supervisory workers in order to identify more supervisors who could be interested in applying to the developed training programme. According to the requirements specified in the developed by-laws of the programme, 59 construction supervisory workers were ultimately selected according to their credentials and performance assessed in the selection interview sessions. The panel of interviewers consisted of seven academic experts who are from the construction engineering background. Through discussions with the interviewers, a marking scheme was created, which included two categories (A and B), where Category A evaluated the qualifications of the applicants in relation to the eligibility requirements, and Category B assessed their subject interest, knowledge, interest, communication abilities, job experience, attitude, self-discipline, job-related competence and ability to apply modern practices. The majority of the selected applicants (construction supervising staff) were working on building construction projects (41%), whereas a noticeable portion of supervisory workers was involved in road/highway (37%) and water supply (17%) construction projects. Noticeably, every single one of the selected supervisors had at least one year's worth of job experience in construction, with the most (30%) having between six and ten years. Each of Sri Lanka's nine provinces is well-represented among the chosen construction supervisors. The training elements were delivered to those 59 supervisors in accordance with the instructions outlined in the apprenticeship model produced by Manoharan vd. (2021b).

To evaluate the supervisors' abilities under the relevant ECs, a comprehensive marking tool was created through a sequence of conversations with academic specialists, as indicated in Table 1. Noticeably, the designed marking tool guarantees that the distributed weights of ECs in relation to the learning domains of Bloom's taxonomy listed in Table 1 are met. During the preparation of the marking guide, the mapping levels of those ECs with the 20 POs (shown in Table 2) were also taken into account. In this course unit, 40% of the training elements were devoted to enhancing construction supervisors' cognitive abilities (knowledge), particularly in terms of examining how they specify terms and approach problems. Another 40% of the apprenticeship aimed to evaluate the supervisors' competence with an emphasis on sensory information and readiness to convert taught reactions for action.

The supervisors' attitudes are the focus of the final 20% of the training, which encourages active engagement in assessments by leveraging their feelings and emotions. The ratio of the examined construction supervisors' knowledge, skills and attitude levels was 2:2:1. Each construction supervisor received a score within a range presented in Table 3 after he/she was evaluated for each EC under each category according to its degree of descriptions and criteria. The final performance scores were then obtained using the weightage given to the ECs throughout the relevant domains (as indicated in Table 1). Based on a series of discussions among the panel of assessors, the description statements and standards were developed with the ranges of scores to defining the levels of ECs, as presented in Table 3.

Table 3. The Range of Scores and the Standard Levels of the Competencies

Descriptions/Standard		Score Range
E (Exemplary / Superior)	E1 (Slightly above)	95 - 100
	E2 (Same level)	90 - 94
	E3 (Slightly below)	85 - 89
A (Accomplished / Proficient)	A1 (Slightly above)	80 - 84
	A2 (Same level)	75 - 79
	A3 (Slightly below)	70 - 74
D (Developing / Fair)	D1 (Slightly above)	65 - 69
	D2 (Same level)	60 - 64
	D3 (Slightly below)	55 - 59
B (Beginning / Attempted)	B1 (Slightly above)	50 - 54
	B2 (Same level)	45 - 49
	B3 (Slightly below)	40 - 44
I (Inadequate)	I1 (Weak)	30 - 39
	I2 (Very Weak)	20 - 29
	I3 (Unacceptable)	0 - 19

Endorsement of the Research Methods and Tools

A number of review sessions involving documentary evidence, interviews, observations, workshops and panel discussions were conducted among an expert panel comprising four academicians and four industry specialists, with an emphasis on the research methods, plans and tools used as illustrated in the aforementioned sections. Noticeably, all the academicians who participated in these reviews had doctorate qualifications in the civil engineering field. On the other hand, the industry specialists who were involved in the review processes had chartered engineering qualifications. Moreover, it is noteworthy that all those participants had more than 10 years of professional experience in the construction industry.

Results and Discussion

Figure 2 shows the different clusters of supervisory members at various degrees of standards and descriptions for each element of competence while also considering the entire competency unit when offering the academic components.

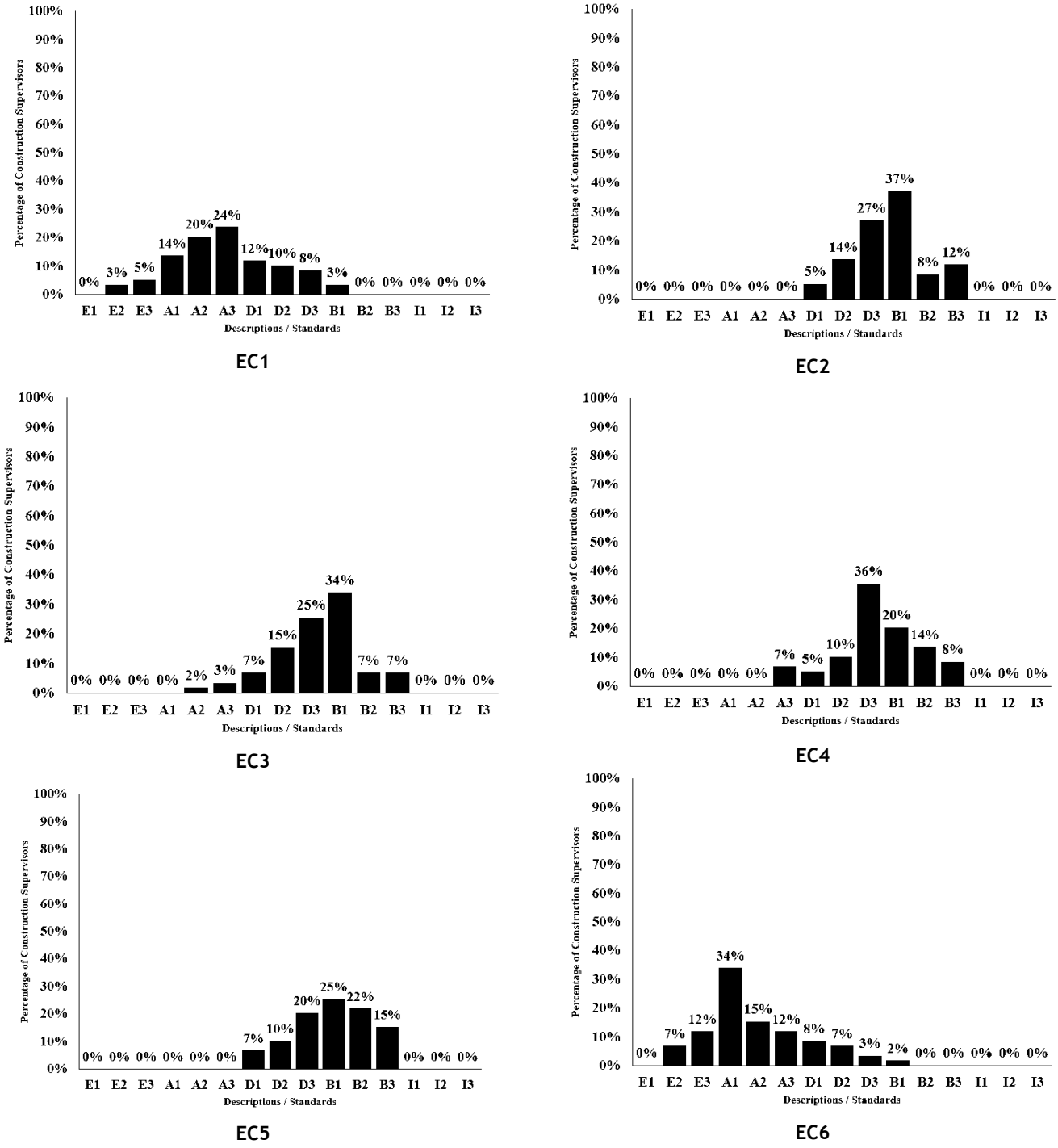
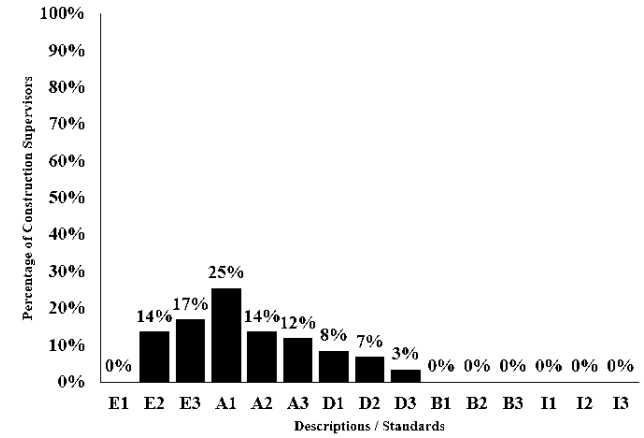
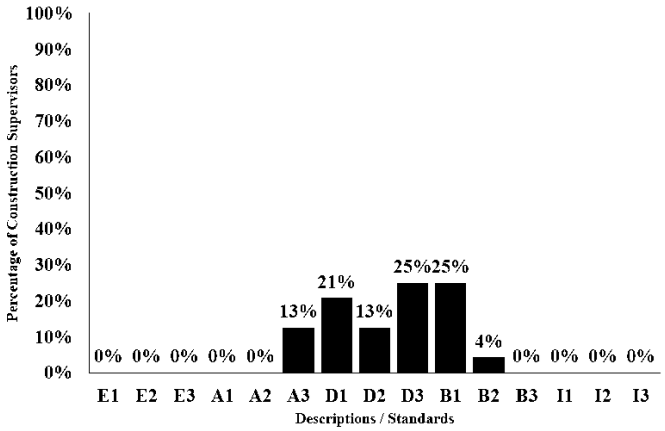


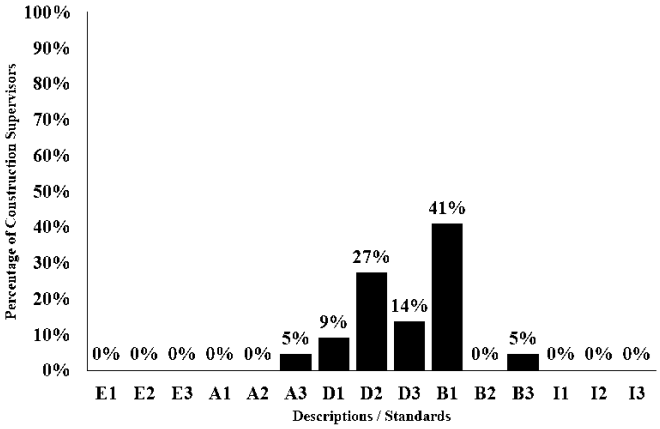
Figure 2. Clusters of Supervisors at Various Degrees of Standards and Descriptions



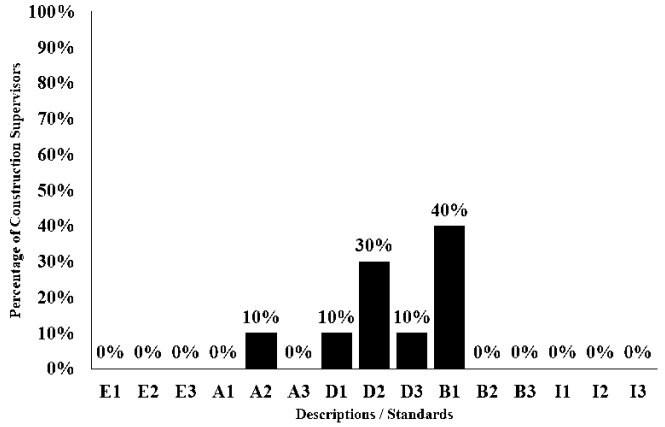
EC7



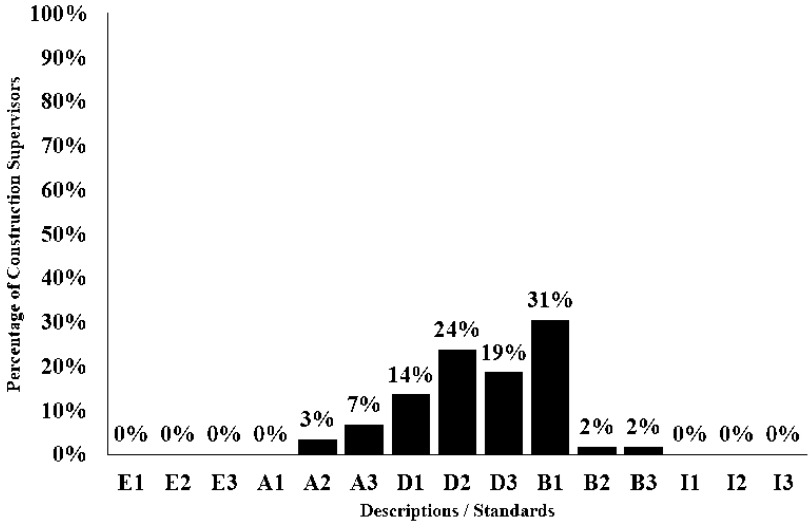
Competency unit - building projects



Competency unit - road projects



Competency unit - water supply projects



Competency unit - overall

Figure 2. Clusters of Supervisors at Various Degrees of Standards and Descriptions (Continued)

Taking on the construction site supervisors' competence of applying the theoretical elements of project management practices into construction tasks (EC1), around 65% of the supervisory staff were at the accomplished level, and 30% of them were at the developing stage. When it comes to their abilities in performing tasks with an understanding of labour laws and policies (EC2), none were found to be at an accomplished level, whereas around 45% of them were at the developing stage, and the remaining were at a beginning level. Considering the supervisors' abilities in construction project activity scheduling and planning (EC3), only 5% of them were at an accomplished level, whereas half of the remaining supervisors were at the

developing stage, and the remaining were at an attempted level. When it comes to the supervisors' competencies in maintaining quality assurance and control in construction activities (EC4), the results are similar to EC3. Taking on their abilities in working with an understanding of construction contract laws (EC5), around 35-40% of them were at a fair level, and the remaining were at an attempted level. Compared to these first five ECs, the supervisors showed much better performance in the last two ECs, which are involved in the cash flow analysis in construction process flows (EC6) and the development of plans and training materials for the enhancement of labour skills associated with fundamental levels of financial processes, managing tasks and quality control aspects of construction (EC7). When it considers EC6, one-fifth of them were superior, three-fifth of them had proficient level competencies, and the remaining one-fifth were at the developing stage. A ratio of 3:5:2 was reported among these three levels when it comes to EC7. Noticeably, none of those 59 supervisors was found that have inadequate/weak level abilities for any competency element at the end of training. Considering the whole competency unit, none of the supervisors was exemplary/superior, 10% were at a proficient stage, 55% still had the developing level of competencies in it, and the remaining were at the beginning stage. The results further reveal that the supervisors working on building and water supply project tasks showed slightly better levels of performance than the supervisory workers involved with road construction tasks.

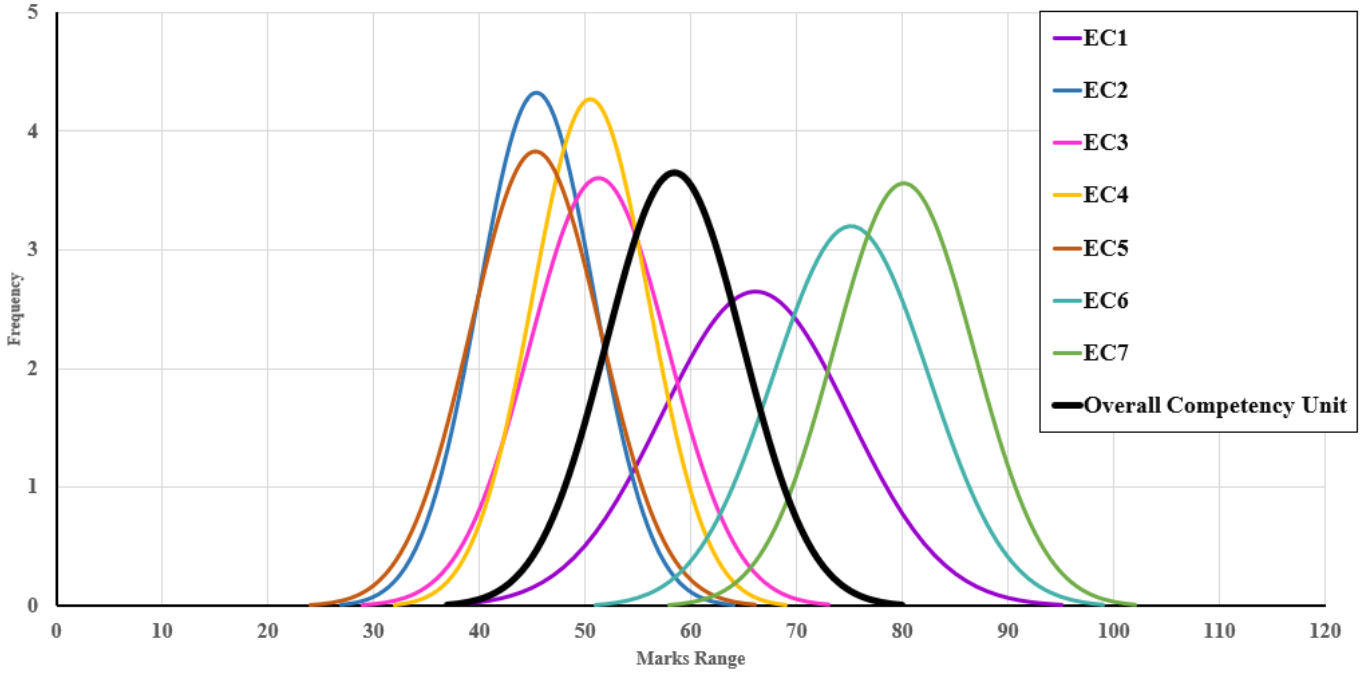


Figure 3. Curves of Frequency Distributions of Construction Supervisors' Performance

Table 4. Scores of Site Supervisors under the Different Competency Characteristics

Elements of Competencies (ECs) / Competency Unit (CU)	Building Projects			Road Projects			Water Supply Projects			Overall		
	MN	ST	CV	MN	ST	CV	MN	ST	CV	MN	ST	CV
EC1	67.23	5.24	0.08	63.86	8.71	0.14	66.40	7.38	0.11	66.12	8.87	0.13
EC2	46.15	7.42	0.16	43.31	6.34	0.15	47.63	8.25	0.17	45.41	5.45	0.12
EC3	52.38	8.86	0.17	47.71	6.69	0.14	55.30	6.37	0.12	51.28	6.53	0.13
EC4	51.46	8.95	0.17	48.37	8.72	0.18	50.28	5.42	0.11	50.51	5.52	0.11
EC5	47.35	6.7	0.14	43.95	6.73	0.15	44.56	5.36	0.12	45.26	6.15	0.14
EC6	73.01	6.82	0.09	78.92	8.6	0.11	76.07	6.56	0.09	75.16	7.36	0.10
EC7	78.38	5.79	0.07	79.42	6.18	0.08	86.58	6.28	0.07	80.16	6.62	0.08
Overall Competency Unit	58.95	6.23	0.11	56.74	7.11	0.13	60.42	6.18	0.10	58.48	6.45	0.11
MN: Mean; ST: Standard Deviation; CV: Coefficient of Variation												

Figure 3 depicts the curves of frequency distributions of construction supervisors' performance in all seven ECs and the whole competency unit (CU) aspect, and Table 4 lists the average performance scores they received for every competency element. Overall, the uppermost mean score of 80 was reported in EC7, whereas the least average score (45) obtained was in EC2 and EC5 (which indicates the attempted level of competency standards). The mean score of supervisors in the whole CU was 58.48, and the mean score values for the various project types showed no discernible differences. This ensures that the proposed training components are highly applicable and generalisable for the supervision procedures in all kinds of construction project work.

In all categories of ECs, the coefficient of variation (CV) values of the performance scores were less than 18%. This guarantees the results' inter-rater reliability in accordance with the levels of CV values listed by Statistics Canada (2020). This further ensures that the suggested training components can be used generally for the industry's long-term-based applications. The results stated above were also shown together with the observation of a panel

of experts. Interestingly, the panel had academic specialists from the training provider and other institutions in addition to professionals from the industry sector. Overall, the panel expressed satisfaction with all the competency element categories and emphasised the importance of expanding these applications and processes in the contexts of developing countries similar to the Sri Lankan setting.

As shown in Table 5, a new guideline that could be generalised and useful in predicting and understanding what levels of competence can actually be taken into consideration in supervisory attributes will be offered as a result of the above-described findings, which is an important outcome of this study. This could significantly improve the processes for making decisions and planning in relation to advancements in technical expertise, business, apprenticeships, employment restrictions and work outputs.

Table 5. The Generalised Guideline with the Cross-section on the Levels of Supervisory Attributes

Elements of Competencies (ECs) / Competency Unit (CU)	Building Projects	Road Projects	Water Supply Projects	Overall
EC1	D1	D2	D1	D1
EC2	B2	B3	B2	B2
EC3	B1	B2	D3	B1
EC4	B1	B2	B1	B1
EC5	B2	B3	B2	B2
EC6	A3	A2	A2	A2
EC7	A2	A2	E3	A1
Overall Competency Unit	D3	D3	D2	D3

As a consequence of the enhanced competencies of supervisory resources in developing plans and apprenticeship materials for enhancing labour skills associated with fundamental levels of financial processes, managing tasks and quality control aspects of construction (EC7), the majority of the labourers, who were supervised by those 59 construction supervisors, acquired the competencies necessary to carry out their tasks with the autonomy. Importantly, they gained their ability to do tasks linked to their jobs using a wide range of knowledge and skills, both theoretical and practical, and also to generate their own conceptions, thoughts and impressions up to certain levels and guide less-experienced co-workers on job sites. These changes in the behavioural patterns of work processes have led to reducing the gap between the workers' job schedules and degrees of supervision aspects. This emphasises how the ability of the workers to match their cognitive/knowledge and operational capabilities to the mix of the job process, demands of learning and duties is significant to determining the necessary features of supervisory techniques. On the other hand, the labour productivity levels in the projects (where those supervisors and labourers work) demonstrated a significant improvement. Continuous observations of the project management teams (PMTs) of the chosen projects also confirmed a considerable improvement in the reduction of activity delays, as well as the quantity and quality standards of work performed in labour activities as a result of the work-based training applications of this study.

The aforementioned results affirm that this investigation has addressed the concerns about performance assessments/ measurements expressed by recent other investigations up to a point. The projected outcomes of construction supervisory training practices offered in the results of Manoharan vd. (2020), as well as the components of performance outcomes in workforce operations offered in the findings of Manoharan vd. (2022) may soon be suitably attained by industry practices in numerous developing countries. The above-highlighted results may support the conceptual foundations of the digital tools proposed in the findings of Dickinsonvd. (2018) for improving job-based apprenticeship practices and competence evaluation methods. Besides, using those digital technologies, the apprenticeship delivery and evaluation methods described in this research can be improved in future scenarios, in line with the procedures advised by Dickinsonvd. (2018) for utilising digitalised techniques associated with photography/videography for the tasks related to the delivery of on-the-job training delivery and assessment of skills.

According to the instructions given by the study of Mohandesvd. (2022), the exploratory and descriptive functions of the case study done on the training elements can be used to verify the replication logic of the study. The case study's construct validity was blatantly obvious. It demonstrates how the chain of evidence has been formed and where each piece of the case study can be found. As demonstrated in Table 4 and Table 5, the findings unambiguously demonstrate how the units of analysis in the case study are related causally. The study's presentation of patterns of variance in each EC while taking into account various kinds of projects has assured the internal validation of the research findings. Particularly, the results of the expert reviews and discussions on the findings demonstrated the generalisability, validity and applicability of the suggested procedures in evaluating the effectiveness and quantity of construction operational flows. This guarantees the external validation of the suggested procedures and the quality of their outputs. It demonstrates that the suggested procedures can be applied to any kind of construction project as well as ventures in other emerging industries. In this case study, design logics, data-gathering methods and data analysis strategies were all readily apparent. Based on the various stages and aims, both quantitative and qualitative methodologies were applied for analysing the data. The case study applications included meta-evaluations connected to customary institutional and industrial procedures.

Conclusion

This study has shown efficient systems to upgrade construction supervisory characteristics to the attainment of higher construction efficiency and productivity intensities by enhancing their abilities in applying construction planning and management approaches. The work duties of construction supervisory staff, the schedules of work processes, the construction labour productivity and sustainability-focused career enhancement of industry workers have all been significantly impacted, as illustrated in Section 4 titled 'Results and discussion'. The study findings are significant because they have impacts on how the construction sector views the required upskilling and reskilling approaches and how they must be implemented in order to find out what competency degrees should be applied practically and conceptually in supervision attributes connecting with the enhancement of constructiveness of project flows.

In order to improve the value of the construction supervisory workers' job function, this study introduces advanced attributes to the supervision techniques that are crucial in increasing worker productivity and effectiveness. For instance, the construction supervisors' greater capacity to assess labour performance under EC7 may present better strategies for setting up the crews for different tasks by taking into consideration the particular

strengths, firmness and flaws of labourers. Thus, construction supervisory staff might find a viable route to achieving as professional NVQ assessors. These improvements or alterations in the supervisory outcomes may have more effects on the characteristics of the job roles of civil engineers and construction managers to sustain the values of human resources under various categories connecting to project flows and work outputs. In order to meet the industry's evolving needs, challenges and problems in the next normal conditions, the study findings will promote adjustments to the training curricula in vocational education institutions.

Taking on further implications due to the supervisors' improved abilities as per the characteristics of EC 7, the results of the study confirm the relationship between labour operations and supervision procedures connected to the effectiveness of construction workflows, establishing a solid working relationship between organisational management and employees supporting to the construction industry's long-term existence. Consequently, the processes will behave differently, and the gaps and deviations between site operations and organisational policies will be minimised or eliminated. As a result, it is predicted that the number of skilled workers will grow quickly and that more workers will transition from the interim stage to the permanent stage of employment in the industry. Further, this investigation helps to raise the quality standards of site work and lessen local businesses' excessive preference for hiring foreign labour.

Although financial flows, resource availability, project operational flows and organisational policies differ between the chosen construction organisations where the study methods were applied, the statistical tests resulted in the reliability assurance of the research findings showing only marginal divergence in the quantitative values obtained between the different types of projects. This guarantees the research applications are well-suited to a wide range of construction sector businesses. The majority of the supervisors in the construction business, whose levels of competence range from the technician to managerial stage job descriptors, are the only ones who can apply for the study. Although the study's applicability was restricted to the context of Sri Lanka, similar methods may be suited to other emerging countries to get equivalent conclusions in their industry-based processes and outcomes. The research findings may also impact the workflow practices used by other rising industries in order to strengthen the guiding policies/practices associated with their resource usage. Moreover, this study recommends that future investigations focus on analysing the job processes and characteristics of many other work categories in various businesses from varied settings. This investigation also suggests that future research should use quantitative methods to compare the enhancement of construction supervisory competencies with the improved levels of labour efficiency and productivity. Future research can also concentrate on examining how digital technology might be used to improve training procedures for the construction industry.

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References

Anil, M., Patel, C.G., & Pitroda, J.R. (2019). Analysis of causes, effects and impacts of skills shortage for sustainable construction through analytic hierarchy process. *International Journal of Technical Innovation in Modern Engineering & Science*, 5(5), 168-176.

Berkani, A., & Köymen, E. (2023). The role of city information modeling (CIM) in design and development of smart cities: The case of amsterdam. *PLANARCH - Design and Planning Research*, 7(2), 163-170. http://doi.org/10.5152/Planarch.2023.22084.

Dickinson, J.K., Woodard, P., Canas, R., Ahamed, S., & Lockston, D. (2011). Game-based trench safety education: development and lessons learned. *Electronic Journal of Information Technology in Construction*, 16, 118-132.

Gündüz, E. (2023). Determination of sustainable development strategies focused on rural tourism, kilistra sample. *PLANARCH - Design and Planning Research*, 7(1), 8-18. http://doi.org/10.5152/Planarch.2023.221122.

Hai, D.T., & Tam, N.V. (2019). Analysis of affected factors on construction productivity in Vietnam. *International Journal of Civil Engineering and Technology*, 10(2), 854-864.

Hatem, Z. M., & Kassem, M. A. (2023). Multi-attitude perspective on scheme development: applicability for construction industrial transformation. *PLANARCH - Design and Planning Research*, 7(2), 203-215. http://doi.org/10.5152/Planarch.2023.23152.

Hickson, B.G., & Ellis, L. (2013). Factors affecting construction labour productivity in Trinidad and Tobago. *The Journal of the Association of Professional Engineers of Trinidad and Tobago*, 42(1), 4-11.

Kocalar, A. C. (2022). Approaches to reduce and prevent accidental risks in site management and inspection by planning in the balloon tour. *PLANARCH - Design and Planning Research*, 6(1), 13-26. http://doi.org/10.5152/planarch.2022.1027756.

Manoharan, K., Dissanayake, P., Pathirana, C., Deegahawature, D., & Silva, R. (2020). Assessment of critical factors influencing the performance of labour in Sri Lankan construction industry. *International Journal of Construction Management*, 23(1), 144-155. https://doi.org/10.1080/15623599.2020.1854042.

Manoharan, K., Dissanayake, P., Pathirana, C., Deegahawature, D., & Silva, R. (2021a). A competency-based training guide model for labourers in construction. *International Journal of Construction Management*, 23(8), 1323-1333. https://doi.org/10.1080/15623599.2021.1969622.

Manoharan, K., Dissanayake, P., Pathirana, C., Deegahawature, D., & Silva, R. (2021b). A curriculum guide model to the next normal in developing construction supervisory training programmes. *Built Environment Project and Asset Management*, 12(5), 792-822. https://doi.org/10.1108/BEPAM-02-2021-0038

Manoharan, K., Dissanayake, P., Pathirana, C., Deegahawature, D., & Silva, R. (2022). A labour performance score and grading system to the next normal practices in construction. *Built Environment Project and Asset Management*, 13(1), 36-55. https://doi.org/10.1108/BEPAM-10-2021-0125.

Manoharan, K., Dissanayake, P., Pathirana, C., Deegahawature, D., & Silva, R. (2023). The standpoint of engineers on the project-level causes controlling the labor efficiency in road project operations in the Sri Lankan construction sector. *PLANARCH - Design and Planning Research*, 1-8. http://doi.org/10.5152/Planarch.2023.23140.

Mohandes, S.R., Durdyev, S., Sadeghi, H., Mahdiyar, A., Hosseini, M.R., Banihashemi, S., & Martek, I. (2022). Towards enhancement in reliability and safety of construction projects: developing a hybrid multi-dimensional fuzzy-based approach. *Engineering, Construction and Architectural Management*, 30(6), 2255-2279. https://doi.org/10.1108/ECAM-09-2021-0817.

Victor, O.N. (2018). Impact of low labour characteristics on construction sites productivity in EBONYI State. *International Journal of Advanced Research in Science, Engineering and Technology*, 5(10), 7072-7087.

Hughes, R., & Thorpe, D. (2014). A review of enabling factors in construction industry productivity in an Australian environment. *Construction Innovation*, 14(2), 210-228. https://doi.org/10.1108/CI-03-2013-0016.

Serdar, D., & Jasper, M. (2011). On-site labour productivity of New Zealand construction industry: key constraints and improvement measures. *Australasian Journal of Construction Economics and Building*, 11(3), 18-33. https://doi.org/10.5130/ajceb.v11i3.2120.

Silva, G.A.S.K., Warnakulasuriya, B.N.F., & Arachchige, B.J.H. (2018). A review of the skill shortage challenge in construction industry in Sri Lanka. *International Journal of Economics, Business and Management Research*, 2(1), 75-89.

Statistics Canada (2020). *Guide to the labour force survey 2020*. Canada.

TVEC (2017). *Construction industry sector training plan 2018 – 2020*. Sri Lanka.

TVEC (2021). *National Vocational Qualification Framework*. Sri Lanka.

Uwakweh, B.O., & Maloney, W.F. (1991). Conceptual model for manpower planning for the construction industry in developing countries, *Construction Management & Economics*, 9(5), 451-465. https://doi.org/10.1080/01446199100000034.

Windapo, A.O. (2016). Skilled Labour Supply in the South African construction industry: The nexus between certification, quality of work output and shortages. *SA Journal of Human Resource Management*, 14(1), 1-8. http://doi.org/10.4102/sajhrm.v14i1.750.