BRIDGING THE SKILL GAP: AN INDUSTRY-ACADEMIA TRAINING FOR CIVIL ENGINEERING STUDENTS IN MALAYSIAN POLYTECHNICS

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Abstract. Malaysian Polytechnics, as pivotal Technical and Vocational Education and Training (TVET) institutions, are mandated to produce job-ready graduates for the construction industry. However, a significant misalignment persists between the project management (PM) competencies taught in the Diploma of Civil Engineering and the practical skills demanded by industry. This study investigates this gap by identifying critical PM competencies from an industry perspective, analyzing the current polytechnic curriculum, and developing a strategic framework for alignment. A sequential explanatory mixed-methods design was employed, comprising an industry survey (n=127), a qualitative content analysis of PM syllabi from 15 polytechnics, and a gap analysis. Industry results prioritized practical, site-based competencies: Site Supervision & Safety Management (M=4.85), Quality Control & Assurance (M=4.80), and Scheduling Software Proficiency (M=4.72). In contrast, curriculum analysis revealed a predominant theoretical focus, with insufficient coverage of digital tools (e.g., BIM in 7% of syllabi) and localized standards. The gap analysis was statistically significant ($p<0.001$) for the top industry-ranked competencies. The study confirms a substantial theory-practice divide and proposes the Polytechnic Industry-Integrated Project Management (PII-PM) Framework, a five-pillar model emphasizing contextualized content, digital skills integration, active learning pedagogy, structured industry collaboration, and a continuous feedback mechanism. This framework provides an actionable roadmap for polytechnics to enhance graduate employability and contribute directly to Malaysia's infrastructure goals.

Keywords: *TVET, Malaysian polytechnic education, Civil Engineering, project management, industry-acsdemia gap, curriculum alignment*

Introduction

The Malaysian construction industry, driven by national initiatives like the Twelfth Malaysia Plan (2021-2025) and mega-projects such as the East Coast Rail Link (ECRL), is a critical engine of economic growth. The success of these projects is contingent upon a competent technical workforce capable of effective on-ground execution. Graduates of the three-year Diploma in Civil Engineering from Malaysian Polytechnics are trained to fill this crucial role as civil engineering technologists and supervisors, acting as the vital link between professional engineers and skilled tradespeople (MOHE, 2021). At this supervisory level, foundational project management (PM) competencies are not ancillary but essential, directly influencing key project outcomes: cost, time, quality, and safety (CIDB Malaysia, 2020). However, industry reports consistently highlight a skills gap where new diploma graduates lack the practical PM prowess required for efficient site supervision, communication, and problem-solving (Ismail et al., 2021; 2019). This gap leads to prolonged onboarding periods and increased training costs for employers, undermining the core TVET principle of producing "job-ready" graduates.

While the existence of a generic skills gap is acknowledged, a systematic analysis focusing specifically on discrete PM competencies within the Malaysian polytechnic context is scarce. Previous studies have often focused on soft skills or general employability (Adnan et al., 2012), leaving a critical lacuna in understanding the precise nature of the PM misalignment. This study, therefore, seeks to address this gap by answering the following research questions: (1) What project management competencies are deemed most critical by the Malaysian construction industry for polytechnic civil engineering graduates? (2) To what extent are these competencies integrated into the current PM curriculum of Malaysian Polytechnics? (3) What is the nature and extent of the alignment gap? (3) How can the PM curriculum be strategically enhanced to bridge this gap?

Literature review

The role of TVET and Malaysian polytechnics

Malaysian Polytechnics are central to the government's agenda of strengthening TVET to meet the demands of a high-skilled economy (Omar et al., 2021). Their mission is inherently industry-driven, focusing on practical skills and employability. The effectiveness of this mission hinges on a dynamic curriculum that evolves in tandem with industry practices.

Project management competencies for Civil Engineering technologists

For diploma-level graduates, PM competencies differ from those required of project managers. They are more tactical and site-focused. The Project Management Body of Knowledge (PMBOK® Guide) provides a foundation, but competencies must be contextualized for the local construction environment (PMI, 2017). This includes knowledge of local regulations (e.g., OSHA 1994, CIDB standards), quality assessment systems (QLASSIC), and common contractual arrangements.

The industry-academia gap in PM education

The disconnect between academic instruction and industry needs is a global challenge, particularly in fast-evolving fields like construction (Ali et al., 2016). In Malaysia, studies have noted that graduates often possess theoretical knowledge but lack practical skills in areas like BIM, modern procurement, and digital collaboration tools (Nizam et al., 2024). This study builds on this literature by providing a granular, competency-based assessment of the gap specifically within the polytechnic subsystem.

Conceptual framework

This study is guided by a framework adapted from the TVET curriculum alignment model (Nilsson, 2010), which posits that optimal graduate outcomes are achieved when there is a tight coupling between curriculum content, pedagogical methods, and industry requirements. The framework visualizes the current state (misalignment) and the desired state (alignment) through a systematic comparison of industry-identified needs and curriculum-offered content, as illustrated in *Figure 1*.

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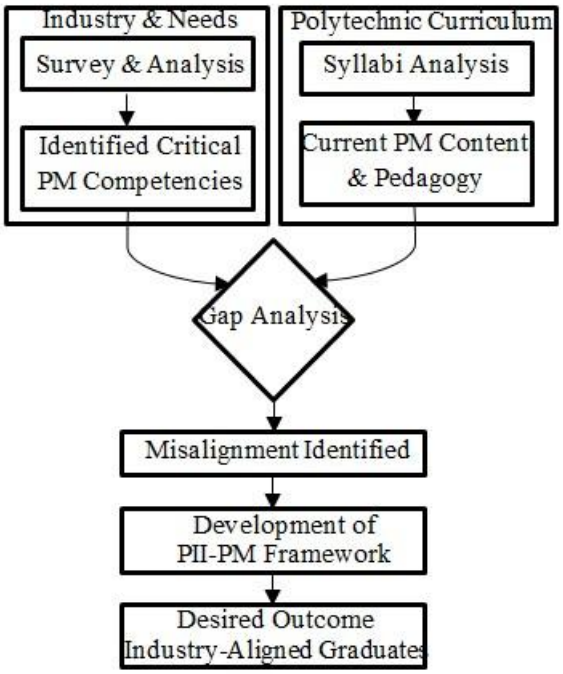

Figure 1. *Research conceptual framework for aligning PM training with industry needs.*

Materials and Methods

A sequential explanatory mixed-methods design was employed (Creswell and Clark, 2017), comprising three distinct phases.

Phase I: Quantitative Industry Survey

A structured online questionnaire was developed. Section A captured demographic data. Section B listed 20 PM competencies derived from literature and expert consultation. Respondents rated the importance of each competency for a new graduate on a 5-point Likert scale. The instrument was validated by a panel of three experts (CVI>0.80), and a pilot test (n=15) confirmed its reliability (Cronbach's Alpha=0.89). Using purposive and snowball sampling, 127 professionals from contractors, consultants, and client organizations were surveyed. Data were analyzed using SPSS v28. Descriptive statistics (mean, standard deviation) ranked the competencies.

Phase II: Qualitative Curriculum Analysis

Official syllabus documents for the core PM module were collected from 15 Malaysian Polytechnics. A qualitative content analysis was performed, coding the documents for: (1) Content Coverage (presence/depth of the 20 competencies), (2) Pedagogical Methods, and (3) Assessment Methods. Coverage was rated as High (detailed learning outcomes with practical application), Medium (theoretical coverage with limited practice), or Low (minimal or no mention). Thematic analysis identified patterns.

Phase II: Gap Analysis and Framework Development

The quantitative and qualitative findings were integrated. The mean importance score (M) for each competency was compared against its curriculum coverage rating. A paired-samples t-test determined if the gap was statistically significant. The PII-PM Framework was developed iteratively based on the identified gaps and best practices.

Results and Discussion

Industry Perspective on Critical PM Competencies

The respondent profile was diverse: 45% contractors, 35% consultants, 20% clients; 60% had over 10 years of experience. *Table 1* presents the top 10 ranked competencies, underscoring a strong demand for practical, site-oriented skills.

***Table 1**. Top 10 PM competencies as rated by industry (N=127).*

Rank	Competency	M	SD	Interpretation
1	Site Supervision & Safety Management (OSHA 1994)	4.85	0.36	Extremely Important
2	Quality Control & Assurance (e.g., QLASSIC)	4.80	0.41	Extremely Important
3	Scheduling & Software Usage (e.g., MS Project)	4.72	0.48	Very/Extremely Important
4	Construction Methods & Equipment Management	4.68	0.52	Very Important
5	Material Procurement & Inventory Control	4.60	0.55	Very Important
6	Communication & Reporting Skills	4.58	0.59	Very Important
7	Basic Understanding of Construction Contracts	4.55	0.61	Very Important
8	Risk Management & Problem-Solving	4.52	0.63	Very Important
9	Cost Control & Estimation Basics	4.45	0.67	Very Important
10	Teamwork & Leadership	4.40	0.70	Very Important

Note: M=Mean; SD=Standard Deviation.

Analysis of Current Polytechnic PM Curriculum and Gap Analysis

The syllabus analysis revealed a consistent but theoretically skewed curriculum. While foundational PM concepts were covered, practical application was limited. The misalignment is quantified in *Table 2*. For instance, Site Supervision & Safety (M=4.85) was covered in all syllabi but rated 'Medium' due to its theoretical nature, resulting in a 'High' severity gap. The most severe disconnect was in Quality Control (QLASSIC) (M=4.80), which had 'Low' coverage. The deficiency in digital tools was stark, with BIM covered in only 1 syllabus (7%). Pedagogy was predominantly lecture-based, with final exams constituting 60-70% of the grade. A paired-samples t-test confirmed that the difference between industry importance scores and curriculum coverage scores for the top five competencies was statistically significant ($t(4) = 8.91$, $p < 0.001$).

***Table 2**. Gap Analysis between industry needs and curriculum coverage.*

Industry Competency (Top 5)	IM	CC	GS
Site Supervision & Safety	4.85	Medium (Theoretical, lacks local code depth)	High
Quality Control (QLASSIC)	4.80	Low (Mentioned in 33% of syllabi)	Very High
Scheduling Software	4.72	Low-Medium (Hands-on in 40% of polytechnics)	High
Construction Methods	4.68	High (Adequately covered)	Low
Material Procurement	4.60	Medium (Covered, lacks practical logistics)	Medium

Note: IM=Industry Mean; CC=Curriculum Coverage; GS=Gap Severity.

The findings reveal a pronounced theory-practice divide, directly illustrating the "misalignment" component of the conceptual framework (*Figure 1*). The industry's top priorities are applied competencies rooted in daily site operations and adherence to Malaysian standards, while the curriculum delivers a theoretical foundation. This misalignment can be attributed to factors affecting the "Polytechnic Curriculum"

component of the framework: (1) Rigid Curriculum Update Cycles: Formal reviews are slow, unable to keep pace with rapid technological adoption (e.g., BIM). (2) Resource Limitations: High costs of software licensing and IT infrastructure. (3) Faculty Expertise Gap: Instructors may lack recent industry experience with digital tools. (4) Assessment Bias: High-stakes theoretical examinations discourage practical and PBL approaches. The implications are significant. For graduates, this gap results in "practice shock." For employers, it means increased training costs. For the nation, it hampers the efficiency of critical infrastructure projects. This discussion underscores the urgent need for the intervention proposed in the framework.

The PII-PM Framework

To bridge the identified gaps and achieve the "desired state" of industry-aligned graduates, the Polytechnic Industry-Integrated Project Management (PII-PM) Framework is proposed. It consists of five interconnected pillars, designed to directly address the deficiencies found in the gap analysis. *Pillar 1: Contextualized and Modernized Curriculum* (1) Action: Integrate mandatory modules on local standards (OSHA 1994, QLASSIC) using actual documents and case studies from Malaysian projects. (2)Action: Introduce a foundational module on BIM, utilizing free software viewers to teach model navigation and information extraction. *Pillar 2: Mandatory Digital Skills Integration* (1) Action: Establish a core, assessed module on scheduling software (e.g., MS Project) where students create schedules for real-world project scenarios. (2) Action: Incorporate training on cloud-based collaboration platforms (e.g., Google Workspace, Asana) for document management and communication simulations. *Pillar 3: Active and Experiential Pedagogy* (1) Action: Replace 50% of lecture hours with Problem-Based Learning (PBL) using authentic project challenges (e.g., delay analysis, resource allocation problems). (2) Action: Implement role-playing simulations for site meetings, client consultations, and safety briefings. *Pillar 4: Structured and Enhanced Industry Collaboration* (1) Action: Formalize partnerships with construction firms for structured, learning-oriented site visits (e.g., focused on quality inspection processes). (2) Action: Revamp the industrial training program to include a specific PM logbook, requiring students to document and reflect on their involvement in PM tasks. *Pillar 5: Continuous Feedback and Quality Loop* (1) Action: Establish formal Industry Advisory Panels (IAPs) for each program to provide annual curriculum feedback. (2) Action: Conduct systematic tracer studies to gather longitudinal data on graduate skill performance in the workplace.

Conclusion

This study confirms a significant misalignment between industry needs and the current PM training for civil engineering students in Malaysian Polytechnics. The industry requires graduates proficient in practical, digital, and localized PM skills, while the curriculum delivers a more theoretical foundation. The proposed PII-PM Framework offers a comprehensive strategy to realign polytechnic education with its TVET mission, thereby enhancing graduate employability and contributing to national development goals. The study's limitations include a sample size that, while adequate, could be expanded for greater generalizability, and a curriculum analysis based on syllabus documents which may not fully capture actual classroom delivery. Future work will involve: (1) Pilot Implementation: Collaborating with two polytechnics to

implement and refine the PII-PM Framework. (2) Impact Assessment: Conducting a quasi-experimental study to measure the framework's impact on student learning outcomes and employer satisfaction. (3) Longitudinal Study: Tracking the career progression of graduates from the pilot program compared to a control group.

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Conflict of interest

The authors confirm that there is no conflict of interest involve with any parties in this research study.

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