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A Meta-Analysis of Polytechnic Students' Knowledge and Awareness of 3D (Dirty, Dangerous, Difficult) Jobs Prior to Industrial Training

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Abstract

This meta-analysis synthesizes research on Malaysian Polytechnic students' knowledge, awareness, and perceptions of Dirty, Dangerous, and Difficult (3D) jobs prior to industrial training. While TVET is central to Malaysia's national development agenda, local youth continue to shun 3D sectors such as construction, manufacturing, and agriculture, leading to heavy reliance on foreign labor. This study draws from journal articles, theses, conference proceedings, and reports published between 2010 and 2025. A systematic review process identified more than ten relevant studies, which were analyzed thematically. The review reveals that students generally have moderate to high levels of conceptual knowledge of 3D jobs and occupational safety, but practical readiness and willingness to pursue 3D careers remain limited. Negative perceptions include low wages, unsafe working conditions, limited career prospects, and persistent social stigma, emerging as the primary deterrents. Gender and demographic factors further influence perceptions, with female graduates facing cultural barriers in male-dominated industries. The findings highlight that student reluctance is not ignorance but a rational assessment of labor market realities. The study underscores the need for structural reforms, including competitive wages, stronger safety curricula, improved industrial training experiences, and gender-sensitive educational practices. The implications are significant for aligning TVET outcomes with national workforce needs, enhancing graduate employability, and reducing dependency on foreign labor. By consolidating fragmented evidence, this meta-analysis contributes to a clearer understanding of the TVET and industry inconsistency and provides a foundation for targeted interventions.

Keywords: Polytechnic Students, Knowledge, Awareness, 3D Jobs, Dirty Dangerous Difficult, Industrial Training, Meta-Analysis

Introduction

Technical and Vocational Education and Training (TVET) is widely recognized as a cornerstone of Malaysia's economic growth strategy. Substantial investments have been directed towards strengthening TVET institutions, particularly Polytechnics, which play a crucial role in preparing graduates for employment in key industrial sectors. Despite this commitment, a inconsistency persists: the very industries that TVET is designed to support, which classified as Dirty, Dangerous, and Difficult (3D), are consistently avoided by local youth. The result is a labor market characterized by dependence on foreign workers and underutilization of local graduates (Ahmad et al., 2018; Nurhidayah Abdullah, 2022). This inconsistency raises questions about the preparedness of students, the adequacy of Polytechnic training, and the broader value proposition of 3D employment.

Studies have explored the reluctance of students and graduates to enter 3D sectors, but the evidence remains fragmented across methodologies and contexts (Zulkiflee et al., 2020; Isa & Hassan, 2018). Some research highlights gaps in safety preparedness (Mohamed et al., 2021), while others emphasize socio-cultural stigma and economic disincentives (Saadiah Ismail, 2021; Nandini Balakrishnan, 2016). What remains underexplored is the synthesis of these findings to understand the baseline state of Polytechnic students before industrial training formative period that bridges classroom learning and workplace realities. This meta-analysis addresses that gap, consolidating prior research to build a comprehensive understanding of students' knowledge, awareness, and readiness regarding 3D jobs.

The objectives of this study are: (i) to assess the level of Polytechnic students' conceptual knowledge of 3D work, (ii) to evaluate their preparedness and attitudes towards engaging in 3D sectors, and (iii) to identify the systemic and cultural factors shaping their perceptions. In doing so, the study contributes evidence to inform curriculum reforms, policy interventions, and industry partnerships that can improve the attractiveness of 3D sectors to local graduates. Ultimately, addressing this inconsistency is essential not only for graduate employability but also for Malaysia's long-term economic sustainability.

Literature Review

The preparedness of Polytechnic students for 3D jobs is situated within a complex ecosystem of governance structures, labor market realities, and cultural perceptions. The Malaysian TVET system has long been critiqued for its fragmented governance, with responsibilities spread across multiple ministries and accreditation bodies (Subramaniam & Abdul Aziz, 2023). This lack of coherence results in inefficiencies and inconsistencies that weaken the credibility of TVET qualifications. At the same time, a persistent stigma portrays vocational education as a second-class option, further discouraging students from fully embracing careers in 3D industries (Ahmad & Rosnan, 2024).

Economic realities reinforce this stigma. Jobs in construction, agriculture, and manufacturing are widely seen as unattractive due to low wages, poor working conditions, and limited career progression (Ahmad et al., 2018). Surveys show that many Malaysian youths would not consider 3D jobs unless they are abroad, where similar roles are better paid and more respected (Saadiah Ismail, 2021). This aligns with the concept of the 'gaji cukup makan' economy, where salaries are sufficient only for subsistence and fail to reflect the risks and demands of the job (Abd Rashid et al., 2024).

Occupational safety and health (OSH) is another critical dimension. Studies indicate that while students may have moderate theoretical knowledge of OSH, their practical skills such as confidence in using Personal Protective Equipment (PPE), remain weak (Mohamed et al., 2021). This gap creates vulnerabilities during industrial training, where students are exposed to real hazards. Gender adds another layer of complexity. Although female participation in Polytechnics has increased, women face structural barriers in male-dominated industries, including gender bias, stereotyping, and limited support systems (Goh et al., 2025).

These challenges are not unique to Malaysia. Developed countries like Japan face similar issues with their '3K' (Kitanai, Kiken, Kitsui) jobs (Nandini Balakrishnan, 2016). However, Japan's reliance on domestic labor highlights cultural differences, while Malaysia's dependence on foreign workers has rooted the perception of 3D jobs as undesirable. Synthesizing these insights provides a more nuanced understanding of Polytechnic students' reluctance to pursue 3D careers.

Methodology

This study adopts a qualitative meta-analytical approach, synthesizing empirical evidence from diverse sources. As presented in Figure 1, a systematic search was conducted using Google Scholar, Scopus, and Web of Science, following PRISMA guidelines to ensure transparency and replicability. Search terms included 'Polytechnic,' 'TVET,' 'Industrial Training,' '3D jobs,' and 'Dirty Dangerous Difficult.' The review covered literature published between 2010 and 2025, in English and Malay.

Inclusion criteria required studies to (i) focus on Malaysian Polytechnic or equivalent TVET populations, (ii) address knowledge, awareness, or perceptions of 3D jobs, and (iii) present empirical findings. Exclusion criteria filtered out purely theoretical reviews, studies outside the timeframe, and those unrelated to industrial training or 3D employment. More than ten studies met the criteria and were subjected to thematic analysis.

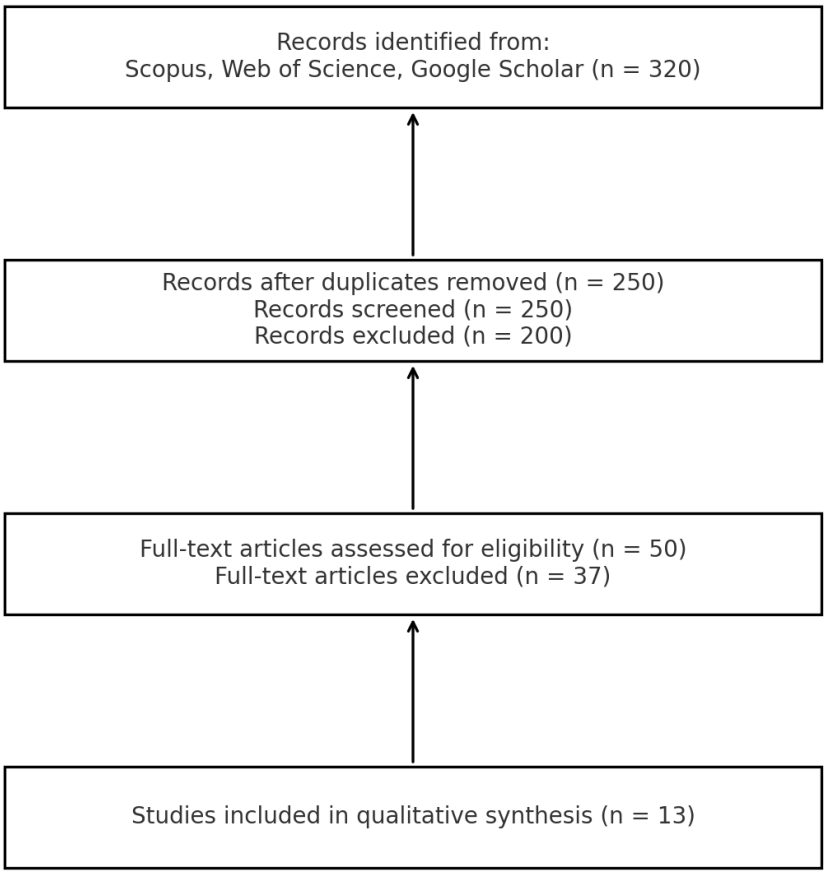

Figure 1. PRISMA Flow Diagram of Study Selection Process

Thematic synthesis involved coding data into recurring categories: (1) conceptual knowledge, (2) safety preparedness, (3) negative perceptions, (4) demographic and gender factors, and (5) systemic influences such as wage structures and labor market dynamics. This allowed integration of diverse findings into cohesive themes for analysis.

Data Findings

The synthesis of studies reveals consistent patterns in Polytechnic students' knowledge and perceptions of 3D jobs. While conceptual understanding is moderate to high, readiness and willingness remain low. The table below summarizes key studies included in this meta-analysis.

Table 1
Meta-Analysis Table

Author(s) & Year	Population & Context	Methodology	Key Findings
Zulkiflee et al. (2020)	Malaysian youth (Gen Y)	Survey	Neutral or poor understanding of 3D; reluctance due to safety and respect issues.
Zulkiflee et al. (2022)	Malaysian youth (Gen Y)	Instrument validation	Wages, recognition, career development, and job security are key motivators.
Isa & Hassan (2018)	Construction stakeholders	Survey	Low wages, poor working conditions, and unattractive environments deter locals.
Ahmad et al. (2018)	General workforce review	Literature review	Malaysians reluctant to work in 3D sectors locally but willing abroad.
Mohamed et al. (2021)	Vocational students in Kelantan	Survey	Moderate OSH knowledge; weak PPE compliance and accident reporting.
Hassan & Bakar (2025)	Polytechnic students	Survey	Industrial training improves teamwork but critical problem-solving weaker.
Abd Rashid et al. (2024)	Polytechnic graduates (PTSB)	Mixed methods	High employment rates but underemployment and low wages persist.
Goh et al. (2025)	Female workers in 3D industries	Interviews	Gender bias, patriarchal culture, communication barriers.
Norliza Abdullah (2023)	Polytechnic graduates (PSIS)	Tracer study	High employability rates but job-skill mismatch evident.
Yaakob et al. (2018)	Employers of Polytechnic grads	Interviews	Graduates are technically competent but lack soft skills.

The evidence highlights a recurring inconsistency: awareness exists, but willingness is low. These themes are elaborated in the discussion.

The synthesis of studies reviewed in this meta-analysis reveals several consistent patterns that illuminate how Polytechnic students, and related stakeholders perceive 3D jobs. For instance, Zulkiflee et.al., (2020) conducted a survey on Malaysian youth (Generation Y) and found that most respondents held either neutral or poor understanding of 3D industries. Importantly, their reluctance to work in these sectors was not only shaped by safety concerns but also by perceptions of low social respect associated with such jobs. This indicates that, even before students enter industrial training, negative images of 3D work already influence their career outlook.

Building on this, a subsequent study by Zulkiflee et al. (2022) developed and validated instruments to identify the determinants influencing youth participation in 3D industries. Their findings emphasize that wages and benefits, recognition, career development, and job security are the central factors shaping career decisions. This aligns with broader labor market studies showing that graduates assess job options based on rational economic and

professional considerations. Where 3D jobs are seen as deficient in these aspects, students logically choose to avoid them.

Complementary evidence from Isa and Hassan (2018) within the construction sector also highlights structural disincentives. Their survey of industry stakeholders identified low wages, poor working conditions, and unattractive job environments as primary reasons for the lack of local involvement in construction that related to 3D work. Taken together, these studies establish a recurring theme: students are aware of the economic and social drawbacks associated with 3D jobs and make career decisions accordingly.

Safety-related findings reinforce this picture. Mohamed et.al., (2021) studied vocational students in Kelantan and reported that while students displayed moderate levels of theoretical knowledge on occupational safety and health (OSH), their practical skills were significantly weaker. For example, many lacked confidences in using personal protective equipment (PPE) consistently and were hesitant to report workplace accidents. These results suggest that classroom knowledge does not always translate into effective workplace practice, leaving students vulnerable when transitioning into industrial training.

Meanwhile, Hassan and Bakar (2025) explored the impact of industrial training on Polytechnic students. Their study showed that industrial training experiences significantly improved soft skills such as teamwork and adaptability. However, students continued to struggle with higher-order competencies such as critical problem-solving, indicating that while training enhances employability in some respects, it does not fully close the skills gap.

Graduate outcomes were further examined by Abd Rashid et.al (2024), who reported that although Polytechnic graduates enjoy high employment rates, a substantial proportion are underemployed or earn below the minimum wage. This echoes tracer study findings by Norliza Abdullah (2023), who found that while employability rates are high, job-skill mismatches remain prevalent. These patterns highlight that students' reluctance to join 3D sectors is partly informed by the visible struggles of recent graduates in securing meaningful and adequately compensated employment.

Finally, gender-related challenges are evident. Goh et.al. (2025) documented how women in male-dominated 3D industries face patriarchal workplace cultures, gender bias, and communication barriers. Similarly, Yaakob et.al. (2018) found that employers often view Polytechnic graduates as technically competent but deficient in soft skills, particularly in areas such as leadership and communication. These studies suggest that even when graduates have the technical ability to succeed in 3D jobs, non-technical challenges, ranging from gendered barriers to interpersonal skills gaps has limit their success and persistence in these sectors.

Collectively, the evidence from these studies paints a coherent picture: Polytechnic students' understanding of 3D jobs is not naïve or uninformed. They are well-aware of the challenges, which include economic, social, and safety-related, that define these sectors. Their reluctance reflects a rational evaluation of the poor value proposition offered by 3D employment, reinforced by both their own limited training experiences and the outcomes observed among recent graduates.

Discussion

The findings indicate that Polytechnic students' reluctance to enter 3D sectors stems less from a lack of knowledge and more from rational evaluations of labor market realities. This aligns with prior studies emphasizing underemployment, low wages, and socio-cultural stigma (Saadiah Ismail, 2021; Nandini Balakrishnan, 2016). Industrial training emerges as a pivotal intervention: poorly structured experiences confirm biases, while high-quality placements can reshape perceptions (Hassan & Bakar, 2025).

Beyond the inconsistency of knowledge versus reluctance, the findings of this meta-analysis reveal deeper structural issues that shape Polytechnic students' perceptions of 3D work. One key theme is the disjunction between official statistics on employability and the lived experiences of graduates. While employability surveys often report figures above 90 percent, this masks widespread underemployment, where graduates are employed but in roles that do not align with their field of study or skill level (Abd Rashid et al., 2024; Norliza Abdullah, 2023). Students are increasingly aware of these mismatches through social networks and alumni, and this awareness feeds into their rational rejection of 3D careers. In this sense, their reluctance is a pre-emptive response to observe economic outcomes rather than a lack of motivation or resilience.

Another dimension concerns the interplay of global and local labor markets. Research highlights that Malaysians are often willing to take on 3D jobs abroad, such as in Singapore or South Korea, where wages and working conditions are superior (Saadiah Ismail, 2021). This demonstrates that the aversion is not to the nature of the work itself, but to the conditions under which it is offered domestically. This conclusion has significant policy implications since attempts to rebrand 3D jobs will fail, unless structural reforms are implemented to increase pay and protections. Campaigns that simply encourage students to value 3D work without addressing the economic reality will likely be met with skepticism.

The discussion must also consider gender as a lens for interpreting these findings. The increasing participation of women in Polytechnics is a positive trend, yet the persistence of gender bias in 3D industries remains a deterrent. Female students face unique anxieties about entering male-dominated workplaces, including fears of harassment, marginalization, or being undervalued (Goh et al., 2025). Without explicit curriculum content that prepares women for these challenges and without organizational reforms in industry, the pipeline of female Polytechnic graduates into 3D sectors will remain weak. Gender-sensitive policies and stronger mentorship networks are critical to overcoming these barriers.

Finally, the role of industrial training as a transformative experience cannot be overstated. High-quality placements that expose students to structured learning, supportive mentors, and safe working environments can disrupt negative perceptions and offer a counter-narrative to the stigmatized image of 3D work (Hassan & Bakar, 2025). Conversely, poorly managed placements can reinforce existing stigma, leading students to avoid the sector altogether. This highlights the centrality of partnerships between Polytechnics and industry. Employers must recognize internships not merely as low-cost labor but as strategic investments in talent pipelines. When industrial training is properly resourced and aligned with career pathways, it has the potential to shift perceptions and increase graduates' willingness to pursue 3D careers.

Taken together, these insights underscore the importance of multi-level interventions. Addressing the reluctance of Polytechnic students to enter 3D work will require coordinated reforms across governance, industry, and education. By tackling wage structures, improving safety standards, embedding gender-sensitive practices, and ensuring meaningful industrial training, Malaysia can begin to resolve the TVET–industry inconsistency and better align graduate outcomes with national labor market needs.

Comparative insights from international contexts reinforce this analysis. Japan's 3K jobs, though stigmatized, continue to attract domestic labor due to structural support and cultural acceptance (Nandini Balakrishnan, 2016). In Malaysia, however, reliance on foreign workers entrenches the stigma, signaling that reforms must go beyond awareness campaigns to address systemic wage and safety issues.

Conclusion

This meta-analysis concludes that Polytechnic students' knowledge of 3D work is sufficient, yet their reluctance reflects systemic flaws. Key reforms include (i) embedding practical OSH training, (ii) strengthening industrial training frameworks, (iii) addressing gender bias, and (iv) ensuring competitive wages. Without these changes, the inconsistency of producing technically competent graduates who avoid 3D industries will persist. Aligning student aspirations with labor market needs is essential to the success of Malaysia's TVET agenda.

In addition to these findings, the study highlights the interconnectedness of policy, education, and industry practices. Policymakers must not only reform wage and safety standards but also address fragmented TVET governance structures that undermine institutional effectiveness. Polytechnics should adopt more holistic training approaches that integrate technical skills with soft skills, gender sensitivity, and real-world safety practices. At the same time, industry partners must reframe industrial training from being a short-term labor resource into a long-term talent development strategy. Future research should further explore longitudinal impacts of industrial training on career trajectories, as well as cross-country comparisons to identify best practices in sustaining local participation in 3D sectors. By aligning these three dimensions; policy, pedagogy, and practice, Malaysia can begin to transform 3D work into a dignified and attractive career path for Polytechnic graduates.

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