



Institutional Support and Sustainable Welding Programme Quality in Malaysia: Issues and Challenges for Career Resilience

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Abstract

This review examines how institutional support and program quality shape sustainable welding education and career resilience in Malaysian vocational colleges. It integrates Malaysian evidence on vocational-college infrastructure, instructor perspectives, employer expectations, work-integrated learning, green skills, employability, career choice, and adaptability, while using welding-specific studies from comparable vocational systems to clarify mechanisms that Malaysian studies have not yet tested directly. The literature indicates that program quality is multidimensional: curriculum relevance, safe and functional workshops, instructor capability, authentic industrial exposure, credible assessment, and explicit development of communication, problem-solving, teamwork, and self-management all matter. Malaysian evidence also shows a persistent implementation problem. Curriculum and industrial-training provisions are often rated positively, while infrastructure is more uneven; employers value communication and thinking skills but report dissatisfaction with graduates' performance in these areas. Career resilience is best understood as an interaction between institutional conditions and student resources rather than as an individual trait. Work-based learning, curriculum relevance, institutional support, career self-efficacy, social support, and employability skills are linked to adaptability, but most studies are cross-sectional and based on self-reported data. Sustainability is emerging through green-skill frameworks and evidence of positive readiness among Malaysian welding students, yet operational measures of energy use, fumes, waste, materials, safety culture, and environmental performance remain limited. The central challenge is therefore integration: Malaysian welding programs need institutional systems that connect resources, pedagogy, industry, sustainability, assessment, and career guidance across the student-to-work transition.

Keywords: Institutional Support, Welding Program Quality, Sustainable TVET, Employability Skills, Career Resilience

Introduction

Malaysian vocational colleges were established as part of a broader transformation aimed at developing skilled human capital capable of responding to technological advancements and

changing labor-market demands. In engineering-related programs, including welding technology, achieving this objective requires more than the delivery of occupational techniques. It also depends on institutions' capacity to maintain well-equipped workshops, ensure equipment reliability, develop instructors' competencies, coordinate industrial training, assess students' practical skills against recognized standards, and prepare students to navigate uncertain employment trajectories. Consequently, a program may provide adequate theoretical instruction yet remain limited as a sustainable pathway to employment if students lack access to safe practical training, up-to-date equipment, meaningful workplace exposure, relevant career information, or the adaptive resources necessary to manage post-graduation challenges.

The literature addresses these concerns through several interrelated concepts. Institutional support encompasses management commitment, facilities, equipment maintenance, instructor development, student guidance, and industry partnerships. Program quality is commonly associated with curriculum relevance, instructional competence, workplace learning, assessment practices, certification, and graduate outcomes. Sustainable vocational education extends these concerns to the development of green skills, resource efficiency, environmental responsibility, ethical practice, and preparedness for changing industrial requirements. Meanwhile, career resilience is reflected in career adaptability, self-efficacy, future orientation, goal setting, social support, employability skills, perseverance, and help-seeking behavior. Within welding education, these concepts intersect with specialized areas such as welding technology, welding engineering, gas and arc welding, shielded metal arc welding (SMAW), occupational health and safety, welding procedure specifications, inspection, certification, industrial attachment, work-based learning, and workplace-integrated learning.

Against this background, five interconnected questions are addressed in this review. First, the institutional conditions that enable or constrain the delivery of welding education in Malaysian vocational colleges are examined. Second, the characteristics of quality in welding programs and their alignment with industry requirements are explored. Third, the incorporation of sustainability principles and green skills into technical and vocational education is investigated. Fourth, the employability capabilities identified by employers and graduates are analyzed. Finally, the development of career adaptability and resilience among vocational students and graduates is examined.

Institutional Support and College Capacity in Welding Education

Institutional support is a fundamental condition for the effective delivery of welding education, encompassing infrastructure, instructor capability, institutional management, industry partnerships, and student support services. Malaysian evidence indicates that infrastructure remains a concern in vocational colleges, with a survey of 116 technical instructors reporting less favorable ratings for infrastructure than for curriculum implementation and industrial training (Noor et al., 2023). Similarly, research involving 566 students and 75 lecturers in vocational-college mechanical programs emphasized the importance of up-to-date facilities and well-maintained workshop equipment for safe and effective practical learning (Kamin et al., 2018). Welding-specific evidence further identified equipment limitations, teaching methods, student motivation, and discipline as factors influencing learning outcomes, with weaknesses in theoretical understanding, welding

positions, welding procedure specifications, and the application of ISO 5817 standards despite stronger practical performance (Sofian et al., 2025). These findings suggest that effective welding education requires reliable, industry-relevant equipment, safe workshop environments, and sufficient opportunities for repeated practice, standards-based assessment, and corrective feedback.

Beyond infrastructure, institutional capacity depends on instructor competence, instructional quality, and effective management. A Malaysian mixed-method study involving 171 TVET students identified instructional competence as an important component of educational quality and examined its relationship with students' perceived need for further training (Lam & Hassan, 2020). However, instructor development may be constrained when essential resources are inadequate. Evidence from Malaysian vocational colleges highlights the need to align professional development with the provision and maintenance of welding equipment, personal protective equipment, ventilation systems, consumables, and inspection instruments (Noor et al., 2023). A qualitative study conducted in two vocational schools in another national context also described the potential benefits of institutional management, material support, and systematic professional-welder certification for student achievement, confidence, and employment opportunities, although inadequate funding for facility repairs remained a challenge (Syamsuddin & Prasetyo, 2021). Collectively, these findings indicate that institutional support requires an integrated approach combining instructor development, adequate facilities, systematic assessment, and effective resource management. Nevertheless, further research is needed to establish how these institutional conditions relate to welding competency and graduate employment outcomes in Malaysian vocational colleges.

Industry partnerships represent another important dimension of institutional capacity because they connect college-based learning with workplace requirements. Malaysian evidence indicates that although students were generally considered prepared for workplace participation, some industrial-training tasks were insufficiently aligned with their fields of study, while English-language proficiency and soft skills required further development (Pillai et al., 2011). Similarly, a study involving 269 employers participating in the on-the-job training of Malaysian vocational-college graduates identified communication, thinking, and problem-solving as important workplace competencies (Haron et al., 2019). A survey of Malaysian manufacturing employers also reported gaps across eight employability domains, particularly English communication and thinking skills (Yen et al., 2023). Further evidence from work-integrated learning involving 83 Malaysian students, assessed by workplace mentors, associated work quality with knowledge application, judgement, decision-making, discipline, adaptability, ethics, and work performance (Theerasak & Khampirat, 2019). These findings suggest that effective partnerships should extend beyond student placement to include relevant workplace tasks, appropriate supervision, occupational safety, structured feedback, and progressive competency development. The quality of industrial training therefore needs to be evaluated in terms of its contribution to learning and workplace preparedness rather than the number of placements provided alone.

Institutional support also encompasses career guidance, counselling, and assistance with the transition from education to employment. A study of engineering students in Malaysian vocational colleges reported moderately high levels of career decision-making and

employability skills but recommended integrating career information and guidance more actively into learning activities (Bakry et al., 2020). Similarly, a study involving 234 graduates from Malaysian vocational colleges in Johor across welding, electrical, electronic, construction, and automotive programs identified difficulties in occupational selection, program–career alignment and understanding employer expectations. Differences across colleges were also observed in graduates' career choices and perceptions of program suitability, although the study did not establish which interventions would be most effective in addressing these challenges (Kiong & Zulkifli, 2024). These findings highlight the importance of providing continuous career support through occupational information, structured reflection during industrial training, career counselling, alumni networks, employer engagement, and post-graduation guidance.

Overall, institutional support in welding education should be understood as an interconnected system of resources, professional capabilities, industry engagement, and student services. Adequate infrastructure provides the conditions for safe practical learning, while competent instructors and effective management support curriculum implementation and assessment. Industry partnerships connect learning with occupational expectations, and career guidance helps students translate their developing competencies into informed employment decisions. However, the available evidence does not establish the independent or combined effects of these institutional factors on welding competency, career resilience, and sustained employment among Malaysian vocational-college graduates. Further empirical investigation is therefore needed to examine how institutional support contributes to program quality and student outcomes across different vocational-college settings.

Welding Program Quality and Industry Alignment

The quality of welding programs depends on the alignment of curriculum content, assessment practices, and industry-required competencies. A Malaysian study of engineering programs in vocational colleges reported favorable instructor ratings for curriculum implementation and industrial training; however, these findings do not establish whether welding curricula adequately reflect current industrial practices or assess competence against specific welding standards (Noor et al., 2023). Welding-specific evidence highlights gaps in students' understanding of welding positions, welding procedure specifications, and ISO 5817 standards, despite stronger performance in practical steel-plate activities than in theoretical knowledge (Sofian et al., 2025). These findings indicate that practical task completion alone may not sufficiently demonstrate occupational competence. Accordingly, program assessment should integrate direct evaluation of weld quality with students' ability to select appropriate procedures, control welding variables, identify defects, conduct inspections, and explain technical decisions. Furthermore, welding curriculum development should be guided by occupational requirements, with appropriate attention to theoretical instruction, teaching methods, practical training, and instructor preparation (Wang, 2012). This approach is consistent with Malaysian employer evidence highlighting the importance of communication, thinking, and problem-solving skills alongside technical competence (Haron et al., 2019; Yen et al., 2023). Collectively, these findings suggest that welding program quality requires an integrated approach that combines practical proficiency, theoretical understanding, compliance with occupational standards, professional judgement, and transferable workplace competencies.

Welding competency develops through repeated practical performance, corrective feedback, and the application of knowledge across different welding processes, materials, positions, and workplace conditions. A qualitative study of welding work-based learning integrated school-based, community-based, and industrial learning, with student development evaluated through tests, competency assessments, and industrial-practice reports. This approach highlights the importance of connecting learning experiences across settings and assessing competency development as a continuous process (RM et al., 2022). Similarly, a quantitative study involving 104 welding students in Indonesia identified positive associations between industrial work-practice experience, student motivation, workshop facilities, and welding competency, suggesting that practical exposure, student engagement, and access to appropriate resources should be considered collectively when evaluating program quality (Prastya & Rofiq, 2025). Further evidence indicated a moderate relationship between students' perceptions of welding technology courses and work readiness ($r=0.577$), with the course perceptions accounting for 33.3% of the variance in work readiness ($R^2=0.333$). However, given the ex-post-facto design and questionnaire-based measures, these findings demonstrate an association rather than a causal effect of instructional provision (Januariyansah et al., 2025). Collectively, these studies suggest that effective welding program quality depends on integrating practical experience, appropriate facilities, student engagement, and continuous competency assessment, while ensuring that learning experiences are relevant to workplace expectations.

Certification contributes to welding program quality when it is supported by credible standards, current occupational requirements, and assessments of demonstrated competence. A qualitative study of professional-welder certification in Indonesia reported that systematic implementation was associated with perceived benefits in student achievement, confidence, employment access, and wages, although inadequate funding for facility repairs remained a challenge. However, the study's local context and qualitative design limit the generalizability of these findings to Malaysian vocational colleges (Syamsuddin & Prasetyo, 2021). Similarly, international evidence highlights the use of recognized welding and instructor certifications, including alignment with American Welding Society (AWS) entry-level and intermediate guidelines, as mechanisms for establishing competency benchmarks and connecting curriculum design with educator capabilities and professional credentials (Snyder & Septriana, 2017). Nevertheless, Malaysian employer studies indicate that technical certification alone does not fully represent graduate employability, as employers also value communication, thinking, problem-solving, teamwork, technology use, discipline, and self-motivation (Haron et al., 2019; Yen et al., 2023). Accordingly, welding program quality assurance should assess two complementary dimensions: occupational competence, including safe working practices, welding performance, and inspection skills; and transferable employability competencies, including communication, collaboration, problem-solving, and adaptability to changing industrial requirements. Integrating both dimensions into assessment and quality assurance would provide a more comprehensive basis for evaluating graduates' occupational readiness and transition into employment.

Occupational safety and professional identity are integral to welding program quality and graduate employability. A study of Malaysian manufacturing employers identified work safety, integrity, customer service, creative and innovative thinking, problem-solving, and

leadership as important employability indicators, suggesting that safe working practices should be embedded in professional conduct rather than treated merely as a prerequisite for workshop participation (Rasul et al., 2013). Similarly, research involving welding employers highlighted employability, occupational competence, and safety consciousness as important expectations for welding and fabrication graduates (Eguabor et al., 2017). In Malaysian vocational welding programs, these expectations can be translated into observable learning outcomes, including hazard identification, appropriate use of personal protective equipment, ventilation awareness, workshop housekeeping, material and process traceability, defect communication, and appropriate responses to unsafe conditions. Beyond technical competence and safety, professional identity also contributes to students' preparation for employment. A qualitative study of a community-college welding program in southern California highlighted the importance of technical and transferable skills, welder identity, workplace roles, employer collaboration, and employment support in shaping students' understanding of their future occupations (Kirby, 2023). Although the findings are context-specific, they suggest that welding education should integrate technical training, safety consciousness, professional behavior, and engagement with employers to prepare students for the practical and social expectations of the workplace.

Sustainability and Green Skills Development in Welding Education

Sustainability and green skills are increasingly recognized as important components of technical and vocational education, encompassing environmental knowledge, resource efficiency, green-technology application, and responsible professional practice. A study involving 332 engineering lecturers from four Malaysian polytechnics identified green competencies related to pollution control, environmental research, green-technology use, natural-resource management, energy conservation, recycling, reuse, and sustainable design (Malaysia et al., 2021). These competencies align with earlier Malaysian TVET research that conceptualized green skills as contributing to the environmental, economic, and social dimensions of sustainable development (Kamis et al., 2017), as well as research highlighting the importance of green technology, resource efficiency, and sustainability-oriented curricula in preparing the future workforce (Ramli et al., 2018). In welding education, these principles can be incorporated into activities involving energy-efficient equipment operation, consumable management, welding-fume control, waste reduction, material efficiency, and environmentally responsible process selection.

Malaysian evidence specific to welding students provides further insight into sustainability readiness. A study involving 101 students enrolled in a welding technology program at a Malaysian public skills-training center reported high levels of awareness, knowledge, and favorable attitudes towards green-skill implementation (Wilson et al., 2025). However, these findings reflect students' reported awareness, knowledge, and attitudes rather than directly observed environmental performance or subsequent employment outcomes. Similarly, a Malaysian higher-education TVET framework identified five green-skill domains: knowledge and comprehension, cognitive abilities, practical work competencies, personal and entrepreneurial skills, and ethics and professionalism. Developed through policy analysis, expert consensus, and institutional validation, the framework emphasized alignment among curriculum, teaching, and assessment, although it was not a welding-specific evaluation of student outcomes (Ibrahim et al., 2026). Collectively, these studies suggest that sustainability-oriented welding education should integrate environmental knowledge with practical,

cognitive, and ethical competencies rather than rely solely on students' awareness or positive attitudes.

Environmental responsibility also has implications for occupational safety, technical quality, and professional conduct. Welding students need to understand how operational decisions affect energy consumption, material waste, worker exposure, product durability, and compliance with applicable requirements. Program assessment should therefore examine students' ability to justify welding procedures, document their work, manage resources responsibly, and follow appropriate safety and environmental practices. These competencies can be embedded across workshop instruction, equipment maintenance, industrial training, inspection procedures, and project-based learning (Malaysia et al., 2021; Ibrahim et al., 2026). Such integration would position sustainability as a cross-curricular responsibility rather than an isolated subject or policy objective.

Nevertheless, the effective implementation of green skills depends on institutional capacity, including functional equipment, appropriate consumables, effective ventilation, suitable storage facilities, monitoring procedures, and instructor competence. Malaysian evidence indicating less favorable ratings for infrastructure than for curriculum implementation and industrial training highlights a potential constraint on the consistent delivery of sustainability-oriented practical learning (Noor et al., 2023). Although Malaysian welding students have demonstrated encouraging levels of green-skill awareness, knowledge, and attitudes, further empirical investigation is needed into institutional implementation, instructor capability, observable workshop practices, and employer expectations (Wilson et al., 2025). Accordingly, the quality of sustainable welding education should be evaluated through demonstrable outcomes, such as responsible resource use, appropriate waste handling, energy-conscious equipment operation, and environmentally responsible problem-solving.

Employability and Future-Ready Competency Development

Employability in technical and vocational education extends beyond technical proficiency to include communication, thinking, problem-solving, interpersonal skills, teamwork, leadership, technological literacy, and professional qualities. Malaysian studies involving vocational-college training, manufacturing employers, and TVET industry experts consistently highlight the importance of these transferable competencies alongside occupational capabilities (Haron et al., 2019; Rasul et al., 2013; Bassah & Noor, 2023). However, employer expectations do not always correspond with graduates' demonstrated capabilities. A survey of 63 Malaysian manufacturing employers reported gaps across eight employability domains, particularly English communication, thinking, self-motivation, positive attitudes, teamwork, work planning, technology, and discipline (Yen et al., 2023). These findings suggest that welding programs need to integrate transferable competencies into technical instruction so that students can communicate workplace requirements, report defects, solve practical problems, and coordinate work safely, in addition to producing welds that meet specifications.

Evidence concerning students' employability skills further indicates that competency development may be uneven across domains. Malaysian studies involving technical and vocational trainees reported moderate to relatively high overall employability, with personal qualities generally stronger than thinking, information use, resource management, and

technology-related competencies (Bakar & Hanafi, 2007; Bakar et al., 2013). Similarly, a study involving 149 welding students in Indonesia reported stronger ratings for technology and occupational health and safety than for learning, self-management, initiative, planning, communication, and problem-solving (Areisy & Sudira, 2022). Although these studies involve different populations and contexts, their findings highlight the limitations of relying exclusively on overall employability scores. In Malaysian welding programs, competency assessment should therefore distinguish technical proficiency from communication, critical thinking, information use, resource management, and other transferable skills to identify specific development needs.

Work-integrated learning provides an important mechanism for connecting these competencies with workplace requirements, although industrial placement alone does not guarantee meaningful learning. Malaysian research has identified mismatches between industrial-training tasks and students' fields of study, alongside continuing needs for English proficiency and soft-skill development (Pillai et al., 2011). Evidence from workplace mentors also associates work quality with the ability to learn and apply knowledge, judgement, discipline, adaptability, ethics, and work performance, highlighting the importance of evaluating the quality of workplace learning environments (Theerasak & Khampirat, 2019). In welding education, relevant workplace experiences may include material preparation, fit-up, welding, inspection, repair, documentation, safety procedures, and quality control. Integrating these experiences with school-based instruction, competency assessments, and industrial-practice reports could strengthen the relationship between curriculum outcomes and workplace performance (RM et al., 2022). Formal partnerships, prepared workplace mentors, common assessment rubrics, and structured employer feedback may further support the quality and relevance of industrial training.

Beyond initial employability, future-ready competency development concerns graduates' capacity to maintain and develop their capabilities as occupational requirements change. Malaysian employer studies emphasize communication, thinking, problem-solving, technology use, discipline, and self-motivation as important workplace expectations (Haron et al., 2019; Yen et al., 2023). Research on career resilience also identifies adaptability, self-efficacy, social support, goal orientation, and future concern as resources relevant to managing career-related change (Mahfud et al., 2024; Zahari & Omar, 2019). Nevertheless, perceived employability, competency ratings, and employer expectations do not directly establish long-term employment stability or career progression. The available evidence more frequently addresses employability skills and readiness than employment retention, wage progression, occupational mobility, or job quality. Consequently, longitudinal graduate tracking is needed to examine how institutional support, program quality, and future-ready competency development relate to sustained employment and career progression among Malaysian vocational-college welding graduates.

Career Resilience and Graduate Transition to Employment

Career resilience in vocational education is closely related to career adaptability, self-efficacy, social support, and the ability to manage occupational transitions and changing workplace demands. A study involving 720 students in Malaysian skills-based training institutions found positive relationships among career interest, career knowledge, career adaptability, and career choice. Although career adaptability was identified as the most important factor in the

model, it recorded the lowest mean score among the factors examined, suggesting a potential area for institutional attention (Ashari et al., 2018). Similarly, research involving 226 Malaysian vocational-college diploma students examined career future concern, personal goal orientation, perceived social support, and career adaptability in the context of technological change and potential job mismatch (Zahari & Omar, 2019). While the available evidence does not establish the relative effects of these factors, it supports examining career adaptability in relation to students' social and institutional environments. Evidence from Indonesian welding students also reported high career adaptability among the groups studied, with welding students obtaining higher scores than computer-network students, although the findings cannot be directly generalized to Malaysian vocational-college students (Danis Rizki Swastika, 2022).

Institutional support and work-based learning may contribute to career adaptability by strengthening students' confidence in their ability to perform occupational tasks, respond to challenges, and make informed career decisions. A comparative study involving 476 vocational students in Indonesia and Malaysia found that work-based learning, curriculum relevance, institutional support, and career self-efficacy had direct relationships with career adaptability. Career self-efficacy mediated the relationships between work-based learning and career adaptability and between institutional support and career adaptability, but not the relationship between curriculum relevance and adaptability (Mahfud et al., 2024). Complementary evidence from 120 Malaysian vocational-college graduates in electronic technology indicated a strong, statistically significant correlation between soft skills and career adaptability, with teamwork identified as the dominant factor reported in explaining adaptability (Puad et al., 2024). Although the latter study did not involve welding graduates and its correlational design does not establish causation, the findings highlight the relevance of transferable competencies and supportive learning experiences to career development.

Career resilience is also associated with students' ability to make informed occupational decisions and navigate the transition from education to employment. Studies of Malaysian vocational-college students and graduates have identified difficulties in understanding career options, assessing program-career alignment, and identifying employer expectations, despite moderate-to-high levels of career decision-making and employability skills among some student groups (Bakry et al., 2020; Kiong & Zulkifli, 2024). Research involving 329 Malaysian foundation students further identified relationships between career maturity, career decision-making self-efficacy, and career adaptability, highlighting career competency, goal selection, and career planning as relevant factors (Rahim et al., 2021). Although these findings originate from different educational populations, they suggest that career planning should be developed as an explicit capability through structured guidance, occupational information, and opportunities for students to evaluate their interests and competencies against employment requirements. For welding students, this support could include information about fabrication, maintenance, inspection, quality control, further certification, entrepreneurship, and changing industry requirements.

The learning environment also plays a role in supporting resilience. Longitudinal qualitative research in Norwegian vocational education identified commitment, perseverance, self-regulated learning, goal orientation, self-efficacy, and help-seeking as relevant to resilience among vulnerable students and apprentices, while emphasizing the influence of school and

workplace learning environments (Schmid & Haukedal, 2022). Although this evidence is not specific to Malaysia, it provides a useful perspective for considering how supportive institutional practices may facilitate students' responses to educational and occupational challenges. In Malaysian welding programs, such practices could include clear performance expectations, formative feedback, opportunities to learn from errors, accessible instructor support, structured workplace mentoring, and mechanisms for addressing placement mismatches or unsafe working conditions. These measures should complement, rather than replace, students' own responsibility for learning and career development.

Collectively, the evidence suggests that career resilience should be examined as a developmental outcome associated with individual capabilities and the educational and workplace environments in which students learn. Institutional support, curriculum relevance, work-based learning, social relationships, and career guidance may provide conditions that facilitate adaptability and confidence, although the strength and direction of these relationships vary across studies and populations (Mahfud et al., 2024; Zahari & Omar, 2019). Nevertheless, much of the available evidence concerns career adaptability, self-efficacy, soft skills, and career decision-making rather than longitudinal employment outcomes. Further research involving Malaysian vocational-college welding students and graduates is therefore needed to establish how these factors relate to employment transitions, job retention, occupational mobility, and sustained career development.

Equity, Identity, and Labor-Market Fit

The alignment between welding education and labor-market requirements is influenced by program availability, regional industry demand, technological developments, and students' understanding of occupational opportunities. Research on welding education has highlighted potential supply–demand imbalances that may affect competition for employment (Danis Rizki Swastika, 2022), while Malaysian evidence indicates that vocational-college graduates may experience difficulties identifying suitable occupations, assessing program–career alignment, and understanding employer expectations (Kiong & Zulkifli, 2024). These findings highlight the importance of incorporating current labor-market information into program planning and career guidance. Welding programs should expose students to diverse occupational pathways, including fabrication, construction, manufacturing, energy, maritime industries, inspection, repair, and maintenance, while developing transferable competencies that support occupational mobility as industry requirements change (Theerasak & Khampirat, 2019).

Equity and differentiated student support are also relevant to program quality and graduate transitions. Malaysian studies have reported variations in certain vocational-choice experiences and abilities, although one comparative study found no statistically significant gender differences in employability skills among Malaysian and Thai students participating in work-integrated learning (Kiong & Zulkifli, 2024; Theerasak & Khampirat, 2019). However, these findings do not establish whether gender influences participation, belonging, workshop safety, discrimination, progression, or employment retention among Malaysian welding students. Similarly, although communication, self-confidence, and social support have been identified as relevant considerations in TVET, evidence remains limited concerning how these resources are distributed among students from different socioeconomic, geographical, linguistic, and educational backgrounds (Bassah & Noor, 2023; Zahari & Omar, 2019). Further

research is therefore needed to examine whether institutional support is equitably accessible and how learning environments influence students' occupational identity, persistence, and career development.

Occupational identity further connects program quality with career resilience because students need to understand the professional responsibilities, employment opportunities, and progression pathways associated with welding. Qualitative research on a welding program highlighted the importance of technical and transferable skills, workplace roles, occupational stigma, employer collaboration, and employment support in shaping students' perceptions of the occupation (Kirby, 2023). Malaysian evidence also indicates relationships among career adaptability, occupational interest, career knowledge, and career choice (Ashari et al., 2018). These findings suggest that career preparation should extend beyond general encouragement to pursue vocational education and provide students with accurate occupational information, exposure to different professional roles, and feedback linking their developing competencies to workplace requirements. Presenting welding as a technically demanding, safety-critical, and increasingly technology- and sustainability-oriented occupation may also help students understand its broader professional responsibilities and potential career pathways (Rasul et al., 2013).

Institutional and regional differences further complicate the alignment between vocational programs and labor-market needs. Malaysian research has identified differences across vocational colleges in graduates' career choices, perceptions of program-career fit, and understanding of employer requirements, while instructor evaluations have also highlighted concerns relating to infrastructure and program implementation (Kiong & Zulkifli, 2024; Noor et al., 2023). Colleges serving different industrial sectors may consequently require different equipment, procedures, certifications, and work-integrated learning arrangements. Effective program development should therefore combine national standards with relevant regional industry information, employer feedback, and systematic monitoring of student and graduate outcomes. Multi-site research using common measures, employer assessments, institutional indicators, and graduate follow-up would help distinguish individual competency differences from institutional influences.

Future-ready welding education must also respond to technological and environmental change without compromising foundational welding knowledge, process control, and occupational safety. Malaysian TVET research has emphasized green technology, resource efficiency, and sustainability-oriented competencies (Ramli et al., 2018), while green-skills research has identified energy conservation, recycling, resource management, environmental data collection, and pollution control as relevant curriculum components (Malaysia et al., 2021). These competencies can be incorporated into welding activities involving digital documentation, inspection records, production planning, troubleshooting, energy monitoring, consumable management, and waste reduction. However, positive awareness and attitudes towards green skills do not necessarily demonstrate their practical application (Wilson et al., 2025). Assessment should therefore focus on observable performance, including students' ability to apply environmental and safety controls while meeting technical requirements.

Achieving these outcomes requires capable instructors and sustained industry collaboration. Malaysian studies have identified instructional competence as an important component of educational quality and infrastructure as a continuing implementation concern (Lam & Hassan, 2020; Noor et al., 2023). Industry partnerships can support instructor development, curriculum review, access to current equipment, industry-relevant assessment, and the integration of emerging occupational practices into teaching. Their effectiveness, however, should be evaluated through demonstrable improvements in learning outcomes, workshop activities, assessment practices, and employer feedback rather than the existence of formal agreements alone (Bassah & Noor, 2023; Haron et al., 2019). Furthermore, career adaptability research suggests that institutional support, work-based learning, self-efficacy, and soft skills are relevant to students' capacity to manage changing career demands (Ashari et al., 2018; Mahfud et al., 2024; Puad et al., 2024). These capabilities can be developed through mentoring, reflective learning, progressive certification, career planning, and problem-based activities that encourage students to seek feedback, diagnose errors, learn new procedures, and adapt to unfamiliar work situations.

Collectively, the literature indicates that equity, occupational identity, labor-market alignment, and future readiness are interconnected dimensions of sustainable welding education. Nevertheless, important evidence gaps remain concerning equitable access to institutional support, regional differences in program implementation, the practical application of green and digital competencies, and the relationship between these factors and graduates' long-term career outcomes. In particular, the available literature does not establish whether green or digital curriculum changes improve career resilience among Malaysian welding graduates. Longitudinal research tracking students from vocational colleges into employment is therefore needed to examine how institutional support, program quality, competency development, and career adaptability relate to employment stability, continued training, occupational mobility, and environmental performance.

Synthesis of Key Issues and Challenges in Sustainable Welding Education

The preceding discussion identifies several interconnected issues and challenges affecting the development of sustainable welding education in Malaysian vocational colleges. These include institutional capacity, program quality, sustainability integration, employability competency development, career resilience, industry collaboration, and responsiveness to technological and labor-market changes. Table 1 summarizes the key findings, major challenges, and supporting empirical studies discussed in this review.

Table 1

Summary of Key Issues and Challenges in Sustainable Welding Education in Malaysian Vocational Colleges

No.	Main Theme	Key Findings	Issues and Challenges	Supporting Studies
1	Institutional Support and College Capacity	Institutional support includes infrastructure, equipment, instructor competencies, management commitment, industry partnerships, and student guidance.	Uneven infrastructure provision, equipment maintenance constraints, limited resources, and insufficient career guidance may affect program implementation.	Noor et al. (2023); Kamin et al. (2018); Lam and Hassan (2020); Bakry et al. (2020); Kiong and Zulkifli (2024)
2	Welding Program Quality and Industry Alignment	Program quality depends on curriculum relevance, occupational standards, practical training, assessment, certification and workplace learning.	Gaps in theoretical knowledge, welding procedure specifications, welding standards, inspection skills, and alignment between training tasks and industry requirements.	Sofian et al. (2025); Wang (2012); RM et al. (2022); Januariyansah et al. (2025); Syamsuddin and Prasetyo (2021)
3	Sustainability and Green Skills Development	Relevant green skills include energy conservation, waste reduction, pollution control, resource management, recycling, environmental responsibility, and ethical practice.	Positive awareness and attitudes do not necessarily translate into observable sustainable practices. Institutional resources and instructor capabilities may constrain implementation.	Kamis et al. (2017); Ramli et al. (2018); Malaysia et al. (2021); Wilson et al. (2025); Ibrahim et al. (2026)
4	Employability and Future-Ready Competency Development	Employability extends beyond technical skills to communication, critical thinking, problem-solving, teamwork, leadership, technology use, ethics and self-management.	Employer expectations may exceed graduates demonstrated capabilities, particularly in English communication, thinking skills, teamwork, self-motivation and work planning.	Bakar and Hanafi (2007); Haron et al. (2019); Yen et al. (2023); Bassah and Noor (2023); Areisy and Sudira (2022)
5	Career Resilience and Graduate Transition	Career adaptability, self-efficacy, social support, career planning, perseverance and work-based learning are associated with students' career development.	Students may experience uncertainty in career selection, program-career alignment, employer expectations and transitions into employment. Long-term employment outcomes remain insufficiently established.	Ashari et al. (2018); Zahari and Omar (2019); Mahfud et al. (2024); Puad et al. (2024); Rahim et al. (2021)

6	Equity, Occupational Identity and Labor-Market Alignment	Career development is influenced by occupational information, regional industry needs, institutional context and perceptions of welding as a profession.	Limited evidence on gender-related experiences, unequal access to support, regional differences, occupational identity and the alignment between graduate supply and labor-market demand.	Kiong and Zulkifli (2024); Theerasak and Khampirat (2019); Kirby (2023); Danis Rizki Swastika (2022)
7	Industry Collaboration and Work-Integrated Learning	Industry partnerships provide workplace exposure, mentoring, practical experience, employer feedback and opportunities to align curricula with occupational requirements.	Industrial placements may involve tasks unrelated to students' specializations, inconsistent supervision, limited feedback and insufficient integration between college learning and workplace assessment.	Pillai et al. (2011); Theerasak and Khampirat (2019); Haron et al. (2019); RM et al. (2022)
8	Technological Change and Future Readiness	Future-ready welding education requires continued learning, digital documentation, technological literacy, sustainable production practices and adaptability to changing industrial requirements.	Limited longitudinal evidence establishes whether digital and green curriculum innovations improve career resilience, employment stability, occupational mobility or environmental performance.	Ramli et al. (2018); Mahfud et al. (2024); Wilson et al. (2025); Ibrahim et al. (2026)

As summarized in Table 1, the challenges facing welding education extend beyond technical training and cannot be addressed through curriculum improvement alone. Institutional support, industry-aligned program quality, sustainability-oriented learning, and future-ready competency development need to be considered as interconnected dimensions of vocational education. Nevertheless, the reviewed literature indicates gaps in longitudinal evidence concerning how these factors collectively contribute to graduates' career resilience and sustainable employment. These gaps provide a basis for further empirical investigation.

Conclusion

Institutional support, welding program quality, sustainability, and career resilience should be examined as interconnected dimensions of vocational education. Adequate facilities alone cannot guarantee occupational competence without effective pedagogy and appropriate assessment. Similarly, curricula may become disconnected from workplace requirements without regular industry feedback, while industrial placements may provide limited learning opportunities when supervision and mentoring are inadequate. Green-skill awareness also needs to be translated into practical workshop behaviors, and career guidance requires credible occupational information to help students make informed decisions about their future pathways. At the same time, developing career resilience requires attention to both

students' personal resources and the institutional conditions that enable them to respond to changing employment demands.

These considerations provide a basis for examining an integrated welding program quality framework for Malaysian vocational colleges. Such a framework would encompass safe and well-maintained workshops, instructors with current industry-relevant expertise, standards-based practical assessment, supervised and authentic work-based learning, employer-informed employability development, the integration of green and ethical practices, and structured career guidance. Its effectiveness should be evaluated by tracking students from program entry through graduation and into employment, using evidence from practical performance assessments, employers, institutional records, and graduate outcomes rather than relying exclusively on self-reported data.

Nevertheless, an important empirical question remains unresolved: how, and through which mechanisms, do institutional support and sustainable welding program quality contribute to the development of future-ready competencies and career resilience among students in Malaysian vocational colleges? Addressing this question requires welding-specific, multi-college, and longitudinal research that examines institutional conditions, student competency development, workplace experiences, and graduate progression over time. Such research would provide a stronger empirical foundation for understanding how vocational colleges can prepare welding graduates to meet evolving industrial requirements while developing sustainable and resilient careers.

References

- Areisy, H. J., & Sudira, P. (2022). Employability skills of state vocational high school students on welding engineering expertise competency. *Jurnal Pendidikan Vokasi*, 12(1).
- Ashari, Z. H. M., Azman, N., & Rasul, M. S. (2018). Factors predicting career choice among Malaysian students in skills-based training institutions. *International Journal for Educational and Vocational Guidance*.
- Bakar, A. R., & Hanafi, I. (2007). Assessing employability skills of technical-vocational students in Malaysia. *Journal of Social Sciences*.
- Bakar, A. R., Mohamed, S., & Hamzah, R. (2013). An assessment of workplace skills acquired by students of vocational and technical education institutions. *International Education Studies*, 6(11), 15-22.
- Bakry, N. S., Puad, M. H. M., Asimiran, S., Kadir, S. A., & Rashid, A. M. (2020). Exploring career decisions and employability skills among engineering students in vocational colleges. *International Journal of Academic Research in Business and Social Sciences*, 10(12).
- Bassah, N. S. H., & Noor, M. A. M. (2023). Employability skills needed for TVET graduates in Malaysia: Perspective of industry expert. *Online Journal for TVET Practitioners*, 8(1).
- Danis Rizki Swastika, S. P. S., & Sudjani. (2022). Comparative study of students' career adaptability in computer and network engineering with welding engineering. In *Proceedings of the 4th International Conference on Innovation in Engineering and Vocational Education (ICIEVE 2021)*.
- Eguabor, E., Aigbavboa, C., & Pretorius, J. H. C. (2017). Industry expectation from graduates of welding and fabrication from the perspective of engineering technology graduates in Nigeria. In *Lecture Notes in Computer Science*.

- Haron, M. A., Hussain, M. A. M., Zulkifli, R. M., Nashir, I. M., & Ma'arof, N. N. I. (2019). Employability skills needed by vocational college graduates: Feedback from the industry. *International Journal of Sustainable Construction Engineering and Technology*.
- Ibrahim, N., Rahim, Z. A., Iqbal, M. S., & Bahri, N. A. S. (2026). Integration of green skills in the TVET curriculum of higher education: Toward an ethical and sustainable workforce. *Aposta: Revista de Ciencias Sociales*.
- Januariyansah, S., Yulanto, D. M., Siregar, B., Situmorang, H. N., Gunawan, S., & Doni, R. (2025). Employment 5.0: The relationship between students' perception of welding technology courses and the work readiness. *Jurnal Dinamika Vokasional Teknik Mesin*, 10(2).
- Kamin, M. F. A. Y., Arsat, M., Nasir, A. N. M., Hamid, M. Z. A., Saud, M. S., Mokhtar, M., & Mamat, M. A. (2018). A conceptual model on preparing student in mechanical engineering program at Malaysian vocational colleges.
- Kamis, A., Alwi, A., Ismail, B. L. H., Normah, Z., & Yunus, F. A. N. (2017). Integration of green skills in sustainable development in technical and vocational education. *UTHM Institutional Repository*.
- Kiong, T. T., & Zulkifli, M. A. N. B. (2024). Employability challenges of vocational college graduates in the state of Johor. *Jurnal Pendidikan Teknologi Kejuruan*, 7(2).
- Kirby, B. (2023). Stakeholder goals and desired student outcomes for a community college welder training program. *Zenodo*.
- Lam, K. W., & Hassan, A. (2020). Factors influencing instruction competencies as perceived by technical and vocational education and training students in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, 10(1).
- Mahfud, T., Masek, A., Suyitno, S., Ihsan, A. N. N., Fransisca, Y., Pranoto, P. W., Pranoto, A., Hadi, S., & Susanto, A. (2024). The role of work-based learning in enhancing career adaptability: An empirical study from vocational students in Indonesian and Malaysian universities. *Integration of Education*, 28(3), 436–453.
- Malaysia, U. T. H. O., Sern, L. C., Baharom, N., Foong, L. M., Nadrah, W. M. W. H., Islamiah, R. D., & Ana, A. (2021). Integrating green skills into TVET curricula in polytechnics Malaysia. *Journal of Technical Education and Training*, 13(3).
- Noor, M. S. M., Mohamad, M., & Paimin, A. N. (2023). Implementation of skilled training programs at vocational college: A view of the instructors' perspectives. *Online Journal for TVET Practitioners*, 8(3).
- Pillai, S., Khan, M. H., Ibrahim, I. S., & Raphael, S. (2011). Enhancing employability through industrial training in the Malaysian context. *Higher Education*.
- Prastya, S., & Rofiq, Z. (2025). The dominant influence of internship, motivation, and facilities on vocational high school students' welding competency. *International Journal of Research and Innovation in Social Science*.
- Puad, M. H. M., Rahim, F. A. A., Omar, M. K., Kang, E. K. M. S., & Pyng, H. S. (2024). Probing the relationship between soft skills and career adaptability among vocational college graduates. *International Journal of Research and Innovation in Social Science*.
- Rahim, N. S. A., Jaafar, W. M. W., & Arsad, N. M. (2021). Career maturity and career decision-making self-efficacy as predictors of career adaptability among students in foundation program, Universiti Putra Malaysia. *Asian Journal of University Education*, 17(4).
- Ramli, S., Rasul, M. S., & Affandi, H. M. (2018). Sustainable development: Needs of green skills in the Fourth Industrial Revolution (4IR). *International Journal of Academic Research in Business and Social Sciences*, 8(9).

- Rasul, M. S., Rasul, M. S., & Mansor, A. N. (2013). Employability skills indicator as perceived by manufacturing employers. *Asian Social Science*, 9(8), 42-55
- RM, A. R., Nuhadi, D., & Yoto, Y. (2022). Implementation of work-based learning on welding engineering expertise competency in the manufacturing industry. *Journal of Vocational Education Studies*, 5(1).
- Schmid, E., & Haukedal, C. L. (2022). Identifying resilience-promoting factors in vocational education and training: A longitudinal qualitative study in Norway. *Empirical Research in Vocational Education and Training*.
- Snyder, S., & Septriana, D. (2017). Vocational welding excellence: Integration by adopting AWS Level I and II entry and intermediate-level welder curriculum guidelines and welding educator certification under the American Welding Society established programs. In *Proceedings of the International Conference on Teacher Training and Education 2017*.
- Sofian, M., Putra, A. Y. W., & Ikhsanudin, I. (2025). Analisis pencapaian kompetensi siswa pada mata pelajaran shielded metal arc welding di SMKN 2 Kota Serang. *STEAM Engineering*.
- Syamsuddin, A., & Prasetio, W. E. (2021). The implementation of the competence certification for professional welders at SMKN 2 Wonosari and SMKN 2 Pengasih. *Journal of Vocational Education Studies*.
- Theerasak, S.-N., & Khampirat, B. (2019). Comparing employability skills of technical and vocational education students of Thailand and Malaysia: A case study of international industrial work-integrated learning. *Journal of Technical Education and Training*.
- Wang, D. (2012). Ability to target the training of welding professionals. *Hunan Agricultural Machinery*.
- Wilson, C. V. S., Sern, L. C., & Razak, M. (2025). Readiness of green skill implementation among welding program students at public skill training center. *Online Journal for TVET Practitioners*.
- Yen, W. T. M., Yen, Y. Y., Choy, C. S., Nee, T. W., & Ming-Li, T. (2023). Perspectives of employers on graduate employability skills: A case of Malaysia. *Asian Development Policy Review*.
- Zahari, Z., & Omar, M. K. (2019). Relationship between career future concern, personal goal orientation, and perceived social support to career adaptability among Malaysian vocational college. *Universiti Putra Malaysia Institutional Repository*.