TVET and the Economic Competitiveness of Sarawak: The Role of the Mechanical Engineering Certificate Program in Developing a Skilled Workforce

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Abstract

Mechanical engineering plays a vital role in industrialisation through the design, analysis, manufacturing, and maintenance of mechanical systems. In response to technological advancement and the growing demand for skilled workers, Malaysia has prioritised Technical and Vocational Education and Training (TVET), particularly in Sarawak. The Post-COVID Development Strategy (PCDS) 2030 underscores the need for a skilled workforce to support key sectors such as oil and gas, manufacturing, and renewable energy. Despite this, the demand for mechanical engineering expertise in Sarawak remains low, leading to labour shortages and dependence on foreign workers. Existing TVET institutions are not fully aligned with emerging industrial technologies or workforce needs. This study explores the feasibility and demand for introducing a Certificate in Mechanical Engineering (CME) at Politeknik Mukah and its potential impact on workforce development, industry alignment, and economic growth. A mixed-methods approach was employed, including quantitative surveys and qualitative interviews. Participants included 234 secondary school students, 33 polytechnic lecturers, and 49 industry representatives. Additionally, in-depth interviews were conducted with six government stakeholders and industry experts. Findings reveal strong industry support, with 96.7% of surveyed companies endorsing the relevance of mechanical engineering training and over 70% of students expressing interest in the programme. Industry stakeholders highlighted the need for technicians skilled in maintenance, automation, and renewable energy. Employers agreed that a CME programme could address labour shortages, enhance productivity, and better align education with industrial needs. The study concludes that implementing a CME would strengthen Sarawak's skilled labour pool, reduce reliance on foreign workers, and support industrial development. It recommends harmonising TVET with industry demands to ensure long-term economic sustainability. Politeknik Mukah is well-positioned to offer the CME in alignment with future labour market requirements and the goals of PCDS 2030

Keywords: TVET, Skilled-workforce, Politeknik, CME, Sarawak 2030.

1.0 Introduction

Mechanical engineering is a crucial field in contemporary industrial advancement, involving essential components such as design, analysis, manufacturing, and maintenance of mechanical systems. The demand for highly skilled professionals in this field has constantly been increasing, driven by technological advances that require individuals with both theoretical knowledge and practical expertise (Pelz et al., 2021). Mechanical engineering

education contributes to national economic growth and enhances Malaysia's global competitiveness by developing a workforce capable of meeting the demands of rapidly evolving industries.

Malaysia has emphasised the significance of Technical and Vocational Education and Training (TVET) in driving national economic development, mainly through the Twelfth and Thirteenth Malaysia Plans. (Idrus, 2023). In the 2023 Budget presentation, the government recognised TVET as a key strategy for developing a highly skilled local workforce. In line with this vision, Sarawak's Post-COVID-19 Development Strategy 2030 (PCDS 2030) aims to expand its skilled workforce to meet the demands of its rapidly growing energy and technology industries. (Sinar Harian, 2022). To achieve this, the state government plans to increase TVET enrollment by at least 20% by 2025, with a long-term goal of producing 500,000 skilled workers by 2030 (Bernama, 2023), several initiatives have been introduced to support this objective, including strategic industry collaborations, the implementation of the Sarawak Workforce Information System (SWIS), and efforts to enhance scientific literacy among students.

This study examines the demand and necessity for a Certificate in Mechanical Engineering (CME) programme in Sarawak and assesses its potential implications should it be introduced. The primary objectives include identifying industry demand, evaluating workforce needs, and analysing the program's impact on local industries and employment opportunities. The scope of the study encompasses four key aspects: analysing post-secondary school students in Mukah as prospective enrollees, assessing graduate employability through interviews with industry representatives and government agencies, gathering expert insights on the future of mechanical engineering, and evaluating the readiness of educators to ensure the program meets both academic and industry standards.

The significance of this study lies in its ability to provide data-driven insights into program demand, ensuring its alignment with government strategic plans while offering micro-level input to the Department of Polytechnic and Community College Education (JPPKK) for curriculum development. Every new program introduced by Politeknik Malaysia must undergo a comprehensive needs assessment to uphold academic quality and national policy objectives. Ultimately, this research seeks to ensure that graduates of mechanical engineering programs acquire the knowledge, technical skills, and competencies necessary to contribute effectively to Malaysia's economic growth, particularly in Sarawak's evolving industrial landscape.

2.0 Literature Review

Sarawak plays a crucial role in developing a highly skilled workforce, particularly in the mechanical engineering sector, which is closely linked to oil and gas, manufacturing, and renewable energy industries. According to PCDS 2030, the state aims to increase its skilled labour force to 30–40% by 2030 (Dayak Daily, 2024), compared to the national target of 60% (Suara Sarawak, 2024). Currently, Sarawak has a workforce of 1.5 million and

intends to produce over 500,000 skilled workers by 2030 (Utusan Borneo, 2024a). This effort is essential to supporting the state's economic growth, which increasingly depends on high-tech industries, including the Sarawak Corridor of Renewable Energy (SCORE), a key driver of investment in the energy and manufacturing sectors.

In 2020, however, the State's economy is estimated to contract between 3.5% to 5.0% because of the Covid-19 pandemic (Sarawak Government., 2021). A 24.2% drop in the State's exports led to a less favourable job market. At the national scale, reports indicate that Malaysia's unemployment rate rose from 3.1% in 2019 to 4.3% in 2020 (Department of Statistics Malaysia, 2021). 723 local workers were laid off within a year, leaving them with no choice but to reskill or retool themselves to survive and sustain their livelihoods (Ashari & Farouk, 2023).

The National TVET Policy 2030 and the transformation of skilled labour play a critical role in Sarawak's economic planning. Statistics indicate that Malaysia lags in skilled labour development, with only 28% of the workforce classified as qualified, whereas developed nations require at least 50% (MASSA, 2021). The Sarawak state government has introduced various initiatives to enhance workforce skills, including strengthening TVET institutions and developing the Sarawak Workforce Information System (SWIS) to identify labour market gaps. (TVS, 2023a). The demand for skilled labour in mechanical engineering continues to rise, driven by substantial investments in the manufacturing sector, totalling RM8.07 billion from foreign investors and RM1.01 billion from local investors in 2024 (MIDA, 2024).

Sarawak must triple the enrolment rate in Technical and Vocational Education and Training (TVET) institutions to reduce dependence on foreign labour (TVS, 2023b). Premier Sarawak, Datuk Patinggi Tan Sri Abang Johari Tun Openg, has emphasised that prolonged reliance on foreign workers in critical sectors could negatively impact the state's economic growth and business sustainability. Referring to a 2014 study by Universiti Malaysia Sarawak (UNIMAS), he highlighted that by 2030, over one million new jobs are expected to be created in Sarawak, with more than 600,000 requiring skilled and semi-skilled workers. However, the current capacity of TVET institutions in Sarawak remains limited, resulting in insufficient skilled labour to meet industry demands.

Currently, Sarawak has 104 TVET institutions, comprising both public and private institutions, with a total training capacity of approximately 30,000 trainees (TVS, 2023b). Collectively, these institutions produce around 11,000 graduates annually across various skill-based disciplines. However, at this rate, Sarawak is projected to grow only 500,000 skilled workers by 2030, which falls significantly short of actual industry demands. To address this issue, the state government, through the Ministry of Education, Innovation, and Talent Development (MEITD), is actively expanding technical training centres to increase training capacity. Additionally, Sarawak is enhancing the quality of existing TVET programs to ensure alignment with evolving industry requirements. Efforts are also being made to boost the appeal of TVET

programs, encouraging both male and female students to enrol. These initiatives aim to ensure a sufficient supply of skilled labour to support Sarawak's sustainable economic growth while reducing dependency on foreign workers.

One of the key strategies outlined in PCDS 2030 is strengthening the workforce in the oil and gas industry, which remains a significant driver of Sarawak's economic growth. Major corporations such as Petronas, Shell, and Murphy Oil have invested in various exploration and processing projects for oil and natural gas. The LNG facility in Bintulu, one of the largest in the world, plays a crucial role in Malaysia's energy exports. Additionally, Sarawak is positioning itself as a green hydrogen hub, with exports expected to commence by 2027 (Agnes Tugong, 2024; Bernama, 2025). The global hydrogen market, projected to be valued at USD 189.19 billion by 2050, presents a strategic opportunity for Sarawak. Expected revenues will reach RM12.1 billion by 2030, and over 45,000 jobs will be created in the sector.

The manufacturing industry also plays a pivotal role in Sarawak's economic development, with the Sarawak Corridor of Renewable Energy (SCORE) as a key economic driver. Press Metal, the largest aluminium producer in Southeast Asia, has generated substantial employment opportunities in Mukah and Samalaju. Additionally, OM Materials operates ferrosilicon and manganese smelting plants in Samalaju Industrial Park, while X-FAB Sarawak has expanded the semiconductor industry, providing high-tech job opportunities. Manufacturing contributes 27.7% to Sarawak's GDP, with significant investments in infrastructure and skilled labour development (Utusan Borneo, 2024b).

Beyond energy and manufacturing, Sarawak is also prioritising infrastructure and logistics development to support the mechanical engineering sector. Privatised in 1993, Bintulu Port is a key logistics hub for LNG, palm oil, and timber exports. The expansion of port infrastructure has bolstered economic growth by enhancing the competitiveness of local products and attracting foreign investments (Utusan Borneo, 2024b). Sarawak Energy Berhad (SEB) continues to expand hydroelectric capacity through the Bakun and Murum dams in the renewable energy sector, supplying power to various large-scale industries.

Sarawak has introduced various education and training initiatives to ensure the availability of a highly skilled workforce. PCDS 2030 emphasises human capital development, encouraging students to pursue TVET programs, with a target to increase enrolment by at least 20% by 2025 (UKAS, 2024). The demand for skilled mechanical engineering professionals is expected to rise significantly, aligning with Sarawak's economic modernisation agenda prioritising green technology and renewable energy.

This study confirms that a Certificate in Mechanical Engineering (CME) is critical to supporting Sarawak's economic growth. With substantial energy, manufacturing, and logistics investments, the demand for skilled labour is higher than ever. Through implementing PCDS 2030 and the National With

the implementation of PCDS 2030 and the National TVET Policy 2030, Sarawak is poised to grow its skilled workforce and be a frontrunner in technology and innovation. Thus, Politeknik Mukah must play a leading role in creating an industry-relevant workforce, hence fostering the sustainable economic growth of the state.

3.0 Methodology

The present research adopted a mixed-methods design, integrating qualitative and quantitative research designs to assess the demand for the Certificate in Mechanical Engineering course in Politeknik Mukah. The rationale for utilising a mixed-methods design was to avoid some of the intrinsic limitations of using either the quantitative or the qualitative methods exclusively, as posited by Creswell and Plano (2017). Having both sources of information provides a more extensive and consistent analysis. It gathers statistical trends and synthesises in-depth industry expertise to examine the viability and efficacy of the proposed program.

3.1 Quantitative

This study utilised descriptive statistics to examine quantitative data collected via questionnaires and evaluate perceptions, readiness, and employability of the proposed Certificate in Mechanical Engineering programme. The questionnaire was adapted and modified without changing its original meaning from the Research, Innovation, and Commercialisation Unit of Politeknik Mukah and shared via Google Forms to guarantee content validity and instrument reliability. It consisted of several essential requirements respectively:

i. Demographic Information – This section captures respondent profiles such as age, gender, education level, and work experience.

ii. Lecturer Readiness – Assessing instructors' preparedness, teaching competencies, and curriculum acceptance.

iii. Industry Perception – Evaluating program relevance based on industry needs and graduate employability.

iv. Student Perception – Measuring student interest, understanding of mechanical engineering, and willingness to enrol in the program.

Mean scores were interpreted using Creswell and Plano's (2017) where the scale was 1.00–1.80 (Very Low), 1.81–2.60 (Low), 2.61–3.40 (Moderate), 3.41–4.20 (High), and 4.21–5.00 (Very High). This method facilitated a thorough comprehension of student preparedness for the program and the viewpoints of lecturers and industry experts for curriculum efficacy. A purposive sample strategy was employed to guarantee data relevance, identifying three principal respondent groups.

Data collection from 49 various scales of industry covered multiple regions in Sarawak, including Miri (11 companies), Bintulu (23 companies), and Kuching (1 company), to provide a comprehensive employability assessment.

The data was acquired through Mechanical Engineering students who underwent industrial practical training in Session 2 2023/2024. Additionally, Krejcie and Morgan's (1970) of sampling method was used to ensure adequate sample size, determining that out of 587 Form 5 students from all 3 high schools available in Mukah district (Kementerian Pendidikan Malaysia, 2025), a sample of 234 respondents was required for statistical significance. The questionnaire was distributed online and in physical format to maximise response rates. Quantitative data was analysed using the Statistical Package for the Social Sciences (SPSS), with descriptive analysis applied to derive mean values, standard deviations, and percentages for each survey item.

Overall, the methodology was meticulously designed to ensure the validity and applicability of findings, providing a comprehensive assessment of student readiness, industry demand, and the challenges in developing a skilled mechanical engineering workforce. Integrating quantitative and qualitative approaches strengthens the study's ability to inform the establishment of the Certificate in Mechanical Engineering program at Politeknik Mukah.

3.2 Qualitative

The qualitative part of this study consisted of interviews with six professionals from leading organisations in Sarawak, including Press Metal, Samalaju Industrial Port, and XFAB Sarawak. These interviews sought to gain information on industry needs for mechanical engineering graduates and assess the relevance and applicability of the proposed Certificate in Mechanical Engineering programme. One of the key stakeholders, the resident of Mukah Division, was also interviewed to obtain input from the local government regarding the economic effects of the project that might arise.

Content analysis was used to examine the long-structured interviews. The audio recordings were transcribed verbatim into text with the help of technological tools so that salient themes could be determined and categorised considering research objectives. These interviews gave comprehensive details regarding mechanical engineering competencies, local workforce issues, and the industry's expectations of polytechnic graduates. Then, qualitative findings were compared to quantitative data to estimate the demand and fit of the proposed program.

For the qualitative study, a focus group interview approach was employed. A total of six industry experts from institutions across Sarawak, who also serve as Industry Panel members for the Department of Mechanical Engineering at Politeknik Mukah, were selected as interview respondents. Additionally, one key district stakeholder, the Resident of Mukah Division, was included in the study to provide insights from a local governance perspective. The number of interview respondents was selected based on (Chen & Chua, 2024) suggestion, which states that in qualitative research involving populations with the same demographic data, a sample size as small as five subjects is acceptable. Meanwhile, Creswell (2017) states that the ideal number of qualitative respondents is three to ten people depending on the depth of the

study. Table 1 show a list of qualitative respondents.

Table 1: Qualitative respondents.

Interviewee	Post	Company's name
1	Maintenance Technician	Press Metal Sarawak Sdn. Bhd. Mukah
2	Associate Engineer 2	Press Metal Bintulu Sdn. Bhd
3	Supervisor Heavy Handling Equipment Maintenance	Samalaju Bintulu Port Sdn Bhd
4	Supervisor Conveyor Heavy Equipment Maintenance	Samalaju Industrial Port Sdn Bhd
5	Associate Staff Engineer	XFAB Sarawak Sdn Bhd
6	Mechanical Technician	Ting's Band Saw Service

4.0 Results and Discussion

This study contains two results namely quantitative analysis through surveys and qualitative analysis through interviews with stakeholders such as lecturers, industry, students, and local authorities. The main objective of this study is to assess the readiness and employability of the CME program at Mukah Polytechnic based on current industry needs and student interests.

4.1 Demography Outline

A quantitative study for starters consisting of 33 lecturers, with 54.5% having graduated in General Mechanical Engineering, makes it the most common field in this group. As much as 24.2% of the lecturers had degrees in the field of Manufacturing. Meanwhile, 9.1% have qualifications in Mechatronics and another 9.1% fall into the other category, which might cover various other fields that are not specifically mentioned. Finally, only 3% of the lecturers have a qualification in the field of Materials, making them the most common in that group. Industry is the second category of respondents involved in this quantitative study.

This study has involved 61 industries, but only 49 have provided feedback from the survey form as illustrated in Table 2. Referring to Table 3, it was found that most of the industry types 41 which has responded is the industry in Services and Maintenance, namely as much as 42.6%. Followed by the general industry (Mechanical/electronic/semi-insulation) at 24.6%, Manufacturing at 21.3% and Utilities and Power Supply at 8.2%. High school students are the third category of respondents involved in this study. Overall, this study involved 203 students who had returned the questionnaire form. The survey results indicated that there are 77 male pupils and 126 female students. Data from the school indicates that pupils from SMK Three Rivers comprise the largest proportion at 40.4%, followed by SMK St Patrick at 63% and SMK Mukah at 58%.

Table 2: List of companies by district.

District	Number of companies
Miri	11
Baram	1
Bintulu	23
Sibu	4
Sarikei	2
Mukah	4
Sri Aman	2
Kota Samarahan	1
Kuching	1
Total	49

Table 3: Industry response sector.

District	Percentage, %
Manufacturing	21.3
Service & Maintenance	42.6
Mechanical Contractor	1.6
Utility & Power Supply	8.2
Mechanical Industry / Electronics / Semiconductor	24.6
Others	1.6
Total	100

4.2 Quantitative

The study findings on lecturer readiness for implementing this program indicate that most respondents agreed on the continued relevance of the program within the context of Industry 4.0. Additionally, most (81.8%) of lecturers reported having sufficient knowledge and skills to teach in the program. Instructors' knowledge, skills, and attitudes serve as primary predictors of competency, influencing the effectiveness of technical education, student success, and workforce preparedness. By reinforcing these three dimensions through structured training, industry collaboration, and policy support, it can ensure that its TVET sector remains competitive, sustainable, and aligned with national economic goals (Omar et al., 2020).

Further analysis in Table 4 revealed high overall perceptions of the program's suitability and graduate employability, with an average mean score of 4.52. Among the highest-rated competencies was the ability to diagnose and repair mechanical system failures, particularly in mechanical machinery and electrical-electronic equipment, which received the highest mean score of 4.70. This underscores the critical importance of these technical skills in mechanical engineering. Graduate employability is increasingly influenced by structural determinants, particularly the extent and effectiveness of institution-industry collaborations. As industries demand graduates with both technical expertise and workplace competencies, education institutions must align their curricula, training methodologies, and industry engagement

strategies to enhance employment outcomes (Aliu & Aigbavboa, 2020).

Table 4: Instructor perceptions toward the CME program.

Item	Percentage, %	
	Yes	No
I have the knowledge to teach in this program.	78.8	21.2
I have the skills to teach in this program.	81.8	18.2
I am ready to teach in this new program.	72.7	33.3
This program remains relevant in the context of Industry 4.0.	75.8	24.2

The industry's perception of the proposed program is highly favourable. All participating companies concurred that the program is well-suited for implementation at Politeknik Mukah, with 96.7% affirming that its graduates possess the potential for employment within their organisations. The mean score of 4.75 indicates that technical competencies, particularly in machine maintenance and repair, are critical industry requirements. Overall, the high mean score of 4.47 suggests that industry stakeholders recognise this program as a strategic initiative to develop a highly skilled workforce that is well-equipped to meet labour market demands. To secure the future of work, institutions must align student goals with industry needs through dynamic, industry-integrated programs such as industrial training support, academic advisors, etc. This approach ensures that graduates are workforce-ready, industries thrive with skilled professionals, and higher education institutions remain central to economic and social development (Singh & Blessinger, 2024).

Industry respondents in Table 5 generally indicated that a certificate-level program could substantially contribute to industry players in Sarawak's economic sector by ensuring a consistent supply of skilled workers who align with industry demands, enhance productivity, and support economic sustainability. Given Sarawak's economic structure—heavily reliant on oil and gas, manufacturing, construction, and logistics, a certificate-level TVET program is critical in bridging the gap between education and industry requirements (Iqbal, 2021). Reducing skills gaps is essential for enhancing workforce competitiveness and driving economic growth in an era of rapid technological advancement (Jamaludin et al., 2023). By enhancing the educational offerings in TVET, governments may not only close the divide between education and employment but also mitigate youth unemployment and cultivate a resilient, future-ready workforce.

Table 5: Industry perceptions toward CME program.

Item	Mean	Standard Deviation
Ability to detect malfunctions in mechanical machinery	4.75	0.60
Ability to repair electrical and electronic equipment	4.70	0.74
Ability to perform maintenance on mechanical machinery	4.66	0.70
Capability to work effectively in a team	4.72	0.58

Among secondary school students surveyed, illustrated in Table 6, a majority (81.3%) expressed interest in a learning approach that integrates theoretical and practical components. Additionally, 71.9% of students reported a specific interest in mechanical engineering, while 90.1% believed the program remains relevant to Industry 4.0 requirements. The mean score of 4.10 further indicates that most students recognise the importance of acquiring mechanical engineering knowledge to enhance their competitiveness in the job market (Broo et al., 2022). This is positive feedback enabling them to look into the future to integrate seamlessly into industry roles, adapt to evolving technologies, and advance in their careers. Although some students acknowledged a lack of prior information about the program, overall career interest in the field remains high to pursue further studies at the polytechnic level, recording the highest mean score of 4.36.

Table 6: High school student perceptions toward the CME program.

Item	Percentage, %	
	Yes	No
Interest in both theoretical and practical learning	81.3	18.7
Interest in the field of Mechanical Engineering	74.9	25.1
The program remains relevant in the context of Industry 4.0	90.1	9.9

4.3 Quantitative.

This study's qualitative findings were derived from interviews with industry experts and local government officials to collect their thoughts on providing CME at Politeknik Mukah. This investigation offers an enhanced comprehension of industry requirements, job prospects, and the program's significance to the economic advancement of Mukah and vicinity. All interviews started by asking about their acknowledgement and purpose for the existence of Politeknik Malaysia, particularly Politeknik Mukah. Generally, they all recognise the role of Politeknik Mukah as one of the top TVET institutions, with a consensus answer.

4.3.1 Relevance of CEM in the industry

Discussions with industry specialists indicated that Mukah's industrial sector, especially in aluminium, electrical and electronics, and shipbuilding, exhibits a significant demand for proficient mechanical engineering professionals. Industry participants underscored that the demand for skilled labour transcends technical domains such as machine maintenance and repair, energy management, automotive engineering, and electrical and electronics technology. The authors emphasised the program's ability to generate highly qualified individuals who address the needs of both regional and local industries (Laundon et al., 2023).

Experts agreed that a CME is essential in addressing the lack of skilled workers in Sarawak's significant industries by producing professionals ready to provide instant contributions to industries facing labour shortages. This approach reduces the reliance on imported labour and gives businesses a steady supply of qualified technical personnel needed to sustain operations and drive growth. Industries within Sarawak that might directly benefit from

graduates holding certificates are:

i. Oil and Gas – technicians specialise in equipment maintenance, welding, and pipeline servicing.

ii. Manufacturing – requires machine operations, CNC machining, and industrial maintenance expertise.

iii. Construction – graduates are needed for mechanical installations, HVAC servicing, and heavy machinery maintenance.

iv. Logistics and transportation – technical roles involve vehicle maintenance, material handling, and workshop support.

4.3.2 Industrial Growth (Mukah) and Its Connection to CME

Industry representatives also noted that Mukah and its surrounding areas are experiencing rapid industrial growth, particularly in the manufacturing and maintenance sectors (Letchumanan et al., 2023). However, they acknowledged that the current skilled workforce in mechanical engineering remains insufficient to meet sectoral demands. Therefore, they firmly believe that introducing this program at Politeknik Mukah will catalyse the development of a skilled workforce in the region.

In addition to industry viewpoints, interviews with Mukah Division District Office members offered more insights into the necessity for workforce development within the region's economic and infrastructure framework. Mukah possesses a robust infrastructure encompassing road networks, telecommunications, and educational institutions, rendering it an optimal site for executing this initiative. The area has enormous economic potential in numerous industries, such as oil and gas and aquaculture (Jenol et al., 2024; Samdin & Kamaruddin, 2019), palm oil and sago production (Ukaejiofo, 2020) and manufacturing.

The District Office officials emphasised the importance of aligning the education programme with Sarawak's economic development program, particularly the PCDS 2030, which specifies the need for a highly skilled labour force in the manufacturing and technology industries. It plays a critical role in advancing industrial growth and infrastructure development by providing a continuous supply of skilled technicians to address the growing needs of critical industries, especially energy, construction, and heavy industry. These sectors necessitate a constant influx of technically skilled personnel to implement expansion initiatives, construct new facilities, and effectively expand industrial zones.

The local authorities also pointed out that Mukah could capitalise on its strategic link with Bintulu, one of the major industrial centres in Sarawak, to promote human resource development. Technical courses can be provided through institutions like Politeknik Mukah, enabling more locals to be trained and consequently driving economic development in Central Sarawak. Both the local authorities and the Sarawak state government view the promotion of

TVET as a strategic goal to guarantee long-term economic competitiveness. Hence, expanding training capacity, enhancing program quality, and promoting student intake in TVET are essential steps towards meeting the 2030 skilled labour force goal (TVS, 2023b).

4.3.3 Industry Endorsement and Support for CME

By equipping graduates with practical, industry-relevant skills, the certificate program ensures that Sarawak's industrial sectors remain competitive, resilient, and less dependent on external labour sources, ultimately supporting long-term economic sustainability. Furthermore, most industry representatives expressed their willingness to collaborate with Politeknik Mukah in key areas, such as:

i. Providing industrial training for students.

ii. Facilitating industrial attachments for lecturers.

iii. Offering employment opportunities for graduates.

They emphasised that industrial training is essential in ensuring that graduates are fully prepared for the workforce and can adapt to industry requirements (Hora, 2019). The programme enhances industrial productivity by producing skilled technicians with practical, hands-on expertise who can be rapidly deployed into the workforce. Unlike degree holders, who often require extended training, certificate graduates are immediately employable in roles that demand technical precision, routine maintenance, and hands-on troubleshooting. Their ability to perform essential tasks efficiently ensures minimal downtime, reduced operational costs, and improved overall efficiency, allowing businesses to operate smoothly and maintain high productivity levels. This direct impact on workforce readiness and operational efficiency significantly contributes to Sarawak's economic growth by ensuring industries remain competitive, cost-effective, and sustainable.

The program also promotes industry-specific training and strengthens TVET-industry collaboration by ensuring that training programs meet industry needs. Through strong partnerships with industry players, TVET institutions can develop specialised learning pathways that enhance workforce readiness and align graduates with actual job market demands. This collaboration facilitates:

i. Apprenticeship-based learning, where students gain real-world industry experience before entering the workforce.

ii. Company-sponsored certifications, where graduates receive specialised training tailored to employer requirements, increasing employability.

iii. Work-based training modules ensure that TVET curricula align with industry expectations, preparing graduates for immediate workforce integration.

By embedding industry-driven training models within certificate-level programs, graduates are not only trained but also trained for real industry needs, making TVET a sustainable and dynamic support system for Sarawak's economic growth. This approach ensures that TVET remains relevant, responsive, and integral to developing a highly skilled and competitive workforce, ultimately reinforcing the state's economic resilience.

4.3.4 Career Prospects Development for CME Graduates

The local district Resident and industry representatives strongly agree that the Certificate programme will add value to enhance Sarawak's TVET ecosystem by creating a systematic and sustainable workforce development strategy that aligns with industry requirements. A strong certificate-level TVET sector guarantees a steady supply of trained technicians, allowing industries to sustain productivity, minimise skills mismatches, and improve economic stability. Ongoing governmental backing enables such programs to establish TVET as a principal provider of skilled labour, granting local industries access to proficient, job-ready personnel while diminishing reliance on external workforce sources. By cultivating a TVET system that is sensitive to industry needs and future-oriented, Sarawak can maintain economic resilience, facilitate industrial growth, and create enduring employment opportunities, contributing to a robust and self-sustaining economy.

Additionally, it will become a platform to offer a pragmatic solution for Sarawak's industries by cultivating a workforce of proficient specialists ready for immediate deployment to satisfy industrial requirements. This program markedly diminishes reliance on foreign labour and improves productivity and efficiency across various sectors. Aligning TVET training with actual job requirements equips graduates with essential skills to enhance Sarawak's industrial sustainability. The expansion of the industrial sector necessitates a certificate-level workforce, which underpins long-term economic stability and ensures the relevance and efficacy of the TVET system.

The CME program has the potential to considerably boost workforce skills and strengthen Sarawak's economic competitiveness through robust collaboration among educational institutions, industries, and local government (Watters et al., 2016). A meticulously designed certificate program yields job-ready graduates capable of promptly contributing to significant projects, alleviating labour shortages that may hinder industrial progress. By imparting fundamental mechanical skills to local people, firms can achieve sustainable expansion without overdependence on foreign labour, fortifying Sarawak's industrial ecosystem and assuring enduring economic resilience. Consequently, local officials assert that the CME is significantly pertinent and vital for bolstering critical industrial sectors and facilitating sustainable economic development in Sarawak.

4.3.5 Industry Readiness and Willingness to Employ CME Graduates

From an employability perspective, industry representatives agreed that the CME program graduates have strong career prospects. Most companies affirmed that certificate holders are qualified for entry-level technician roles, with opportunities for career progression to senior technician or technical

supervisor positions. Additionally, they emphasised that work experience and additional certifications, such as Wireman Certification, Chargeman License, and Energy Efficiency Accreditation, would significantly enhance graduate employability at higher levels (Broo et al., 2022).

The CME programme is vital in strengthening the local and state employment market and reducing unemployment by providing practical, industry-relevant skills to individuals who do not pursue higher academic pathways but require technical expertise. By equipping local and national with the necessary competencies, industries can hire homegrown talent, reducing dependency on foreign labour and lowering the costs of recruiting foreign workers. This, in turn, leads to higher income levels, improved job stability, and increased economic circulation within the state as more wages remain within the local economy. The continuous presence of proficient local labour guarantees Sarawak's industries stay competitive and autonomous, fostering enduring economic sustainability and expansion.

5.0 Conclusion.

This study highlights the importance of a Certificate in Mechanical Engineering in mitigating Sarawak's skilled labour deficit and facilitating its industrial and economic growth. Robust backing from industry stakeholders, educators, and students underscores the program's significance and imperative, especially in the context of Industry 4.0 and PCDS 2030. The quantitative investigation verifies a substantial demand for mechanical engineering graduates, with industry representatives emphatically supporting their employability. Simultaneously, qualitative findings underscore pressing worker demands in the oil and gas, industrial, construction, and logistics sectors. Sarawak's swift industrialisation—especially in renewable energy, innovative manufacturing, and infrastructure development—has increased the demand for proficient mechanical experts, yet the state continues to rely heavily on foreign labour.

A certificate-level TVET program is a strategic intervention, ensuring a steady supply of competent, job-ready graduates who directly integrate into the workforce. This program enhances productivity, strengthens economic sustainability, and reduces labour dependency by aligning training with real-world industry demands. Additionally, TVET-industry collaboration is essential for the program’s long-term success, with industry representatives committed to internship placements, faculty-industry attachments, and direct graduate employment. Local authorities and policymakers also recognise TVET expansion as a strategic priority, necessitating increased training capacity, quality enhancement, and student participation to meet the 2030 skilled workforce target.

Given Mukah’s industrial linkage with Bintulu, implementing this program at Politeknik Mukah would enhance workforce resilience, reduce unemployment, and support industrial diversification, ensuring Sarawak’s long-term competitiveness in the global economy. As Sarawak advances as a regional hub for energy, manufacturing, and logistics, this program will play

a pivotal role in sustainable economic development, reinforcing Sarawak's vision for a technologically advanced, self-sustaining economy while ensuring industrial growth and workforce stability.

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Conflicts Of Interest
The manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the review, agree with its Submission and declare no conflict of interest in the manuscript.

References
Agnes Tugong. (2024, February 26). *Sarawak eksport hidrogen pada 2027*. Utusan Borneo Online. https://www.utusanborneo.com.my/2024/02/26/sarawak-eksport-hidrogen-pada-2027

Aliu, J., & Aigbavboa, C. O. (2020). Structural determinants of graduate employability: Impact of university and industry collaborations. *Journal of Engineering, Design and Technology, 19*(5), 1080–1100. https://doi.org/10.1108/JEDT-05-2020-0189

Bernama. (2023, December 11). Sarawak bantu usaha kerajaan persekutuan lahir modal insan kemahiran tinggi - Abang Johari. *Astro Awani.* https://www.astroawani.com/berita-malaysia/sarawak-bantu-usaha-kerajaan-persekutuan-lahir-modal-insan-kemahiran-tinggi-abang-johari-449668

Bernama. (2025, February 20). Kerajaan Persekutuan sokong aspirasi Sarawak jadi hab pengeluaran hidrogen. *BERNAMA.* https://www.bernama.com/bm/news

Broo, D. G., Kaynak, O., & Sait, S. M. (2022). Rethinking engineering education at the age of industry 5.0. *Journal of Industrial Information Integration, 25*, 100311. https://doi.org/10.1016/j.jii.2021.100311

Chen, X., & Chua, A. Y. K. (2024). From attraction to monetization: How do knowledge influencers trigger users' willingness to subscribe to knowledge products? *Internet Research.* https://doi.org/10.1108/INTR-11-2022-0992

Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3rd ed.). Sage Publications.

Dayak Daily. (2024, July 9). 40 peratus tenaga kerja mahir menjelang 2030 – Sagah. *DayakDaily.* https://dayakdaily.com/40-peratus-tenaga-kerja-mahir-menjelang-2030-sagah/

Department of Statistics Malaysia. (2021). *ownCloud: DOSM.* https://cloud.stats.gov.my/index.php/s/3obZZmkofDYnyAZ#pdfviewer

Hora, M. T. (2019). *Beyond the skills gap: Preparing college students for life and work.* Harvard Education Press.

Idrus, Z. (2023, January 26). TVET agenda utama Kerajaan Perpaduan - AUTeM. *Astro Awani.* https://www.astroawani.com/berita-malaysia/tvet-agenda-utama-kerajaan-perpaduan-autem-403661

Iqbal, K. (2021). Managing the skill gap through better education, TVET and training strategies. In *Education, health, poverty and social inclusiveness* (Vol. 88, pp. 1).

Jamaludin, R. B., Hamid, A. H. A., & Alias, B. S. (2023). Empowering technical and vocational education and training (TVET). *International Journal of Academic Research in Business and Social Sciences, 13*(12), 3072–3080. http://dx.doi.org/10.6007/IJARBSS/v13-i12/20159

Jenol, M. A., et al. (2024). Feasibility of agricultural biomass in Southeast Asia for enzymes production. *Renewable and Sustainable Energy Reviews, 200*, 114601. https://doi.org/10.1016/j.rser.2024.114601

Kementerian Pendidikan Malaysia. (2025). *Risalah maklumat asas pendidikan KPM.* https://emisonline.moe.gov.my/risalahmap/

Laundon, M., McDonald, P., & Greentree, J. (2023). How education and training systems can support a digitally-enabled workforce for the manufacturing industry of the future: An exploratory study. *Education + Training, 65*(6/7), 909–922. https://doi.org/10.1108/ET-04-2023-0158

Letchumanan, S., et al. (2023). Characterisation of minerals and other properties of Mukah coal. *Journal of Advanced Mechanical Engineering Applications, 4*(1), 1–11.

https://penerbit.uthm.edu.my/ojs/index.php/jamea/article/view/9038

MASSA. (2021, September 26). Malaysia hanya ada 28 peratus pekerja mahir. *Majoriti.* https://majoriti.com.my/berita/2021/09/26/malaysia-hanya-ada-28-peratus-pekerja-mahir

MIDA. (2024, December 16). *Kenyataan media archives.* Malaysian Investment Development Authority. https://www.mida.gov.my/ms/announcement-media-release/announcement-media-release-ms/

Morgan, K. (1970). Sample size determination using Krejcie and Morgan table. *Kenya Projects Organization (KENPRO), 38*, 607–610. https://doi.org/10.13140/RG.2.2.11445.19687

Omar, M. K., Zahar, F. N., & Rashid, A. M. (2020). Knowledge, skills, and attitudes as predictors in determining teachers' competency in Malaysian TVET institutions. *Universal Journal of Educational Research, 8*(3), 95–104. https://doi.org/10.13189/ujer.2020.081612

Pelz, P. F., et al. (2021). *Mastering uncertainty in mechanical engineering.* https://library.oapen.org/bitstream/handle/20.500.12657/50950/1/978-3-030-78354-9.pdf

Samdin, Z., & Kamaruddin, N. (2019). The future of lignocellulose in Malaysian bioeconomy. In *Lignocellulose for future bioeconomy* (pp. 301–313). https://doi.org/10.1016/B978-0-12-816354-2.00016-5

Sarawak Government. (2021). *ownCloud: DOSM.* https://cloud.stats.gov.my/index.php/s/3obZZmkofDYnyAZ#pdfviewer

Sinar Harian. (2022, February 7). Sarawak lancar pelan tindakan Strategi Pembangunan Pasca Covid-19 2030. *Sinar Harian.* https://www.sinarharian.com.my/article/186723/edisi/sarawak-lancar-pelan-tindakan-strategi-pembangunan-pasca-covid-19-2030

Singh, A., & Blessinger, P. (2024). The new future and the employment imperative: Effectively aligning student interest, industry needs and university programmes. *Journal of Applied Research in Higher Education, 16*(2), 469–482. https://doi.org/10.1108/JARHE-09-2022-0285

Suara Sarawak. (2024, July 10). Sarawak mahu lahirkan 30 peratus pekerja berkemahiran tinggi. *Suara Sarawak.* https://suarasarawak.my/sarawak-mahu-lahirkan-30-peratus-pekerja-berkemahiran-tinggi/

TVS. (2023a, March 4). SWIS, lindungi hak pekerja di Sarawak. *TVS.* https://www.tvsarawak.my/2023/03/14/swis-lindungi-hak-pekerja-di-sarawak/

TVS. (2023b, December 11). Sarawak perkasa pembangunan modal insan TVET. *TVS.* https://www.tvsarawak.my/2023/12/11/sarawak-perkasa-pembangunan-modal-insan-tvet/

Ukaejiofo, R. U. (2020). Examining climate adaptation policies and strategies in agricultural livelihoods in Serawak, Malaysian Borneo. *International Journal of Global Warming.* https://doi.org/10.1504/IJGW.2024.135988

UKAS. (2024, June 21). *Berita - Laman web Jabatan Premier Sarawak.* https://premierdept.sarawak.gov.my/web/subpage/news_view/2932/UKAS

Utusan Borneo. (2024a, March 20). Kerajaan Sarawak sasar miliki 500,000 pekerja mahir. *Utusan Borneo Online.* https://www.utusanborneo.com.my/2024/03/20/kerajaan-sarawak-sasar-miliki-500000-pekerja-mahir

Utusan Borneo. (2024b, May 15). Sarawak rekodkan RM22.8 bilion nilai pelaburan diluluskan dalam sektor utama, perkhidmatan dan pembuatan pada 2023. *Utusan Borneo Online.* https://www.utusanborneo.com.my/2024/05/15/sarawak-rekodkan-rm228-bilion-nilai-pelaburan-diluluskan-dalam-sektor-utama-perkhidmatan

Watters, J., Pillay, H., & Flynn, M. (2016). Industry-school partnerships: A strategy to enhance education and training opportunities. *(Add publisher if available)*