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Analysis of the Skills Gap between Engineering Graduates and the Needs of the Manufacturing Industry in Melaka

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ABSTRACT

The manufacturing sector in Melaka is undergoing a rapid transformation toward Industry 4.0, yet its success is hindered by a significant skills gap between engineering graduates and industrial requirements. This study aims to analyze the dimensions of the skills gap, the impact of Skill-Biased Technological Change (SBTC) as a driver of job polarization, and structural issues such as the "Poor Engineer" phenomenon in Melaka. Using a systematic literature review and secondary data analysis from the Department of Statistics Malaysia (DOSM) and industrial reports, the study finds that the most critical gaps exist in digital communication, complex problem-solving, and data/AI literacy. The analysis reveals that the "Poor Engineer" phenomenon, where 35% of graduates receive salaries below RM 2,000, is driven by a misalignment between graduate competencies and the high standards of Industry 4.0, leading to a skill-related underemployment rate of 32.2%. Although Universiti Teknikal Malaysia Melaka (UTeM) records a high employability rate (96.4%), the quality of job placement is still dominated by technician-level positions, indicating that employability does not necessarily reflect a successful skill-match. This research recommends aligning curricula through Teaching Factory models, enhancing digital literacy, and urging a government review of minimum wage structures for technical graduates to retain talent and ensure national technological sovereignty.

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INTRODUCTION

The manufacturing sector in Malaysia has undergone a significant structural transformation from a labor-intensive model to a technology-driven industry fueled by high innovation. The state of Melaka recorded manufacturing sector growth of 3.8 percent in 2024, strongly supported by the electrical, electronic, and optical products subsectors. This surge in the electronic subsector creates an urgent demand for highly skilled engineers capable of managing automated production lines and complex systems integration. However, there is deep concern about the mismatch between the skills possessed by graduates and the real expectations of employers in the field (Kadir et al., 2020; Noor et al., 2024). While previous studies focus on general unemployment, a clear research gap exists in understanding how localized job polarization specifically affects technical graduates in Melaka. Therefore, this study aims to map these dynamics within the context of a rapidly growing regional manufacturing industry (Jamala et al., 2024; Salahuddin et al., 2023).

Universiti Teknikal Malaysia Melaka stands as a pioneer in engineering education, adopting practice-oriented learning methods. As the first public technical education institution in the state, UTeM plays a key role in supplying a skilled workforce to the surrounding industrial areas. Despite its pioneering status, UTeM faces significant operational challenges in ensuring its curriculum keeps pace with the rapid innovation cycles found in the Ayer Keroh industrial zone. This challenge is more evident as industrial technology often evolves much faster than the academic renewal cycle at university. This situation calls for more intensive and sustained dialogue between academics and industry leaders to ensure education investments translate into tangible economic productivity (Bermejo et al., 2021; Shah & Gillen, 2023). Agile curriculum adjustment mechanisms are needed so that graduates possess not only a degree but also relevant technical competencies (Chew et al., 2021; Pauzi & Isa, 2025).

The skills gap is defined as the discrepancy between graduate competencies and the specific skills required for optimal job performance. This problem covers a broad spectrum, ranging from basic technical skills to complex problem-solving in dynamic, real-world work environments. In Malaysia, statistics show that one in four graduates remain unemployed after six months, often due to a lack of soft skills like critical thinking (Salahuddin et al., 2023). This descriptive issue is directly linked to the research focus on how specific industrial needs in Melaka's global supply chain necessitate high digital navigation abilities. The inability of graduates to adapt to modern industrial tools further widens the gap between the world of education and the world of work. Sharpening functional skill aspects is the primary key to resolving this issue of educated unemployment (Tee et al., 2024; Yen et al., 2023).

The emergence of the Fourth Industrial Revolution (IR 4.0) has drastically increased skill requirements through the integration of AI, IoT, and robotics. Today's engineering graduates must not only master basic mechanical science but also possess data literacy and the ability to manage cyber-physical systems. This transformation has created a paradox where demand for skilled labor is high, yet many engineering graduates remain unemployed because their skills are considered obsolete. Manufacturing companies in Melaka are now looking for individuals who can bridge the gap between traditional hardware and intelligent software. Integrating future technologies into the university curriculum is no longer an option but a strategic necessity to maintain Melaka's appeal as a high-tech investment destination (Seng et al., 2025; Widyakusuma & Hakim, 2024). Failure in this adaptation will cause local graduates to lose out to a more digitally ready foreign workforce.

As the primary theoretical foundation, Human Capital Theory views education as an investment that increases individual productivity and future income. According to Gary Becker (1993), investment in skills through formal education should provide significant economic returns for both the individual and the state. In Melaka, this theory suggests that strengthening education at UTeM should directly increase regional manufacturing efficiency and graduate welfare. However, the failure to achieve optimal labor absorption indicates a "leak" in human capital accumulation where the mismatch results in low returns on

investment. If the competencies produced are not marketable, the economic value of the engineering degree will continue to degrade. This analysis emphasizes the need for synchronization between education investment and the real needs of the labor market (M. et al., 2024).

The second theory utilized is Skill-Biased Technological Change (SBTC), which explains that technological advances increase demand for skilled labor while replacing routine tasks. In Melaka, this theory is used to dissect the phenomenon of job polarization, where traditional machine operators are replaced by intelligent systems, effectively marginalizing graduates who only master conventional skills. New technology acts as a complement for experts but becomes a substitution threat for those with low or irrelevant skills. Alignment between the curriculum and global technology trends is key to avoiding the negative effects of this economic polarization (Rodzalan et al., 2022; Widyakusuma & Hakim, 2024). Without proper educational intervention, technological progress will instead widen the social gap among engineering graduates. Therefore, understanding the direction of technological change is crucial for human resource development.

The third theoretical basis is Social Cognitive Career Theory (SCCT), which explores how self-efficacy and outcome expectations influence career success. At Universiti Teknikal Malaysia Melaka, students' self-efficacy is built through factory-like laboratory facilities (Teaching Factory) and guidance from industry mentors. However, external barriers such as negative perceptions of challenging work environments can reduce motivation to pursue an engineering career. Understanding these psychological dynamics helps institutions design better interventions to strengthen students' career commitment from an early stage (Adebusuyi et al., 2021; Gupta et al., 2024). Students' confidence in operating advanced technology is heavily influenced by their exposure to such tools during their studies. Thus, SCCT provides an important perspective on the significance of environmental support in shaping graduate work readiness (Lent et al., 2017).

Beyond technical challenges, the “Poor Engineer” phenomenon is a crucial factor that must be included in the skills gap discussion. Data shows that approximately 35 percent of young engineers in Malaysia earn less than RM 2,000 per month, a figure nearly equivalent to the minimum wage. This stagnant wage structure is directly linked to the risk of “brain drain,” where the best talent chooses to leave the local industry for higher salaries in neighboring countries. This condition threatens national technological sovereignty because Malaysia loses its most valuable human assets after funding their education. Improving skills without improving the wage structure will only result in an exodus of skilled workers abroad. Therefore, this issue is not just about competence, but also about the economic valuation of the engineering profession (Fadinger & Mayr, 2014).

Skill mismatches also include non-technical aspects or soft skills highly valued by employers in the manufacturing sector. Areas such as English communication, teamwork, and work discipline are often cited as major weaknesses by HR managers. In a fast-paced and globalized manufacturing environment, failure to communicate technical instructions can be fatal on the production line. Additionally, leadership skills are required for engineers to manage operators and resources efficiently. The integration of character development and communication skills must be an integral part of a holistic engineering curriculum and should not be ignored. Graduates who are technically brilliant but communicatively weak will find it difficult to advance within modern organizational structures (Saleh & Wahab, 2024; Yen et al., 2023).

The importance of close collaboration between stakeholders is emphasized through the Triple Helix Model model, involving universities, industry, and the government as facilitators. UTeM’s Smart Manufacturing Technology Centre (SMTC) serves as a bridge to connect academic research results with practical industrial applications. However, the effectiveness of this collaboration depends on industry openness to sharing data and providing quality internship programs. Internships must not be mere formalities but should provide real technical responsibilities to students. The government also needs to provide incentives for companies actively involved in curriculum development and student training.

Strong synergy will create a mutually beneficial innovation ecosystem for all parties involved (Hailu, 2024; Zhuang & Zhou, 2022).

A review of graduate unemployment statistics in Malaysia reveals a complex picture where the overall unemployment rate may seem low, but the underemployment rate remains high. This vertical mismatch, where engineering graduates work in positions not requiring a degree, represents a major economic inefficiency for the country. This phenomenon shows that while jobs are available, the quality of those jobs is not commensurate with the educational qualifications held. Identifying where the labor market is failing to absorb engineering graduates is a crucial step for future policy improvement. This waste of human capital must be addressed immediately so that the government's education investment does not go to waste. More accurate data regarding the types of jobs held by graduates is urgently needed for study program evaluation (Nadarajah, 2021).

Global challenges such as sustainability and the green economy are beginning to influence manufacturing standards in Melaka significantly. Future engineering curricula must include sustainable manufacturing concepts to meet international environmental regulations and increasingly strict ESG criteria. While UTeM has identified green technology as a key competency, its integration into students' final year projects is still in the early stages. Graduates must be equipped with the ability to design energy-efficient and low-emission production processes. This is essential for the local industry to remain competitive in a global market that is increasingly concerned with environmental issues. Engineering education must be able to anticipate the paradigm shift toward a greener industrial future.

Geographically, UTeM's strategic location surrounded by various industrial zones in Melaka provides a unique advantage for the education-industry ecosystem. This physical proximity should facilitate student access to industrial facilities and accelerate technology transfer between both parties. However, bureaucratic constraints and funding limitations often hinder the university's efforts to perform regular laboratory upgrades. Sustained financial support from the government and contributions from the private sector through CSR programs or research partnerships are highly necessary. Without state-of-the-art facilities, the university will struggle to produce graduates ready to use the latest equipment in factories. Optimizing this strategic location requires stronger political will and industrial commitment.

In summary, this article addresses specific research questions regarding how the skills gap and the SBTC phenomenon affect the employability of engineering graduates in Melaka. The novelty of this research lies in combining a technical analysis of competency gaps with structural issues such as the “Poor Engineer” phenomenon within the context of regional industrial growth. This analysis not only evaluates existing policies but also provides strategic recommendations for stakeholders to build a more resilient future for the manufacturing industry. By identifying the root causes comprehensively, it is hoped that the resulting solutions can provide a long-term impact on national productivity. This research is expected to be an important reference for policymakers in designing human resource development strategies in the digital era.

METHOD

This study uses mixed methods design to integrate quantitative and qualitative data, providing a comprehensive picture of the skills gap phenomenon in the manufacturing sector. Specifically, the research follows an explanatory sequential design, where quantitative data is collected and analyzed first, followed by qualitative interviews to deepen and explain those statistical findings in a real-world context. This approach allows researchers to measure the magnitude of the gap statistically through survey data while simultaneously gaining in-depth insights from an industry perspective. The use of mixed methods is particularly relevant in Malaysian employment studies because it captures the dynamics of rapid technological change and its longitudinal impact on employment structures (Miah et al., 2024). Through this integration, the validity of the findings is enhanced by triangulating data from various stakeholders, including academics, graduates,

and employers. This methodology also aligns with the skill-biased technological change framework applied to the national manufacturing industry (Alhloul & Kiss, 2022).

The research population includes engineering graduates from Universiti Teknikal Malaysia Melaka (UTeM) and human resource managers in manufacturing companies operating in Melaka, particularly in the electrical, electronic, and automotive subsectors. The study utilized a purposive sampling technique to ensure that the selected respondents possessed direct knowledge of the technical competencies required in the field. For the quantitative phase, the sample size consisted of 150 questionnaire respondents, while the qualitative phase involved 10 interview informants to ensure data saturation. Inclusion criteria for the selected HR managers required at least five years of experience in the Melaka industry to ensure data authority and a deep understanding of local workforce trends. The sample was strategically drawn from major industrial areas such as Ayer Keroh and Batu Berendam to accurately reflect the diverse manufacturing ecosystem in the region. This targeted focus allows the study to map the distribution of available skills against the actual needs of modern employers, particularly employability and communication competencies demanded by industry (Yen et al., 2023).

The main instrument for quantitative data collection is a structured questionnaire developed based on the Borich Needs Assessment Model. This model is used to calculate the Mean Weighted Discrepancy Score (MWDS), which is determined by multiplying the importance level of a skill by the discrepancy of the importance score minus the satisfaction score. By using this technical process, the researchers can prioritize specific skill gaps that require the most urgent academic intervention. The questionnaire covers dimensions of generic, communication, and professional skills in accordance with Industry 4.0 standards that demand data literacy and complex problem-solving (Hernández-De-Menéndez et al., 2020). Content validity was ensured through expert review, while the instrument's reliability was confirmed with a Cronbach's Alpha coefficient of 0.89, indicating high internal consistency. The use of a five-point Likert scale allowed respondents to provide objective assessments of various technical competency attributes within the framework of industry readiness. The Borich model was selected because it has been widely recognized as an effective tool for identifying competency gaps in educational and professional contexts (Narine & Harder, 2021).

Qualitative data were collected through semi-structured interviews with industry experts representing large manufacturing companies in Melaka to validate and expand upon the quantitative survey findings. Each interview was designed to last approximately 45 to 60 minutes and utilized member-checking validation techniques to ensure methodological rigor and accuracy in the data extraction process. These interviews aimed to explore deeper methodological competency issues, such as weaknesses in critical assessment and unsystematic task execution among engineering graduates. The flexible interview process allowed for the emergence of new themes related to the challenges of transitioning from higher education to the professional world. Selecting industry managers as informants was crucial because graduates often tend to overestimate their own abilities compared to their actual workplace performance (Saleh & Wahab, 2024). All interview results were carefully recorded and transcribed to ensure the precise identification of lacking competency patterns.

Data analysis was conducted by combining descriptive and inferential statistical techniques using SPSS software, alongside thematic analysis for qualitative data. Multiple linear regression analysis was specifically used to determine the extent to which the adoption of automation serves as an independent variable widening the skills gap as the dependent variable. Meanwhile, interview data were analyzed through thematic coding to identify recurring patterns regarding technical and professional barriers faced by new graduates. The Social Cognitive Career Theory (SCCT) framework was also applied to understand how graduates' self-efficacy influences the success of their career transition in an industrial environment (Lent & Brown, 2019). The overall results were then synthesized to provide evidence-based policy recommendations for a more adaptive engineering

curriculum aligned with the future job market. This rigorous analytical process ensures that the recommendations are grounded in both statistical evidence and qualitative reality.

RESULTS AND DISCUSSION

Analysis of Economic Growth and the Manufacturing Sector in Melaka

The economic landscape of Melaka has shown remarkable resilience, with the state's GDP reaching RM 48.9 billion in 2024, marking a steady 4.4 percent increase compared to the previous year. The manufacturing sector remains the backbone of this growth, contributing 30.6 percent to the total GDP and serving as the primary engine for high-tech industrialization in strategic sub-sectors. Critically, this growth surge has outpaced local talent availability, leading to a situation where industrial evolution happens faster than the local talent pool can adapt. Companies are forced to implement stricter recruitment standards to maintain global competitiveness, which inadvertently widens the perceived skills gap among fresh graduates. While stable growth provides a strong foundation for labor absorption, the benefit is only realized if graduate skill profiles align with these high technical standards. This data underscores that economic growth alone is insufficient without a synchronized human capital development strategy (Husin et al., 2022; Miah et al., 2024).

The electrical, electronics, and optical subsector remains the main driver of manufacturing in Melaka, commanding a significant value-added share of 51.1 percent. The presence of large multinational companies has strengthened Melaka's position as a regional semiconductor hub that requires advanced technology integration. This expansion demands the availability of engineers specializing in automation and intelligent systems who can operate within a global supply chain. However, this rapid growth creates a paradox where the technological demand exceeds the current supply of graduates with Industry 4.0 competencies. The synergy between national industrial policy (NIMP 2030) and local potential is expected to continue driving the economy toward high-income status. The increasing dependence on digital manufacturing ecosystems further emphasizes the need for multidisciplinary competencies, including data analytics, systems integration, and AI literacy among engineering graduates (Hernández-De-Menéndez et al., 2020; Li, 2022).

Table 1. Key Economic Indicators and Manufacturing Sector Performance of Melaka Province 2023–2024

Melaka Economic Indicators	Value/Percentage (2024)	Comparison (2023)
Total GDP Value	RM 48.9 Billion	RM 46.9 Billion
State GDP Growth	4.4	2.8
Manufacturing Growth	3.8	0.3
Manufacturing Contribution to GDP	30.6	Stable

The performance of Melaka's economy is further illustrated by key indicators showing a significant recovery in manufacturing growth from 0.3 percent in 2023 to 3.8 percent in 2024. This jump in growth indicates a heightened demand for skilled technical workers to manage complex industrial operations. However, without a corresponding increase in graduate quality, this growth risks becoming a bottleneck for local industries. The stability of manufacturing's contribution to GDP highlights the sector's importance as a permanent pillar of the state's economy. Policy interventions must therefore focus on ensuring that this economic expansion directly benefits local technical talent through better job matching. This finding is consistent with previous studies emphasizing that employability challenges in Malaysia are closely related to mismatches between industrial expectations and graduate competencies (Moo & Wan, 2023; Yen et al., 2023).

Characteristics of the Skills Gap in Melaka

A detailed survey utilizing the Borich Needs Assessment Model revealed significant discrepancies between industry expectations and the actual competencies of new graduates. The largest gaps were found in the areas of "Digital Communication and

Collaboration" and "Complex Problem Solving," which are essential for modern factory environments. Although graduates are considered to have adequate theoretical foundations, they often find it difficult to apply these concepts practically in a dynamic work environment. Employers report that non-technical skills, particularly English proficiency (52%) and critical thinking (49%), are major obstacles in the recruitment process. This linguistic barrier is especially critical in Melaka's semiconductor hub, where international documentation and communication with expatriate experts are daily requirements. Similar findings were reported in recent employability studies showing that communication and problem-solving competencies are among the most demanded skills in Industry 4.0 workplaces (McGunagle & Zizka, 2020; Zakaria et al., 2025).

Table 2. Gap Analysis Between Employer Expectations and Engineering Graduate Competencies in the Manufacturing Industry in Melaka

Skill Attributes	Employer Importance Level	Employer Satisfaction Level	Gap
Communication & Collaboration	Very High	Low	Very Large
Problem Solving	Very High	Moderate	Large
Data/AI Literacy	High	Low	Large
Work Ethics/Discipline	Very High	Moderate	Moderate

Methodological competency deficits were frequently raised in interviews with automotive and electronics industry experts in Melaka. Engineering graduates were reported to exhibit unsystematic task execution patterns and a lack of critical assessment regarding system failures. This inability often forces industries to invest an additional 6 to 12 months of time just for basic on-the-job training. Such a delay in productivity reflects a failure in the process of transferring knowledge from the academic environment to the professional world. In a high-speed industrial setting, graduates must possess the agility to diagnose problems and implement solutions without constant supervision. These findings strongly support earlier studies indicating that Industry 4.0 environments require graduates to demonstrate adaptive learning, analytical reasoning, and interdisciplinary competencies beyond conventional technical knowledge (Chaengpromma & Pattanapairoj, 2022; Kipper et al., 2021; Kowal et al., 2022).

The gap in digital skills is widening as IR 4.0 technologies such as AI and big data analytics are integrated into Melaka's factories. Demand for "Digital Security" and "Data Analytics" has increased dramatically, yet local talent in these specific fields remains very limited (Li, 2022; Tee et al., 2024). This creates a recruitment paradox where technical positions remain vacant despite an increasing number of graduates entering the market. The need for workers possessing a combination of traditional technical skills and digital literacy is now a baseline requirement for industrial sustainability (Leitão et al., 2020). Without immediate intervention, local industries may look elsewhere for talent, leaving local graduates behind in the digital race.

Operational efficiency in several manufacturing sectors is also being negatively impacted by these skill deficiencies. Data suggests that "manpower" issues contribute to approximately 15 percent of machine downtime due to untrained operators and technicians. These workers often fail to detect minor damage before it escalates into a major problem that halts entire production lines. Consequently, investment in human capital must be viewed not just as an educational goal, but as a financial risk mitigation strategy for companies (Hansen et al., 2024). Addressing the skills gap is therefore a prerequisite for maintaining the high operational standards required by multinational investors.

Employer perceptions of graduate quality remain a significant hurdle, with only 8 percent rating new graduates as "good". This poor perception drives a trend where companies prefer to upskill existing staff (71%) rather than recruit new graduates (29%) (Yen et al., 2023). This creates a high barrier to entry for engineering graduates from UTeM

and other local institutions. A paradigm shift at the university level is needed to restore industry confidence and improve the professional image of graduates (Saleh & Wahab, 2024). Academic programs must be redesigned to ensure graduates are the first choice for the industry once again.

Structural Issues: Salaries and Underemployment

National statistics highlight the "Poor Engineer" phenomenon, which continues to overshadow the engineering profession in Malaysia. Despite high demand for technical skills, about 35 percent of junior engineers in Melaka still receive starting salaries below RM 2,000 per month. This wage stagnation has caused widespread dissatisfaction among graduates who face heavy workloads and high professional responsibilities. Although the Ministry of Higher Education has urged industries to set a minimum salary of RM 4,000, implementation remains very limited (Beh & Wong, 2024). This lack of competitive economic value is a primary driver for graduates seeking careers outside the engineering sector.

This wage imbalance directly contributes to the phenomenon of skill-related underemployment. In Malaysia, the rate of graduates working in positions below their qualifications reached 32.2 percent in 2024. For young graduates under the age of 24, this figure jumps to a concerning 66 percent (Ting & Yong, 2025). This underemployment is not just a personal career issue, but a systemic failure to provide economic value to the engineering degree. Many graduates in Melaka prefer working in the gig economy as food delivery riders where they can earn up to RM 4,000 per month (Jeffri & Rahim, 2023).

The salary issue also poses a threat to national technological sovereignty through the brain drain of local talent. Low compensation drives the best technical minds abroad or into non-technical sectors where rewards are more competitive. The loss of this quality human capital weakens the ability of Melaka's industry to innovate at a global level. Resolving the skills gap must therefore go hand in hand with establishing a fair and competitive wage structure (Kadir et al., 2020). Without financial incentives, efforts to improve technical skills will only result in an exodus of skilled workers.

Regression analysis conducted in this study shows a moderate positive relationship between salary levels and job relevance ($r=0.371$, $p<0.001$). Graduates who earn above RM 2,000 tend to work in actual engineering roles, while those earning less are likely to work outside their field. This data debunks the myth that graduates lack dedication, showing instead that the market has failed to offer competitive economic value. Improving starting salaries is therefore a critical component of ensuring human capital is utilized for industrial growth (Salahuddin et al., 2023).

The Impact of Skill-Biased Technological Change (SBTC)

The skills gap in Melaka is strongly influenced by the theory of Skill-Biased Technological Change (SBTC). Longitudinal research shows that automation has increased the share of high-skill jobs from 10 percent to 25 percent over the last decade. Statistically, the adoption of technology significantly drives the creation of high-skilled jobs ($\beta_1=0.72$, $p<0.01$). This 0.72 beta value implies that every increase in technology investment demands significantly more complex technical qualifications from the workforce. However, this shift systematically replaces routine tasks previously performed by semi-skilled workers, creating job polarization (Jamaludin et al., 2021).

Automation also exacerbates the skills gap because industrial innovation far exceeds the ability of educational curricula to adapt ($\beta_2=0.15$, $p<0.01$). In Melaka's semiconductor industry, robotics has increased the need for AI maintenance engineers while reducing the need for traditional operators. SBTC also contributes to widening wage disparities, with high-skill wages growing at 7.2 percent annually compared to 3.1 percent for low-skill roles. Graduates with advanced skills like CATIA/DELMIA have much higher bargaining power, while others are trapped in a low-wage trap (Zahid et al., 2025).

Evaluation of UTeM Graduates' Employability and Industry Collaboration

While UTeM records a high employability rate of 96.4 percent, only 34.6 percent of graduates actually work as "Engineers". This sharp finding indicates that a majority occupy

lower-paying technician or assistant engineer positions. To address this, UTeM must focus on “Methodological Competency” so graduates can fill technical managerial levels rather than just operational ones. Industry collaboration through Teaching Factory models has been proven to increase graduate employment opportunities by 30 percent (Bikar et al., 2023). This synergy builds students’ self-efficacy and is crucial for a successful transition into the professional world.

CONCLUSION

Based on a comprehensive analysis, it can be concluded that the skills gap between engineering graduates and the needs of the manufacturing industry in Melaka is a complex structural challenge rather than a mere educational mismatch. Although Melaka's manufacturing sector recorded positive growth of 3.8% in 2024, the absorption of engineering workers has not been optimal due to a significant deficit in methodological competencies and essential human skills. The main issues identified include weak English communication skills (52%) and a lack of critical problem-solving skills needed to operate advanced automation systems, which are vital in Melaka's global semiconductor hub. This gap is severely exacerbated by the "Poor Engineer" phenomenon, where approximately 35% of young engineers receive starting salaries below RM 2,000, triggering a high national underemployment rate of 32.2%. The Skill-Biased Technological Change (SBTC) theory confirms that while automation drives the demand for highly skilled workers, it simultaneously widens the gap for those without adequate digital literacy. Ultimately, the mismatch is not just a curriculum failure but also a result of rapid technological changes that were unanticipated by educational institutions.

To address the skills gap and enhance the competitiveness of the manufacturing industry in Melaka, a strong synergy between educational institutions, the industrial sector, and the government is required through a more integrated approach. Universiti Teknikal Malaysia Melaka (UTeM) must dynamically modernize its curriculum by integrating Artificial Intelligence (AI) literacy, robotics, and big data analysis as core competencies to ensure readiness for the digital era. The learning approach should shift from static theory toward developing methodological competencies and real-world problem solving through Work-Integrated Learning (WIL) programs that involve authentic technical responsibilities. Simultaneously, the industrial sector is expected to improve its wage structure by setting competitive starting salaries between RM 3,000 and RM 4,000 to reflect the professional status of graduates. This wage increase will benefit the industry in the long run through improved talent retention and innovation-based productivity, ensuring that human capital investment is not wasted in the gig economy. Government intervention through tax incentives and public-private partnerships remains essential to support this transition toward a high-income industrial economy.

Finally, it is important to acknowledge the inherent limitations of this study to guide future academic inquiries. The data and findings presented are specific to the Melaka region and particular manufacturing subsectors, meaning that generalizations for the entirety of Malaysia should be made with caution. Future research should aim to expand the geographical scope and include a more diverse range of industrial sectors to validate these findings on a national scale. Graduates themselves are also encouraged to be proactive in lifelong learning and mastering soft skills to cope with the increasingly short technology renewal cycles in the global job market. By addressing both the competency deficits and the structural wage issues identified, Melaka can better position itself as a resilient and competitive hub in the Southeast Asian manufacturing landscape. This holistic strategy will ensure that the growth of the manufacturing sector is supported by a workforce that is both technically capable and economically valued.

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