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Review Paper

Digital Workforce Screening: A SWOT Perspective on IT Program Readiness in Malaysian Vocational Education

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Abstract: Screening assessments in vocational colleges are a strategic innovation in educational evaluation, designed to identify the cognitive and technical readiness of students entering program-specific courses. In Malaysia, the Information Technology (IT) program within Technical and Vocational Education and Training (TVET) plays a pivotal role in equipping students with programming, computational thinking (CT), and digital skills essential for the Fourth Industrial Revolution (IR4.0) and the digital economy. However, cognitive screening assessments tailored to IT programs in vocational colleges remain underexplored, leading to inconsistencies in student intake quality and misalignment between curriculum expectations and industry demands. This study employs a SWOT analysis framework to examine the strengths, weaknesses, opportunities, and threats of integrating screening assessments for programming and CT in vocational IT education. Data were collected through a literature review from major databases including Scopus, Web of Science, and Google Scholar, focusing on empirical studies in programming and CT. Findings highlight several strengths: improved problem-solving abilities, industry relevance, and enhanced employability for graduates. Weaknesses include limited institutional resources, insufficient teacher training, and uneven student readiness. Opportunities emerge through government initiatives, educational technologies, and industry collaborations, while threats stem from rapid technological change and persistent digital divides. The study underscores the need for program-specific screening tools that ensure equitable access, enhance employability, and align vocational IT programs with evolving industry standards, thereby supporting Malaysia's digital transformation and competitiveness.

Keywords: Computational thinking; information technology; programming; SWOT analysis; Vocational education.

Introduction

Information Technology (IT) has become one of the most critical areas of study globally, as the digital revolution continues to reshape industries and economies (Grego et al., 2025). Around the world, IT programs are not only central to higher education institutions, but are also rapidly being integrated into secondary and vocational education systems (Belmar, 2022). Countries recognize the importance of producing graduates skilled in programming, coding, and computational thinking to meet the demands of the 21st-century workforce (Kiener et al., 2022). As the Fourth Industrial Revolution (IR 4.0) transforms how businesses operate, IT has become an essential field that underpins advancements in digital technologies across various

sectors, enhancing production efficiency and creating new job opportunities in artificial intelligence, big data, cybersecurity, and automation (Mottaeva et al., 2023).

In Malaysia, the development of IT education has followed a trajectory that reflects national efforts to build a resilient, digitally literate society. From its early expansion in the 1980s to recent policy initiatives such as the Malaysia Education Blueprint (PPPM, 2013), the Digital Education Policy (Educational Resources and Technology Division, 2023), and the Malaysia Digital Economy Blueprint (Educational Resources and Technology Division, 2023), IT has become central to national development goals. These frameworks emphasize the importance of digital skills development across all education levels, including TVET, where IT program is positioned to produce skilled, work-ready graduates for Malaysia's growing digital economy.

The IT program in vocational colleges offers hands-on, industry-relevant training that aligns closely with the practical needs of the workforce. However, despite its growing significance, several systemic challenges remain. The lack of structured, program-specific screening mechanisms to assess the cognitive and technical readiness of incoming students. Many vocational colleges continue to face inconsistencies in student intake quality, leading to misalignment between curriculum expectations and actual student competencies in programming and computational thinking (Fortino, 2022; Lopes et al., 2023). Besides, addressing limitations in early detection in screening, an intervention program may improve academic performance and foster equity by confirming that all students experience quality education (N Mohd Nabil et al., 2025).

Vocational education in Malaysia has since evolved to address specific industry needs, particularly in producing skilled workers who are proficient in areas such as coding and programming. Vocational IT programs provide students with hands-on experience, aligning their training with real-world applications (Ksiezopolski et al., 2022). The integration of 21st-century skills, such as critical thinking, problem-solving, and creativity, has become essential in these programs. This focus on skills is crucial not only for the development of the local economy but also for ensuring Malaysia's competitiveness in the global market. Computational thinking, which involves logical analysis and systematic problem-solving, has emerged as a cornerstone of modern education, particularly in the teaching of coding and programming (T. T. Wu et al., 2024). These skills are vital for addressing real-world problems using technology, and they form the basis of many IT programs worldwide (T.-T. Wu et al., 2023).

Given the expanding role of IT in Malaysia's vocational education, it is important to critically examine the strengths, weaknesses, opportunities, and threats; associated with these programs. A SWOT analysis provides a structured framework for understanding the current state of IT education, identifying areas for improvement, and exploring potential opportunities for growth. This paper will use the SWOT framework to assess the state of Malaysia's IT vocational education, with a particular focus on the screening test for new intakes, which aims to improve student selection processes and ultimately enhance program outcomes. Through this analysis, the paper seeks to offer strategic recommendations to better align vocational IT education with industry needs and ensure that Malaysia continues to produce a competitive, future-ready workforce.

Literature Review

The foundation of IT dates to the mid-20th century, when the development of the first computers sparked the beginning of a new era. In the 1940s and 1950s, the creation of large-scale machines like ENIAC and UNIVAC marked the birth of computing technology, primarily designed for military and scientific use. However, over the next few decades, IT evolved rapidly with the advent of microprocessors in the 1970s, personal computers in the 1980s, and the internet in the 1990s into 2000s (Joshi et al., 2022). These innovations transformed IT into an indispensable component of both industrial operations and daily life, with applications spreading across every sector, from finance and healthcare to education and entertainment.

As the industry progressed through the 1990s and into the 21st century, IT expanded far beyond its initial scope of basic data processing. Technologies such as cloud computing, artificial intelligence, big data analytics, and cybersecurity have redefined the global technological landscape (Joshi et al., 2022). IT is now embedded in almost every aspect of modern life, from communication and transportation to business operations and personal entertainment. The rise of smartphones, social media platforms, e-commerce, and

digital services has connected billions of people worldwide, reshaping global economies and cultures. Countries worldwide have embraced IT as a key driver of economic growth, productivity, and innovation, and it has become essential for both developing and developed economies (Mohamed et al., 2022; Niranga et al., 2022).

In Malaysia, the evolution of IT closely mirrored global trends, with a significant push towards modernization in the 1980s. The Malaysian government recognized the potential of IT as a tool for economic development, leading to the establishment of the Multimedia Super Corridor (MSC) in the 1990s. This initiative aimed to position Malaysia as a hub for high-tech industries and foster the growth of IT companies. Over the years, Malaysia has developed a strong IT infrastructure, with universities, colleges, and vocational institutions playing a key role in producing a skilled workforce. Today, IT programs are offered across a wide range of educational levels, from secondary schools to higher education institutions.

IT as a field encompasses several key areas of study, including computer science, software engineering, data science, cybersecurity, network administration, and artificial intelligence. Each of these disciplines plays a crucial role in building and maintaining the technology systems that support modern economies. For instance, data science has revolutionized how industries approach decision-making by enabling companies to analyse vast amounts of data to derive actionable insights (Mulla, 2024). Similarly, cybersecurity has become vital as cyber threats become more sophisticated, ensuring the protection of sensitive information and infrastructure (Vinisha Bhagwani & Balasinorwala, 2023). Software engineering, on the other hand, is fundamental to the development of applications and systems that drive industries ranging from healthcare to finance.

The benefits of IT in industry and daily life are numerous. In industries, IT enables businesses to automate processes, improve efficiency, and create innovative products and services. For example, in the manufacturing sector, IT-driven automation systems have significantly increased productivity and reduced costs. In healthcare, IT systems allow for electronic health records, telemedicine, and advanced diagnostic tools that improve patient care. On a personal level, IT has transformed the way people communicate, shop, and access information (Choi et al., 2022). The proliferation of smartphones, social media platforms, and online services has made the digital economy a central part of daily life, contributing to greater connectivity and convenience for billions of people worldwide.

In the educational context, preparing experts in IT starts early, often as part of foundational learning in secondary schools. In Malaysia, the government has introduced IT-related subjects such as coding and computational thinking into the secondary school curriculum, ensuring that students acquire essential digital skills at a young age (PPPM, 2013). These subjects are designed to foster critical thinking, problem-solving, and creativity, all of which are crucial in the IT field. As students' progress to higher levels of education, they are given the opportunity to specialize in various IT disciplines. Vocational colleges, polytechnics, and universities offer a wide range of programs that cover different areas of IT, from programming and software development to network administration and cybersecurity.

Higher education institutions, particularly universities, play a critical role in producing the next generation of IT experts. By offering specialized diploma and degree programs in fields like computer science, information systems, and software engineering, universities and colleges equip students with the knowledge and skills needed to enter the workforce and contribute to Malaysia's growing IT sector. Graduates from these programs are highly sought after by companies both locally and internationally, as the demand for skilled IT professionals continues to rise (Dada et al., 2023). Industry leaders such as Microsoft, Google, and IBM have been at the forefront of technological advancements, providing innovative solutions and shaping the global IT landscape. These companies have contributed to the development of cutting-edge technologies, such as cloud computing and artificial intelligence, which are now driving the digital transformation of industries worldwide. In Malaysia, local IT companies like Axiata, Maxis, and Telekom Malaysia, along with international firms operating within the country, play a significant role in advancing the nation's IT infrastructure and digital economy.

Hence, IT is a critical driver of global development, and its importance cannot be overstated. As technology continues to evolve, the demand for skilled IT professionals will only increase. Educational

institutions, from secondary schools to universities, are essential in preparing students for careers in IT, ensuring that they have the skills needed to succeed in a rapidly changing digital landscape. By aligning education with industry needs, Malaysia can continue to produce IT experts who will contribute to the country's economic growth and help position it as a leader in the global digital economy.

Methodology

This research utilizes the concept paper using SWOT model as a strategic planning tool to evaluate and refine organizational strategies. The model assists in the methodical evaluation of an organization's existing strategy, enabling informed decision-making for future planning. The SWOT model was selected for its efficacy as an evaluative instrument for strategic plan analysis, providing a constructive and comprehensive perspective for decision-making (Zheng, 2024). The model provide diverse views and further insights across distinct educational contexts (Mohd Noh et al., 2024).

SWOT analysis is a strategic planning tool used to identify and evaluate the Strengths, Weaknesses, Opportunities, and Threats related to a specific project, organization, or initiative (Dou et al., 2024; Puyt et al., 2024; Rika Yohana Sari et al., 2024). It was introduced in the 1960s by Albert Humphrey, a management consultant at the Stanford Research Institute. Humphrey developed the SWOT framework as part of a research project aimed at identifying why corporate planning often failed. The goal was to provide a clear and systematic method for analysing the internal and external factors that affect an organization's ability to achieve its objectives. This analytical framework helps decision-makers understand internal and external factors that could impact the success or failure of their efforts. By categorizing these factors, SWOT analysis facilitates strategic thinking and planning, enabling organizations to leverage strengths, address weaknesses, capitalize on opportunities, and mitigate threats (Karadzhov, 2025; Paroli et al., 2023). Its success is attributed to a comprehensive and methodical strategy that allows decision-makers to draw on strengths and opportunities while confronting problems.

SWOT analysis was predominantly used in business and corporate strategy (Sharath Kumar & Praveena, 2023). Companies employed it to assess their competitive position, understand market dynamics, and make informed decisions about product development, marketing, and expansion (Avrilia Ayunia Widyaningrum et al., 2024). However, as the framework's utility became evident, its application expanded to other areas, including healthcare, government and public policy , non-profit organizations (Rika Yohana Sari et al., 2024), environmental studies and education (Dou et al., 2024). In recent years, SWOT analysis has also adapted to digital transformation, with organizations leveraging data analytics and artificial intelligence to conduct more nuanced and dynamic SWOT analyses. SWOT has been increasingly used as a pedagogical tool to teach strategic thinking and critical analysis. Educational institutions have also adopted it for institutional planning, curriculum development, and program evaluation. The adaptability of SWOT analysis has allowed it to remain relevant in an ever-changing world, providing a robust framework for addressing contemporary challenges.

Figure 1 outlines the components of the SWOT model, which serves as a strategy-based evaluation framework. The acronym SWOT stands for the four key elements: Strengths (S), Weaknesses (W), Opportunity (O), and Threats (T) (Humphrey, 2005).

Figure 1. SWOT strategy-based model.

Figure 2 presents the SWOT framework of questions for analysing four elements of a topic, including strengths, weaknesses, opportunity, and threats. Each element provides specific questions to explore the key dimensions the unique advantages (Strengths), area of enhancement (Weaknesses), nascent potential (Opportunities) and limitations and potential obstacles (Threats). This framework guides a comprehensive evaluation of screening assessment to assess its impact, feasibility, and potential for enhancement, especially within the context of educational testing.

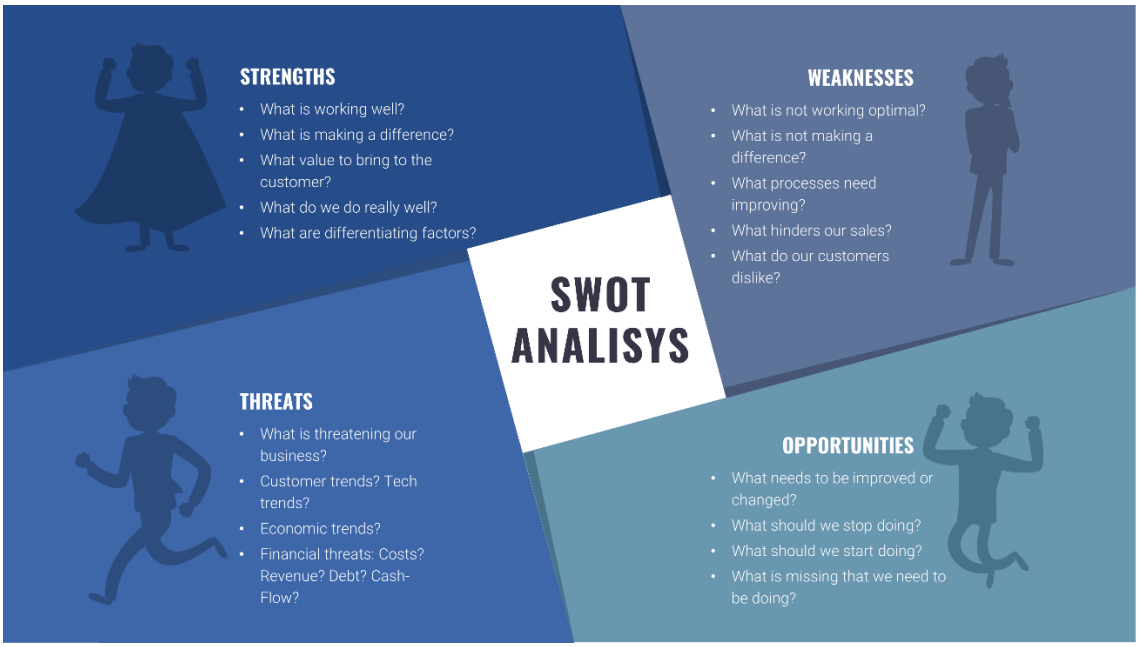

Figure 2. SWOT framework of questions for analysing various aspects of topic.

The study was conducted by analysing the current literature found in reputable databases, including Web of Science, Scopus, and Google Scholar. The use of reputable databases is crucial for ensuring the credibility and reliability of the information gathered. These databases have been extensively utilized in previous research to conduct thorough literature reviews, validate findings, and build a robust theoretical framework for diverse research topics (Eyzaguirre & Fernandes, 2024). The research utilized keywords such as "screening assessment," "programming," and "computational thinking" to ensure a comprehensive review of relevant studies. This approach allowed the researchers to identify and evaluate existing knowledge,

theories, and applications of screening assessment within educational settings. The articles were then screened based on two criteria as shown on Table 1. The selection criteria included only publications on empirical studies, excluding those using simulation data, conceptual studies, and reviews, and limited to publications in the programming and CT. Findings were carefully analysed and categorized according to the four SWOT elements. Empirical evidence highlighting improved problem-solving skills through programming was classified as a Strength, while studies identifying teacher training limitations were coded as a Weakness. Similarly, insights related to government support and industry collaboration were considered Opportunities, whereas technological obsolescence and the digital divide were grouped under Threats. Once the literature selection was finalized, the subsequent step entailed a detailed examination of the findings, discussion, and conclusions of each article to identify the strengths, weaknesses, opportunities, and threats of screening assessment that covers basic programming and CT skills for IT programs.

Table 1. Inclusion and exclusion criteria.

No	Criteria	Inclusion criteria	Rejection criteria
1.	Types of publication	Empirical studies with real data	Other than empirical studies with real data – empirical studies using simulation data, conceptual papers, review papers, method reviews
2.	Language	English	Other than English – publications reported in other than English language

The Findings and Discussions

The findings of this study provide valuable insights into the application of cognitive diagnostic approaches in the evaluation of program-specific screening instruments across vocational education settings. Figure 3 presents the SWOT analysis, focusing on the four key components of integration of programming and CT, which will be elaborated upon in the following sections. Each component is summarized, hence provide a clear framework for understanding how each component contributes to achieving the desired educational outcomes through screening test.

Figure 3. SWOT analysis of integration of programming and CT in vocational education.

1. Strengths

The integration of programming and computational thinking (CT) into vocational education brings numerous strengths that can significantly enhance the quality and relevance of vocational training (Hermans et al., 2024; Rosli et al., 2024). One of the primary strengths lies in the ability of these skills to improve students' problem-solving capabilities. Programming and CT inherently require logical reasoning, algorithmic thinking, and systematic problem-solving approaches, all of which are transferable skills that can be applied across various vocational domain (Mohd Khairul & Mustafa, 2024; Susilowati et al., 2024). As students engage with

programming tasks, they develop a mindset that is analytical and solution-oriented, enabling them to tackle complex, real-world problems more effectively.

Moreover, the inclusion of programming and CT fosters innovation among vocational students. By equipping students with the tools to create, modify, and optimize digital solutions, vocational education can cultivate a generation of innovators capable of contributing to advancements in their respective fields (Nadeem et al., 2025). This innovative capacity is not only beneficial for the students but also for the industries they enter, as it drives productivity and competitiveness in the broader economy.

Another significant strength is the enhancement of employability. In today's job market, digital literacy is a key determinant of employability, and vocational students with proficiency in programming and CT are better positioned to secure employment in technology-driven sectors (Jia & Huang, 2023). These skills are highly valued across a range of industries, from manufacturing to healthcare, where automation and data analysis are becoming increasingly integral. Thus, integrating programming and CT into vocational curricula can directly contribute to reducing the skills gap and meeting the demands of the modern workforce.

2. Weaknesses

There are notable weaknesses associated with the integration of programming and CT into vocational education that need to be addressed. A major challenge is the limited access to resources, particularly in underfunded vocational institutions. Many vocational schools may lack the necessary infrastructure, such as up-to-date computer labs, software, and internet connectivity, which are essential for teaching programming and CT effectively (Duci et al., 2024; Gupta & Hayath, 2022). This resource gap can lead to disparities in the quality of education and widen the digital divide between different regions and institutions.

Another critical weakness is the insufficient training of instructors. Effective teaching of programming and CT requires educators who are not only proficient in these areas but also skilled in pedagogical strategies tailored to vocational students (Aljameel, 2022). However, many vocational educators may not have received adequate training in these disciplines, leading to a gap in instructional quality. Without ongoing professional development and support, teachers may struggle to deliver programming and CT content in a way that is engaging and accessible to all students (Amiel & Blitz, 2022; Kravik et al., 2022).

Additionally, varying levels of student readiness pose a challenge. Vocational students often come from diverse educational backgrounds, and not all may have prior experience or interest in programming and CT. This variation can make it difficult to design a curriculum that meets the needs of all learners, potentially leading to disengagement or frustration among students who find the material too challenging or irrelevant to their vocational goals (Mbiada et al., 2023).

3. Opportunities

Despite the weaknesses, there are significant opportunities for the successful integration of programming and CT into vocational education. One of the most promising opportunities is the rapid advancement of emerging technologies. The increasing accessibility of tools such as cloud computing, open-source software, and educational platforms allows vocational institutions to offer programming and CT courses without the need for expensive infrastructure (Pan et al., 2024; Raffi et al., 2025; Singhal & Ahuja, 2023). Additionally, advancements in educational technology, such as interactive learning environments and gamification, provide new ways to engage students and make programming and CT more accessible and appealing.

Another opportunity lies in the potential for industry collaborations. As industries increasingly rely on digital technologies, there is a growing interest in partnering with vocational institutions to develop curricula that align with industry needs (Evelina, 2024; Soleh et al., 2023). Such partnerships can provide vocational students with hands-on experience, internships, and exposure to real-world applications of programming and CT. These collaborations can also lead to the development of certification programs that validate students' skills, further enhancing their employability.

Government initiatives also present a significant opportunity. Many governments recognize the importance of digital skills in the modern economy and have implemented policies and funding programs to support their development in education. Vocational institutions can leverage these initiatives to obtain funding,

resources, and support for integrating programming and CT into their curricula. Such initiatives can also promote equity by ensuring that all students, regardless of their background, have access to high-quality digital education.

4. Threats

The opportunities are substantial; there are also threats that could undermine the integration of programming and CT into vocational education. One of the most significant threats is the rapid obsolescence of technological tools (Isaksson Persson, 2023). In the fast-paced world of technology, programming languages, software, and hardware can quickly become outdated. Vocational institutions may struggle to keep up with these changes, leading to a curriculum that is no longer relevant or aligned with industry standards. This obsolescence can also affect the perceived value of the skills being taught, as students may find themselves learning technologies that are no longer in demand.

The digital divide is another critical threat. Despite efforts to improve access to digital resources, there remain significant disparities in access to technology between different regions and socio-economic groups (Afzal et al., 2023). Students in underprivileged areas may not have the same opportunities to develop programming and CT skills as their peers in more affluent regions, exacerbating existing inequalities in educational outcomes and future job prospects (Qaribilla et al., 2024).

Finally, there is the risk of creating disparities in educational outcomes (Topal & Geçer, 2025). If programming and CT are not integrated in a way that is inclusive and accessible to all students, there is an unfortunate that certain groups, particularly those who are less familiar with digital technologies, could be left behind (Chadwick et al., 2023). This could lead to a situation where only a subset of students benefits from the integration of these skills, while others are further marginalized (Afzal et al., 2023).

Conclusion

In conclusion, the findings have highlighted the strategic relevance of integrating programming and computational thinking (CT) within the Information Technology (IT) program in Malaysian vocational education. Through the SWOT analysis, these skills bring substantial strengths to vocational training, including enhanced problem-solving abilities, greater innovation capacity, and improved employability for students. These advantages align with national goals of equipping a future-ready workforce that can thrive in Malaysia's digital economy.

Several weaknesses still hinder the full potential of this integration. Resource limitations, insufficient instructor training, and diverse student readiness levels present real challenges to effective implementation. These issues must be addressed through policy support, infrastructure development, and professional upskilling to ensure equitable access and delivery of IT education across vocational institutions in Malaysia. Opportunities exist in the form of government initiatives, advancing educational technology, and industry collaborations that can enhance curriculum relevance, provide real-world exposure, and create certification pathways. At the same time, threats such as the digital divide, rapid technological change, and inequitable learning outcomes need to be mitigated through continuous curriculum updates, inclusive instructional strategies, and adaptive learning environments.

However, due to practical constraints, this study cannot provide a comprehensive review of assessment for programming and CT. This study only analyses the application of programming and CT skills using the SWOT analysis model to evaluate its strengths, weaknesses, opportunities, and threats within the context of educational testing. Other evaluation tool such as SCORE (strengths, challenges, opportunities, responses, and effectiveness), SOAR (strengths, opportunities, aspirations, results) and NOISE (needs, opportunities, improvement, strengths, exceptions) can be used to further evaluate programming and CT skills by offering different perspectives and additional insights in various educational settings.

Future studies should focus on developing and validating program-specific screening assessments that measure both cognitive and technical readiness of incoming vocational students. Further research can also explore models for scalable teacher training, the long-term impact of CT integration on student outcomes, and the role of public-private partnerships in sustaining digital transformation in vocational education. A data-

driven approach to evaluating these interventions will be essential to ensuring Malaysia's continued progress in producing digitally skilled and competitive graduates.

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