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The Domains and Components of Industry 4.0 Talent for TVET Students Through Work-Based Learning

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Abstract

The Fourth Industrial Revolution (IR4.0) era of artificial intelligence, characterised by the digitization of technology, has revolutionised organisations worldwide, including corporate organizations. This shift has resulted in the emergence of a workforce with enhanced skills and competencies. This study aims to pinpoint the essential elements of IR4.0 talent domains that students from top technical and Vocational Education and Training (TVET) providers require for their Work-Based Learning (WBL) programmes. Consistent with the IR4.0 National Policy of Malaysia, this study contributes to the current workforce preparedness that could handle the challenges and opportunities of the revolution, consistent with Malaysia's IR4.0 National Policy. Qualitative data was collected through semi-structured interviews with 6 academic and 5 industry experts. The data were analysed through theme analysis and reliability analysis using Fleiss's Kappa analysis. The study identified 21 key components across four domains: cognitive skills (6 components), operational work skills (5 components), individual skills (7 components), and professionalism (3 components). All of this simply emphasises the importance of acquiring IR4.0 competencies in TVET programmes, particularly through work-based learning, for TVET graduates to have the competencies needed in practice and the mindset towards success within the current context of industry, as well as to contribute to future talent readiness.

1. Introduction

Digital technology and artificial intelligence (AI) have significantly influenced worldwide industries in the dynamic terrain of Industry 4.0 (IR4.0). IR4.0 is a period characterised by the rapid integration of advanced technologies such as AI, robotics, big data, cloud computing, the Internet of Things (IoT), and biotechnology across all sectors. (Zeba et al., 2022; Matits, 2022; Mazlan et al., 2025). The advent of IR4.0 has fundamentally transformed the characteristics and dynamics of labour and employment. The emergence of new occupations has necessitated the acquisition of certain skill sets, including digital literacy, problem-solving aptitude, creativity, teamwork proficiency, effective communication, and a commitment to lifelong learning. Furthermore, it has

revolutionised or altered conventional occupations that depend on repetitive or physical duties. Simultaneously, this transition has occurred, according to Puhovichová and Jankelová (2022) and Yap et al. (2023).

The presence of IR4.0 characteristics in the labour market data affects the nature of the problems and opportunities that necessitate the workforce to enhance their knowledge, skills, and related abilities. Technical and Vocational Education and Training (TVET) is essential for the education system as it has the potential to provide students with practical skills that are relevant to the job market and are taught effectively (Masran et al., 2025). A notable TVET institution in Malaysia is the Polytechnic, renowned for producing graduates who possess the skills necessary to fulfil the diverse requirements of business. Polytechnic aims to achieve excellence by offering a diverse range of programmes that align with industry requirements. This will help establish strong and dynamic connections with the industry while providing high-quality education and training in technical and vocational fields. The institution will utilise work-based learning methods and digital technologies and actively collaborate with stakeholders within the context of IR4.0. Abdullah et al. (2021), Ahmad et al. (2019), and Mohd et al. (2017) assert that Polytechnic aims to achieve high standards by providing a diverse range of programmes that are in line with the requirements of the business, thereby establishing robust and dynamic connections with the industry.

The aim of this paper is to identify and explore the talent domains relevant to IR4.0 that students need to acquire through Work-Based Learning. The latter closely aligns with the National Policy on 4IR, which aims to leverage advanced technologies like AI, robotics, big data, and the Internet of Things for national development (Kolandan, 2019). The study seeks to align with these strategic areas by investigating the development of critical talent for IR4.0. Such identification and nurturing of the domains using work-based learning will result in Polytechnic producing graduates who are technically proficient in their field and, at the same time, adaptable to the continuous technological changes in industry development (Kolandan, 2019; Economic Planning Unit, 2021; MIDA, 2021). This will ensure that the workforce of the future not only has the technical skills but also the critical thinking, complex problem solving, and collaboration skills to perform work in a technologically advanced environment. This aligns with the National Policy of IR4.0, which aims to make coherent efforts for national growth and sustainability (Gunathunge & Lakmal, 2021).

1.1 Work-Based Learning

Work-Based Learning (WBL) is an educational approach that combines theoretical and practical learning by simulating work contexts (Mazlan et al., 2025). The method aims to provide students with opportunities to apply their acquired knowledge in real-world job environments. Undoubtedly, this must be a fundamental element of the desired qualities in a TVET student for IR4.0 (Rahman et al., 2020). In addition to acquiring technical expertise, WBL fosters the development of essential interpersonal skills, including leadership, teamwork, and communication. The WBL curriculum at the Polytechnic enhances students' employability skills, academic performance, and industry preparation by providing practical experiences in real work contexts that align with industry expectations (Adan et al., 2021; Ahmad et al., 2019; Mohd et al., 2017).

WBL facilitates the execution and utilisation of authentic projects that need analytical thinking, problem-solving, and the ability to adjust to changing work contexts. This methodology effectively addresses the demand for soft skills, which are essential in the context of IR4.0 (Le & Hong, 2021; Iniesto et al., 2021). However, the execution of WBL poses a significant difficulty. Essential steps for achieving successful implementation involve guaranteeing top-notch hands-on experience, enhancing assessment and surveillance, and delivering efficient oversight (Wahib, 2021). However, to successfully achieve WBL (Charlier et al., 2022; Hondonga & Chinengundu, 2021), it is necessary to have sufficient infrastructure, proper resource allocation, comprehensive staff training, and strong managerial support. Put simply, WBL fosters the development of highly skilled individuals in the field of IR4.0, specifically targeting TVET students at polytechnic institutions.

WBL provides students with hands-on experiences, involves them in the acquisition of digital competencies, and fosters the development of interpersonal skills (Nurjanah et al., 2022; Iniesto et al., 2021). It is vital to redefine how industry actors collaborate effectively and clearly define the WBL framework to connect the current state of IR4.0 with the needs of the industry. Successful implementation and support of WBL can significantly enhance the talent quality of IR students in the TVET programme at the Polytechnic.

1.2 Industry 4.0

Within the past few years, there has been a substantial and expanding body of scholarship that has explored IR4.0, particularly in developing nations. According to Dewanarayana and Wimalaratana (2021), industrial revolutions are technology developments that cause disruptions in the manufacturing sector and alter global competitiveness at a higher rate than earlier revolutions. Industrial Revolution 1.0 was the first step in the process of the Industrial Revolution. One of the first steps in the Industrial Revolution, which began in the latter half of the 18th century, was the invention of the steam engine. A century later, at the beginning of the 18th century, the second iteration of the Industrial Revolution began with the introduction of mass manufacturing through the production of

interchangeable parts. This led to the creation of automobiles, telephones, and aeroplanes. During the beginning of the twentieth century, Revolution 3.0 began, which was accompanied by the introduction of technological and digital advancements. This occurred after another century had passed. As a result of the rapid advancement of technology, the fourth iteration of the Industrial Revolution came into existence in 2011. This revolution was characterised by the introduction of the IoT, with an emphasis on AI (Colombo et al., 2021; Hamid et al., 2021).

Integrated Robotics and Automation (IR4.0) refers to the incorporation and application of intelligent digital technologies in a wide range of manufacturing and industrial processes. Malaysia is one of the countries that is making progress in the development of IR4.0. In 2018, the government of Malaysia initiated the Industri4WRD National Policy to expand the manufacturing and allied industry sectors and foster economic growth (MITI, 2018). Within the framework of the National Policy on Science, Technology, and Innovation (NSTIP) 2021–2030 (MOSTI, 2021), the Malaysian government initiated the implementation of the National 4IR Policy in the middle of the year 2021 (Economic Planning Unit, 2021). To achieve the goal of transforming Malaysia into a technologically advanced nation by the year 2030, the Economic Planning Unit has set a target for the year 2030.

1.3 IR4.0 Talent

The individuals who have obtained the abilities and information required to engage in IR4.0 in an efficient manner are known as IR4.0 talent. The revolution is typified by the fundamental integration of digital technologies into manufacturing and industrial processes, which has completely changed the way industries function today. The need for IR4.0 expertise stems from the fact that interdisciplinary knowledge combining engineering, computer science, and business management also includes advanced IT abilities in data analytics, AI, and machine learning. Professionals with these competencies will be better able to optimise workflows, increase output, and foster innovation (McKinsey & Company, 2022; Abdul Rahim et al., 2022).

The future of Malaysia's economy and industry depends on IR4.0 talent. The Ministry of Higher Education Malaysia has introduced the new Malaysian Higher Education Development Plan (PPPTM) 2026-2035, which is a continuation of the soon-to-expire Malaysia Education Development Plan 2015-2025 (MoE, 2015). It emphasises even more how work done in an environment with IR4.0 skills maintains competitiveness in the global marketplace (MoHE, 2024). The goal of the policy is to close the skills gap and provide Malaysian workers with the resources they need to adjust to the fast-evolving global economy. By cultivating IR4.0 talent, Malaysia may draw in investments, boost its manufacturing sector competitiveness, and create high-value jobs, laying the groundwork for sustainable development (Abdul Rahim et al., 2022).

In addition to PPPTM 2026–2035, Malaysia is taking numerous steps to guarantee that the nation's training and educational programmes will be in line with the demands of IR4.0. Among the strategies are encouraging employees to pursue lifelong learning as a means of skill development and introducing digital technologies into the curriculum. By prioritising IR4.0 talent development, Malaysia will cultivate a resilient and adaptable labour force capable of propelling the nation's industrial transformation and economic advancement. This is consistent with the research conducted by MITI (2018), Yong et al. (2020), and McKinsey & Company (2022).

2. Methodology

This study used the qualitative research method, beginning with document analysis (Sanusi & Puteh, 2023). First and foremost, we meticulously studied various journals, case studies, academic books, and reports. We prepared a questionnaire for the semi-structured interview after gaining an overview and understanding of the available literature. Scholars such as Patton, 1990, and Kvale, 1996, had recognised the power of the interview as a means of qualitative data collection. To provide deeper insights and perspectives, we purposefully selected experts related to the interview format. Experts transcribed and validated the interviews to ensure their accuracy and validity. Using manual coding techniques, we applied thematic analysis to extract themes from the transcripts.

This study utilised a systematic coding approach derived on the works of Hassan and Puteh (2023) and Cummings (1985). Each code adhered to a systematic format (e.g., FI-EP1-AC), wherein the initial component (FI) denotes the interview type (Face-to-Face Interview), the subsequent component (EP1) identifies the interviewed respondent (Expert 1), and the final component (AC) signifies the respondent's organisational affiliation (academia or industry). This coding approach improved uniformity, transparency, and traceability inside the dataset, consequently bolstering the trustworthiness of the ensuing study. We then checked the reliability of each theme list in each domain using Fleiss' Kappa coefficient (Fleiss, 1971; Landis and Koch, 1977; Hassan et al., 2019).

The study used an interview protocol as the research instrument to collect relevant information. We conducted interviews using an established protocol within the social sciences (Fontana & Frey, 1994). We adopted the semi-structured interview method due to its flexibility in accommodating different types of questions during the interview process (Bryman, 2016; Robson, 2002). We conducted a pilot study with a few field experts to refine the questions before the real interviews (Yin, 2003; Maxwell, 2013).

In this study, the respondents will be selected based on purposive sampling to reach those people who are experts in academic development related to IR4.0. According to Glaser and Strauss (1967), a sample size of 3 to

10 is practical for achieving the objectives of this study. We conducted eleven expert interviews to ensure data saturation (Mason, 2010; Sanusi & Puteh, 2023). Table 1 illustrates that we selected 6 academic experts and 5 industry experts for the expert panel, based on criteria that aligned best with the requirements of this research study.

Firstly, we performed document analysis to identify domains and elements of IR4.0 talent from recent journals and studies. We then conducted expert interviews to validate the findings, adhering to Corbin and Strauss's (2008) method for data saturation. We used thematic and reliability analysis methods, including Fleiss's Kappa, for data analysis. Document analysis remains a robust approach for qualitative research (Yin, 1994; Bowen, 2009). This study's qualitative component involved analysing interview protocols using thematic analysis to identify patterns (Braun & Clarke, 2006). We transcribed the audio recordings from the interviews and used a structured thematic analysis process to extract study-related themes through content analysis.

Table 1 *Interview expert selection*

Expert	Criteria	Number of Experts
Academic	• Has more than 5 years of teaching and service experience. • Have knowledge in the field of IR4.0 (automation) at the university level. • Have experience handling students of WBL programmes. • Experienced in the industry.	6 people
Industry	• Have experience working in the IR4.0 field more than 5 years. • Academic approval areas based on IR4.0 (Engineering, Technology, and IT). • Have experience handling students of WBL programmes. • Holding the position of at least an engineer.	5 people

3. Findings

The domains and components of IR4.0 talent were identified through interviews with eleven subject-matter experts. In total, this study found 55 components in four different IR4.0 talent domains: 7 for cognitive skills, 29 for operational work skills, 13 for individual skills, and 6 for professionalism. In order to generate graduates that are well-rounded, problem solving, creativity, and innovation must be added as extra components. This implies that those receiving instruction or training ought to foster innovation as a desirable quality or aptitude.

> "We need to see whether we want to produce a graduate with these qualities, if so, we need to add one more component, which is problem-solving, innovation, and creativity."- FI-EP1-AC.
>
> "… Under cognitive? Earlier, that was, complex problem solving, Creative and innovative."- Fi-EP4-AC.
>
> "… among them is, earlier I informed one of them, which is creativity. Creativity and innovation are closely related, and they comply with the cognitive domain as well."- FI-EP10-IN.

Innovative stands as a crucial element across various fields, especially in fields like manufacturing and software. It plays a crucial role in driving progress within industries, graduates can make valuable contributions through their ideas, technology, and abilities. Without innovation, one may rely on existing methods, whereas embracing innovation allows for improvement and advancement in approaches.

> "… Okay, innovation is indeed one of the important aspects, right? For example, let me take an example in the field of manufacturing..."- FI-EP2-AC.
>
> "… in the software field, okay. It requires creativity and innovation. So, in software, mostly to create something new or to troubleshoot problems, it requires creativity and innovation..."- FI-EP8-IN.
>
> "In China, their graduates can contribute to companies with more advanced technology, meaning they can contribute their ideas, technology, or abilities to the company. ... innovation is important."- FI-EP5-AC.
>
> "… so besides analysing the data, there needs to be innovation or creativity because if you don't innovate, it means you might be using a method that already exists. If you are innovative, you will improve upon the existing method..."- FI-EP6-AC.

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> "… because what they learned before, they already have a good foundation or benefit, they just need to demonstrate after what they have learned and contribute to an organization in terms of productivity, innovation, and dedication..."- FI-EP9-IN.
>
> "Yes. Innovative. Sometimes, when we've been working for a long time, we have a way to solve this, so we just use it. Maybe we haven't thought of another way. We need new people to share ideas with us. There might be other more efficient ways to solve problems. This is what we want to see for fresh graduates who want to join the industry..."- FI-EP7-IN.

WBL students are equipped with research and development (R&D) skills through their exposure to real-world R&D processes in industries. It emphasizes the importance of continuous innovation within these environments.

> "… WBL students also possess talent in research and development (R&D). They are exposed to real factory R&D. Because in this factory, innovation is continuous."- FI-EP11-IN.

Industry 4.0 (IR4.0) encompasses a wide range of industries, from software development to manufacturing, and highlights the crucial need of inventive talent in these contexts. In order to solve complicated problems, boost productivity, and promote continual progress in organisations, creativity and innovation must be included. The development of creative thinking, the promotion of research and development capacities, and the exposure of students to real-world situations are all greatly enhanced by WBL programmes. Upon entering the workforce, graduates' innovative capabilities become an invaluable tool for organisations to thrive in the ever-evolving IR4.0 era. Table 2 presents the results obtained from the interviews with experts.

Table 2 *Component of IR4.0 obtained from expert interview*

No	Domain (Theme)	Components (Sub-Theme)	Expert Panel											
			1	2	3	4	5	6	7	8	9	10	11	Total
1	Cognitive Skills	Innovative	√	√		√	√	√	√	√	√	√	√	10
		Critical Thinking	√	√	√		√					√	√	6
		Creative	√	√		√	√			√	√	√	√	8
		Decision Making	√		√	√								3
		Problem Solving	√	√		√	√	√	√		√	√	√	9
		Adaptability	√	√	√	√	√	√		√	√	√		9
		Analytic thinking		√	√	√			√	√	√	√		7
2	Operational Work Skills	Maintenance	√	√				√					√	4
		Multi-Discipline /flexible	√	√	√		√				√			5
		Troubleshooting	√					√			√	√	√	5
		Programming	√	√		√		√	√		√			6
		Ability to use tool		√			√							2
		Leadership		√	√	√	√	√	√	√	√	√		9
		Teamwork	√	√		√				√	√			5
		Ability to demonstrate deep investigation		√				√						2
		Ability to use simulation software		√		√	√	√	√		√			6
		Conflict management		√										1
		Persuasion	√		√	√	√	√						5
		Change management			√									1
		Data Analysis			√		√	√		√				4
		Operation management			√									1
		Supply chain management			√									1
		Entrepreneurship			√	√								2
		Collaboration			√		√			√				3

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No	Domain (Theme)	Components (Sub-Theme)	Expert Panel											
			1	2	3	4	5	6	7	8	9	10	11	Total
2	Operational Work Skills	Numeracy skill			√				√					2
		Project management		√		√	√				√			4
		Digital literacy					√							1
		Data Management			√		√							2
		Design						√						1
		Process Improvement						√			√			2
		Embedded System	√											1
		Presentation	√			√		√	√	√	√			6
		Networking	√											1
		Cyber Security	√		√		√							3
		IOT	√			√								2
		Communication	√	√		√	√	√	√	√	√	√	√	10
3	Individual skills	Lifelong Learning	√	√	√	√	√	√	√	√	√	√		10
		Persevere	√		√	√		√		√	√	√		7
		Self-Learning	√		√		√		√	√	√	√		7
		Multi-Tasking	√										√	2
		Time management		√		√	√				√	√	√	6
		Confident		√										1
		Passionate			√	√		√	√	√			√	6
		Discipline					√	√	√	√	√		√	6
		Proactive			√				√	√	√	√	√	6
		Commitment								√				1
		Self-motivation				√			√		√			3
		Work management		√							√	√	√	4
		Attention to detail					√							1
		Lifelong Learning	√	√	√	√	√	√	√	√	√	√		10
4	Professionalism	Ethics		√		√		√	√		√	√	√	7
		Attitude	√	√	√	√	√		√	√	√	√		9
		Open Minded		√										1
		Responsible		√	√	√			√	√	√	√	√	8
		Religious value			√									1
		Safety Awareness			√			√					√	2

Figure 1 demonstrates that Table 2 lists the components that garnered consensus from over six experts. Initially, 55 components were discerned via expert interviews. Redundant or semantically analogous components were amalgamated, yielding an enhanced list. This curated list was later confirmed by Fleiss' Kappa reliability testing to ascertain inter-rater agreement. The iterative procedure culminated in a reduction of the list to 21 consensus components. The cognitive skills domain consists of 6 components, the operational work skills domain includes 5 components, the individual skills domain encompasses 7 components, and the professionalism skills domain contains 3 components.

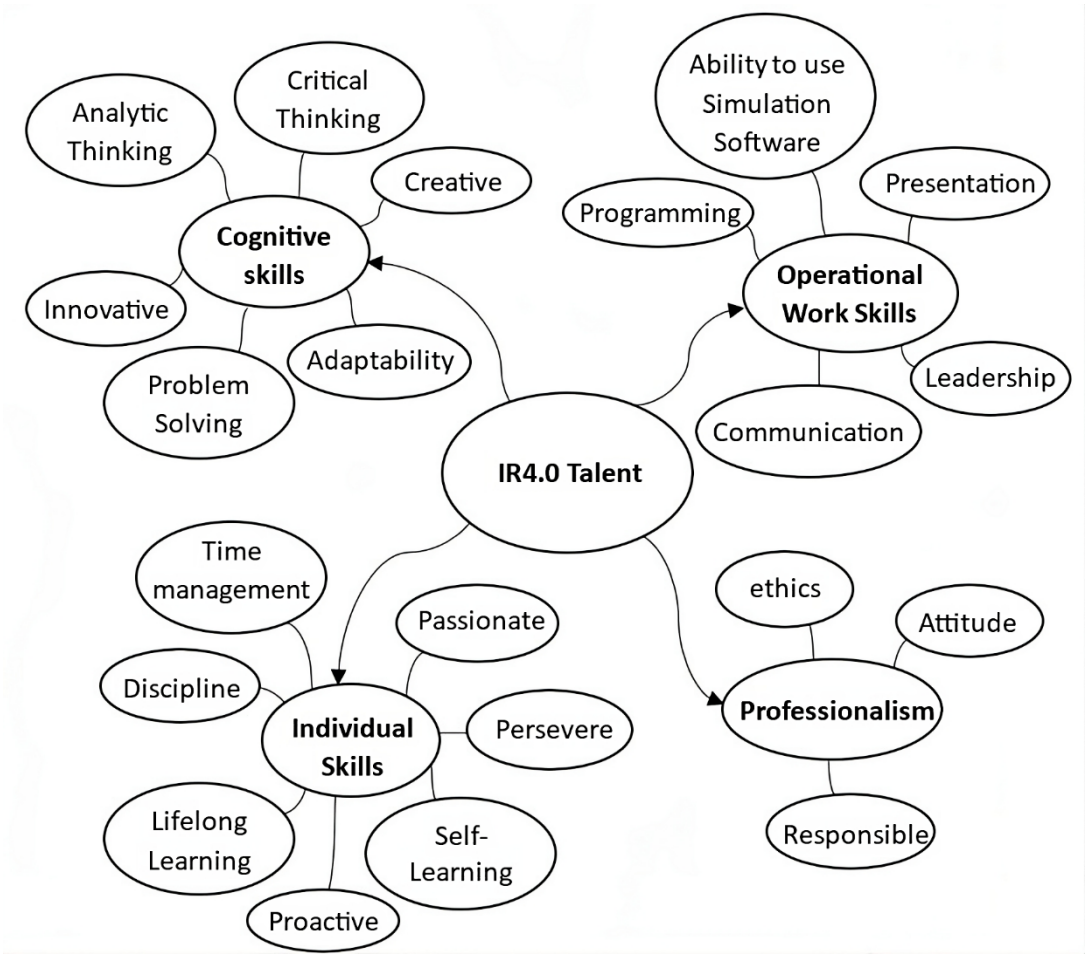

Fig. 1 *IR4.0 talent domains and components based on consensus of experts*

4. Discussion

The final list of components, agreed upon by at least six experts, fully reflects a shared understanding of what is critical in the IR4.0 talent. Cognitive skills, operational work skills, individual skills, and professionalism are the 21 key components that we have narrowed down from our findings. This method is akin to putting together a jigsaw puzzle, with each component contributing an important piece to the overall picture of preparing graduates for the digital age.

Six key components comprise cognitive skills, which include problem-solving and analytical skills. Think of these components as the mental strength needed to solve problems and develop creativity in today's fast-paced world. These skills are essential because they enable individuals to navigate a complex industrial environment and drive innovation. Recent studies, for example, emphasise the need for high-level cognitive skills such as decision-making and analytical capabilities in Industry 4.0 environments and highlight the role of TVET in developing these competencies through targeted teaching methods and assessments (Amiron et al., 2019).

Operational work skills, on the other hand, are what set the framework for successful task completion. Five have already been identified from this study ranging from technical knowledge to mastery of digital tools. These are the talents that keep the wheels turning in an increasingly technological landscape. Graduates will be adequately prepared to meet the technological requirements of Industry 4.0 if they are incorporated into TVET education curricula. Colombo et al. (2021) state that students' competitiveness in the industrial sector is contingent upon their ability to comprehend digital tools and technologies.

Individual skills, or soft skills, are what define us as human beings. The abilities of leadership, flexibility, and communication cannot be mechanised. This study has discovered seven components in this domain and emphasises the need to develop collaboration, innovation, and resilience in students. Soft skills facilitate effective collaboration and innovation, which are a must in a rapidly changing industrial landscape. Le and Hong (2021) underscore the importance of developing these interpersonal skills in students to enable them to collaborate effectively in their future careers. In addition, project-based learning methods greatly facilitate the development of these types of skills by creating workplace-related scenarios, thus promoting students' problem-solving skills (Amiron et al., 2019).

Professionalism is not just a tick in a box; it encompasses values such as integrity, accountability, and a commitment to lifelong learning, which ensures its value. These are not values that one would like to have, but they are essential to a smooth workflow and the individual's success in an ever-changing industry. Schwab (2016) claims that a commitment to lifelong learning and ethical behaviour is essential for sustainable career development in the context of Industry 4.0. These professional attributes are essential for developing a workforce that can adapt to constant technological advancements and adhere to industry standards (Amiron et al., 2019).

The following breakdown of competencies across different areas reveals that acquiring technical or operational skills is just the beginning of what is required to ensure IR4.0 success. Educational institutions should provide a suite of well-balanced competencies at both personal and professional levels so that graduates will have a more than adequate toolkit to operate successfully in today's increasingly digitalized world. While technical know-how is undoubtedly essential, we cannot overlook its softer counterpart. Communication, flexibility, and the desire to learn and understand new knowledge will prove to be much more important in IR4.0 environments. This is also in line with existing literature that emphasises the aspects of interdisciplinary collaboration and growth mindset instilled in students (Amiron et al., 2019).

Finally, WBL programmes would help to bridge the gap between theoretical and practical knowledge. This would provide students with the necessary practical skills and industrial knowledge to confront career obstacles, as we could integrate IR4.0 components into these experiences. However, it is not all plain sailing. Sometimes, resource constraints and a shortage of instructors act as barriers. A further problem resides in the extensive distribution of talents across many disciplines. A single WBL course may be constrained in its ability to provide students with a comprehensive range of skills, given that cognitive skills, operational job skills, and individual skills each have several components and are subject to time limits. To tackle this issue, WBL curricula should emphasise essential abilities, implement modular routes for specialist skill development, and enhance industry collaborations to offer varied workplace experiences. These solutions jointly facilitate the equilibrium of the learning burden, while allowing students to progressively cultivate both the breadth and depth of competencies linked to IR4.0.

According to Ngatiman et al. (2023), TVET institutions must cooperate with industry to ensure learners are relevantly skilled and equipped with the latest knowledge in areas of specialization. Educational institutions, education departments, and ministries cannot tackle such challenges alone. It requires collaboration, joint investment, and cooperation between government departments, educational institutions, and appropriate industry partners to provide students with the quality education they need as they move into the future (Amiron et al., 2019).

Conclusion

This study concludes that TVET programmes, especially those that use WBL, must have the IR4.0 talent components highlighted. This research guarantees that IR4.0 competencies are relevant and applicable in preparing students for the digital age by finalising components based on expert consensus. Contributing to curriculum development, instructional approaches, and industry partnerships are the identified components across cognitive skills, operational work skills, individual skills, and professionalism. Incorporating these elements into work-based learning courses provides students with the knowledge and attitude needed to thrive in today's job market. Integration of IR4.0 into TVET programmes has the potential to improve education, but there are still obstacles to overcome, such as a lack of funding and qualified teachers. The only way to overcome these challenges and provide students with high-quality WBL experiences that adequately prepare them for the demands of IR4.0 industries is for educational institutions, legislators, and industry leaders to work together. This study highlighted the importance of IR4.0 skills in technical and vocational education and training programmes, particularly WBL programmes. Expert agreement on the final set of requirements would reassure everyone that the IR4.0 competencies are useful in preparing students for life in the digital world. This study predominantly depended on expert opinions; thus, confirmation with a wider population is crucial. The 21 highlighted components will provide the foundation for creating a structured survey instrument in future research concerning TVET students participating in WBL programmes. This empirical validation will enhance the framework's resilience and assure its alignment with actual WBL outcomes. In addition to national validation, future research should seek cross-institutional and cross-country benchmarking to assess the generalisability of these components across various TVET contexts and regional environments. Comparative research of this kind will reveal both universal competencies and context-specific requirements, therefore providing broader insights into global TVET growth. The various components identified through cognitive skills, operational work skills, individual skills, and professionalism will provide a solid basis for curriculum development, instructional approaches, and industry partnerships. By integrating these elements into WBL courses, we better equip graduates with the mindset and practical skills necessary to thrive in the ever-changing work environment.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors are responsible for the study conception, research design, data collection, data analysis, result interpretation and manuscript drafting.

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