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Shaping Industry 4.0 Ready Talent: TVET Experts' Strategies in Content Selection - NGT and ISM Approach

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Abstract

The rapid advancement of digital technologies and the evolving demands of the labour market have triggered transformative changes in the education and training landscape. In the era of cutting-edge technologies and digitalisation, traditional industry processes have been revolutionised, giving rise to new occupational profiles. Consequently, young talents entering the workforce need new competencies to cope with the infusion of rapid changes in technology. To address this, the integration of digital technologies in Technical and Vocational Education and Training (TVET) plays a pivotal role in preparing individuals for Industry 4.0. The recent COVID-19 pandemic has further accelerated online and remote learning adoption, underscoring the imperative of digitalisation in TVET. The objective of this study is to identify strategies for technical TVET instructors to select content that is Industry 4.0 fit and can be implemented in TVET settings. Supported by evidence-based experts' recommendations, this study delves into instructional design strategies to enhance the quality of TVET in shaping Industry 4.0 ready talents. Developed through

the consensus collective consensus, the model takes shape through the Nominal Group Technique (NGT) and Interpretive Structural Modelling (ISM) approach and involves nine experts, with each having more than ten years of experience in mechanical and manufacturing-related diploma programmes from both public and private TVET institutes in Malaysia. These experts have a wealth of experience and bring diverse perspectives, contributing from varied portfolios, which include curriculum development, assessment, media, industry advisor to institute, teacher training, and management. The findings revealed six prioritised strategies to be focused on. These strategies converged into three themes: industry-relevant work process-oriented, bite-size and flexible, as well as focus on the higher cognitive domain. The study offers a practical solution and reference for TVET practitioners in selecting content to ensure the talents are Industry 4.0-ready.
Keywords: *Tvet, Malaysia, Talent, Development, Industry 4.0, Teaching, Learning, NGT, ISM*

Introduction

Digital technologies and changing job market demands have brought significant changes to education and training. Industry 4.0, marked by advanced technologies and widespread digitisation, has transformed traditional industrial processes, creating entirely new job roles. As a result, new entrants to the workforce need fresh skills for this digital era. Integrating digital technologies into TVET is crucial for preparing individuals for Industry 4.0 (Spöttl, 2017; Spöttl & Windelband, 2021). Moreover, the COVID-19 pandemic emphasises the vital role of digitalisation in TVET. On the same note, the potential workforce from TVET institutes in ASEAN is challenged with low levels of preparedness, confusion, and ignorance, as well as disruption and uncertainty (Adnan et al., 2021). While many studies are focusing on the various perspectives on the negative impacts brought forth by Industry 4.0, it is notable that technology and digitisation, with the emergence of the cyber-physical system, created solutions to problems in manufacturing and engineering fields.

The Malaysian government, recognising its industrial progress and megatrends, is looking ahead to the future with the New Industrial Master Plan (NIMP) 2030. Through this initiative, the Ministry of International Trade and Industry (MITI) aims to expedite industry transformation to fulfil Malaysia's goals by the year 2030. In the pursuit of creating high-value job opportunities and enhancing opportunities in Malaysia, there is a crucial need to transition from low-skilled, labour-intensive occupations to knowledge-intensive (Singh et al., 2022) and higher cognitive domains. This shift aligns with global trends like Industry 4.0 technologies, climate change, demographic changes, and globalisation (NIMP, 2030), all of which are reshaping the job landscape. Therefore, skills transformation and the development of future competencies, especially for the vulnerable bottom 20% to 30% of the workforce that is routine and predictable threatened by automation, are central to the industrial strategy. As Industry 4.0 changes the workforce and occupational profiles (Spöttl, 2020), it is becoming increasingly difficult to predict and keep up with the demands and expectations in many ASEAN countries, including Malaysia (Rajadurai et al., 2018). Globally, TVET is undergoing rapid transformations, driven primarily by the increasing complexity of work processes and the rapid technological advancements, which are closely linked to and influenced by digitalisation (Stolte, 2021). Thus, addressing the competencies needed for the changing work profile and the needs of the industry, TVET instructors must be guided with strategies to select content that aligns with industry needs.

Problem Statement

Globally, TVET is undergoing rapid transformations, driven primarily by the increasing complexity of work processes and the rapid technological advancements, which are closely linked to and influenced by digitalisation. In ASEAN, there is a lack of awareness of critical Industry 4.0 skills and career readiness. In Malaysia, the 11th Malaysian Development Plan (2016-2020), as outlined by the Economic Planning Unit, has emphasised key objectives in enhancing labour market efficiency, aligning TVET programmes with industry demands, promoting lifelong learning, and elevating training quality. The Twelfth Malaysia Plan (2021-2025) lined up the policy enablers in line with this study for developing future talent and accelerating technology adoption and innovation. However, challenges persist in ensuring TVET institutions possess the necessary infrastructure, resources, and training to integrate digital technologies effectively (ILO, 2020). The COVID-19 pandemic accelerated the adoption of digitalisation in TVET worldwide, revealing digital divides and challenges related to technology access and digital literacy among instructors. These challenges, coupled with the lack of technical and non-technical competency among Malaysian TVET instructors (Saipudin & Suhairom, 2021), highlight the pressing need to address talent development in TVET to meet the demands of Industry 4.0.

Amid the evolving demands of the workforce, there is a recognised need to adapt TVET practices to align with the modern workplace. TalentCorp's report on the Critical Occupations List 2022/2023 has identified significant issues in recruiting talents for the workforce, particularly because of too few applicants or no applicants at all, applicants lack the required credentials or certification/ qualification, or lack required skill of quality checking for niche products. Additionally, recent studies by have revealed the lack of technical and non-technical competency, practical skills training, and industry experience among Malaysian technical TVET instructors. More alarming, this study by Kuntadi et al. (2022) revealed that students from Indonesia and a selected Malaysian public university have not yet reached their maximum potential and are not fully prepared to meet the digital demands of Industry 4.0. These findings highlight the need for the future talent and workforce to acquire new skill sets and competencies to thrive in a rapidly changing technological landscape (Bezuidenhout, 2018). To address these challenges, the transformation of TVET programmes should prioritise higher-order thinking, digitalisation, and integration of advanced technology (Liu et al., 2020).

Achieving this transformation requires a comprehensive and flexible teaching and learning process that extends beyond traditional classroom teaching, incorporates industry needs, and fosters a dynamic learning environment (Ismail & Hassan, 2019). It is essential to regularly review and reassess educational policies, practices, and professional development activities to ensure they remain aligned with the evolving environment and technological advancements (Carter et al., 2020). Therefore, TVET institutions must address the evolving demands of work and industry requirements. The current approach lacks comprehensive guidance for the successful implementation of Digital TVET, as it lacks essential characteristics and criteria for selecting industry-aligned content significant to Industry 4.0. The need for addressing Industry 4.0 and the changing work profile, digital divide, and unavailability strategies to shape the quality and teaching in TVET has led to this study, tailored to assist technical TVET instructors in managing the teaching and learning process within a digital and industry-relevant contextual framework. Additionally, there is a collective aspiration to elevate the quality of TVET to produce highly competent and job-ready graduates. Recognising that the nature of technology is dynamic, the proposed study accommodates the shaping of future-ready talents.

Research Questions

The guiding research questions are as follows:

RQ 2.1 What are the proposed strategies, according to TVET experts' consensus, in content selection for shaping Industry 4.0 ready talent?

RQ 2.2 Which of the proposed strategies, according to TVET experts' consensus, should be prioritised in content selection for shaping Industry 4.0 ready talent?

Literature Review

TVET and Industry 4.0

Industry 4.0 is characterised by the integration of cyber and physical with the aim of creating smart and connected factory systems. Infusion of advanced technologies with the Internet of Things (IoT), artificial intelligence (AI), and digitalisation into the physical and biological systems in manufacturing and industry helps to increase efficiency, reduce costs, and improve product quality. Content has evolved from print to audio, interactive and now digital content, such as 3D models, digital twins, virtual reality simulations, and other digital representations of physical assets, plays a critical role by enabling the creation of smart factories and the efficient management of production processes. This digitalisation allows for greater automation and connectivity in the manufacturing process, leading to increased efficiency and improved quality control. It is expected to lead to job displacement but also the development of new job skills that require competence qualification (Zulnaidi et al., 2020; Schröder, 2019; Ridzwan et al., 2017). In line with increased automation, digitalisation of work processes, and AI, there are new competencies to be developed. Various authors have presented ways to cluster competencies. Spöttl, Parvikam, and Paryono (2021) highlighted the new cluster of competencies as broad competencies or new basics, context-specific competencies, and abstract competencies. AI-driven generative technologies are changing the design process of the manufacturing industry, thus shifting the focus toward critical thinking, empathy, and creativity, abstract competencies.

TVET focuses on providing students with the competencies needed for specific trades or industries. The International Labour Organization reported that institutions drive innovation. TVET provides the skilled workforce needed to operate and maintain the advanced technology used in Industry 4.0. TVET helps to prepare workers for the changing job market and the new skills that will be required in Industry 4.0. The relationship between the world of work and TVET institutions suggests that changes in the industry and the job market have a significant impact on the training provided at these institutions. Cooperation between the two is necessary for producing graduates who are well-suited for the job market and who can directly influence the practice of the industry since progress can only be achieved when theory is directly linked to practice.

Curriculum Development Approaches In Malaysia Tvet

Approaches to curriculum development in Malaysia TVET vary. Develop A Curriculum, or DACUM is a process for analysing a job and creating a comprehensive job profile chart that includes duty and task statements. The training curriculum is based on the job profile chart. In Malaysia, trained facilitators, known as accredited process facilitators, are responsible for conducting the DACUM analysis and breaking down tasks into a sequence of steps. The resulting task analysis is used to develop a training curriculum that includes the knowledge, skills, attitudes, tools, equipment, and materials needed to perform the job. DESCUM is a process used by the Department of Skills Development in Malaysia to develop standards and curricula for specific jobs. The process involves identifying competency units developed into a competency profile chart to provide an overview of the job title. The specific work activity in each competency unit details the work steps taken and the criteria for performance assessment. The output of the process is a competency profile for each competency unit. The chart detailed curriculum that includes knowledge, skills, attitude, safety and environment considerations, assessment criteria, tools, equipment, materials, and weightage for each competency unit and work activity. CUDBAS involves analysing a job to create an ability chart that describes the knowledge, skills, and attitudes required for that job, used to develop a training curriculum. The completed ability statements I used for the identification of competency levels among instructors as a tool for need training analysis and to outline the depth and breadth of the training programme. Public institutions commonly use this approach for the design of upskilling courses.

Work-process curricula are an upcoming method of designing TVET curricula suggested by German experts based on the work processes that are commonly used in a specific industry or field. The curricula are developed in partnership with highly skilled workers who have broad-based experience in the industry. The core work processes that are identified have characteristics such as being common in companies operating in the branch or field, having complex actions in teams or individually, describing the core requirements in a determined area in a job or occupation, and comprising many sub-tasks. The core work processes provide an overview of how a job/occupation is performed and a deeper understanding of the conditions and requirements of the job or occupation. The work processes detail the content of work, tools, methods/procedures, organisation of work, and requirements or deliverables. These requirements may include adherence to safety regulations, health, safety, and environmental acts, or certification body requirements.

Addressing Digitalisation

The lack of adequate skill sets to expedite the movement towards Industry 4.0 in Malaysia is a challenge (Pavlova, 2019). Additionally, TalentCorp Critical Occupations List 2022/2023 reported that too few applicants or no applicants at all, applicants lack the required credentials, certification or qualification, or lack the required skill of quality checking for niche products. These various sources highlighted that lack of awareness of the concept of Industry 4.0 and its benefits, curricula of courses offered by local higher learning institutions are not up to date with current industry practices, and graduates lack the required technical and soft skills to succeed in these critical roles. Additionally, technical TVET instructors are not fully ready and do not really understand how to apply elements of Industry 4.0 in Malaysia and ASEAN member states (Ho & Phua, 2021; Nurjanah & Ana, 2022; Puriwat & Tripopsakul, 2020). It is important to establish a culture of innovation and collaboration to respond to the demands of digital transformation effectively. Understanding the requirements of Ind 4.0 and what skills will be needed to succeed is a top Industry 4.0 investment priority. Their organisations will enhance the technical TVET instructors' readiness and graduate performance. It can be achieved by involving all stakeholders, updating curriculum content, improving delivery methods, and effectively utilising technology. Technology, on the other hand, as suggested by Jonassen (2009), should be used as a cognitive tool that relies on the learner to provide intelligence. Juhary (2022) suggested that curricula should be redesigned and updated to provide students with knowledge, exposure, and experience. This process can be difficult to implement and may become obsolete quickly due to rapid technological changes. An alternative is to incorporate updated, industry-relevant content within the existing curriculum. In the context of Industry 4.0, the focus of content selection for TVET programmes is advanced manufacturing technologies, such as robotics, automation, and IoT, as well as related areas like data analytics and cybersecurity.

Additionally, this content may include the key Industry 4.0 principles, such as digitalisation and interconnectivity, to help them understand how these technologies are transforming the way businesses operate. The content of TVET programmes for Industry 4.0 will, however, vary depending on the specific industry or occupation the programme focuses on and the level of education offered. The direction of the TVET programme must be outlined clearly (Ibrahim & Nashir, 2022). However, with rapid change and advancement in technology, vagueness and constant change set the orientation.

Understanding the needs of the industry and the labour market is important for technical TVET instructors to select content for developing effctive teaching materials and activities in the learning and teaching process. The training content should align with the current job market demands and focus on developing the transversal skills required for future job success. The student-centred learning and incorporating practical, industry-relevant methodologies enhance their learning performance and employability skills (García-Pérez et al., 2021). It helps technical TVET instructors ensure that the skills and knowledge are aligned with the current and future demands of the workforce and that students are prepared for the job market upon graduation (Kenayathulla, 2021; Kenayathulla et al., 2019). Successful implementation from higher learning institutions in terms of future-ready curricula and realising digital transformation must be understood by all stakeholders, especially the learners and instructors. Industry 4.0 requires a multi-disciplinary skill set from workers, including technical and non-technical skills and practical experience. Hands-on training programmes that provide real-world experience are crucial in preparing workers for successful careers in this rapidly changing environment (Madsen et al., 2016). Moreover, educational settings affect the amplitude of learning and what is learned (Christiansen et al., 2022).

Based on the literature reviewed, the authors believe that to effectively implement Industry 4.0 in a TVET setting, strategies to select the content that is certification and industry-relevant. Therefore, the objectives are to acquire TVET experts' collective opinion on the strategies to be applied for selecting content for the learning and teaching process fit for Industry 4.0 based on a relationship model.

Technology and Content

Many technical instructors find that knowledge-based concepts or theoretical sessions can successfully transition online (Code et al., 2020). When thinking about 21st-century and online learning in TVET, the question is how technology can support skills training. Addressing the curriculum's 'hands-on' or practical aspects posed significant challenges and alternative platforms and strategies should be carefully selected and implemented to provide students with the necessary knowledge, exposure, and experience, considering that certain L&T activities may not be feasible online.

There is a need to redesign and revitalise the curricula as well as explore and implement alternative platforms and strategies to provide students with valuable knowledge, exposure, and experiential learning opportunities. However, revamping a curriculum will not be easy since it relates to approval and accreditation, which the accreditation bodies regulate. Another concern is incorporating current and industry-relevant standards and practices into the TVET curriculum design (Spottl, 2019).

The perspectives on curriculum design and implementation in remote learning encompass a range of viewpoints and concerns. The scholars acknowledge the challenges in translating hands-on aspects to an online format, emphasising the unique nature of remote learning experiences. Furthermore, they emphasise the importance of ensuring quality learning experiences for students despite the shift to online platforms. However, there are differing views on the feasibility of executing certain activities online and whether the content should remain the same or be adapted. Nevertheless, the content for synchronous and asynchronous learning situations should be the same since there is no change in the curriculum (Gaytan & McEwen, 2007). Having the same content for synchronous learning situations will allow instructors to shift from classroom to remote delivery or online quickly. The only difference is that no physical touch is available, which is much appreciated in some cultures. In planning and organising a session, decisions on content, expected outcomes and deployment methods are constructively aligned. Additionally, to stay relevant, there is a need for programme content to be aligned and adapted to the new reality quickly (Benis et al., 2021).

This study delves into the considerations related to curriculum design and implementation in the context of learning within TVET. Emphasise that while theoretical aspects of technical education can transition successfully to online formats, there are significant challenges in replicating hands-on or practical components. The study recognises that not all educational content, particularly practical skills, can be effectively delivered remotely. Suggests redesigning curricula and exploring alternative platforms to provide students with valuable knowledge, exposure, and experiential learning, acknowledging the need to adapt to the unique demands of online learning. However, they also acknowledge the complexity of curriculum changes, including accreditation and industry relevance issues, echoing the importance of aligning educational content with industry standards.

The literature debates over whether content should remain consistent across synchronous and asynchronous learning situations, with some scholars advocating for uniformity. The idea aligns with the L&T principle of constructively aligning content, expected outcomes, and deployment methods for effective teaching. In conclusion, the review revealed the perspectives and considerations in adapting TVET curricula for technology-driven learning, emphasising the importance of maintaining quality and alignment with industry standards, which are key aspects of the study.

Research Method

The identification of the strategies conducted used the NGT and ISM assisted by software. NGT and ISM were deployed in this study based on the design and development research model development by Richey and Klein (2007). The first method employed in this investigation is the NGT technique, which involved consulting nine technical TVET instructors specialising in mechanical and manufacturing-related diploma programmes. The experts are briefed on the objective of the discussion and the expected outcomes by an appointed facilitator. The NGT uses a hybrid session while the ISM is done remotely.

Nominal Group Technique (NGT)

NGT is a systematic tool used to determine a group's shared viewpoints on a certain subject. The application of these instruments can be seen in the works of many scholars. NGT is a systematic tool used to elicit a group's collective opinions and insights on a particular subject (Potter et al., 2004; Harvey & Holmes, 2012). Its versatile application extends across various academic domains, including mental health (Mahmud & Mustapha, 2022; Mustapha et al., 2022), heat energy (Rade et al., 2017), submarine operations (Moelyanto et al., 2021), safety management (Khan et al., 2017), showcasing its application versatility and effectiveness in various research disciplines.

Introduced in the 1960s, NGT originally served as a method for conducting group discussions aimed at generating information to address specific issues. Over time, it has gained recognition and adoption by scholars from diverse fields, including consumer groups, health, medical sciences, and social work. The method's appeal lies in its cost-effectiveness and efficiency, making it an attractive choice for researchers.

One of NGT's key strengths is its capacity for idea generation and clarification, ensuring that every participant's perspective is not only heard but also acknowledged (Wiggins et al., 2020). This collaborative approach facilitates a comprehensive exploration of topics, making it a valuable tool for researchers and professionals seeking to harness the collective wisdom of a group while efficiently addressing complex issues.

The NGT has been used by scholars across disciplines because it is a cost-effective and time-efficient method for data collection. The merits of the application based on articles reviewed using NGT include:

1. Provides equal opportunity for all members to have a voice in contributing their ideas and opinions.
2. Facilitates the generation of a substantial number of ideas in a relatively short amount of time.
3. Encourages members to critically evaluate the clarity, strengths, and weaknesses of each idea.
4. Allow participants to contribute their perspectives and ensure each voice is heard.
5. Promotes group decision-making among group members.
6. Effective data collection, valuable information generation, and clarification in response to specific issues through group discussions.
7. Prioritisation of information, which allows participants to prioritise and discuss the generated information, ensuring that the most important ideas are given appropriate attention.
8. Interdisciplinary applicability.

The facilitator posed the stimulus question to a group of nine experts, a recommended size by. These experts have over ten years of experience in manufacturing and mechanical-related diploma programmes and portfolios related to assessment, management, curriculum development, and innovation. During the idea generation, the experts respond individually to each stimulus question and write their solutions independently. The ideas were recorded and shared with the group to avoid a single train of thought. These idea statements were reviewed and refined collectively in the group to increase clarity. The group reached a consensus on the proposed idea statement by voting. The voting score is based on a 5-point Likert scale. Each expert indicated their level of agreement with each statement using 1 = Strongly disagree, 2 = Disagree, 3 = Not sure, 4

= Agree, 5 = Strongly agree. Statements that reached 70% of expert consensus or more, according to Deslandes et al. (2010) and Dobbie et al. (2004), are identified as *suitable* strategy ideas. Based on the percentage of the scores, the statements are ranked in descending order. The NGT process was completed according to schedule, and quick decision-making was avoided. The output of the NGT is a list of 16 *suitable* strategy statements.

Interpretive Structural Modelling (ISM)

ISM Concept Star is the licensed software used to build the relationship model. The four main input for the ISM software is the title, relation phrase, construct, and idea list. The ideas entered into a dialogue box are suitable strategy statements. Each strategy statement in the idea list was voted on. The same experts from the NGT process are involved in this process. The experts voted "yes" or "no," depending on their individual expert opinions on each of the strategy statements. The construct that is being used is "In managing day-to-day learning and teaching process. There are various challenges faced by TVET technical instructors in selecting content fit for Industry 4.0. The strategy is to ...." The relationship phrase used during the voting between the strategy statements is "This strategy is more significant than...". The defined construct and the relationship statement guide the experts.

Each expert voted "yes" if they agreed with the relationship and "no" if otherwise. The final decision regarding the relationship is made based on the majority count of the experts' votes. The output of the ISM is a relationship model. The analysis of the model continues to determine the category of each strategy statement.

Results

This structured process of small-group discussion in NGT was used in the study to generate strategies from nine experts. Experts prioritised all strategies by voting on the proposed strategy statements. All 16 strategy statements are identified as suitable according to expert consensus. These strategy statements are numbered from one to 16 in no specific order. The percentage of the score, rank priority, and voter consensus for each strategy statement using Microsoft Excel software is displayed in Table 1.

Table 1. Expert Consensus on Strategy Statements

Strategy	Strategy Statement	Percentage	Rank priority	Expert Consensus
7	Have flexibility in content for students to adopt and adapt to situations that increase learnability.	98	1	Suitable
6	Use digitalised content.	96	2	Suitable
11	Weigh the industry's need against curriculum experts.	94	3	Suitable
12	Incorporate digital media / ICT infra.	94	3	Suitable
1	Refer to a standard (National Occupational Skills Standard (NOSS) or industry standard).	92	4	Suitable
9	Create practical content that can be done online using a platform that is readily accessible.	92	4	Suitable
15	Incorporate content using a wide range of technology applications software/simulation VR for practical use.	92	4	Suitable
16	Do more project-based content - prepare, design, and choose learning content to include more holistic competencies.	92	4	Suitable
2	Create content in a work process-oriented manner, a complete task or process that integrates technical competencies (analysing, interpreting, optimising processes, troubleshooting, and maintaining devices.	88	5	Suitable
4	Assess student's level of knowledge/prior knowledge in relation to content to be covered.	88	5	Suitable
5	Know the demand for apps/software applications before we propose and search for the content.	88	5	Suitable
8	Create SMART content to allow students/trainers to choose based on preference to create interest.	88	5	Suitable
13	Incorporate response to the market's demands and the industry's needs.	88	5	Suitable

3	Create bite-sized, reusable content that is manageable by students for a specified time frame/duration.	86	6	Suitable
10	Incorporate rules, regulations, policies, processes, and procedures applied in the industry into the content.	78	7	Suitable
14	Enforce the use of established standards.	76	8	Suitable

Source: Prepared by the author,(2024)

Based on Table 1 above, The strategy with more than 95% of votes is Strategy 7 - Have flexibility in content for students to adopt and adapt to situations that increase learnability and Strategy 6 – Use digitalised content. The strategies having more than 90% agreement are Strategy 11- Weigh the industry's need against curriculum experts, Strategy 12 - Incorporate digital media / ICT infra, Strategy 1- Refer to a standard (National Occupational Skills Standard (NOSS) or industry standard), Strategy 9 - Create practical content that can be done online using a platform that is readily accessible, Strategy 15 - Incorporate content using a wide range of technology applications software/simulation VR for practical use and Strategy 16 - Do more project-based content - prepare, design, and choose learning content to include more holistic competencies. The strategies that more than 85% of experts agreement are Strategy 2 - Do more project-based content - prepare, design, and choose learning content to include more holistic competencies, Strategy 4 - Assess student's level of knowledge/prior knowledge in relation to content to be covered, Strategy 5 - Know the demand of apps/software applications before we propose and search for the content, Strategy 8 - Create SMART content to allow students/trainers to choose based on preference to create interest, Strategy 13 - Incorporate response to the market's demands and the industry's needs and Strategy 3 - Create bite-sized, reusable content that is manageable by students for a specified time frame/duration. The two lowest ranked strategies, but have more than 75% of experts' agreement, are Strategy 10 - Incorporate rules, regulations, policies, processes, and procedures applied in the industry into the content and Strategy 14 - Enforce the use of established standards.

Generally, the relationship model development is a tedious process. However, the backend programming in the ISM Concept Star software helps to identify the relationship between each strategy. It is used to identify the strategies that influence or drive the behaviour of the system.

The final output generated by the Concept Star software is a relationship model shown in Figure 1 below. The relationship model generated by the software helps the authors to understand the relationship between each strategy statement. The arrows in Figure 1 dictate the driving factor. The logic behind this is that if element A drives element B, and element B drives element C, Then it can be concluded that element A drives element C. However, the logic is not true otherwise. Element C is dependent on element B, and element B is dependent on element A. In Figure 1 below, Strategy 2, Strategy 3, and Strategy 8 drive Strategy 16, Strategy 16 drives Strategy 13, and Strategy 13 drives Strategy 1, Strategy 6, and Strategy 15. Then, it can be concluded that Strategy 2, Strategy 3, and Strategy 8 drive Strategy 1, Strategy 6, and Strategy 15. The term driving power and dependent power used in the next part (Reachability Matrix) is related to this logic.

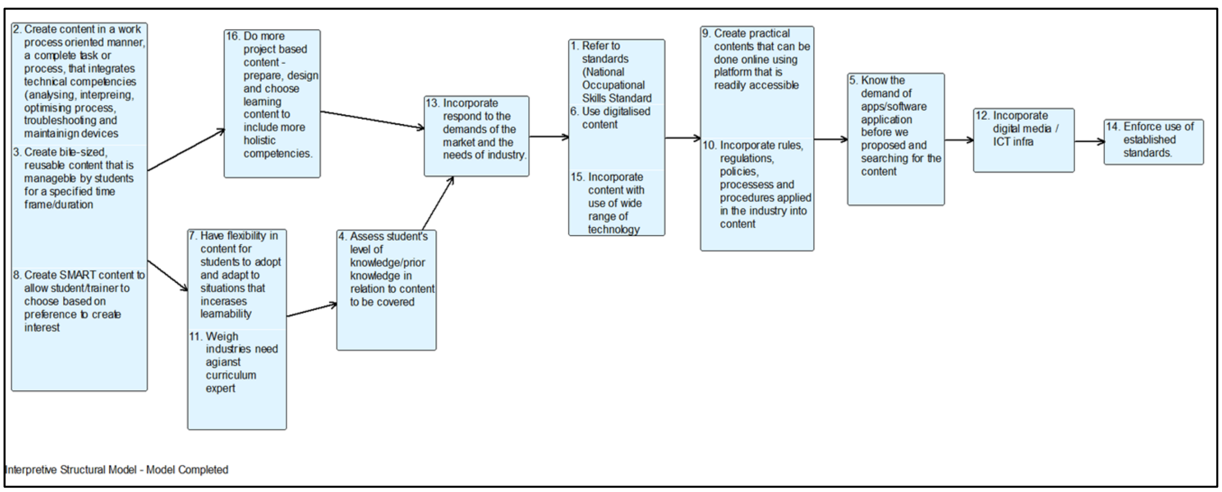

Figure 1: Relationship Model for Content Selection Strategies

From the relationship model Figure 1, the driving power and the dependent power for each strategy are identified.

The values "0" and "1" are derived from Figure 1 using the following rule. "i" and "j" are the strategies.

Input (*i*, *i*) is marked as "1" because *i* drive *i*

Input (*i*,*j*) is marked as "1", because *i* drive *j*

Input (*j*, *i*) is marked as "0" because *i* is not driven by *j*.

The interconnections between the driving power and dependent power for each strategy are important to categorise the strategies. It is further discussed under the sub-heading MICMAC Diagram.

The interconnections between these strategies are mapped out in a matrix called the reachability matrix, given in Error! Not a valid bookmark self-reference. below.

Table 2. Reachability Matrix

Strategy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Driving power
1	1	0	0	0	1	1	0	0	1	1	0	1	0	1	1	0	8
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
4	1	0	0	1	1	1	0	0	1	1	0	1	1	1	1	0	10
5	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	3
6	1	0	0	0	1	1	0	0	1	1	0	1	0	1	1	0	8
7	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	0	12
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
9	0	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	5
10	0	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	5
11	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	0	12
12	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2
13	1	0	0	0	1	1	0	0	1	1	0	1	1	1	1	0	9
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
15	1	0	0	0	1	1	0	0	1	1	0	1	0	1	1	0	8
16	1	0	0	0	1	1	0	0	1	1	0	1	1	1	1	1	10
Dependent Power	11	3	3	6	14	11	5	3	13	13	5	15	8	16	11	4	

Source: Prepared by the author,(2024)

The result of the partitioning is shown in Table 3 as follows. There are ten levels for the sixteen strategies. Strategies 2,3 and 8 are at Level 10. Level 1 started with Strategy 14.

Table 3. Partitioning of Reachability

Strategy	Reachability Set	Antecedent Set	Intersection	Level
	1,5,6,9,10,12,14,15	1,2,3,4,6,7,8,11,13,15,16	1,6,15	5
	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16	2,3,8	2,3,8	10

	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16	2,3,8	2,3,8	10
	1,4,5,6,9,10,12,13,14,15	2,3,4,7,8,11	4	7
	5,12,14	1,2,3,4,5,6,7,8,9,10,11,13,15,1 6	5	3
	1, 5,6,9,10,12,14,15	1,2,3,4,6,7,8,11,13,15,16	1,6,15	5
	1,4,5,6,7,9,10,11,12,13,14, 15	2,3,7,8,11,	7,11	9
	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16	2,3,8	2,3,8	10
	5,9,10,12,14	1,2,3,4,6,7,8,9,10,11,13,15,16	9,10	4
	5,9,10,12,14	1,2,3,4,6,7,8,9,10,11,13,15,16	9,10	4
	1,4,5,6,7,9,10,11,12,13,14, 15	2,3,7,8,11	7,11	9
	12,14	1,2,3,4,5,6,7,8,9,10,11,12,13,1 5,16	12	2
	1,5,6,9,10,12,13,14,15	2,3,4,7,8,11,13,16	13	6
	14	1,2,3,4,5,6,7,8,9,10,11,12,13,1 4,15,16	14	1
	1,5,6,9,10,12,14,15	1,2,3,4,6,7,8,11,13,16	1,6	5
	1,5,6,9,10,12,13,14,15,16	2,3,8,16	16	8

Source: Prepared by the author,(2024)

Micmac Diagram

The purpose of the MICMAC diagram is to analyse the drive power and dependence power of factors (Attri et al., 2013). The MICMAC diagram is obtained by using the values of the x (dependence power) and y (driving power) axes as (x, y) coordinates in a Cartesian graph. The x and y values are identified and presented in Table 4 below. The coordinate is marked by using the strategy number. By using these values as the coordinate points in a Cartesian graph, each strategy is categorised into a specific quadrant. Each quadrant denotes a specific characteristic for the driving and dependent power, as shown in Table 5.

Table 4. Driving power and dependence power.

Strategy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
x	11	3	3	6	14	11	5	3	13	13	5	15	8	16	11	4
y	8	16	16	10	3	8	12	16	5	5	12	2	9	1	8	10

Source: Prepared by the author,(2024)

The Cartesian graph or MICMAC diagram is given in Error! Reference source not found. accordingly.

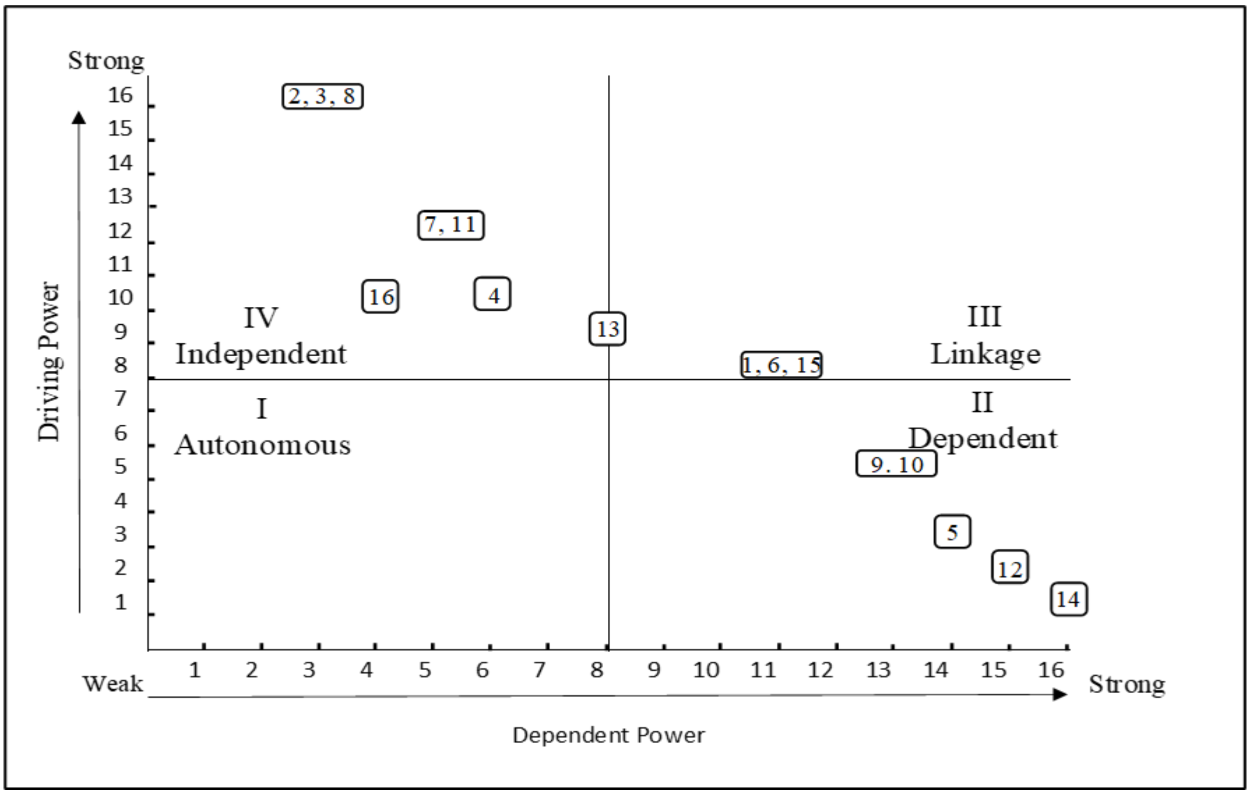

Figure 2: Micmac Diagram

Based on the driving power and dependent power, the strategies are categorised into four quadrants. The description of the characteristics of the strategies according to each quadrant is given in Table 5 below.

Table 5. Characteristics of Quadrant

Quadrant	I	Autonomous. Strategies have weak drive power and weak dependence power. The strategies that enter this quadrant are generally not related to the system and may have little relationship even though the relationship can be strong. There is no strategy for this characteristic in this study.
Quadrant	II	Dependent. weak driver-strongly dependent strategies. The strategies in this quadrant are dependent on the independent strategies.
Quadrant	III	Linkage. Strong driver-strongly dependent strategies. Strategy 6, Strategy 13 and Strategy 15 must be addressed carefully because the relationship between the strategies is unstable.
Quadrant	IV	Independent. Strong driver-weak dependent strategies. Strong strategies that drive the system.

Source: Prepared by the author,(2024)

Therefore, the quadrants to be addressed are Quadrant IV, Quadrant II, and Quadrant III. By referring to the MICMAC diagram, six independent strategies have strong driving powers. These strategies are shown in Table 6 as follows.

There are six dependent strategies, as shown in Table 7 below.

Table 6. Independent Strategies

Strategy	Statement
2	Create content in a work process-oriented manner, a complete task or process that integrates technical competencies (analysing, interpreting, optimising process, troubleshooting, and maintaining devices
3	Create bite-sized, reusable content that is manageable by students for a specified time frame/duration.
8	Create SMART content to allow students/trainers to choose based on preference to create interest.
7	Provides flexibility in content for students to adopt and adapt to different situations, thereby increasing learnability.
11	Weigh the industry's need against curriculum experts.

4	Assess students' levels of knowledge/prior knowledge in relation to the content to be covered.
16	Incorporate more project-based content, which involves preparing, designing, and choosing learning content to include more holistic competencies.

Source: Prepared by the author,(2024)

Table 7. Dependent Strategies

Strategy	Statement
1	Refer to a standard (National Occupational Skills Standard (NOSS) or industry standard).
5	Know the demand for apps/software applications before we propose and search for the content.
9	Create practical content that can be done online using a platform that is readily accessible.
10	Incorporate rules, regulations, policies, processes, and procedures applied in the industry into content.
12	Incorporate digital media / ICT infra.
14	Enforce the use of established standards.

Source: Prepared by the author,(2024)

Strategy 5 Do the real thing based on real work from the industry (contextual learning), Strategy 13 Create a technical guidance team comprising experts from the institute and industry (field experts); and Strategy 15 Fully digitalised the content (can be used for synchronous and asynchronous learning) are categorised as linking strategies.

Discussion

The practical implications of this study on the instructor's role in TVET settings are significant. The study offers technical TVET instructors a structured guide to navigating the complexities of the L&T process in the Digital TVET landscape. To some extent, the study addressed the concerns raised in the problem statement. The following subheadings describe some practical implications in responding to these concerns.

Focused Strategies

The three core strategic themes derived from the prioritised strategies are industry-relevant work-process oriented, bite-size and contextual, and higher cognitive domain focus. By focusing on these three core themes, technical TVET instructors can design content relevant to industry needs, easily digestible for learners, and promote the development of higher-order cognitive skills. These themes align with the principles of Industry 4.0 and the requirements of digitalisation.

Industry-relevant work-process oriented

Strategy 2 emphasises the importance of creating content designed in a work process-oriented manner, incorporating complete tasks or processes that integrate technical competencies to weigh the industry's needs against curriculum experts (strategy 11). This theme aligns with the Industry 4.0 concept, which emphasises the integration of digital technologies into industrial processes. Students can develop relevant skills and knowledge that apply to the industry by incorporating real-world work processes into the content. This approach relates to behaviourism by focusing on skill development through structured learning processes.

Bite-sized and flexible

Strategy 3 and Strategy 8 contribute to the bite-sized and flexible content theme. Strategy 3 suggests creating reusable content that is manageable within a specified time frame, allowing students to learn in bite-sized chunks and supporting cognitivist principles of chunking information for better retention and reinforcement. Strategy 8 emphasises creating SMART (Specific, Measurable, Achievable, Relevant, Time-bound) content, enabling students and trainers to choose topics based on their preferences and interests. Therefore, assessing students' levels of knowledge/prior knowledge in relation to the content to be covered (Strategy 4) seems important in order to support flexibility. This theme is closely related to the demands of Digital TVET, where learners require flexibility in accessing and consuming content, allowing them to learn at their own pace and according to their specific needs. This theme aligns with constructivism and collaboration, as it encourages active engagement, critical thinking, and the application of knowledge in authentic contexts.

Focus on the higher cognitive domain

Strategy 7 and Strategy 16 highlight the significance of incorporating higher-order cognitive skills and competencies into the content. Strategy 7 promotes flexibility in content, enabling students to adopt and adapt to different situations, thereby increasing their learnability. Learnability aligns with the need for students to develop critical thinking, problem-solving, and adaptability skills in Industry 4.0. Strategy 16 suggests incorporating more project-based content involving preparing, designing, and selecting learning materials that foster holistic competencies. This theme emphasises higher-level cognitive processes, such as analysis, interpretation, optimisation, troubleshooting, and maintenance, which are essential in the digitalised TVET landscape.

Enforcing rules and relying solely on established standards may hinder technical TVET instructors from effectively integrating meaningful content material into their teaching. Over time, these industry standards can become outdated, stifling innovation and creativity within the learning process. Achieving a dynamic and effective learning environment necessitates a delicate balance between independent characteristics that drive innovation and dependent characteristics that ensure practicality and relevance.

Independent characteristics, which include crafting industry-relevant, work-process-oriented content, creating adaptable bite-sized learning modules, and emphasising higher-order cognitive skills, act as catalysts for learning innovation. These attributes encourage educators to think creatively, adapt to evolving needs, and prioritise critical thinking and problem-solving skills among students.

However, the true impact of these independent characteristics emerges when they are seamlessly integrated with their dependent counterparts. For example, industry-relevant content gains added practicality when it aligns with established standards, ensuring that students acquire up-to-date, industry-recognised knowledge and skills. Likewise, crafting manageable content proves effective when it is accessible through easily available platforms (as recommended in Strategy 9) and aligns with assessments of students' prior knowledge (as in Strategy 4).

Moreover, promoting a focus on higher cognitive domains (as in Strategy 8) becomes more meaningful when coupled with flexibility and adaptability in students' learning experiences (as in Strategy 7). This approach allows students to apply critical thinking skills in diverse contexts, ultimately enhancing their overall capacity to learn.

For dependent strategies that emphasise work process-oriented content, contextual learning from industry (Strategy 5) becomes crucial. The real-world application provided by this linking strategy ensures that students gain practical insights and relevant skills aligned with industry demands. Additionally, the formation of a technical guidance team comprising experts from both the institute and industry (Strategy 13) directly support the creation of bite-sized, reusable content (dependent Strategy 3) by providing expert insights and ensuring the content aligns with industry standards.

On the other hand, the linking strategies also play a pivotal role in supporting independent strategies. For instance, creating practical online content (independent Strategy 9) is facilitated by fully digitalising the content (Linking Strategy 15), enabling a seamless transition to both synchronous and asynchronous learning. The demand for apps/software applications (independent Strategy 5) is addressed by the linking strategy of doing the real thing based on real work from the industry (Strategy 5), ensuring that the curriculum is aligned with current industry needs.

In conclusion, the collaboration between innovative independent traits and practical dependent traits is vital for successful learning. To put this into practice, teachers should focus on real-world content aligned with industry needs, allowing students to apply their knowledge practically. This approach enhances students' readiness for the workforce. By combining innovation with reliability in teaching, instructors can offer students a well-rounded learning experience that prepares them for success in their chosen field. Graduates from vocational programmes can then enhance their abilities and collaborate effectively with technology instead of competing against it.

Addressing Digitalisation

The works from discuss how the fourth industrial revolution is changing the job market through automation and digitalisation. This shift may lead to job losses and a need for people to learn new skills to stay competitive in the changing job market. The study addresses this by emphasising the integration of industry-specific technical competencies in delivering TVET instruction, ensuring learners acquire the relevant skills needed in the evolving job market.

Furthermore, contribute to the discussion by specifically addressing the identification of occupational profiles, the anticipation of skills needed and acquiring the relevant competencies in the face of digitalisation. In this context, the study's emphasis on content selection or development becomes particularly valuable. The study details the strategies to be focused on in preparing talents for the future. The model helps technical TVET instructors to effectively incorporate industry-relevant skills into their instruction, design authentic learning and assessment tasks, and align to address the needs of the identified occupational profiles. As highlighted in the findings, there is a significant emphasis on the need for learners to acquire skills aligned with industry requirements. Preparing for an occupation that is technology-driven requires a new work profile environment. Aligning TVET with the dynamic requirements of the modern workforce, the development of work process-oriented content (Schroeder, 2019) in the study emerges as a crucial strategy and sets the first characteristics for content selection in addressing the changing work profile. The strategy entails meticulously designing L&T materials structured around industry-specific work processes, encompassing comprehensive tasks and integrating the requisite technical competencies as well as placing focus on the higher-cognitive domain, incorporating the latest technological advancements (Spöttl et al., 2019), that resonate with the ever-evolving work profile.

Conclusion

Meaningful content promotes meaningful learning. The choice of content facilitates meaningful learning, as it shapes the competencies that students develop. In the context of TVET, the effective implementation of Industry 4.0 requires the identification of content selection strategies that not only meet certification standards but also align with industry requirements, which are more current and relevant. Guided by a resolute commitment to shaping Industry 4.0-ready talent, our strategic focus converges on key themes: industry-relevant work-process orientation, bite-size and contextual content, and a targeted focus on the higher cognitive domain. This strategic alignment is not only crucial but non-negotiable, ensuring our learners emerge not only equipped but primed for the demands of Industry 4.0, reflecting the dynamic needs of the market and industry evolution.

The integration of digital resources into TVET instruction provides technical TVET instructors with the flexibility and creative freedom to personalise and enhance the learning experience. Up-to-date and industry-aligned digital content benefits both technical TVET instructors and students, fostering a dynamic learning environment. This approach resonates with the principles of Industry 4.0, emphasising the integration of industry-relevant content, including digital technologies, data analytics, artificial intelligence, and data-driven decision-making, into curricula.

Technical TVET instructors face the critical task of differentiating between what is currently taught and what is needed to shape the workforce for the future. As Industry 4.0 continues to shape workforce requirements, these strategies contribute to the development of a competent workforce aligned with the evolving needs of various industries. Many education and training systems worldwide struggle to keep pace with these changes, resulting in using outdated curricula and teaching methods that may not adequately prepare students for the demands of tomorrow. Talent development remains paramount. Consequently, this study lays the groundwork for a transformative shift in the TVET landscape toward Industry 4.0 readiness.

Technical TVET instructors must acquire the skills necessary to integrate technology into their daily teaching routines effectively. It includes leveraging intelligent machines and digital tools to enhance learning experiences, facilitate information access, engage students, and promote abstract competencies. The synthesis of technical TVET instructors' experience, expertise, and computational competence empowers them to create dynamic and formidable learning environments that push the boundaries of what is achievable.

A pivotal contribution of this study is its emphasis on industry relevance in curriculum design. There is little value in concentrating on these dependent strategies when the critical strategies that demand our attention are being overlooked. Not only are these neglected strategies essential, but they also possess the capability to drive quality significantly. Rather than adhering to fixed curriculum content, the model dynamically incorporates industry demands and trends into the content dimension. It ensures that TVET programmes remain in sync with the evolving needs of the job market, mitigating the risk of outdated curricula. The strategies equip technical TVET instructors with the knowledge and skills that are directly aligned with industry requirements, bridging the gap between what is currently taught and what the modern workplace demands from tomorrow's workforce.

Authors contributions

This study is a co-authored article. Raihan Tahir conceptualised the study and wrote the initial draft under the supervision of Zuraidah Abdullah, who provided critical feedback and edited the manuscript to comply with the requirements of the publisher.

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