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Competency Index of Technical Vocational Education and Training (TVET) Instructors for 4.0 Industrial Revolution

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ABSTRACTS

The purpose of this research is to develop the Competency Index of TVET instructors towards Industrial Revolution 4.0 (IR4.0). The new technological waves from IR4.0 bring changes and development to current technology, and the TVET education system in Malaysia is bound to face a similar fate. TVET instructors play the biggest role to shape the human product in TVET institutions. A competent TVET instructor will yield competent human capital. Therefore, the reinforcement of the TVET system should begin with the main player which is the TVET instructor. Therefore, a Delphi study will be conducted involving 11 expert panels to identify the index of Competency of TVET instructors towards IR4.0. With the findings from this Delphi study, a questionnaire about Competency Index will be developed. Then, the questionnaire will be distributed to 147 TVET instructors from the electrical and electronics department at the institution under the Ministry of Youth and Sport. The data collected from the questionnaire will help the researcher to develop the Competency Index of TVET instructors towards IR4.0. The findings of the study will help the TVET institution in preparing TVET instructors to become specialized, highly-skilled, competent, and efficient in the attempt to strengthen the teaching profession, which is in line with IR4.0.

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1. INTRODUCTION

Technical Vocational Education and Training (TVET) is the education and training that include formal, non-formal, and informal learning that prepares young people with knowledge and skills for employment (Tripney & Hombrados, 2013). TVET system is well-recognized worldwide for example, in Germany, the TVET system is highly recognized due to its combination of theory and training embedded in a real-life work environment (Reinhard *et al*., 2016). Meanwhile, in Australia, the TVET system is very well-known due to its strong focus on industry demand, skills application, and to its scalability and flexibility (Karmel, 2014). And in China, the TVET system has successfully enhanced the employability of its labor force and can contribute to China's social and economic development (Li & Pilz, 2019).

The purpose of this research is to develop the Competency Index of TVET instructors towards Industrial Revolution 4.0 (IR4.0). The new technological waves from IR4.0 bring changes and development to current technology, and the TVET education system in Malaysia is bound to face a similar fate. TVET instructors play the biggest role to shape the human product in TVET institutions.

The findings of this study are based on the objective of the research, which includes developing a TVET index of competencies among TVET instructors in the Public Skills Training Institutions for the 4th Industrial Revolution. This includes determining the existing levels of knowledge, skill, and attitudes among TVET instructors, and the levels of competencies index based on the three elements among the instructors too.

The key findings of the study initially describe the demographic profile of the participants. Next, this chapter summarizes the research findings of document analysis from the perspectives of the panel experts. Finally, this chapter ends with a summary.

2. METHODS

The detailed method is described in our previous study (Shahroni & Mingha, 2022). In short, we did the interview. In conducting the interview, the study involves eleven participants. All participants selected possess more than ten years of experience in the Public Institutions' teaching and learning environment. The demographic profile is taken into consideration because the findings of the study could be influenced by their gender and working experience.

11 participants are coded using inductive coding which tends to be more efficient in the long run. The inductive coding method is utilized when the researcher knows little about the research subject and conducting heuristic or exploratory research. In qualitative research, coding is how you define the data you are analyzing. It is a process of identifying a passage in the text or other data items (photograph, image), searching, identifying concepts, and finding relations between them. In these findings, the initial coding, also known as open coding; is utilized in determining each participant's information during the data collection process. The initial codings are classified as (1) PI means Public Institution, (2) TVET means Technical Vocational Education and Training, and (3) the number of panelist coding determine the number of participants in the interview. Participants' coding, gender, and working experience among panel experts in the interview are shown in **Table 1**.

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Table 1. Demographic profile of respondents**.**

No.	Participant's Coding	Gender	Working Experience
1.	Code: PI/TVET/01	Male	>15 years
2.	Code: PI/TVET/02	Male	>20 years
3.	Code: PI/TVET/03	Female	>15 years
4.	Code: PI/TVET/04	Male	>18 years
5.	Code: PI/TVET/05	Female	>15 years
6.	Code: PI/TVET/06	Male	>15 years
7.	Code: PI/TVET/07	Female	>21 years
8.	Code: PI/TVET/08	Male	>15 years
9.	Code: PI/TVET/09	Male	>23 years
10.	Code: PI/TVET/010	Male	>15 years
11.	Code: PI/TVET/011	Male	>21 years

3. RESULTS AND DISCUSSION

3.1. Analysis of levels of knowledge, skills, and attitude among TVET instructors in the public skills training institution for the 4th industrial revolution

This section explains the analysis of levels of knowledge, skills, and attitude among TVET instructors gathered qualitatively from respondents in Public Skills Training Institution in Malaysia. This section explains the demographic profile of the respondent in detail, **Table 2** shows the analysis of each level (knowledge, skills, and attitude) gathered from 11 respondents.

3.1.1. Demographic profile of the respondents

Respondents are from several universities, such as Kolej Vokasional Bentong (KV), Institut Kemahiran Belia Negara (IKBN), Universiti Teknologi Mara (UiTM), Universiti Teknologi Malaysia (UTM), and Universiti Tun Hussein Onn Malaysia (UTHM).

Respondent PI/TVET/01 holds a Ph.D. in TVET, TVET Education master's, and Bachelor's Degree in Electrical. He has wide experience in the field of electricity and electronics since he first became a teacher in 1995. He was later, a lecturer and Head of the Electronic Electrical Technology Department at KV from 2000 to 2021, and is currently the Director of KV in one of the institutes in the state of Terengganu. Respondent PI/TVET/02 holds a Bachelor's Degree in Electronic Engineering from MMU. He has five years of working experience in Biomedical Engineering and 11 years in TVET. He is currently working at the Electrical Technology Department at IKBN Kinarut, Papar, Sabah.

Respondent PI/TVET/03 holds a Master's Degree in Technical and Vocational Education and a Bachelor of Electronic Engineering (Mechatronics) from UTM. He started working as a Vocational Training Officer at IKBN Kinarut and is currently the Head of Electrical Technology Department at IKBN Wakaf Tapai, Terengganu since 2010. Respondent PI/TVET/04 graduated with a Bachelor of Electronic Engineering (Power Power) and Advanced Diploma in Industrial Automation SHRDC, Shah Alam. He has more than 18 years of working experience starting as a Vocational Training Officer at IKBN Bukit Mertajam and IKBN Dusun Tua. Before that, he worked as an Electrical and Project Engineer at CST Sdn. Bhd. in 2004-2009.

Respondent PI/TVET/05 holds a Bachelor of Electrical Power Engineering from UiTM. He is currently the Head of the Electrical Technology Department at IKTBN Bukit Mertajam, P. Pinang. Before that, he worked as a Production Engineer and assistant engineer for six years in a private company. He started working in the government sector from 2004 until now starting at ILP Kepala Batas and IKBN Naka, Kedah. Respondent PI/TVET/06 graduated with a

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Bachelor of Electronic Engineering (Industry) from UTM and holds an Advanced Diploma in Malaysian Skills (Vocational Training Manager) from CIAST, Shah Alam, and Certificate in Electronic Engineering (Communication) Polytechnic Ungku Omar. He has more than 15 years of working experience in the private sector and the government. Currently working as a Vocational Training Officer (Electronic Technology) at IKBN Seri Iskandar, Perak.

Respondent PI/TVET/07 holds a Bachelor of Electrical Engineering from UTM. Formerly, he was the Head of Electrical Technology Department at IKBN Alor Gajah, Melaka, and at present working as a Vocational Training Officer at IKTBN Sepang, Selangor from 2021. He has more than 21 years of working experience since 2000 at ST Microelectronic Muar and then at IKBN Alor Gajah, IKBN Dusun Tua, and now at IKTBN Sepang. Respondent PI/TVET/08 graduated with a Master of Technical and Vocational Education from UTM and a Bachelor of Electrical Engineering (Automated Systems & Robotics) from UTHM. He is also a diploma holder of a Diploma in Electronic Engineering from UTM. He has more than 15 years of working experience starting as a Vocational Training Officer at IKTBN Sepang Selangor. Since 2021, IKBN Alor Gajah has been transferred to IKBN Alor Gajah as the Head of the Electrical Technology Department.

Respondent PI/TVET/09 has more than 23 years of working experience in the private and government sectors. He graduated with a Bachelor of Manufacturing Mechanical Engineering from UTHM. He was a vocational training officer at several public skills training centers and is currently the Senior Assistant Director, Maintenance Development Division, Youth Skills Development Division, Ministry of Youth and Sports Malaysia. Respondent PI/TVET/10 holds a Bachelor of Electrical Engineering from UTHM and has 15 years of working experience starting in several private companies, then to ILP Nibong Tebal, Penang, and now IKBN Dusun Tua. He is currently serving as the Vocational Training Officer in electrical technology at IKBN Dusun Tua, Selangor. Respondent PI/TVET/11 graduated with a Master of Education (Teknik & Vocational) from UTM and a Bachelor of Electrical Engineering from UiTM. He has 21 years of working experience as a Vocational Training Officer starting at ILP Pasir Gudang and ILP Mersing, Johor. Next to IKBN Kinarut, Sabah and now at IKTBN Sepang, Selangor.

3.1.2. Levels of knowledge

Findings indicated that the majority of the respondents highlights that the level of knowledge competency is moderate (PI/TVET/01, PI/TVET/02, PI/TVET/03, PI/TVET/04, PI/TVET/06, PI/TVET/07, and PI/TVET/11). While the other respondents claim that their levels of knowledge competency are high (PI/TVET/05, PI/TVET/08, PI/TVET/09, and PI/TVET/10).

3.1.3. Levels of skills

Findings indicated that the majority of the respondents highlights that the level of skills competency is moderate (PI/TVET/1, PI/TVET/2, PI/TVET/3, PI/TVET/4, PI/TVET/6, PI/TVET/7, and PI/TVET/11). The remaining respondents claim that the levels of skills competency are high (PI/TVET/5, PI/TVET/9, and PI/TVET/10). Only respondent of PI/TVET/3 states that the level is good.

3.1.4. Levels of attitude

Findings indicated that the levels of attitude competency are moderate (PI/TVET/2, PI/TVET/3, PI/TVET/4, PI/TVET/7, PI/TVET/8, and PI/TVET/11). The other respondents claim that the levels of attitude competency are high (PI/TVET/1, PI/TVET/5, and PI/TVET/10). Two respondents stated that the levels are goo (PI/TVET/6 and PI/TVET/9).

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Details findings concerning the levels of knowledge, skills, and attitude competencies among TVET instructors in the Public Skills Training Institution for the 4th Industrial Revolution are illustrated in **Table 2**.

Table 2. Analysis of knowledge, skill, and attitude among TVET instructors in the public skills training institution for the 4th industrial revolution.

Respondents	Competencies		
	Knowledge	Skills	Attitude
PI/TVET/01	Moderate	Moderate	High
PI/TVET/02	Moderate	Moderate	Moderate
PI/TVET/03	Moderate	Moderate	Moderate
PI/TVET/04	Moderate	Moderate	Moderate
PI/TVET/05	High	High	High
PI/TVET/06	Moderate	Moderate	Good
PI/TVET/07	Moderate	Moderate	Moderate
PI/TVET/08	High	Good	Moderate
PI/TVET/09	High	High	Good
PI/TVET/10	High	High	High
PI/TVET/11	Moderate	Moderate	Moderate

3.2. Analysis of the types of training required among TVET Instructors in the public skills training institution for the 4th industrial revolution

This section explains the analysis of Types of Training Required among TVET Instructors in the Public Skills Training Institution for the 4th Industrial Revolution.

Findings indicated that all respondents provide varied information on training required in their institutions. This relates to the management consideration and narrows down to the implementation of the training required among instructors. The majority of the respondents state that soft kills, cybergogy, Internet of Things (IoT), 4IR types of training, monitoring, cloud computing, wiring installation, electrical automation, and technical skills certification are among the most consideration to be implemented in the thrive of 4IR in the Public Institution. Details findings concerning the types of training required are illustrated in **Table 3**.

3.3. Analysis of the development of an index of competencies among TVET instructors in the public skills training institution for the 4th industrial revolution

This section explains the development of the Index of Competencies among TVET Instructors in the Public Skills Training Institution for the 4th Industrial Revolution.

3.3.1. Levels of items of competency index based on knowledge

Findings indicated that the majority of the respondents highlights the elements of IR4 as the main competency index based on knowledge (PI/TVET/1, PI/TVET/2, PI/TVET/4, PI/TVET/7, PI/TVET/8, PI/TVET/9, PI/TVET/10, and PI/TVET/11). While the remaining competency index to develop based on knowledge are varied from cloud computing (PI/TVET/3, PI/TVET/5, and PI/TVET/6), the concept of IoT (PI/TVET/3, PI/TVET/5, PI/TVET/6, and PI/TVET/9), higher-order thinking skills (PI/TVET/1 and PI/TVET/2), augmented reality (PI/TVET/5 and PI/TVET/9), big data analysis (PI/TVET/3 and PI/TVET/6), internet applications and electronic devices (PI/TVET/1), STEM education (PI/TVET/3), simulation (PI/TVET/5), robots (PI/TVET/5), 3D printing (PI/TVET/6), system development, application development, advanced IT technology (PI/TVET/8), and the concept of cyber-physical system (PI/TVET/11).

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Table 3. Types of training required among TVET instructors in the public skills training institutions for the 4th industrial revolution**.**

Respondents	Types of Training Required
PI/TVET/01	1. Professional Skills related to TVET IR 4.0
PI/TVET/02	1. Soft skills 2. Intelligent installation and wiring skills using international protocols such as KNX 3. Technical Skills recognized by accredited bodies: ST Competency Certificate, KNX Partner Certificate, Advanced, and Tutor by KNXC
PI/TVET/03	1. Cybergogy 2. Quality Management System and Training in particular 3. Monitoring
PI/TVET/04	1. Knowledge and skills related to basic IR 4.0 technology such as internet configuration, cloud computing, and IR 4.0 ready equipment
PI/TVET/05	1. Training on the latest technology for digital learning
PI/TVET/06	1. Electrical smart devices 2. Other exercises that meet the 9 pillars of IR 4.0
PI/TVET/07	- - -
PI/TVET/08	1. System development based on the latest technology
PI/TVET/09	1. Training of methods, use, and implementation of IR 4.0 teaching digitization
PI/TVET/10	1. The field of electrical automation 2. IoT Courses
PI/TVET/11	1. Disclosure of IR 4.0 concept leading to IR 4.0 TVET Training

3.3.2. Levels of items of competency index based on skills

Findings indicated that the majority of the respondents highlights Information and Communications Technology (ICT) as the most required items of the competency index based on skills (PI/TVET/1, PI/TVET/3, PI/TVET/6, PI/TVET/8, PI/TVET/9, and PI/TVET/10). While other respondents provide varied information; each of the stated about 3D printing skills (PI/TVET/1), communication skills and mastering soft skills (PI/TVET/2), programming language and data processing (PI/TVET/3), basic programming, use of simulation skills, application system integration, and application development (PI/TVET/4), simulations and robots (PI/TVET/5), programming (PI/TVET/7), online teaching and learning tools (PI/TVET/10), basic programming simulations kills, and integration system (PI/TVET/11).

3.3.3. Levels of items of competency index based on attitude

Findings indicated that the majority of the respondents highlight information about being positive (PI/TVET/1, PI/TVET/4, PI/TVET/6, PI/TVET/7, PI/TVET/8, and PI/TVET/11), and being creative and critical thinking skills' attitude (PI/TVET/3, PI/TVET/4, and PI/TVET/5). While other respondents provide varied information; each of the states being positive, professional dedication, and integrity (PI/TVET/1), professionalism, cooperation, and interpersonal skills (PI/TVET/2), cooperation and interpersonal skills (PI/TVET/3), willing to accept change (PI/TVET/4 and PI/TVET/5), keep learning new science and technology (PI/TVET/5), dare to try, teamwork, and focus (PI/TVET/6), eager learner (PI/TVET/7), flexible, civilized and innovative (PI/TVET/9), dedication, foster student's enthusiasm, and desire to learn new sciences (PI/TVET/10), and willing to accept changes (PI/TVET/11).

Details findings concerning the development of the Index of Competencies among TVET Instructors in the Public Skills Training Institution for the 4th Industrial Revolution are illustrated in **Table 4**.

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Table 4. Index of competencies among TVET instructors in the public skills training institutions for the 4th industrial revolution.

Respondents	Index of Competencies		
	Knowledge	**Skills**	**Attitude**
PI/TVET/01	1. Master Higher Order Thinking Skills 2. IR Element 4.0 3. ICT TVET IR 4.0 4. Internet applications and electronic devices	1. 3D printing skills 2. ICT skills 3. Systematic Data Management	1. Positive 2. Professional 3. Dedication 4. Integrity
PI/TVET/02	1. Understand and master the concepts and elements of IR 4.0 2. Critical thinking	1. Communication skills 2. Mastering soft kills	1. Professionalism 2. Identity 3. Enthusiastic in the field being ventured into
PI/TVET/03	1. IoT 2. Cloud Computing 3. Big Data 4. STEM	1. ICT 2. Programming language 3. Data processing	1. Problem-solving 2. Cooperation 3. Interpersonal skills 4. Creative and Critical Thinking Skills
PI/TVET/04	1. IR Element 4.0 2. Real implementation of IR 4.0 in the industry	1. Basic programming 2. Use of simulation skills 3. AR skills 4. Application system Integration 5. Application development	1. Positive 2. Creative and innovative 3. Willing to accept change
PI/TVET/05	1. IoT 2. AR (Augmented Reality) 3. Cloud Computing 4. Simulation 5. Robots	1. IoT 2. AR 3. Cloud Computing 4. Simulation 5. Robots	1. Positive 2. Willing to accept change 3. Think out of the box 4. Keep learning new science/technology
PI/TVET/06	1. The concept of IoT 2. Operating system for cloud development 3. Use of Big Data 4. 3D printing	1. ICT 2. Problem-solving 3. Project management	1. Positive 2. Dare to try 3. Teamwork 4. Focus
PI/TVET/07	1. IR Element 4.0	1. Programming 2. Data Analysis	1. Positive 2. Eager Learner
PI/TVET/08	1. IR Element 4.0 2. System development 3. Application development 4. Advanced IT knowledge	1. Advanced IT	1. Positive 2. Flexible 3. Civilized 4. Innovate
PI/TVET/09	1. IR Element 4.0 2. IoT 3. AR 4. Simulation 5. Teaching methods and digitization	1. ICT	1. Positive 2. Flexible 3. Civilized 4. Innovative
PI/TVET/10	1. IR Element 4.0	1. ICT 2. Online teaching and learning tools	1. Dedication 2. Foster student enthusiasm 3. Desire to learn new sciences
PI/TVET/11	1. IR Element 4.0 2. The concept of a cyber-physical system (CPS)	1. Basic programming 2. Simulation skills 3. AR skills 4. Integration system	1. Positive 2. Willing to accept change

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4. CONCLUSION

Based on the discussion among expert panels gathered from the interview, the TVET Index of Competencies is developed. All information assembled from the data based on the knowledge, skills, and attitude of TVET instructors provides high consensus in developing the index of competencies.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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