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Readiness and Understanding of Technical Vocational Education and Training (TVET) Lecturers in the Integration of Industrial Revolution 4.0

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This study aims to determine the readiness and understanding of Technical Vocational Education and Training (TVET) lecturers in the implementation of Industrial Revolution 4.0 (IR4.0). A total of 203 TVET lecturers in Malaysia were involved in this study, which also used descriptive and inferential statistics. Findings reveal a high level of readiness, understanding and implementation of IR 4.0 amongst the TVET lecturers. A significant relationship likewise exists amongst readiness, understanding and implementation of IR4.0. Findings also show that the TVET lecturers' understanding is a mediator of the relationship between readiness and implementation of IR4.0. Lastly, results imply that the lecturers can further enhance their effort in implementing IR4.0 to achieve the Mission of 2020.

Key words: *Industrial Revolution 4.0, Integration, Lecturer, Readiness, Technology.*

Introduction

Industrial Revolution 4.0 (IR4.0) is categorised as new area of technology that combines the physical, digital and biological worlds. It involves all disciplines, such as economics and industry, and includes human life as a whole (Schwab, 2016). Ibrahim, Baharuddin and Baharom (2018) stated that the Fourth Industrial Revolution involves automation technology, which presents new challenges to all sectors in Malaysia, including the education sector. Hence, it requires people to make changes and be at par with digital transformation for

competitiveness. Historically, the first industrial revolution depended on the use of vapor-powered machines, whereas the second industrial revolution was powered by electricity. The pillars of the third industrial revolution were information technology and computers. However, IR4.0, covers the discovery of various new technologies, such as automation, analysis, Internet of things (IoT) and mass or big data, simulation, system integration and robotic applications, to further spur the progress of the modern world. IR4.0 marks the emergence of physical cyber systems, which involve an entirely new capability for humans, machinery and new methods of technology. Schwab (2016) explained that IR4.0 has the potential to increase income levels and improve the quality of life on a global scale. However, people who currently have access to the digital world can reap the most profitable aspects of IR4.0. Millions of people can be reached through digital networks, thereby increasing the efficiency of an organisation.

Hannon (2017) stated that educational methods should also undergo evolution to be at par with the evolution of technology. Accordingly, the education system should act immediately to keep pace with development. The education system currently focusses on the industrial economy, and needs transformation to meet future demands, which are substantially focussed on automation. The Malaysian Ministry of Higher Education will implement higher education reforms to meet the demands of IR4. The Curriculum for Technical Vocational Education and Training (TVET) should be equipped with the latest teaching and learning (T&L) system to meet the requirements of IR4.0. It is aimed to produce high-quality human capital, particularly those with the ability to compete with the needs of the local and global industrial markets. The course or program curricula offered by TVET institutions have to be integrated with current skills and technology. Therefore, IR4.0 should be understood and studied.

To address the challenges of this new revolution, the main concern of educational institutions in Malaysia is to rapidly move forward in tandem with other advanced countries that have previously applied IR4.0. Accordingly, Malaysian Polytechnic, which is one of the country's TVET institutions, have to offer a prestigious educational system towards adopting new methods that consider the rapid development of technology, particularly IR4.0 (Shafei, Haris & Hamzah, 2018). This system should begin with the preparation of competent and highly skilled instructors who meet the needs of IR4.0. Therefore, instructors should be fully involved in reforming the curriculum and improving teaching facilities. Thus, all lecturers have to prepare to face the challenges and transformation in higher education to cope with the current T&L methods of IR4.0. Undoubtedly, lecturers will be challenged by the complexity of educating millennials and the digital generation. Digital learners learn differently. In the present state (i.e. the world of technology and communication), learners can acquire any information everywhere (i.e. through various channels). The role and duties of lecturers have changed because they no longer simply teach but assume a major responsibility as curators of their students' core knowledge. Lecturers should prepare for Generation Z, which requires that they learn new skills (D'Souza, 2018).

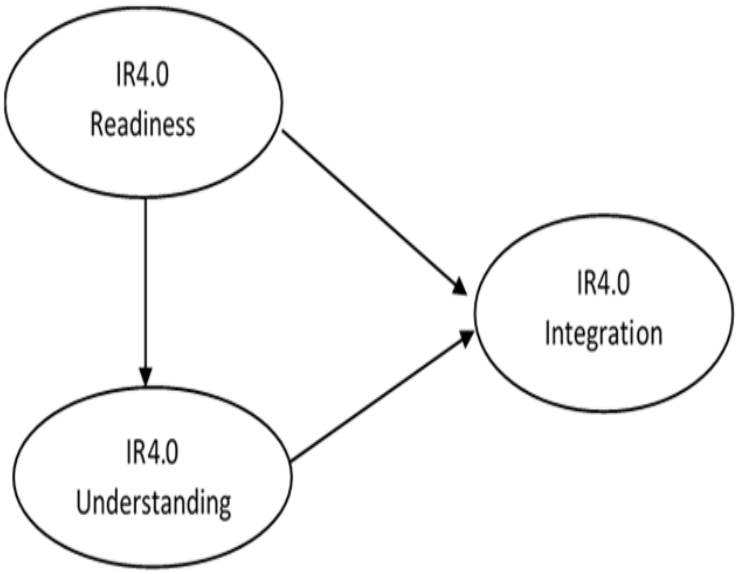
Polytechnic is the largest TVET provider in Malaysia based on the current development of education transformation (Ibrahim, Baharuddin & Baharom, 2018). In light of this, this study was conducted to identify the level of readiness, understanding and implementation of IR4.0 amongst TVET lecturers in Malaysia. This research was also conducted to determine the influence of lecturers' readiness on their implementation of IR4.0. Additionally, this study aimed to identify any significant mediating role of understanding in the relationship between readiness and implementation of IR4.0.

Methodology

Research Design

This study conducted a correlation survey to determine the readiness and understanding of TVET lecturers and the implementation of IR4.0. This research also aimed to identify the significant link between lecturers' readiness and understanding in implementing IR4.0 using structural equation modelling (SEM). Moreover, this study intended to use SEM to examine the relationship between understanding and professional ethics, as well as the effects of such a relationship on IR4.0 readiness (Hoyle, 1995, Byrne, 2012; Piaw, 2014;). Piaw (2006) stated that a survey is a method used to collect sample information using a questionnaire, in which respondents are required to answer independently. Figure 1 shows a prior model that the current research adopted and developed from existing theories and previous studies.

Figure 1. Prior Model



The objective of study are:

1. To identify the contribution of IR4.0 readiness to IR4.0 Integration
2. To identify the contribution of IR4.0 readiness to IR4.0 understanding
3. To identify the effect of IR4.0 understanding as a mediator contribution of IR4.0 readiness to IR4.0 integration

Participants

The participants of the survey conducted were TVET lecturers in Malaysia and were selected using the simple random sampling method. Patton (1990) mentioned that no rules are used in determining sample size but a large sample is preferred for research surveys using a questionnaire. Sudman (1976) asserted that a minimum of 100 elements are required for each major group or subgroup in a sample. The current research involved 203 lecturers in Malaysia, 86 (42.4%) of whom were male and 117 (57.6%) were female. A total of 45 (22.2), 71 (35.0%) and 87 (42.9%) lecturers have below 5 years, 5 to 10, and at least 10 years of teaching experience, respectively. The respondents completed a questionnaire that included five items on IR4.0 readiness, IR4.0 understanding and professional ethics.

Measurement

The scales to measure IR4.0 understanding, readiness and integration were adapted from Hutkemri and Zamri (2017). The scales were used as data collection tools for the present study. The scale consists of 15 questions addressing the level of IR4.0 understanding (5-items), readiness (5-items) and integration (5-items). A 5-point Likert scale ranging from 1 ('strongly disagree') to 5 ('strongly agree') was employed to measure IR4.0 understanding, readiness and integration. The questionnaire was referred to two experts to verify its validity, which refers to the accuracy and truthfulness of a tool for measuring an instrument. Before an actual study is carried out, the instrument must first undergo a certain process to test its validity and ability to measure what should be measured (Pallant, 2013). After amendments were made on the basis of the recommendations of the experts, the pilot study was conducted on 50 TVET lecturers in Bangi, Malaysia. The pilot study aimed to test the respondents' understanding of the accuracy and appropriateness of terms, sentence structure and use of language, thereby reducing the format and words in the questionnaire items (Baba, 1997). The results of the pilot study were processed using SPSS version 25.0, with a few items tested using Cronbach's alpha to measure the reliability. Konting (1997) indicated that Cronbach's alpha values between .60 and .80 are acceptable, but values below .60 are considered low and unacceptable. Moreover, the results indicated that the questionnaire items had a high reliability in the range of .78–.96 (IR4.0 understanding, $\alpha = .91$; IR4.0 readiness, $\alpha = .78$; IR4.0 integration, $\alpha = .88$).

Data Analysis

Data analysis was conducted in three steps. The first step considered significant data on screening-related issues, such as handling of missing data and multi-collinearity. Outliers and normality were identified using the Statistical Package for the Social Sciences (SPSS) 25.0. Outliers were identified through a boxplot for each sub-construct. For the examination of normality, the skewness and kurtosis values of each item ranging from −1.96 to +1.96 at the .05 significance level (Hair, Black, Babin, & Anderson, 2010) were used. In terms of multi-collinearity, the correlation amongst factors should be below .90 (Kline, 2005). In the second step, confirmatory factor analysis (CFA) and descriptive statistics were conducted. CFA using AMOS 18.0 was performed to explore whether the established dimensionality and factor-loading pattern fit the Malaysian context. Moreover, a measurement model was examined between the related variables for each construct developed from theories and empirical studies. In the final step, an a priori model was evaluated. The fit indices of the measurement and structural models were also tested in reference to the specific criteria.

Indirect effects were analysed using a bootstrapping procedure with the bias corrected percentile method (Guan, 2003). Byrne (2013) and Guan (2003) validated that the bootstrapping procedure in the AMOS program is suitable for the management of non-normal data. Goodness of fit was examined using chi-square ($\chi 2$) ($p > .05$), comparative fit index (CFI > .90), Tucker–Lewis index (TLI > 0.90) and root-mean-square error of approximation (RMSEA< .08) (Awang, 2012). Additionally, Cronbach's alpha coefficients, composite reliability (CR) and average variance extracted (AVE) were calculated. Cronbach's alpha was computed to determine the reliability of the instrument. CR considers that indicators have distinct loadings, whilst AVE captures the variance of its indicator (Awang, Afthanorhan, & Asri, 2015; Mohamad, Mohammad, Ali, & Awang, 2018). Hair et al. (2010) reported that alpha values from .60 to .70 are satisfactory. CR should be above .60, whilst AVE should be over .50 (Awang, 2012; Mohamad, Mohammad, Ali & Awang, 2018).

Results

In the current research, the amount of missing data varied from 0% to .5% per item and the missing items were completely random (MCAR) (Kline, 2005). Table 1 reveals a strong level of correlation (.79 to .90) between constructs. The analysis revealed that the correlation between IR4.0 understanding and readiness ($r = .90$, $p < .01$), IR4.0 understanding and IR4.0 integration ($r = .80$, $p < .01$) and IR4.0 readiness and IR4.0 integration ($r = .79$, $p < .01$) were significant and strong. This correlation indicates that the discriminant validities of the variables were attained because the correlation matrix yielded correlations below.90 (Kline, 2005). In terms of univariate normality, the preliminary analysis shows that all items of the IR4.0

understanding, readiness and integration reached univariate normality (i.e. skewness and kurtosis values ranged from −1.02 to .30).

Table 1: Correlation matrix, means and standard deviations

Variable	**1**	**2**	**3**
1. IR4.0 understanding	1		
2. IR4.0 readiness	.90**	1	
3. IR4.0 Integrating	.80**	.79**	1
Skew	−1.02	−.59	−.34
Kurtosis	.30	−.23	−.38
Mean	4.26	4.01	3.86
SD	.80	.71	.86

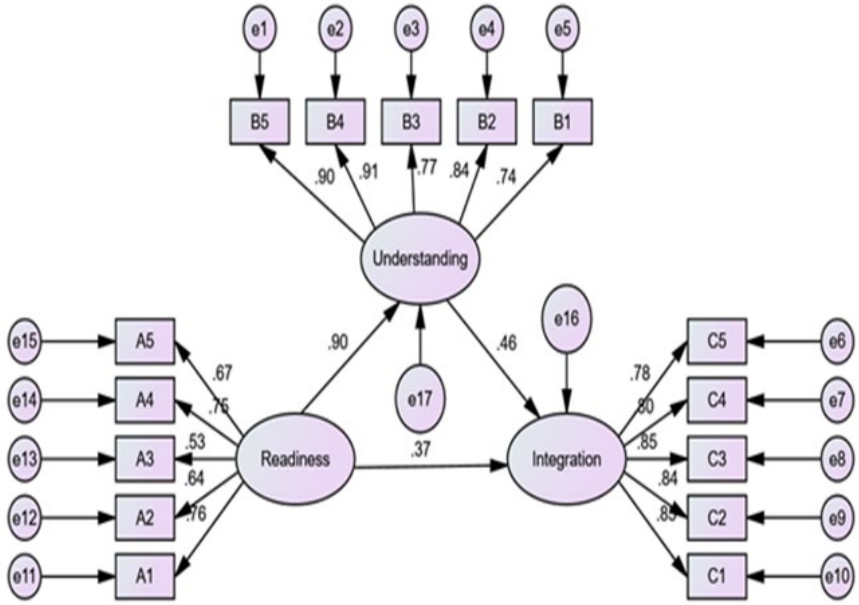
**Correlation is significant at the 0.01 level (two-tailed)

The bootstrapping procedure was used to obtain accurate and stable parameter estimates for this data set (Awang, 2012; Hayes, 2009). Additionally, the mean values varied amongst the variables, with IR4.0 understanding at M = 4.26 and SD = .80, IR4.0 readiness at M = 4.01 and SD = .71 and IR4.0 integration at M = 3.86 and SD = .86. All variables were at high levels (Wiersma, 2000).

Testing the Hypothetical Structural Model

The outcomes of the SEM analysis revealed the hypothetical structural model at $\chi^2 = 338.51$, $\chi^2/df = 3.89$, RMSEA = .07, TLI = .90 and CFI = .90. All evaluations resulted in an acceptable model fit for the Malaysian context. All factor loadings of the three variables ranged from .53 to .91, which exceeded the .50 desirable standard (Hair et al., 2010). Additionally, the CFA model presented in Figure 2 became the final model that indicated the contribution of IR4.0 readiness to understanding and integration in the Malaysian context. The final model of current research can be used as an alternative in explaining previous studies on the relationships amongst IR4.0 understanding, readiness and integration.

Figure 2. Final model of the study



Contribution of IR4.0 Readiness to IR4.0 Understanding

IR4.0 readiness positively affected IR4.0 Understanding. A significant contribution was noted between the two constructs ($\beta = .90$, $t = 11.493$, $p < .01$). Thus, the hypothesis that lecturers who observe IR4.0 readiness perform well in IR4.0 understanding is fully confirmed.

Contribution of IR4.0 Readiness to IR4.0 Integration

IR4.0 readiness positively affected IR4.0 integration. A significant contribution was noted between the two constructs ($\beta = .37$, $t = 1.994$, $p < .05$). Thus, the hypothesis that students who utilise IR4.0 readiness show positive IR4.0 integration is fully confirmed.

Mediating Effects of IR4.0 Understanding on The Contribution of IR4.0 Readiness to IR4.0 Integration

IR4.0 understanding shows a significant mediating effect on the contribution of IR4.0 readiness to IR4.0 integration. Table 2 lists the results of the mediating effect analysis using the bootstrapping procedure.

Table 2: Output of mediating effect

Path	Direct effect		Indirect effect		
	B	*p* value	B	*p* value	Result
R -> U -> I	.37	.05	.46	.05	Partial mediating

Note: R: IR4.0 Readiness; U: IR4.0 Understanding and R: IR4.0 Integration.

Table 2 illustrates the outputs of the mediating effects of IR4.0 understanding as determined using the bootstrapping procedure. Accordingly, only a positive partial mediating effect ($\beta = .46$, $p < .05$) for IR4.0 readiness on IR4.0 integration ($\beta = .90$, $p < .01$) was found.

Discussion

The findings indicate that the TVET lecturers' readiness for IR4.0 is at a high level. High levels of readiness amongst the TVET lecturers can be the result of sufficient courses and trainings on IR4.0. TVET lecturers are also willing to attend any external courses related to IR4.0. Suitable programs have also been implemented, such as round table conferences, on the direction of the education system in line with IR4. Additionally, opportunities have been provided for TVET lecturers to enhance their confidence and commitment (Norshidah, 2011). However, the results of the current study do not support those of Ibrahim, Baharuddin and Baharom (2018) and Shafei, Haris and Hamzah (2018). These studies found that IR4.0 readiness amongst TVET lecturers was only moderate.

The current study has also found that the lecturers' understanding of IR4.0 is at a high level. They are highly committed to understanding and improving their knowledge and current pedagogical skills. However, this finding is the opposite of the research findings of Ibrahim, Baharuddin and Baharom (2018), which found that the level was moderate. The education system should focus on IR4.0 to produce holistic, creative, inventive and critical graduates. Therefore, a comprehensive collaboration of various relevant stakeholders is necessary to organise various efforts and actions to meet the new wave of education advances (Azman & Ibrahim, 2018). Failure to initiate IR4.0 would cost institutions to be non-significant in the global competition. Thus, lecturers need further exposure, particularly in preparing to face IR4.0. This solution can be made possible through training and human resource development.

The results also show that the IR4.0 implementation is at a moderately high level. The lecturers have implemented some IR4.0 elements through course works, industrial collaborations and work-based learning. Ibrahim, Baharuddin and Baharom (2018) explained that encouragement and an improved ecosystem are necessary for the lecturers to implement all elements at a high level.

Naim (2018) explained that analyses were performed on the TVET curriculum to determine the readiness level of the program and its impact on graduates in terms of meeting the needs of IR4.0. This readiness involves nine skills and nine new technologies. The skills are digital literature, decision making, project management, creative/analytical thinking, problem solving, entrepreneurship and techno entrepreneurship, global thinking and life-long learning. Moreover, these skills are consistent with the goal of the Ministry of Education to restore the authority of public universities and institutions of higher learning, such that the world views Malaysia as an inclusive, moderate and glorious country.

SEM analysis also noted a direct impact of IR4.0 readiness on IR4.0 implementation. Teachers' readiness has an indirect influence on IR4.0 integration in teaching and learning amongst TVET lecturers. Therefore, instructors with a high level of readiness will have a high tendency to integrate IR4.0 in teaching and learning. Despite the high level of IR4.0 readiness amongst TVET lecturers, their IR4.0 integration remains at a moderate level. The effect of readiness was also discussed, in which an understanding enables lecturers to effectively use technological tools in obtaining information to be used in their T&L sessions (Davis, 2001). The use of IR4.0 integration in teaching mathematics often involves the use of the Internet to obtain information.

IR4.0 understanding is a significant mediator of the contribution of IR4.0 readiness to IR4.0 integration in T&L. Moreover, understanding is essential in enabling lecturers to integrate IR4.0 in their T&L. Accordingly, having excellent IR4.0 understanding alone is insufficient to encourage one to integrate IR4.0 in T&L. Technology is primarily utilised as a teaching aid. Therefore, integrating IR4.0 is also hindered by other constraints, including the confidence of teachers towards the use of technology, training, time and technical problems/support systems (Mumtaz, 2000). Additionally, integrating IR4.0 requires lecturers to be knowledgeable in managing technologies that are as simple as CD-ROMs, the Internet and educational software (Tapscott, 2003). However, TVET lecturers must start to use additional infrastructures, such as screens, speakers, LCD projectors, computer laboratories and educational software. ICT infrastructures and facilities in an institute must also be monitored to ensure that they are fully utilised by lecturers. Furthermore, other areas must be marginalised to improve ICT use in T&L, specifically in an era of globalisation, in which knowledge is easily and instantly available.

IR4.0 will be implemented in stages in all public and private education institutions in Malaysia. Moreover, IR4.0 will bring significant changes in tertiary education, particularly in the use of technologically advanced T&L methods, thereby eventually requiring active and competent lecturers. Indeed, lecturers are the most important personnel in ensuring that the learning and teaching of the IR4.0 concept is implemented effectively, which is key in realising its application in the education system. As a teaching force, particularly in technical fields, lecturers should be equipped with the necessary knowledge and skills and be prepared with the

needs of IR4.0. TVET lecturers should be given additional opportunities to prepare and strengthen themselves with knowledge, specifically in engineering, automation and information technology, to address the elements of IR4.0.

Indirectly, lecturers should improve their T&L methods in tandem with the rapid technological changes in industry-based education 4.0. The findings of this study are expected to be the ideal reference for top management. In this manner, appropriate action can be taken and slight changes in management can be implemented to ensure that lecturers have the necessary knowledge, competency and readiness to face challenges. Various parties should collaborate to realise the IR4.0 that will be applied in the higher education system. This collaboration encompasses the incorporation of ideas from instructors, top management of higher learning institutions, governments, industry and other parties to enable the implementation of IR4.0 and to ultimately meet the pre-stated goals. Additionally, appropriate equipment and the existing elements of IR4.0 facilities should be provided to facilitate its implementation at higher learning institutions. Moreover, TVET lecturers should also reinstate their readiness, understanding and skills to keep pace with IR4.0. Thus, management should be aggressive in managing strategies and taking more effective and appropriate steps for the TVET lecturers to successfully overcome the challenges of IR4.0.

Conclusions

The findings and information gathered in this study could become a valuable reference for other parties in implementing IR4.0 at higher education levels. This study contributes a new IR4.0 lecturers' readiness model, which involves two main factors, namely, IR4.0 understanding and IR4.0 integration. Future researchers could consider these factors to gather in-depth information on IR4.0 implementation amongst lecturers. Hence, all higher learning institutions should be prepared to face this challenge by providing various activities towards the production of competitive graduates. Ultimately, lecturers have to be mentally and physically ready to address the challenges of IR4.0.

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