

Assessing the RIASEC Model's Impact on Critical Thinking in Industry 4.0

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Abstract: *The advent of Industrial Revolution 4.0 (IR 4.0) necessitates not only technologies advancements in manufacturing but also the development of essential human competencies, such as critical thinking, which beyond the capabilities of automated systems. This study draws the inspiration from the Holland theory to examine the influence of RIASEC model on critical thinking competency within the context of IR 4.0. Survey data were gathered from 98 bachelor students enrolled in work-based learning (WBL) programs at polytechnics in Malaysia, with focus on individuals from low-income backgrounds. This study employing a quantitative method and purposive sampling was utilized for sample selection. Partial Least Square Structural Equation Modelling (PLS-SEM) via Smart PLS 3.0 software was employed to analyze both measurement and structural models. The findings indicate a positive relationship between four RIASEC model and critical thinking competency. The study concludes with discussion on the implications and limitations of the findings, along with suggestions for future research direction related to the RIASEC model's impact on IR 4.0 competency.*

Keywords: RIASEC model, industrial revolution 4.0, critical thinking, low income group

1. Introduction

Industrial Revolution 4.0 (IR 4.0) is poised to change the landscape of work, business, and societal structures in this decade. Malaysia has acknowledged IR4.0 as the driver for augmenting the nation's productivity, as highlighted by the several ministries namely the Ministry of Finance (MOF) and Ministry of International Trade and Industry (MITI). The IR 4.0 encompasses the stages of exploration, innovation, design, and implementation of abstract ideas into products, machinery, or systems with the goal of enhancing comfort and raising the standard of living for humanity (Paim, 2017). Consequently, the call for updated skills has led to a decline across multiple sectors, with only individuals possessing specific competencies and advanced education capable of effectively navigating and managing these technologies (Chiam & Joshua, 2019; Ullah et al., 2019). Since the year 2023, technological changes have reshaped the structure of work that is displacing approximately 800 million workers globally.

The 2023 survey conducted by McKinsey Global Institute across 46 countries and 800 jobs reveals approximately one-fifth of the workforce facing potential changes in their roles. This scenario indirectly contributes to a rising unemployment rate among the youth demographic. Youth unemployment will affect the country's growth because the impact of unemployment is closely related to future poverty (Calvin & Juita, 2020). However, to uplift people from the

grips of poverty is by moving parallel with competencies that can fulfill the requirements of technological advancements (MOF, 2019). The accelerating of new required competency will enormously affect career experiences and help generate income.

The World Economic Forum's (WEF) 2016 report identifies key competencies that have reshaped various industries, with a particular emphasis on critical thinking competency. Hence, individuals are encouraged to prioritize the enhancement of their critical thinking competency to remain competitive in the evolving job market, thereby increasing their chances of securing employment and ultimately improving their income prospects (Mumme & Cameron, 2019; Sumit, 2020).

In attempts to identify the compatibility of critical thinking competency with individual characteristics, this study draws inspiration from Holland theory for further investigation. Holland theory is a prominent theory that centers on individual's tendency to seek and create work environments that allow to show the work characters (Holland, 1997; Nye et al., 2017), utilize the RIASEC model to assess an individual's interest, abilities, and environmental fit. The RIASEC model encompasses individuals type namely Realistic, Investigative, Artistic, Social, Enterprising, and Conventional. Thus, this study is motivated to examine the effect of RIASEC model on critical thinking competency. Since many low-income people face the challenges situation with the presence of IR 4.0 especially in search for employment, hence, the implementation of this study low-income people as targeted group.

In addition, workers with lower skill or those employed in blue-collar positions within specific industries encounter employment challenges in the era of IR 4.0. This condition became worse when almost 60 percent (%) of the Malaysian job market was dominated by low and medium skilled workers from low-income group (Hawati et al., 2019; Rashid, 2020). Previous data indicated that the industrial revolution only benefits a small elite minority (Paim, 2017). Hence, the intention of the present study is to examine how RIASEC model affects the critical thinking competency among low-income groups.

2. Literature Review

RIASEC Model

The RIASEC model is shaped through Holland theory (1959, 1997). Previous studies had proven that RIASEC model by Holland theory can explore individual creative career (Vuyk & Kerr, 2019), assessed people's affective responses (Phan & Rounds, 2018), identifying individual job satisfaction, job retention, and job performance (Holland, 1997; Sheldon et al., 2020).

The Realistic type enjoy doing hands-on and manual activities such as building, repairing, operating a machine, and joining sports (Athanasou, 2017; 2018), while the Investigative type is characterized by individuals filled with curiosity, are highly critical, and prefer to solve problems by observing, analyzing, and reasoning (Li et al., 2018; Mashadza, 2019; Orkibi, 2016). Individuals who are the Artistic type frequently work with forms, designs, and patterns. They often like activities that require self-expression, originality, imagination, and creativity (Athanasou, 2017; 2018; Li et al., 2018). Besides that, individuals who are categorized in Social type like to choose a field related to providing service to others or helping others (Athanasou, 2017; 2018). Meanwhile, an individual categorized as Enterprising type would like to be employed in those sectors that involve leadership roles, managerial activities, and entrepreneurship intention (Bergner et al., 2018; Han & Sears, 2020; Li et al., 2018). People

with Conventional interests prefer to follow a set of procedures and routines. usually organized, careful, conscientious, and effective (Athanasou, 2017; 2018). In this sense, this type of person prefers work in a well-structured environment (Athanasou, 2017; 2018; Nye et al., 2012).

Competency in The Context of Industrial Revolution 4.0

During the era of IR 4.0, the evolving nature of work presents challenges that demand individuals to possess a diverse set of skills (Hariyanti et al., 2017; Teng et al., 2019). Critical thinking has consistently been highlighted as an essential competency for IR 4.0, according to the World Economic Forum (WEF) reports spanning from 2015 to 2022. Moreover, critical thinking is categorized as competency that are difficult to acquire in this age (Jabatan Tenaga Kerja Semenanjung Malaysia, 2018; Joynes et al., 2019; Moneva et al., 2020; WEF, 2016). Additionally, a study done by Khalid & Ahmad (2021) has found that one of the employability skills which are suited to the working environment of IR 4.0 was critical thinking. In addition, Nugraha et al. (2020) disclose that competency such critical thinking become employability competencies in TVET areas. In fact, Kamaruzaman et al. (2019) found that critical thinking competency was in line with IR 4.0 requirement particularly for engineering field.

Hence, this competency is considered very important that to be possessed by students to deal with the competitive work challenges. The sophisticated technologies brought require the nature of work, business, and society to prepare with something different thereby only individuals who are quickly adapted to the new reality as well as qualified and highly educated will be able to control such technologies (Azmi et al., 2018; Evanthia, 2020). However, this should not imply that other competencies are no longer important since IR 4.0 require individual to possess multi-skilled.

Critical thinking encompasses the capability of individual to analyze information and formulate reasoned judgements by evaluating sources, including data, facts, and research findings. This competency indirectly enhances human abilities in communication, information literacy, and ability to interpret and evaluate evidence (Joynes et al., 2019). In fact, with proficient critical thinking competency, individuals can effectively assess complex situations, generate effective solution, and make a good decision (Moneva et al., 2020).

Hypothesis Development

In attempts to develop hypotheses in this study, several variables have been identified as contributing factors to critical thinking. These variables consist of RIASEC model on the IR 4.0 context namely critical thinking.

The relationship between Realistic type and critical thinking competence has been highlighted through past studies when Isdianti et al. (2021) found the learning process involving the use of a simple machine material was improved critical thinking skills among students. Besides that, when Realistic type is identified has a correlation with individuals who are fond of hands-on activities, there are studies revealed that hands-on activities implemented during the learning process can improve student's critical thinking skills (Sabdaningtyas & Ambarita, 2019). Hence, based on these findings, this study proposes the following hypotheses:

H1: Realistic type has a positive effect on critical thinking competency.

Other than that, Investigative type is inclined towards the field of science, technology, engineering, and mathematics (STEM), then there is a connection with critical thinking. Previous studies have revealed that STEM can improve student's critical thinking competency

other than being an effective alternative to develop a critical thinking skill among students (Elfrida Yanty Siregar et al., 2019; Linh et al., 2019; Mater et al., 2020). Therefore, following hypotheses are proposed:

H2: Investigative type has a positive effect on critical thinking competency.

The study done by Ümit (2020) indicates that the Artistic type has a significant influence on critical thinking competency through the metacognitive awareness level. Indeed, metacognitive awareness has proven to be able to produce critical thinkers through the activities of organizing, analyzing, reasoning, and evaluating an idea (Amin et al., 2020; Kozikoğlu, 2019; Ümit, 2020). The proof that artistic aspect can promote critical thinking is also highlighted by Kisida et al. (2015) which reveals that there is a positive effect of art museum visits on student's critical thinking ability particularly in examining an artwork. Hence, based on these studies, this study proposed the following hypotheses:

H3: Artistic type has a positive effect on critical thinking competency.

As mentioned earlier, individuals with the Social type have an advantage in working with others. Apart from that, the study on collaborative learning by Loes & Pascarella (2017) and cooperative learning by Espey (2017) found will increase the student's critical thinking skills. Both learning concepts provide the opportunities for students to work together with others aims to gain knowledge, achieved shared learning goals as well as together and help each other learn (Espey, 2017; Loes & Pascarella, 2017). Thus, the following hypotheses are proposed:

H4: Social type has a positive effect on critical thinking competency.

For that reason, the Enterprising type is perceived to suit CPS competencies. Additionally, the studies on the relationship between Enterprising type and critical thinking competence frequently examined in the business literature. The critical thinking skills among students was developed through business activities or entrepreneurial thinking programs (Calma & Davies, 2020; Dragoi, 2019). Usually, such activities or programs capable to polish student's leadership, decision making, communicating, problem solving and critical thinking competencies (Calma & Davies, 2020; Dragoi, 2019; Zapalska et al., 2018). Therefore, the following hypotheses are proposed:

H5: Enterprising type has a positive effect on critical thinking competency.

All those procedures and routines stressed individuals possess the CPS and critical thinking competency to be successful in practice (Dinçer & Kiliç, 2018; Latif et al., 2018). Thus, the hypotheses for this study proposed are as follows:

H17: Conventional type has a positive effect on critical thinking competency.

Hence, based on the underlying theory, theoretical framework, and some findings from previous studies, six hypotheses were developed which inspired the formation of a conceptual framework. The conceptual framework shows that RIASEC model can affect the critical thinking competency.

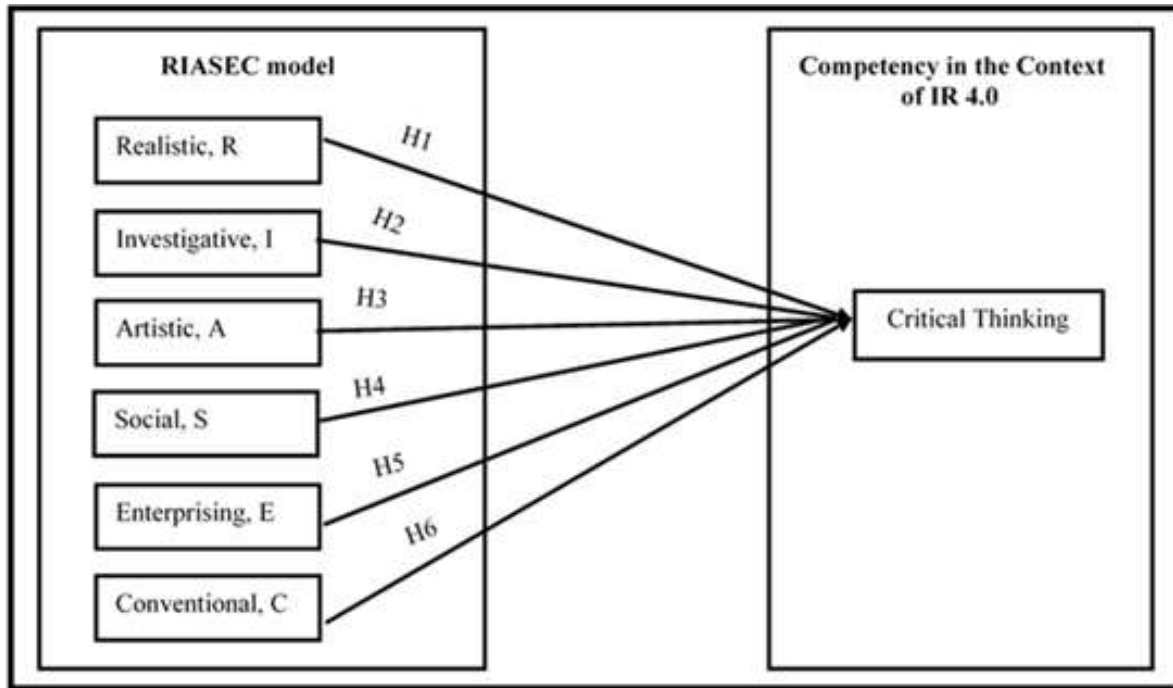


Figure 1: Conceptual Framework

3. Research Methodology

This study employed an explanatory research design and quantitative research method. The primary data were collected via questionnaires through online survey involving students from four Malaysian polytechnics that offer degree-level programs, namely PUO, PSA, PSAS and PIS. Furthermore, the study samples were purposively selected based on the criteria like degree students who undergo WBL programs from the B40 group. Responses from 134 respondents were received, but only 98 questionnaires were used for the data analysis. The measurements of all variables used were enlisted in the study based on the literature and were rated using a 5-point Likert scale. In addition, PLS-SEM was used for instrument validation, confirmatory factor analysis, reliability, and hypothesis testing.

4. Result and Discussion

Demographic

The analysis of the data involved a sample of 98 respondents, comprising 46 females (46.00%) and 52 males (53.10%). In terms of age, the majority respondents fell within the 21-25 years old (80.60%), while the fewest respondents were aged between 26-30 years old, totalling 19 individuals (19.40%). The respondents are mostly made up of Malays 80 (81.60%), followed by Indian 13 (13.33%), Chinese 3 (3.11%), and others 2 (2.00%). Distribution of polytechnic consists of PUO 42 (42.99%), followed by PSA 38 (38.88%), PIS 15 (15.33%), and PSAS 3 (3.00%). As far as education program are concerned, 23 (23.50%) are from BCT program as highest, followed by BEU program 21 (21.40%), and the least are From BMA program 4 (4.11%). In terms of training sector during practical training, majority of respondents are employed at private sector with 88 (89.80%). Lastly, highest number of respondents have household income below than RM2,500 with 51 respondents (52.00%), followed by income range is RM 2,501 to RM 3,170 with 24 (24.50%) and the least income range is RM 3,171 - RM 3,970 with 9 (9.20%).

Table1: Demographic Profile of Respondents Analysis

| Demographic Variable | Characteristics | Frequency (n = 98) | Percentage (%) |
|---|---------------------|--------------------|----------------|
| Parents' income (household income) | Below RM 2,500 | 51 | 52.0 |
| | RM 2,501 - RM 3,170 | 24 | 24.5 |
| | RM 3,171 - RM 3,970 | 9 | 9.2 |
| | RM 3,971 - RM 4.850 | 14 | 14.3 |
| Gender | Male | 52 | 53.1 |
| | Female | 46 | 46.9 |
| Age | 21 - 25 years old | 79 | 80.6 |
| | 26 - 30 years old | 19 | 19.4 |
| Race | Malay | 80 | 81.6 |
| | Chinese | 3 | 3.1 |
| | Indian | 13 | 13.3 |
| | Other | 2 | 2.0 |
| Polytechnic | PUO | 42 | 42.9 |
| | PSA | 38 | 38.8 |
| | PSAS | 3 | 3.0 |
| | PIS | 15 | 15.3 |
| Program | BTH | 15 | 15.3 |
| | BCT | 23 | 23.5 |
| | BEU | 21 | 21.4 |
| | BMS | 19 | 19.4 |
| | BMA | 4 | 4.1 |
| | BFM | 16 | 16.3 |
| Training Sector during practical training | Government Sector | 6 | 6.1 |
| | Private Sector | 88 | 89.8 |
| | Others | 4 | 4.1 |

1) PUO: Politeknik Ungku Omar; 2) PSA: Politeknik Sultan Salahuddin Abdul Aziz Shah; 3) PSAS: Politeknik Sultan Azlan Shah ; 4) PIS: Politeknik Ibrahim Sultan ; 5) BMS: Bachelor of Manufacturing Engineering Technology (Supply Chain Management) With Honours; 6) BCT: Bachelor of Civil Engineering Technology with Honours; 7) BEU: Bachelor of Electronic Engineering Technology (Medical Electronics) with Honours; 8) BFM: Bachelor of Technology in Facility Management with Honours; 9) BMA: Bachelor of Manufacturing Engineering Technology (Automotive Design) With Honours; 10) BVC: Bachelor of Design in Visual Communication & New Media with Honours; 11) BTH: Bachelor of Science (Honours) International Tourism and Hospitality Management

Measurement Model

In terms of measurement analysis, the model is evaluated through the scales' reliability and validity. The evaluation included examining composite reliability (CR), assessing convergent validity through average variance extracted (AVE), and evaluating discriminant validity using the (Heterotrait-monotrait ratio [HTMT] criteria as proposed by (Henseler et al., 2015). The assessment of CR involved analyzing the factor loadings value. According to Hair et al. (2017), the recommended value of factor loadings is exceeded 0.5. Based on result in Table 1, factor loadings for all items exceeded the value of 0.5 suggested but several items (POR2, POR6, POR7, POR8, PER1, PER5, POI1, POI5, POI7, POI8, PEI4, PEI6, POA1, POA6, POA7, POA8, PEA1, PEA4, PEA6, POS1, POS2, POS6, POS7, POS8, PES5, PES6, POE1, PEE5,

PEE6, POOC7, PEC1, PEC6, CT10, CT12) were deleted due to low factor loadings. In order to verify the validity of the variables, the AVE for each construct was computed. According to Hair et al. (2011), a minimum threshold of 0.500 is recommended for the AVE values of all constructs. As indicated in Table 2 below, the AVE value reported in this study exceeds 0.500, aligning with the suggestions of Chin, (2010), Hair et al., (2011), and Kock, (2011).

Table 2: Assessment of Measurement Model

| Variables | Measurement Items | Loadings | CR | AVE |
|---------------|---|----------|-------|-------|
| Realistic | POR1: I have athletic ability | 0.702 | 0.928 | 0.620 |
| | POR3: I derive satisfaction from working with machines | 0.809 | | |
| | POR4: I enjoy with various objects | 0.839 | | |
| | POR5: I derive satisfaction from working with tools | 0.874 | | |
| | PER2: I derive pleasure from fixing automobiles | 0.746 | | |
| | PER3: I like fixing furniture | 0.795 | | |
| | PER4: I like repairing mechanical instrument | 0.743 | | |
| | PER6: I like repairing building or household appliances | 0.776 | | |
| Investigative | POI1: I like to think | 0.714 | 0.923 | 0.601 |
| | POI3: I enjoy observing, learning, investigating, analyzing, and evaluating things, including problems and situations | 0.725 | | |
| | POI4: I find satisfaction in thoroughly engaging in problem-solving | 0.822 | | |
| | POI6: I am good at comprehending abstract concepts | 0.767 | | |
| | PEI1: I derive satisfaction from exploring the underlying causes of a phenomenon or an accident | 0.749 | | |
| | PEI2: I enjoy confirming a scientific theory through practical application. | 0.773 | | |
| | PEI3: I enjoy contemplating the principles behind the development or change of things. | 0.862 | | |
| | PEI5: I enjoy thoroughly studying a particular theory using a series of references or data | 0.780 | | |
| Artistic | POA2: I enjoy utilizing imagination or creativity | 0.749 | 0.900 | 0.531 |
| | POA3: I enjoy participating in tasks that enable me to showcase my artistic talents | 0.809 | | |
| | POA4: I possess innovative traits | 0.790 | | |
| | POA5: I enjoy attending stage plays | 0.700 | | |
| | POA7: I like to attend art exhibitions | 0.620 | | |
| | PEA2: I like designing the logo of a company or an organization | 0.642 | | |
| | PEA3: I enjoy crafting portraits or capturing photographs | 0.771 | | |
| | PEA5: I find pleasure in designing furniture, clothing, or posters | 0.724 | | |
| Social | POS3: I derive satisfaction from assisting others | 0.789 | 0.919 | 0.588 |
| | POS4: I enjoy educating and training individuals | 0.707 | | |
| | POS5: I derive satisfaction from fostering the development of individuals | 0.705 | | |
| | POS7: I excel in attentive listening to others | 0.799 | | |
| | PES1: I enjoy conversing with people to bring them happiness | 0.846 | | |
| | PES2: I find satisfaction in understanding human interactions | 0.860 | | |
| | PES3: I derive fulfilment from assisting individuals who are impoverished, ill, or lonely | 0.685 | | |
| | PES4: I have a passion for participating in charitable endeavours | 0.721 | | |

Table 2: Assessment of Measurement Model (cont.)

| Variables | Measurement Items | Loadings | CR | AVE |
|--|---|----------|-------|-------|
| Enterprising | POE2: I derive satisfaction from trying to influence or persuade others | 0.692 | 0.897 | 0.522 |
| | POE3: I derive satisfaction from exercising power and leadership | 0.777 | | |
| | POE4: I enjoy undertaking actions that influence the decisions of others | 0.798 | | |
| | POE5: I possess robust managerial capabilities | 0.696 | | |
| | PEE1: I am inclined towards participating in the planning for the developmental orientation of a team or company | 0.735 | | |
| | PEE2: I favor participating in investment analysis for a company | 0.674 | | |
| | PEE3: I favor participating in social marketing practices | 0.623 | | |
| | PEE4: I prefer engaging in work that involves allocating the human, material, or financial resources of an organization | 0.766 | | |
| Conventional | POC1: I enjoy executing tasks with meticulous attention to detail | 0.717 | 0.938 | 0.626 |
| | POC3: I am capable of adhering to established procedures | 0.849 | | |
| | POC4: I am attentive and cautious | 0.767 | | |
| | POC5: I am organized and systematic | 0.808 | | |
| | POC6: I am precise and accurate in my work | 0.705 | | |
| | PEC2: I find satisfaction in conducting inventory checks of supplies or products | 0.808 | | |
| | PEC3: I enjoy inspecting paperwork or products for errors and flaws | 0.891 | | |
| | PEC4: I find pleasure in recording data and inspecting materials | 0.771 | | |
| PEC5: I enjoy managing daily tasks in the office | 0.789 | | | |
| Critical Thinking | CT1: I believe it is crucial to systematically evaluate information | 0.827 | 0.967 | 0.725 |
| | CT2: I believe it is important to recognize inconsistencies in others' thinking | 0.746 | | |
| | CT3: I believe it is crucial to comprehend the logical connections between ideas | 0.830 | | |
| | CT4: I believe it is essential to efficiently solve problems and make precise decisions | 0.827 | | |
| | CT5: I believe it is crucial to distinguish between pertinent and extraneous information | 0.917 | | |
| | CT6: I believe it is crucial to formulate robust evidence-based arguments | 0.896 | | |
| | CT7: I believe it is crucial to assess situations from various perspectives | 0.870 | | |
| | CT8: I believe it is crucial to question my observations and assumptions by addressing difficult inquiries | 0.874 | | |
| CT9: I believe it is crucial to interpret the true significance of information | 0.847 | | | |
| CT11: I believe it is crucial to draw conclusions based on evidence | 0.864 | | | |
| CT13: I feel it is important to identify misconceptions and gaps in my own reasoning | 0.858 | | | |

Discriminant validity is evaluated using Fornell and Larcker (1981). As shown in Table 3, all HTMT values are below the recommended threshold of 0.90 as suggested by Hair et al. (2017), indicating that the model meets the stated criterion. The discriminant validity is used to identify phenomena that not represented by other constructs in the model.

Table 3: HTMT ratio

| | #1 | #2 | #3 | #4 | #5 | #6 | #7 |
|----------------------|-------|-------|-------|-------|-------|-------|----|
| #1 Artistic | | | | | | | |
| #2 Conventional | 0.486 | | | | | | |
| #3 Critical Thinking | 0.306 | 0.595 | | | | | |
| #4 Enterprising | 0.633 | 0.387 | 0.548 | | | | |
| #5 Investigative | 0.392 | 0.281 | 0.511 | 0.550 | | | |
| #6 Realistic | 0.318 | 0.227 | 0.206 | 0.284 | 0.518 | | |
| #7 Social | 0.454 | 0.527 | 0.577 | 0.506 | 0.471 | 0.148 | |

Note: Discriminant validity is established at HTMT below 0.90

Structural Model

The structural model was run using bootstrapping procedure with a resampling rate of 5000 to test the hypotheses (Hair et al., 2017). The results are shown in Table 4. This study tested six hypotheses and four were found to be significant. Specifically, Investigative type $\beta = 0.225$, $t = 2.350$, $p < 0.05$, Social type $\beta = 0.223$, $t = 2.485$, $p < 0.05$, Enterprising type $\beta = 0.55$, $t = 2.113$, $p < 0.05$, and Conventional type $\beta = 0.383$, $t = 3.605$, $p < 0.05$. Meanwhile, Realistic type and Artistic type were not significant. Thus, H2, H4, H5, and H6 were supported. The R2 was 0.525, which indicates that 52.5% of the variance in critical thinking can be explained by the construct proposed in this model. According to Hair et al. (2017), an R2 value of 0.75 is deemed substantial, 0.50 is considered moderate, and 0.26 is regarded as weak. Hence, the R2 value obtained in this study is substantial.

Table 4: Hypotheses Testing Result

| Hypothesis | Relationship | Beta | SE | t-Value | P-Value | LL | UL | VIF | f2 | R2 |
|------------|--------------|--------|-------|---------|---------|--------|-------|-------|-------|-------|
| H1 | R → CT | 0.008 | 0.095 | 0.080 | 0.468 | -0.172 | 0.140 | 1.381 | - | |
| H2* | I → CT | 0.225 | 0.096 | 2.350 | 0.010 | 0.029 | 0.358 | 1.781 | 0.060 | |
| H3 | A → CT | -0.168 | 0.115 | 1.457 | 0.073 | -0.340 | 0.019 | 1.695 | 0.035 | 0.525 |
| H4* | S → CT | 0.223 | 0.090 | 2.485 | 0.007 | 0.071 | 0.366 | 1.614 | 0.065 | |
| H5* | E → CT | 0.255 | 0.121 | 2.113 | 0.018 | 0.056 | 0.452 | 1.782 | 0.077 | |
| H6* | C → CT | 0.383 | 0.106 | 3.605 | 0.001 | 0.202 | 0.554 | 1.427 | 0.217 | |

Note: *supported hypotheses (t -value ≥ 1.645 at $p \leq 0.05$)

5. Discussion, Implication and Future Research

According to Holland theory, this study hypothesized that RIASEC model would have positive relationship on critical thinking. The findings indicated that only four RIASEC models showed statistically significant and positive relationship with critical thinking: Investigative, Social, Enterprising, and Conventional.

The present study reveals that Realistic type did not show any significant effect on critical thinking and this can be attributed to students' misunderstandings or misconceptions about the basic level of critical thinking aspects (Stupple et al., 2017). Students' understandings on critical thinking change according to the different disciplines and fields of study. For instance, students observe that critical thinking is recognizing the limits of individuals and emphasizing negative aspects. This argument conclude that students' misconceptions made students feel critical thinking competencies are not suitable with their personal and environmental orientations which contributed to the result.

The research findings illustrated that Investigative type positively affected critical thinking competency. This finding has a relation with the samples who are involved in the field of science, technology, engineering, and mathematics (STEM). Previous studies have revealed that STEM can improve student's critical thinking competency other than being an effective alternative to develop a critical thinking skill among students (Elfrida Yanty Siregar et al., 2019; Linh et al., 2019; Mater et al., 2020).

Furthermore, Artistic types which indicate a strong and negative effect on critical thinking competency can be argued through the situation in which students were not provided opportunities to prove their competencies. These students may face difficulties in terms of the culture of the work community, physical structures, interpersonal relations, and support from the management in organization and interpersonal relations during WBL training (Nevalainen et al., 2018). Moreover, past studies have disclosed the difficulties experienced by students during WBL training in which students are considered as mere employees and forced to face company constraints that overwhelm the training project (Rouvrais et al., 2018). Consequently, these difficulties hinder the readiness of students from taking the responsibilities, including teamwork engagement, personal learning, and professional development (Nevalainen et al., 2018).

Moreover, the research findings illustrate that the social type positively affected critical thinking competency. As mentioned earlier, individuals with the Social type have an advantage in working with others. Since the samples of the study undergoing the WBL program, they were indirectly involved with collaboration and cooperative learning. This finding parallel with previous study that found collaboration and cooperative learning will increase the student's critical thinking skills (Loes & Pascarella, 2017; Espey, 2017).

Meanwhile, Enterprising type positively affected critical thinking competency. This finding is supported by the previous study. The studies on the relationship between Enterprising type and critical thinking frequently examined in the business literature. The critical thinking skills among students was developed through business activities or entrepreneurial thinking programs (Calma & Davies, 2020; Dragoi, 2019). Usually, such activities or programs capable to polish student's leadership, decision making, communicating, problem solving and critical thinking competencies (Calma & Davies, 2020; Dragoi, 2019; Zapalska et al., 2018).

The finding in this study also illustrated that the Conventional type positively affected critical thinking competency. The finding is supported by the previous study that revealed Conventional type who are interested with procedures and routines will stressed individuals to possess the critical thinking competency to be successful in their practice (Dinçer & Kiliç, 2018).

Managerial implications

There is a list of practical contributions underlined in this study. The finding of this study may be used as a guideline for the Malaysian government in implementing a holistic and effective training program for the targeted group. The training program that will be provided should emphasize the formation of critical thinking competency. An effective training program is crucial in enhancing knowledge and competencies of human capital to be more globally competitive in the future. This is to prevent targeted group being left behind and to ensure that they have the necessary competencies to be applied in the workplace.

Other than that, the framework designed is valuable to address skill mismatch issue that may occur in various situations, including over or under qualification mismatch, the field of study mismatch or career mismatch. The results found may be used as a guideline to ensure that the public or private resources are invested in the right place and will grant beneficial returns in terms of job creation or wages. This is essential in providing job opportunities that correspond with the competencies or academic qualifications owned by society in general and the targeted group in particular. This matter can guarantee both job and life satisfaction of the society, consequently increasing the productivity of the country.

Limitations of the study

The limitation concerns a sample of the study that was rather homogenous. The study only focused on 1) TVET programs in Malaysia; 2) involving degree students from Malaysian polytechnics and; 3) the majority of the samples was from the same background of the field of study i.e. engineering field. Moreover, as the data collected were somewhat limited to Malaysian TVET institutions particularly polytechnics, the findings might be specific to polytechnics culture and environment as well as personalities and interests whereas those elements may differ from one institution to another even different from one country with another country.

Future research direction

Based on the study limitations, future research should utilize data from a wider variety of institutions with diverse student populations. The purpose is to form a larger sample size and could have generated more accurate results. Firstly, the sample for the next study may involve university students or training centers outside the Malaysian context, for instance, in the Asian context. Secondly, the sample to be involved needs to have work experience or undergo practical training to ensure questionnaire answer without bias.

6. Conclusion

Many non-automatic or industries 3.0 have progressively transformed to keep up with industrial revolution 4.0. Industrial revolution 4.0 is not just about investing in new technology and tools to improve manufacturing efficiency but also providing the key to society learning the new skills that robots cannot do. The top skills seen that can be mastered besides robots is critical thinking. An effort used to identify individual tendencies towards critical thinking competence is through the RIASEC model.

This study is motivated to examine how the RIASEC model can affect competency in the IR 4.0 context namely critical thinking. The result of the study has confirmed the validity and reliability of the instruments. This study has proven that four types of RIASEC model namely Investigative, Social, Enterprising and Conventional strongly affect critical thinking competency. Therefore, H2, H4, H5 and, H6 were supported. These results reflected through the WBL programme participant that usually involves with tasks such as analyse and evaluate information, reasoning, and situations, according to appropriate standards; cooperating and helping others; and learning by imitating, discussing, and repeating that are very closely related to critical thinking.

The result of study is expected to add up the diversity of knowledge and enlightenment in the literature specifically to Holland theory, fields of studies such as human resources, human behavior, psychological economic and management. The contributions were unlimited to the literature because the research findings can practically contribute to the government,

organization, and related agencies in terms of planning, designing, and offering the effective training program to targeted group. Finally, it is hoped that this study can be further developed by future researchers to provide more insights and knowledge in literature and in turn will provide greater contributions to the numerous parties.

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