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Exploring digital competencies domain and elements for information technology graduates in Malaysia

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ABSTRACT

This paper explores the reliability of an instrument to evaluate digital competencies domain and elements for polytechnics' information technology (IT) graduates in Malaysia towards future industrial revolution using exploratory factor analysis (EFA). This study thereby obtained 146 items from the previous phase (industries experts' interview) which was later developed according to the study's objectives. Experts validated the items, and after that, a pilot study was executed with 102 randomly chosen Polytechnics' IT lecturers from four Malaysian Polytechnics as the respondents for this study. Four domains had been decided which are Personal Effective Competencies, Functional Competencies, Essential Competencies, and Industrial Revolution 4.0 (4IR) Competencies. Elements for each domain were created using the EFA, in which internal reliability was achieved for all construct dimensions. There were 15 elements gained through EFA for those four domains.

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1. INTRODUCTION

The new paradigm of education involves emphasizing how teachers teach and how students learn, which are significantly emphasized in the education curriculum and teaching [1]. Advanced competences, technology-based learning transformations, and non-cognitive abilities are all required in the current learning process [2]. The development of information and communication technologies (ICT) has an intense effect on all aspects of technology, especially when there is a speed in new features. Therefore, each country's preparedness level must be increased to meet the ever-changing demands of the world's social, cultural, and economic priorities [3]. These new technologies are used by people all over the world in their everyday lives for better living conditions.

As technology evolves, more industries adopt these new technologies as the specifications of their jobs are evolving with technology change [4], [5]. The development of technology in ICT is currently related to the rise of the current industrial revolution, known as the Industrial Revolution 4.0 (IR4.0). Germany began implementing the National Industry 4.0 Plan in April 2013 in line with the fact that manufacturing is their major economic activity [4]. The Industrial Revolution 4.0 (IR4.0) is considered as a transformation from an agrarian economy to industrial manufacturing, leading to a new economic pattern [6]. However, in 2015 IR4.0 has been highlighted as the use of new technologies and is more relevant to adapting different work systems with a systematic technical and practical operational level [7].

This revolution undoubtedly affects the job specification and graduates' skills in information technology because most innovations and new technologies involve the use of digital business and ICT in their transitions. Competence is the ability to put information into practice in order to act, exhibiting individual competence in the process [8]. ICT has become prominent in modern societies as a tool in reforming education systems, fostering economic growth through creating new goods and services, as well as providing access to knowledge and expertise to promote changes in agriculture, health, and education. The use of ICT also links communities and teachers [9]. This reform significantly affects many country's higher education system as the higher education institution is the industry's provider [10].

The curriculum, skills of education, literacy, and education methods are evolving as ICT offers teachers and students the tools for a more profound knowledge base [9], [11]. However, since IR4.0 is the main topic among the industries experts, the most highlighted issue is that current workers and graduates are not competent enough to meet the IR4.0 skills demand [5], [12]. The employees or jobseekers must keep up with the rapid changes in workplace environment that is transitioning towards digital technology, as employers demand wide variety of skills to fulfil current job expectations [13]. According to the Malaysia's Ministry of Higher Education through Graduate Tracing Survey, the percentage of polytechnic graduates who are employed increased to 83.9% in 2018 [3] compared to 62.1% in 2015 [7]. However, beside the increase in employability percentage, sadly not all graduates manage to secure jobs accordingly to the field of their studies. Based on previous study, most of graduates do not get to work in their study field including IT graduates [3]. Based on that research too, 78.5% of Information and Communication Departments graduates from the polytechnic in that study do not work in the IT field. This situation is contradicted to the current analysis which highlights that ICT is among the most desired course of study in which its graduates are most likely to get jobs [14].

Based on the discussion, this paper mainly exploring the type of IT graduates that should be developed by Malaysian Polytechnics to meet the market needs of the industry and how far IT graduates from Malaysian Polytechnics will meet the industry's digital competencies in the future. Therefore, the purpose of this paper is to explore digital competencies elements for each of digital competency's domain for Malaysian Polytechnics' IT Graduates towards Future Industrial Revolution.

2. RESEARCH METHOD

This study employs quantitative approach by using questionnaire to conduct survey as the method of gathering data. The population for this study includes all lecturers of the information technology and communication department (JTMK) in the Malaysian polytechnics. JTMK is chosen because in the IR4.0 transition, ICT has become one of the critical industries not only to IT industry but also to other sectors. This is due to wide implementation of the trend in digitization, automation, and the use of ICT in various industries [3]. Therefore, IT students need to have particular skills to ensure that they are competitive to be hired during the era of IR4.0. The instrument is developed by researchers through the input from ICT industry's experts through three rounds of Modified Delphi. Next, in order to provide reliability and validity of the instrument, the questions were thoroughly assessed, where experts in the field were consulted for this reason. The validation of the instrument was done by experts from industries during Modified Delphi round, supervisor, associate professors from IT field, those who have experience in IT field more than seven years, language experts that have been certified, and also statistician experts to validate the questions before proceeding to the next steps.

Next, the revised questionnaires were distributed to four random polytechnics to gather data. As this study purposely aims to explore the elements for each of domains or components, Exploratory Factor Analysis (EFA) is chosen to analyze the dimensions of the items and to measure the construct using the data acquired. EFA is used to each construct to identify whether the items create different dimensions from prior research. New dimensions are expected in the current study [15]–[17]. EFA is used widely in getting the theme or component for each construct as used by previous researchers [16]. Preferred minimum sample size for EFA to obtain valid results is 100 [8], [18]. Then, instruments were distributed to the polytechnic's IT lecturers from Information and Technology Department (JTMK) as: i) Politeknik Metro Kuala Lumpur (PMKL); ii) Politeknik Metro Tasek Gelugor (PMTG); iii) Politeknik Seberang Perai (PSP); iv) Politeknik Sultan Abdul Halim Muadzam Shah (PMS); and v) Politeknik Besut Terengganu (PBT).

Few criteria have been set for the respondents such as the respondents need to have at least five years of experience teaching IT students in polytechnics to ensure the reliability of the study as the lecturers need to give their overall perspective of digital competencies amongst their students based on their experience. All of the respondents are chosen using simple random sampling method where the questionnaires were distributed using the Google Form link as the medium of data collection. The link was sent to Research and Innovation Officer for each polytechnic. Following that, a total of 102 questionnaires were considered to be valid to be analyzed.

The 146 items are included in the questionnaire using five-point interval Likert scale because 5-point Likert scale is less confusing and increases response rate [19], [20]. For example, the score of 1 represents "lowest competency level," whereas 5 represents "highest competency level." The respondents were also asked to provide demographic details such as gender, years of service, highest academic qualification, duration of industry attachment, and working experience in the industry.

3. RESULTS AND DISCUSSION

Exploratory Factor Analysis (EFA) was conducted for all constructs to test the dimensionality items as this study developed the questionnaire based on previous phase. EFA reduces a big number of factors into a manageable amount and sets the dimensions underlying measured factors to latent constructs, enabling the development and improvement of the theory [15], [21], [22]. The EFA process includes the mean score and standard deviation for each item measured by Kaiser-Meijer-Olkin (KMO) sampling adequacy. The values of the Bartlett test are taken and measured based on p-value. Bartlett test is considered significant when p-value<0.05 [22]–[24]. Total variance clarified for each construct must exceed 60% the minimum requirement, with the factor loading exceeding 0.6 [22], [23] for all items. The items' dimension is based on their components. Lastly, Cronbach's alpha score is also measured to demonstrate test and scale or known as internal reliability of the construct [23]–[25].

3.1. EFA for personal effectiveness competencies (PEC) construct

The construct for personal effectiveness competencies (PEC) was represented by 49 items in the questionnaire for this study. However, after being analyzed, 27 elements did not fulfil the criteria in EFA. Therefore, all 27 items are dropped from the construct. The standard deviation was computed to further analyze the data distribution [26]. The standard deviation determines the normal distribution of the data based on the error and variance figures to estimate the mean [25], [27], [28]. The mean and standard deviation cuts for each item are shown in Table 1 that indicates the lowest mean value (M=2.57).

Table 1. The mean and standard deviation for every item measuring PEC

		Mean	Std. Deviation
PE1	Modulating their voice when speaking to suit the listener or audience	3.10	1.30
PE2	Communicate interpersonally in a familiar work situation	3.01	1.42
PE3	Confident in delivering the presentation	2.91	1.21
PE4	Expressing ideas concisely	2.81	1.15
PE5	Communicate well in English	2.81	1.40
PE6	Start communicating with confident	2.81	1.16
PE7	Overcome issues while communicating with others	2.91	1.23
PE8	Overcome issues during the presentation	2.81	1.20
PE9	Communicate with respect and politely to higher level such as head of department, head of courses and lecturers.	3.11	1.33
PE10	Show appropriate facial expression in explanation	3.07	1.32
PE11	Respect diversity, individual differences, and perspective	3.17	1.35
PE12	Demonstrate commitment in task given	3.07	1.33
PE13	Know how to restrain themselves in a certain amount of pressure	3.07	1.42
PE14	Show professional attitude when handling task	3.20	1.37
PE15	Identify obstacles to effective teamwork	3.37	1.30
PE16	Delegate work fairly among teammate	3.10	1.32
PE17	Work independently in gaining knowledge	2.92	1.38
PE18	Independently finding new sources to finish the task	3.20	1.40
PE19	Show full interest in their work	3.18	1.35
PE20	Show effort while finishing their assignment	3.08	1.32
PE21	Have skills of making decisions	2.57	1.15

Next, the principal analysis method component (PCA) with Varimax Rotation was performed. Table 2 shows that the value of the Bartlett test is significant (p-value<0.05). The KMO adequacy measure value is 0.927, which is above the minimum value of 0.6, indicating that Bartlett test is significant [26], [29], [30]. The KMO value shows that the value was greater than 0.6 and close to 1.0 and Bartlett's test significance value close to 0.0 indicates that the data is adequate and appropriate for next reduction procedure [23], [24].

Table 2. The value for KMO and Bartlett's test for PEC construct

		Test value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.942
Bartlett's Test of Sphericity	Approx. Chi-Square	2571.595
	df	253
	Sig.	.000

Total variance explained is also an extraction procedure to reduce the items to the reasonable number before further analysis [24], [31]. This process will divide the components with eigenvalues exceeding 1.0 and being extracted to different components as shown in Table 3 [23]. Based on the table, the PEC construct is measured using three components where component 1 measures a construct of 31.740%, component 2 measures a construct of 24.676%, and component 3 measures a construct of 20.318%. The amount of budget variance for the personal effectiveness competencies construct is 76.734% which exceeds the minimum requirement of 60%.

Table 3. Total variance explained for PEC construct

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	14.899	64.780	64.780	7.300	31.740	31.740
2	1.496	6.504	71.284	5.676	24.676	56.417
3	1.253	5.450	76.734	4.673	20.318	76.734

Next, the result in Table 4 shows that the distribution of items for the three components for PEC constructs. The component has been grouped to certain number of items with their respective factor loading. In this process, only item that exceed factor loading of 0.6 will be retained [9], [30], [31]. According to that, from 49 items, 27 items are dropped as the weighting values factor is below 0.6. The remaining items are grouped based on the component as shown in Table 4.

Table 4. The PEC component and their respective items

	Component		
	1	2	3
PR1	.667		
PR2	.721		
PR3	.749		
PR4	.753		
PR5	.807		
PR6	.839		
PR7	.788		
PR8	.775		
PR9	.694		
IC1		.667	
IC2		.790	
IC3		.783	
IC4		.758	
IC5		.794	
IC6		.695	
IC7		.725	
PS1			.713
PS2			.676
PS3			.688
PS4			.688
PS5			.810

Reliability analysis is a procedure used to measure the items under each construct and determined the degree of the error [15]. The measure of reliability instruments is estimated through Cronbach's alpha values [23], [26]. The Cronbach's alpha value of an instrument must exceed the minimum limit of 0.7 to be used in the next phase [24], [29]. PEC construct has indicated that professional as the component 1 followed by component 2 which independent and confident and third component which is passion. According to Table 5, the Cronbach's alpha for each component is computed and possesses a high reliability standard as 0.968, 0.953 and 0.87 for component 1, component 2 and component 3 respectively. Therefore, these three components are recommended to be used for measuring the PEC construct in the next analysis.

Table 5. The internal reliability for the PEC construct

Component	N of items	Cronbach's alpha
1. Professional	9	0.968
2. Independent and confident	7	0.953
3. Passion	5	0.870
All items	21	0.972

3.2. EFA for functional competencies (FC) construct

Next, the same process need have been done to the next construct. There were 40 items represent the construct for functional competencies (FC), and after being analyzed, 24 items did not fulfil the criteria in EFA which represent the value of factor loading were below than 0.6 [30], [32]. Therefore, all these 24 items are dropped from the construct. Table 6 have shown the descriptive analysis, that includes the value, means and standard deviations of the 26 extracted factors. The lowest mean identifies basic compatibility issues between hardware components (M=2.81) while describe the purposes of software or system testing has the highest mean value (M=3.49). Other 24 items' mean value score and standard deviation for each item's measured constructs are shown in Table 6.

Table 6. The mean and standard deviation for every item measuring FC

		Mean	Std. Deviation
FC1	Enter, edit and organize structured information in a database	2.92	1.26
FC2	Create database tables	3.21	1.48
FC3	Modify non-relational database tables	2.91	1.37
FC4	Understand the different hardware and software components that may be used to implement a network	2.84	1.35
FC5	Explore the basic constructs of object-oriented programs in relation to manipulation of data objects	3.26	1.27
FC6	Describe specified data protection methods	2.97	1.24
FC7	Use specified security tools to identify and prevent breaches of security	2.98	1.19
FC8	Explore different life systems and life cycles' models	2.94	1.24
FC9	Understand the importance of effective planning before coding and testing before implementation	3.43	1.26
FC10	Explore different system testing techniques	3.21	1.25
FC11	Describe relevant parts of the testing process in developing system	3.18	1.27
FC12	Describe the purposes of software or system testing	3.49	1.30
FC13	Interpret specified technical information about the test	2.93	1.27
FC14	Gather and record relevant test information and test results	2.99	1.31
FC15	Demonstrate the proper use of hardware devices	2.74	1.33
FC16	Identify basic compatibility issues between hardware components	2.81	1.28
FC17	Recognize common operational problems caused by hardware	2.88	1.26
FC18	Explain the function and purpose of software tools	3.13	1.20
FC19	Troubleshoot computer components and peripherals	2.93	1.13
FC20	Troubleshoot operating systems	3.23	1.43
FC21	Troubleshoot networks	3.13	1.34
FC22	Code using at least one basic programming language	3.40	1.31
FC23	Think like a computer with the logic of programming	3.22	1.26
FC24	Describe fundamentals of programming	3.03	1.08
FC25	Describe application lifecycle management	3.03	1.05
FC26	Describe object-oriented programming	3.23	1.33

Next, Table 7 has shown the value of the KMO for the functional competencies construct was 0.927. The KMO value was higher than the threshold value of 0.6 as per suggested by previous researcher [20], [22], [26]. The Bartlett's Test of Sphericity was also significant where the value of Chi-square=2863.62 and p-value <0.001. The KMO value for FC construct also shows that the value was greater than 0.6 and close to 1.0 and Bartlett's test significance value close to 0.0 indicates that data for FC construct with 24 items is adequate and appropriate for next reduction procedure [2], [33].

Table 7. The value for KMO and Bartlett's test for FC construct

		Test value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.927
	Approx. Chi-Square	2863.620
Bartlett's Test of Sphericity	df	325
	Sig.	.000

Table 8 shows the total variance explained for FC construct. As illustrated in Table 8, FC construct is measured using four components where components 1 measures a construct of 26.056%, component 2 measures 19.102%, component 3 measures a construct of 16.208% and lastly, component 4 measures a construct of 15.311%. Therefore, the amount of budget variance for the FC construct is 76.676% which exceeds the minimum requirement of 60% [15], [31].

Table 8. Total variance explained for FC construct

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	15.070	57.960	57.960	6.774	26.056	26.056
2	1.954	7.515	65.475	4.966	19.102	45.157
3	1.539	5.919	71.394	4.214	16.208	61.365
4	1.373	5.282	76.676	3.981	15.311	76.676

The rotated component matrix results for the FC construct suggested a four-component solution as shown in Table 9. The 26 items distribute neatly into four components that measure functional competencies. shows the distribution of items for the four components of FC constructs. These 26 items show in Table 9 have factor loading greater than 0.6.

Table 9. FC component and their respective items

	Component			
	1	2	3	4
DS1	.626			
DS2	.729			
DS3	.689			
DS4	.715			
DS5	.741			
DS6	.824			
DS7	.809			
DS8	.697			
DS9	.681			
SD1		.699		
SD2		.713		
SD3		.745		
SD4		.746		
SD5		.688		
SD6		.654		
PT1			.614	
PT2			.715	
PT3			.655	
PT4			.617	
PT8			.746	
PT9			.644	
HS1				.682
HS2				.764
HS3				.668
HS4				.639
HS5				.640

The reliability estimates for the FC constructs are presented in Table 10. The Cronbach's alpha values range between 0.875 to 0.955 for four component of FC construct which represent that the construct is strongly reliable and can be accepted. All components have Cronbach's alpha value exceeding the minimum value of 0.7 which indicates that they are good to be used for the next phase [15], [31].

Table 10. The internal reliability for the FC construct

Component	N of items	Cronbach's alpha
1. Database, Security and System Testing	9	0.955
2. System Analysis and Design	6	0.942
3. Programming and Troubleshoot	6	0.905
4. Hardware and Software	5	0.875
All items	26	0.970

3.3. EFA for essential competencies (EC) construct

The construct for essential competencies (EC) was represented by 19 items in the questionnaire for this study as shown in Table 11. However, after being analyzed, eight elements did not fulfil the criteria in EFA [27]. Therefore, all eight items are dropped from the construct. The standard deviation was computed to further analyze the data distribution [15] which also determines the normal distribution of the data based on the error and variance figures to estimate the mean [29]. The mean and standard deviation cuts for each item are shown in Table 11 that indicates the lowest mean value (M=3.72).

Next, the principal analysis method component (PCA) with Varimax Rotation was performed. Table 12 shows that the value of the Bartlett test is significant (p-value<0.05). The Kaiser-Meyer-Olkin's (KMO) adequacy measure value is 0.717, which is above the minimum value of 0.6, indicating that Bartlett test is significant [30]–[32] and data is adequate and appropriate for next reduction procedure [28].

Table 11. The mean and standard deviation for every item measuring EC

		Mean	Std. Deviation
EC1	Explain the reason in choosing the solution for their decision in solving the problem	3.93	1.01
EC2	Describe the characteristics of storage devices	3.67	1.25
EC3	Explain the functions of storage devices	3.79	0.68
EC4	Explain the functions of peripheral devices	4.03	0.70
EC5	Explain the functions of core input devices	3.75	0.80
EC6	Assemble the computer	3.69	0.88
EC7	Boot the computer	4.16	0.85
EC8	Install the operating systems	3.77	1.00
EC9	Install computer software and essential hardware requirement	3.76	1.19
EC10	Utilize office effectively (Word, Excel, Power Point)	3.72	0.92
EC11	Able to make good presentation slide	4.27	0.75

Table 12. The value for KMO and bartlett's test for EC construct

		Test value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.717
Bartlett's Test of Sphericity	Approx. Chi-Square	755.017
	df	55
	Sig.	.000

In the context of the study, the measurement of the EC construct is presented in Table 12. This construct is assessed using three distinct components, each contributing a certain percentage to the overall measurement. Component 1 accounts for 26.056% of the construct, component 2 represents 19.102%, component 3 contributes 16.208%, and finally, component 4 measures 15.311% of the construct. The construct variance for the EC construct is discussed in Table 13, where it is revealed to be 76.676%. This percentage indicates the extent to which the actual measurement deviates from the expected value for the EC construct. In this case, a variance of 76.676% is considered favorable, as it surpasses the minimum requirement of 60% [34].

Table 13. Total variance explained for EC construct

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4.598	41.798	41.798	2.811	25.552	25.552
2	2.297	20.886	62.684	2.749	24.994	50.546
3	1.195	10.860	73.544	2.530	22.998	73.544

There were three components of EC construct measured. Table 14 shows the distribution of items for the three components in EC constructs. Only 11 items are accepted as the factor loading exceeds the minimum limit of 0.6 [30]. The items are grouped based on the component as shown in Table 14. Based on Table 14, the components than being analyzed and being named according to items themed. Table 15 shows Cronbach's alpha values for three components in EC construct. All three components, technical computing (0.868), initializing computer and storage (0.715) and computer-related hardware (0.856) have the Cronbach's alpha value exceeding the minimum value of 0.7 [35].

Table 14. The EC component and their respective items

	Component		
	1	2	3
TC1	.641		
TC2	.797		
TC3	.688		
TC4	.923		
IC1		.627	
IC2		.702	
IC3		.794	
IC4		.601	
CR1			.780
CR2			.915
CR3			.877

Table 15. The internal reliability for the EC construct

Component	N of Items	Cronbach's alpha
1. Technical computing	4	0.868
2. Initializing computer and storage	4	0.715
3. Computer-related hardware	3	0.856
All items	11	0.850

3.4. EFA for 4IR competencies (4IRC) construct

Last construct that being measured was 4IR competencies (4IRC) which represent by 36 items. However, after being analyzed, only 19 items fit the EFA criteria which carried the factor loading that more 0.6 [23], [24], [31]. The mean value score and the standard deviation for each item and measured constructs are shown in Table 16.

Table 16. The mean and standard deviation for every item measuring 4IRC

		Mean	Std. Deviation
IR1	Identify game platforms	3.58	0.84
IR2	Identify game genres	3.53	0.82
IR3	Describe a game user interface	3.43	1.11
IR4	Describe artificial intelligence (AI)	3.07	1.12
IR5	Differentiate between tool creation and game programming	3.28	1.18
IR6	Explain the basic concepts of cloud computing	3.37	1.09
IR7	Explain technical threats associated with cloud computing	3.31	0.99
IR8	Describe the impact of IoT	3.43	1.10
IR9	Describe cloud computing terminology	3.65	1.17
IR10	Describe general principle and practices of IoT	3.56	1.02
IR11	Distinguish between different types of clouds	4.20	1.26
IR12	Explain the basic concept of virtualization	3.98	1.38
IR13	Explain the basic concept of cybersecurity	3.50	1.06
IR14	Explain how to use cybersecurity	3.33	1.02
IR15	Explain the basic concept of Big Data	3.63	1.17
IR16	Describe the data science in real world	3.63	1.38
IR17	Explain the technique to share Data to work	3.21	1.25
IR18	Apply Data Science with Python	3.26	1.15
IR19	Describe cloud computing architecture	3.49	0.92

Principal analysis method component (PCA) with Varimax Rotation was performed on 36 items measuring 4IR competencies and shows that the Bartlett test is significant (p-value <0.05). Kaiser-Meyer-Olkin's (KMO) value is 0.752 exceeding the minimum value of 0.6 as shown in Table 17. The value shows that the Bartlett test is significant [26], [30], [32] and data is adequate and appropriate for next reduction procedure [15].

Table 17. The value for KMO and Bartlett's test for 4IRC construct

		Test value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.752
Bartlett's Test of Sphericity	Approx. Chi-Square	858.600
	df	171
	Sig.	.000

In the subsequent analysis, Table 18 presents the measurement of the 4IR competencies construct. This construct is evaluated using five components, with each component contributing a specific percentage to the overall measurement. Component 1 represents a construct of 17.281%, component 2 measures a construct of 12.873%, component 3 accounts for 12.592%, component 4 measures a construct of 12.036%, and finally, component 5 contributes a construct of 11.229%. Accordingly, the construct variance for the 4IR Competencies construct is reported to be 66.011% in Table 18. This percentage reflects the extent to which the actual measurement deviates from the expected value for the 4IR Competencies construct. Notably, a variance of 66.011% surpasses the minimum requirement of 60% [36], indicating a favorable outcome.

The rotated component matrix results for the 4IRC construct suggested a five-component solution, as shown in Table 19. From 36 items, 17 items are dropped as the weighting values factor is below 0.6 [32]. The remaining items which other 19 items distribute neatly into five components as shown in Table 19.

Table 18. Total variance explained for 4IRC construct

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5.448	28.675	28.675	3.283	17.281	17.281
2	2.607	13.721	42.396	2.446	12.873	30.153
3	1.657	8.722	51.118	2.393	12.592	42.746
4	1.529	8.047	59.165	2.287	12.036	54.782
5	1.301	6.846	66.011	2.134	11.229	66.011

Table 19. The 4IRC component and their respective items

	Component				
	1	2	3	4	5
GM1					.658
GM2					.651
GM3					.600
GM4					.766
AI1		.748			
AI2		.829			
AI3		.657			
AI4		.603			
IO1				.801	
IO2				.729	
IO3				.828	
CC1			.755		
CC2			.658		
CC3			.705		
CD1	.698				
CD2	.841				
CD3	.601				
CD4	.829				
CD5	.847				

Table 20 shows Cronbach’s alpha values for five components in the 4IRC construct [37]–[39]. The reliability value range between 0.701 and 0.55, suggesting that the items representing the constructs are reliable and acceptable because Cronbach’s alpha value exceeding the minimum value of 0.7 [6], [40]. All the items also reliable to be used for next phase.

Table 20. The internal reliability for the 4IRC construct

Component	N of items	Cronbach’s alpha
1. Cybersecurity and data science	5	0.855
2. Artificial intelligence	4	0.718
3. Cloud computing	3	0.701
4. Internet of thing	3	0.802
5. Gamification	4	0.703
All items	19	0.853

3.5. Polytechnics' IT graduates digital competencies framework

Figure 1 shows the first phase of framework that contains constructs or known as domain, and second-order constructs which are referred to as elements with certain number of sub-constructs [15], [41], [42]. Every sub-construct is measured using certain number of measuring items in the questionnaire [15]. This framework consists of four construct which is personal effective competencies (PEC), functional competencies (FC), essential competencies (EC) and 4IR competencies (4IRC). Each construct was divided into several component and these components comes from the EFA as per explained in sub-topic 3.1 to 3.4. As this framework is specifically developed for polytechnics' IT students and graduates, the framework is different from previous digital competencies framework that has been proposed by previous researcher to accommodate research on teachers, lecturers, undergraduates, and school students [43]–[45]. This study's framework is more specific and detailed into digital competency of IT students. Therefore, this framework will be validated using confirmatory factor analysis in the next phase.

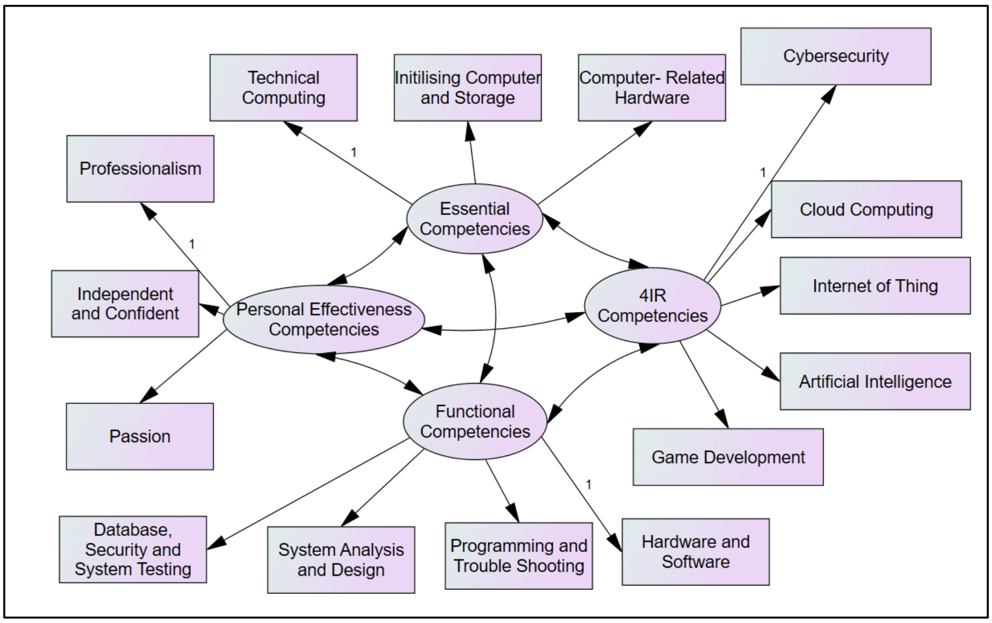

Figure 1. The polytechnics' IT graduates digital competencies framework domain and elements

4. CONCLUSION

This study contributes to the development of a digital competency's framework, particularly for Polytechnics' IT students and graduates. Four domains have been set and each domain has its own respective elements dimensions from EFA findings. Based on the EFA outcomes, the current study has figured three components or elements for Personal Effectiveness Competencies domains, which are Professionalism, Independent and Confident and Passion. These three-components had 0.972 Cronbach's alpha values for the Internal Reliability which indicates that these three components are reliable for next phase. Next domain which is Functional Competencies domain has four elements that are Database, Security and System Testing, System Analysis and Design, Hardware and Software and Programming and Troubleshoot. These four components are also reliable to be used in the next phase when the Cronbach's alpha values for the internal reliability is 0.970. Third domain, Essential Competencies had produced three components which are Technical Computing, Initializing Computer and Storage and Computer-related Hardware. These three components are also reliable based on the Cronbach's alpha value at 0.850 which is high in internal reliability. Next, the last domain of 4IR Competencies had produced five elements such as Cybersecurity and Data Science, Artificial Intelligence, Cloud Computing, Internet of Thing and Game Development. The internal reliability for these five components is 0.853 Cronbach's alpha value which indicates that they are reliable to be used in the next phase. Therefore, based on the obtained results and framework, all of the considered items are applicable for this study and proposed to be validated in the next phase using Confirmatory Factor Analysis to see whether the model is fit and reliable to be used in gathering data in polytechnics.

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