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Mapping Skills Assessment through Skills Bio-chart Data Analytics

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Abstract

This paper presents the concept of the Skills Bio-chart as a novel method to measure progressive growth pathway for skills assessment in Malaysia, particularly targeting the Technical and Vocational Education and Training (TVET) stream. The architecture of the Skills Bio-chart is designed using graph theory mapping in line with two key constructs, which is the learning outcome domains (LOD) of the Malaysian Qualifications Framework (MQF) and the competency framework of the National Occupancy Skills Standards (NOSS). The extended mapping of predefined skill sets integrates with the LOD components which correlate to the NOSS competency matrix to form multiple factorial graph connection. Sampling only from the Information and Communications Technology (ICT) sector under the NOSS subset, the analytics in this paper is limited to only the certificate level (Level 1 to Level 3) of TVET and skills education. The user interface (UI) of the Skills Bio-chart is incorporated into the Skills Biometrics Service Platform which serves as a customized online learning database platform that functions as the backend support unit. Additionally, this paper presents the factor analysis on the acceptance of the Skills Bio-chart model as a significant competency measurement tool through the Technology Acceptance Model (TAM) testing.

Keywords

Skills Bio-chart, Skills Biometrics Service Platform, Skills mapping and assessment, Technology Acceptance Model, TVET and skills education

Introduction

In recent years, the increase in Technical Vocational Education and Training (TVET) pathway shows a shift in demand in skills education, contributing to the economic growth in Asia [Pavlova, 2014]. Over the last decade, Malaysia has strategized on the development of TVET where the National Key Economic Area (NKEA) forecasted the availability of over 1.3 million TVET jobs, particularly in the clerical, service industry and operations divisions [Phang, 2011][Hilmi, 2016][RMK10]. Figure 1 illustrates the economic growth sectors based on the Economic Transformation Programme (ETP) statistics which largely represents the country's gross national income (GNI) in 2016.

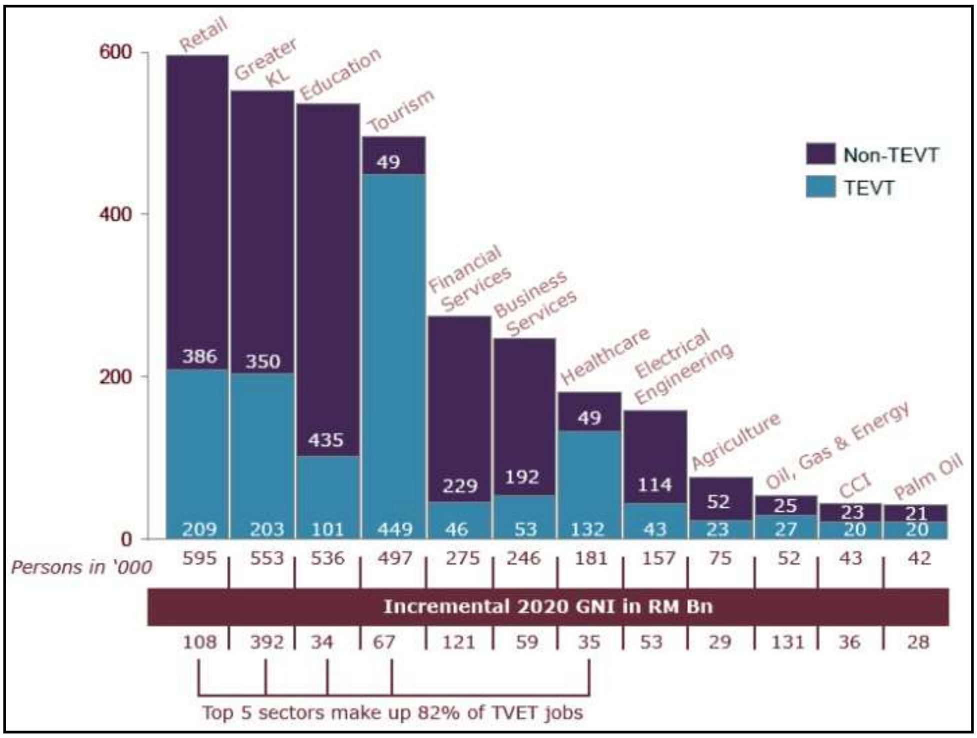

Figure 1. Economic Transformation Programme (ETP) 2016 Chart, showing the 8 National Key Economic Areas (NKEA). (Info in courtesy of Pemandu, BCG Analysis)

However, the TVET landscape in Malaysia have always suffer from major problems namely uncoordinated governance, fragmented delivery, competency gaps and the lack of recognition for technologist [Phang, 2011], which leads to the case of having multiple distinct accreditations and coordinating bodies as shown in Figure 2. The instance of multiple providers significantly disadvantages TVET candidates as there is no standardization in measurement and assessments to map progressive pathways to the right job scope. Even the option to cross pathway to the academic stream is often not possible as most providers' independent certification are not recognized.

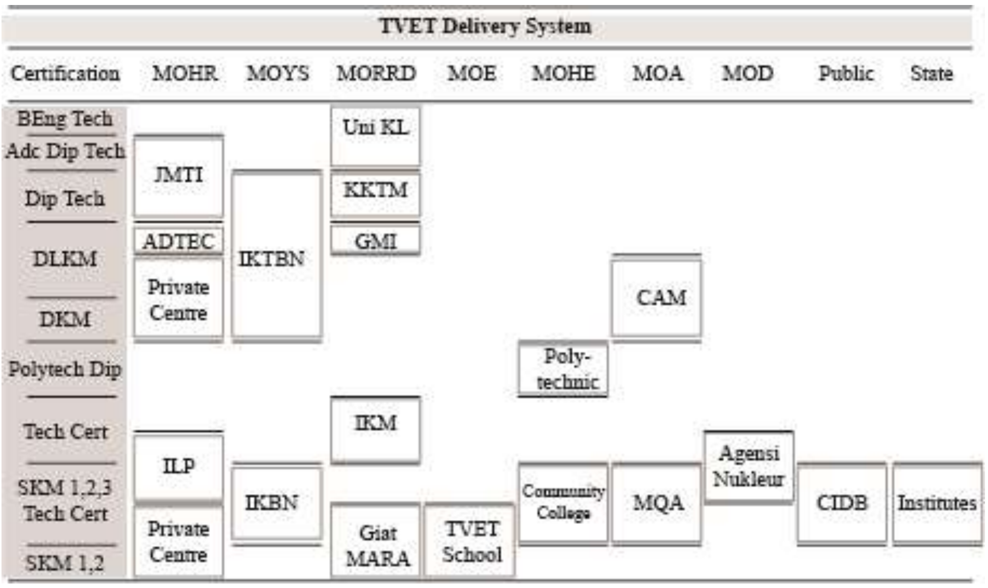

Figure 2. Multiple providers in accrediting and governing. No singular authority to coordinate policies

To address the issue on conforming towards the standardization of TVET assessment, the proposed model of the Skills Bio-chart adopts certain axiom in aligning directly to the established academic point of reference such as the integrated cumulative grade point average (iCGPA) [MOE] attainment design as well as the competency mapping of the National Occupancy Skills Standards (NOSS) framework [EPU, 2016]. The idea is to identify correlated variables as means of measurement for growth in progressive skills education in line with normalized education standards within the requirements of the national qualifications framework. Through the Skills Bio-chart theoretical model, the mapping of progressive pathway development in skills focuses primarily on conforming to normalized assessment criteria.

Malaysian Learning Frameworks

As shown in Figure 3, both the Skills education pathway and TVET pathways in Malaysia primarily only encompass the first 5 out of 8 levels of the Malaysian Qualification framework (MQF) [MQA].

MALAYSIAN QUALIFICATIONS FRAMEWORK (MQF)

MQF Levels	Sectors: Skills	Sectors: TVET	Sectors: Higher Education	Lifelong Learning
8			Doctorate	Accreditation for Prior Experiential Learning (APEL)
7			Master's Postgraduate Cert & Diploma	
6			Bachelor's Graduate Cert & Diploma	
5	Skills Advanced Diploma	Advanced Diploma	Advanced Diploma	
4	Skills Diploma	Diploma	Diploma	
3	Skills Certificate 3	Vocational & Technical Certificate	Certificate	
2	Skills Certificate 2			
1	Skills Certificate 1			

Figure 3. Malaysian Qualifications Framework (MQF) chart. (Courtesy of Malaysian Qualifications Agency, MQA)

For the higher education stream, the measurement and assessment primarily focus on the conventional Cumulative Grade Point Average (CGPA) based evaluation on a maximum score value of 4.0, where the emphasis reflects the mapping of credit hours of a programme. This involves mapping the MQF learning outcome domains specifically to the Programme Objectives (PO), Programme Learning Outcome (PLO) and Course Learning Outcome (CLO) of any given programme [MQA].

On the contrary, the skills learning pathway includes the Sijil Kemahiran Malaysia (SKM) model, where the assessment method is entirely different. With a maximum value of 60% in support of the development of skill sets, which is evaluated primarily through portfolio development, and the remaining 40% supporting the development of knowledge and understanding with assessment through examination. The mapping of the SKM model refers to the competency units derived from the NOSS competency units. In addition, the examination assessment covers both written and practical evaluation, as well as formative assessment of weekly progression assessments that add to the total scoring [EPU, 2016].

Nevertheless, most assessments being practiced focuses on the reflection of the candidate's performance of the programme rather than targeting directly on the candidate's performance based on the skills evaluation criteria.

New Assessment Models

With the implementation of the Malaysian Education Blueprint [MOE], the education administration units, especially the Malaysian Qualifications Agency (MQA), has engaged into new mediations in improving the advanced education evaluation framework where the CGPA model has been upgraded to the iCGPA model. One of the key features of the iCGPA framework is the alignment of the spider-web framework (Figure 4) that maps to the 8 MQF learning outcome domains covering 15 sub-attributes.

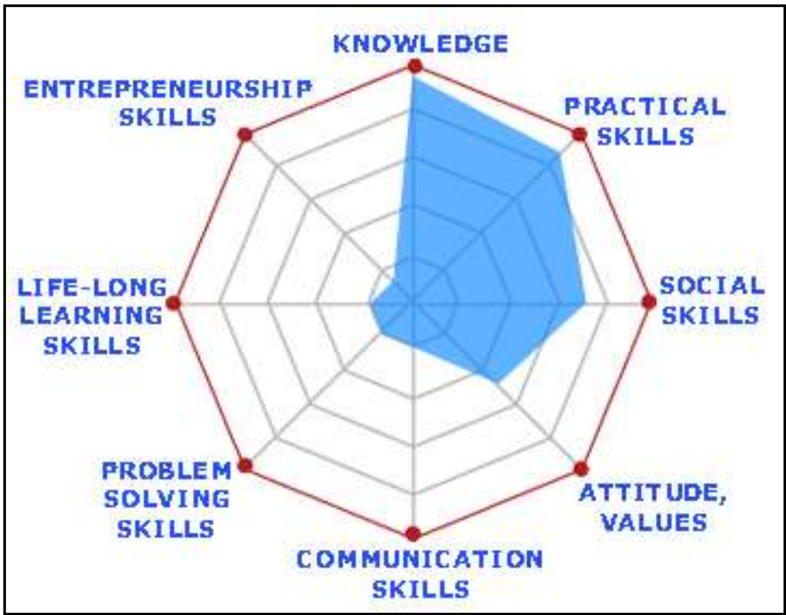

Figure 4. Sample of Integrated Cumulative Grade Point Average (iCGPA) spiderweb framework.

Additional learning models emphasized in the blueprint as well includes the 2 years industry, 2 years college (2U2I), as well as the Massive Open Online Course (MOOCs), which have been practiced in different universities and colleges throughout 2016 and 2017. In any case, despite the well planned interventions, it would still require a significant amount of time to test out the impact for these new initiatives to prepare graduates for the job market. With the shift towards the fourth industrial revolution (IR4.0), the demand for skills education for one to thrive in future job markets will significantly increase globally [WEF]. The methodology of teaching and learning have continuously evolve through online form and systems where new features and formats redefining education technology grows within the needs of the industrial transformation [Lee, 2018].

Materials and Methods

The underlying mechanics of the Skills Bio-chart adopts graph theory concepts in mapping MQF Learning Outcomes domains (LOD) directly to specific skill set within its algorithms, particularly looking at paths and circuits [Diestel, 2000] within multigraphs, forming patterns like directed graphs and spanning trees. The core mapping refers to globalized skill sets which are referenced to the list of skills required to thrive in alignment with IR4.0 denoted by the World Economic Forum (WEF) [WEF]. The mapping correlates to the MQF guidelines on the sub attributes level that is defined within each domain. Each candidate's data set can then be measured in detail, outlining distinct characterization of each skill set, thus formulating a network graph guide for skills jobs mapping, as shown on Figure 5.

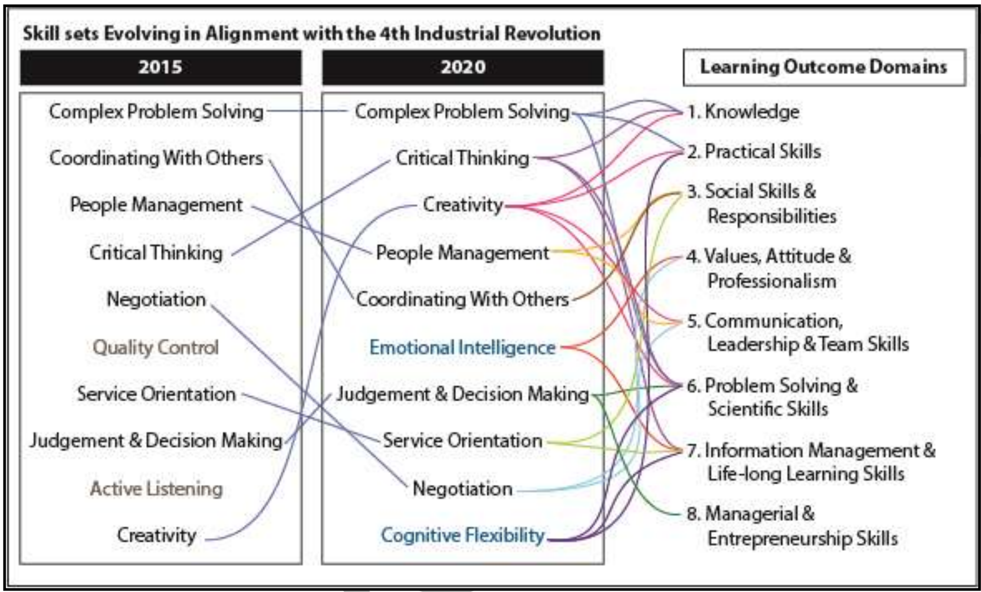

Figure 5. Skills Jobs Mapping to MQF Learning Outcomes

Graph theory mapping is primarily used in the construction of the Bio-chart as it allows more complex relationship mapping to show progressive growth, and not just a static interval to define the assessment.

The next part of the skills mapping is then connected to the NOSS sub-branches, and directly conforms to the iCGPA framework. Figure 6 shows a sample of the mapping based on the graph network to a sample job scope of a 3D animator comparison within level 3 to level 5, and how the skill-sets now directly relates to the MQF learning outcome domain.

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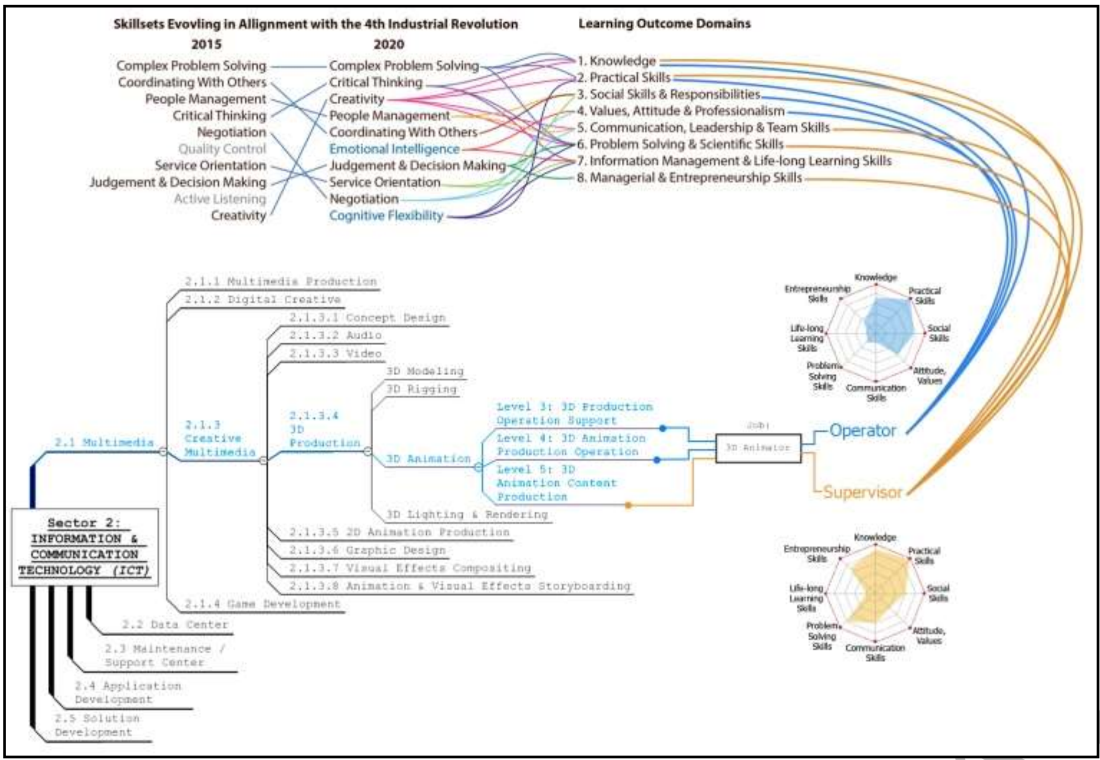

Figure 6. Sample Mapping of NOSS Sub-sector to a Sample Job Linking Directly to MQF Learning Outcomes.

Extracting the specific data of a Level 3 candidate to show the regression of the pathway for a 3D animator (operator) in alignment with the skills mapping and learning outcome domain in the following mapping (Figure 7).

Graph theory mapping enables flexibility in mapping a complex relationship. The mapping paths can be classified as routes or circuits where a complete loop can be attained to complete the learning circuit. Different distributed loops within the graph network can establish patterns that can conform to an active relationship model, where relevant LOD serves as the nodes within the graph construct in correlation to the type and level of the jobscope.

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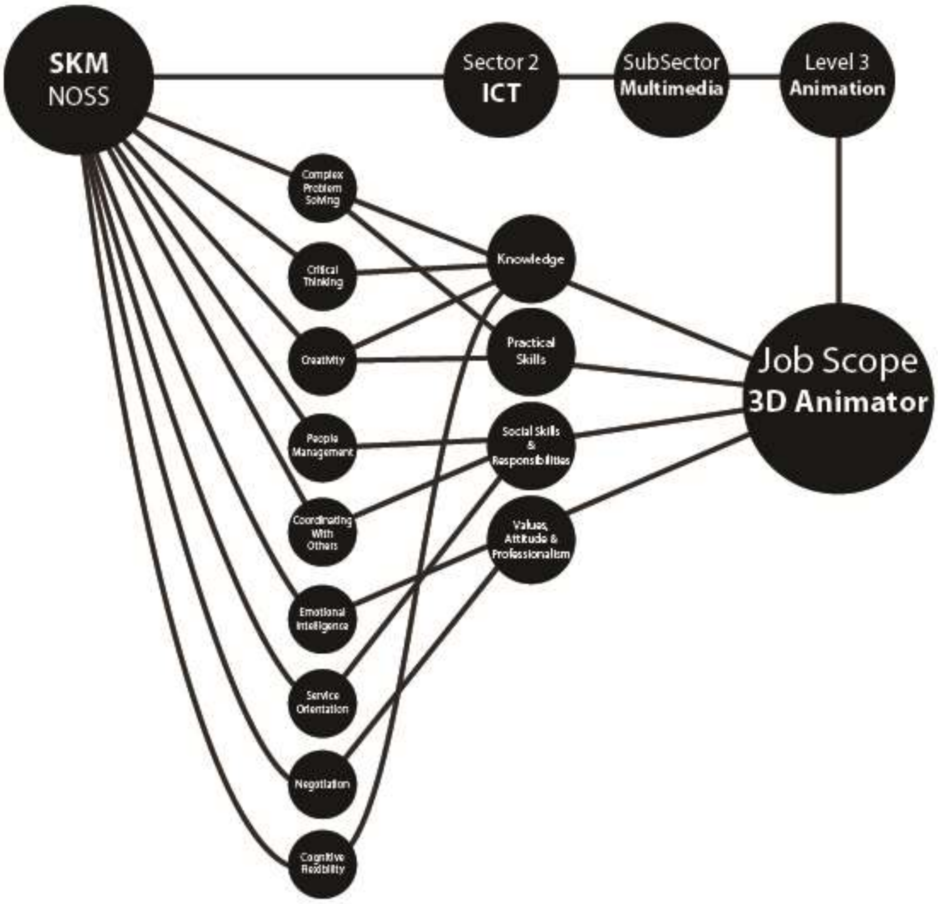

Figure 7. Multigraph schematic of candidate mapping pathway

Skills Bio-chart Construction Framework

Subsequent from the graph theory mapping, the graphics user interface (GUI) design of the Skills Bio-chart (Figure 8) clearly portrays the full characteristics of each candidate, enabling better comparative features to other candidates. This differs from just subjecting to the conventional mean percentile value. The Skills Bio-chart concept emerges customary from a common biometrics framework, where a multitude of symptoms can be identified from a health bio-chart which breaks down the metadata features [Mogli, 2011]. Similar to most biometrics framework, the idea is to design analytical schematics of information that differs from one individual to another. Each candidate's Bio-chart showcases different pattern and data based on growth and development over time.

The Skills Bio-chart categories mainly links back to the MQF LOD, with the segmentation of grouping, namely *core*, *extended*, and *compliment*. The grouping serves as clusters to formulate a novel theorem to calculate the Skills Ratings (SR) point system.

The design of the Skills Bio-chart reflects many GUI design trending in this era of technological inspiration, such as websites, gaming user interface, and even featured productions, though the content is different. The Skills Bio-chart has four distinct interfaces, which are 'candidate', 'trainer', 'industry', and 'governance'. For instance, the *industry group's* interface displays more content and syllabus development features, where as the *governance group's* interface displays more analytics and tracer studies.

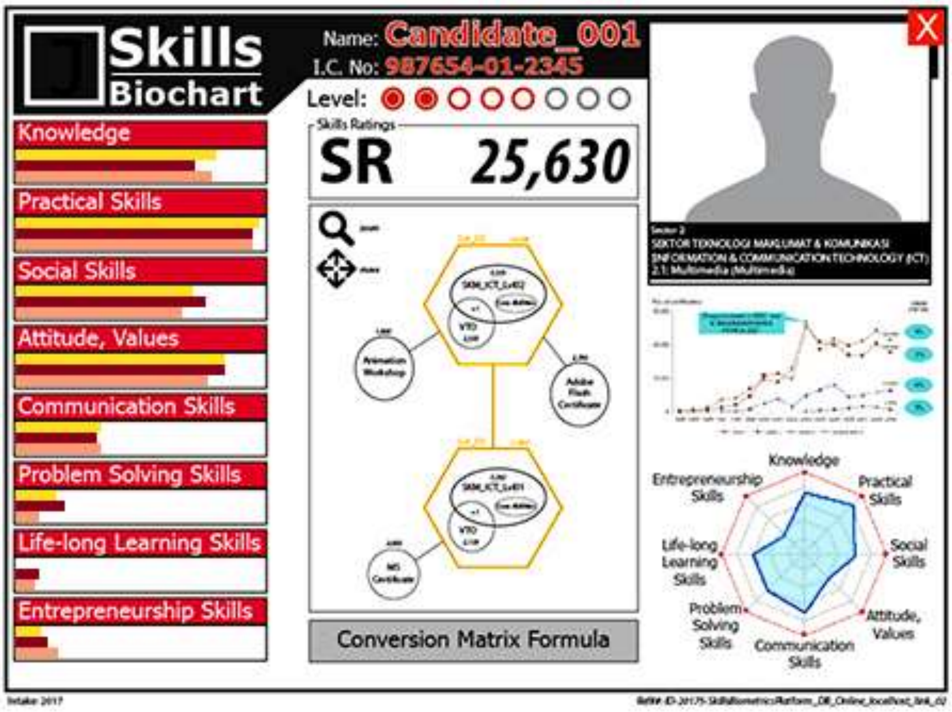

Figure 8. Candidate's Skills Bio-chart, part of the Skills Biometrics Service Platform

Methods and Procedures of Testing

The paper adopts the Technology Acceptance Model (TAM) analysis [Davis, 1989] to measure the acceptance of the Skills Bio-chart technological design, particularly looking at the two key measurement criteria, "*Ease of Use*" and "*Perceived Usefulness*". Figure 9 shows the extended framework of TAM in line with the Skills Bio-chart alignment.

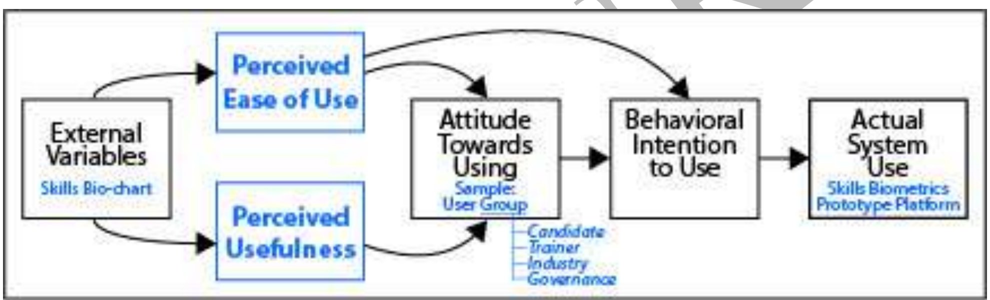

Figure 9. TAM Framework Integrating Skills Bio-chart Design

A prototype version of the Skills-Biometrics service platform (Figure 10) was developed and applied to a sample group for testing in Klang Valley selected schools, stakeholders and administration office in Malaysia with a total of 103 participants, based on four different grouping, namely the candidate, trainer, industry and governance. Each login category links to a different interface designed specifically to cater to the particular user group, displaying only the relevant data set.

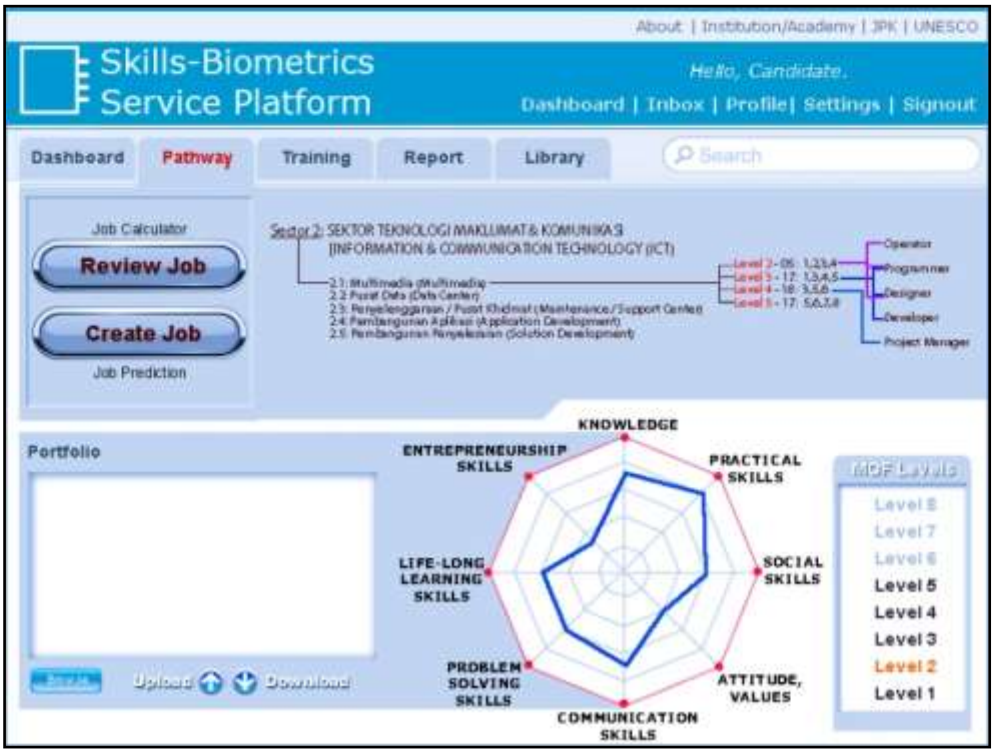

Figure 10. Skills Biometrics Service Platform. Candidate's user interface.

The user testing was conducted through a survey designed customarily based on TAM, focusing on acquiring the feedback on the *usefulness* and the *ease of use* of the Skills Bio-chart within the Skills Biometrics platform. Validation and reliability test of the survey was previously performed using correlation (0.05 significance) for the validation test and Cronbach's Alpha (0.96) for the reliability. Observed variables from the responses were coded following the Likert scale rule of values ranging from 1 to 7.

Data was analyzed based on Structural Equation Modeling (SEM) particularly using Confirmatory Factor Analyses (CFA) to firstly measure the goodness of fit of TAM, and secondly, to outline how the constructs are related to one another. The measurements to validate the model for goodness of fit statistics used here are Chi-Square (p value), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI), and Root Mean Square Error Approximation (RMSEA) [Renny, 2013].

Results and Discussion

Perceived ease of use is the latent construct which was measured using 3 endogenous indicators (manifest variables), namely complexity, usability and learning speed. All these observed indicators clearly portray close contribution with each other in building perceived ease of use. The same applies to the perceived usefulness latent construct has been also measured by using 3 endogenous indicators, which are satisfaction, dependency rate and support. As both latent constructs are the highest level of exogenous variables, there is a correlation covariance connecting the two. Figure 11 shows the Confirmatory Factor Analysis (CFA) of the TAM results.

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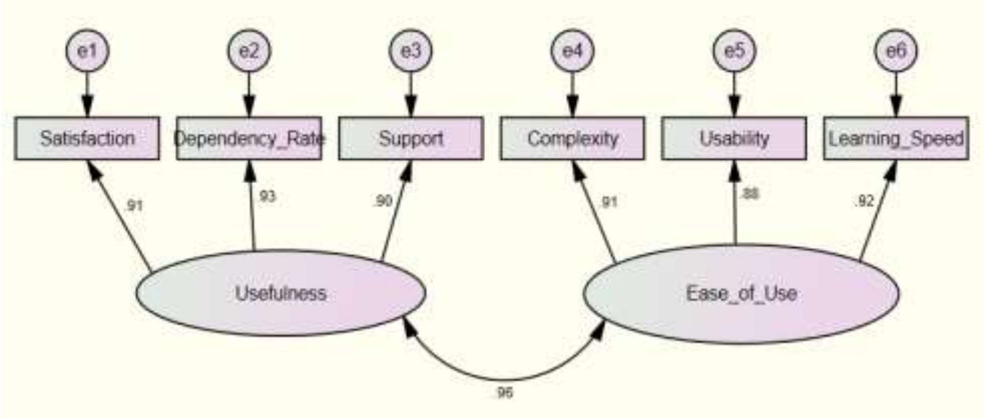

Figure 11. Skills Bio-chart TAM output.

Table 1 shows the Goodness of Fit statistics measuring the dataset with reference to the acceptable values.

Table 1 Goodness of Fit statistics

Index	Acceptance Value	Model Output
Chi-Square (P-value)	> 0.05	0.083
Goodness of Fit Index (GFI)	Close to 0.9 (good fit)	0.956
Adjusted Goodness of Fit Index (AGFI)	Close to 0.9 (good fit)	0.883
Normed Fit Index (NFI)	Close to 0.9 (good fit)	0.980
Root Mean Square Error (RMSEA)	< 0.08	0.085

Based on the results of the test, the overall acceptance model conforms to a good fit except for the RMSEA value that is slightly higher than the acceptance value. This mainly reflected the biasness within the unfiltered error sampling that can be modified to exclude from the constraint matrix [Hooper, 2008]. The factors can be reduced relatively to the full set of indicators to correct for the error. The p-value is also quite low based on the sample size but still within acceptable range of the absolute fit index.

The attained results are similarly in consistent with previous researches adopting TAM, where the use of new technology gears towards a positive impact in representing the conceptual model [Renny, 2013][Li 2008][Hooper 2008].

Conclusion

This paper introduces the Skills Bio-chart as a novel model designed to measure and report progressive skills development and assessment with the support of an independent online system, specifically catering for TVET and skills education pathway. The creative design of the assessment system gears to re-engineer skills education development, to enhance the continuous growth towards the '*upskilling*' and '*upscaling*' of skilled graduates. The primary sampling group in this paper only covers selected subset within the ICT sector, and although the results are very positive, the statistical representation for other sectors within NOSS might significantly differ in measurements and outcomes. Extended mapping and analysis under other NOSS sectors will be conducted in future research plans. Extended research for the Skills Bio-chart will also be carried out particularly looking more closely at correlation of other learning outcome domains conforming to the progressive TVET levels.

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