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# Factor analysis: Competency framework for measuring student achievements of architectural engineering education in Indonesia

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**Abstract**

This study aims to prove the validity test and estimate the instrument's reliability to measure student achievement in the department of architectural engineering education in Indonesia. The cluster random sampling technique was used to determine the number of students consisting of 103 vocational education students. This study uses a survey method to examine and analyze the structure of students' competency achievements factors. The collected empirical data were analyzed using descriptive and inferential statistics using Exploratory Factor Analysis (EFA). EFA test is intended to reveal factors that can be formed from instruments that have been established for measurement of achievements of vocational student competencies. The analysis results using EFA showed that the instrument had good construct validity. The result of this research shows that the instrument test for measuring the achievement of student competencies has good reliability and consists of 30 competency items covering ten competency aspects, namely general competencies, technical drawing, statically structures, basic building construction, land measurement engineering, software application and building interior design, road and bridge construction, estimated construction costs, building construction and utility, creative and entrepreneurship product competencies.

***Keywords***: *achievement competency, vocational education, architectural engineering education, exploratory factor analysis*

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## Introduction

The quality of human resources (HR) is the key to the competitiveness of a nation to determine who can develop in global competition and maintain survival. Innovative, creative, technology literate, and having multiple intelligences are the hallmarks of superior human resources (Slamet, 2013). Manpower issue is always related to human resources, thus the quality of human resources needs to be improved and developed to obtain a competent workforce with high morale will maintain the industry and strengthen the country's economy (Widodo & Pardjono, 2013). The 2019 Global Competitiveness Index database on the World Economic Forum (WEF) states that one of Indonesia's shortcomings is the $65^{th}$ skill pillar of 141 countries. The pillar includes an index of the current and future components of the workforce skills that is still low to make Indonesia's competitiveness decline (Forum Económico Mundial, 2019).

Furthermore, based on the INSEAD data (2019) "The Global Talent Competitiveness Index", Indonesia was ranked 67th in 125 world countries. This also shows that the provision of human resources to improve the competitiveness of educational skills is still weak (Lanvin, & Monteiro, 2019). The data supported in Human Development Report 2019 show that the Indonesian HR quality index ranks 111th out of 189 countries in the world. The quality of human resources is important, especially to obtain follow-up so that Indonesian human resources are able to compete in facing the era of globalization, technological development, and other global challenges (United Nations Development Programme, 2019). Thus, such condition that Indonesia does not have yet is quality human resources.

The increasing number of the construction sector makes Indonesia the construction market in the ASEAN country (Daryono et al., 2020). Indonesia has the largest construction market compared to neigh boring countries. The need for a professional workforce increase will affected by the rise in the construction market until 2025 (Kesai et al., 2018). Besides, the world of work continues to change creating new challenges for employers and employees (Suarta et al., 2018). The progress of industry resulted in the advancement of the employment sector and the number of workers in the construction sector. Indonesian employment data explains that the construction sector is in the top four with 18.98% in August 2019. Employment of the population of each business sector shows the ability in the construction sector in the labour absorption rate (Central Bureau of Statistics, 2020).

Preparing vocational high school graduates, according to the industrial qualifications and technological developments, is one of the goals for vocational education. Therefore, students must be equipped with competencies in line with the needs of the business and industrial world (Diwangkoro & Soenarto, 2020; Fakhri & Munadi, 2019). Educational development based on community needs will produce competent graduates (Muaini, Zamroni, & Dwiningrum, 2019). Thus, quality vocational education is able to adjust economic development and the progress of science and technology. Essentially, in order to strengthen the global economy, there must be successful vocational education as support.

Vocational high schools institutions in Indonesia are called *Sekolah Menengah Kejuruan*. Vocational high schools (VHS) are organized to prepare students for work after completing vocational education. Zhang (2009) explains that one of the basic goals for vocational education can be successful, namely by increasing students' skills. If after graduating students can work immediately, then the problems of unemployment in Indonesia will decrease.

The research of Joo (2018) states that there are four premise factors that contribute to increasing the employment rate of vocational education graduates, including professional teachers, industry-equivalent curriculum, leadership spirit, and also link and match. Vocational education realizes the aim to strengthen education to become professional and improve economic and social development so that the increase in employment rates of vocational education graduates does not run optimally (Xiao, 2009). The first factor as a cause of absorption of Building Engineering graduates is the low teaching and learning process. The teaching and learning process of vocational schools that have not maximized the learning of soft skills and hard skills together, the school emphasizes the learning of hard skills only for competencies that are required to work. The learning process as explained by Sutarto and Jaedun (2018) "emphasizes authentic-learning and assessment that promote higher-order thinking skills: creative, innovative, and problem-solving in real life", to support the competencies of graduates who are ready to work in the construction industry. A nation can develop the new world, which is necessary to prepare superior and quality human resources with multiple and broad skills, as well as multilingual literacy to be able to develop sustainably (Widarto et al., 2012; Triyono et al., 2018).

The second factor is the graduate competency standards applied in learning process. Some competencies are not applied due to time constraints in the implementation of the learning process. Research by Manap, Hassan, and Syahrom (2017) concludes that the constraints include the lack of the equipment in VHS, teaching strategies to increase students' readiness to work in the industry, competent and unqualified workers carried out to the maximum.

The competency framework is a tool that determines the competencies that are needed by individuals to reduce current challenges and enforce sustainable development (Lai, Hamisu, & Salleh, 2019). This research was conducted due to the problem of competitiveness of vocational students. This situation is influenced by the irrelevance of school competencies with the current state of development of the construction industry technology. The main solution is growing and developing student competitiveness by increasing student competency through vocational education (Rahdiyanta, Nurhadiyanto, & Munadi, 2019), because this condition causes the low competitiveness of competencies in entrepreneurial and technical skills in both national and international markets (Sukardi, Wildan, & Fahrurrozi, 2019; Ismail & Hassan, 2019).

Thus, it is crucial to conduct research to determine the framework of vocational education competencies in developing techniques in accordance with industrial competencies. This is done to obtain ideal standard of work competency information that must be mastered by vocational students so that they become competent workers in the field of construction services and whether the competencies provided in vocational schools are in accordance with the competencies that are needed by the construction service industry.

## Method

### Participant Characteristics

This research is based on a descriptive survey study, drawing conclusions from testing hypotheses to get answers to the problems studied (Creswell, 2012; Ingleby, 2012). This research was conducted at nine VHS in Central Java and Yogyakarta, Indonesia. Because the number of VHS in Central Java and Yogyakarta are stratified, the sample was collected using cluster sampling and stratified random sampling (Creswell, 2014). Determination of the number of respondents of vocational education students in the department of architectural engineering was done by cluster random sampling technique, resulting in 103 students. The samples in the range of 100 are acceptable (MacCallum et al., 1999; Sugiyono, 2019).

### Measures and Covariates

The questionnaire was prepared based on the Regulation of the Minister of Education and Culture No. 34 of 2018 concerning the national standards for vocational secondary education, SKKNI No. 374 of 2013 for implementing buildings and public facilities, SKKNI No. 85 and 205 of 2015, and No. 340 of 2013. The questionnaire consisted of ten aspects of competence containing five competency indicator for each. The questionnaire consisted of ten questions measured on a four-point Likert scale at 4 'Very Good', 3 'Good', 2 'Not Good', and 1 'Very Not Good'. Competency aspects to measure the achievement of student competencies in the department of architectural engineering are shown in Table 1.

Table 1. The Instrument for Measuring the Achievement of Vocational Student Competencies

| No | Competency Aspects | Item |
|---|---|---|
| 1 | General competencies | A 1-5 |
| 2 | Technical drawing competencies | B 1-5 |
| 3 | Statically structures competencies | C 1-5 |
| 4 | Basic building construction competencies | D 1-5 |
| 5 | Land measurement engineering competencies | E 1-5 |
| 6 | Software application and building interior design competencies | F 1-5 |
| 7 | Road and bridge construction competencies | G 1-5 |
| 8 | Estimated construction costs competencies | H 1-5 |
| 9 | Building construction and utility competencies | I 1-5 |
| 10 | Creative and entrepreneurship product competencies | J 1-5 |
| | **Number of Item** | **50** |

## Research Method

Testing of construct validity was carried out using factor analysis with the employment of Explanatory Factor Analysis (EFA) method (Barbara & Linda, 2010). Factor analysis using descriptive statistics is intended to ensure as well as simplify any coherent variables and variables with each other in one factor (Hidayat et al., 2018). The reliability test was obtained based on the Cronbach alpha value. Furthermore, the component factor analysis using the EFA method was intended to ensure the validity and confirmation of the construction.

## Data Analysis

The first data analysis is a descriptive statistical test that includes multicollinearity, normality, and also data reduction using SPSS 25.0. The testing of the normality of data on the construct of the measurement model was carried out based on the value of skewness and kurtosis with a recommended value ranging from -1.96 to +1.96 at a significance level of 0.05 for each question item (Kline, 2005; Hair et al., 2010). The multicollinearity analysis can conclude the inter-change matrix with a value of ≤ 0.90 (Tabri & Elliott, 2012). In addition, all items were included in the factor analysis criteria and the data analyzed using EFA in order to determine the factors measuring the achievement of the student competencies.

Exploratory Factor Analysis (EFA) data analysis was performed using the SPSS in order to reveal how many factors can be formed so that it can find out the correlating factors and the contribution value of each variable in order to measure the factors (Kumar, 2012). The analysis results are based on the Kaiser-Meyer-Olkin (KMO) values, the Bartlett test values, the Measure of Sampling Adequacy (MSA), the communality values, the total variance values that are described related to eigenvalues, factor loading, and also the plot scree. Furthermore, for the assessment of the hypothesized construct position, the construct validity was carried out using the convergent and discriminant validity.

# Findings and Discussion

## Findings

### *Preliminary Analysis*

The first result conducted in this study is a preliminary analysis intended to find out the data that has been obtained from the survey results. The data were obtained from 103 vocational education students majoring in architecture engineering in Indonesia and covering ten aspects consisting of five questions each. All 50 questions are called competency items. Table 2 shows the multicollinearity and normality data.

Because 20 items other than those presented in Table 2 get skewness and kurtosis values outside the range of -1.96 to +1.96 and a significance level with a value of ≤0.05 (Hair et al., 2010; Hidayat et al., 2018), then the 20 items are declared not normally distributed and excluded, and are not included in the next factor analysis. After the items were removed, 30 items of data that still survived or were normally distributed were analyzed again with descriptive statistics as presented in Table 2. There are 30 items that reach normality with the skewness values ranging from -1.612 until -0.641, and then the kurtosis values ranging from -0.935 to +1.857. Furthermore, the descriptive statistics reveal that the mean value ranges from 3.408 to 3.786. The value of deviation standard ranges from 0.412 to 0.760. The variance ranges from 0.170 to 0.577. The acquisition of total values ranged from 351.0 to 390.0 from the maximum value of 412.0.

In the case of multicollinearity, the relationship between ten competency items analyzed in the construction value ranges from 0.306 to 0.632. Sequentially, pearson correlations and sig. (2-tailed) on each variable A to J are as follows: (0.327; 0.001), (0.413; 0.000), (0.607; 0.000), (0.632; 0.000) (0.616; 0.000), (0.306; 0.002), (0.620; 0.000), (0.554; 0.000), (0.483; 0.000). These results indicate that the discriminant validity of each competency variable achieved because the inter-correlation matrix value is ≤0.90 (Kline, 2005; Hidayat et al., 2018) and the correlation is significant at the 0.01 level (2-tailed).

Table 2. Results of Statistical Descriptive Analysis and Data Normality (N= 103)

| No | Variable | Mean | Sd | Var. | Skew | Kurtosis | ∑ |
|---|---|---|---|---|---|---|---|
| 1 | A1 | 3.631 | 0.56 | 0.314 | -1.221 | 0.543 | 374 |
| 2 | A2 | 3.738 | 0.44 | 0.195 | -1.098 | -0.811 | 385 |
| 3 | A3 | 3.476 | 0.65 | 0.428 | -1.086 | 1.009 | 358 |
| 4 | B1 | 3.408 | 0.76 | 0.577 | -1.254 | 1.283 | 351 |
| 5 | B2 | 3.447 | 0.73 | 0.544 | -1.384 | 1.857 | 355 |
| 6 | B3 | 3.534 | 0.62 | 0.389 | -0.998 | -0.029 | 364 |
| 7 | C1 | 3.602 | 0.56 | 0.320 | -1.074 | 0.185 | 371 |
| 8 | C2 | 3.524 | 0.60 | 0.370 | -1.163 | 1.695 | 363 |
| 9 | C3 | 3.524 | 0.65 | 0.428 | -1.268 | 1.372 | 363 |
| 10 | D1 | 3.553 | 0.59 | 0.348 | -0.943 | -0.082 | 366 |
| 11 | D2 | 3.621 | 0.54 | 0.296 | -1.057 | 0.109 | 373 |
| 12 | D3 | 3.505 | 0.62 | 0.390 | -1.128 | 1.427 | 361 |
| 13 | E1 | 3.563 | 0.53 | 0.288 | -0.645 | -0.797 | 367 |
| 14 | E2 | 3.670 | 0.49 | 0.243 | -0.982 | -0.438 | 378 |
| 15 | E3 | 3.689 | 0.50 | 0.255 | -1.287 | 0.620 | 380 |
| 16 | F1 | 3.563 | 0.53 | 0.288 | -0.645 | -0.797 | 367 |
| 17 | F2 | 3.660 | 0.56 | 0.266 | -1.118 | 0.151 | 377 |
| 18 | F3 | 3.660 | 0.51 | 0.266 | -1.118 | 0.151 | 377 |
| 19 | G1 | 3.621 | 0.56 | 0.316 | -1.170 | 0.415 | 373 |
| 20 | G2 | 3.602 | 0.56 | 0.320 | -1.074 | 0.185 | 371 |
| 21 | G3 | 3.621 | 0.52 | 0.277 | -0.916 | -0.322 | 373 |
| 22 | H1 | 3.660 | 0.53 | 0.285 | -1.265 | 0.644 | 377 |
| 23 | H2 | 3.689 | 0.50 | 0.255 | -1.287 | 0.620 | 380 |
| 24 | H2 | 3.563 | 0.66 | 0.445 | -1.450 | 1.657 | 367 |
| 25 | I1 | 3.786 | 0.41 | 0.170 | -1.418 | 0.012 | 390 |
| 26 | I2 | 3.767 | 0.44 | 0.200 | -1.612 | 1.481 | 388 |
| 27 | I3 | 3.728 | 0.44 | 0.200 | -1.041 | -0.935 | 384 |
| 28 | J1 | 3.456 | 0.63 | 0.407 | -0.987 | 1.012 | 356 |
| 29 | J2 | 3.612 | 0.54 | 0.299 | -1.009 | -0.002 | 372 |
| 30 | J3 | 3.476 | 0.63 | 0.409 | -1.056 | 1.118 | 358 |

Table 3. Reliability Analysis of Competency Items

| No. | Competency Aspects | Item | CA | Overall CA |
|---|---|---|---|---|
| 1 | General competencies | 3 | 0.7 | 0.9 |
| 2 | Technical drawing competencies | 3 | 0.7 | |
| 3 | Statically structures competencies | 3 | 0.7 | |
| 4 | Basic building construction competencies | 3 | 0.7 | |
| 5 | Land measurement engineering competencies | 3 | 0.7 | |
| 6 | Software application and building interior design competencies | 3 | 0.8 | |
| 7 | Road and bridge construction competencies | 3 | 0.9 | |
| 8 | Estimated construction costs competencies | 3 | 0.8 | |
| 9 | Building construction and utility competencies | 3 | 0.8 | |
| 10 | Creative and entrepreneurship product competencies | 3 | 0.7 | |

*Reliability of Instrument*

Reliability is the stability and suitability of each score found. It is said to be reliable if the question items get the same and identical scores when the instrument is tested to several clans and in different times and places (Hidayat et al., 2018). The reliability value of an item is based on the Cronbach Alpha value. According to Lin (2002), if the Cronbach Alpha value is ≥ 0.7, then the item on the instrument is reliable, and vice versa, if the Cronbach Alpha value is < 0.7, then it is not reliable. The results of the instrument's reliability are shown in Table 3.

The Cronbach Alpha results in this research instrument are in the reliable category. Overall, the Cronbach Alpha value obtained was ≥ 0.7, this value is included in the recommended value by Lin (2002). In general competencies, technical drawing, statically structures, basic building construction, land measurement engineering, as well as creative and entrepreneurship product competencies get a value of α = 0.7, while software application and building interior design, estimated construction costs, building construction and utility competencies get a value of α = 0.8, and road and bridge construction get a value of α = 0.9 (≥0.7; Lin, 2002). Therefore, the instrument to measure the achievement of student competencies has a good level of reliability.

*Exploratory Factor Analysis (EFA)*

In this EFA test, the study considers testing items that have passed the multicollinearity and normality and reliability tests for each item. All 30 items that passed were included in ten aspects of competency. EFA test criteria are based on the KMO Index values, Bartlett's Test, Measure of Sampling Adequacy (MSA), communalities, factor loading, eigenvalues, and plot scree. The results of the KMO Measure of Sampling Adequacy obtained a value of 0.886, that is more than 0.70, then the coverage of each factor is satisfactory. The Bartlett's Test of Sphericity Approx. Chi-Square obtained a value of 1932.501; df = 35; Sig. = 0.000. The scree plot pattern was used to reduce variance to several factors. The point at which the slope of the line begins to change is where the limit of the number of factors that can take. This point is called the inflection point. In Figure 1, after the 10th point, the line begins to change in tilt and the variations explained are less and less. Thus, it can reduce 30 items to ten factors.

The next step of identifying the extraction of community values, eigenvalues, percentage variants, and loading factors is shown in Table 4. The value of communalities indicates the value of the variable under study whether it can explain the magnitude of the effective contribution (%) of each variant to the factor formed for each item. The results of the communalities in this instrument range from 0.751 to 0.909 (≥0.50) can be categorized as adequate variants in the instrument. MSA values range from 0.709 to 0.961 (≥ 0.70). The rotated component matrix shows the loading factor on each factor. The results of data analysis, it is recommended for all items to measure of competency achievement. This value is obtained from high loading factors ranging from 0.461 to 0.899 (>0.40). In addition, Table 5 shows a summary of the results of the EFA value of the competency framework to determine the competency attainment of architectural engineering students in Indonesia.

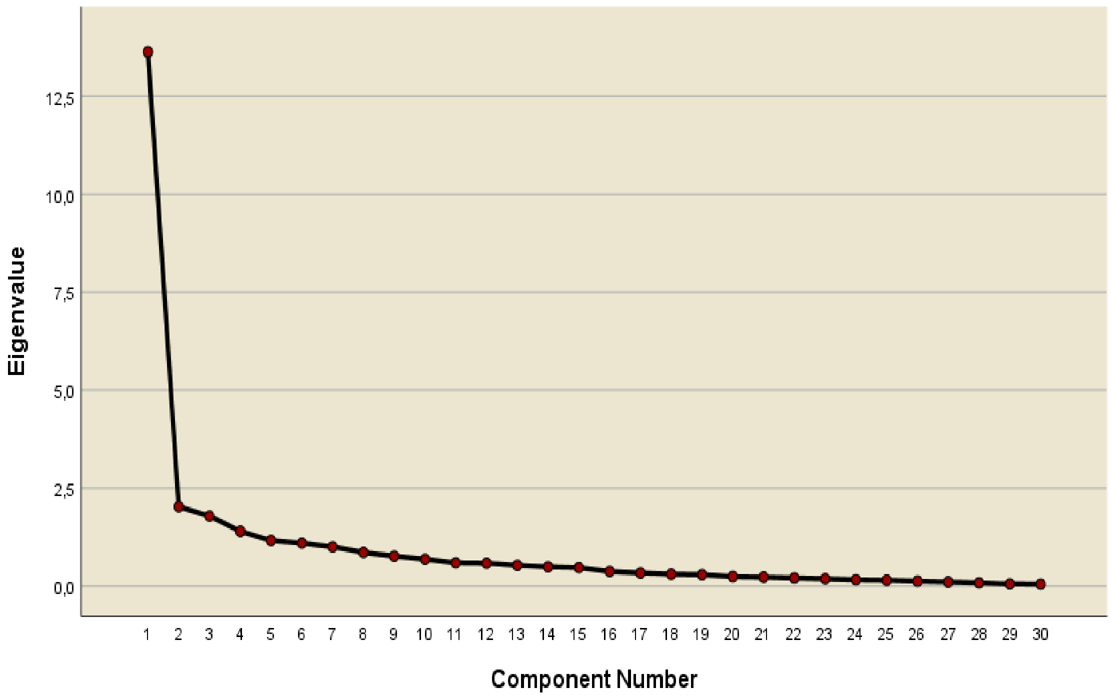


Figure 1. Scree Plot of Achieving Student Competency Framework

Table 4. MSA, Communalities, Factor Loading

| Var. | Item | MSA | Comm. | Factor Loading | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Components | | | | | | | | | |
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| A | A1 | 0.741[a] | 0.751 | | | | | 0.828 | | | | | |
| | A2 | 0.709[a] | 0.770 | | | | | 0.760 | | | | | |
| | A3 | 0.795[a] | 0.717 | | | | | 0.772 | | | | | |
| B | B1 | 0.821[a] | 0.888 | | | | | | | 0.899 | | | |
| | B2 | 0.861[a] | 0.820 | | | | | | | 0.739 | | | |
| | B3 | 0.813[a] | 0.870 | | | | | | | 0.837 | | | |
| C | C1 | 0.882[a] | 0.784 | | | | | | | | | 0.501 | |
| | C2 | 0.926[a] | 0.782 | | | | | | | | | 0.558 | |
| | C3 | 0.875[a] | 0.758 | | | | | | | | | 0.514 | |
| D | D1 | 0.939[a] | 0.767 | 0.705 | | | | | | | | | |
| | D2 | 0.878[a] | 0.909 | 0.794 | | | | | | | | | |
| | D3 | 0.873[a] | 0.880 | 0.850 | | | | | | | | | |
| E | E1 | 0.887[a] | 0.719 | | | 0.717 | | | | | | | |
| | E2 | 0.846[a] | 0.794 | | | 0.710 | | | | | | | |
| | E3 | 0.872[a] | 0.873 | | | 0.677 | | | | | | | |
| F | F1 | 0.931[a] | 0.764 | | | | | | | | 0.503 | | |
| | F2 | 0.930[a] | 0.779 | | | | | | | | 0.461 | | |
| | F3 | 0.889[a] | 0.762 | | | | | | | | 0.600 | | |
| G | G1 | 0.925[a] | 0.879 | | | | | | 0.760 | | | | |
| | G2 | 0.865[a] | 0.884 | | | | | | 0.718 | | | | |
| | G3 | 0.865[a] | 0.861 | | | | | | 0.709 | | | | |
| H | H1 | 0.870[a] | 0.829 | | | | 0.590 | | | | | | |
| | H2 | 0.912[a] | 0.864 | | | | 0.649 | | | | | | |
| | H2 | 0.927[a] | 0.803 | | | | 0.711 | | | | | | |
| I | I1 | 0.961[a] | 0.809 | | 0.706 | | | | | | | | |
| | I2 | 0.948[a] | 0.797 | | 0.658 | | | | | | | | |
| | I3 | 0.883[a] | 0.797 | | 0.761 | | | | | | | | |
| J | J1 | 0.861[a] | 0.885 | | | | | | | | | | 0.785 |
| | J2 | 0.894[a] | 0.804 | | | | | | | | | | 0.667 |
| | J3 | 0.854[a] | 0.816 | | | | | | | | | | 0.775 |

Table 5. Measurement Indicators in the Exploratory Factor Analysis Test

| Index | Value Results | Recommendation | Decision |
|---|---|---|---|
| Index KMO | 0.886 | $0.50 < x \leq 0.8$ | Fit |
| | | $0.80 < x \leq 1.0$ | Fit |
| Bartlett's Test | $p < 0.000$ | $p < 0.05$ | Fit |
| MSA | 0.709 – 0.961 | >0.07 | Fit |
| Factor Loading | 0.461 – 0.899 | 0.4 – 0.9 | Fit |
| Eigenvalues | >2.228 | ≥1.0 | Fit |

## Discussion

After EFA test was done to show that the analyzed student data involve ten factors: general competencies, technical drawing competencies, statically structures, basic building construction, land measurement engineering, software application and building interior design, road and bridge construction, estimated construction costs, building construction and utility competencies, and creative and entrepreneurship product competencies. This is in line with the original fact structure, although 20 competency items have fallen from 20 items since the data do not meet the descriptive statistical requirements and normality of data so there are still 30 items of competency items. This study is in line with previous studies by Hidayat et al. (2018), Hazriyanto and Ibrahim (2019), Lai et al. (2019), and Nashir, Mustapha, Ma'arof, and Rui (2020).

Table 6. Competency Framework for Measuring Student Achievements of Architectural Engineering Education

| Construct | Item | | Competency |
|---|---|---|---|
| General competencies | A | A1 | Having a habit of behaving honestly in carrying out their job duties |
| | | A2 | Being able to complete work according to the criteria set in the workplace |
| | | A3 | Having the ability to generate innovative work ideas according to their expertise |
| Technical drawing competencies | B | B1 | Presenting the types, functions and engineering drawing tools |
| | | B2 | Drawing orthogonal (2D) and pictorial (3D) projections |
| | | B3 | Drawing symbol, notation, and dimensional rules on engineering drawings |
| Statically structures competencies | C | C1 | Presenting factors influencing the building structure based on design and loading criteria |
| | | C2 | Presenting various styles and ways of arranging styles in building structures |
| | | C3 | Calculating the forces (moment, shear, normal force, and rod force) on the building structure |
| Basic building construction competencies | D | D1 | Implementing occupational health and safety in building works |
| | | D2 | Presenting the types of construction work (buildings, roads, bridges and irrigation) |
| | | D3 | Carrying out concrete, steel, wood, earth and stone construction work |
| Land measurement engineering competencies | E | E1 | Carrying out measurement principles of land measurement techniques |
| | | E2 | Performing maintenance techniques and checking optical types |
| | | E3 | Carrying out the operation of tools for levelling, theodolite, and stake out work |
| Software application and building interior design competencies | F | F1 | Presenting data on the needs of interior design work |
| | | F2 | Creating 2D and 3D construction drawings with colour schemes and artificial lighting |
| | | F3 | Creating interior designs with elements, materials, models and accessories in every room |
| Road and bridge construction competencies | G | G1 | Presenting road and bridge classification |
| | | G2 | Presenting road and bridge pavement material specifications |
| | | G3 | Drawing of the detailed construction of roads and bridges |
| Estimated construction costs competencies | H | H1 | Presenting materials specifications for building, road and bridge construction work |
| | | H2 | Calculating the estimated cost of construction work |
| | | H3 | Checking the results of the estimated construction costs |
| Building construction and utility competencies | I | I1 | Creating floor plans, cuts, and building construction drawings |
| | | I2 | Creating detailed building construction drawings |
| | | I3 | Making isometric drawings of clean water and dirty water installations, electricity installations, air conditioners, and lightning rods |
| Creative and entrepreneurship product competencies | J | J1 | Presenting the attitudes and behaviour of entrepreneurs |
| | | J2 | Creating worksheets/work drawings for making prototypes of services |
| | | J3 | Creating and test product/service prototypes |

This study aims to test the instrument for measuring the achievement of vocational education student competencies from architectural engineering study programs in Indonesia. The results of the instrument analysis in this study have a high level of overall reliability: the Cronbach Alpha value=0.9 (≥0.7) The value is calculated in the categorization criteria (Lin, 2002), the highest reliability value in basic building construction competency is the Cronbach Alpha value=0.9, and the lowest value is the competence of creative and entrepreneurial products with a Cronbach Alpha value of 0.7, therefore, the competence of creative and entrepreneurial products taught to be mastered by vocational students must be increased so the achievement of entrepreneurial competencies owned by students is deeper.

Factor analysis shows ten factors with ten items formulated consisting of 30 competency items. Each item shows a satisfactory loading with a value of 0.474 to 0.987 (≥0.40). Moreover, from the EFA analysis, the KMO index=0.886; Bartlett's Test = p <0.000; MSA = 0.709-0.961; Factor Loading = 0.461-0.899; Eigenvalues >2.228, these values meet the minimum criteria recommended (Hidayat et al., 2018; Hazriyanto & Ibrahim, 2019). The results of the analysis of convergent validity and discriminant validity have met the multivariate analysis requirements. Thus, the development instrument is suitable for measuring the level of mastery of vocational education student competencies in the building department consisting of architectural engineering study programs which mainly involve these ten factors. Further studies are expected to develop a competency framework model and be able to apply and evaluate applications in continuous learning. The list of competencies to measure student achievement in architectural engineering education in Indonesia is shown in Table 6.

## Conclusion

This study confirms the validity and reliability of the measurement instrument for the achievement of the competency level of students of architectural engineering vocational schools in Indonesia. This research shows that the instrument test for measuring the achievement of student competencies has good reliability. The EFA analysis shows that the instrument has good construct validity consisting of 30 competency items covering ten competency aspects, namely general competencies, technical drawing, statically structures, basic building construction, land measurement engineering, software application and building interior design, road and bridge construction, estimated construction costs, building construction and utility, creative and entrepreneurship product competencies.

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