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# Factor Analysis of Supporting Air Conditioning Practicum Activity in Vocational Education

Ega Taqwali Berman*
Prodi Pendidikan Teknologi dan Kejuruan
Sekolah Pascasarjana Universitas Pendidikan Indonesia
Bandung, Indonesia
*egatb@upi.edu

Ida Hamidah
Departemen Pendidikan Teknik Mesin
Universitas Pendidikan Indonesia
Bandung, Indonesia
idahamidah@upi.edu

Budi Mulyanti
Departemen Pendidikan Teknik Elektro
Universitas Pendidikan Indonesia
Bandung, Indonesia
bmulyanti@upi.edu

Agus Setiawan
Departemen Pendidikan Teknik Mesin
Universitas Pendidikan Indonesia
Bandung, Indonesia
agus_setiawan@upi.edu

***Abstract*—Vocational education has specificity in the composition of practical learning that is more dominant than theoretical learning. The optimal implementation of practicum needs to be supported by various related factors. The purpose of this research is to find out the factors that support air conditioning practicum in vocational education. The quantitative approach was used in this study and the questionnaire was used to collect research data consisting of: laboratories, tools and practicum materials, lecturers/instructors, laboratory assistants/technicians, laboratory regulations, practicum schedules, learning resources, practicum worksheets, and practicum evaluation tools. The populations in this study were students of refrigeration and air conditioning study programs at a vocational education institution in Bandung, Indonesia. All data processing and statistical analysis uses the IBM Statistics SPSS version 21.0. The results showed that there were relationships between a number of variables that were independent of each other. Nine independent variables were identified at the beginning of the study as a source of support for practicum and then grouped into two new factors. Both of these factors have a correlation greater than 0.5, so it can be concluded that it is appropriate to summarize the nine variables analyzed. Based on the Rotated component matrix, it is known that the practicum evaluation tool variable has the highest correlation, this shows that the evaluation of student practicum performance is very important to be a reference for completing competency and planning for practicum activities in the future.**

***Keywords—air conditioning practicum, laboratory, vocational education***

## I. Introduction

Vocational education is education that prepares students to be more able to work effectively. The characteristics of vocational education include being able to combine the functions of education and training. Vocational education prepares students to be able to work independently or fill jobs in the industrial world [1]. Vocational education is a place to forge one's maturity and skills so that it cannot only be borne by a group but rather becomes a shared responsibility [2]. Vocational education is also directed to increase individual independence in entrepreneurship in accordance with their competencies [3]. In vocational education the composition of practical learning is more dominant than theoretical learning.

Practical learning can facilitate students to gain direct experience [4]. The first experience for students in learning, thinking, and solving problems can be obtained through practical activities [5]. Strengthening the basic knowledge in the scientific and applied fields such as computer science, science, and engineering can be done in practical activities in the laboratory [6–7]. Practicum activities in the laboratory are very crucial activities in vocational education [8]. Practical activities in the laboratory increase student achievement and interest in the subject matter discussed in class and further assist their learning [9]. The development of students' hands on and minds on can be supported by practical based learning strategies. Therefore, practicum-based learning can be used as an alternative learning that is able to direct students to learn actively to organize their conceptual understanding [10].

In general, practicum activities in developed countries are carried out in ideal conditions because they are supported by modern learning tools. But for developing countries like Indonesia, the availability of learning resources and practical tools is always an obstacle in their implementation [11]. Students memorize more concepts without a deep understanding of the problems they face and they often have difficulty in gaining contextual experiences in the learning process [12]. Whereas strengthening student competencies by providing direct experience can help to teach difficult concepts and strengthen students to be able to do work comprehensively, which is followed up by in-depth discussion of relevant theories [13]. The experience of applying practical knowledge can facilitate students in overcoming/solving problems in their future work [14].

The implementation of air conditioning practicum in vocational education is carried out based on a learning program plan that has been prepared for one semester. The practicum material delivered were: measurement of air temperature, measurement of refrigerant pressure, refrigerant filling, inspection of refrigerant leaks, measurement of electrical quantities, inspection of electrical component functions, installation of AC units, and maintenance of AC units. All these activities are designed with actual conditions so that students can realize their knowledge with their real work after they graduate. However, there are several obstacles that cause practicum activities to be suboptimal, including: (a) Practicum instructions are generally recipes that students must do; (b) Practicum activities are often not measured adequately and accurately; (c) Practicum equipment is often inadequate in terms of quantity and specifications; (d) Practicum activities require a long time; (e) Requires more expensive costs for providing practical tools and materials; (f) The unavailability of adequate laboratory facilities so that practicum activities cannot be carried out; (g) Lack of supporting staff for practicum implementation; and (h) Lack of instructor's ability to design and implement practicum [15–16]. Based on these explanations, this study aims to find out the factors that support the activities of air conditioning practicum in vocational education.

## II. METHODS

This study uses a quantitative approach. A questionnaire was created using Google Form and was used to capture research data. A total of 31 statement items were arranged on a Likert scale with five answer choices. All statement items have represented nine independent variables consisting of: laboratories, practicum tools and materials, lecturer/instructor, laboratory assistant/technician, laboratory regulations, practicum schedule, learning resources, practicum worksheets, and practicum evaluation tools. The populations in this study were students of refrigeration and air conditioning study programs at a vocational education institution in Bandung, Indonesia. Samples were selected as many as 54 students who had carried out the air conditioning practicum and filled out the questionnaire. All questionnaire data collected was then tabulated in Microsoft Excel to facilitate the subsequent data processing. The data is then tested for validity and reliability. If all data are valid and reliable, it is followed by a normality test. All data processing and statistical analysis uses the IBM Statistics SPSS version 21.0.

The factor analysis procedure using SPSS is as follows:

- Construct the Correlation Matrix. The analytic process is based on the correlation matrix between the existing variables. If the determinant approaches 0, then the correlation matrix between the variables is interrelated. so factor analysis can be used.
- Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO-MSA) and Bartlett's Test. KMO is useful for measuring the feasibility of the sample and Bartlett's test of sphericity is used to test the accuracy of the factor model. The requirements are if the KMO value is greater than 0.50 and the value of Bartlett's Test of Sphericity (Sig.) $< 0.05$, then the factor analysis technique can be continued.
- Anti-image matrices. This indicator is to determine the adequacy of the number of samples per variable. Anti image matrices are recommended values above 0.5 which can be seen in the output marked "a" in the anti image correlation column.
- Communalities. This is a value that indicates the contribution of a number of variables to the factors formed. The greater the communalities of a variable, the more closely related the factors formed.
- Total Variance Explained. This output is useful for determining the number of factors that can be formed by a number of variables. The explanation can be seen in the Eigenvalues as a condition to be a factor, where the Eigenvalues must be $> 1$ and the amount of variance that can be explained by the factor with a number of forming variables.
- Scree plot. The Scree Plot image shows the number of factors formed. You do this by looking at the value of Component points that have an Eigenvalues $> 1$.
- Component Matrix. This indicator shows the loading factor value of each variable against the factor. Loading Factor is a value that shows correlation of a variable to the factor formed.
- Rotated component matrix. This output is to ensure that a variable belongs to a group of factors. The method can be determined by looking at the largest correlation value between variables and the factors formed.
- Component Transformation Matrix. This indicator is to show the accuracy of the factors in summarizing all existing variables. Correlation factor value must be $>$ 0.5.

## III. RESULTS AND DISCUSSION

The results of the factor analysis using the IBM Statistics SPSS version 21.0 produce several assumptions that can be used to find relationships between a number of variables that are independent of each other so that one or several sets of variables can be made that are fewer than the number of initial variables. In this case the variables that have the greatest correlation will group to form a set of variables called a factor.

## A. *Determinant of Correlation Matrix*

Table 1 the Determinant of Correlation Matrix shows the results of calculating the correlation value between the tests variables. Based on the data, the value of the Determinant of Correlation Matrix is 0.008. Because this value is close to 0, the correlation matrix between variables is thus interrelated.

TABLE I. DETERMINANT OF CORRELATION MATRIX

| | | **Laboratory** | **Tools and materials** | **Lecturer / instructor** | **Laboratory assistant / technician** | **Laboratory regulations** | **Practicum schedule** | **Learning resources** | **Practicum worksheets** | **Practicum evaluation tool** |
|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | Laboratory | 1.000 | .487 | .489 | .574 | .193 | .496 | .440 | .492 | .683 |
| | Tools and materials | .487 | 1.000 | .614 | .522 | .303 | .546 | .568 | .510 | .440 |
| | Lecturer / instructor | .489 | .614 | .1000 | .733 | .416 | .587 | .463 | .523 | .344 |
| | Laboratory assistant / technician | .574 | .622 | .733 | 1.000 | .440 | .491 | .557 | .551 | .498 |
| | Laboratory regulations | .193 | .303 | .416 | .440 | 1.000 | .655 | .298 | .189 | .251 |
| | Practicum schedule | .496 | .546 | .587 | .491 | .655 | 1.000 | .406 | .367 | .282 |
| | Learning resources | .440 | .568 | .463 | .557 | .295 | .406 | 1.000 | .484 | .573 |
| | Practicum worksheets | .492 | .510 | .523 | .551 | .189 | .67 | .484 | 1.000 | .445 |
| | Practicum evaluation tool | .583 | .440 | .344 | .498 | .251 | .282 | .673 | .445 | 1.000 |
| Sig. (1-tailed) | Laboratory | | .000 | .000 | .000 | .081 | .000 | .000 | .000 | .000 |
| | Tools and materials | .000 | | .000 | .000 | .013 | .000 | .000 | .000 | .000 |
| | Lecturer / instructor | .000 | .000 | | .000 | .001 | .000 | .000 | .000 | .005 |
| | Laboratory assistant /technician | .000 | .000 | .000 | | .000 | .000 | .000 | .000 | .000 |
| | Laboratory regulations | .081 | .013 | .001 | .000 | | .000 | .015 | .086 | .034 |
| | Practicum schedule | .000 | .000 | .000 | .000 | .000 | | .001 | .003 | .019 |
| | Learning resources | .000 | .000 | .000 | .000 | .015 | .001 | | .000 | .000 |
| | Practicum worksheets | .000 | .000 | .000 | .000 | .086 | .003 | .000 | | .000 |
| | Practicum evaluation tool | .000 | .000 | .005 | .000 | .034 | .019 | .000 | .000 | |
| a. Determinant = .008 | | | | | | | | | | |

## B. *KMO and Bartlett's test*

Table 2 shows the KMO and Bartlett's test. The KMO number appears to be 0.813. Because the value is 0.813 > 0.5, this shows the adequacy of the sample. The KMO and Bartlett's test (the chi-square value) are 237.914 with a significance value of 0.000. This shows that there is a correlation between variables and is feasible for further processing. Furthermore, to find out which variables can be further processed and which can be issued can be seen in the Anti-image matrices output.

TABLE II. KMO AND BARTLETT'S TEST

| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | | .813 |
|---|---|---|
| **Bartlett's Test of Sphericity** | Approx. Chi-Square | 237.914 |
| | df | 36 |
| | Sig. | .000 |

## C. *Anti-Image Matrices*

Table 3 Anti-Image Matrices, look at the Anti Image Correlation section, seen the numbers marked with "a" that indicate the amount of MSA of a variable. Laboratory variables 0.776, tools and materials 0.891, lecturer/instructor 0.844, laboratory assistant/technician 0.830, laboratory regulations 0.636, practicum schedule 0.726, learning resources 0.880, practicum worksheets 0.943, and practicum evaluation tool 0.788. All MSA values of each variable are > 0.5, then all variables can be processed further.

## D. *Communalities*

Table 4 Communalities displayed the value of a laboratory variable of 0.611. This means that around 61.1% of the variance in laboratory variables can be explained by the factors formed. The tools and materials variable is 0.597, so it can be interpreted that 59.7% of the variants of the tools and materials variable can be explained by the factors formed. Explanation for other variables is done in the same way. The smaller the value of communalities means the weaker relationship with the factors formed.

TABLE III. ANTI-IMAGE MATRICES

| | | **Laboratory** | **Tools and materials** | **Lecturer / instructor** | **Laboratory assistant / technician** | **Laboratory regulations** | **Practicum schedule** | **Learning resources** | **Practicum worksheets** | **Practicum evaluation tool** |
|---|---|---|---|---|---|---|---|---|---|---|
| Anti-image convenance | Laboratory | .429 | -.011 | .005 | -.097 | .150 | -.152 | .044 | -.049 | -.192 |
| | Tools and materials | -.011 | .460 | -.113 | .025 | .049 | -.093 | -.126 | -.070 | -.050 |
| | Lecturer / instructor | .005 | -.113 | .347 | -.173 | .005 | -.073 | .020 | -.057 | .049 |
| | Laboratory assistant / technician | -.097 | .025 | -.173 | .327 | -.103 | .053 | -.082 | -.057 | -.030 |
| | Laboratory regulations | .150 | .049 | .005 | -.103 | .464 | -.247 | .011 | .055 | -.097 |
| | Practicum schedule | -.152 | -.093 | -.073 | .053 | -.247 | .339 | -.034 | -.010 | .090 |
| | Learning resources | .044 | -.126 | .020 | -.082 | .011 | -.034 | -.499 | -.060 | -.165 |
| | Practicum worksheets | -.049 | -.070 | -.057 | -.067 | .055 | -.010 | -.060 | .574 | -.052 |
| | Practicum evaluation tool | -.192 | -.050 | .049 | -.030 | -.097 | .90 | -.165 | -.052 | .486 |
| Anti-image correlation | Laboratory | .776a | -.025 | .012 | -.260 | .336 | -.400 | .095 | -.099 | -.421 |
| | Tools and materials | -.025 | .891a | -.284 | .066 | .106 | -.235 | -.262 | -.135 | -.105 |
| | Lecturer / instructor | .012 | -.284 | .844a | -.513 | .013 | -.212 | .048 | -.128 | .119 |
| | Laboratory assistant / technician | -.260 | .066 | -.513 | .830a | -.264 | .158 | -.202 | -.154 | -.076 |
| | Laboratory regulations | .336 | .106 | .013 | -.264 | .636a | --.623 | .023 | .107 | -.205 |
| | Practicum schedule | -.400 | -.235 | -.212 | .158 | -.623 | .726a | -.083 | -.023 | .223 |
| | Learning resources | .095 | -.262 | .048 | -.202 | .023 | -.083 | .880a | -.111 | -.335 |
| | Practicum worksheets | -.099 | -.135 | -.128 | -.154 | .107 | -.023 | -.111 | .943a | -.098 |
| | Practicum evaluation tool | -.421 | -.105 | -.119 | -.076 | -.205 | .223 | -.335 | -.098 | .788a |

a. Measures of Sampling Adequacy (MSA)

TABLE IV. COMMUNALITIES

| **Variables** | **Initial** | **Extraction** |
|---|---|---|
| Laboratory | 1.000 | .611 |
| Tools and materials | 1.000 | .597 |
| Lecturer / instructor | 1.000 | .671 |
| Laboratory assistant / technician | 1.000 | .690 |
| Laboratory regulations | 1.000 | .784 |
| Practicum schedule | 1.000 | .790 |
| Learning resources | 1.000 | .592 |
| Practicum worksheets | 1.000 | .581 |
| Practicum evaluation tool | 1.000 | .621 |

Extraction Method: Principal Component Analysis.

TABLE V. TOTAL VARIANCE EXPLAINED

| **Component** | **Initial Eigenvalues** | | | **Extraction Sums of Squared Loading** | | | **Rotation Sums of Squared Loading** | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Total* | *% of Variance* | *Cumulative %* | *Total* | *% of Variance* | *Cumulative %* | *Total* | *% of Variance* | *Cumulative %* |
| 1 | 4.738 | 53.143 | 53.143 | 4.783 | 58.143 | 58.143 | 3.969 | 39.659 | 39.659 |
| 2 | 1.155 | 12.834 | 65.978 | 1.155 | 12.834 | 65.978 | 2.369 | 26.319 | 65.978 |
| 3 | .715 | 7.945 | 73.923 | | | | | | |
| 4 | .600 | 6.668 | 80.591 | | | | | | |
| 5 | .540 | 5.996 | 86.586 | | | | | | |
| 6 | .462 | 5.136 | 91.723 | | | | | | |
| 7 | .348 | 3.864 | 95.587 | | | | | | |
| 8 | .229 | 2.550 | 98.136 | | | | | | |
| 9 | .168 | 1.864 | 100.000 | | | | | | |

Extraction method: Principal Component Analysis.

## *E. Total Variance Explained*

Table 5 Total Variance Explained shows the value of each variable analyzed. In this study there were nine variables analyzed. There are two types of analysis to explain a variant, namely Initial Eigenvalues and Extraction Sums of Squared Loadings. In the Initial Eigenvalues variants indicate the factors formed. If all the factors added together indicate the number of variables (i.e. 4.783 + 1.155 + 0.715 + 0.600 + 0.540 + 0.462 + 0.348 + 0.229 + 0.168 = 9). While in the Extraction Sums of Squared Loadings section shows the number of variations or the number of factors that can be formed. In the output results above there are two variations of factors which are 4.783 and 1.155, respectively. Furthermore, based on the Total Variance Explained output table in the Initial Eigenvalues section, there are two factors that can be formed from the nine variables analyzed. The Eigenvalues Component 1 value is 4.783 > 1, then called factor 1 and is able to explain 47.83% of variation. While the value of Eigenvalues Component 2 is 1.155 > 1 then it is called factor 2 and is able to explain 11.55% variation. If the factors 1 and factor 2 are added together they are able to explain 59.38% of the variation.

### F. Scree Plot

Figure 1 Scree plot shows the number of factors formed. The limit value of the factor forming Eigenvalues is 1, if less than 1 means that there are no factor forming variables. Thus, from the graph it appears that there are 2 factors formed. This means the same as the results of the previous definition

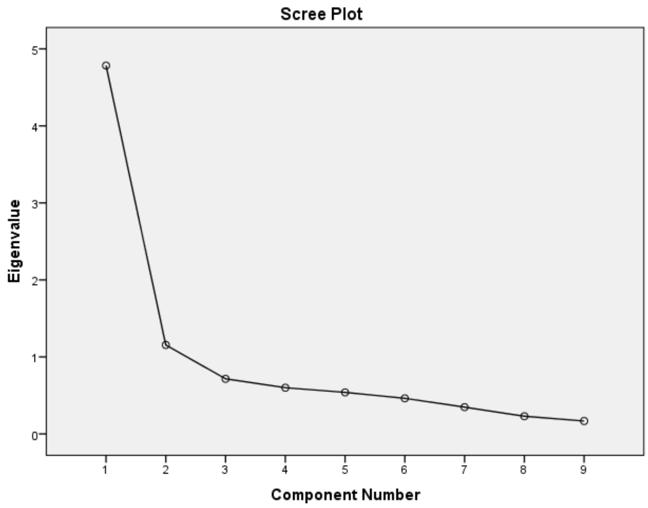


Fig. 1. Scree plot.

TABLE VI. COMPONENT MATRIX

| Variables | Component | |
|---|---|---|
| | *1* | *2* |
| Laboratory assistant/technician | .830 | .002 |
| Lecturer/instructor | .803 | .165 |
| Tools and materials | .772 | -.041 |
| Learning resources | .734 | -.229 |
| Laboratory | .733 | -.271 |
| Practicum schedule | .732 | .505 |
| Practicum worksheets | .702 | -.296 |
| Practicum evaluation tool | .670 | -.415 |
| Laboratory regulations | .547 | .696 |
| Extraction method: principal component analysis.<br>A. 2 components extracted. | | |

### G. Component Matrix

Table 6 Component Matrix shows the value of the correlation or relationship between each variable with the factor to be formed. As can be seen in the output table that the laboratory assistant/technician variable has a correlation value of the variables to factor 1 and factor 2 of 0.830 and 0.002, respectively. For other variables, the meaning is done in the same way.

### H. Rotated Component Matrix

To ensure which variables are included in which factor group, it can be determined by looking at the value of the largest correlation between variables and factors (Components) that are formed. Based on the data shown in Table 7 Rotated component matrix, the results of the rotational model factor analysis can be explained as follows:

- The practicum evaluation tool variable. The correlation value of this variable to factor 1 = 0.787 and factor 2 = 0.049. Because the correlation value of factor 1 > factor 2, the practicum evaluation tool variable is part of the factor 1 group.
- Laboratory variables. The correlation value of this variable to factor 1 = 0.755 and factor 2 = 0.203. Because the correlation value of factor 1 > factor 2, the laboratory variable is part of the factor 1 group.
- Variable practicum worksheets. The correlation value of this variable to factor 1 = 0.744 and factor 2 = 0.164. Because the correlation value of factor 1 > factor 2, the practicum worksheets variable is part of the factor 1 group.
- Variable learning resources. The correlation value of this variable to factor 1 = 0.732 and factor 2 = 0.238. Because the correlation value of factor 1 > factor 2, the learning resources variable is part of the factor 1 group.
- Laboratory assistant/technician variables. The correlation value of this variable to factor 1 = 0.676 and factor 2 = 0.482. Because the correlation value of factor 1 > factor 2, the laboratory assistant / technician variable is part of the factor 1 group.
- Variable tools and materials. The correlation value of this variable to factor 1 = 0.653 and factor 2 = 0.413. Because the correlation value of factor 1 > factor 2, the tools and materials variable is part of the factor 1 group.
- Variable laboratory regulations. The correlation value of this variable to factor 1 = 0.044 and factor 2 = 0.885. Because the correlation value of factor 2 > factor 1, the variable laboratory regulations are part of the factor 2 group.
- Variable practicum schedule. The correlation value of this variable to factor 1 = 0.305 and factor 2 = 0.835. Because the correlation value of factor 2 > factor 1, the practicum schedule variable is part of the factor 2 group.
- Variable lecturer / instructor. The correlation value of this variable to factor 1 = 0.559 and factor 2 = 0.599. Because the correlation value of factor 2 > factor 1, the lecturer/instructor variable is part of the factor 2 group.

TABLE VII. ROTATED COMPONENT MATRIX

| Variables | Component | |
|---|---|---|
| | *1* | *2* |
| Practicum evaluation tool | .787 | .049 |
| Laboratory | .755 | .203 |
| Practicum worksheets | .744 | .164 |
| Learning resources | .732 | .238 |
| Laboratory assistant/technician | .676 | .482 |
| Tools and materials | .653 | .413 |
| Laboratory regulations | .044 | .885 |
| Practicum schedule | .305 | .835 |
| Lecturer/instructor | .559 | .599 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.a
a. Rotation converged in 3 iterations.

Referring to the discussion above, the distribution of variables included in each factor formed is:

- Factor 1: practicum evaluation tools, laboratories, practicum worksheets, learning resources, laboratory assistants/technicians, tools and materials.
- Factors 2: laboratory regulations, practicum schedule, lecturer / instructor.

### *I. Component Transformation Matrix*

Table 8 Component Transformation Matrix shows that in component 1 the correlation value is 0.816 > 0.5, and component 2 the correlation value is 0.816 > 0.5. Because the correlation of all components > 0.5, the two factors formed can be concluded feasible to summarize the nine variables analyzed.

TABLE VIII. COMPONENT TRANSFORMATION MATRIX

| Component | 1 | 2 |
|---|---|---|
| 1 | .816 | .578 |
| 2 | -.578 | .816 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

## IV. CONCLUSION

Research on factor analysis of supporting air conditioning practicum in vocational education has been carried out. Nine independent variables were identified at the beginning of the study as a source of support for the practicum and after analyzing the data they grouped into two new factors. Both of these factors have a correlation value greater than 0.5, so it can be concluded that it is appropriate to enclose the nine variables analyzed. Variable practicum evaluation tool has the highest correlation; this shows that evaluating student performance during practicum activities is very important to be a reference for achieving competency and planning for practicum activities in the future.

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