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# FUZZY ANALYTICAL HIERARCHY PROCESS – BASED PRIORITY IDENTIFICATION OF EMPLOYABILITY SKILLS FOR VOCATIONAL EDUCATION STUDENTS

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## Abstract

This study attempts to reveal which Emplorability Skill (ES) attributes are the main priorities that must be mastered by vocational school graduates from the perspective of vocational high school (VHS) teachers in Indonesia. Determination of ES factors (main attributes) is conducted through the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method. Content analysis techniques are used to determine a set of attributes that are used in several frameworks and the Multi-Criteria Decision Making (MCDM)-based method is Fuzzy AHP in order to help determine priorities in decision making. This study involved 378 vocational schoolteachers as assessors of ES attributes. The results show that communication skills, teamwork, abilities to solve problems, ability to self-management, ability to plan and organize, ability to use technology, and ability to learn lifelong are attributes of employability skills that are widely used within the global context. The most prioritized attributes needed by vocational graduates based on the teachers' perspective are the ability to interact with colleagues, the ability to use basic information technology, and the ability to have a personal vision and mission. The results of this study are expected to be used as useful information for such related parties as the government as policy makers, schools for improving the quality of graduates and teaching, industry for improving the quality of workers, as well as for students and graduates for preparing themselves to become professional workers.

Keywords: Employability skills, Fuzzy AHP, Multi-criteria decision making, Vocational higher education.

## 1. Introduction

Employability Skills (ES) are a set of skills needed to acquire, retain, and perform a good job. They are very important for workers to have as today's industry requires each and every one of them to have for their successful career [1-3]. Professionally, ES includes all possibilities of a person to succeed in various jobs with all situations and conditions in the world of work; therefore, ES is considered a fundamental basis for workers [4]. ES is one of he focuses on the implementation of vocational education, one of which is providing direction to graduates so that they have the main skills at work [5]. Even though vocational education is more focused on developing skills and attitudes. However, in several different countries, such as vocational education in Nigeria, learning focuses on developing aspects of knowledge and skills [6], while in Indonesia learning places more emphasis on technical abilities (hard skills) and soft skills [7]. According to Bennett and Soenarto.[8] The biggest challenge for vocational education is to produce graduates who have academic skills (academic skills), the ability to master specific skills (technical skills) and balanced employability skills. Therefore, ES in vocational education is very important as a complement to technical abilities and attitude skills.

The results of research related to ES have different views on the main criteria for skills that are important for prospective workers to master. ES skills that are important to master from the perspective of students, for example: problem solving and analytical skills [9], ability to update information, and effective communication [10]. Based on research findings in India that students and industry in general accept communication skills, practical/technical skills, general knowledge skills, and skills in using the latest technology have the same level of importance [11]. The results of another study concluded that communication skills, teamwork, problem solving, and proven technology use were considered the most important ES variables [12]. From the results of these studies, it can be seen that the ES attribute has various criteria, and the scope is very broad. Different countries have different standards in determining the criteria for the main skills in work that must be prepared by graduates of secondary or higher education. Educational institutions, educators and stakeholders must consider and reformulate ES priorities that must be owned by prospective workers in accordance with the challenges of the industrial revolution 4.0 [13].

A multi-criteria decision making (MCDM) method is an option to determine the main priority of ES from various variables that are to be mastered by prospective workers. MCDM is a method (modeling) that is reliable in dealing with complex engineering problems and is effective as a decision-making tool from various criteria through operating models [14]. One of the MCDM methods that is widely used by researchers today is the Analytical Hierarchy Process (AHP). AHP has several advantages as it is easy to integrate with other MCDM techniques, simple, easy to use, and has high flexibility [15]. However, AHP also has a weakness, namely not being able to handle subjective judgments from experts or respondents [16]. To handle the subjectivity of expert assessment results, lately many researchers have tried to combine the AHP method with one of the artificial intelligence algorithms known as Fuzzy Logic. This development is known as Fuzzy Analytic Hierarchy Process (Fuzzy AHP), which offers interval assessment using Triangular Fuzzy Number (TFN) [17]. Studies related to ES aspects that need to be mastered by prospective workers are more focused on digging up information from the perspective of students and the industry. There are still very few similar studies that exploring the teachers' perspective. To gain more knowledge about the

priority factors of ES from the teachers' perspective and to fill the gaps in knowledge and research methods on this topic, this study tries to uncover which ES attributes are the top priorities that vocational school graduates must master from the perspective of vocational teachers. high school (VHS) in Indonesia. Determination of ES factors (main attributes) is conducted using the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method.

## 2.Methods

### 2.1. Fuzzy AHP

In this paper, Fuzzy AHP is used to determine the weight of the relative importance of the criteria in determining the main attributes of ES that are important to be mastered by prospective VHS graduates. Fuzzy AHP was developed to solve problems through fuzzy hierarchical [18]. In Fuzzy AHP, pairwise comparison matrix is formed in Triangular Fuzzy Number (TFN). Fuzzy Number is a triangle obtained by fuzzification adjusted to nine Saaty Scale [19]. In relation to several methods Fuzzy AHP introduced by previous researchers, this study used the method of Fuzzy Synthetic Extent (Chang). The Fuzzy AHP procedure is as follows:

#### 2.1.1. Step 1

Prepare and develop an instrument for determining the priority of ES for VHS graduates. The instruments compiled refer to the ES framework such as the commonwealth Department of Education Science and Training (DEST) [20], Division of Academic and Technical Education (DATE) [21], International Labor Office (ILO) [22], European Social Fund [23], Munadi et al.[24], Precision Consultancy [25] and Skill Future SG [26]. The researchers conducted a content analysis by considering the uniformity of the ES attributes of the seven frameworks used in these countries and then determined the criteria and sub-criteria for further analysis using the Fuzzy AHP method. Table 1 shows the results of determining the criteria and sub-criteria of the ES attributes that are used as the basis for determining the main ES attributes from the perspective of the VHS teacher. After compiling the ES criteria and sub-criteria, then the hierarchical structure is described (see Fig. 1).

**Table 1. Criteria and sub-criteria attributes ES.**

| Criteria | Code | Sub criteria | Code |
|---|---|---|---|
| Communication Skill | COM | Verbal Communication | COM.1 |
| | | Active listening | COM.2 |
| | | Comprehends written material | COM.3 |
| | | Conveys information in writing | COM.4 |
| | | Observes carefully | COM.5 |
| Teamwork Skill | TWS | Interacting with co-workers | TWS.1 |
| | | Respecting the thoughts and opinions of others in the group | TWS.2 |
| | | Taking accountability for actions | TWS.3 |
| | | Accepting feedback | TWS.4 |
| | | Mobilizing a group for high performance | TWS.5 |
| Problem-solving Skill | PSS | Thinking creatively | PSS.1 |
| | | Solving problems independently | PSS.2 |
| | | Identifying problems | PSS.3 |
| | | Identifying and suggesting new ideas (initiative) | PSS.4 |
| Self-management Skill | SMS | Have a personal vision and goals | SMS.1 |
| | | Evaluate and monitor own performance | SMS.2 |

| | | | |
|---|---|---|---|
| | | Confident in your own ideas and vision | SMS.3 |
| | | Responsible | SMS.4 |
| Planning and organizing Skill | POS | Managing time and priorities | POS.1 |
| | | Organizing tasks for others and yourself | POS.2 |
| | | Take initiative in making decisions | POS.3 |
| | | Planning resources | POS.4 |
| | | Collect, analyse and organize information | POS.5 |
| Use of Technology Skill | TUS | Have a variety of basic Information technology skills | TUS.1 |
| | | Applying Information technology as a management tool | TUS.2 |
| | | Using Information Technology to manage data | TUS.3 |
| | | Learn new information technology skills | TUS.4 |
| Lifelong learning Skill | LLS | Learn independently | LLS.1 |
| | | Adaptable | LLS.2 |
| | | Abstract thinking skills | LLS.3 |
| | | High enthusiasm for learning | LLS.4 |

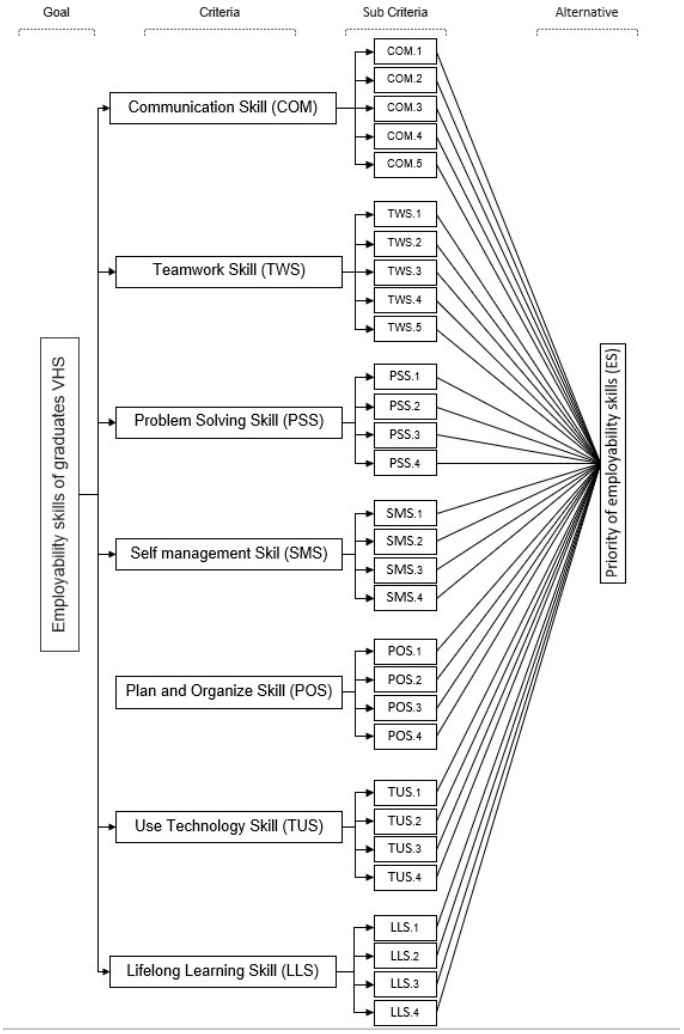


**Fig. 1. ES hierarchy structure.**

### 2.1.2. Step 2

Create a matrix of pairwise comparison for each level of criteria and sub-criteria, the matrix is n x n in size where n indicates the number of criteria. Comparisons are made based on the judgment of the respondents. The ES criteria and sub-criteria were compared with each other using the Saaty 9 relative importance scale [27]. Pairwise comparison scores were then transformed into linguistic variables with concepts as listed in Table 2.

Combining the results of the expert questionnaires. Pairwise comparison scores were transformed into linguistic variables with the transformation concept listed in Table 2.

**Table 2. Triangular fuzzy numbers used in this study.**

| Linguistic Variable | Positive Triangular Fuzzy Numbers | Positive Reciprocal Triangular Fuzzy Numbers |
|---|---|---|
| Extremely strong | (9, 9, 9) | (1/9, 1/9, 1/9) |
| Intermediate | (7, 8, 9) | (1/9, 1/8, 1/7) |
| Very strong | (6, 7, 8) | (1/8, 1/7, 1/6) |
| Intermediate | (5, 6, 7) | (1/7, 1/6, 1/5) |
| Strong | (4, 5, 6) | (1/6, 1/5, 1/4) |
| Intermediate | (3, 4, 5) | (1/5, 1/4, 1/3) |
| Moderate strong | (2, 3, 4) | (1/4, 1/3, 1/2) |
| Intermediate | (1, 2, 3) | (1/3, 1/2, 1) |
| Equally strong | (1, 1, 1) | (1, 1, 1) |

### 2.1.3. Step 3

The AHP scale that has been converted into the TFN scale can be poured into the matrix pairwise comparisons like the following [28]:

$$\tilde{A} = (\tilde{a}_{ij})_{nxn} = \begin{pmatrix} (1,1,1) & (l_{12}, m_{12}, u_{12}) & \cdots (l_{1n}, m_{1n}, u_{1n}) \\ (l_{21}, m_{21}, u_{21}) & (1,1,1) & \vdots (l_{2n}, m_{2n}, u_{2n}) \\ \vdots & \vdots & \vdots \quad \vdots \\ (l_{n1}, m_{n1}, u_{n1}) & (l_{n2}, m_{n2}, u_{n2}) & \cdots \quad (1,1,1) \end{pmatrix} \tag{1}$$

where $\tilde{a}_{ij} = (l_{ij}, m_{ij}, u_{ij}) = \tilde{a}_{ji}{}^{-1} = \left(\frac{1}{u_{ji}}, \frac{1}{m_{ji}}, \frac{1}{l_{ji}}\right)$with $i,j = 1,...,n$ and $i \neq j$.

### 2.1.4. Step 4

The pairwise comparison matrix that has been formed, the next step is to determine the Fuzzy synthetic extent value by using the following equation [29]:

$$Si = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{j=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \tag{2}$$

To obtain $M_{gi}^{j}$, then the operation of adding the value of fuzzy extent analysis M for the matrix is carried out using the addition operation on each TFN number in each row as follows:

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} lj, \sum_{j=1}^{m} mj, \sum_{j=1}^{m} uj\right) \tag{3}$$

with $i$ = 1, 2,..., $n$. Meanwhile, to obtain the value $\left[\sum_{i=1}^{n}\sum_{j=1}^{m}M_{gi}^{j}\right]^{-1}$ an addition operation is carried out for the entirenumber triangular fuzzy $M_{gi}^{j}$ (j = 1,2,...,$m$).

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m}M_{gi}^{j}\right]\left[\sum_{i=1}^{n}\sum_{j=1}^{m}l_{ij},\sum_{i=1}^{n}\sum_{j=1}^{m}m_{ij},\sum_{i=1}^{n}\sum_{j=1}^{m}u_{ij},\right] \quad (4)$$

So to calculate the inverse of the initial equation, namely:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m}M_{gi}^{j}\right]^{-1}=\left(\frac{1}{\sum_{i=1}^{n}u_1},\frac{1}{\sum_{i=1}^{n}m_1},\frac{1}{\sum_{i=1}^{n}l_1}\right) \quad (5)$$

### 2.1.5. Step 5

Perform a calculation of the probability level comparison between numbers fuzzy. This comparison is used for the weight value for each criterion. For two numbers TFN $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u2)$, the degree of probability $M_2 \geq M_1$ can be defined as follows:

$$(M_2 \geq M_1) = sup[min(\mu_{M1}(x),\mu_{M2}(x))] = hgt(M_1 \cap M_2) = \mu_{Mn}(d) \quad (6)$$

$$V(M_2 \geq M_1) = \begin{cases} 1 & ,if\ m_2 \geq m_1 \\ 0 & ,if\ l_1 \geq u_2 \\ \frac{l_1-u_2}{(m_2-u_2)-(m_1-l_1)} & ,for\ other \end{cases} \quad (7)$$

To compare the $M_1$ dan $M_2$, it takes the value of $V(M_1 \geq M_2)$ dan $V(M_2 \geq M_1)$. The degree of probability for the value fuzzy $M$ is greater than the $k$ value fuzzy $M$i ($i$ = 1,2,...,$k$), can be defined as follows:

$$\begin{aligned} &V(M \geq M_1, M_2, ..., M_k) \\ &= V[(M \geq M_1), (M \geq M_2), ...,\ and\ \ (M \geq M_k)] \\ &= \min V(M \geq M_i), i = 1, 2, ..., k \end{aligned} \quad (8)$$

So that the value of

$$d'(A_i) = min\, V\,(S_i \geq S_k) \quad (9)$$

$k$ = 1, 2,...., $n$; $k \neq i$.

Then the weight vector is carried out to facilitate interpretation which is defined as follows:

$$W' = [d'(A_1), d'(A_2), \ldots., d'(A_n)]^T \quad (10)$$

where $Ai$ ($i$ = 1,2,...,$n$) is n elements and $d'(Ai)$ is a value that describes the relative choice of each decision attribute.

### 2.1.6. Step 6

Next is to normalize the weights so that the values in the vector weights are allowed to be analogous to weights and consist of numbers non-fuzzy using the following equation:

$$d(A_i) = \frac{d'(A_i)}{\sum_{i=1}^{n} d'(A_i)} \quad (11)$$

for $i$ = 1, 2,.., $n$.

### 2.1.7. Step 7

Make decisions from the results of fuzzy calculations AHP.

## 2.2. Respondents

Respondents and data that are ready to be processed are 378 respondents, the following demographic information from respondents is presented in Table 3.

**Table 3. Demographic information of respondent data.**

| Variable | | Total | Percentage |
|---|---|---|---|
| Gender | Male | 166 | 43.92% |
| | Female | 212 | 56.08% |
| Age | 22-29 Years | 80 | 21.16% |
| | 30-39 Years | 109 | 28.84% |
| | 40-49 Years | 138 | 36.51% |
| | 50-59 Years | 51 | 13.49% |
| Employment Status | Civil Servant | 221 | 58.47% |
| | Non-Civil Servant | 157 | 41.53% |
| High School group: | Technology | 267 | 70.63% |
| | Non- Technology | 111 | 29.37% |
| School Type: | Public | 279 | 73.81% |
| | Private | 99 | 26.19% |
| School Accreditation Status: | A | 294 | 77.78% |
| | B | 71 | 18.78% |
| | C | 7 | 1.85% |
| | Not Accredited | 6 | 1.59% |
| Work Period | 1-10 Years | 154 | 40.74% |
| | 11-20 Years | 170 | 44.97% |
| | 21-30 Years | 43 | 11.38% |
| | >30 Years | 0 | 0.00% |

From the number of respondents in this study, the gender of the teachers was dominated by female by 56.08%, then from the age group the most were teachers who had an age range of 40-49 years. In terms of the employment status, most of them are civil servants while based on the Vocational School family, the type of school and the accreditation status of the respondents are mostly from Vocational Technology Schools, most of them are public schools accredited an A, meaning the schools have the highest rank of the accreditation. Based on years of service, the highest percentage is in the age range 11-20 year which is 44.97%. The demographic information of this respondents' data will be used as a reference for researchers to extract more in-depth information related to this research.

# 3. Results and Discussion

## 3.1. Results

Based on the analysis, there are 7 frameworks of employability skills that come from various sources ranging from 2002 to 2020, as shown in Table 4. Most studies that measure employability skills always refer to frameworks that have been developed by such institutions as Commonwealth Department of education science and Training(DEST) [20], Division of Academic and Technical Education (DATE)

[21], International Labor Office (ILO) [22], European Social Fund [23], Munadi et al. [24], Precision Consultancy [25] and Skill Future SG [26]. Of the many attributes of employability skills, the next researcher synthesizes them and sets the main attributes based on the most slices of sources platform employability skills.

**Table 4. Results of identification of attributes of employability skills from various frameworks.**

| No. | Criteria | Intersecting Framework | Item |
|---|---|---|---|
| 1 | Communication Skill | [20-25] | 6 |
| 2 | Use of Technology Skill | [20-26] | 6 |
| 3 | Teamwork Skill | [20, 22-25] | 5 |
| 4 | Problem-solving Skill | [20, 22-25] | 5 |
| 5 | Planning and organizing Skill | [20, 21, 24, 25] | 4 |
| 6 | Lifelong learning Skill | [20, 22, 24, 25] | 4 |
| 7 | Self-management Skill | [20, 23-25] | 4 |

As the basis for making multi-criteria decisions through AHP, attributes that have more than 3 intersecting frameworks are selected. The attributes of communication skills, use of technology skill, teamwork skill, problem-solving skill, planning and organizing skills, lifelong learning skill, and self-management skill were chosen as the top priority. Out of the 7 attributes, 31 sub-criteria were obtained, then the hierarchical value would be determined. by the Fuzzy-AHP algorithm, the 31 sub-criteria can be seen in Table 1.

After the determination of the sub-criteria and the judging process by the experts, the AHP data processing begins with a pairwise comparison matrix. The matrix is with reference to the TFN value as described previously. The paired comparison matrix formed is of order 31×31 because the number of variables is 31, then Table 4 shows a summary of the paired matrix of order 31×31 which is indicated by the initials of each variable. The following is a summary of the pairwise comparison matrix as shown in Table 5.

**Table 5. Fuzzy pairwise comparison matrix AHP.**

| | **COM.1** | | | **COM.2** | | | **….** | **LLS.3** | | | **LLS.4** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | **l** | **m** | **u** | **….** | **l** | **m** | **u** | **l** | **m** | **u** |
| COM.1 | 1.00 | 1.00 | 1.00 | 2.00 | 3.00 | 4.00 | …. | 4.00 | 5.00 | 6.00 | 4.00 | 5.00 | 6.00 |
| COM.2 | 0.25 | 0.33 | 0.50 | 1.00 | 1.00 | 1.00 | …. | 2.00 | 3.00 | 4.00 | 1.00 | 1.00 | 1.00 |
| …. | …. | …. | …. | …. | …. | …. | …. | …. | …. | …. | …. | …. | …. |
| LLS.3 | 4.00 | 5.00 | 6.00 | 2.00 | 3.00 | 4.00 | …. | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| LLS.4 | 1.00 | 1.00 | 1.00 | 2.00 | 3.00 | 4.00 | …. | 4.00 | 5.00 | 6.00 | 4.00 | 5.00 | 6.00 |

After creating the Pairwise Comparison fuzzy AHP matrix, then calculating the fuzzy synthetic extent weights using the changes extent technique proceeds, while the calculation is by adding up each column from each level as in Eq. (3). The result is that each sub-criteria has a number of values for each criterion as presented in Table 6.

The result of the sum of each column is calculated again by adding up each row using Eq. (4) to get the inverse value of this matrix. The inverse value for each row can use Eq. (5). Then the next calculate the value of the step is fuzzy synthesis extent to for each criterion by multiplying each value Matrix by the inverse matrix as in Eq. (2). Then the value is obtained fuzzy extent as shown in Table 7.

**Table 6. The results of adding up the TFN values.**

| Sub Criteria | ∑ l | ∑ m | ∑ u |
|---|---|---|---|
| COM.1 | 76.34 | 97.40 | 118.50 |
| COM.2 | 25.58 | 30.32 | 35.75 |
| COM.3 | 21.25 | 21.80 | 22.83 |
| COM.4 | 17.98 | 18.67 | 20.00 |
| COM.5 | 30.42 | 39.12 | 48.50 |
| TWS.1 | 133.00 | 159.00 | 185.00 |
| TWS.2 | 39.08 | 54.71 | 71.00 |
| TWS.3 | 19.75 | 20.47 | 21.92 |
| TWS.4 | 18.21 | 19.06 | 20.75 |
| TWS.5 | 20.50 | 21.13 | 22.33 |
| PSS.1 | 64.75 | 84.99 | 105.50 |
| PSS.2 | 24.33 | 25.93 | 28.08 |
| PSS.3 | 84.25 | 106.33 | 128.50 |
| PSS.4 | 22.04 | 23.86 | 26.50 |
| SMS.1 | 105.00 | 129.00 | 153.00 |
| SMS.2 | 22.83 | 24.59 | 27.08 |
| SMS.3 | 25.13 | 26.66 | 28.67 |
| SMS.4 | 43.67 | 60.18 | 77.25 |
| POS.1 | 86.00 | 109.00 | 132.00 |
| POS.2 | 19.08 | 19.92 | 21.58 |
| POS.3 | 19.87 | 20.59 | 22.08 |
| POS.4 | 36.17 | 48.84 | 62.25 |
| POS.5 | 30.42 | 38.17 | 46.75 |
| TUS.1 | 113.00 | 137.00 | 161.00 |
| TUS.2 | 22.34 | 23.80 | 25.83 |
| TUS.3 | 18.30 | 19.19 | 21.00 |
| TUS.4 | 43.83 | 61.38 | 79.50 |
| LLS.1 | 48.67 | 68.18 | 88.25 |
| LLS.2 | 25.38 | 27.05 | 29.42 |
| LLS.3 | 25.55 | 29.20 | 33.50 |
| LLS.4 | 67.92 | 87.13 | 106.50 |
| Total | 1,350.61 | 1,652.69 | 1,970.83 |
| Invers | 0.000507 | 0.000605 | 0.000740 |

**Table 7. Value of fuzzy synthesis extent on each criterion.**

| | l | m | u |
|---|---|---|---|
| S1 | 0.04 | 0.05893 | 0.09 |
| S2 | 0.01 | 0.01834 | 0.03 |
| S3 | 0.01 | 0.01319 | 0.02 |
| S4 | 0.01 | 0.01130 | 0.01 |
| S5 | 0.02 | 0.02367 | 0.04 |
| S6 | 0.07 | 0.09621 | 0.14 |
| S7 | 0.02 | 0.03311 | 0.05 |
| S8 | 0.01 | 0.01239 | 0.02 |
| S9 | 0.01 | 0.01153 | 0.02 |
| S10 | 0.01 | 0.01279 | 0.02 |
| S11 | 0.03 | 0.05143 | 0.08 |
| S12 | 0.01 | 0.01569 | 0.02 |
| S13 | 0.04 | 0.06434 | 0.10 |
| S14 | 0.01 | 0.01444 | 0.02 |

| | | | |
|---|---|---|---|
| S15 | 0.05 | 0.07805 | 0.11 |
| S16 | 0.01 | 0.01488 | 0.02 |
| S17 | 0.01 | 0.01613 | 0.02 |
| S18 | 0.02 | 0.03642 | 0.06 |
| S19 | 0.04 | 0.06595 | 0.10 |
| S20 | 0.01 | 0.01205 | 0.02 |
| S21 | 0.01 | 0.01246 | 0.02 |
| S22 | 0.02 | 0.02955 | 0.05 |
| S23 | 0.02 | 0.02310 | 0.03 |
| S24 | 0.06 | 0.08290 | 0.12 |
| S25 | 0.01 | 0.01440 | 0.02 |
| S26 | 0.01 | 0.01161 | 0.02 |
| S27 | 0.02 | 0.03714 | 0.06 |
| S28 | 0.02 | 0.04126 | 0.07 |
| S29 | 0.01 | 0.01637 | 0.02 |
| S30 | 0.01 | 0.01767 | 0.02 |
| S31 | 0.03 | 0.05272 | 0.08 |

After getting value of fuzzy synthesis extents which further makes value comparisons possible level, the comparison value is obtained by comparing the values obtained with reference to statement (7). The results of the comparison can be seen in Table 8. The first comparison is done by looking at the possibilities with the statement if $m2 \geq m1$ then the value obtained is 1.00 if the possibility of the statement is not fulfilled then we look at the second statement, namely if $l1 \geq u2$ then if it is appropriate then it is given a value of 0.00 if it is still not fulfilled then the calculation is carried out with the equation:

$$\frac{l_1 - u_2}{(m_2 - u_2) - (m_2 - l_1)} \tag{12}$$

**Table 8. Results of comparison of likelihood levels and normalization values.**

| | **S1>** | **S2>** | **S3>** | **…** | **S30>** | **S31>** |
|---|---|---|---|---|---|---|
| S1 | | 0.00 | 0.00 | … | 0.00 | 0.87 |
| S2 | 1.00 | | 0.21 | … | 1.00 | 1.00 |
| S3 | 1.00 | 1.00 | | … | 1.00 | 1.00 |
| … | … | … | … | … | … | … |
| S29 | 1.00 | 1.00 | 0.55 | … | 1.00 | 1.00 |
| S30 | 1.00 | 1.00 | 0.46 | … | | 1.00 |
| S31 | 1.00 | 0.00 | 0.00 | … | 0.00 | |
| Minimum | 0.35 | 0.00 | 0.00 | … | 0.00 | 0.00 |
| Normalization | 0.09 | 0.00 | 0.00 | … | 0.00 | 0.00 |

Table 8 shows normalization values, which is obtained from Eq. (11). This normalized value will be used as the weight of the value of Fuzzy AHP using the technique of Chang's extent of each sub-criterion, while the results of the priority level order of ES graduates from Vocational Schools are as shown in Fig. 2.

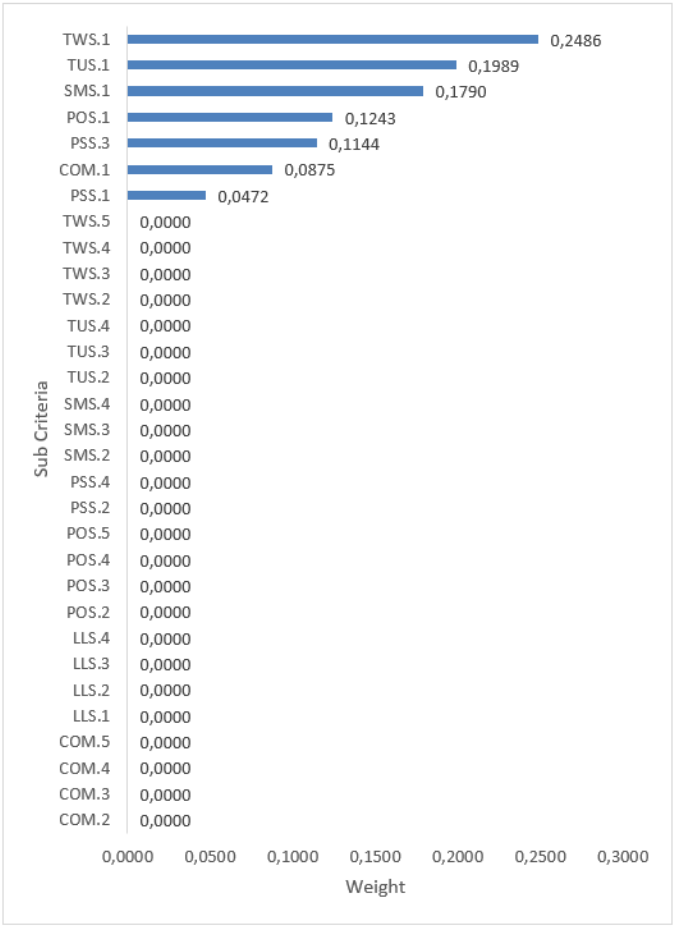


**Fig. 2. Results of weights of fuzzy AHP through Chang's extent technique.**

## 3.2. Discussion

Figure 2 shows the order of priority levels of employability skills needed by the graduates. The first order is the ability to interact with colleagues which is included in the ability to work together in which it has the highest weight among the others (0.1058). This result is in line those of several previous works which stated that the ability to interact with colleagues is the most important ability needed by graduates [3, 30, 31]. Lane [32] also stated that collaboration, leadership and communication skills are important to be taught in vocational education, so that collaborative learning is one of them prepared for the development of these skills. According to McLeish [33], one of the benefits of cooperation will be to build interaction among fellow workers so that the process of transferring their knowledge and skills is very fast, which will be more profitable for the company. Therefore, the company places great emphasis on the importance of job skills for workers. Pusriawan and Sunaryo [7] also agree with this as they have researched students regarding the needs of employability skills of Vocational School graduates in Palu City, Indonesia. The results show that cooperation skills have a very high score in the category of importance and are in the 2nd position out of the 9 competencies listed. The first position is occupied by occupational health and safety

skills. Occupational safety skills are important for graduates because these skills are intended to protect the health and safety of workers from all risks and dangers that threaten in the workplace [14]. But unfortunately in this study occupational safety and health skills are not included in the skills identified, because globally there are still few frameworks that discuss these skills. Therefore, the authors agree with the results and also some relevant studies that interacting with colleagues is the most important attribute needed and prepared by students and graduates of vocational education, because vocational education emphasizes these skills, then these skills are much needed by companies because equivalent to vocational education, especially Vocational School graduates, work more in groups.

Furthermore, in second place, there is the ability to have various basic information technology skills with a weighted value of 0.0864, indicating that the ability to use basic information technology is important to have. This statement is in line with research in Malaysia, which according to the manufacturing industry in Malaysia, basic skills, thinking skills, resource skills, systems skills and technology are the most important skills needed by graduates [34]. Then mastery of the use of information technology is very much needed by employees because the industry currently uses a lot of the latest technologies to simplify work [35, 36]; therefore, these skills must be prepared by workers [14]. This is important because the current industrial development is in line with the rapid development of technology, therefore the industrial world requires its workers to master information technology to facilitate their work. In preparing these skills, vocational education facilitates students with teaching in mastering information technology such as computer skills and information processing in the KTSP curriculum [37] and digital simulations in the 2013 curriculum. information that will be a provision for them to work in the workplace.

The ability to have a personal vision and goals that are included in the self-management group placed the third position as the weight obtained from the results of fuzzy AHP calculations is 0.0832. Having a personal vision and goals becomes a fairly high priority level, but this is not in line with research by Robinson et al. [9], as they stated that the ability of visioning was ranked 6th out of 16 identified abilities and included in the category of minor importance. This is in agreement with the results of Robinson and Garton study [38] proving that the ability of visioning was at a moderate level of need. Therefore, the result of this study seems to contradict with those of several previous studies. This is likely due to the difference of research objects where previous research explores the perceptions of students and industry while in this study explores the perceptions of teachers. The teachers in this case as facilitators developing skills that focus on building student character so that what is carried over is how to shape the vision and commitment of students to work well in the workplace. Thus, according to them, the skills to have vision and commitment in the workplace are important things for graduates to have.

Another interesting thing that needs to be studied is the ability to communicate verbally which is ranked 6$^{th}$ as it is usually placed in the first position. Previous works stated that verbal communication is the most important thing for graduates of vocational education [39, 40], and communication skills are important with a high level of importance [41]. However, this study proved that communication occupies the sixth of the 31 skills identified, this happens because the object of research is different where previous research has focused more on research related to the perception of graduates from the fields of management and accounting and

social studies where they put more emphasis on the communication aspect. Meanwhile, this study focuses more on the perception of vocational schoolteachers where they emphasize that vocational graduates must emphasize the cooperative aspect. However, verbal communication skills should be the main thing for vocational education graduates because the demands of the world of work now and in the future need and importance will increase [42]. It is believed that good communication will increase competitiveness in the global market, because good communication will increase networking for partners, making it easier to find work besides opening up networks for them in entrepreneurship because it does not rule out the possibility that Vocational School graduates can open their own businesses, therefore verbal communication skills are important for graduates to have.

It has also been proven that out of the 31 sub-criteria, only 7 criteria whose weight was identifiable as because the fuzzy method used is the method of fuzzy Synthesis extent where the calculation has used the TFN interval assessment, then this method has one stage where the value of the synthesis on the variables is compared by looking at several possibilities until a definite value is obtained. This method is almost too sharp in taking into account the uncertainty value of the respondent so that it can remove unnecessary and really unimportant criteria or sub-criteria [43]. It is evident from the results of the study which show that only 7 sub-criteria out of 31 sub-criteria can be sorted and the rest is worth 0.00 (see Fig. 2), meaning that it cannot be sorted, so this method is suitable for decisions that absolutely set priorities without looking at the overall ranking order.

## 4. Conclusion

Based on the results and discussion of this study, it can be concluded that the attributes of employability skills that have uniformity are based on a review of several frameworks used in several countries, namely, communication skills, ability to use technology, ability to work together, ability to solve problems, ability to plan and organize, lifelong learning skills, and self-management. Based on the perspective of the Vocational School teachers assisted by the MCDM decision system, it is proven that the ability to interact with colleagues, the ability to use basic information technology, and the ability to have a personal vision and mission are the attributes of employability skills which are important and to be mastered by Vocational School graduates. The results of this study should be used as a guiding reference to related parties such as to the school as a consideration or input for fulfilling the curriculum and improving the quality of graduates. In addition, it is also useful for the industry as users, as it is necessary to improve the quality of workers and prospective workers who are recruited. For students, graduates and workers, this information is to provide an overview of the employability skills needed today as well as adding knowledge and information for readers in general. It is also recommended that future research focus on bigger and more in-depth analysis, one of which is by comparing the priority levels based on gender, age, years of service, and other variables.

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