The Implementation of Decision Support System in Recruiting Prospectives Employees at SMK Telkom Malang Using Fuzzy Tsukamoto Method

Bias Damiasa¹
Magistrate of Vocational Education, Malang State University
biasd30@gmail.com

Pashatania Fitri Indah Lestari²
Magistrate of Vocational Education, Malang State University
pashatania.lestari@gmail.com

Anik Nur Handayani³
Magistrate of Vocational Education, Malang State University
aniknur.ft@um.ac.id

Abstract—Vocational graduates are expected to fill job vacancies according to the needs of the business/industry. With the increasingly fierce labor market competition, graduates from Vocational High Schools are expected to not only have competency but also excellent soft skills in order to have a great chance of being accepted to work in the desired industry. PT. Visionet Internasional is one of the companies that from year to year always conducts recruitment process for prospective employees from 12th grade students at SMK Telkom Malang. The number of students willing to participate in the program which are not balanced with the number of staff and the short amount of time to select prospective employees is feared to affect the final results of recruitment. To get the expected results, a decision support system was developed to provide recommendations for PT Visionet in accepting or rejecting prospective candidates. This system is web based and applies the Fuzzy Tsukamoto algorithm. The Spearman Correlation test used to compare the results from system and experts shows a high level of accuracy, with rs value 0.739394.

Keywords: Decision Support System, Recruitment, Fuzzy Tsukamoto

I. INTRODUCTION

In SMK Telkom Malang, the absorption of graduates, both from the Department of Software Engineering (RPL) and Computer and Network Engineering (TKJ), is high. One of the ways that many 12th grade students do to be absorbed by the workforce is by utilizing the recruitment process held in schools. Several different industries engaged in Information Technology came to SMK Telkom Malang to find and recruit prospective graduates with the required qualifications. One company that from year to year always does the recruitment process for prospective employees at Telkom Malang Vocational School is PT Visionet Internasional, or more commonly referred to as Visionet. Telkom Malang Vocational School is considered to have students with the skills and soft skills needed by the company. In collaboration with the Industrial Relations Unit of SMK Telkom Malang, the recruitment process held in this school is always in great demand because it makes it easier for students in the process of finding employment.

Some staff are specifically brought in directly from the office based in Tangerang to conduct recruitment which lasted for two to three days. However, the number of candidates who are not balanced with the number of staff and the short time to select prospective employees is feared to affect the final recruitment results. To get the expected results, an objective recruitment mechanism is needed but also efficient to capture the best prospective employees. This is important because employee qualifications can influence the productivity and earnings of the company.

Based on that background, a web application is developed to be a solution in supporting the recruitment process of Visionet prospective employees conducted at SMK Telkom Malang. This application acts as a decision support system that can help companies, in this case Visionet, to make decisions regarding the best candidates to be recruited as employees. This application implements the Fuzzy Tsukamoto Method to achieve objective and efficient recruitment results.

This study aims to develop web applications that are able to act as a decision support system in determining Visionet's best prospective candidates more objectively and efficiently.

II. RELATED WORKS

Several previous researches have applied the Fuzzy Tsukamoto Method to solve the same problem. The first one is "Selection of Prospective Employees Using Fuzzy Tsukamoto" which aims as a tool for decision making to determine the best prospective employees based on the value of the variables that have been determined by the company. The values of these variables are then calculated using the Tsukamoto fuzzy method. The ranking of the results of the Tsukamoto FIS is compared with the ranking produced by experts using the Spearman correlation test. The correlation test value of 0.6136 indicates that the system has produced an accurate solution. [1]

The second research is "Tsukamoto Fuzzy Inference System To Determine the Feasibility of Prospective Employees" of which goal is to help companies to make decisions and choose prospective employees who really deserve to be accepted. To test the accuracy between expert
ranking and the system, Spearman’s non parametric correlation test was used. Correlation test produces an accuracy value of 0.952 which means the level of accuracy between experts and the system is very high. [2]

Based on the results of both researches, it can be concluded that the system or application that applies the Fuzzy Tsukamoto Method can be used as a decision support in determining the best prospective employee in a company. Both studies show that the system shows accurate results when compared with expert results.

III. METHOD

1. Formation of Fuzzy Sets

Input and output variables in the Tsukamoto method consist of one or more sets. For input variables, the system uses the qualifications needed by Visionet. Meanwhile, the output variable is a recommendation for prospective employee recruitment.

Fuzzy sets are entities that represent a certain condition or condition in a fuzzy variable. There are four linguistic variables used, including KURANG, CUKUP, BAiK, and SANGAT BAiK. The formation of this fuzzy set is adjusted to the provisions stated on the report cards of 12th grade students at SMK Telkom Malang. Linguistic variables are combined with fuzzy sets, each of which has a defined membership function. The following is a modeling of the membership function of each input variable and output variable.

a) Score on Web Programming

\[
\mu_{KURANGWeb}(x) = \begin{cases} 
1 & 0 \leq x \leq 55 \\
\frac{56-x}{56-55} & 55 < x \leq 70 \\
\frac{71-x}{71-70} & 70 < x \leq 85 \\
\frac{86-x}{86-85} & 85 < x \leq 100 \\
0 & x > 100 
\end{cases}
\]

\[
\mu_{CUKUPWeb}(x) = \begin{cases} 
0 & 0 \leq x < 50 \\
\frac{x-55}{56-55} & 56 \leq x \leq 70 \\
\frac{71-x}{71-70} & 70 < x \leq 85 \\
\frac{86-x}{86-85} & 85 < x \leq 100 \\
0 & x > 100 
\end{cases}
\]

\[
\mu_{BAiKWeb}(x) = \begin{cases} 
0 & 0 \leq x < 70 \\
\frac{71-x}{71-70} & 70 \leq x \leq 85 \\
\frac{86-x}{86-85} & 85 < x \leq 100 \\
0 & x > 100 
\end{cases}
\]

\[
\mu_{SANGATBAiKWeb}(x) = \begin{cases} 
0 & 0 \leq x < 85 \\
\frac{86-x}{86-85} & 85 \leq x \leq 100 \\
0 & x > 100 
\end{cases}
\]

b) Score on Mobile Application Programming

\[
\mu_{KURANGsoftskill}(z) = \begin{cases} 
1 & 0 \leq z \leq 60 \\
\frac{61-z}{61-60} & 60 < z \leq 70 \\
0 & z > 70 
\end{cases}
\]

\[
\mu_{CUKUPsoftskill}(z) = \begin{cases} 
0 & 0 \leq z < 60 \\
\frac{61-z}{61-60} & 60 \leq z \leq 75 \\
\frac{76-z}{76-75} & 75 < z \leq 90 \\
0 & z > 90 
\end{cases}
\]

\[
\mu_{BAiKsoftskill}(z) = \begin{cases} 
0 & 0 \leq z < 90 \\
\frac{91-z}{91-90} & 90 \leq z \leq 100 \\
0 & z > 100 
\end{cases}
\]

Meanwhile, the output variable which acts as a decision support has three linguistic variables, including TIDAK REKOMENDASI and REKOMENDASI. Output variables are modeled as follows.

\[
\mu_{TIDAKREKOMENDASI}(z) = \begin{cases} 
0 & 0 \leq z < 90 \\
\frac{91-z}{91-90} & 90 \leq z \leq 100 \\
0 & z > 100 
\end{cases}
\]

\[
\mu_{REKOMENDASI}(z) = \begin{cases} 
1 & 0 \leq z \leq 100 \\
0 & z > 100 
\end{cases}
\]
2. Fuzzy Inference System Rules

Fuzzy inference is used to formulate mapping from input variables to output variables using fuzzy logic. This mapping will be the basis of which decisions will be made, or patterns that are visible. The decision rules used in this study are given in Table 1. The formation of these rules is done by considering the qualifications required by Visionet.

![Graph showing fuzzy membership functions](image)

\[
\mu_{\text{TIDAK REKOMENDASI}}(x) = \begin{cases} 
1 & 0 \leq x < 4 \\
\frac{(6 - x)}{(6 - 4)} & 4 \leq x < 6 \\
0 & x \geq 6
\end{cases}
\]

\[
\mu_{\text{REKOMENDASI}}(x) = \begin{cases} 
\frac{(x - 4)}{(6 - 4)} & 4 \leq x < 6 \\
1 & 6 \leq x \leq 10 \\
0 & x \geq 10
\end{cases}
\]

Table 1 Rules Used in The System

<table>
<thead>
<tr>
<th>Rule</th>
<th>Nilai Web</th>
<th>Nilai Android</th>
<th>Nilai Softskill</th>
<th>Hasil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D</td>
<td>D</td>
<td>Kurang</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>2</td>
<td>D</td>
<td>D</td>
<td>Cukup</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
<td>D</td>
<td>Baik</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
<td>D</td>
<td>Sangat Baik</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>5</td>
<td>D</td>
<td>C</td>
<td>Kurang</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>6</td>
<td>D</td>
<td>C</td>
<td>Cukup</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>7</td>
<td>D</td>
<td>C</td>
<td>Baik</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>8</td>
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</tr>
<tr>
<td>9</td>
<td>D</td>
<td>B</td>
<td>Kurang</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
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<td>D</td>
<td>B</td>
<td>Cukup</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
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<td>D</td>
<td>B</td>
<td>Baik</td>
<td>Rekomendasi</td>
</tr>
<tr>
<td>12</td>
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<td>B</td>
<td>Sangat Baik</td>
<td>Rekomendasi</td>
</tr>
<tr>
<td>13</td>
<td>D</td>
<td>A</td>
<td>Kurang</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
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</tr>
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<td>A</td>
<td>Baik</td>
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</tr>
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</tr>
<tr>
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<td>Sangat Baik</td>
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</tr>
<tr>
<td>21</td>
<td>C</td>
<td>C</td>
<td>Kurang</td>
<td>Tidak Rekomendasi</td>
</tr>
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<td>Cukup</td>
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</tr>
<tr>
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<td>C</td>
<td>C</td>
<td>Baik</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>24</td>
<td>C</td>
<td>C</td>
<td>Sangat Baik</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>25</td>
<td>C</td>
<td>B</td>
<td>Kurang</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>26</td>
<td>C</td>
<td>B</td>
<td>Cukup</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
<td>27</td>
<td>C</td>
<td>B</td>
<td>Baik</td>
<td>Rekomendasi</td>
</tr>
<tr>
<td>28</td>
<td>C</td>
<td>B</td>
<td>Sangat Baik</td>
<td>Rekomendasi</td>
</tr>
<tr>
<td>29</td>
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<td>A</td>
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<td>Tidak Rekomendasi</td>
</tr>
<tr>
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<td>C</td>
<td>A</td>
<td>Cukup</td>
<td>Tidak Rekomendasi</td>
</tr>
<tr>
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<td>A</td>
<td>Baik</td>
<td>Rekomendasi</td>
</tr>
<tr>
<td>32</td>
<td>C</td>
<td>A</td>
<td>Sangat Baik</td>
<td>Rekomendasi</td>
</tr>
</tbody>
</table>

3. Defuzzification

The next step, is to find the output value in the form of a crisp value (z) known as the defuzzification process. The method used is the Center Average Defuzzyfier method, as follows.

\[
Z = \frac{\sum(\alpha_{pi} \times z_i)}{\sum \alpha_{pi}}
\]

Z = center average defuzzyfier
\(\alpha_{pi}\) = alpha predicate value (minimum value of membership degree)
Zi = crisp value obtained from the results of inference
I = number of fuzzy rules

IV. RESULTS

The system developed is a web-based system that can be used as a decision support in recruiting prospective employees of PT Visionet Internasional from 12th grade students of SMK. The algorithm used is Fuzzy Tsukamoto. Inputs processed in this application are adjusted to the qualifications required by Visionet, consisting of report cards on Dynamic Web Programming. The following is an example of the system’s implementation.
With the score of Web Programming at 95 labeled as A, the score of Mobile Device Programming is 80 labeled as B, and the Softskill score is 100 labeled as Sangat Baik, the result displayed on the system are... This result is then used as a recommendation for Visionet to accept or reject prospective candidates.

Following are the Fuzzy Tsukamoto manual calculations for the same input variable.

**Problem 1**
Score of Web Programming = 95
Score of Mobile App Programming = 80
Score of Softskill = 100

**Problem solving:**
Web Programming = 95
This score belongs into two sets: CUKUP and BAIK, which results into
\[ \mu_{	ext{CUKUP}}[95] = \frac{71 - 95}{71 - 70} = 0.8 \]
\[ \mu_{	ext{BAIK}}[95] = \frac{95 - 71}{95 - 70} = 0.2 \]
Mobile App Programming = 80
This score belongs into two sets: BAIK and SANGAT BAIK, which results into
\[ \mu_{	ext{BAIK}}[80] = \frac{86 - 80}{86 - 71} = 0.3 \]
\[ \mu_{	ext{SANGAT BAIK}}[80] = \frac{80 - 85}{85 - 80} = 0.7 \]
Softskill = 100
This score belongs into two sets: BAIK and SANGAT BAIK, which results into
\[ \mu_{	ext{BAIK}}[100] = \frac{91 - 100}{91 - 90} = 0.2 \]
\[ \mu_{	ext{SANGAT BAIK}}[100] = \frac{100 - 91}{100 - 90} = 0.8 \]

Determining the value of \( \alpha \) and \( z \) for each rules
\[ \alpha_{60} = \min(\mu_{	ext{SANGAT BAIK}}[95], \mu_{	ext{BAIK}}[80], \mu_{	ext{SANGAT BAIK}}[100]) = \min(1, 1, 1) = 1 \]

According to the membership set function of Hasil REKOMENDASI, then
\[ Z_{60} = Z_{min} + \frac{\alpha_{60}(Z_{max} - Z_{min})}{\alpha_{60}(Z_{max} - Z_{min}) + Z_{min}} \]
\[ Z_{60} = 1(6 - 4) + 4 = 2 + 4 = 6 \]

The result is 6 according to the Tsukamoto Method

**Problem 2:**
Web Programming = 70.2
Mobile App Programming = 85.7
Softskill = 90.8

Apakah siswa tersebut direkomendasikan sebagai karyawan?

**Problem solving:**
Web Programming = 70.2
This score belongs into two sets: CUKUP dan BAIK, which results into
\[ \mu_{	ext{CUKUP}}[70.2] = \frac{71 - 70.2}{71 - 70} = 0.8 \]
\[ \mu_{	ext{BAIK}}[70.2] = \frac{70.2 - 71}{71 - 70} = 0.2 \]
Mobile App Programming = 85.7
This score belongs into two sets: BAIK and SANGAT BAIK, which results into
\[ \mu_{	ext{BAIK}}[85.7] = \frac{85.7 - 86}{86 - 85} = 0.3 \]
\[ \mu_{	ext{SANGAT BAIK}}[85.7] = \frac{85.7 - 85}{85 - 85} = 0.7 \]
Softskill = 90.8
This score belongs into two sets: BAIK dan SANGAT BAIK, which results into
\[ \mu_{	ext{BAIK}}[90.8] = \frac{90.8 - 91}{91 - 90} = 0.2 \]
\[ \mu_{	ext{SANGAT BAIK}}[90.8] = \frac{90.8 - 90}{91 - 90} = 0.8 \]

Determining the value of \( \alpha \) and \( z \) for each rules
\[ \alpha_{27} = \min(\mu_{	ext{CUKUP}}[70.2], \mu_{	ext{BAIK}}[85.7], \mu_{	ext{BAIK}}[90.8]) \]
According to membership function set of TIDAK REKOMENDASI, then

\[
\alpha_{27} = \mu_{\text{CUKUPWeb}}[X] \cap \mu_{\text{BAIKAndroid}}[Y] \\
\cap \mu_{\text{SANGATBAIKSoftskill}}[Z] = \min(\mu_{\text{CUKUPWeb}}[70.2], \mu_{\text{BAIKAndroid}}[85.7], \mu_{\text{SANGATBAIKSoftskill}}[90.8]) = 0.7
\]

According to membership function set of TIDAK REKOMENDASI, then

\[
\alpha_{32} = \mu_{\text{BAIKWeb}}[X] \cap \mu_{\text{BAIKAndroid}}[Y] \\
\cap \mu_{\text{BAIKSoftskill}}[Z] = \min(\mu_{\text{BAIKWeb}}[70.2], \mu_{\text{BAIKAndroid}}[85.7], \mu_{\text{BAIKSoftskill}}[90.8]) = 0.2
\]

According to membership function set of TIDAK REKOMENDASI, then

\[
\alpha_{43} = \mu_{\text{BAIKWeb}}[X] \cap \mu_{\text{BAIKAndroid}}[Y] \\
\cap \mu_{\text{SANGATBAIKSoftskill}}[Z] = \min(\mu_{\text{BAIKWeb}}[70.2], \mu_{\text{BAIKAndroid}}[85.7], \mu_{\text{SANGATBAIKSoftskill}}[90.8]) = 0.2
\]
[R47] JIKA NilaiWeb BAIK & NilaiAndroid SANGAT BAIK & NilaiSoftSkill BAIK MAKA Hasil Rekomendasi
\[
\alpha_{47} = \mu_{BAIK\text{Web}}[X] \cap \mu_{SANGAT\text{BAIKAndroid}}[Y] \cap \mu_{BAIK\text{Soft\ skill}}[Z]
\]
\[
= \min(\mu_{BAIK\text{Web}}[70.2], \mu_{SANGAT\text{BAIKAndroid}}[85.7], \mu_{BAIK\text{Soft\ skill}}[90.8])
\]
\[
= \min([0.2], [0.7], [0.2]) = 0.2
\]
According to membership function set of REKOMENDASI, then
\[
Z_{47} - Z_{\text{min}} = \alpha_{47}
\]
\[
Z_{47} = a_{47}(Z_{\text{max}} - Z_{\text{min}}) + Z_{\text{min}}
\]
\[
Z_{47} = 0.2(6 - 4) + 4
\]
\[
Z_{47} = 4.4
\]
Tsukamoto method uses Center of Average to determine crisp output:
\[
z = \frac{x_{27} + x_{28} + \ldots + x_{31} + x_{32} + x_{33} + x_{34} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} + x_{57} + x_{58} + x_{59} + x_{60} + x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{69} + x_{70} + x_{71} + x_{72} + x_{73} + x_{74} + x_{75} + x_{76} + x_{77} + x_{78} + x_{79} + x_{80} + x_{81} + x_{82} + x_{83} + x_{84} + x_{85} + x_{86} + x_{87} + x_{88} + x_{89} + x_{90} + x_{91} + x_{92} + x_{93} + x_{94} + x_{95} + x_{96} + x_{97} + x_{98} + x_{99} + x_{100}}{100}
\]
\[
z = 0.2 \times 0.3 + 0.7 \times 0.2 + 0.2 \times 0.2 + 0.2 \times 0.2 = 0.26
\]
\[
z = 0.26
\]
The result obtained is 4.82 with Tsukamoto Method. The defuzzification value generated by the system is pretty close to what was obtained from manual calculation.

To determine the level of accuracy, a comparison between the results from system and experts is done using the Spearman correlation test. The following is a table that shows the results of system and expert comparisons.

<table>
<thead>
<tr>
<th>Data</th>
<th>Z System</th>
<th>Z Expert</th>
<th>System Rank</th>
<th>Expert Rank</th>
<th>di</th>
<th>(d^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>7</td>
<td>-3</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>4.81</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>5.28</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
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<td>9</td>
<td>7</td>
<td>-2</td>
<td>4</td>
</tr>
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<td>7</td>
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<td>0</td>
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<td>2</td>
<td>-3</td>
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<td>2</td>
<td>-2</td>
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<td>5</td>
<td>6</td>
<td>2</td>
<td>-4</td>
<td>16</td>
</tr>
</tbody>
</table>

\[\Sigma d^2 = 43\]

The value of rs calculated with the Spearman Correlation formula:
\[rs = 1 - \frac{6\Sigma d^2}{n(n^2 - 1)}\]
\[rs = 1 - \frac{6 \times 43}{10(100 - 1)}\]
\[rs = 1 - \frac{258}{990}\]
\[rs = 1 - 0.260606061\]
\[rs = 0.739394\]

The result is then interpreted using The Spearman Correlation Interpretation Table.

<table>
<thead>
<tr>
<th>Nilai</th>
<th>Makna</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,00-0,19</td>
<td>Sangat rendah/sangat lemah</td>
</tr>
<tr>
<td>0,20-0,39</td>
<td>Rendah/lemah</td>
</tr>
<tr>
<td>0,40-0,59</td>
<td>Sedang</td>
</tr>
<tr>
<td>0,60-0,79</td>
<td>Tinggi/kuat</td>
</tr>
<tr>
<td>0,80-1,00</td>
<td>Sangat tinggi/sangat kuat</td>
</tr>
</tbody>
</table>

In accordance with the interpretation table, the value of rs (0.739394) belongs to the high / strong category. So by using the Spearman correlation test, the results of the accuracy of the expert ranking and the system number are 0.739394.

V. CONCLUSION

From the discussion and implementation of the system described earlier, the following conclusions are obtained:
1) Fuzzy Tsukamoto Logic can be used to help industry, in this case Visionet, as a consideration for recruiting prospective employees from 12th grade students of Telkom Telkom
2) The web-based application developed accepts input report cards for Web Programming and Mobile
Programming subjects, and the value of soft skills, according to the qualifications required by Visionet.

3) There are two types of output from this application, namely TIDAK REKOMENDASI and REKOMENDASI. This result is a material consideration for Visionet to accept or reject employee candidates.

4) The Spearman Correlation test used to compare the results from system and experts shows a high level of accuracy, with rs value 0.739394.

REFERENCES
