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COMPETITIVE CANDIDATE DETERMINATION SYSTEM FOR STUDENTS WITH COMPARATIVE ANALYSIS OF WEIGHTED PRODUCT (WP) ALGORITHM AND TECHNIQUE FOR ORDER BY SIMILARITY (TOPSIS)

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ABSTRACT

The competition will be one of the indicators that make a university at its best. The more students who take part in competitions will certainly have a positive impact on the university itself. The achievements and victories achieved by students are interpreted as a form of university success in educating students both in terms of theory and practical skills. The track record of student achievement will always make the accreditation of a university even better because it presents graduates who are competent in their fields. The selection process will be something that needs to be done considering that many criteria must be met by the student before being declared ready to compete for both in theory and practice so that a decision support system is needed that can provide recommendations for student choices. This research will discuss the process of determining the candidate for the race by analyzing two methods, namely the Weighted Product (WP) method and the Technique for Order by Similarity to Ideal Solution (TOPSIS) method in which the two methods will analyze what percentage of the resulting level of accuracy is the output on the system is the same as the manual calculation. Furthermore, the writer will also analyze how far the difference is between the two methods using Euclidean Distance and the weighting of the criteria using a Likert Scale. The results of the comparative analysis show that the WP method is the best method with a value of 0.14281 because it has a value close to zero compared to the TOPSIS method with a value of 0.51238 even though both produce the same level of accuracy reaching 100%, but the WP method is still more optimal in terms of program execution speed (Micro time) with an average time of 0.0781 seconds while the TOPSIS method takes an average of 0.2234 seconds

Keywords: *Decision Support System, Candidate Participants, Likert Scale, Weighted Product, Technique for Order by Similarity to Ideal Solution, Euclidean Distance*

1. INTRODUCTION

The best way to win the competition is to take advantage of technology. Building information technology-based systems in a precise, structured and simple manner is very important for the competitive advantage of modern companies and organizations. In the world of higher education, higher education is an effective place to transform knowledge and also a means of student education. Every college wants students who can implement their academic potential to reach achievements.

Faculty of computer science and information technology the Universitas Sumatera Utara always sends students every year to take part in competitions both in the field of technology and other competitive fields, but there is rarely a selection process for students who want to take part in competitions and there are no suitable parameters for objective assessment. Students sometimes register themselves if there is a competition without a selection process in it so there is a lack of preparation to compete.

One reason for choosing this topic was because the selection process was limited to filing and tended to take a long time to announce the participants who passed because it was still done manually, such as announcing it through paper

affixed to the campus wall magazine. Each campus in selecting students for the competition should be done based on the criteria for academic aspects. For that, it is necessary to make web-based DSS software in this context.

Web technology has been increasing and improving in the last few years and it becomes one of the major improvements in the Information Technology (IT) world [1]. PHP is a "strong" language used in developing dynamic and interactive web applications. This is because of one of the defining features that PHP offers developers, namely the ease to connect and manipulate databases due to the built-in Database function provided by PHP itself. Apart from that, PHP is a powerful language because it offers several key advantages, such as performance, scalability, open-source, and portability [2]. The micro time function is one of the PHP functions used to restore the current Unix timestamp with units of microseconds [3].

Weighted Product (WP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) are methods widely used to assist in making decisions. For instance, TOPSIS is used to rank attributes or criteria, rank suppliers, and evaluate optimal generation. Meanwhile, WP is used to calculate the attribute weights evaluate optimal generation, and evaluate the optimum generation of a particular [4].

Euclidean distance technique is an identification and classification technique based on Euclidean metrics that are related to trial and error, where the distance between points is related to the length of the line between them. The Euclidean distance is calculated using the Pythagorean formula [5].

The Likert scale is a measurement scale developed by Likert in 1932. In his discussion, he provides interpretation results in the form of an "opinion survey" [6]. This scale has four or more question items that are combined to form a score/value that represents individual traits, for example, knowledge, attitudes, and behavior. In the data analysis process, a composite score, usually the sum or average, of all the questions can be used. Five-point Likert scale with a weighted scoring range of 0–100 and which is a reliable measure of usability.

In the comparative analysis, the writer will compare it with Euclidean Distance to see how far the difference is between the two algorithms used and comparing the execution speed of the two methods using the Microtime function in PHP programming.

2. RELEVANT RESEARCH

In previous research conducted by Agus Setyawan, Florentina Yuni Arini, and Isa Akhlis [7] in 2017 entitled "Comparative Analysis of Simple Additive Weighting Methods and Weighted Product Methods Against the New Employee Recruitment Decision Support System (DSS) at PT. Warta Media Nusantara ", the test results show that the average execution time of the SAW method is 0.4106s while the execution time of the WP method is 0.92s. Average execution time is obtained by dividing the total execution time by the number of trials. From the average implementation time, it is known that the SAW method is faster in calculating the New Employee Recruitment Decision Support System than the WP method. This is because the SAW method uses a simpler calculation method than the WP method so that the required process is less. This is similar to research [8] which explains that the simplicity of the calculation makes the SAW method the fastest method in the calculation process compared to other MADM methods.

Research conducted by S Oktaviana, A Rozzaaq, and D A Rosatama in 2018 entitled "Comparative analysis using the WP and TOPSIS methods to find the best mountains for hiking", the test results show that the WP method to be the best order with 100%. For the Accuracy calculation value, the TOPSIS method becomes the second-best method with a percentage of 98.82% [9].

Research conducted by Suhartono, Didit, and Tika Sari in 2019 with the title "Comparison of Weighted Product Methods and TOPSIS in Determining Recipients of the Hopeful Family Program" resulted in an accuracy rate of 89.48% where the TOPSIS method was more suitable in case study selection, eligibility for PKH recipients [10].

3. PROCESS ANALYSIS

The system built is a decision support system in determining candidates for the competition. In simple terms, users can see various kinds of competitions (competitions in the field of IT, arts, etc.) along with the quota of participants, then they choose the competition according to their wishes, then the system will calculate the weighting using the Weighted Product (WP) method followed by the process of calculating the Technique for Order method. by Similarity to Ideal Solution (TOPSIS) to analyze the comparison of output and program

execution speed. After users choose the competition they want, users can see the results of the announcement on their respective accounts after passing a series of selections, be it a theory test, a practical test, and uploading supporting files to the system. The following are the processes that the system will perform:

3.1 Determination of competition

The system built will be able to accommodate various types of competitions and accommodate many criteria and student registrants with a predetermined participant quota

3.2 Determination of criteria

The system built will be able to help provide recommendations for decision-making based on three main criteria, namely theoretical tests, practical tests, and supporting files.

Table 1: Type and Example of Criteria.

No	Type of Criteria	Example of Criteria
1	Theory test	Written programming comprehension test
2	Practice test	Practice test presenting the work
3	Support Files	Uploading of a similar competition certificate

3.3 Determination of weight

The weights of the criteria for determining candidates for competition in this system use the level of importance in the form of a Likert scale in table 2.

Table 2: Weight Value Criteria Based on the Likert Scale.

Name of Value	Value
Very not important	1
Not important	2
Quite important	3
Important	4
Very important	5

3.4 Determination of parameter value

Some of the criteria used in this system are qualitative data, so to facilitate the calculation process it is necessary to classify the data criteria. However, because this case study system accommodates many fields of competition, to make testing and analysis easier, it is enough to do it in one race. One of the fields of competition that will be tested in this research is the IT field with the "Web Development Competition" which is taken from the standardized weight of the web programmer at PT. Cipta Harapan Samudera. The parameter value of each criterion can be seen in table 3

Table 3: Data Parameter Value Criteria for Web Development Competition

No	Criteria	Parameter	Type	Likert Scale
C_1	Understand the concepts of HTML and CSS	Important	Theory	4
C_2	Mastering the programming language PHP, JavaScript, JQuery, and Ajax	Very important	Theory	5
C_3	Understand the use of the PHP framework	Quite important	Theory	3
C_4	Have good logic, analysis, and problem-solving	Important	Theory	4
C_5	Understand design software	Quite important	Theory	3
C_6	Mastering Object-Oriented Programming	Very important	Theory	5
C_7	Understand the concept of web hosting and domains	Quite important	Practice	3
C_8	Mastering MySQL database management	Very important	Theory	5
C_9	Understand the use of version control (GIT)	Important	Theory	4
C_{10}	Attach KHS about the value of web programming	Quite important	Support files	3
C_{11}	Award or certificate for those who have participated in similar competitions	Quite important	Support files	3
C_{12}	Able to	Important	Practice	4

	communicate and present			

3.5 Accommodate attached files

If the criteria used to require an attachment file in the assessment, the system will receive an uploaded file from the enrolling student

3.6 Calculation of alternatives according to the competition criteria

After the admin presses the calculate button, the system will calculate alternative recommendations for candidate participants according to the value per criteria entered by the admin including an assessment of the upload of the supporting files and a series of theoretical/practical tests.

3.7 Displays candidate recommendations

The system will normalize the weight and display the name of the participant's recommendation in a tablet form, complete with ranking, method execution speed, announcement button, and analysis button.

3.8 Announcing the results to the student account

If the admin presses the "Announce" button, the system will continue the selection results which can automatically be seen on the account of each student registrant, precisely on the announcement menu.

4. MANUAL TESTING

In the manual calculation testing between the two methods, namely, WP and TOPSIS will be carried out to 7 student registrants who are given the same weight and value per criteria. The following are the scores per criteria given to the 7 alternatives

Alternative	Criteria											
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
Haristia Kumala	70	70	60	80	70	80	50	80	60	80	70	80
Arif Iskandar	80	80	70	80	90	70	60	70	70	70	80	90
Boby Kurniawan	60	70	60	70	90	60	80	70	60	80	80	70
Muhibuddin	80	90	70	80	80	90	70	70	70	80	60	90
Rudianto Sihombing	70	90	70	80	50	70	70	80	80	90	50	70
Hadhe Panji	60	50	70	70	80	70	60	80	60	80	70	90
Ricky Julpiter	80	60	80	70	60	70	80	70	90	70	70	80

Figure 1: Alternative value per criteria.

4.1 Weighted Product method

Normalization is carried out to compare the parameter values between the criteria weight values with one another, so that the total criteria weight $\sum wj = 1$

$$Wj = \frac{wj}{\Sigma wj}$$

Become:

$$W_1 = \frac{4}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{4}{46} = 0.087$$
$$W_2 = \frac{5}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{5}{46} = 0.1087$$
$$W_3 = \frac{3}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{3}{46} = 0.0652$$
$$W_4 = \frac{4}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{4}{46} = 0.087$$
$$W_5 = \frac{3}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{3}{46} = 0.0652$$
$$W_6 = \frac{5}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{5}{46} = 0.1087$$
$$W_7 = \frac{3}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{3}{46} = 0.0652$$
$$W_8 = \frac{5}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{5}{46} = 0.1087$$
$$W_9 = \frac{4}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{4}{46} = 0.087$$
$$W_{10} = \frac{3}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{3}{46} = 0.0652$$
$$W_{11} = \frac{3}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{3}{46} = 0.0652$$
$$W_{12} = \frac{4}{4+5+3+4+3+5+3+5+4+3+3+4} = \frac{4}{46} = 0.08$$

So that the total weight after normalization becomes:

$\sum wj = w1 + w2 + w3 + w4 + w5 + w6 + w7 + w8 + w9 + w10 + w11 + w12 = 1$

That is :

$\sum wj =$ 0.087 + 0.1087 + 0.0652 + 0.087 + 0.0652 + 0.1087 + 0.0652 + 0.1087 + 0.087 + 0.0652 + 0.0652 + 0.087 = 1

Table 4: Weight After Normalization

Criteria	Initial Weight	New Weight
Understand the concepts of HTML and CSS	4	0.087
Mastering the programming language PHP, Javascript, JQuery, and Ajax	5	0.1087
Understand the use of the PHP framework	3	0.0652
Have good logic, analysis, and problem-solving	4	0.087
Understand design software	3	0.0652
Mastering Object-	5	0.1087

Oriented Programming		
Understand the concept of web hosting and domains	3	0.0652
Mastering MySQL database management	5	0.1087
Understand the use of version control (GIT)	4	0.087
Attach KHS about the value of web programming	3	0.0652
Award or certificate for those who have participated in similar competitions	3	0.0652
Able to communicate and present works well	4	0.087

Determine the vector value S
The vector value S, which can be calculated using the following formula:

$$(S_i = \Pi_{j=1}^{n} (X_j^*)^{wj})$$

Raise and multiply the value of each alternative per criteria by the previously normalized weight.

$$S_1 = (X_{11}^{w1})(X_{12}^{w2})(X_{13}^{w3})(X_{14}^{w4})(X_{15}^{w5})(X_{16}^{w6})(X_{17}^{w7})(X_{18}^{w8})(X_{19}^{w9})(X_{110}^{w10})(X_{111}^{w11})(X_{112}^{w12})$$

Becomes:

$$S_1 = (70^{0.087})(70^{0.1087})(60^{0.0652})(80^{0.087})(70^{0.0652})(80^{0.1087})(50^{0.0652})(80^{0.1087})(60^{0.087})(80^{0.0652})(70^{0.0652})(80^{0.087}) = 71.128692173385$$

$$S_2 = (80^{0.087})(80^{0.1087})(70^{0.0652})(80^{0.087})(90^{0.0652})(70^{0.1087})(60^{0.0652})(70^{0.1087})(70^{0.087})(70^{0.0652})(80^{0.0652})(90^{0.087}) = 75.457915838002$$

$$S_3 = (60^{0.087})(70^{0.1087})(60^{0.0652})(70^{0.087})(90^{0.0652})(60^{0.1087})(80^{0.0652})(70^{0.1087})(60^{0.087})(80^{0.0652})(80^{0.0652})(70^{0.087}) = 69.255011534828$$

$$S_4 = (80^{0.087})(90^{0.1087})(70^{0.0652})(80^{0.087})(80^{0.0652})(90^{0.1087})(70^{0.0652})(70^{0.1087})(70^{0.087})(80^{0.0652})(60^{0.0652})(90^{0.087}) = 77.946019945666$$

$$S_5 = (70^{0.087})(90^{0.1087})(70^{0.0652})(80^{0.087})(50^{0.0652})(70^{0.1087})(70^{0.0652})(80^{0.1087})(80^{0.087})(90^{0.0652})(50^{0.0652})(70^{0.087}) = 72.711315265209$$

$$S_6 = (60^{0.087})(50^{0.1087})(70^{0.0652})(70^{0.087})(80^{0.0652})(70^{0.1087})(60^{0.0652})(80^{0.1087})(60^{0.087})(80^{0.0652})(70^{0.0652})(90^{0.087}) = 68.666704292828$$

$$S_7 = (80^{0.087})(60^{0.1087})(80^{0.0652})(70^{0.087})(60^{0.0652})(70^{0.1087})(80^{0.0652})(70^{0.1087})(90^{0.087})(70^{0.0652})(70^{0.0652})(80^{0.087}) = 72.575296804507$$

Determine the vector value V
The vector value V is to be used for ranking.
The formula is as follows:

$$V_i = \frac{S_i}{\Sigma_{j=1}^{m} S_i}$$

Where the vector value (V) is a choice that will be used in determining the ranking of each vector S with the total vector value S
Simply put like:

$$V_1 = \frac{S_1}{S_1 + S_2 + S_3 + S_4 + S_5 + S_6 + S_7}$$

Following are the results of calculating preferences (V_i) :

$$V_1 = \frac{71.1287}{71.1287+75.4579+\ .255+7\ .946+72.7113+68.6667+72.5753} = \frac{71.1287}{507.7409} = 0.140089$$

$$V_2 = \frac{75.4579}{71.1287+\ .4579+69.255+\ .946+72.7113+68.6667+72.5753} = \frac{75.4579}{507.7409} = 0.148615$$

$$V_3 = \frac{69.255}{71.1287+75.4579+69.255+7\ .946+72.7113+68.6667+72.5753} = \frac{69.255}{507.7409} = 0.136398$$

$$V_4 = \frac{77.946}{71.1287+75.4579+\ .255+77.946+72.7113+68.6667+72.5753} = \frac{77.946}{507.7409} = 0.153515$$

$$V_5 = \frac{72.7113}{71.1287+75.4579+69.255+77.946+72.7113+68.6667+72.5753} = \frac{72.7113}{507.7409} = 0.143206$$

$$V_6 = \frac{68.6667}{71.1287+75.4579+69.255+77.946+\ .7113+68.6667+72.5753} = \frac{68.6667}{507.7409} = 0.13524$$

$$V_7 = \frac{72.5753}{71.1287+75.4579+69.25\ .946+\ .7113+68.6667+72.5753} = \frac{72.5753}{507.7409} = 0.142938$$

Finding the highest value from the calculation of the vector V

Rank	Alternative	Student Name	Vektor S	Vektor V
1	A_4	Muhibuddin	77.9460	0.153515
2	A_2	Arif Iskandar	75.4579	0.148615
3	A_5	Rudianto Sihombing	72.7113	0.143206
4	A_7	Ricky Julpiter	72.5753	0.142938
5	A_5	Haristia Kumala	71.1287	0.140089
6	A_3	Boby Kurniawan	69.2550	0.136398
7	A_6	Hadhe Panji	68.6667	0.13524

Figure 2: Result of weighted product decisions.

4.2 TOPSIS method

Normalization of the matrix. Matrix normalization is done by squaring each element of the matrix in figure 1, for example, cell A_1-C_1 squared to be 70 x 70 = 4900 the results are as follows:

Alternative	Criteria											
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
Haristia Kumala	4900	4900	3600	6400	4900	6400	2500	6400	3600	6400	4900	6400
Arif Iskandar	6400	6400	4900	6400	8100	4900	3600	4900	4900	4900	6400	8100
Boby Kurniawan	3600	4900	3600	4900	8100	3600	6400	4900	3600	6400	6400	4900
Muhibuddin	6400	8100	4900	6400	6400	8100	4900	4900	4900	6400	3600	8100
Rudianto Sihombing	4900	8100	4900	6400	2500	4900	4900	6400	6400	8100	2500	4900
Hadhe Panji	3600	2500	4900	4900	6400	4900	3600	6400	3600	6400	4900	8100
Ricky Julpiter	6400	3600	6400	4900	3600	4900	6400	4900	8100	4900	4900	6400
Total	36200	38500	33200	40300	40000	37700	32300	38800	35100	43500	33600	46900

Figure 3: Value squared.

The total row (in blue) is obtained by adding up each row on each criterion. For example the total column C_1 is obtained from 4900 + 6400 + 3600 + 6400 + 4900 + 3600 + 6400 = 36200. After getting the total, then normalizing it by dividing each element of the matrix value figure 1 by the root (sqrt) of the corresponding total rows, the result is as follows :

Alternative	Criteria											
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
Haristia Kumala	0.368	0.357	0.329	0.399	0.35	0.412	0.278	0.406	0.32	0.384	0.382	0.369
Arif Iskandar	0.42	0.408	0.384	0.399	0.45	0.361	0.334	0.355	0.374	0.336	0.436	0.416
Boby Kurniawan	0.315	0.357	0.329	0.349	0.45	0.309	0.445	0.355	0.32	0.384	0.436	0.323
Muhibuddin	0.42	0.459	0.384	0.399	0.4	0.464	0.389	0.355	0.374	0.384	0.327	0.416
Rudianto Sihombing	0.368	0.459	0.384	0.399	0.25	0.361	0.389	0.406	0.427	0.432	0.273	0.323
Hadhe Panji	0.315	0.255	0.384	0.349	0.4	0.361	0.334	0.406	0.32	0.384	0.382	0.416
Ricky Julpiter	0.42	0.306	0.439	0.349	0.3	0.361	0.445	0.355	0.48	0.336	0.382	0.369

Figure 4: Normalized matrix.

For example for row A_1 obtained from:

$$A_1\text{-}C_1 = \frac{70}{\sqrt{36200}} = 0.368$$

$$A_1\text{-}C_2 = \frac{70}{\sqrt{38500}} = 0.357$$
$$A_1\text{-}C_3 = \frac{60}{\sqrt{33200}} = 0.329$$
$$A_1\text{-}C_4 = \frac{80}{\sqrt{40300}} = 0.399$$
$$A_1\text{-}C_5 = \frac{70}{\sqrt{40000}} = 0.35$$
$$A_1\text{-}C_6 = \frac{80}{\sqrt{37700}} = 0.412$$
$$A_1\text{-}C_7 = \frac{50}{\sqrt{32300}} = 0.278$$
$$A_1\text{-}C_8 = \frac{80}{\sqrt{38800}} = 0.406$$
$$A_1\text{-}C_9 = \frac{60}{\sqrt{35100}} = 0.32$$
$$A_1\text{-}C_{10} = \frac{80}{\sqrt{43500}} = 0.384$$
$$A_1\text{-}C_{11} = \frac{70}{\sqrt{33600}} = 0.382$$
$$A_1\text{-}C_{12} = \frac{80}{\sqrt{46900}} = 0.369$$

Normalization of weights.
Weighted normalization is obtained from the multiplication of the matrix in figure 4 (normalized matrix) with figure 3 (weight criteria), the results are as follows:

Alternatif	Kriteria											
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
Haristia Kumala	1.472	1.784	0.988	1.594	1.05	2.06	0.835	2.031	1.281	1.151	1.146	1.478
Arif Iskandar	1.682	2.039	1.153	1.594	1.35	1.803	1.002	1.777	1.495	1.007	1.309	1.662
Boby Kurniawan	1.261	1.784	0.988	1.395	1.35	1.545	1.335	1.777	1.281	1.151	1.309	1.293
Muhibuddin	1.682	2.293	1.153	1.594	1.2	2.318	1.168	1.777	1.495	1.151	0.982	1.662
Rudianto Sihombing	1.472	2.293	1.153	1.594	0.75	1.803	1.168	2.031	1.708	1.295	0.818	1.293
Hadhe Panji	1.261	1.274	1.153	1.395	1.2	1.803	1.002	2.031	1.281	1.151	1.146	1.662
Ricky Julpiter	1.682	1.529	1.317	1.395	0.9	1.803	1.335	1.777	1.922	1.007	1.146	1.478

Figure 5: Normalized weight.

For example for row A_1 obtained from:

A_1-C_1 = $0.368 * 4 = 1.472$
A_1-C_2 = $0.357 * 5 = 1.784$
A_1-C_3 = $0.329 * 3 = 0.988$
A_1-C_4 = $0.399 * 4 = 1.594$
A_1-C_5 = $0.35 * 3 = 1.05$
A_1-C_6 = $0.412 * 5 = 2.06$
A_1-C_7 = $0.278 * 3 = 0.835$
A_1-C_8 = $0.406 * 5 = 2.031$
A_1-C_9 = $0.32 * 4 = 1.281$
A_1-C_{10} = $0.384 * 3 = 1.151$
A_1-C_{11} = $0.382 * 3 = 1.146$
A_1-C_{12} = $0.369 * 4 = 1.478$

Positive/negative ideal matrix.

The ideal solution matrix is obtained based on weighted normalization and the criteria attribute (cost or benefit). Since all criteria are of benefit, the ideal positive solution is the maximum value of weighted normalization. While the negative ideal solution is the minimum value of weighted normalization.

Type	Positive / Negative ideal matrix.											
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
Positive	1.682	2.293	1.317	1.594	1.35	2.318	1.335	2.031	1.922	1.295	1.309	1.662
Negative	1.261	1.274	0.988	1.395	0.75	1.545	0.835	1.777	1.281	1.007	0.818	1.293

Figure 6: Positive/negative ideal matrix.

Positive/negative ideal solution distance

To find the total nd ranking, you must find the distance between the positive and negative ideal solutions obtained from the processing of figure 5 (weight normalization) and figure 6 (positive/negative ideal matrix). The trick is to square the difference between each element of the weighted normalized matrix and the ideal solution matrix, and then add up each alternative, after which it is rooted. For example, to find the positive ideal distance A_1as follows:

A_1 Positive:

$$\sqrt{\begin{matrix}(1.472-1.682)^2+(1.784-2.293)^2+(0.988-1.317)^2\\+(1.594-1.594)^2+(1.05-1.35)^2+(2.06-2.318)^2\\+(0.835-1.335)^2+(2.031-2.031)^2+(1.281-1.922)^2\\+(1.151-1.295)^2+(1.146-1.309)^2+(1.478-1.662)^2\end{matrix}} = 1.145$$

A_1 negative :

$$\sqrt{\begin{matrix}(1.472-1.261)^2+(1.784-1.274)^2+(0.988-0.988)^2\\+(1.594-1.395)^2+(1.05-0.75)^2+(2.06-1.545)^2\\+(0.835-0.835)^2+(2.031-1.777)^2+(1.281-1.281)^2\\+(1.151-1.007)^2+(1.146-0.818)^2+(1.478-1.293)^2\end{matrix}} = 0.963$$

Preference is obtained from the ideal negative divider divided by the sum of the positive and negative ideal.

$$V_i = \frac{D_i}{D_i^- + D_i^+}$$

The following is the result of the preference calculation (V_i) :

$$V_1 = \frac{0.963}{1.145 + 0.963} = 0.4568$$
$$V_2 = \frac{1.306}{0.893 + 1.306} = 0.5939$$
$$V_3 = \frac{1.064}{1.347 + 1.064} = 0.4413$$
$$V_4 = \frac{1.557}{0.672 + 1.557} = 0.6985$$
$$V_5 = \frac{1.287}{1.071 + 1.287} = 0.5458$$
$$V_6 = \frac{0.808}{1.462 + 0.808} = 0.3559$$
$$V_7 = \frac{1.115}{1.14 + 1.115} = 0.4945$$

The best alternative is the one with the greatest preference. So that the ranking is as follows

Rank	Alternative	Student Name	Preference (V_i)
1	A_4	Muhibuddin	0.6985
2	A_2	Arif Iskandar	0.5939
3	A_5	Rudianto Sihombing	0.5458
4	A_7	Ricky Julpiter	0.4945
5	A_5	Haristia Kumala	0.4568
6	A_3	Boby Kurniawan	0.4413
7	A_6	Hadhe Panji Kastowo	0.3559

Figure 7: Result of TOPSIS decisions.

5. SYSTEM TESTING

Following are the results of the implementation and testing of data into the system by entering the same test data to meet the suitability of the data

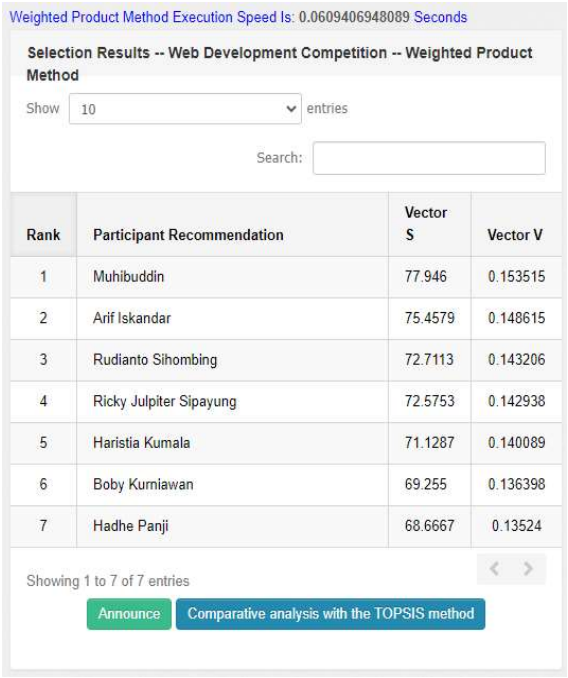


Figure 6: Result of System Recommendation (WP).

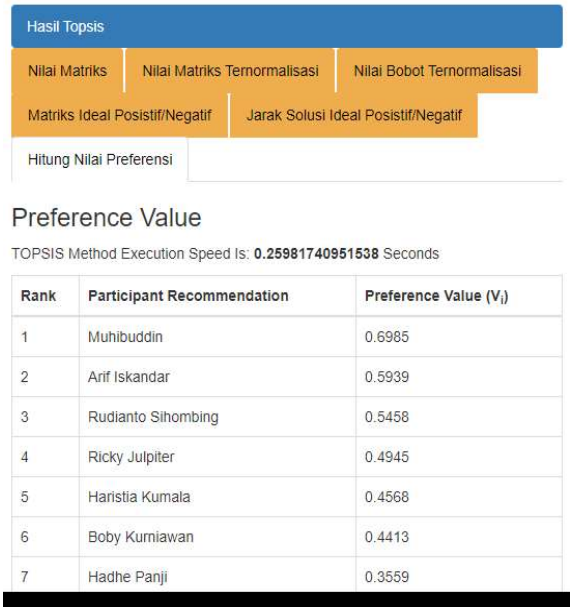


Figure 7: Result of System Recommendation (TOPSIS).

6. COMPARATIVE ANALYSIS

Based on manual testing and system testing, a comparative analysis will be carried out at the following points

1. Comparison of Euclidean Distance between the two methods
2. Comparison of calculation accuracy between systems with manual calculations
3. Comparison of program execution speed between the two methods

6.1 Euclidean Distance result

The comparative analysis uses the Euclidean Distance method to see which method is the most optimal in terms of the ranking priority averages of the two methods.

Table 5: Euclidean distance comparison analysis.

Enrolling Students	$WP_{(vector\ v)}$	$TOPSIS_{(preference)}$
Muhibuddin	0.1535	0.6985
Arif Iskandar	0.1486	0.5939
Rudianto S	0.1432	0.5458
Ricky Julpiter	0.1429	0.4945
Haristia K	0.1400	0.4568
Boby K	0.1363	0.4413
Hadhe Panji	0.1352	0.3559
Average	**0,14281**	**0,51238**

Based on the average results of the two methods used, it can be said that the Weighted Product method is the best because it has a value close to zero.

6.2 Comparison of calculation accuracy levels

In addition to the comparative analysis using Euclidean Distance, a comparative analysis of calculation accuracy is also used which is described as follows

Table 6: Comparison result of calculation accuracy.

Recommended Alternative	WP	TOPSIS
A_4	A_4	A_4
A_2	A_2	A_2
A_5	A_5	A_5
A_7	A_7	A_7
A_1	A_1	A_1
A_3	A_3	A_3
A_6	A_6	A_6

Testing of the WP method and the TOPSIS method is carried out to determine the recommendations of candidates for competition by using the following formula:

$$\text{Accuracy} = X / N \times 100\%$$

Where:
N = number of data tested
X = number of correct data

TOPSIS method accuracy accuracy
= X / N x 100%
= 7/7 x 100% = 100%

Weighted Product (WP) method accuracy
= X / N x 100%
= 7/7 x 100% = 100%

6.3 Comparison of program execution speed

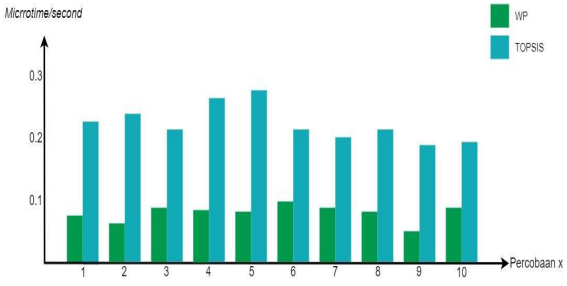
In addition to the comparative analysis of calculation accuracy, a comparative analysis of the execution speed of the PHP file was also carried out. The following table shows the results of the experiment execution time in the PHP program listing part of the calculation method of 10 trials in micro time/second

Table 7: Type and Example of Criteria.

Trial	Speed *(Micro time/Second)*	
	WP	TOPSIS
1	0.074 second	0.236 second
2	0.068 second	0.242 second
3	0.049 second	0.220 second
4	0.089 second	0.255 second
5	0.088 second	0.259 second
6	0.097 second	0.226 second
7	0.093 second	0.198 second
Average	**0.0781 second**	**0.2234 second**

As seen in Table 7 above, the comparative analysis in terms of time shows that the weighted product is the best method because it has a value close to zero compared to the TOPSIS method.

Figure 8: Execution speed comparison chart.



6.4 Difference from prior work

The difference between the results of the system and relevant research can be seen in the following table:

Table 7. Difference from prior work

No.	Prior work	Our Research
1.	Agus Setyawan, Florentina Yuni Arini, and Isa Akhlis in 2017 entitled "Comparative Analysis of Simple Additive Weighting Methods and Weighted Product Methods Against the New Employee Recruitment Decision Support System (DSS) at PT. Warta Media Nusantara ", the test results show that the average execution time of the SAW method is	Comparative analysis using Euclidean Distance shows that the WP method is the best in determining candidates for competition participants compared to the TOPSIS method. The total average time required for the WP method to execute the program is 0.0781 seconds while the total time required for the TOPSIS method to execute the program is

	0.4106s while the execution time of the WP method is 0.92s.	0.2234 seconds. The level of accuracy of the system calculation with manual calculations on the WP method and the TOPSIS method in determining the candidate for competition reaches 100%
2.	S Oktaviana, A Rozzaaq, and D A Rosatama in 2018 entitled "Comparative analysis using the WP and TOPSIS methods to find the best mountains for hiking", the test results show that the WP method to be the best order with 100%. For the Accuracy calculation value, the TOPSIS method becomes the second-best method with a percentage of 98.82%	
3.	Suhartono, Didit, and Tika Sari in 2019 with the title "Comparison of Weighted Product Methods and TOPSIS in Determining Recipients of the Hopeful Family Program" resulted in an accuracy rate of 89.48% where the TOPSIS method was more suitable in case study selection, eligibility for PKH recipients.	

7. CONCLUSION

Based on the results of the analysis and implementation results of the system for determining candidates for competition participants using the comparative analysis of the Weighted Product (WP) method and the Technique for Order by Similarity to Ideal Solution (TOPSIS) method so that it can be concluded that:

1. Comparative analysis using Euclidean Distance shows that the WP method is the best in determining candidates for competition participants compared to the TOPSIS method.
2. The total average time required for the WP method to execute the program is 0.0781 seconds while the total time required for the TOPSIS method to execute the program is 0.2234 seconds.
3. The level of accuracy of the system calculation with manual calculations on the WP method and the TOPSIS method in determining the candidate for competition reaches 100%.
4. This system can assist the campus in determining candidate recommendations according to the competition criteria.
5. The ranking results produced by the WP method and the TOPSIS method have the same ranking order.
6. This system is only a tool for a decision support system for determining candidates for competition, the final decision remains in the hands of the decision-maker

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