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Implementation of Simple Additive Weighting (SAW) Method and Profile Matching for Employee Selection

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Abstract: Employees are an important element in a company that determines the progress of a company. With good quality employees in a company, it is easier to achieve desired goals of a company. Conventional (manual) recruitment method is vulnerable to non-technical factors such as frequent duplicate data or invalid data. In such condition, a Decision Support System (DSS) will be helpful in making decision process valid and reliable. In this paper, a Simple Addictive Weighting (SAW) method and Profile Matching were proposed to solve employee selection problem. This research was conducted at UPT Career Development and Entrepreneurship Universitas Brawijaya Malang, using data collected from written test selection in 2019. The effectiveness of both methods is analyzed by means of confusion matrix. SAW method give Accuracy rate of 94.7%, Precision rate of 87.5%, Recall rate of 91.3% and F-measure rate of 89.4%. On the other hand, Profile Matching method obtained the Accuracy rate of 90.4.7%, Precision rate of 81.4%, Recall rate of 81.4% and F-measure rate of 81.4%. From these results, it can be concluded that both methods have a high accuracy value accompanied by a high precision value when used for the selection process. This system can also reduce the bias of the same data very well, as can be seen from the high Recall and F-measure rates.

Keywords: decision support system, employee selection, simple additive weighting method, profile matching, confusion matrix.

1. INTRODUCTION

Employees are an important element in a company in determining the progress of a company. With good quality employees in a company, it makes easier for the company to achieve the goals of a company. Selection of effective applicants or employee candidates to assess technical abilities, education, work experience as well as psychological assessments of applicants, psychological tests will generally show a person's emotional state, in addition, a technical ability test will show a person's competence to work. However, someone with good technical skills, if not supported by sufficient emotional intelligence, will experience difficulties in his work environment [1].

At present, the method used in the employee selection process at the Career Center of Universitas Brawijaya Malang (UPKK) is still using conventional methods, by using human labor in the process of determining whether or not applicants will qualify. This method is vulnerable to non-technical factors such as frequent duplicate data or invalid data. To solve this problem, the right Decision Support System is needed in determining decision making. There are various kinds of decision support system methods, namely: AHP, WP, TOPSIS, Simple Addictive Weighting (SAW), Profile Matching, expert systems and simple linear regression. Of all the decision support system methods above, the method chosen in determining the decision to acquire new employees is Profile Matching and SAW [2].

The SAW method is a systematic method of decision making that is able to show assessing the competence of applicant according to the criteria set by the company or decision maker based on systematic data analysis [3] while the Profile Matching Method is a method that compares competencies owned by the candidate and the competency of the position. So that it can be seen that the difference in competence is also often referred to as a gap. The smaller the gap (difference) a candidate gets, the candidate has a greater final score and is very close to the required qualifications [4].

Based on the description of the above problems, regarding the needs of the UPKK regarding a decision support system to assist in the selection of recruitment for employees of a company in recruiting, comparing the results of the process using the Simple Addictive Weighting (SAW) method and the Profile Matching method is an interesting thing. The application of this method is in the employee candidate selection system in UPKK so that it can help to see the potential of prospective employees to occupy a certain position in a certain institution in the company.

2. LITERATURE REVIEW

In 2016, M. Isman conducted research using SAW to support employee selection decisions at PT Philips Seafood Indonesia. The results of this study indicate the highest value is 77.5 with a range of 0-100. Manual calculations and calculations using a decision support system are claimed to get the similar results so that the system has high validity [5]. In other studies, using a similar method, it is said that the results of the 30-applicant data used get the comparison between manual and system calculations that have an accuracy of 81% [6].

Several other studies that have been carried out using the Profile Matching method, namely supporting sorting decisions based on the type of voice of the new members of the BIOS choir division studied by Syah in 2017. The results show that the system performance he designed can be used to make member admission decisions with the output in the form order based on the highest to the lowest end with the number of test data as much as 61, has a validity percentage of 77.04%. In fact, other studies have shown an accuracy of 96.2% [7] [8].

Based on some of the studies that have been described, it can be seen that the use of the Simple Additive Weighting and Profile

Matching methods has satisfactory results in each method. This research will deal with the application and accuracy comparison of the Simple Additive Weighting and Profile Matching methods, with the case study of selection of prospective employees based on data held by UPKK Universitas Brawijaya.

2.1. Decision Support System

Michael S. Scott Morton (1970) first articulated the important concept of a Decision Support System (DSS). Michael S. Scott Morton defines DSS as an interactive computer-based system, which helps decision makers to use data and various models to solve unstructured problems.

The concept of DSS is characterized by a computer-based interactive system that helps decision making utilizing data and models to solve unstructured problems. Basically, the DSS is designed to support all stages of decision making starting from identifying problems, selecting relevant data, determining the approach used in the decision-making process, to evaluating alternative choices [9].

2.2. Simple Additive Weighting (SAW)

Simple Additive Weighting is a method that is often used for decision making because this method is more efficient and has a fairly high accuracy. This method uses the largest (selected) result as its output. In the Simple Additive Weighting method, there are 2 types of criteria, namely the criteria that are beneficial (benefit) and criteria that are detrimental (cost). The advantages of this method in the form of the ability to assess more accurately because it is based on the value of the criteria and weighting preferences are predetermined and can choose the best alternative from a number of alternatives, other than that due to the increase in the after determining the weight values for each attribute [10].

2.3. Profile Matching

Profile Matching is a method where this method first determines the competency value (ability) required for a position. The competence of these abilities must be met by the holder or the candidate whose performance will be assessed. Broadly speaking, Profile Matching is a comparison process between individual competencies and job competencies so that the difference in competence is known as a gap, and the smaller the gap resulting from the comparison process above, the greater the weight value. This means that they have a greater chance of becoming an employee candidate to occupy the position [11].

In other literature, it is stated that the Profile Matching method is a decision-making mechanism by assuming that there is an ideal predictor variable level that must be met or passed. In Profile Matching, identification of good or bad groups of employees or job applicants. The employees in the group are measured using several assessment criteria. In Profile Matching, the job applicants who are appointed are those who are closest to the ideal profile of a successful employee [4].

2.4. The application of DSS uses SAW and Profile Matching

The concept of DSS (as shown in Figure 1) is characterized by a computer-based interactive system that helps decision making utilizing data and models to solve existing problems.

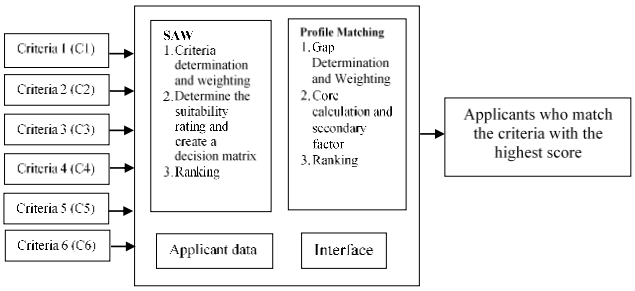

Figure 1. Application of SAW and Profile Matching in DSS

3. STUDY DESIGN AND METHODOLOGY

The method used in this research is data collection, design, implementation, testing and analysis as well as drawing conclusions and suggestions. Figure 2 shows the research methodology carried out in this research.

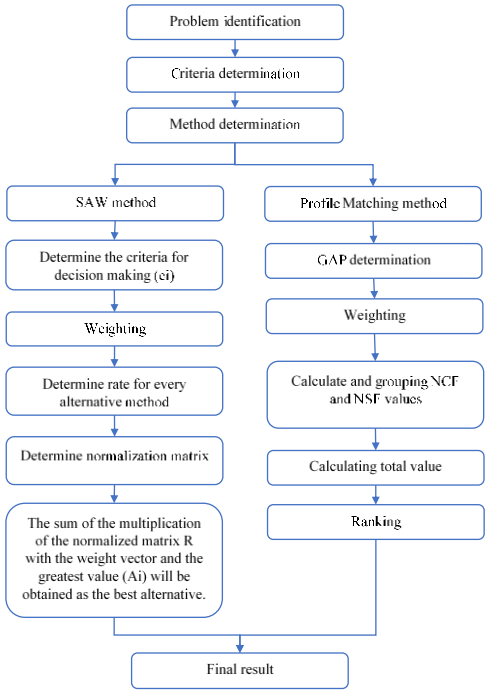

Figure 2. Research method.

3.1. Data Source

The data source used as research material is the primary data source. The data required is the result of selection of employee interviews with variables of educational suitability, GPA, which comes from the University, technical abilities, work experience, proficiency test results, biographical information, and data of all applicants who register at one particular company with the same position in accordance with company needs. In this study, the company under study was PT Kayaba Indonesia. This company opens vacancies for 4 positions, namely: Production Foreman & Warehouse, Foreman Production Planning & Control, Foreman PCE & Maintenance, and Supervisor Management System Information. Each vacancy has its own qualifications. In this study, the Foreman position requires qualifications in the form of

male gender, D3 Department of Mechanical / Electrical / Industrial Engineering, minimum GPA of 2.75, single, maximum age 24 years, while for supervisor positions requires qualifications such as S1 Informatics Engineering Department, minimum GPA 2.75, single, maximum age 26 years.

The data sources obtained are stored in the form of CSV (Comma Separated Values) files. This data will then be loaded through the application, and output in the form of a CSV file as well.

3.2. System Planning

The system to be used is a computer with hardware specifications an Intel Core i3 processor, with 4 GB of RAM. The software used is the Ubuntu 18.04 LTS operating system and the Python 3.6 programming language.

In the initial step of the SAW method, the data used is a CSV file that will be inputted through the application. The data will later take values from 5 to 11 criteria selected as a reference. After that, the ranking calculation will be carried out using the SAW method. After the calculation is complete, the system will issue the name and point of the result and can be saved as a CSV file. The system process flow image can be seen in Figure 3.

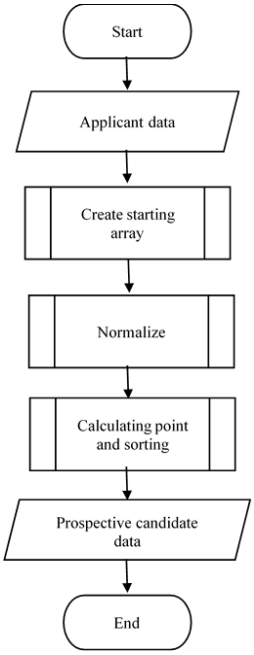

Figure 3. System design with SAW method.

In working on the Profile Matching method applied by the researcher, initially the CSV data is entered by the user then the system will run. When the system is started, a preprocessing process will first run to prepare the data so that it is ready to be processed. Then the calculation process will be carried out using the Profile Matching method to find out which candidate is closest to the predetermined criteria. An overview of the process flow is shown in Figure 4.

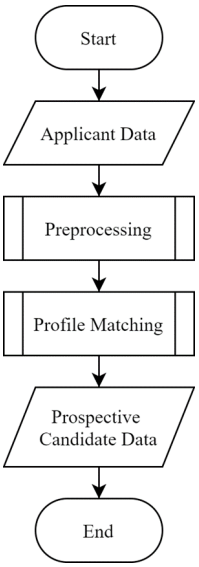

Figure 4. System design with Profile Matching method.

Each candidate will be given a score according to the conditions they have. The process of assigning candidate competency scores in the SAW method is depicted in Figure 5.

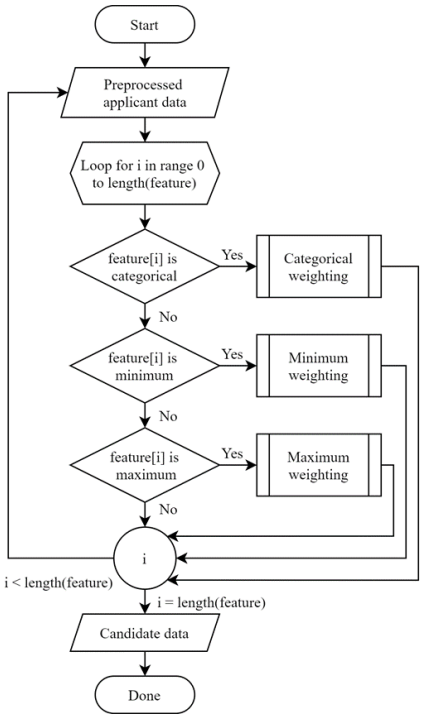

Figure 5. Flowchart of candidate scoring with SAW.

Scoring to each candidate will be divided into 3 ways, the first is to assign scores to features that are categorical. Categorical features include Study Program, Gender, Department, Faculty and Civil Status. Then the candidate value which has a value equal to the ideal profile value that has been determined by the user will get a value of 2, otherwise it will have a value of 1. Second is the value of features based on the minimum limit. Features that use a minimum score in determining the desired

conditions include GPA, TOEFL / TOEIC scores, Height, Year of Graduation, and Year of Entry. Candidates who have a value more than the same as the ideal profile value that has been determined by the user will get a score of 2, if not then it will have a value of 1. Then the third is a feature that uses the maximum value in determining the desired conditions, including weight and age. Candidates who have a value less than equal to the ideal profile value defined by the user will get a score of 2, otherwise it will have a value of 1.

The calculation process in Profile Matching that used in system development is shown in Figure 6.

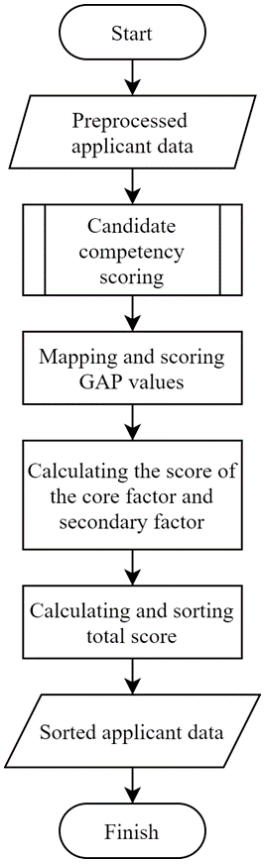

Figure 6. Flowchart of candidate scoring with Profile Matching.

These systems are implemented on computer using programming software with Python programming.

4. RESULTS AND DISCUSSION

4.1. Data Preparation

The data used are from PT XX's applicants (real name of the company is keep confidentially) with the criteria for the applicant's initial data in the form are full name, position, gender, civil status, place of birth, date of birth, age, height, weight, home address, cellphone number, email, type of English test (TOEIC/TOEFL), TOEIC/TOEFL test score, University, educational stage, year of university entry, year of university graduation, date of graduation trial, semester, GPA, study program, department, faculty, interest, completeness of transcript, completeness of Certificates/SKL, work experience (company, position and length of work), and organizational experience (organization, position, period). In minimizing misunderstandings in university input, normalization is carried out for university features. The number of applicants was 564 applicants with the desired positions, namely: Production Foreman & Warehouse, Foreman Production Planning & Control, Foreman PCE & Maintenance and Supervisor Management Information System. Foreman positions have specific criteria such as male gender, D3 Department of Mechanical / Electrical / Industrial Engineering, minimum GPA of 2.75, single, maximum age 24 years, while supervisor positions require qualifications such as S1 Department of Informatics, minimum GPA of 2.75, Single, maximum age 26 years

4.2. Results of SAW Method

The calculating steps to get the scores using the SAW method are as follows (Tables 1-9 are the corresponding results of each steps).

4.2.1. Determine the criteria (Ci) set by PT XX which will be used as a reference in making decisions.

Table 1. Criteria used in the Company

No	Criteria number	Criteria	Information	Weight
1	C1	Benefit	Educational stage	0.6
2	C2	Benefit	Department	0.5
3	C3	Benefit	GPA	0.4
4	C4	Benefit	Civil status	0.3
5	C5	Cost	Age	0.2
6	C6	Benefit	Gender	0.1

4.2.2. Provide the value of each alternative on each predetermined criterion. Each criterion must be assigned.

Table 2. Weighting of C1

No	User	Educational level	Score
1	User1	SMK	1
2	User2	D3	2
3	User3	S1	1
4	User4	S1	1
5	User5	D4	1

Table 3. Weighting of C2

No	User	Department	Category	Score
1	User1	Accountant	Not available	0
2	User2	Mechanical Engineering	Available	1
3	User3	Industrial Engineering	Available	1
4	User4	Informatics	Not available	0
5	User5	Electrical Engineering	Available	1

Table 4. Weighting of C3

No	User	GPA	Score
1	User1	3	3
2	User2	3,05	3,05
3	User3	3,32	3,32
4	User4	3,19	3,19
5	User5	3,29	3,29

Table 5. Weighting of C4

No	User	Civil status	Score
1	User1	Single	1
2	User2	Single	1
3	User3	Single	1
4	User4	Single	1
5	User5	Single	1

Table 6. Weighting of C5

No	User	Birth date	Score
1	User1	18/11/2001	18
2	User2	22/03/1998	21
3	User3	01/01/1994	26
4	User4	18/09/1996	23
5	User5	13/09/1996	23

Table 7. Weighting of C6

No	User	Gender	Score
1	User1	Woman	0
2	User2	Man	1
3	User3	Man	1
4	User4	Man	1
5	User5	Man	1

4.2.3. Determine the suitability rating of each alternative on each criterion

Table 8. Table of Ratings in each Criterion

No	User	Criterion					
		C1	C2	C3	C4	C5	C6
1	User1	0,5	0	0,90361	1	1	0
2	User2	1	1	0,91867	1	0,857143	1
3	User3	0,5	1	1	1	0,692308	1
4	User4	0,5	0	0,96084	1	0,782609	1
5	User5	0,5	1	0,99096	1	0,782609	1

4.2.4. Decision matrix based on criteria (Ci), then performed the matrix normalization

$$X = \begin{bmatrix} 0,5 & 0 & 0,903614458 & 1 & 1 & 0 \\ 1 & 1 & 0,918674699 & 1 & 0,857142857 & 1 \\ 0,5 & 1 & 1 & 1 & 0,692307692 & 1 \\ 0,5 & 0 & 0,960843373 & 1 & 0,782608696 & 1 \\ 0,5 & 1 & 0,990963855 & 1 & 0,782608696 & 1 \end{bmatrix}$$

4.2.5. Normalization in each criterion

Criteria of level, including benefit:

$R1.1 = \frac{1}{2} = 0.5$

$R1.2 = \frac{2}{2} = 1$

$R1.3 = \frac{1}{2} = = 0.5$

$R1.4 = \frac{1}{2} = = 0.5$

$R1.5 = \frac{1}{2} = = 0.5$

Criteria of major, including benefit:

$R2.1 = \frac{0}{1} = 0$

$R2.2 = \frac{1}{1} = 1$

$R2.3 = \frac{1}{1} = 1$

$R2.4 = \frac{0}{1} = 0$

$R2.5 = \frac{1}{1} = 1$

Criteria of GPA, including benefit

$R3.1 = \frac{3}{3.32} = 0.9036144$

$R3.2 = \frac{3.05}{3.32} = 0.9186746$

$R3.3 = \frac{3.32}{3.32} = 1$

$R3.4 = \frac{3.19}{3.32} = 0.9608433$

$R3.5 = \frac{3.29}{3.32} = 0.990963$

Criteria of status, including benefit

$R4.1 = \frac{1}{1} = 1$

$R4.2 = \frac{1}{1} = 1$

$R4.3 = \frac{1}{1} = 1$

$R4.4 = \frac{1}{1} = 1$

$R4.5 = \frac{1}{1} = 1$

Criteria of Age, including benefit:

$R5.1 = \frac{18}{18} = 1$

$R5.2 = \frac{18}{21} = 0,85714285$

$R5.3 = \frac{18}{26} = 0,69230769$

$R5.4 = \frac{18}{23} = 0,78260869$

$R5.5 = \frac{18}{23} = 0,7826087$

Criteria of sex, including benefit

$R6.1 = \frac{0}{1} = 0$

$R6.2 = \frac{1}{1} = 1$

$R6.3 = \frac{1}{1} = 1$

$R6.4 = \frac{1}{1} = 1$

$R6.5 = \frac{1}{1} = 1$

4.2.6. Final Result of SAW Method

Table 9. Final Result of SAW Method

No	Alternative	Criterion						Sum
		Benefit				Cost	Benefit	
		C1	C2	C3	C4	C5	C6	
1	User 2	0,6	0,5	0,36746988	0,3	0,171428571	0,1	2,038898451
2	User5	0,3	0,5	0,396385542	0,3	0,156521739	0,1	1,752907281
3	User3	0,3	0,5	0,4	0,3	0,138461538	0,1	1,738461538
4	User4	0,3	0	0,384337349	0,3	0,156521739	0,1	1,240859089
5	User1	0,3	0	0,361445783	0,3	0,2	0	1,161445783

From 564 initial data, researchers processed by using the SAW method and filtered 144 data of prospective employees. From the 144 data of prospective employees, the researchers got some recommendations based on the highest ranking (rank 1- 5) of these prospective employees, namely:

1. User 2 with total points 2.038898451
2. User 5 with total points 1.752907281
3. User 3 with total points 1.738461538
4. User 4 with total points 1.240859089
5. User 1 with total points 1.161445783

The data will be tested for the accuracy and specificity by using the Confusion Matrix method. The results of the Confusion Matrix test are given in Table 10.

Table 10. Confusion Matrix SAW Table

Initial Data		**564**
Result	SAW	144
Confusion Matrix	TP	126
	FP	18
	FN	12
	TN	408
Accuracy		94.7%
Precision		87.5%
Recall		91.3%
F - Measure		89.4%
Specificity		95,8%

From the table 10, there were 564 initial participants and screened into 154 participants by using the SAW method. It was shown that the SAW method had an accuracy of 94.7%, a precision of 87.5%, a recall of 91.3%, and an F-Measure of 89.4%.

The accuracy of 94.7% in the SAW method is greater than the research hypothesis which stated that the accuracy rate of SAW method was 80-90%. This indicates that the SAW method has a very good level of accuracy to be applied in the new employee candidate selection system. This high level of accuracy is also supported by a high number of high precision (87.5%). This shows that the SAW method is very specific to be used in selecting employee candidate recommendations according to predetermined criteria. This is supported by the high recall rate of 91% and a F-Measure value of 89.4%.

4.3. Result of Profile Matching Method

The calculating steps to get the scores using the SAW method are as follows (Tables 11-20 are the corresponding results of each steps).

4.3.1. GAP mapping

Table 11. C1 GAP calculation

Alternative	C1 (Age)		
	Employee profile	Position profile	GAP
User1	24	24	0
User2	26	24	-2
User3	24	24	0
User4	24	24	0
User5	23	24	1

Table 12. C2 GAP calculation

Alternative	C2 (Status)		
	Employee profile	Position profile	GAP
User1	Single	Single	0
User2	Single	Single	0
User3	Single	Single	0
User4	Single	Single	0
User5	Single	Single	0

Table 13. C3 GAP calculation

Alternative	C3 (Education)		
	Employee profile	Position profile	Employee profile
User1	SMK	User1	SMK
User2	D3	User2	D3
User3	S1	User3	S1
User4	S1	User4	S1
User5	D4	User5	D4

Table 14. C4 GAP calculation

Alternative	C4 (Major)		
	Employee profile	Position profile	GAP
User1	Business	Mechanical Eng.	1
User2	Mechanical Eng.	Mechanical Eng.	0
User3	Industrial Eng.	Mechanical Eng.	1
User4	Informatics	Mechanical Eng.	1
User5	Telecommunication Eng.	Mechanical Eng.	1

Table 15. C5 GAP calculation

Alternative	C5 (GPA)		
	Employee profile	Position profile	GAP
User1	2,82	3	0
User2	3,26	3,05	0
User3	3,33	3,32	0
User4	3,16	3,19	0
User5	3,46	3,29	0

Table 16. C6 GAP calculation

Alternative	C6 (Gender)		
	Employee profile	Position profile	GAP
User1	Woman	Man	1
User2	Man	Man	0
User3	Man	Man	0
User4	Man	Man	0
User5	Man	Man	0

4.3.2. Weighting

Table 17. Weighting results

Alternative	Weight					
	C1	C2	C3	C4	C5	C6
User1	2	2	1	1	2	1
User2	1	2	2	2	2	2
User3	2	2	1	1	2	2
User4	2	2	1	1	2	2
User5	2	2	1	1	2	2

4.3.3. Calculating and grouping of core and secondary factor

Table 17. Grouping of core and secondary factor

No	Category	Information	Factor
1	C1	Age	Secondary
2	C2	Graduation year	Core
3	C3	Education stage	Core
4	C4	Major	Core
5	C5	GPA	Core
6	C6	Gender	Core

Table 18. Core and secondary factor calculation

Alternative	Weight					
	C1	C2	C3	C4	C5	C6
User1	0,4	1,6	0,8	0,8	1,6	0,8
User2	0,2	1,6	1,6	1,6	1,6	1,6
User3	0,4	1,6	0,8	0,8	1,6	1,6
User4	0,4	1,6	0,8	0,8	1,6	1,6
User5	0,4	1,6	0,8	0,8	1,6	1,6
Core factor 80% secondary factor 20%						

4.3.4. Total calculation of score

Table 19. Total calculation score

User	NSF	NCF	NCI	Rank
User1	0,4	1,4	1,8	5
User2	0,2	2	2,2	1
User3	0,4	1,6	2	3
User4	0,4	1,6	2	4
User5	0,4	1,6	2	2

4.3.5. Final ranking result

Table 20. Total rank

User	NSF	NCF	NCI	Rank
User2	0,2	2	2,2	1
User5	0,4	1,6	2	2
User3	0,4	1,6	2	3
User4	0,4	1,6	2	4
User1	0,4	1,4	1,8	5

From the initial 564 data, after the Profile Matching Method was carried out, the filtered data was obtained for 140 prospective employees. From the 140 data on prospective employees, recommendations for prospective employees are obtained based on the ranking of the highest. Prospective employees include:

1. User 2 with total points 2.8
2. User 5 with total points 2.7
3. User 3 with total points 2.7
4. User 4 with total points 2.7
5. User 1 with total points 2

The data will be tested for accuracy and specificity using the Confusion Matrix method. The results of the Confusion Matrix test are given in Table 21.

Table 21. Confusion Matrix of Profile Matching

Initial Data		564
Result	PM	140
Confusion Matrix	TP	114
	FP	26
	FN	26
	TN	377
Accuracy		90,4 %
Precision		81,4 %
Recall		81,4 %
F - Measure		81,4 %
Specificity		93,5 %

5. CONCLUSION

From the research that had been done, it could be concluded that:

1. The Simple Addictive Weighting (SAW) Method and the Profile Matching Method are proven to have the equal level of accuracy, namely 80-90% in the process of recruiting new employees
2. The Simple Addictive Weighting (SAW) Method and the Profile Matching Method are proven to have the equal level of Sensitivity to recall, namely 80-90% in the process of recruiting new employees.
3. The Simple Addictive Weighting (SAW) Method and the Profile Matching Method are proven to have the equal level of Precision, namely 80-90% in the process of recruiting new employees.

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