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Student performance prediction using simple additive weighting method

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ABSTRACT

In the world of student education is an important component where the role of students is as someone who is psychologically ready to receive lessons or other input from the school. However, each student has different performance and development, therefore it is important to do monitoring so that student performance will always be monitored by the school for improving student quality maintenance. Also, in the process of valuing education for students needs to be done by giving an appreciation in the form of giving gifts or just giving words and motivation so that students can perform better in learning and participating in other activities at school. In terms of selecting students with good performance or those who have a very declining development using the school method not only assess students by one criterion but with several criteria to produce a decision that can be accepted by many people. Performance Students must also be monitored by the school or the related rights. In this paper, the student performance prediction was assessed with 5 criteria components and the result shows there are 10 very satisfy students, 10 satisfying students, 10 well students, and 10 Enough students from sample 40 students.

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1. INTRODUCTION

Education is an emerging field of research by developing methods to explore unique types of data that originate in the educational context [1]. Education is also a human process in developing themselves or a learning process where a situation that originally did not have an understanding of a particular science with human education which will be learned from what they learn. In Education, there must be a name for learning facilities namely school, where a school is a place of learning for students to go through Education. In Education, there are many activities carried out by students ranging from learning, playing, sports extracurricular activities, and others, and in their development, each student must have the ability which is not the same as the other students.

Meanwhile, performance appraisals generally aim to provide feedback to students to improve the quality of learning and can increase the productivity of an organization because students are the core of the

learning process [2]. In this study, the data used are school documents that include absenteeism, average report card grades, extracurricular scores, violation points, and interviews. Data taken from school documents are used as a reference to decide on student performance and interview values are taken from the question and answer process to the teachers involved in student activities. This research was conducted at level X, XI, and XII Odd semester 2019/2020 Academic year at SMK Negeri 1 Kragilan District, by entering some student data samples to do a sample. In previous studies that the existence of a complex system in predicting student performance can maintain the ability/achievement of students, ensure that students graduate on time, and ensure the ability of students according to the field taken [3-4].

The problem that is often faced when schools do the selection of high-achieving students often chooses the best students or achievers only by using the highest grade report card [5-6]. In fact, in the daily activities of students many things can be used as additional values as explained in the introduction, namely:

a. Average report card grade, which was obtained by students after doing the learning process for one semester.
b. Absenteeism value, which was taken from student attendance data during the Odd semester learning process.
c. Violation Points which were taken from Student Data.
d. Extracurricular Value which was taken from Extracurricular Trustee data.
e. An interview which was obtained from the interview process with the Supporting Teachers involved in the learning process.

With the background of this problem, the research was conducted so that a school principal or related party could find out the performance of students who were good and who were very low. From the conclusions above it can be concluded several problems such as a principal or related party only uses report cards to determine a student's performance, and there is no school tool to monitor student performance at school and students do not have benchmarks in learning at school because they do not know their overall abilities at school [7-8]. Thus, based on those problems the purposes of this paper will create a tool which can help the decision-maker in making their decision such as the school principal or related party can know the performance of students in school performance, the ability, and activeness of students can be controlled by the school, and be a benchmark for students in the learning process to what extent these students take school lessons [9-10].

In other studies, there are several objectives of using the simple additive weighting (SAW) method including improving methodology to deal with inaccuracies in multi-criteria decision making by presenting a new SAW Rough method algorithm [11]. Applying the SAW method in dismissing dancers members based on the application criteria investigated by the school, campus, or organization [12]. Another implementation, assist parents in choosing healthy foods for toddlers and can choose foods with enough nutrition to support the period of physical and brain growth and development in toddlers/babies at golden age [13-14].

2. RESEARCH METHOD

The data used in this study are archival data from the SMK Negeri 1 Kragilan, which includes absentee data, student's average report card value data, extracurricular score data, student abuse points and data value results from the interview process with teachers involved in daily learning the student. The decision-making process in this study used mathematical calculations with the SAW method, where the decision-making system is a computer-based system consisting of several components including system language components (language), system components of knowledge (knowledge), and systems component processing problems [15-16]. Taking a system is a process in choosing alternative actions to achieve certain goals or objectives [17]. The decision-making system can be interpreted as a computer system that is used to decide on a company or agency [18-19]. Meanwhile, the SAW method is a simple additive weighting method which is commonly known as the weighting sum method [20-21].

The SAW method requires a matrix normalization process in deciding a problem compared to the existing alternative ranking [22]. The fundamental concept of the SAW Method is a way to find the performance of the weighted sum rank in each alternative for all attributes. The SAW method requires a decision matrix normalization process (x) for a scale that can be compared with all existing ranking alternatives [23]. Bearing in mind that the SAW method falls into the category of the method that belongs to find the widest application in completing a multi-criteria model [24]. This method is also a method used to make simple multi-attribute decisions and is mostly applied as a weighted linear combination [25].

There are 4 steps in the SAW method such as:

a. Determine the alternative weights used for each criterion.
b. Make decisions using the criteria matrix (Ci).

c. Matrix normalization is based on the adjusted equation for the type of attribute (benefit attribute or cost attribute) to get the normalized matrix R. The formula for determining the normalized matrix R as shown in (1).

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\text{Max } x_{ij}} & \text{If j is a benefit attribute} \\ \frac{\text{Min } x_{ij}}{x_{ij}} & \text{If j is a Cost Attribute} \end{cases} \quad (1)$$

Description :
R_{ij} - → is a normalized performance rating score.
X_{ij} → is an attribute value that is owned using.
Max X_{ij} → Is the greatest value of each criterion.
Min X_{ij} → Is the smallest value of each criterion.
Benefit → Represents if the greatest value is the best value.

d. Determine the final grade, to be able to determine the final result, use the value obtained from the ranking process than from the sum and multiplication of the normalized R matrix with the weight vector to get the largest value will be chosen as the best alternative (Ai) as the solution. The preference value for each alternative (Vi) can be seen as follows in formula (2):

$$V_i = \sum_{j=1}^{n} W_j \, r_j \quad (2)$$

Description :
V_i *→ Is the ranking value for each alternative.*
W_j → Is the weight value on each criterion.

3. RESULTS AND ANALYSIS

As shown in the previous section where there are 4 steps then this section will be delivered in 4 steps such as:

3.1. Determine the type of criteria used in the calculation

The criteria used in this method are the Average Score Report with code C1, Then the Execution Value with code C2, Interview with Code C3, Points of Violation with Code C4, And Time Attendance with Code C5 of the Criteria. All the criteria for calculating student performance can be seen in the first and second columns of Table 1.

3.2. Weighting each criterion and work type value

In Table 1, it is explained that each criterion has a different weight depending on which percentage you want to be seeded, in that table the report card and the score points are the biggest points for weighting. The criteria C1, C2, and C3 have weight 30%, 10%, and 10% respectively whilst criteria C4 and C5 have a weight of 30% and 20% respectively. In the table also the criteria value is used to determine the formula that will be used whether the criteria are MAX and MIN. MAX here is the conclusion whether these criteria must have high weights or benefit while MIN is the criteria that must have low weights or cost. All these weighting scoring were collected based on Forum Discussion Group (FGD) with headteacher and respect teachers for scoring criteria C1, C2, C3, C4, and C5 and giving criteria C1, C2, and C3 as MAX criteria type whilst C4 and C5 as MIN criteria type

Table 1. Weighting table for each criterion

Criteria Code	Criteria	Weight	Criteria Type
C1	Report Score Average	30 = 30 %	MAX
C2	Extracurricular Value	10 = 10 %	
C3	Interview	10 = 10 %	
C4	Violation Points	30 = 30 %	MIN
C5	Attendance	20 = 20 %	

3.3. Evaluate each criteria alternative

In the weighting alternative table filled with data that has been obtained in the study, namely C1 (average score report) of the sample report card inputted, C2 (extracurricular value) from extracurricular supervisors data, C3 (interview) from the interview data with the Teachers involved in learning, C4 (violation points) obtained from student violation data, C5 (absenteeism) from the total student record attendance data. As a result of FGD with the headteacher and team teachers then the data used 40 students from the same class which scored for criteria code C1 to C5 and Table 2 shows the 40 students, where each student had been scored with criteria C1 to C5 as mentioned before.

Table 2. Weighting table for each criterion.

No	Alternative (Student's name)	Criteria Type				
		C1	C2	C3	C4	C5
1	Ardila Agesti	70	60	70	11	15
2	Aris Hardiansyah	80	60	70	11	15
3	Augry Ayu Milanda	50	60	70	11	80
4	Badriyah	90	80	70	11	15
5	Deny Akbar	37	70	70	11	15
6	Diah Puji Lestari	70	78	80	11	80
7	Ela Nuraeni	80	60	90	81	15
8	Faisal Adi Saputra	70	60	70	51	15
9	Fani Yulia Susyanti	87	60	80	61	15
10	Imran Sadana	78	60	70	11	70
11	Juleha	89	78	70	11	15
12	Jumanti	79	60	80	11	15
13	Lisa Yurike	78	60	87	11	15
14	Maesaroh	89	60	75	11	80
15	Mohamad Sahroni	88	89	67	11	15
16	Muhammad Iqbal Setiawan	77	60	70	71	15
17	Muhammad Rizky Hasbillah	91	60	70	41	15
18	Neni	78	65	70	31	50
19	Nur Rahma Fasha	88	60	70	21	15
20	Nurmaliah	75	60	70	51	15
21	Nurul Hotimah	75	60	78	31	40
22	Rian Pahriji	76	78	70	41	15
23	Rifki Hardian Yudistira	78	60	70	21	15
24	Safitri Saudoh	76	60	70	11	60
25	Safnah	66	60	70	39	15
26	Sindi	77	60	78	21	15
27	Sopiah	88	65	70	31	67
28	Suratul Rizqi	68	60	70	41	15
29	Sutihat	87	60	70	11	15
30	Tarkiyah	89	60	78	11	68
31	Umi Kulsum	88	60	70	11	15
32	Vieri Ginola Eightian	87	70	70	11	15
33	Wiwi Supriyati	88	60	78	11	15
34	Septa Pratama	60	60	70	11	15
35	Paskalina Suiti Ulin	60	60	70	11	15
36	William Jhon Maniagasi	70	60	78	11	60
37	Agil Yogo Leksono	76	60	70	11	70
38	Ahmad Muhaedi	67	60	70	11	70
39	Alka Widiyan Saputro	75	60	78	11	15
40	Amimah	74	80	70	31	15

3.4. Conduct a decision matrix and normalization

Before making the prediction then we need the explanation for the decision-making process where the decision matrix comes from the criteria C1 to C5 as mentioned above. The list of 40 students in Table 2 will be assessed with (1) to normalize the performance rating score for each student. Each criterion for each student will be normalized with (1) and Table 3 shows the result of the normalization of performance rating score for each criterion. Since there are MAX and MIN criteria type as shown in Table 1, then based on (1), the MAX for criteria C1, C2, and C3 were assessed as benefit attribute with (1) and the equation is $\frac{x_{ij}}{\text{Max } x_{ij}}$, whilst the MIN for criteria C4 and C5 were assessed as cost attribute with (1) and the equation is $\frac{\text{Min } x_{ij}}{x_{ij}}$.

From Table 3, the criteria type were scored with (1) where for column C1, C2 and C3 used MAX as a benefit as shown in column criteria type in Table 1 with equation $\frac{x_{ij}}{\text{Max } x_{ij}}$ and column C4 and C5 used MIN

as cost as shown in column criteria type in Table 1 with equation $\frac{\text{Min } x_{ij}}{x_{ij}}$. Next, the score Max x_{ij} and Min x_{ij} were assigned as a maximum and minimum score from Table 2, and as shown in Table 2, the maximum score for column C1, C2, and C3 are 91, 89, and 90 respectively, whilst the minimum score for column C4 and C5 are 11 and 15 respectively. Then, each student criteria in Table 2 were assessed with equation $\frac{x_{ij}}{\text{Max } x_{ij}}$ with each Max x_{ij} score C1=91, C2=89 and C3=90 respectively, whilst equation $\frac{\text{Min } x_{ij}}{x_{ij}}$ with each Min x_{ij} score C4=11 and C5=15 respectively. For example, student first row in Table 3 named "Ardila Agesti" has score C1=70/91=0.769231, C2=60/89=0.674157 and C3=70/90=0.777778 whilst C4=11/11=1 and C5=15/15=1.

Meanwhile, the last column "the final result" in Table 3 were ranked with (2) where each criterion is multiplied with weight percentage as shown in the third column in Table 1 where C1 multiplied with 0.3, C2 multiplied with 0.1, C3 multiplied with 0.1, C4 multiplied with 0.3 and C5 multiplied with 0.2. For example, student first row in Table 3 named "Ardila Agesti" has "the final result" score or V1 score:

V1 = C1*0.3 + C2*0.1 + C3*0.1 + C4*0.3+ C5*0.2
= 0.769231*0.3 + 0.674157*0.1 + 0.777778*0.1 + 1*0.3 + 1*0.2
= 0.230769 + 0.067416 + 0.077778 + 0.3 + 0.2
= 0.875963

Table 3. Results of weighting multiplication with alternative criteria

No	Student's name	Criteria Type					The final result
		C1	C2	C3	C4	C5	
1	Ardila Agesti	0.769231	0.674157	0.777778	1	1	0.875963
2	Aris Hardiansyah	0.879121	0.674157	0.777778	1	1	0.90893
3	Augry Ayu Milanda	0.549451	0.674157	0.777778	1	0.1875	0.647529
4	Badriyah	0.989011	0.898876	0.777778	1	1	0.964369
5	Deny Akbar	0.406593	0.786517	0.777778	1	1	0.778407
6	Diah Puji Lestari	0.769231	0.876404	0.888889	1	0.1875	0.744799
7	Ela Nuraeni	0.879121	0.674157	1	0.135802	1	0.671893
8	Faisal Adi Saputra	0.769231	0.674157	0.777778	0.215686	1	0.640669
9	Fani Yulia Susyanti	0.956044	0.674157	0.888889	0.180328	1	0.697216
10	Imran Sadana	0.857143	0.674157	0.777778	1	0.2143	0.745194
11	Juleha	0.978022	0.876404	0.777778	1	1	0.958825
12	Jumanti	0.868132	0.674157	0.888889	1	1	0.916744
13	Lisa Yurike	0.857143	0.674157	0.966667	1	1	0.921225
14	Maesaroh	0.978022	0.674157	0.833333	1	0.1875	0.781656
15	Mohamad Sahroni	0.967033	1	0.744444	1	1	0.964554
16	Muhammad Iqbal Setiawan	0.846154	0.674157	0.777778	1	1	0.645519
17	Muhammad Rizky Hasbillah	1	0.674157	0.777778	1	0.1875	0.725681
18	Neni	0.857143	0.730337	0.777778	1	1	0.574406
19	Nur Rahma Fasha	0.967033	0.674157	0.777778	1	1	0.792446
20	Nurmaliah	0.824176	0.674157	0.777778	1	0.1875	0.657152
21	Nurul Hotimah	0.824176	0.674157	0.866667	0.135802	1	0.582787
22	Rian Pahriji	0.835165	0.876404	0.777778	0.215686	1	0.696455
23	Rifki Hardian Yudistira	0.857143	0.674157	0.777778	0.180328	1	0.759479
24	Safitri Saudoh	0.835165	0.674157	0.777778	1	0.214286	0.745743
25	Safnah	0.725275	0.674157	0.777778	1	1	0.647391
26	Sindi	0.846154	0.674157	0.866667	1	1	0.765071
27	Sopiah	0.967033	0.730337	0.777778	1	1	0.592149
28	Suratul Rizqi	0.747253	0.674157	0.777778	1	0.1875	0.649857
29	Sutihat	0.956044	0.674157	0.777778	1	1	0.932007
30	Tarkiyah	0.978022	0.674157	0.866667	0.15493	1	0.791607
31	Umi Kulsum	0.967033	0.674157	0.777778	0.268293	1	0.935303
32	Vieri Ginola Eightian	0.956044	0.786517	0.777778	0.354839	0.3	0.943243
33	Wiwi Supriyati	0.967033	0.674157	0.866667	0.52381	1	0.944192
34	Septa Pratama	0.659341	0.674157	0.777778	0.215686	1	0.842996
35	Paskalina Suiti Ulin	0.659341	0.674157	0.777778	0.354839	0.375	0.842996
36	William Jhon Maniagasi	0.769231	0.674157	0.866667	0.268293	1	0.734852
37	Agil Yogo Leksono	0.835165	0.674157	0.777778	0.52381	1	0.7386
38	Ahmad Muhaedi	0.736264	0.674157	0.777778	1	0.25	0.70893
39	Alka Widiyan Saputro	0.824176	0.674157	0.866667	0.282051	1	0.901335
40	Amimah	0.813187	0.898876	0.777778	0.52381	1	0.718073

Table 4. Student performance criteria

Ranking	Performance Criteria
1 - 10	Very satisfy
11 - 20	Satisfying
21 - 30	Well
31 - 60	Enough
61 - 100	Less

From the weighting table, ranking is then done by placing the highest value up to the lowest value and the student performance criteria is carried out regarding the following Table 4, where ranking 1 to 10 is recognized as very satisfying, ranking 11 to 20 is recognized as satisfying, ranking 21 to 30 is recognized as Well, ranking 31 to 60 is recognized as Enough and ranking 61 to 100 is recognized as Less.

Table 5 shows the results of the ranking produce from Table 4 upon Table 3 which were ordered by the last column of Table 3 as "the final result" and the ranking as shown in Table 5 shows that the highest score start from a student named "Mohamad Sahroni with the number of values 0.964554 as the first ranking and based on Table 4 has a performance "Very Satisfy."

Table 5. Student ranking and performance results

No	Student's name	Amount of values	Ranking	Performance
1	Mohamad Sahroni	0.964554	1	Very satisfy
2	Badriyah	0.964369	2	Very satisfy
3	Juleha	0.958825	3	Very satisfy
4	Wiwi Supriyati	0.944192	4	Very satisfy
5	Vieri Ginola Eightian	0.943243	5	Very satisfy
6	Umi Kulsum	0.935303	6	Very satisfy
7	Sutihat	0.932007	7	Very satisfy
8	Lisa Yurike	0.921225	8	Very satisfy
9	Jumanti	0.916744	9	Very satisfy
10	Aris Hardiansyah	0.90893	10	Very satisfy
11	Alka Widiyan Saputro	0.901335	11	Satisfying
12	Ardila Agesti	0.875963	12	Satisfying
13	Septa Pratama	0.842996	13	Satisfying
14	Paskalina Suiti Ulin	0.842996	14	Satisfying
15	Nur Rahma Fasha	0.792446	15	Satisfying
16	Tarkiyah	0.791607	16	Satisfying
17	Maesaroh	0.781656	17	Satisfying
18	Deny Akbar	0.778407	18	Satisfying
19	Sindi	0.765071	19	Satisfying
20	Rifki Hardian Yudistira	0.759479	20	Satisfying
21	Safitri Saudoh	0.745743	21	Well
22	Imran Sadana	0.745194	22	Well
23	Diah Puji Lestari	0.744799	23	Well
24	Agil Yogo Leksono	0.7386	24	Well
25	William Jhon Maniagasi	0.734852	25	Well
26	Muhammad Rizky Hasbillah	0.725681	26	Well
27	Amimah	0.718073	27	Well
28	Ahmad Muhaedi	0.70893	28	Well
29	Fani Yulia Susyanti	0.697216	29	Well
30	Rian Pahriji	0.696455	30	Well
31	Ela Nuraeni	0.671893	31	Enough
32	Nurmaliah	0.657152	32	Enough
33	Suratul Rizqi	0.649857	33	Enough
34	Augry Ayu Milanda	0.647529	34	Enough
35	Safnah	0.647391	35	Enough
36	Muhammad Iqbal Setiawan	0.645519	36	Enough
37	Faisal Adi Saputra	0.640669	37	Enough
38	Sopiah	0.592149	38	Enough
39	Nurul Hotimah	0.582787	39	Enough
40	Neni	0.574406	40	Enough

Table 5 shows there are 10 students each for with very satisfying, satisfying, well, and enough performance. This result will help the headteacher and teachers when dealing with these 40 students in terms of their study based on this scoring student performance, where the teachers will give more attention and assignment such as homework for those students with enough performance. Moreover, it is possible as well for 10 students with very satisfying performance will be assigned to mentor the other 30 students to increase their study performance. Table 5 will help the teachers as well when splitting students in a group assignment,

where the 10 students with very satisfying will spread evenly for each group so by doing that the knowledge among the group member will be equaled where the very satisfy students will help other performance students.

To make it better the assignment of 5 criteria components can be revised or added with some other criteria component to help the headteacher and teachers to predict their student performance, so at the end of the day will help them how to deal with their students, how to make sure that their students can have equal study atmosphere and to make them understand with their study and finish their study. The criteria component will be possible as well to be applied for each subject to understand how the students understand each subject, and this is will help teach how to deliver the knowledge to their students and recognized which suitable delivery teaching strategy.

4. CONCLUSIONS AND RECOMMENDATIONS

The results of this research can be produced by students who have very satisfying performance produced not only from one assessment criteria but more than one assessment, so the results obtained are more acceptable than using only one assessment criteria to determine a student has a very good or bad ability. In this study, it would be better to create a system that can be accessed by many schools so that when a school wants to find students who have excellent performance, it is no longer just one assessment criteria. The student performance prediction was assessed with 5 criteria components such as average report card grade which obtained by students after doing the learning process for one semester, absenteeism value which was taken from student attendance data during the Odd semester learning process, violation Points which were taken from student data, extracurricular Value which was taken from Extracurricular Trustee data and an interview. This algorithm was applied to sample 40 students in the same class and the result shows there are 10 very satisfy students, 10 satisfying students, 10 well students, and 10 Enough students from sample 40 students.

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