Implementation weighted product method to determine multiple intelligence child

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Abstract. Multiple Intelligence can be known through words, numbers, music, pictures, physical activity or motor skills in a social-emotional way. Multiple Intelligence is basically the development of brain intelligence (IQ), emotional intelligence (EQ), and spiritual intelligence (SQ). Intelligence is the ability possessed by a person to see a problem, then solve the problem or make something that can be useful for others. Intelligence or intelligence can be viewed as the ability to understand the world, think rationally, and use resources effectively when faced with a challenge. Some argue that the notion of intelligence is the general human ability to perform actions that have goals and think in a rational way. In addition, intelligence can also be interpreted as a personal ability to understand, innovate, and provide solutions to various situations. Multi Attribute Decision Making (MADM) is used in making decision support systems using Weighted Product (WP) to define child Multiple Intelligence. 8 intelligences with 8 criteria with specified weights. The data tested based on the data of new students who have enrolled in SMP Negeri 3 Kepanjen with the amount of data 226 students who have registered and fill in the questionnaire (indicator) that has been provided through www.teskecerdasan.com. The results of these are graphs that have been ranked based on the Weighted Product (WP) method villages.

1. Introduction
Intelligence or intelligence can be seen as the ability to understand the world, think rationally, and use resources effectively when faced with a challenge. There are those who argue that the notion of intelligence is the general ability of humans to take actions that have goals and think rationally. In addition, intelligence can also be interpreted as a personal ability to understand, innovate, and provide solutions to various situations.

Through words, numbers, music, pictures, physical activities or even motoric abilities through social-emotional ways can be used to determine children's intelligence. Many research results on children's intelligence suggest parents to give a lot of experience and stimulation to children. The intense stimulation and sensation of experience is useful to arouse children's intelligence which is crystallized into the concept of intelligence theory which he calls 'Multiple Intelligences' or Compound Intelligence, [1].

The tendency of parents to impose their will can cause children to feel depressed so they lose their enthusiasm for learning and tend to become lazy at school even wrong thinking often causes conflict between parents and children. Based on research, in schools there are approximately 40% of gifted children, but unable to achieve the equivalent of the actual capacity possessed [2]. As a result, even though they are highly skilled, many talented children are classified as underachievers in school.
Multiple Intelligence is basically the development of brain intelligence (IQ), emotional intelligence (EQ), and spiritual intelligence (SQ). Intelligence is the ability possessed by someone to see a problem, then resolve the problem or make something that can be useful for others. The theory of multiple intelligences was proposed by Gardner through his book entitled Frames of Mind: Theory of Multiple Intelligence in 1983. At first Gardner stated that there were seven types of intelligence in accordance with the development of research, Gardner then included the eighth intelligence, namely the intelligence of Naturalists [3]. The eight intelligences include linguistic intelligence, logic-mathematical intelligence, intrapersonal intelligence, interpersonal intelligence, musical intelligence, visual-spatial intelligence, kinesthetic intelligence, and naturalist intelligence.

Multi-Attribute Decision Making (MADM) is used to solve problems in discrete space. Therefore Multi-Attribute Decision Making is usually used to conduct assessments or selection of a limited number of alternatives.

There are 3 stages of the Multi-Attribute Decision Making process, namely 1). preparation of situation components, 2). analysis, and 3). information synthesis [4]. At the stage of compiling components, situation components, an estimated table will be formed that contains identification of alternatives and specification of objectives, criteria and attributes. In general, MADM is selecting the best alternative from a number of alternatives.

There are several methods that can be used to solve the Multi-Attribute Decision Making problem, namely: Method SAW (Simple Additive Weighting Method), WP (Weighted Product), ELECTRE (ELimination Et Choix TRADUANTE), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and AHP (Analytic Hierarchy Process).

Previous research related is research conducted by Moh. Ahsan in journal eeccis UB 2015, entitled Multiple Intelligence Determining Departments in High Schools Using Multi-Attribute Decision Making Techniques, it's used AHP and SAW Method [5]. Related research was also carried out by Howard Gardner and Thomas Hatch with the title “Multiple Intelligences Go to School Educational Implications of the Theory of Multiple Intelligences” these results give some support to the major claims of the theory, inasmuch as children ranging in age from 3 to 7 do exhibit profiles of relative strength and weakness. Thus, the rather different profile of results obtained with our two young populations indicates that, in future research, we must pay closer attention to three factors: (a) the developmental appropriateness of the materials; (b) the social class background, which may well exert an influence on a child's ability and willingness to engage with diverse materials; and (c) the exact deployment of the Spectrum materials and assessment instruments in the classroom [6].

2. Method of implementation

The method in the execution of this study uses the waterfall method in its implementation, namely the work done from top to bottom in sequence. The steps to be taken in this study include:

- Library Studies are theories that need to be understood to support the smooth running of this research. The following are supporting theories which consist of a). Learn about Multi Attribute Decision Making (MADM) and Weighted Product Method (WP). b). Learn how the Weighted Product (WP) method and Multiple Intelligence work to be applied to determine children's intelligence and c). Learn the algorithms that will be used in decision support systems (DSS).

- Multi Attribute Decision Making (MADM) decision support system design uses Weighted Product (WP) in accordance with the methods in MADM. Program design is carried out before implementing the application and then tests.

- Trial and system evaluation. This is done at SMP 3 Negeri Kepanjren which is based on the number of students and students in the institution to see how far the accuracy of the system has been made.

3. The applied method

Multiple Attribute Decision Making (MADM) is to determine the weight value for each attribute, then proceed with a ranking process that will select alternatives that have been given. Basically, there are 3
approaches to find attribute weight values, namely subjective approaches, objective approaches and integration approaches between subjective and objective. Each approach has strengths and weaknesses. In the subjective approach, the weight value is determined based on the subjectivity of the decision makers, so that several factors in the alternative ranking process can be determined freely. Whereas in the objective approach, the weight value is calculated mathematically so that it ignores the subjectivity of the decision maker.

One way to specify the purpose of the situation | Oi, i=1,....n | is by listing the possible consequences of the alternatives that have been identified | Ai, i=1,....n |. Besides that, the attributes that will be used are also compiled | ak, k=1,....m |. The Multi-Attribute Decision Making (MADM) model is evaluating alternative N to M attributes or criteria, where each attribute does not depend on each other. Each alternative decision matrix for each attribute, X is given as [7].

\[ X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \]  

(1)

Where \( x_{ij} \) is the second alternative performance rating on the jth attribute. Weight values that indicate the relative importance of each attribute are given as, W.

\[ W = \{w_1, w_2, w_3, \ldots \} \]

(2)

Performance rating (X), and weight value (W) are the main values that represent the absolute preferences of decision makers. MADM ends with a ranking process to get the best alternative obtained based on the overall value of the given preference.

The WP (Weighted Product) method uses multiplication to connect the attribute rating, where the rating of each attribute must be paired first with the weight of the attribute in question [8]. This process is the same as the normalization process. The preference for alternative Ai is given as follows:

\[ s_i = \prod_{j=1}^{n} x_{ij}^{w_j} \]

\[ w_j = \frac{w_j}{\sum w_j} \]

Where \( \sum w_j = 1 \). Wj is the rank positive for the profit attribute, and is negative for the cost attribute.

The relation preferences of each alternative are given as follows:

\[ V_i = \frac{\prod_{j=1}^{n} x_{ij}^{w_j}}{\prod_{j=1}^{n} (x_{ij}^{-})^{w_j}} \]

4. Results and discussion
The WP (Weighted Product) method starts by determining the weight in each criterion that will be used as a reference. The weight used in this study is the benefit of the value of 24 from the importance values of 5, 4, 3, 2, 1, 3, 1 so that the Weight of Interest of each criterion can be obtained is 0.208333333, 0.166666667, 0.208333333, 0.125, 0.083333333, 0.041666667, 0.125 and 0.041666667.

| Table 1. Weight of Interest used in research |
|-----------------------------------------------|
| Cost / Benefit | Benefit | Benefit | Benefit | Benefit | Benefit | Benefit | Benefit | Benefit | Total Weight |
|----------------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Interest       | 5       | 4       | 5       | 3       | 2       | 1       | 3       | 1       | 24           |
| Weight of Interest | 0.208333 | 0.16667 | 0.20833 | 0.125   | 0.0833  | 0.04167 | 0.125   | 0.0417  | 1            |
Normalization of the X matrix based on equations so that the normalized S matrix is obtained, the following table 2.

| Alternative / Criteria          | S_1 | S_2 | S_3 | S_4 | S_5 | S_6 | S_7 | S_8 |
|--------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Linguistic Intelligence       | 1   | 3   | 2   | 2   | 3   | 5   | 3   | 4   |
| Mathematical Intelligence    | 3   | 2   | 4   | 2   | 5   | 1   | 2   | 2   |
| Interpersonal Intelligence    | 4   | 2   | 3   | 1   | 3   | 2   | 2   | 4   |
| Musical Intelligence          | 2   | 3   | 2   | 5   | 2   | 2   | 3   | 5   |
| Visual-Spatial Intelligence   | 2   | 3   | 4   | 5   | 2   | 1   | 1   | 3   |
| Kinesthetic Intelligence      | 3   | 4   | 5   | 2   | 3   | 2   | 3   | 2   |
| Naturalist Intelligence       | 5   | 2   | 3   | 1   | 2   | 2   | 3   | 5   |

Table 2. Matrix X.

The value of w_j is rank positive for profit attributes, and negative for cost attributes, all the criteria in this study are positive values: 0.20833333, 0.16666667, 0.20833333, 0.125, 0.08333333, 0.04166667, 0.125 and 0.04166667. This value is obtained from

\[ w_1 = \frac{5}{5 + 4 + 5 + 3 + 2 + 1 + 3 + 1} = \frac{5}{24} = 0.20833333 \]
\[ w_2 = \frac{4}{5 + 4 + 5 + 3 + 2 + 1 + 3 + 1} = \frac{4}{24} = 0.16666667 \]
\[ w_3 = \frac{5}{5 + 4 + 5 + 3 + 2 + 1 + 3 + 1} = \frac{5}{24} = 0.20833333 \]
\[ w_4 = \frac{3}{5 + 4 + 5 + 3 + 2 + 1 + 3 + 1} = \frac{3}{24} = 0.125 \]
\[ w_5 = \frac{1}{5 + 4 + 5 + 3 + 2 + 1 + 3 + 1} = \frac{1}{24} = 0.08333333 \]
\[ w_6 = \frac{3}{5 + 4 + 5 + 3 + 2 + 1 + 3 + 1} = \frac{3}{24} = 0.125 \]
\[ w_7 = \frac{1}{5 + 4 + 5 + 3 + 2 + 1 + 3 + 1} = \frac{1}{24} = 0.04166667 \]

Table 3. Benefit attribute value (Benefit).

| S_1 | S_2 | S_3 | S_4 | S_5 | S_6 | S_7 | S_8 |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 0.208333 | 0.1667 | 0.2083 | 0.125 | 0.0833 | 0.0417 | 0.125 | 0.0417 |

Vector S is calculated using equation 2.5 to obtain the results as follows

\[ S_1 = (1-0.20833333)(3-0.16666667)(2-0.20833333)(2-0.125)(3-0.08333333)(5-0.16666667)(3-0.125)(4-0.04166667) = 2.155129569 \]
\[ S_2 = (3-0.20833333)(2-0.16666667)(4-0.20833333)(2-0.125)(5-0.08333333)(1-0.16666667)(2-0.125)(2-0.04166667) = 2.636528899 \]
\[ S_3 = (2-0.20833333)(3-0.16666667)(4-0.20833333)(4-0.125)(5-0.08333333)(1-0.16666667)(1-0.125)(5-0.04166667) = 2.098328791 \]
\[ S_4 = (4-0.20833333)(2-0.16666667)(3-0.20833333)(1-0.125)(3-0.08333333)(2-0.16666667)(2-0.125)(4-0.04166667) = 2.454814589 \]
Table 4. Value vector.

| Alternative                        | Value V
|-----------------------------------|-----------
| Linguistic Intelligence (A 1)     | 2.15513   |
| Mathematical Intelligence (A 2)   | 2.636629  |
| Interpersonal Intelligence (A 3)  | 2.098329  |
| Intrapersonal Intelligence (A 4)  | 2.454815  |
| Musical Intelligence (A 5)        | 2.622487  |
| Visual-Spatial Intelligence (A 6) | 2.511893  |
| Kinesthetic Intelligence (A 7)    | 3.217194  |
| Naturalist Intelligence (A 8)     | 2.639875  |

The Vector V value will be used to rank the formula based on equation 2.4 so that the results are obtained with the following details:

\[ S_5 = (2^{-0.2083333})(3^{-0.16666666})(2^{-0.2083333})(5^{-0.125})(2^{-0.04166666})(3^{-0.125})(5^{-0.04166666}) = 2.62485619 \]

\[ S_6 = (2^{-0.2083333})(3^{-0.16666666})(4^{-0.2083333})(5^{-0.125})(2^{-0.04166666})(1^{-0.125})(3^{-0.04166666}) = 2.51182749 \]

\[ S_7 = (3^{-0.2083333})(4^{-0.16666666})(5^{-0.2083333})(2^{-0.125})(3^{-0.04166666})(2^{-0.04166666})(3^{-0.04166666}) = 3.21719354 \]

\[ S_8 = (5^{-0.2083333})(2^{-0.16666666})(3^{-0.2083333})(1^{-0.125})(2^{-0.04166666})(2^{-0.04166666})(3^{-0.04166666}) = 2.639874827 \]

Table 5. Value vector V.

| V      | Results                  |
|--------|--------------------------|
| 0.118167 | V_1 Linguistic Intelligence |
| 0.144568 | V_2 Mathematical Intelligence |
| 0.115052 | V_3 Interpersonal Intelligence |
| 0.134599 | V_4 Intrapersonal Intelligence |
| 0.143792 | V_5 Musical Intelligence |
| 0.137728 | V_6 Visual-Spatial Intelligence |
| 0.1764  | V_7 Kinesthetic Intelligence |
| 0.144746 | V_8 Naturalist Intelligence |
The biggest value in the table 5 is V7 with a value of 0.176400366 so V7 is the alternative chosen as the best alternative. In other words, Kinesthetic Intelligence will be chosen as Intelligence possessed.

System Testing Results for one of the students of Kepanjen State Middle School with the name Nabila Dana Diva who has filled in the lift.

![Graph of intelligence results](image)

**Figure 1.** Graph of intelligence results.

5. **The contribution of partner**
The results of the research conducted at SMP 3 Negeri Kepanjen from 226 data registered students and filling out the questionnaire (indicators) provided there were 72 students who registered but did not complete the questionnaire so that the value of intelligence did not appear completely. 12 Students have Interpersonal Intelligence from 226 students, 22 students have Kinesthetic Intelligence, 17 students have Mathematical Intelligence, 25 students have Naturalist Intelligence, 27 students have Verbal-Linguistic Intelligence and 51 students have Visual-Spatial Intelligence results obtained during the date period 01, 07, 2017 to the 20th, 07, 2017.

6. **Conclusion**
This research can be concluded based on the results obtained are:
- The system can determine the Multiple Intelligence of Children of the Kepanjen 3 Middle School based on the questionnaire that becomes the indicator in the study with the Multi-Attribute Decision Making decision using the WP (Weighted Product) Method.
- Implementation in testing can be done outside of school by accessing www.teskeeintelligence.com, but on the implementation in the field students access at school assisted by computer technicians to connect to the internet so that it takes a long time because the correction is still manual in the sense that it still uses cables network.
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