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Implementation of the Extended Promethee II in Upgrade Level of Mechanic

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ABSTRACT

Mechanical service heavy equipment that can also be referred to as a technician is a worker who has expertise in the machine. Heavy equipment as a tool that can help people complete big jobs, such as plantations, infrastructure, factories and others. Equipment of heavy equipment is one of the important things in construction work. The weighted data are the values of each service mechanic in the form of numbers instead of alphabetical ones. So from the calculation process can determine which service mechanic is the best for the feasibility of increasing the level of mechanical service. In this article researchers using The Extended PROMETHEE II (EXPROM2) method is the development of a modified version of the PROMETHEE II method, or similar to PROMETHEE II. An alternative pairwise comparison takes into account any deviations from any criteria considered in the method of The Extended Promethee II (EXPROM2).

Keywords: Mechanic, EXPROM2 Method, DSS

I. INTRODUCTION

The position of mechanical service of heavy equipment is a vital and important position owned by big companies especially in the field of heavy equipment sales such as Excavator, Forklift, Wheel Loader, Tractor and other heavy equipment. Companies do various ways by making breakthroughs to what is sold by the company to the customer can satisfy with service provided, therefore, heavy equipment companies must have a service mechanic that aims when there is damage to equipment, mechanical service can make improvements. The company's profit has heavy equipment service mechanics can help companies gain trust by customers and increase sales of heavy equipment units.

In the position of mechanical service there are several levels, among others: pre-mechanical, mechanical I, mechanical II, mechanical III, mechanic IV. The objective of the company is to raise the level of service mechanics to reward and prosper the employees. The criteria used by the company to determine the service mechanical decisions that can be increased level based on loyalty, report, absenteeism. However, various problems are found when deciding the decision by not using an information system. Use of information systems[1], [2] that support decision system is a tool for corporate leaders to determine a more accurate choice. There are several methods applied to the decision support system such as Simple Additive Weighting (SAW)[3]–[5], Technique for Order Performance by Similarity to Ideal Solution (TOPSIS)[6][7], Weighted Product (WP), Extended PROMETHEE II [8][9], Fuzzy Tsukamoto [10].

In a previous study conducted by Chatterjee, P., Mondal, S., Chakraborty, S. the decision-making system selected a manufacturing industry robot using the steps of The Extended PROMETHEE II method, to determine the ranking of existing criteria and alternatives[11]. In this method, the relative performance of one of the other alternatives is defined by two preference indices, namely the weak preference index, based on the combined preferences function considering the criterion weight, as determined in PROMETHEE II and the rigorous preference index, based on an ideal and anti-ideal.

Ideal and anti-ideal values are directly derived from the decision matrix, and reflect extreme limits for certain criteria. The total preference index is calculated by adding a tight preference index and a weak preference index, thus providing an accurate measure of the intensive preference of one alternative over another considering all criteria[12].

II. METHODS AND MATERIAL

2.1 Mechanic

Mechanical service heavy equipment that can also be referred to as a technician is a worker who has expertise in the machine. Based on the Regulation of the Minister of Work and Transmigration of the Republic of Indonesia No. Per.09 / MEN / VII / 2010, the mechanic is the executive officer of installation, maintenance, repair and/or inspection of equipment/components of the lifter and hauling aircraft.

2.2 The Extended Promethee II (EXPROM II)

The Extended Promethee II (EXPROM2) is a modified method of Promethee II. In the steps of the method, EXPROM2 has a resemblance to Promethee II. Comparison of paired alternatives consider deviations from each criterion considered in the method of The Extended Promethee II (EXPROM2)[11].

The steps of The Extended Promethee II(EXPROM2)[13][9], can be seen below:

Step 1: Normalize the decision matrix

Normalize the decision matrix (x_{ij}), for the gain attribute using equation 1 and for the cost attribute using equation 2:

$$R_{ij} = [x_{ij} - \min(x_{ij})]/[\max(x_{ij}) - \min(x_{ij})] \quad \text{.....(1)}$$

$$i=1, 2, \dots, m ; j = 1, 2, \dots, n$$

$$R_{ij} = [\max(x_{ij}) - x_{ij}]/[\max(x_{ij}) - \min(x_{ij})] \quad \text{.....(2)}$$

Step 2: Calculates evaluative differences from alternative i^{th} with other alternatives.

This step involves calculating the difference in criterion value (d_j) between different alternatives pair-wise.

Step 3: Calculate Preferences $P_j(i, i')$

There are six main types of preference functions, such as ordinary criteria, U-shape criteria, V-form criteria, level criteria, The V-form criteria and Gaussian criteria, but most are common criteria using the following formula:

$$P_j(i, i') = 0 \text{ if} r_{ij} \leq r_{i'j} \quad \text{..... (3)}$$

$$P_j(i, i') = (r_{ij} - r_{i'j}) \text{if } r_{ij} > r_{i'j} \quad \text{.....(4)}$$

Step 4: Calculate the Weak Preferences Index

The preference index calculation is weak by considering the weighted value criterion with the following equation.

$$WP(i, i') = [\sum_{j=1}^{n} W_j x P_j(i, i')] / \sum_{j=1}^{n} W_j \quad \text{.....(5)}$$

Where w_j is the relative importance (weight) of the j criterion.

Step 5: Define the strict preferences

The strict preferences, $SPj(i, i')$ is based on the ratio of dmj values to the range of values as defined by the evaluation of all alternative circuits for a criterion.

$$SP_j(i, i') = [\max(0, d_j - L_j)]/[dm_j - L_j] \quad \text{.....(6)}$$

Where Lj is the limit of preference (0 for the usual criterion preferences function and values unimportant for the other five functions of preference) and dmj differ among other ideal and anti-ideal values of the number of criteria.

Step 6: Compute the strict preferences index

The strict preference index calculation uses the following equation:

$$SP(i, i') = [\sum_{j=1}^{n} W_j x SP_j(i, i')] / \sum_{j=1}^{n} W_j \quad \text{.....(7)}$$

Step 7: Calculates the value of total preferences index

$$TP(i, i') = \text{Min}[1, WP(i, i') + SP(i, i')] \quad \text{.....(8)}$$

Step 8: Determining leaving flow and entering Outrangking Flow

Determination of Leaving Flow and Entering Outrangking Flow using the equation:

Leaving (Positive) Flow

$$\varphi^{+}(i) = \frac{1}{m-1} \sum_{i'=1}^{n} TP(i, i') \; (i \neq i') \quad \text{.....(9)}$$

Entering (Outrangking) Flow.

$$\varphi^{-}(i) = \frac{1}{m-1} \sum_{i'=1}^{n} TP(i', i) \; (i \neq i') \quad \text{.....(10)}$$

Step 9: Calculating the net outrangking flow

$$\varphi(i) = \varphi^{+}(i) - \varphi^{-}(i) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Step 10: Determine the rangking

Determining all the priceless alternatives depends on the value of $\varphi(i)$. The better of alternative is the higher value of $\varphi(i)$.

III. RESULTS AND DISCUSSION

During this system the feasibility of increasing the mechanical level of heavy equipment service is made by the Manager service, which gets report data from the Service Supervisor which will be forwarded to the Director to approve it, the data is reported manually not accompanied by valid service mechanical data. From the procedure of increasing the mechanical level are encountered many constraints because the system has not been using the decision support system.

Application of EXPROM2 method is expected to solve the problem problems.

Table 1. Criteria and Weight

Criateria	Weight	Type
Education (C_1)	0.10	Benefit
Experience (C_2) (In Year)	0.30	Benefit
Keahlian C_3)	0.40	Benefit
Reporting (C_4)	0.20	Benefit

Table 2 is the value range of the Education criteria.

Table 2. Education (C_1)

Information	Value
SMU	1
D3	2
S1	3

Table 3 show the range of values of the reporting criteria.

Table 3. Reporting (C_4)

Information	Value
Cukup	1
Good	2
Excelent	3

Table 4 is a range of values from skill criteria.

Table 4. Skill (C_3)

Information	Value
Engine	1
Electric	2
Overhoul	3

Table 5 is a list of student alternatives to be selected the best.

Table 5. Employee Alternative

Alternative	Criteria			
	C_1	C_2	C_3	C_4
A_1	SMU	2	Electric	Good
A_2	S1	1	Engine	Sangat Bagus
A_3	SMU	3	Engine	Sangat Bagus
A_4	D3	2	Overhoul	Good

Based on table 5 and the range of values on each criterion, the results of each alternative are obtained as follows:

Table 6. The alternative Match Rating Table and Criteria

Alternative	Criteria			
	C_1	C_2	C_3	C_4
A_1	1	2	2	2
A_2	3	1	1	3
A_3	1	3	1	3
A_4	2	2	3	2

The first step is to apply the EXPROM2 method, which is normalizing the decision matrix using equation 1.

C_1 = Education

$$R1,1 = \frac{[1-1]}{[3-1]} = 0$$

$$R2,1 = \frac{[3-1]}{[3-1]} = 1$$

$$R3,1 = \frac{[1-1]}{[3-1]} = 0$$

$$R3,1 = \frac{[2-1]}{[3-1]} = 0.5$$

C_2 = Experience

$$R1,2 = \frac{[2-1]}{[3-1]} = 0.5$$
$$R2,2 = \frac{[1-1]}{[3-1]} = 0$$
$$R3,2 = \frac{[3-1]}{[3-1]} = 1$$
$$R3,2 = \frac{[2-1]}{[3-1]} = 0.5$$

Do the same for C3 and C4 columns The R_{ij} matrix will be as follows:

$$Rij = \begin{bmatrix} 0 & 0,5 & 0,5 & 0 \\ 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0,5 & 0,5 & 1 & 0 \end{bmatrix}$$

The next step is finding for the Preferences $P_j(i,i')$ with equations 3 and 4.

For C1, pairs-wise matrix:
$if\ 0 \leq 1\ True, then\ P_1(1,2) = 0$
$if\ 0 \leq 0\ True, then\ P_1(1,3) = 0$
$if\ 0 \leq 0.5\ True, then\ P_1(1,4) = 0$
$if\ 1 \leq 0\ False\ Else\ if\ 1 > 0\ True,$
$then\ P_1(2,1) = 1 - 0 = 1$
$if\ 1 \leq 0\ False\ Else\ if\ 1 > 0\ True,$
$then\ P_1(2,3) = 1 - 0 = 1$
$if\ 1 \leq 0\ False\ Else$ if $1 > 0$ True,
then $P_1(2,4) = 1 - 0.5 = 0.5$
if $0 \leq 0$ True, then $P_1(3,1) = 0$
if $0 \leq 1$ True, then $P_1(3,2) = 0$
if $0 \leq 0.5$ True, then $P_1(3,4) = 0$
if $0.5 \leq 0$ False Else if $0.5 > 0$ True,
then $P_1(4,1) = 0.5 - 0 = 0.5$
if $0.5 \leq 1$ True, then $P_1(4,2) = 0$
if $0.5 \leq 0$ False Else if $0.5 > 0$ True,
then $P_1(4,3) = 0.5 - 1 = 0.5$

Next, do the same steps for C2, C3 and C4, will get the results as in table 7.

Table 7. Result of comparison of matrix pairs-wise

Alternative	C_1	C_2	C_3	C_4
$P_1(1,2)$	0	0.5	0.5	0
$P_1(1,3)$	0	0	0.5	0
$P_1(1,4)$	0	0	0	0
$P_2(2,1)$	1	0	0	1
$P_2(2,3)$	1	0	0	0
$P_2(2,4)$	0.5	0	0	1
$P_3(3,1)$	0	0.5	0	1
$P_3(3,2)$	0	1	0	0
$P_3(3,4)$	0	0.5	0	1
$P_4(4,1)$	0.5	0	0.5	0
$P_4(4,2)$	0	0.5	1	0
$P_4(4,3)$	0.5	0	1	0

The next process calculates the Weak Preferential Value using equation 5.

WP (1,2) = ((0.1*0) + (0.3*0.5) + (0.4*0.5) + (0.2*0)) / 1
= 0.35
WP (1,3) = ((0.1*0) + (0.3*0) + (0.4*0.5) + (0.2*0)) / 1
= 0.2
WP (1,4) = ((0.1*0) + (0.3*0) + (0.4*0) + (0.2*0)) / 1
= 0
WP (2,1) = ((0.1*1) + (0.3*0) + (0.4*0) + (0.2*1)) / 1
= 0.3

Calculate up to P_4 (4.3), and the results obtained as in Table

Table 8. Weak Preferences

Alternative	Value
WP (1,2)	0.35
WP (1,3)	0.2
WP (1,4)	0
WP (2,1)	0.3
WP (2,3)	0.1
WP (2,4)	0.25
WP (3,1)	0.35
WP (3,2)	0.3
WP (3,4)	0.35
WP (4,1)	0.25
WP (4,2)	0.55
WP (4,3)	0.45

Then use equation 6 to find the value of strict preference, the result as in Table 9

Table 9. Strict Preferences

Alternative	Value
SP(1,2)	0.35
SP (1,3)	0.2
SP (1,4)	0
SP (2,1)	0.3
SP (2,3)	0.1
SP (2,4)	0.25
SP (3,1)	0.35
SP (3,2)	0.3
SP (3,4)	0.35
SP (4,1)	0.25
SP (4,2)	0.55
SP (4,3)	0.45

From WP and SP, calculate the Total Preference value by using an equation to 8.

Table 10. The Total Preference Value

Alternative	Value
TP (1,2)	Min [1, 0.35+0.35] = 0.7
TP (1,3)	Min [1, 0.2+0.2] = 0.4
TP (1,4)	Min [1, 0+0] = 0
TP (2,1)	Min [1, 0.3+0.3] = 0.6
TP (2,3)	Min [1, 0.1+0.1] = 0.2
TP (2,4)	Min [1, 0.25+0.25] = 0.5
TP (3,1)	Min [1, 0.35+0.35] = 0.7
TP (3,2)	Min [1, 0.3+0.3] = 0.6
TP (3,4)	Min [1, 0.35+0.35] = 0.7
TP (4,1)	Min [1, 0.25+0.25] = 0.5
TP (4,2)	Min [1, 0.55+0.55] = 1
TP (4,3)	Min [1, 0.45+0.54] = 0.9

From Table XI will form the dominant aggregate matrix as follows:

$$\begin{bmatrix} - & 0.7 & 0.4 & 0 \\ 0.6 & - & 0.2 & 0.5 \\ 0.7 & 0.6 & - & 0.7 \\ 0.5 & 1 & 0.9 & - \end{bmatrix}$$

The next step calculate Leaving Flow and Entering (Outrangking) Flow using equations 9 and 10.

$$\varphi 1^{+} = \frac{1}{4-1}[0.7 + 0.4 + 0] = \frac{1}{3}\text{x}1.1 = 0.36667$$
$$\varphi 2^{+} = \frac{1}{4-1}[0.6 + 0.2 + 0.5] = \frac{1}{3}\text{x}1.3 = 0.43333$$
$$\varphi 3^{+} = \frac{1}{4-1}[0.7 + 0.6 + 0.7] = \frac{1}{3}\text{x}2 = 0.66667$$
$$\varphi 4^{+} = \frac{1}{4-1}[0.5 + 1 + 0.9] = \frac{1}{3}\text{x}2.4 = 0.8$$
$$\varphi 1^{-} = \frac{1}{4-1}[0.6 + 0.7 + 0.5] = \frac{1}{3}\text{x}1.8 = 0{,}6$$
$$\varphi 2^{-} = \frac{1}{4-1}[0.7 + 0.6 + 1] = \frac{1}{3}\text{x}2.3 = 0.76667$$
$$\varphi 3^{-} = \frac{1}{4-1}[0.4 + 0.2 + 0.9] = \frac{1}{3}\text{x}1.5 = 0{,}5$$
$$\varphi 4^{-} = \frac{1}{4-1}[0 + 0.5 + 0.7] = \frac{1}{3}\text{x}1.2 = 0{,}4$$

The last step calculates the Net (Outrangking) Flow using equation 11.

Table 11. The Leaving Flow and Entering Flow

Alternative	Leaving Flow	Entering (Outrangking) Flow	Net (Outrangking) Flow
A_1	0.366667	0.6	-0.233
A_2	0.433333	0.766667	-0.333
A_3	0.666667	0.5	0.167
A_4	0.8	0.4	0.400

Table 12. Rangking

Alternative	Result	Rank
A_1	-0.233	3
A_2	-0.333	4
A_3	0.167	2
A_4	0.400	1

From the calculation, it is clear that Alternative A_4 is the best alternative of all alternatives.

IV. CONCLUSION

Discussion of the above research can be concluded:

1. Professional heavy equipment service mechanic can assist customers in solving problems that occur in heavy equipment unit. Therefore the criteria of a recommendation of mechanical service feasibility of

heavy equipment made by the company aim to improve the mechanical performance of heavy equipment service, it is taken from the value of the weight criteria of each existing alternative.

2. Application of EXPROM2 method is calculated the value of weight for ranking on each criterion owned by each service machine mechanic by going through several stages such as making matrix x, normalizing, making a normalized matrix, and doing the calculation of preference to obtain the results maximum and accurate that can be recommended to the mechanical level I, from the calculation of the process we can find out a viable alternative to climb the mechanical level I.

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