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RESEARCHARTICLE

DECISION SUPPOR FOR SELECTION OF SYSTEM ANALYST IN INDUSTRY 4.0 GENERATION ERA USING: MCDM-AHP AND PROMETHEE ELIMINATION METHODS

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ABSTRACT

The process of developing information systems in the industrial 4.0 era is a necessity that needs to be done to follow even to maintain the existence of the company even to defeat the competitor companies in the current digital era. Now many large companies can not develop because they do not rely on good information technology in running their companies, even small scale companies are able to develop and defeat large scale companies. System analyst is a work to develop a company system that is able to maintain and improve the company's progress towards its competitors, so the strong question is how to find out the recruitment of system analysts in the selection process can be well known, so as to produce human resources in the field of systems analysts really have competencies in accordance with what is needed. A method that can be done is to do a combination of two methods that can be used to conduct a selection of reliable human resource recruitment, namely the Analytic Hierarchy Process (AHP) and the Promethee elimination method. AHP can be used to measure the weights of each criterion needed and Promethee Elimination can be used to determine the highest selection weights to prioritize.

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INTRODUCTION

Malnutrition The toughest challenge in the industry 4.0 era now is to defeat similar competitors, large companies are not a problem now but companies that are able to handle the technological needs to rule the world (Veena 2016). In the current digitalization era, it is very much needed to master technology that is capable of processing data into digital form, digital industry is very capable of breaking into the world market in introducing and marketing its products in digital form (Yadav 2016). The communication media that are widely used by everyone is in the digital form. Many users use digital or electronic technology to market all forms of their products (Kumari and Mallaiah 2017). Based on this view, the problem that can be raised is the need for superior human resources (Vongsavanh and Campbell 2008) in the era of digitalization and able to handle all forms of electronic data processing to digitalization form (Yadav 2016). The needs of users in the era of digitizing industry are certainly none other than system analysts . So how is the right way to choose human resources for the needs of system analysts in each company to do the recruitment process (Karanja *et al*. 2016) . Of course there are methods that can be used to pass the recruitment process (Vongsavanh and Campbell 2008).There are methods that can be used to pass the recruitment process to the needs of human resources such as the selection of systems analysts namely the collaboration method known as the Analytic Hierarchy Process (AHP) method (Vargas 2010),(Mareschal and Smet 2009), and the Promethee Elimination method (RAO 2009),(Brans JP and Vincke Ph 1985). Both of these methods can be used to conduct a selection process on the needs of human resources such as the needs of system analysts . The work process of the AHP method is to assign ranking weights related to the needs of the criteria used in the selection process (Jones 2018), (Guh, Lou, and Po 2009), while the method of preliminary elimination is used (De

Keyser and Peeters 1996) to carry out the selection process for a number of alternatives which are the focus of the selection process (Moreira, Dupont, and Vellasco 2009) . The seven criteria used as a measurement barometer are: Description of Abstract (DA), Conceptual Design (CD), Logical Data Model (LM), Physical Data Model (PM), Speed Coding (SC), Cyclomatic Complexity (CC), and Matrices Testing (MT), for the SC criteria provides a picture of the inverse assessment with the other six criteria, because this criterion is the smallest assessment as the best assessment, so that the normalization process uses the second concept to determine the index preference (Sun and Han 2010),(Christian, Zhang, and Salifou 2016).The results of the index preferences after being developed from a normalized dataset develop (Ghazinoory, Daneshmand-Mehr, and Azadegan 2013) into as many as 506 data records as preference indexes which will be arranged into a two-dimensional matrices, according to the layout of the data in preference. Thus, it will be able to determine the value of leaving flow, entering flow and net flow (Ghazinoory *et al*. 2013), (De Smet 2016) that are part of the task of the Promethee method to determine the ranking of the selection process for a number of selected system analyst and those affected by elimination.

MATERIALSANDMETHODS

In this section, I will explain several methods that can be used to conduct a selection process on the needs of human resources in the form of system analysts.

Analytic Hierarchy Process(AHP): Each measurement of any problem certainly requires parameters as a measurement tool and the parameters used as a measurement tool are usually numerous and varied. The number of parameters will increase the level of difficulty in carrying out the measurement process, so that the right method is needed and can be used easily to solve the problem. Analytic Hierarchy Process (AHP) is one of the methods used to conduct the selection process for a number of measurement parameters (Saaty, Vargas, and Whitaker 2009),(Chupiphon and Janjira 2016). AHP is able to determine the weighting of importance between each of the multi-parameter measurements (Brunelli, Critch, and Fedrizzi 2013).

The working principle of the AHP is to rank numerical numbers of each criterion, in this case the criteria contain the same meaning as a number of parameters used as a measuring instrument barometer. The data used as a measurement is sourced from a questionnaire method which is compared between criteria one with other criteria, the data is processed using the geometric mean method which is ready to be converted into the AHP scale (Vargas 2010),(Kamble, Vadirajacharya, and Patil 2018)and entered into the form of pairwise matrices adjusted to the order of matrices. Pairwise matrices that have been formed are processed iteratively to determine the optimal eigenvector value (Guh *et al*. 2009). Eigenvector value is said to be optimal meaning that there is no difference between the final eigenvector acquisition calculation with the previous eigenvector acquisition (Thomas L. Saaty 1990).

After obtaining the optimal eigenvector results then determine the amount of consistency, consistency can be used to determine decision support as measured by the acquisition value of consistency ratio (CR) (Guh *et al*. 2009), (Brunelli *et al*. 2013), the amount of which must be less than ten percent. This means that the decision is acceptable, if the opposite results are rejected. Each comparison value carried out must meet the same rules for the entire number of comparisons made. To determine the number of comparisons, it can be done by using (1) which will be related to the use of the random index value (RI) which can be seen in (Table-1). The RI table is a reference for determining the decisions of each comparison used both at the criteria and alternative levels, if this AHP method is used as a whole. In this case the use of the AHP method is not used as a whole, but only limited to the determination of eigenvector level criteria, because the next process is delegated with the method of preliminary elimination which is evidence of collaboration between the two methods (Peterková and Franek 2018).

$$C = \frac{n*(n-1)}{2} \quad (1)$$

Variable C represents the number of comparisons to be used, while the variable n represents the number of orders and is closely related to usage RI Table. So that the decision can be determined from the amount of the consistency ratio (CR) listed in (2).

Table 1.Random Index

Ordo	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.48

$$C = \frac{C}{C} \quad (2)$$

While the consistency index C is obtained based on (3).

$$C = \frac{(\lambda m \quad - n)}{(n-1)} \quad (3)$$

The preparation of pairwise matrices generally meets the rules of using the number of orders $M_{(p,q)}$ with data elements $x_{(p,q)}$ that are used both for alternative criteria and criteria , if AHP application is used in full, pay attention (4).

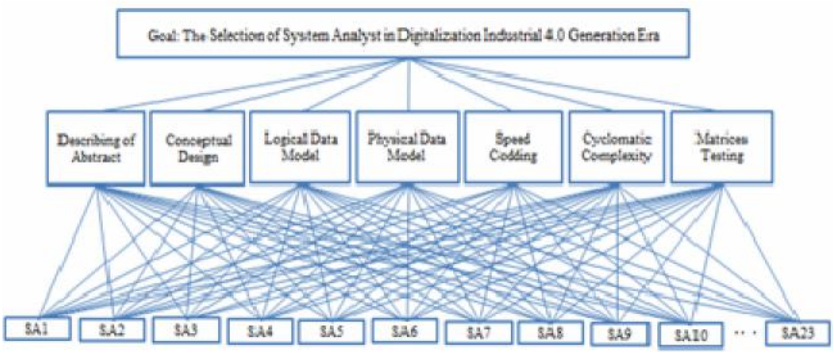

Figure 1. Hierarchy modeling the selection of system analyst.

Criteria	DA	CD	LD	PD	CP	CC	ML	Eigenvector
Abstract Depiction (AD)	1.000	4.000	2.700	2.300	5.000	5.600	5.800	0.369
Conceptual Design (CD)	0.250	1.000	2.230	2.100	4.230	4.340	4.930	0.212
Logical Data Model (LD)	0.370	0.448	1.000	1.240	3.340	4.560	4.670	0.155
Physical Data Model (PD)	0.435	0.476	0.806	1.000	1.230	2.330	3.450	0.111
Codding Program (CP)	0.200	0.236	0.299	0.813	1.000	2.240	3.040	0.074
Cyclomatic Complexity (CC)	0.179	0.230	0.219	0.429	0.446	1.000	1.220	0.043
Matrices Logical (ML)	0.172	0.203	0.214	0.290	0.329	0.820	1.000	0.036
Result λ max=	7.349	*CI*=	0.058	*RI*=	0.044	(Acceptable)		

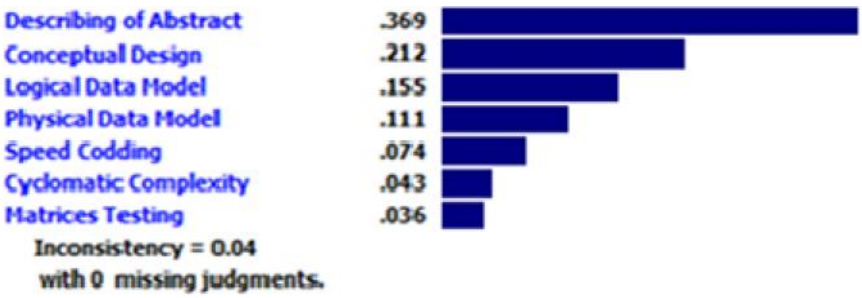

Figure 2. Eigenvector using an expert choice

$$M_{(p,q)} = \begin{bmatrix} x_{(1,1)} & x_{(1,2)} & x_{(1,3)} & \cdots & x_{(1,q)} \\ x_{(2,1)} & x_{(2,2)} & x_{(2,3)} & \cdots & x_{(2,q)} \\ x_{(3.1)} & x_{(3,2)} & x_{(2,4)} & \cdots & x_{(3,q)} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_{(p,1)} & x_{(p,2)} & x_{(p,3)} & \cdots & x_{(p,q)} \end{bmatrix} \quad (4)$$

Promethee: The selection process for human resources such as system analysts uses the Promethee elimination method (De Keyser and Peeters 1996), where the dataset obtained must be normalized first. Normalization process carried out has two data measurement references (Maity and Chakraborty 2015),(Ghazinoory *et al*. 2013), meaning that there is data that has the largest value is the best, if so then using (5) to do the normalization process and there is data with the smallest meaning to have the best value, if like this then do the normalization process uses (6), so the determination of dataset values is somewhat more complicated than usual because the data processed contains two different meanings.

$$B_{(i,j)} = \frac{x_{(i,j)} - x'_{(j)}}{x*_{(j)} - x'_{(j)}} \quad (5)$$

$$K_{(i,j)} = \frac{x_{(i,j)} - x*_{(j)}}{x'_{(j)} - x*_{(j)}} \quad (6)$$

From the normalization process to the listed dataset, then determine the index preference for normalization data by comparing according to the location of the data preference (Aan *et al*. 2017), where data less than zero, will be eliminated, while data more than zero will be processed into the calculation of the method of Promethee elimination which is multiplied by the weight of each criterion used as a parameter (Kaur and Singh 2015).

Table 2. Dataset

Criteria / (Alt)	AD (HB)	CD (HB)	LM (HB)	PM (HB)	SC (LB)	CC (HB)	MT (HB)
SA01	80.34	75.43	75.63	78.54	67.45	86.87	75.97
SA02	82.05	75.73	75.69	79.56	67.70	83.44	76.04
SA03	92.45	82.92	75.43	74.78	56.40	84.03	75.77
SA04	89.45	86.93	77.23	72.74	50.33	85.47	77.58
SA05	91.40	77.61	74.81	80.34	68.33	81.41	75.15
SA06	86.40	78.56	78.15	82.34	50.41	90.21	78.51
SA07	77.89	80.34	80.18	80.36	55.63	86.06	80.55
SA08	89.67	82.04	80.23	80.22	57.22	85.06	80.60
SA09	90.45	84.56	78.45	78.34	48.45	80.52	78.81
SA10	93.45	83.51	74.04	80.09	57.12	80.05	74.38
SA11	84.56	74.18	76.89	81.82	55.78	81.03	77.24
SA12	85.12	81.48	80.51	78.84	57.94	84.16	80.88
SA13	88.46	78.84	81.04	78.93	57.60	79.65	81.41
SA14	85.23	80.64	80.33	80.13	60.11	80.18	80.70
SA15	83.00	72.23	75.05	80.23	57.37	80.36	75.39
SA16	83.67	63.93	77.04	82.90	56.79	79.05	77.39
SA17	75.87	68.58	73.05	75.88	53.37	79.04	92.48
SA18	80.45	82.28	76.92	78.05	60.24	80.56	77.27
SA19	85.42	82.54	80.52	80.03	60.00	79.17	80.89
SA20	86.72	88.46	78.33	78.86	65.00	78.98	78.69
SA21	86.16	70.34	79.41	84.04	69.12	78.21	79.77
SA22	82.43	79.75	81.29	79.58	53.50	81.49	81.66
SA23	83.11	80.00	82.03	75.41	61.34	82.38	82.40

Table 3. Normalization data

Alt	SA01	SA02	SA03	SA04	SA05	SA06	SA07	SA08	SA09	SA10	SA11	SA12	SA13	SA14	SA15	SA16	SA17	SA18	SA19	SA20	SA21	SA22	SA23
SA01		0.03	0.08	0.09	0.07	0.00	0.04	0.02	0.06	0.10	0.06	0.02	0.07	0.06	0.10	0.15	0.26	0.06	0.07	0.07	0.11	0.08	0.08
SA02	0.04		0.07	0.09	0.04	0.00	0.05	0.00	0.04	0.07	0.03	0.01	0.04	0.05	0.07	0.12	0.27	0.07	0.04	0.05	0.08	0.02	0.06
SA03	0.21	0.19		0.07	0.09	0.11	0.21	0.04	0.06	0.07	0.19	0.11	0.12	0.15	0.24	0.29	0.41	0.19	0.14	0.12	0.22	0.18	0.16
SA04	0.24	0.23	0.09		0.16	0.10	0.20	0.04	0.06	0.16	0.20	0.11	0.12	0.15	0.28	0.29	0.45	0.20	0.14	0.10	0.22	0.18	0.16
SA05	0.18	0.14	0.07	0.13		0.07	0.18	0.02	0.05	0.04	0.12	0.10	0.07	0.09	0.16	0.21	0.38	0.18	0.10	0.10	0.15	0.13	0.17
SA06	0.25	0.24	0.23	0.19	0.20		0.18	0.08	0.14	0.23	0.18	0.12	0.14	0.14	0.29	0.25	0.50	0.26	0.15	0.15	0.17	0.17	0.21
SA07	0.18	0.18	0.22	0.18	0.20	0.06		0.01	0.12	0.22	0.17	0.04	0.09	0.06	0.24	0.25	0.38	0.17	0.07	0.13	0.16	0.06	0.10
SA08	0.31	0.28	0.21	0.18	0.20	0.12	0.17		1.28	2.31	3.81	1.44	1.58	1.80	5.07	5.86	8.01	3.87	1.65	2.08	3.66	2.52	2.85
SA09	0.27	0.24	0.14	0.12	0.14	0.10	0.19	0.03		0.13	0.19	0.09	0.07	0.10	0.27	0.27	0.46	0.19	0.09	0.07	0.17	0.14	0.17
SA10	0.25	0.21	0.09	0.15	0.07	0.12	0.22	0.06	0.06		0.18	0.14	0.12	0.13	0.21	0.25	0.41	0.21	0.12	0.12	0.20	0.18	0.22
SA11	0.13	0.10	0.13	0.12	0.07	0.00	0.11	0.02	0.05	0.11		0.04	0.05	0.06	0.11	0.10	0.33	0.11	0.04	0.06	0.05	0.06	0.10
SA12	0.23	0.21	0.19	0.17	0.20	0.08	0.11	0.01	0.09	0.21	0.18		0.06	0.05	0.27	0.27	0.45	0.20	0.05	0.11	0.16	0.07	0.10
SA13	0.28	0.24	0.20	0.18	0.17	0.10	0.16	0.02	0.08	0.18	0.19	0.06		0.00	0.06	0.27	0.27	0.45	0.23	0.06	0.10	0.14	0.08
SA14	0.24	0.20	0.20	0.18	0.16	0.07	0.10	0.00	0.07	0.17	0.14	0.02	0.03		0.22	0.25	0.42	0.18	0.01	0.08	0.11	0.05	0.10
SA15	0.06	0.02	0.07	0.10	0.01	0.00	0.07	0.00	0.03	0.03	0.00	0.02	0.02	0.00		0.07	0.23	0.06	0.01	0.03	0.03	0.02	0.06
SA16	0.14	0.10	0.15	0.13	0.09	0.01	0.11	0.04	0.06	0.12	0.02	0.05	0.05	0.04	0.10		0.28	0.11	0.04	0.06	0.01	0.06	0.11
SA17	0.08	0.08	0.10	0.12	0.09	0.07	0.06	0.06	0.07	0.09	0.08	0.06	0.06	0.06	0.09	0.11		0.08	0.06	0.07	0.07	0.05	0.06
SA18	0.08	0.08	0.08	0.07	0.09	0.02	0.05	0.00	0.00	0.08	0.05	0.01	0.03	0.01	0.12	0.13	0.27		0.01	0.02	0.10	0.02	0.05
SA19	0.26	0.22	0.20	0.18	0.18	0.09	0.12	0.01	0.08	0.17	0.16	0.03	0.04	0.02	0.24	0.24	0.43	0.19		0.08	0.12	0.06	0.11
SA20	0.24	0.21	0.17	0.12	0.16	0.07	0.17	0.04	0.03	0.14	0.16	0.07	0.06	0.07	0.24	0.23	0.42	0.17	0.06		0.13	0.11	0.15
SA21	0.25	0.21	0.23	0.21	0.17	0.06	0.16	0.05	0.00	0.19	0.12	0.08	0.07	0.06	0.21	0.15	0.39	0.22	0.06	0.10		0.11	0.15
SA22	0.22	0.18	0.22	0.20	0.19	0.09	0.09	0.03	0.10	0.20	0.16	0.03	0.04	0.04	0.22	0.24	0.40	0.17	0.04	0.11	0.14		0.06
SA23	0.23	0.21	0.18	0.16	0.21	0.11	0.12	0.05	0.11	0.23	0.18	0.04	0.06	0.06	0.25	0.27	0.39	0.19	0.07	0.13	0.17	0.04	

The value obtained will automatically occupy the position of the matrices element. So that the final process of determining the leaving flow, entering flow and net flow can be done easily to determine the ranking of the process of selecting anally until the system is eliminated by the method of method.To determine the amount of leaving flow values drawn from the two-dimensional matrices, we can use (7), while to determine the value of entering flow using (8). Whereas (7) and (8) illustrate that biased data cannot be taken as a whole conclusion, thus it takes one more stage to unify it, namely determining the amount of net flow value as a process that can be used to determine decision support that can be used through.

Tabel 4. Index preference matrices

Criteria (Alt)	AD 0.369	CD 0.212	LM 0.155	PM 0.111	SC 0.074	CC 0.043	MT 0.036
SA01	0.25	0.47	0.29	0.51	0.08	0.72	0.09
SA02	0.35	0.48	0.29	0.60	0.07	0.44	0.09
SA03	0.94	0.77	0.27	0.18	0.62	0.49	0.08
SA04	0.77	0.94	0.47	0.00	0.91	0.61	0.18
SA05	0.88	0.56	0.20	0.67	0.04	0.27	0.04
SA06	0.60	0.60	0.57	0.85	0.91	1.00	0.23
SA07	0.11	0.67	0.79	0.67	0.65	0.65	0.34
SA08	0.78	0.74	0.80	0.66	0.58	0.57	0.34
SA09	0.83	0.84	0.60	0.50	1.00	0.19	0.24
SA10	1.00	0.80	0.11	0.65	0.58	0.15	0.00
SA11	0.49	0.42	0.43	0.80	0.65	0.24	0.16
SA12	0.53	0.72	0.83	0.54	0.54	0.50	0.36
SA13	0.72	0.61	0.89	0.55	0.56	0.12	0.39
SA14	0.53	0.68	0.81	0.65	0.44	0.16	0.35
SA15	0.41	0.34	0.22	0.66	0.57	0.18	0.06
SA16	0.44	0.00	0.44	0.90	0.60	0.07	0.17
SA17	0.00	0.19	0.00	0.28	0.76	0.07	1.00
SA18	0.26	0.75	0.43	0.47	0.43	0.20	0.16
SA19	0.54	0.76	0.83	0.65	0.44	0.08	0.36
SA20	0.62	1.00	0.59	0.54	0.20	0.06	0.24
SA21	0.59	0.26	0.71	1.00	0.00	0.00	0.30
SA22	0.37	0.64	0.92	0.61	0.76	0.27	0.40
SA23	0.41	0.66	1.00	0.24	0.38	0.35	0.44

$$\Phi^{+}{}_{(i)} = \frac{1}{(1-n)}\sum_{i-1}^{n}\pi_{(i,i)} \quad (7)$$

$$\Phi^{-}{}_{(i)} = \frac{1}{(1-n)}\sum_{i=1}^{n}\pi_{(i,i)} \quad (8)$$

$$\Phi_{(i)} = \Phi^{+}{}_{(i)} - \Phi^{-}{}_{(i)} \quad (9)$$

The decision to be taken must reach stage (9) which has made one between the decisions separate from (7) and (8), this means that the decision can be made from a number of alternatives. This context applies to the selection of system analysts and finally it can be proven that there is collaboration between two methods, namely AHP and Promethee elimination and can be used as a reference in the decision support process at the manager level.

RESULTS ANDDISCUSSION

Starting with the results of data collection from instrumentation in the form of questionnaires addressed to approximately two hundred and fifty-seven respondents as sampling representing data, through questionnaire filling with a convenient sampling deployment technique and then ready to be accumulated, the data acquisition is processed with three stages of scale conversion that are starting from the arithmetic scale conversion to the geometric mean scale and conversion to the AHP scale and formed into pairwise matrices that are ready to be processed by the multi-criteria decision making (MCDM) iteration method with five times the iteration process. Design the case hierarchy model as shown in (Figure 1) as a research aid to determine the amount of eigenvector values that will be used at the elimination process stage by the method of methodology. The results of testing the eigenvector values in (Table 4), after testing using the expert choice application software give the same value to the eigenvector acquisition, pay attention (Figure 2), where the eigenvector values that can be with two different methods give the same value (Wei *et al*. 2016). Based on the acquisition of the assessment dataset used as a source of research consists of seven criteria with twenty-three alternatives that have different meanings of interpretation of the use of the weighting of a number of criteria, meaning that there are criteria that contain the greatest value is the best (HB), conversely there are also criteria that contain the meaning of the smallest value is the best one (LB), so this must be understood more deeply, especially at the stage of the mathematical calculation process that is applied. The basic assessment dataset obtained from the data collection process can be seen in (Table 2), while the results of normalization using (5) and (6) are data that have been normalized and can be immediately processed by the method of Promethee elimination, pay attention (Table 3). so that in the end it will form a preference index of matrices with a total of twenty-three orders with a total of 506 (five hundred and six) data matrices element items. The results of the element matrices can be seen in (Table 4).

The value of the matrices preference index element has gone through a process of elimination in the comparison phase that has been operated with each weighting scale of each criterion. The elimination step will then be sorted by the amount of each row and column matrices. For each row matrices preference index is called leaving flow (7) and for each column of matrices preference index is called entering flow (8), both of which are called Promethee I stages where the decision-making conditions are not perfect to do, because their conditions each weight is still in a separate state. For that we must unite the weights of the two by carrying out the process of accumulation between the two weights. This accumulation process is called the unification of element matrices, known as net flow (9), this process is known as the Promethe II (Mareschal, De Smet, and Nemery 2008). Thus the decision support can be applied by determining the priorities of each alternative which is the selection process.

Conclusionandrecommendations: The optimal selection process for system analysts can be carried out by a combination of two method, Analytic Hierarchy Process and Promethee elimination methods. The results obtained from the collaboration process of the two methods can be used as support for decision making with the following provisions ranked first from the largest weighting 2.21 for SA08, weight 0.14 for SA06, weight 0.5 for SA09, weight 0.04 for SA04 and SA12, and weight 0.03 for SA07 and SA13, the remaining 15 system analysts who do not gain weight are themselves eliminated. Thus it can be said, that the colobaration of both the Analytic Hierarchy Process method and the Promethee elimination method can be used as a reference as an accurate and optimal selection process in decision support.

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