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Decision support system of e-book provider selection for library using Simple Additive Weighting

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Abstract. Each library has its own criteria and differences in the importance of each criterion in choosing an e-book provider for them. The large number of providers and the different importance levels of each criterion make the problem of determining the e-book provider to be complex and take a considerable time in decision making. The aim of this study was to implement Decision support system (DSS) to assist the library in selecting the best e-book provider based on their preferences. The way of DSS works is by comparing the importance of each criterion and the condition of each alternative decision. SAW is one of DSS method that is quite simple, fast and widely used. This study used 9 criteria and 18 provider to demonstrate how SAW work in this study. With the DSS, then the decision-making time can be shortened and the calculation results can be more accurate than manual calculations.

1. Introduction

E-book is an electronic version of a book. The shape of the e-book is the same as the printed version, while the different just it's media presentation that is through electronic media such as smartphones, tablet computers, laptops or personal computers. Currently e-book began favored by various readers, from children to adults. This is because e-book offers some advantages over printed books, such as e-book is easier to carry anywhere, can be read anywhere and anytime, e-book prices are relatively cheaper when compared to the printed version, e-book will not be damaged like a printed book, font size or image can be enlarged, and the e-book is more environmentally friendly because it does not spend a lot of trees for its printing.

The existence of the e-book is actually very helpful for the library as a provider of books for the community or academics. This is because the library will need less space to put the book and the cost is cheaper. Library is currently required to provide services in accordance with the needs of its members, including by providing a choice of printed books and e-book. This will further extend the reach of the library, since e-book can be accessed by members from anywhere, with its personal devices, as long as the device users have permissions that have been validated by the libraries. E-book is also able to answer the limitations of the number of books, thus raising the queue in borrowing books in the library.

Considering the widespread use of e-book today, of course providers of e-book more and more, ranging from free to paid and they compete with each other. The large selection of e-book service

providers, will certainly require the library to choose the best provider that is able to meet all the needs of the library and its members. Many things will be taken into consideration in choosing an e-book provider, such as the content provided, the incorporated publisher, the quality of service, responsibility, authentication and access, and so on. Some considerations can be used as criteria in the selection of providers that best suits the needs of the libraries. Determining the provider with some of these criteria, of course not a simple problem, because the importance of each criterion is not necessarily the same with each other. The management side of the library should determine which provider is the most ideal for each criterion in accordance with the level of importance.

Selecting supplier/provider is a kind of multi-criteria decision making. Many decision method were proposed to build a DSS for selecting supplier. Study to select to logistics service provider analytic network process (ANP) method was found in [1] and [2]. This method can use qualitative or quantitave criteria, but developing the model will needs much time. Other study using ANP to select supplier was found in [3]. Jigeesh [4] proposed a new method, named as Bit Decision Making (BDM) method to solve the multi-criteria decision making for selecting supplier. This method treats such complex system of decision making as a collection and sequence of reasonable number of meaningful and manageable sub-systems by identifying and processing the relevant decision criteria in each sub-system. Each sub-system with its own mathematical model has been treated as a standardized decision sub-system for that phase of making decision in evaluating suppliers. Lee et al [5] designed and implemented BestChoice, a decision support system for supplier selection. It allows the evaluator to create rules for supplier evaluation based on the Multi Attribute Utility Theory, a theory for evaluating the utility of alternatives. BestChoice provides rule structures that can be saved and reused for similar selection cases. Xia and Wu [6] use an integrated approach of analytical hierarchy process improved by rough sets theory and multi-objective mixed integer programming. Liou et al [7] proposed fuzzy preference programming and the analytic network process (ANP) to form a model for the selection of partners for outsourcing providers. Supplier and provider selection also found in [8] and [9].

Simple Additive Weighting (SAW) is one of the simplest yet most reliable methods and has been widely used in decision support systems. Atmojo et al. [10] uses SAW for decision making in smartphone purchases. That study used 10 criteria and use 5 fuzzy language for each criterion. Respondents often use Word of Mouth (WoM) communication as main source of information to reduce the confusion, results of 16 from 27 transactions were contributed from WoM. DSS application contributed only 2 of 27 smartphone transactions. Gupta and Gupta [11] conducted the study about supply chain vendor evaluation. The study was compared SAW, fuzzy SAW and fuzzy TOPSIS method. The study found that SAW match for low complexity of problem with less criteria and less laternatives. SAW is also used in multi-criteria decision making for food selection by Adriyendi [12]. The study evaluated 8 alternatives and eight criteria. The experimental shown that SAW resulted wheat as the best alternative (highest value) with score 0.8833, while WP method resulted wheat as the best alternative with score 0.1563. The result for best choice was same for these two method, but for the next order both of method gave a different result. Afshari et al. [13] implements SAW for the selection of personnel within an organization. The study used seven criteria that they are qualitative and positive for selecting the best one amongst five personnel and also ranking them. The first step done in this study was compare each criterion to others criteria using Saaty's scale on pairwise comparison matrix. After all the criteria weight were gained, the SAW method to select the personnel based on the criteria weight was conducted. Other study was conducted by Haswan [14] using SAW for member election in Unit Patient Pamong Praja, while Daniati and Nugroho [15] combine K-Means clustering and SAW in thesis topic selection. The implementation of SAW in multi-criteria decision support system also found in Jhaa et all [16] and Sinaga and Murnawan [17].

In this study, we use SAW to solve the multi-criteria decision support system to select the e-book provider. Here we use nine criteria. We built an application that give user to give the score value of each criterion based on their preferences and the input the alternatives and also it's score. The

normalization will be conducted to gain the weight of each criterion and then the SAW method will be conducted to produce the decision.

2. Methodology

Decision support system is a system intended to support managerial decision-makers in semistructured decision situations. DSS were meant to be an adjunct to decision-makers to extend their capabilities but not to replace their judgment. They were aimed at decisions where judgment was required or at decisions that could not be completely supported by algorithm [18].

Based on Memariani [19], SAW Technique is one of the most used MADM techniques. It is simple and is the basis of most MADM techniques such as AHP and PROMETHEE that benefits from additive property for calculating final score of alternatives. The flowchart of this method shown in Figure 1.
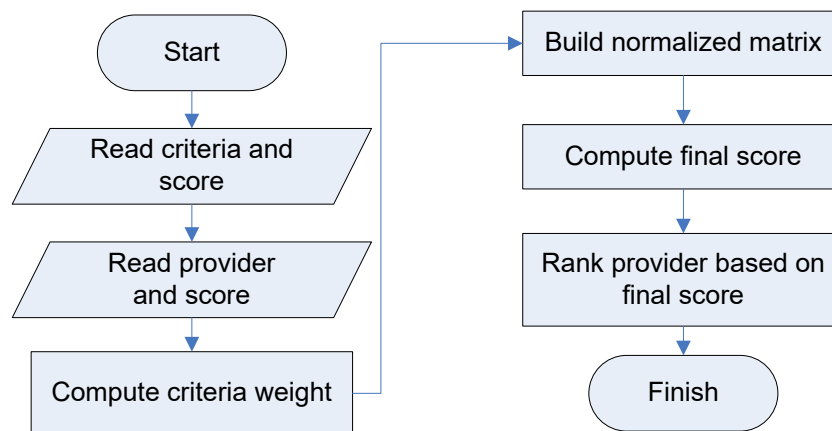
Figure 1. The flowchart of SAW

In SAW technique, final score of each alternative is calculated as follow and they are ranked.

$$P_j = \sum_{k=1}^{m} w_k r_{ji} ; i = 1,2,...,m \tag{1}$$

Where r_{ji} are normalized values of decision matrix elements and calculated as follow:
For profit attributes, we have:

$$r_{ji} = \frac{x_{ji}}{x_i^{Max}} ; x_i^{Max} = \underset{1 < j \le n}{Max} \, x_{ji} ; i = 1,2,...,m \tag{2}$$

And for cost attributes:

$$r_{ji} = \frac{x_i^{Min}}{x_{ji}} ; x_i^{Min} = \underset{1 < j \le n}{Min} \, x_{ji} ; i = 1,2,...,m \tag{3}$$

Profit attribute is the attribute that has positive value in decision making. The higher score of this kind of attribute, then the higher chance for the alternative to be selected on certain criterion. On the other hand, the cost attribute will give the negative value in decision making. The higher score of this kind of attribute will decrease the chance for the alternative to be selected on certain criterion.

3. Result

Based on the literature from Grigson [20] and from the website of Boston College[21], then we used nine criteria for this problem. The number of alternative is eighteen. The criteria, score of criteria, the weight and kind of criteria was shown in Table 1. The minus (-) sign in the table represent the cost

criteria, while the plus (+) sign represent the profit criteria. The weight of each criterion is gain by dividing the criterion score by sum of all score. For example the weight of price = 90/685 = 0.13.

Table 1. The Criteria and Weight

	Price	Digital Right Manage-ment (DRM)	Con-tent	Provi-der Type	Busi-ness Model	Lisence	Technical Support	Resource Capability	Customer Support
Score	90	80	90	60	70	70	75	70	80
Weight	0.13	0.12	0.13	0.09	0.10	0.10	0.11	0.10	0.12
Kind	-	+	+	+	+	+	+	+	+
Symbol	C1	C2	C3	C4	C5	C6	C7	C8	C9

The score for each alternative in every criterion is shown in Table 2. In this experiment, we used 18 alternative provider. For each alternative, there will be a score between 0-100 in each criterion. After all the score was inputted, the next step was to normalized the matrix. To do this step, the maximum for profit criterion and the minimum for the cost criterion were defined to do the normalization based on Equation (2) and (3). The normalization matrix is form by dividing the minimum score of all alternative in price criterion by the value of each alternative in that criterion. For example the normalized value for provider 1 in criterion price = 40/78 =0.51. On the contrary, the normalized value in other criteria were gained by dividing the score of the alternative on certain criterion by the maximum score of all alternatives in certain criterion. For example, the normalized value of provider 3 in DRM = 44/94 = 0.47.

**Table 2.** The score of each alternative in each criterion.

Provider	C1	C2	C3	C4	C5	C6	C7	C8	C9
Provider1	78	65	62	94	95	70	66	55	84
Provider2	91	87	85	48	68	56	66	95	89
Provider3	82	44	86	44	56	58	73	74	60
Provider4	63	61	82	74	60	43	76	63	50
Provider5	41	55	83	90	63	53	74	64	51
Provider6	40	70	88	83	85	54	55	91	65
Provider7	61	90	40	80	51	46	95	83	68
Provider8	42	64	82	65	55	55	81	61	56
Provider9	71	94	78	67	74	56	44	89	55
Provider10	81	45	86	66	44	47	44	65	90
Provider11	85	57	92	84	53	93	69	41	41
Provider12	51	82	75	76	92	46	88	49	84
Provider13	45	53	72	71	60	75	47	61	73
Provider14	51	43	82	55	90	85	43	83	82
Provider15	58	79	61	87	81	54	58	69	87
Provider16	91	84	47	67	63	61	87	92	75
Provider17	81	66	69	69	80	46	42	81	84
Provider18	88	91	60	94	69	86	75	48	77
Min/Max	**40**	**94**	**92**	**94**	**95**	**93**	**95**	**95**	**90**

The average of normalization score of each alternative in all criteria were shown in Figure 2. The highest average score was provider 6 and followed by provider 12, while the lowest was provider 10.
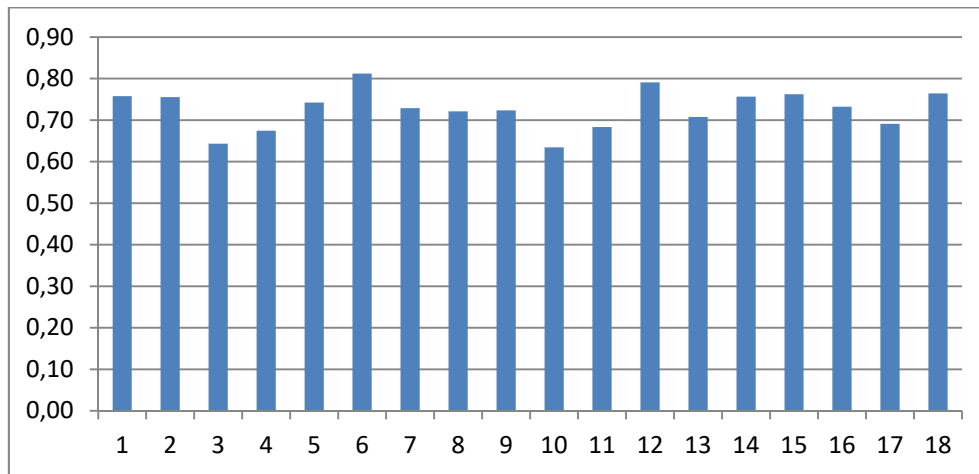
Figure 2. The average value of normalized score for all criteria

The next step of this method was calculating the final score of each alternative based on Equation (1). The result of multiplication of Equation (1) for each alternative will be summed for all criteria to gain the final score. The final score is shown in Figure 3. Form the Figure we can conclude that the hisghest final score was gained by provider 6 and followed by provider 12. The lowest final score was provider 10 and followed by provider 3.
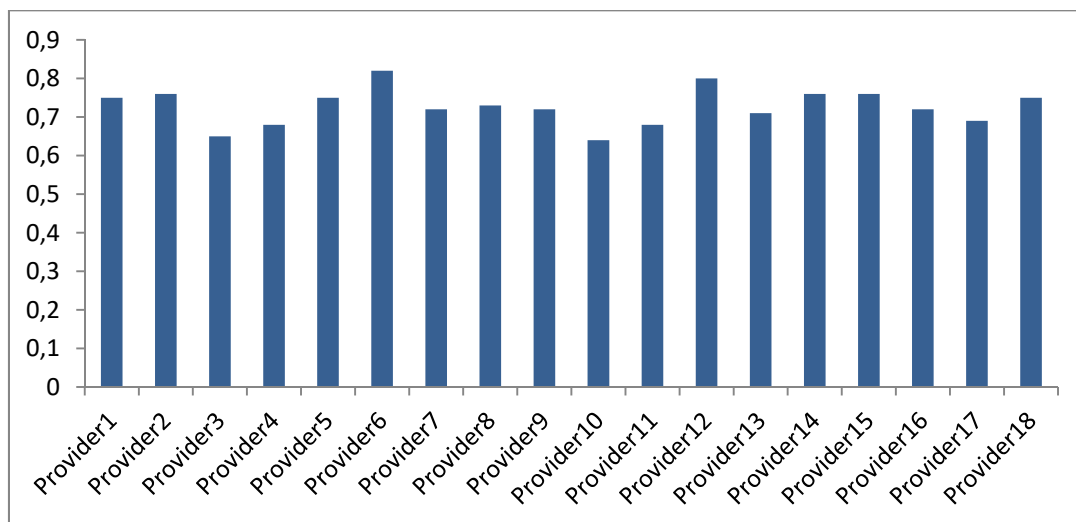
Figure 3. The final score of all providers

The comparison between average score and the final score was shown in Table 3. The table shows that the average score and final score give the different ranking. The same ranking for average and final score filled with blue colour. That differencies can be happened because SAW regard the priority of each criterion and use weight of each criterion to produce the final score, while in average score regardless the priority and asume all the criteria have the same weight.

Table 3. The average and final score

Provider	Average Score	Ranking based on avg score	Final Score	Ranking based on final score
Provider1	0.76	5	0.75	6
Provider2	0.76	7	0.76	3
Provider3	0.64	17	0.65	17
Provider4	0.67	16	0.68	15
Provider5	0.74	8	0.75	7
Provider6	0.81	1	0.82	1
Provider7	0.73	10	0.72	10
Provider8	0.72	12	0.73	9
Provider9	0.72	11	0.72	11
Provider10	0.63	18	0.64	18
Provider11	0.68	15	0.68	16
Provider12	0.79	2	0.8	2
Provider13	0.71	13	0.71	13
Provider14	0.76	6	0.76	4
Provider15	0.76	4	0.76	5
Provider16	0.73	9	0.72	12
Provider17	0.69	14	0.69	14
Provider18	0.76	3	0.75	8

4. Conclusions

This study aimed to build a decision suport system using SAW to help the library management to select the e-book provider. SAW as the most simplest but realiable method was used to conduct a decision support system. This study used 1 cost criterion: price and 8 profit criteria: digital right management, content, provider type, business model, lisence, technical support, resource capability and customer support. The alternative used to demonstrate how the SAW work was eighteen alternatives. From the implementation, it can be conclude that the SAW success to rank all of the alternatives. For the further reasearch we will combine other method to gain the weight of each criterion and work with sub criteria.

5. Acknowledgment

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