CHAPTER II

LITERATURE REVIEW

2.1   Analytical Hierarchy Process

Analytical hierarchy process was developed in 1970's by Thomas Saaty. (Özeyranlı Ergenç & Barış, 2018), The AHP divides complex multi-criteria decision problems into sets of subproblems, associated through a hierarchical structure. The problems are then solved via pairwise comparisons on the relative importance of each subproblem and respective criteria/alternatives, (Jara, J. Joaquín, 2019), The advantages of Analytical Hierarchical Process are:

1.   The technique does not require any other tool for evaluating weights of decision criteria as the tool can determine decision criteria weights and ranking of alternatives.

2.   The approach is capable of utilizing both quantitative and qualitative data in the decision-making process.

The disadvantages of Analytical Hierarchical Process of this this method are consist as follows :

1.   Only a maximum of 15 alternatives could be compared.

2.   There is the challenge of interdependency between alternatives and criteria.

3.   Its use of a pairwise comparison approach can result in inconsistencies in judgment and criteria ranking.

4.   AHP is less effective in cases with a large number of criteria, (Aziken, 2021) (Hasan, 2019).

The analytical hierarchy process, there are several step to used AHP to solve problem but the basic fundamental is :

1.   Establish a hierarchical structure then dividing each problem into groups based on elements that attributes are carried, from a certain level of hieratical order the element on higher level will dominate the element below it.

2. Build *A* Matrix, To find A matrix, after form hierarchical order of problem then determine relative importance order based on 1-9 scale original by T. L. Saaty to scale a_{ij} and qualify people's thinking of judgment on every problem group. Formula (1) is the judgment matrix, a_i / a_j (*i,j* =1,2,…,*n*) represent the element. a_{ij} indicates the relative importance of a_i to a_j :

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{bmatrix} \tag{1}$$

For judgment matrix *A* there is a_{ji} = 1/ a_{ij}.

3. Calculate the sort weight of elements in the same level weight vector w and the maximum eigenvalue λ_{max} :

   1) Multiply the elements in matrix *A* by the row.

   2) Calculate the n times square of the obtained product.

   3) Normalize the root square vector to get the final ranking vector w.

   4) The maximum eigenvalue λ_{max} is calculated by the formula (2), where $(Aw)_i$ means the i elements of Aw

$$\lambda_{max} = \sum_{i=1}^{n} \frac{(Aw)_i}{nw_i} \tag{2}$$

4. Test of sort consistency, to test consistency first need to calculate Consistency Index (CI) by formula (3) then find Random Index (RI) by an R.I table, then calculate the Consistency Ratio (CR) by Consistency Index divide Random Index

$$C.I = \frac{\lambda_{max} - n}{n-1} \tag{3}$$

It is acceptable that the judgment matrix is consistent when C.R. < 0.1. (Wenlue Dong 2018).

2.2 Technique for Others Reference by Similarity to Ideal Solution

Topsis or Technique for Others Reference by Similarity to Ideal Solution is MADM method was initially presented by Hwang and Yoon, (Hajjah & Oktarina,

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2018), this technique has a core idea that is to choose the best solution by simultaneously measuring the distances of each alternative to the positive ideal solution (PIS) and the negative ideal solution (NIS), (Bagi Suyono, 2020).

Procedure of TOPSIS calculation it's quite simple first normalized decision matrix by using formula (4) alternative matrix or X value divided by square root of sum on every X matrix power by 2 as much as length of matrix columns or m value

$$r_{ij=\dfrac{x_{ij}}{\sqrt{\Sigma_{i=1}^{m} x_{ij}^2}}} \tag{4}$$

Next step is to determine weighted normalized decision matrix or y_{ij} value by just multiply r and criteria weight value or W_m

$$y_{ij} = \begin{bmatrix} (r_{11} \times w_1) & (r_{12} \times w_2) & \dots & (r_{1m} \times w_m) \\ (r_{21} \times w_1) & (r_{22} \times w_2) & \dots & (r_{2m} \times w_m) \\ : & : & : & : \\ (r_{n1} \times w_1) & (r_{n2} \times w_2) & \dots & (r_{nm} \times w_m) \end{bmatrix} \tag{5}$$

Where : i = 1,2,3,…,m, j = 1,2,3,…,n, and w = 1,2,3,…,m,

Next step is to find y^+ and y^- value from y matrix by using formula (6) to find y^+ and formula (7) to find y^-

$$y^+ = \{(max\ y_{ij}|j\ \in J')(min\ y_{ij}|j\ \in J'), i = 1,2,\dots,m\} = y_1^+, y_2^+,\dots, y_m^+ \tag{6}$$

$$y^- = \{(min\ y_{ij}|j\ \in J')(max\ y_{ij}|j\ \in J'), i = 1,2,\dots,m\} = y_1^-, y_2^-,\dots, y_m^- \tag{7}$$

Where j for benefit and J' for cost, if benefit on y^+ take the maximal value on columns matrix y and if it is cost on y^+ then take the minimal value on columns matrix y ,The opposite apply for y^- like shown in formula (7), then calculate the ideal positive solution and the ideal negative solution

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(y_{ij-}y_j^+)^2} \tag{8}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij-}y_j^-)^2} \qquad (9)$$

Where to find positive ideal solution means square root of sum on every matrix y_{ij} minus y_j^+ power by 2 as much as length of matrix rows or n value, almost identical solution to calculate ideal negative solution the different were $y_{ij} - y_j^-$, the last step is to calculate the ideal solution or V value by ideal negative divided by sum value of ideal positive plus ideal negative.

$$V_i = \frac{D^-}{(D^+ + D^-)} \qquad (10)$$

Then rank the order Alternatives can be ranked based on sequence V_i. Therefore, the best alternative is one of the shortest distances to the ideal solution and furthest away with the ideal negative solution.(Hajjah & Oktarina, 2018).

2.3 Previous Research

The previous research that correlated with this research if its the same method or might the similarity of the study case this is were the fundamental of information to do the research are shown in table below:

Table 2.1 Previous Research

No	Title	Writer	Issue Raised	Method	Results / Conclusion
1	The Implementation of Analytical Hierarchy Process Method for Outstanding Achievement Scholarship Reception Selection at Universal University of Batam	Marfuah and Suryo Widiantoro	The scholarship distribution by expert selection by university policy using 5 criteria and trying to solve using a multi	AHP	Final result calculator ensuing AHP method calculation with the priority criterion A (0.37%), C (0.23%), E

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No	Title	Writer	Issue Raised	Method	Results / Conclusion
			criteria method to get students who deserve scholarships based on 5 criteria.		(0.21%), D (0.14%) and B (0.06%), value of consistency ratio 0.05. Then the alternative priorities 1 (0.63), 2 (0.26) and 3 (0.11) the consistency ratio values 0.03, where each CR ≤ 0.1 or consistent weighting preference.
2	Ahp-topsis pada seleksi penerimaan bantuan program indonesia pintar	Ari Kusuma Wardana, Rianto	Process determine PIP scholarship is still manual by check student who meet criteria is done one by one, it takes a long time, ahp and topsis was used to select equitable scholarship recipient	AHP & TOPSIS	This combination of AHP and TOPSIS methods helps in selecting children who are entitled to receive assistance from smart Indonesian programs more quickly and on target. The case study was taken at Kalibening 1 Public Middle School, Banjarnegara Regency, based on 8 criteria with 5 alternative end result was rank 1-5 of

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					recommendation of student with consistency value 0.02
3	Selection of Scholarship Acceptance Using AHP and TOPSIS Methods	Patmawati Hasan, Ema Utami, Selviana Yunita, Elvis Pawan, Kaharudin	Many students who apply for a scholarship program certainly need a selection process so that scholarships can be given to students who are eligible and deserve to get it and the number of students or alternatives who register as prospective scholarship recipients is also an obstacle in determining scholarship recipients.	AHP & TOPSIS	The results of testing using the User Acceptance Test, a prototype can be used to select scholarship receipts. Of the 10 respondents who answered agreed 28.33% and 55% strongly agreed. That means 83.33% agree to use the scholarship acceptance selection prototype.
4	Decision Support System for High Achieving Students Selection Using AHP and TOPSIS	Yufika Sari Bagi,Suyono,Michel Farrel Tomatala	Choosing students who excel is not easy especially if there are many criteria that must be considered. Some problems arise when the	AHP & TOPSIS	The end result was alternative with name Ranti H. is in the first place with preference value 0.823, there also comparison with manual

No	Title	Writer	Issue Raised	Method	Results / Conclusion
			selection is carried out manually, such as it takes a long time when the criteria used are many.		system Ranti H. in the second place, factors influencing this difference include the lack of objectification of the committee in making selection.
5	Decision Support System to Recommend Scholarships Using AHP TOPSIS Methods In Education And Culture Office Of Pekanbaru	Alyauma Hajjah, Dwi Oktarina, Gusrianty, Setepen	The selected students must be in accordance with the desired criteria, therefore a method is needed to assist the education authorities and school in selecting students who are eligible to receive scholarships.	AHP & TOPSIS	AHP combined TOPSIS have their respective accuracy of the criteria weights used, while the TOPSIS Method is used in the ranking of students who are recommended to obtain a scholarship from the education and culture office of Pekanbaru.
6	Implementation of TOPSIS method in the selection process of scholarship grantee (case study: BAZIS South Jakarta)	Meriani Catur Utami, Yuni Sugiarti, Ahmad Melani, Yusuf Durachman, A'ang Subiyakto	Selection process scholarship still manual and based on data 2012-2015 almost half student applicant was rejected because many scholarship	TOPSIS	The study applied 7 criteria which is income value of parents, number of dependents, property owned status, GPA, grade of religion subject knowledge,gra

No	Title	Writer	Issue Raised	Method	Results / Conclusion
			applicants every year it's hard make decision due to limited quota and various criteria need to consider to make decision		de of general subject knowledge and the grade of BAZIS subject knowledge, The result of this this study presented the list ranks scholarship recipient based on 7 criteria
7	Penerapan metode ahp sebagai pendukung keputusan penetapan beasiswa	Frieyadie	The problems faced by the school in the process of determining the establishment of scholarships including data collection process is conventionally frequent errors and the absence of clear criteria for students to receive a scholarship and is having trouble because of the scholarship applicants and the number of criteria used to determine the decision of recipients. The research objective to	AHP	The final results obtained from the selection of the scholarship by five experts that Student B is superior to 0.221 (22.1%) while the Student A 0.213 (21.3%), Student E 0.207 (20.7%), Student D 0.182 (18, 2%) and the Student C 0.176 (17.6%).

No	Title	Writer	Issue Raised	Method	Results / Conclusion
			avoid errors in data collection, and better process again what if you have a lot of criteria, so as to obtain the results that expected		
8	A Mixed Method using AHP-TOPSIS for Dryland Agriculture Crops Selection Problem	Hadikurnia wati, Wiwien Winarno, Edy Santoso, Dwi Budi Purwatinin gtyas	Many problems that occur in farmers include 1) problems on agricultural land, 2) problems of farmers' need for information, knowledge that is cheap, fast, quality and flexible, 3) problem of decision making on several alternative choices in determining the type of plants in accordance with the characteristics of the land, The purpose of this study is to create a model that is able to	AHP & TOPSIS	Based on calculations using the AHP and TOPSIS mixed methods the highest priority results obtained from the alternative. The highest priority alternative to the consideration of 11 parameters is green beans. This model is an incredible and adaptable apparatus that is utilized to solve multi-attribute problems, was connected as the choice methodology, and a reasonable decision was chosen.

No	Title	Writer	Issue Raised	Method	Results / Conclusion
			provide recommendations for food crops to be planted by farmers.		
9	Selection of Charging Station Technology to Support the Adoption of Electric Vehicles in Indonesia with the AHP-TOPSIS Method	Setiawan, Andri D. Hidayatno, Akhmad Putra, Bramanda Dwi Rahman, Irvanu	One of the three main obstacles to the development of electric vehicles lies in the lack of charging infrastructure or charging stations.The objective of this research is to select the best alternative to provide recommendations for the Indonesian government in choosing the right type of charging station technology for Indonesia.	AHP & TOPSIS	Decision model has been developed by considering nine criteria and three alternatives, namely battery swapping, inductive, and conductive.Analysis reveals that the alternative, 'Conductive Charging,' holds the first rank among all considered alternatives.
10	The Best Selection of PIP Scholarship: AHP-TOPSIS Vs Fuzzy AHP-TOPSIS	Ari Kusuma Wardana and Rianto	This study aims to provide a comparison and evaluation of the selection of students who	AHP & TOPSIS, Fuzzy AHP & TOPSIS	The results obtained from ranking with the Fuzzy AHP-TOPSIS method for the selection of PIP recipients are

No	Title	Writer	Issue Raised	Method	Results / Conclusion
			are entitled to PIP assistance. Previous research has been evaluated using the AHP-TOPSIS method and in this study comparing the method between AHP-TOPSIS vs Fuzzy AHP-TOPSIS, the purpose of this study is to obtain the effectiveness of both methods.		not much different from the calculations obtained from the AHP-TOPSIS method.

2.4 Kemahasiswaan UMKT

The student division or Kemahasiswaan is the part of UMKT that is responsible for administrative and technical services to stakeholders both internally (students, lecturers, study programs/faculties, employees) and externally (alumni, graduate users, parents, students, etc.). As part of Universitas Muhammadiyah Kalimantan Timur (UMKT), the Student Affairs and Alumni Division supports the philosophy of organizing and developing UMKT, which is characterized, insightful, and progressive, through the development of the Student Affairs and Alumni Division based on Islamic and Muhammadiyah values. (Buku Panduan Akademik UMKT, 2018).

There are several program run by kemahasiswaan one of them in Smart Indonesia Program which alludes to student scholarship quote "Efforts to fulfill student welfare through the provision of scholarships from various sources, such as scholarships from the Universitas Muhammadiyah Kalimantan Timur (UMKT),

Improvement of Academic Achievement (PPA) and PPA Education Cost Assistance (BPP-PPA), Bankaltim Syari'ah, Bank Bukopin Syariah, Bank Syariah Mandiri, Bank Muamalat, Bank CIMB Syariah, East Kalimantan Government, BIDIKMISI and Featured scholarships from the Bureau of Planning and Foreign Cooperation (BP-KLN) Secretariat General of the Ministry of National Education and Culture".(Buku Panduan Akademik UMKT, 2018).

2.5   Kartu Indonesia Pintar Kuliah

Kartu Indonesia Pintar Kuliah (KIP Kuliah) is an abbreviation of the Smart Indonesia College Card, KIP Kuliah is given to recipients of the PIP (Smart Indonesia Program). PIP is assistance in the form of cash, access expansion, and learning opportunities from the government given to students and students who come from poor or vulnerable families to finance education. The Smart Indonesia Program explains that PIP is intended for students who are accepted into tertiary institutions, including people with disabilities with priority targets for KIP recipient, students from poor/vulnerable poor families and/or with special considerations, affirmative students (Papua dan West Papua as well as 3T and TKI) also students affected by disasters, social conflicts or special conditions. KIP Kuliah is a transformation from Bidikmisi which has been running since 2010 and changed to KIP Kuliah in 2020.

KIP Kuliah scholarship recipients receive tuition fees and also living costs, the cost of living is also given directly to the student's account based on the results of the City/District cost of living survey and the socio-economic survey by BPS, (Kemdikbud, 2022).