Analysis of Bias and Subjectivity in Decision Making with AHP Method

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Abstract*—Amid fast-paced development, humankind is faced with the problem of deciding. Concluding the best solution for the problem faced has become an important capability. Structural methods for decision making have been created to overcome problems in decision making such as qualitative variables. One of the examples is Analytical Hierarchy Process (AHP). It offers a hierarchical, mathematical based qualitative decision assessment. AHP takes each stakeholder's view in comparing each alternative in a quantitative value. Thus, creating a logically based decision. However, AHP is still inseparable from bias and subjectivity of the evaluator. This study is conducted to find the impact of bias and subjectivity in AHP and the countermeasures to avoid it. It is also aimed to study the development of AHP method to be a better decision-making method. This study is based on literature review of previous research of the AHP method. Aiming to discover the further potential of AHP in mitigating bias and subjectivity.

Keywords*—Decision, Bias and Subjectivity, Analytical Hierarchy Process (AHP), Development.

I. Introduction

Decision making has been an essential part of civilization. Various aspects of the world were built on top of decisions made by humankind. Therefore, decision making skills have become important skills in personal or professional environments. The ability to create and conclude an objective, appropriate, and consistent decision is now a competence professional sectors seek in an employee. This includes every sector of professional work including business, law, computer science, health, etc.

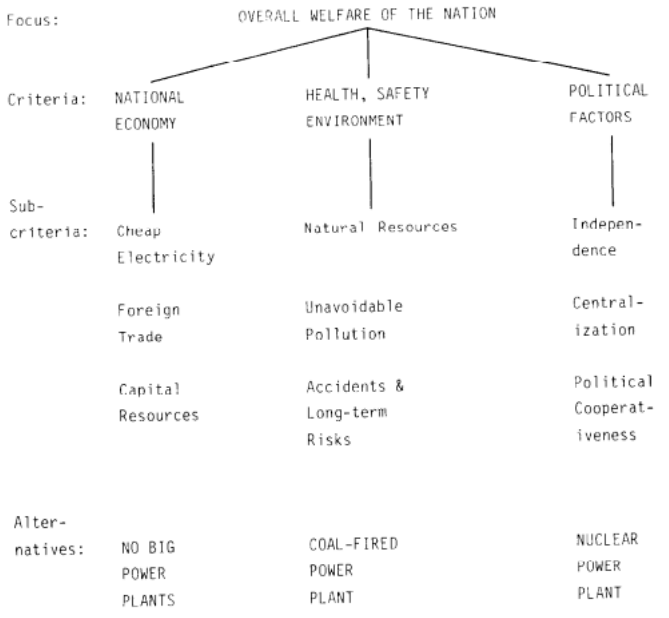
With the complexity of mankind's work now, decision making is all about evaluating every alternative, solution, probability by analyzing every information, factor, impact by the selection. In simple cases, most people will use intuitive methods to decide. But the outcome of intuitive methods is likely a biased decision by the individual's experience and background. The subconscious of human will heavily affect its decision whether the human is aware or not. Therefore, civilization has created an analytical method to conclude the appropriate decision. One of the methods is Analytical Hierarchy Process (AHP).

Structured based method helps decision maker to take decisions objectively. As the process is backed with mathematical standards, it ensures that the decision is in accordance with the conditions and criteria. Furthermore, analytics method helps decision making in the broader utilization such as multi-criteria decision making, multi-stakeholder decision making, and others.

II. Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) was introduced by Thomas Saaty at the Wharton School of University of Pennsylvania in the 1970s. It was introduced as a hierarchical structure-based decision making with multi criteria and alternatives. The background of AHP development was the inability to quantify every criterion. Often in the execution of decision making, the criteria are qualitative variable not quantitative. Therefore, confusion appeared upon backing the decision logically and mathematically. AHP process takes the stakeholders perspective upon qualitative variables in a quantitative scale, then processing it based on the priorities set before. The result of AHP is the value of each alternative. The highest value means the best solution according to the comparison given by the stakeholders. Aside from that, AHP is also usable for quantitative based decision-making.

The general idea of Analytical Hierarchy Process is to expand the objective to several parts. First is the focus. It is the objective of the decision-making process written clearly. This will give the stakeholders or decision-makers a clear understanding of what the decision being made is for. Second is the criteria. In which sectors the decision will have impact or evaluated in are the criteria. The criteria should be a broad topic where sub criteria will be determined as the third part. In this sub criteria, every alternative will be compared to each other. Sub criteria is a topic where it is determined which alternative leads to the focus better. The sub criteria must be a specific part either quantitative or qualitative. If the sub criteria are quantitative its comparison will be based on the data, which alternative supports the focus more. Else, it will be based on the stakeholder evaluation. The comparison is scale-based comparison. In the process, 2 alternatives are compared within 1-9 scale. The last part of AHP is the alternatives. Decision makers should gather every alternative possible to resolve the problem. The alternative solutions then will be compared to each other alternative to determine which is the best solution. When all the AHP parts have been determined, it forms a hierarchical structure. One of the examples is below.



Picture 1. Example of Hierarchical Structure in AHP[6]

After expanding the objective into focus, criteria, sub-criteria, and alternatives, the next step is assessing the value of priority of each decision criteria and alternative in each criterion. The method used is pairwise comparison. This method is comparing every alternative to each of the groups by comparing two alternatives at a time. In the AHP, it is used to compare the priority of two alternatives. In this case, priority measures which alternative supports the focus, or which will direct to the objective. The comparison will be based on a 9-value scale. The explanation of each value in the scale is explained in the table below.

Intensity of importance on an absolute scale	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment strongly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	
Rationals	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

Picture 2. Definition Table of Importance Scale[6]

Pairwise comparison in AHP will be done in a pairwise matrix. In this matrix, the diagonal alternative will be compared to each horizontal alternative (this includes the comparison to its own, which its value will be 1 or equivalent). In the matrix, comparison will define the importance according to the table above. In example, if criteria-1 is equal importance with criteria-2, its pairwise comparison will be 1. The criteria-2 when compared to criteria-1 will also have the pairwise comparison value to be 1. But, if criteria 1 has very strong importance than criteria-2, the pairwise comparison value is 7. When criteria-2 is compared to criteria-1, its value is 1/7, as criteria-1 has very strong importance than criteria-2. As this is done, the pairwise comparison matrix will form a diagonally mirrored value. Look at the example provided below.

LOCATION	SWARTH	NORTHW	U. MICH	VANDERB	CMU
SWARTH	1	1/4	1/3	1/3	7
NORTHW	4	1	2	3	7
U. MICH	3	1/2	1	3	6
VANDERB	3	1/3	1/3	1	4
CMU	1/7	1/7	1/6	1/4	1

Picture 3. Example of Pairwise Comparison Matrix in AHP[6]

When comparing U. Michigan (as horizontal variable), to Vanderbilt (as vertical variable), its value is 3. The value concludes that U. Michigan has a more moderate importance than Vanderbilt. As of that, when Vanderbilt as a horizontal variable, compared to U. Michigan as a vertical variable, its value is 1/3.

The pairwise comparison will be done onto the all the criteria to determine the weight in importance of each. It Is also will be done onto all the alternatives in each criterion. Assuming that there are *n* criteria/alternatives to be compared, there will be *n(n-1)/2* comparison in each criteria comparison and alternative comparison in each criterion. The next step is to calculate the eigenvalues of each compared object. Assume the pairwise comparison matrix is matrix A, to calculate the eigenvalues, the formula used is below.

$$Determinant\ (\lambda I - A) = 0$$

The eigenvalues are the weights of importance or score in the comparison. AHP has a preventive method in assessing the evaluation consistency. The consistency ratio will be calculated using the formula below.

$$CR = \frac{CI\ (Consistency\ Index)}{RI\ (\ Random\ Consistency\ Index)}$$

The Consistency Index (CI) will be calculated by the formula below.

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

The Random Consistency Index will be determined by the total variables compared which are already pre-defined in this table below.

Matrix size	Random consistency index (RI)
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Picture 1. Random Consistensy Index Table in AHP[6]

The Consistency Ratio (CR) should have a value below 10%. When the CR value is greater than 10%, it means that the evaluation in pairwise comparison was not consistent. The comparison relation towards all other variables was not corresponding. It may indicate a subjective or biased comparison.

When all the comparison's CR is in the appropriate value, the

next step of AHP is to calculate the final weight. As each of the criteria has its own weight, it means that every alternative comparison in each criterion is only worth that weight percentage. The final weight or score of each alternative is determined by multiplying its value in each sub-criterion with the value of the criterion. Alternative with the highest score, by calculations, is the best alternative possible. The process will determine around the alternative and criteria, which alternative supports the focus better or able to achieve success in each criterion.

III. AHP EXAMPLE

One example of Analytical Hierarchy Process (AHP) is determining the best solution for an effective and water-saving agricultural irrigation system for dry land areas. This case was a customer-based project conducted in 2023. The problems that were found by the farmer in Jatinangor, West Java, Indonesia was the limited source of water in dry season. To maintain the crop, the farmer needs an alternative source or method to water the crop. Four alternatives solution came up. Wastewater treatment to become water source, an automatic sprinkler system, and an application to teach farmers methods and alternative in responding to the problem. The focus here is to determine which method suits and is effective for the farmers. The criteria are effectiveness, simplicity, and durability. As the customer will be a farmer, the system should have a simple utilization procedure smf long lasting system. These criteria were determined by the farmers' preference. In this project, the sub criteria were not defined as the criteria had already fulfilled the farmers' preference.

As all the AHP expanded parts have been determined, the next step is to do pairwise comparison. The first comparison is among the criteria. The pairwise comparison matrix is below.

Criteria	Effectivity	Simplicity	Durability
Effectivity	1/1	7/1	5/1
Simplicity	1/7	1/1	1/3
Durability	1/5	3/1	1/1

Table 1. Criteria Pairwise Comparison Matrix

In the table, effectiveness and simplicity of use have a value of 7/1. This means that effectiveness is more important than simplicity of use. This decision was taken based on the main objective, namely producing an effective irrigation system. Even though it is quite complicated to use, as long as the system works well, it is not a problem. The effectiveness value for durability is 5/1. This value means that effectiveness is more important than durability. Similar to comparing effectiveness with simplicity of use, the main objective of this research is an effective system. The criterion for durability when compared with simplicity of use is 3/1. This value is taken based on the benefits of a system that lasts longer than a system that is easy to operate. The longer it is used, the system user will continue to learn little by little about the new system. Therefore, a system that lasts longer is slightly more important than durability. After calculations, the eigenvalues or weight of importance of effectivity is 73.1%, simplicity 8.1%, and durability 18.8%. The Consistency Ratio (CR) is 6.8% which means that the evaluation was consistent. In perceiving these numbers, effectivity has the greatest impact on the project. The main criterion for this project is the effectiveness of the system. The next priority is durability followed by simplicity. This is backed by the background of the customer who is a farmer. Therefore, creating an effective yet durable is more important than creating a simple system. As the instructions of the system can be taught to the farmers as well as the troubleshooting.

The next step is to compare every alternative in each criterion. The pairwise comparison matrix for criterion effectivity is below.

Effectivity	Wastewater Treatment	Automatic Sprinkler	Informative Application
Wastewater Treatment	1/1	1/6	1/3
Automatic Sprinkler	6/1	1/1	5/1
Informative Application	3/1	1/5	1/1

Table 2. Alternatives Pairwise Comparison Matrix in Effectivity

The table above shows the comparison results of each alternative solution in terms of effectiveness criteria. Comparison of automatic sprinkler and wastewater treatment is worth 6/1. This value was taken because the main objective is to find the most effective irrigation system from existing solutions. The wastewater treatment system will produce water resources instead of an effective irrigation system. If these abundant resources are not used well, they may not answer this problem. These comparison values will be processed based on the analytic hierarchy process procedure to obtain the value weights. After calculations, the eigenvalue of each alternative is in the table below.

Alternative	**Priority (Eigenvalue)**	**Rank**
Wastewater Treatment	8.8%	3
Automatic Sprinkler	71.7%	1
Informative Application	19.5%	2
Consistency Ratio	9.8%	

Table 3. Eigen Value Calculation Table in Effectivity

The final result of the weight calculation in the effectiveness criteria is that the automatic sprinkler gets the largest value with 71.7% and wastewater treatment gets the smallest value, namely 8.8%. This means that an automatic sprinkler is the most effective solution in terms of effectiveness.

The next 2 comparisons compare every alternative in criteria of simplicity and durability. The simplicity pairwise comparison matrix can be seen below.

Simplicity	Wastewater Treatment	Automatic Sprinkler	Informative Application
Wastewater Treatment	1/1	5/1	3/1
Automatic Sprinkler	1/5	1/1	1/3
Informative Application	1/3	3/1	1/1

Table 4. Alternatives Pairwise Comparison Matrix in Simplicity

In terms of simplicity, wastewater treatment offers the simplest system. In wastewater treatment, the equipment used is already installed. This system does not require users to continue to

control directly. Users simply take the processed water for use. It is different from the automatic sprinkler system that requires customers to maintain and set the system. Therefore, in terms of simplicity of usage, automatic sprinkler is quite complicated and not preferable. After the calculations, the table below shows the results.

Alternative	Priority (Eigenvalue)	Rank
Wastewater Treatment	63.7%	1
Automatic Sprinkler	10.5%	3
Informative Application	25.8%	2
Consistency Ratio	4.0%	

Table 5. Eigen Value Calculation Table in Simplicity

The last comparison is comparing every alternative in terms of durability that can be seen in the pairwise comparison matrix below.

Durability	Wastewater Treatment	Automatic Sprinkler	Informative Application
Wastewater Treatment	1/1	1/3	1/5
Automatic Sprinkler	3/1	1/1	1/3
Informative Application	5/1	3/1	1/1

Table 6. Alternatives Pairwise Comparison Matrix in Durability

After calculations, the value of priority can be seen in the table below.

Alternative	Priority (Eigenvalue)	Rank
Wastewater Treatment	10.5%	3
Automatic Sprinkler	25.8%	2
Informative Application	63.7%	1
Consistency Ratio	4.0%	

Table 7. Eigen Value Calculation Table in Durability

The table above contains comparative values in terms of durability criteria. The definition of durability is how long it takes for the system to no longer be used. The factors can be various things such as broken machines, bad weather, damaged software, and so on. It can be seen that none of the comparison results have significant differences. The informative application has the greatest priority as a virtual application does not require much maintenance. It is different from the wastewater treatment and automatic sprinkler that requires periodic maintenance for the machine and system. As the wastewater treatment is complex and large in scale, it is more probable to malfunction.

All the comparison has been done, the last step of AHP is to calculate the final weight of each alternative. This calculation can be seen in the table below.

Criterion	Effectivity	Simplicity	Durability
Priority	73.1%	8.1%	18.8%
	Effectivity	**Simplicity**	**Durability**
Wastewater Treatment	8.8%	63.7%	10.5%
Automatic Sprinkler	71.7%	10.5%	25.8%
Informative Application	19.5%	25.8%	63.7%
	Wastewater Treatment	**Automatic Sprinkler**	**Informative Application**
Score	13.566500%	58.113600%	28.319900%

Table 8. Final Calculation Table

This final score concludes that automatic sprinkler system is the most suitable solution for the problem. It is by a great difference than other solutions, the best solution for an effective and water-saving agricultural irrigation system for dry land areas.

IV. The Problems of Bias and Subjectivity

Analytical Hierarchy Process (AHP) is a structured multi-criteria decision-making method. It was developed in order to address the qualitative variables included in decision-making. AHP process qualitative variables by using the stakeholder's view toward the subject. Its evaluation is placed upon a quantitative scale which now can be assessed mathematically. The problem of bias and subjectivity arises upon human judgement. The value given toward each alternative and criterion will be heavily affected by the stakeholder background and goal. This will inflict an invalid calculation of the best solution.

The AHP method still takes human's judgment in its process. It still leaves spaces for bias and subjectivity to ruin the assessment objectively. Various perspectives of the stakeholders will create huge differences on the scale. Inconsistency of comparison problem might happen because of this. Bias in the decision-maker's judgments is also a huge threat. Cognitive biases such as anchoring bias, framing effect, and overconfidence may appear upon judgements unconsciously. Anchoring bias will happen if an individual's judgement is influenced by an "anchor" or reference which can be completely irrelevant. Framing effect will take place when a problem or alternative was incompletely explained. This will lead judgement to being not objective. The overconfidence phenomenon will appear when decision-makers overestimate the accuracy of their judgement, that leads to less careful comparison. Those biases and subjectivity will again lead to falsely calculated solutions.

Another thing is the difficulty to quantify a qualitative variable. Even though AHP was developed to overcome this problem, determining one's qualitative value to a quantitative variable is not an easy task. A lot of the variables (criteria and alternatives) are inherently subjective and difficult to quantify. In examples, customer satisfaction and social impact are both intangible criteria. The value given will not be the same among all stakeholders. This will be backed again by the subconscious of the decision-maker upon judging the problems. The impact is the result value is biased and its inseparable from this process.

Along a big group decision-making process, there will be a dominant group that leads the decision. Using AHP method may prevent this from happening directly. Yet, when there are big influences of the dominants, one individual may create an unobjective judgement. There is often the risk of group thinking,

where creativity or individual responsibility is discouraged in the decision-making practice. This may influence the outcome heavily as the dominant “leads” the process subjectively, not objectively.

Among a big group of decision makers, there will always be human error present in the process. Overweighting or underweighting in the pairwise comparison may affect the final decision to be biased toward some criteria, while neglecting other important factors. Moreover, on broad criteria and alternatives, there may be a lack of reasoning in every judgement. This may appear upon the struggle to compare alike variables (in value). This may further contribute to inconsistent or biased results.

V. How AHP Addresses Bias and Subjectivity

Analytical Hierarchy Process (AHP) was also designed to prevent bias and subjectivity though not perfect. The step that prevents unobjective judgement is the calculation of Consistency Ratio (CR). It is calculated by dividing Consistency Index (CI) and Random Consistency Index (RI). By definition, consistency ratio is a metric that indicates a consistent evaluation between pairwise comparison. In example, if criteria-1 is better twice than criteria-2, and criteria-2 is 3 times better than criteria-3. It can be concluded that criteria-1 is 6 times better than criteria-1. If the result is not 6 times better, it can be concluded that the comparison was not consistent.

The Random Consistency Index (RI) was provided by the founder of AHP. It was defined as the average of Consistency Index (CI) of 500 randomly filled in matrices. In the RI table that is provided, the RI value depends on the number of items that are being compared. In AHP, the accepted CR is below 10%. It is necessary to revise the judgments to locate the inconsistency if the CR is greater than 10%.

This step of AHP is functioned to be able to detect inconsistency in the pairwise comparison. Therefore, it should be able to detect whether bias and subjectivity are present in the judgment. Yet, in the real-life execution, there will always be CR greater than 0%. A CR value of 0% indicates that the judgment is perfectly consistent. If it is greater than 0, there are still inconsistent in the judgment, while it is not significant. This step in AHP may identify the presence of unobjective comparison, yet it still cannot erase every of it. It may lead to unsuitable solutions being chosen in the process.

Other than that, small part of AHP such as pairwise comparison help stakeholders to focus on one comparison at a time. Creating this specifically focused environment can reduce the complexity of subjective judgment. The comparison is broken down to smaller parts and manageable. It helps to reduce human errors in judgment that rise upon confusion.

VI. Countermeasures of Bias and Subjectivity

While AHP has already developed several methods in preventing bias and subjectivity to interfere with the result, it is still not enough. There are still big spaces where bias and subjectivity can take place and affect the decision. However, there are measures that one can take to counter bias and subjectivity. It may not remove all the unobjective judgment but reduce the amount and the impact of it.

First is to clearly understand the objective of the decision. The AHP method divides sections of an objective into a hierarchical structured part. In the first part is the focus, followed by criteria, sub criteria, and alternatives. By writing all the parts, decision-makers will get a clearer picture of the problems and alternatives. The stakeholders will be able to understand the criteria used, the reason behind it, how it promotes the goal. Also, there should be an explanation toward everything that relates to the objective. Therefore, there could be an objective judgment in comparing alternatives.

Second, in a group decision making, the comparing process should happen in an isolated environment. Dominant group influence will affect the decision unconsciously. Peeking at the other stakeholder judgment may also happen when the environment is mingled. Therefore, an isolated environment will help the stakeholders to be able to perceive the problems, reviewing alternative solutions, deciding which solutions is the best solution better. This helps to reduce the bias and subjectivity that appear upon group decision-making.

Even though group decision-making seems complex with the difference of perspectives, it is better than overreliance on a single decision-maker. By doing group decision-making, a broader perspective of the problems is brought to the table. When it is only done by a single individual, it is most likely the judgment is biased and subjectively done.

Iteration of AHP method will also contribute to prevention of bias and subjectivity. The reviewing of every judgment made will make sure that the judgment was objectively done. While doing comparisons, it is a must to always check the Consistency Ratio (CR). Whenever the comparison reaches a CR value greater than 10%, it is a must to repeat or revise the judgment.

External validations may help support the chosen solution. By presenting external experts and data, the solution should align with those. If it does not align with the external data, there may be an error while doing the AHP process. Therefore, external validation or third-party reviews will help determine the reliability of the judgments.

Another countermeasure that can be taken in addressing the bias and subjectivity threat in AHP is doing a sensitivity analysis. This will analyze the impact of minor changes in pairwise comparison to the final decision outcome. The main objective of doing the sensitivity analysis is to determine whether the process is resilient to changes in assumptions or judgments. The chosen solution should be stable despite minor modifications in the comparison. In other words, it asses the robustness of the decision by showing the sensitivity of it to small changes in input values. If one criterion dominates the outcome, there may be a subjectivity or bias towards that criterion in the process. It may indicate that those criteria are too subjective or overemphasized.

VII. Developments of AHP

As the utilization of Analytical Hierarchy Process (AHP), surged in the professional sectors. There are some developments of its methodology to overcome problems that may occur. Mainly the bias, subjectivity, and consistency in the AHP process. Many of these developments are combinations of AHP

and another method. The developments are aimed to create a hybrid AHP method that produces a decision better and more objective.

Fuzzy AHP Method (FAHP) is an AHP method where the comparison value is stated with fuzzy numbers. Fuzzy logic was invented by Lotfi Zadeh in 1965. It was developed to deal with imprecise numerical quantities in a practical way. Now it is used to represent uncertainty, vagueness, or imprecision of values that are not available or difficult to express with certainty. As the comparison values are now in fuzzy numbers, the eigenvector method and geometric mean will not be able to be used directly in AHP, making it more complex. The FAHP works by changing pairwise comparison matrix's value to a fuzzy set. When there are multiple decision-makers, the opinions will be aggregated. After done, the fuzzy weights of each criterion will be calculated. It combines multiple fuzzy sets into a single fuzzy set. The fuzzy weights then will be defuzzied where it is transformed to a crisp value for further comparison. When the consistency is measured for limited contradiction, the priority of each variable will be determined with a formula. The result should point to the most appropriate solution with the highest level of priority. FAHP has developed a system to handle human's not exact perspective. It contains the value in a range not exact number. Therefore, it creates a more realistic representation of human judgement. It is also more resilient to inconsistent judgement. As conclusion, FAHP is great on perceiving human's viewpoint into the comparison, therefore giving a better view of judgment.

AHP-Entropy Method is a method combining AHP and the entropy method. This method is the most representative objective weighting tool. The entropy method will be used to assign weight in the pairwise comparison step. By using the entropy method, the assessment given will be at its utmost objectivity. Its value is derived from calculating the value given and its uncertainty. The AHP-Entropy Method will combine subjective and objective methods to calculate the weights of priority that involve both qualitative judgments and quantitative data.

Voting-AHP (VAHP) is a method that combines voting and AHP. When the number of elements in pairwise comparison became greater, it is difficult to form pairwise comparison matrix. Moreover, the possibility of inconsistency of great number of variables becomes a complex task to be resolved. To overcome this, the AHP is combined with a voting method that was developed by Cook and Kress (1990) to aggregate votes based on optimistic policy. In the voting process, each voter will try to find the best weight comparison which represents their position. Therefore, to answer the inability of AHP to consider broad characteristics of the stakeholders, VAHP has the flexibility to formalize the process of big groups with unequal power level and among their members.

Stepwise Weight Assessment Ratio Analysis (SWARA)-AHP is one of the methods for criteria evaluation. It involves consultation with experts and the weighting process. Where VAHP replaced the pairwise comparison with preferential voting, the SWARA-AHP method based their judgment on experts' perspective. In this method, there should be a comparative importance between criteria and alternatives provided by the experts. This makes the method scientifically defined as always backed with experts' data and information.

SWARA-VAHP combines the SWARA-AHP and VAHP method. In this method, the VAHP is done to determine local priorities and alternatives, while SWARA-AHP defines the relative difference between priorities from expert's data. The result of this method is the weight structure to be flexible and backed by the experts.

Best-Worst Method (BWM)-AHP is a method that calculates local priorities of each criterion and alternative using the Best-Worst Method (BWM). The decision maker will pick one best variable and one worst variable. Then, the stakeholder will give his preference over all the criteria on a predefined scale. This method will provide information that is neither as complex as AHP nor as simple as SWARA or VAHP.

BWM-VAHP is a method where BWM-AHP and VAHP are combined. The experts will be the ones who conduct Best-Worst Method to the criteria. This means selecting the best and worst criteria, and ranking the other criteria based on a 9-point scale. This method increased the result accuracy rather than BWM or VAHP as it is backed by the experts.

VIII. Conclusion

The Analytical Hierarchy Process (AHP) is inseparable from the threat of bias and subjectivity to interfere with the result. Even though, there are several countermeasures in order to minimize the impact of subjectivity upon the objective-desired outcome. The examples of such measures are understanding problem, criteria, and alternative to give objective judgment, doing comparison in isolated environments to constrain from external influence, relying on group perspectives, iterations of process, and external validation. Besides that, there are the developments of AHP method which combine AHP to several other methods to produce an objective. Such methods are fuzzy AHP, AHP-Entropy Method, Voting-AHP, Stepwise Weight Assessment Ratio Analysis-AHP, SWARA-VAHP, BWM-AHP, and BWM-VAHP.

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