

## **Why We Need AHP/ANP Instead of Utility Theory in Today's Complex World — AHP from the Perspective of Bounded Rationality**

**Eizo Kinoshita**

Meijo University

4-3-3, Nijigaoka, Kani, Gifu 509-0261 Japan

kinoshit@urban.meijo-u.ac.jp

**For Professor Thomas L. Saaty, with respect and admiration**

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**Summary:** *This paper treats human decision making from the perspective of rationality, and defines a Utility Function and Utility Theory as an instrumentally rational decision making theory and AHP as a procedurally rational decision making theory. Then it is shown that, in practical decision making and the behavior of human being, it is more effective to use the AHP. The paper presents a partial interpretation of a lasting debate on the effectiveness of Utility Function and the AHP, a debate that does not seem to be ending anytime soon.*

### **1. Introduction[1][2][3]**

This paper first describes the idea of bounded rationality by classifying human decision making into three categories. Assuming that bounded rationality is the basis for all human behavior, it then emphasizes that the AHP presents a highly effective decision making process to the decision making of a person who behaves rationally in a restrictive sense. The arrangement of the paper is as follows: section 2 describes classification of rationality and the significances of Utility Functions and the AHP, section 3 describes the effectiveness of the AHP pairwise comparisons in the process of decision making by presenting practical examples, section 4 describes determination of the weights from the pairwise comparison matrix, which is the most significant property of the AHP, using three mathematical background/models, and finally section 5 summarizes the ideas in the paper.

### **2. Classification of Rationality[4]**

#### **2.1 Instrumental Rationality[5][6][7][8]**

According to the common definition of rationality in neoclassical economics, 1) a person has several objectives, 2) a person can make a general assessment of alternative behaviors (combinations of properties to be consumed) in the light of those objectives, and 3) a person can classify alternative behaviors according to his/her preferences. Strictly speaking, four principles of (1) completeness, (2) transitivity, (3) continuity, and (4) independence must be satisfied. This is sometimes called “instrumental rationality” as it defines rationality as an instrument to achieve one’s objectives. If (1) and (2) are satisfied, it is possible to express the preferential order rationally and, if (3) is satisfied as well, it is possible to express the preference using a utility function as an indifference curve that can be defined. Principle (4) is needed for defining a rational choice under uncertainty (or, to be more precise under risk) and assures linearity of the expected utility function in terms of probability.

Because a rational individual with a utility function would prefer to choose an alternative with higher utility value, he/she would be called a “utility maximizer” who chooses an alternative with the highest utility value among several available alternatives. Thus instrumental rationality typically means to maximize the utility of the results of a particular behavior to that individual. This shows that maximization of expected utility is considered to be the principle of rational behavior. However, Simon claims that instrumental rationality stands only if individual choice is based on the following hypotheses.

( I ) attributes of all available alternatives are known

- (II) the probability distribution of uncertainties of results is known
- (III) the principle of expected utility maximization is used

Although one can intuitively see that each of these hypotheses is unrealistic, specific problems of instrumental rationality is discussed in the next section.

The biggest problem that is also perceived intuitively is that many choices, that are significant in economic analysis, are not made based on such rationality. When it comes to choosing a school, a profession, a marriage partner, or a place of residence, which are all very important in one's life, surprisingly a large number of individuals give reasons such as "friends are going", "(believe) it is a fate", "by chance", "have no time to find a better one", or "recommendation of a fortune-teller" as the basis for their choices. It is understandable that smaller daily choices are affected more by routines, customs, and rules.

Even with a particular individual, the preferences change in time and often end up with a list of preferred alternatives that conflicts with the one made earlier. One may argue that there is no conflict since a property may represent a different entity at different times even though its physical existence does not change. However, the argument does not serve well in developing a model for forecasting or benefit assessment. Therefore, it is a common practice to consider that a preference is stable for a certain period of time.

Social psychologists have presented many cases of psychological experiments in which the principle system of Expected Utility Theory failed. All these phenomena are also often observed in special psychological experiments. For example, the phenomenon described in Allais's counter example is well known in the study of gambling. What it represents is that a person is likely to put higher emphasis than expected utility on the fact that there is a marginal probability of high returns, while not paying sufficient attention to the fact that there is the same marginal probability of high losses as indicated by expected utility. Consider an example of choosing between two options:

- (a) \$1000 with the probability of 1
- (b) \$1000 with the probability of 0.89, \$5000 with the probability of 0.10, and \$0 with the probability of 0.01

In this example, choice (a) is preferred over choice (b) in most cases. Then what if the choice has to be made between the following two alternative payoffs?

- (c) \$1000 with the probability of 0.11 and \$0 with the probability of 0.89
- (d) \$5000 with the probability of 0.10 and \$0 with the probability of 0.90

These choices are obtained after subtracting the probability of 0.89 to gain \$1000 equally from choices (a) and (b). In this case, choice (d) is preferred by many. Mathematical representation of these choices will be as follows. Supposing  $u(x)$  represents the utility of  $x$ , the first example where (a) is preferred will be described by an inequality of:

$$1.00 \times u(\$1000) > 0.89u(\$1000) + 0.10 \times u(\$5000) + 0.01 \times u(\$0)$$

By subtracting  $0.89 \times u(\$1000)$  from both sides and adding  $0.89 \times u(\$0)$  to both, we obtain the following.

$$0.11 \times u(\$1000) + 0.89 \times u(\$0) > 0.10 \times u(\$5000) + 0.9 \times u(\$0)$$

This inequality shows that the left side is preferred over the right side and contradicts the fact that choice (d) is preferred over choice (c). This is an example in which the principle of independence established in Expected Utility Theory fails and shows that the utility function is not an accurate model for human behavior. Similar results are observed in selecting a path under a stringent time limit.

In addition, the critical review of Expected Utility Theory has yielded several new theories by modifying a part of the criteria, especially the independence axiom, as represented by Prospect Theory. These theories remind us of the risk of overestimating the human information processing power as if humans were capable of collecting and processing all necessary information, and maximizing utility as a machine would do.

Apart from overestimating human information processing power, applying instrumental rationality to selective behavior, including the process of collecting information, is very difficult considering the unique attributes of information as a property. How can a rational belief in a decision making under uncertainties be defined?

According to the concept of instrumental rationality, and assuming that the maximum utility of information declines gradually, collection of information must be stopped at the point where the maximum cost matches the maximum utility and a rational belief could be described as a future presumption formed at that point. Practically, however, it is hard to assume gradual decline of the maximum utility for highly heterogeneous information. Should it be possible to define the maximum utility and its gradual decline for individual piece of information, the decision-maker has no way of knowing the maximum utility of information that may be obtained next. It is highly probable that a decision-maker would think that one more piece of information would have made a big difference in the decision.

## **2.2 Procedural Rationality[5][9][10][11]**

Rationality of the human decision-making process does not necessarily depend wholly on instrumental rationality, which is maximization of objectives and their utility. It is also necessary to introduce concepts other than utility maximization. One of them is “procedural rationality”.

An alternative plan chosen may not be the best in the light of a person’s objectives, but it may be rational enough when considering the process of making such a choice. In practical sense, we often make decisions based on a simple rule, such as evaluating certain limited attributes only or following a routine pattern. Such behavior does not necessarily promise the optimum results but drastically reduces the cognitive resource necessary for making a decision. When looking upon the capacity of the brain to process information for the assessment of alternatives as a scarce resource, the behavior including the selective process is procedurally rational. The AHP is one of the procedurally rational decision-making methods that follow a given procedure and determine the choice based on a certain process.

Bounded rationality proposed by Simon is a typical theory for explaining procedural rationality, and claims that, although human behavior is intended to be rational, a decision is rational only in a restrictive sense because it depends on the decision-maker’s capacity to collect and process information. Most of the time spent for decision-making is allocated to searching for available alternatives and assessing their outcomes. Since the search and assessment of alternatives are time-consuming and a costly process, Simon claims that the major part of decision-making consists not of the “maximization” strategy as (expected) utility maximization hypothesis presents, but of a strategy to find a satisfactory alternative. In addition to Bounded Rationality, another typical procedural rationality method is to “follow the social standards.” With the exception of Robinson Crusoe, everybody lives in a complex society where an uncountable number of written and unwritten rules exists with historical backgrounds. Nobody can live without adhering to many of them. For example, if nobody obeys the traffic lights, one is forced to decide what to do at every corner by calculating an expected utility assuming the behavior of other cars that may appear from the corner. If the driver of another car does the same calculation, there is a possibility of falling into an endless loop and nobody gets through the intersection. In other words, individual behaviors determine the culture of a society as a whole, from which everybody receives benefits, and it is prejudicial to consider a society as a set of individuals having instrumental rationality.

## **2.3 Expressive Rationality[12]**

Apart from instrumental rationality and procedural rationality, there is another definition, which may be characterized as a psychological definition of rationality. Unlike instrumental rationality, which expresses a choice as an instrument to achieve certain objectives, “expressive rationality” applies to a case in which making a choice itself is an objective. For example, as a means to satisfy an objective of reaching some place faster and more economically, choosing railroad over driving a car is instrumentally rational. In contrast, choosing to drive a car simply because one wishes to identify oneself is called expressive rationality. This is considered to be a part of a dynamic process of forming one’s own attitude and beliefs by understanding oneself through making such decisions.

An example that is easily understood is the famous behavioral motive called “dissolving cognitive dissonance.” A person feels discomfort in having views that conflict with each other and are likely to be motivated to dissolve the dissonance. There are two ways to dissolve a dissonance, an internal one and an external one. One example of the internal method for dissolving a dissonance is to shut out any information that may raise questions about past choices. On the other hand, dissolving a dissonance is also possible by modifying external factors as seen in the justification of one’s own behavior. For example, a person who usually drives a car is likely to express favorable opinion for using a car in a public survey and continue using a car in order to

dissolve his/her cognitive dissonance. In this case, the choice of driving a car itself serves as an objective. This kind of rationality is psychological for which it is difficult to develop a model. Nevertheless, it is an important concept in terms of implementing a national policy. Many Japanese consumers, who are accustomed to the American culture, including motorization, tend to justify their way of life with the “reward” of convenience while holding a doubt about the sustainability of their lifestyle. To change such a way of life, it is necessary to raise public awareness towards the sustainability crisis, propose an alternative that may be less convenient but will not cause dissonance with the recognition of environmental problems, or let individual consumer continue to think they are “rewarded” while securing sustainability by reducing the level of overall convenience in society.

Although the above three common concepts of “rationality” are different ways for implementing “reasonable behavioral principles,” they do not necessarily “maximize” a particular objective. While instrumental rationality assumes that there is always a choice available to maximize utility depending on the objectives, procedural rationality defines rationality throughout the decision-making process including the process of finding alternatives and is a reasonable method employing a systematic procedure to save the cognitive resource, including heuristics. In expressive rationality, on the other hand, the rationality of making a choice is in the expression of one’s self as a part of constructing the whole self in which one’s attitude, recognition, and behavior all agree with each other.

### **3. The Advantage of AHP[1][2]**

In the previous section, instrumental rationality, procedural rationality, and expressive rationality are presented as categories of the rationality of decision-making. This section explains why the AHP, which ensures procedural rationality, is effective in the process of decision-making.

In order to prove the effectiveness of AHP, the writer wishes to present a comment made by a person who has no knowledge of decision-making theories including the AHP (the writer regrets the fact that this person had no knowledge). This is a comment made by Ms. Nanba, a college officer who is involved in the operation and administration of the college and clerical works, and the author’s fellow associate. The point is that she is a kind of person who makes her decision based on her pure intellectual faculties without the knowledge of AHP.

According to her, when she goes shopping and must choose a product among many sold at a shop, her routine is to choose a limited number of products intuitively and then, at that point, start a detailed comparison of the alternative products to choose one. Furthermore, she says she is reminded of this fact every time she sees her son choose a candy. When she takes her son to a confectionary counter and tells him to choose something, he immediately brings back some items among many kinds of snacks, chewing gums, and candies. Most of the time, her son would bring only two items. The interesting point is that, when she tells him to choose one from the two sweets brought back, he would spend a long time deciding which he likes better, far longer than the time he spends choosing the two among the many items available at the shop.

Here is another story heard from a male. When this man and his wife go to a men’s clothing shop to buy a tie, his wife always choose two ties in a relatively short time. After that, she spends a lot of time evaluating the two ties before determining the priority between the two — which tie would fit him better, which one would be suitable for business or parties — just like the above child choosing a sweet.

These stories reveal the essence of human standards in making a choice and coincide with the behavior of pairwise comparisons used in the AHP.

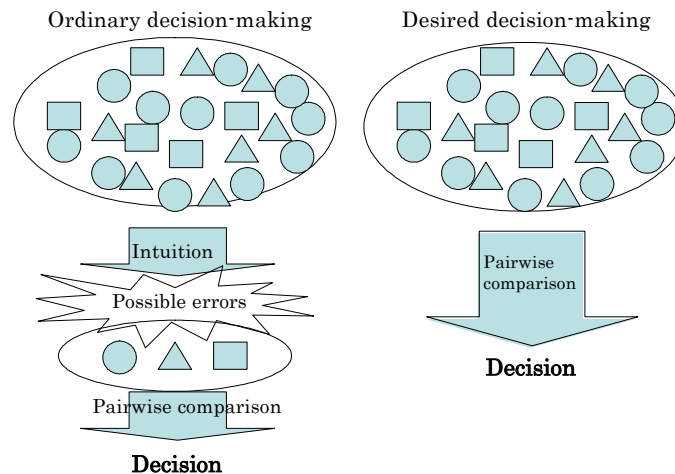
First, a person chooses intuitively a small number from the countless alternatives available. After limiting the number of alternatives, the person uses pairwise comparison to choose the better of two alternatives. The fact reveals the boundary of human decision-making or, in other words, the limited capacity of the human brain. Normally, it is better to clarify attributes of all available alternatives and make an assessment before choosing an alternative. However, it is impossible for the human mind to carry out pairwise comparisons of many alternatives. Making pairwise comparisons for all possible combinations of available alternatives would consume a lot of energy and the task is too much for the human brain. Practically, it is impossible for anybody to remember the result of every pairwise comparison made.

Therefore, we, sinful but good-natured human beings, rely on our intuitive faculties to choose a small number of seemingly good alternatives among the many presented to us. After that, pairwise comparisons are applied,

instinctively, to that small number of alternatives for the job is easy enough for our brains to handle. This process inherently contains a shortfall that might lead us to a wrong conclusion and that is why AHP's pairwise comparison is more advantageous.

When the task is too much for our brain, it is very rational to select a limited number of alternatives before applying pairwise comparison. It reduces the load to our brain, to say the least. However, we often make mistakes in our decision-making, especially when we rely on intuition. What is wrong with the above process is that mistakes occur when we select a small number intuitively. (The error model of the pairwise comparison matrix introduced in the following section was invented to eliminate errors inherent in human decision-making.) Suppose the best solution was among the many alternatives discarded at the time of selecting a small number of candidates, then the ensuing pairwise comparison would not produce expected results no matter how accurately it is carried out. The group of candidates does not contain the best solution. The advantage of the AHP lies in this process. If possible, detailed attributes of all possible alternatives must be evaluated before deciding on an alternative and we all like the idea. However, in reality, our decision-making process is not done that way simply because the limited capacity of our brain does not allow it. What is available to us is the ability to choose the better one from two alternatives. The idea of AHP's pairwise comparison was developed in order to apply this process of choosing one from two at the earliest stage when all available alternatives are there. If it is possible to apply pairwise comparisons to all available alternatives, there would be no chance of overlooking the best solution and the decision-making process is guaranteed to produce good results. This is the advantage of pairwise comparisons proposed in AHP.

Figure 1 depicts the human decision-making process and the advantage of the AHP to summarize the points presented in this chapter. As has been said earlier, everybody prefers to apply pairwise comparisons to all available alternatives to evaluate detailed attributes before deciding on one. However, the capacity of the human brain does not allow this and we must settle on choosing the better one of two candidates. Intuitive selection of a small number of alternatives before applying pairwise comparison reduces the load on our brain and the process becomes simple enough for anybody to understand. At the same time, the rationality of the process, which is reducing the load on our brain by intuitive selection, may produce the unwanted result of choosing a wrong alternative and overlooking the best solution. What is intended by the introduction of the AHP is to eliminate such human errors and apply the process employed in human decision-making, that is pairwise comparison, from the start to perform the correct and desired decision-making.



**Figure 1: Human decision-making process and desired decision-making**

#### **4. Interpretation of Pairwise Comparison Matrix in AHP[1][2]**

This section explains the interpretation of pairwise comparison matrix presented in AHP. First, there are three methods of determining the weight using pairwise comparison matrix as follows.

- 1) Classic interpretation

- 2) Error model
- 3) Equilibrium model

This section explains the foregoing models of estimating the significance  $w_1, \dots, w_n$  evaluated by using a pairwise comparison matrix  $A = [a_{ij}]$ . The classic interpretation is presented first. When  $w_1, \dots, w_n$  is known, the matrix  $A = [a_{ij}]$  is given as follows.

$$A = [a_{ij}] = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \vdots & \vdots & & \vdots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{bmatrix} \quad (1)$$

where,  $a_{ij} = w_i/w_j$ ,  $a_{ji} = 1/a_{ij}$ , and  $W = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}$   $ij = 1, 2, \dots, n$ .

Here, for all  $i, j$ , and  $k$ ,  $a_{ij} \times a_{jk} = a_{ik}$  hold. This means that the decision-maker's preferences are completely coherent. By multiplying an weight vector  $W$  with the pairwise comparison matrix, we obtain the vector  $n \cdot W$ .

$$A \cdot W = n \cdot W \quad (2)$$

This equation can be transformed to an eigenvalue problem as follows.

$$(A - n \cdot I) \cdot W = 0 \quad (3)$$

Here,  $I$  is the identity matrix.

In order to satisfy  $W \neq 0$  in this equation,  $n$  must be equal to the eigenvalue of  $A$ . If so,  $W$  will be considered to be the eigenvector of  $A$ . Further, theoretically speaking, the order of  $A$  is 1 and the resulting eigenvalue  $\lambda_i$  ( $i = 1, 2, \dots, n$ ) will contain only one nonzero term and all other terms will be zero. Since the sum of the main diagonal elements of  $A$  is  $n$ , expressing the only nonzero term  $\lambda_i$  as  $\lambda_{\max}$ , we get  $\lambda_i = 0$ ,  $\lambda_{\max} = n$ , and  $\lambda_i \neq \lambda_{\max}$ .

Therefore, the vector  $W$  is a normalized eigenvector in reference to  $A$ 's maximum eigenvalue  $\lambda_{\max}$ . This shows that the main eigenvector of the matrix  $A$  gives the correct significance unless there is an error in the pairwise comparison matrix  $A$  itself. In practice, however, human decision-making often contains errors and noises. This means that a pairwise comparison matrix usually contains errors. To minimize the effect of such errors, the error model assigns a weight for a pairwise comparison matrix. This is done so that the main eigenvector would give an approximate value of the significance despite such errors. In this principle, a pairwise comparison element  $a_{ij}$  will be expressed as a multiplication of error  $e_{ij}$  and the true value  $w_i/w_j$ .

$$a_{ij} = \frac{w_i}{w_j} e_{ij} \quad (4)$$

This provides a logical reasoning for the fact that  $a_{ij}$  will always be positive values and the evaluation between elements will be expressed as a ratio. By taking the logarithm of both sides of equation (4) and denoting the logarithm with a dot, for simplicity, the following equation is obtained.

$$\dot{a}_{ij} = \dot{w}_i - \dot{w}_j + \dot{e}_{ij} \quad (5)$$

Assuming that  $\dot{e}_{ij}$  has a standard distribution of median 0,  $w_i$  that will minimize the square sum of logarithms of the error terms  $e_{ij}$  will provide the nearest approximate value. This method is called the "logarithmic least square method (LLSM)" and the significance  $w_i$  is given as a solution to the following

optimization problem.

$$\begin{aligned} \min \quad & \sum_{i,j=1}^n (\dot{a}_{ij} - \dot{w}_i + \dot{w}_j)^2 \\ \text{s.t.} \quad & \sum_{i=1}^n \dot{w}_i = 0 \end{aligned} \quad (6)$$

Here, the condition  $\sum_{i=1}^n \dot{w}_i = 0$  is provided in order to eliminate indefiniteness of constant multiplication.

The optimization problem (6) is also a convex quadratic programming problem and it is possible to prove there is only one solution. The solution will give, by inverting the logarithm, the geometric mean of each row of the matrix  $A$ .

$$w_i = \left( \prod_{j=1}^n a_{ij} \right)^{1/n} \quad (7)$$

Therefore, the geometric mean method is equivalent to the logarithmic least square method. Although some people say the geometric mean method is approximation or simplified version of the eigenvector method introduced later, it is a legitimate method with a solid background of a mathematical model.

Finally, let's take a look at the eigenvector method. It is guaranteed by Perron-Frobenius Theorem, which is given below as Theorem 1, that a unique significance can be derived from a given pairwise comparison matrix using the eigenvector method.

Theorem 1

A square matrix  $A$ , of which all elements are positive, has an eigenvalue  $\lambda_{\max}$  that has following properties.

- (1)  $\lambda_{\max} > 0$ , and  $\lambda_{\max}$  is a simple root of the eigenequation.
- (2) There is a positive eigenvector that corresponds to  $\lambda_{\max}$ . Further,  $\lambda_{\max}$  is the only eigenvalue that has a nonnegative eigenvector.
- (3) Absolute values of eigenvalues of  $A$  other than  $\lambda_{\max}$  are all smaller than  $\lambda_{\max}$ .

Since the  $i, j$  th element  $a_{ij}$  of a pairwise comparison matrix  $A=[a_{ij}]$  that consists of  $n$  items is a ratio given by evaluating item  $i$  with the denominator of item  $j$ ,  $a_{ij}w_j$  can be considered an evaluation of item  $i$  when item  $j$  evaluates itself as  $w_j$ . This is called item  $j$ 's "external evaluation" of item  $i$ . Since item  $i$  will be evaluated by  $n-1$  items other than itself, we can determine the value of self-evaluation  $w_i$  so that it will match the average value of all external evaluations of item  $i$ . This can be achieved by solving following equations.

$$\frac{1}{n-1} \sum_{j \neq i} a_{ij} w_j = w_i \quad i = 1, \dots, n \quad (8)$$

However, it is not guaranteed that these simultaneous equations will have positive solutions.

Instead of solving above equations, we can express the difference between self-evaluated value and the average of external evaluations using a ratio and determine the value of  $w_i$  so that it will minimize deviations of this ratio. The following two deviation minimization problems are obtained from this.

$$\begin{aligned} \min \quad & \max_{i=1, \dots, n} \frac{\sum_{j \neq i} a_{ij} w_j}{(n-1)w_i} \\ \text{s.t.} \quad & w_i > 0 \quad i = 1, \dots, n \end{aligned} \quad (9)$$

$$\begin{aligned} \max \quad & \min_{i=1,\dots,n} \frac{\sum_{j \neq i} a_{ij} w_j}{(n-1)w_i} \\ \text{s.t.} \quad & w_i > 0 \quad i = 1, \dots, n \end{aligned} \quad (10)$$

Problem (9) is for limiting the maximum deviation while problem (10) is constructed to raise the minimum deviation.

Regarding these two problems, it is proven that the optimum solutions for these problems will match and, furthermore, the optimum solution  $w_i$  is the main eigenvector of matrix  $A$ . The proof is given by Frobenius' Min-Max Theorem shown as Theorem 2 below. Here, the  $i$  th row of pairwise comparison matrix  $A=[a_{ij}]$  is expressed as a row vector  $A_i$ .

#### Theorem 2

Let the maximum eigenvalue of pairwise comparison matrix  $A=[a_{ij}]$  be  $\lambda_{\max}$ . Then, for an arbitrary positive vector  $w > 0$ , the following inequality will stand.

$$\min \left( \frac{A_1 w}{w_1}, \dots, \frac{A_n w}{w_n} \right) \leq \lambda_{\max} \leq \max \left( \frac{A_1 w}{w_1}, \dots, \frac{A_n w}{w_n} \right) \quad (11)$$

Especially for the main eigenvector  $w^*$  of  $A$ , this becomes an equation, which is a special case of above inequality.

$$\min \left( \frac{A_1 w^*}{w_1^*}, \dots, \frac{A_n w^*}{w_n^*} \right) = \lambda_{\max} = \max \left( \frac{A_1 w^*}{w_1^*}, \dots, \frac{A_n w^*}{w_n^*} \right) \quad (12)$$

As we have seen so far, the AHP's eigenvector method can be formulated as a deviation minimization problem, which could be expressed either in min-max form or max-min form. The problem is constructed in the viewpoint of obtaining a value that will reduce the differences between external evaluations and self-evaluations so that the entire matrix will have a better equilibrium. From this viewpoint, the eigenvector method can be considered a method based on the "equilibrium model".

In this chapter, three different models have been presented in reference to interpretation of pairwise comparison matrix. With either method, the same weight is obtained for any pairwise comparison matrix up to three rows and three columns. For example, given a pairwise comparison matrix:

$$A = \begin{bmatrix} 1 & 3 & 7 \\ 1/3 & 1 & 5 \\ 1/7 & 1/5 & 1 \end{bmatrix} \quad (13)$$

the following weight is obtained no matter which method is used.

$$W^T = (0.649, 0.279, 0.072) \quad (14)$$

## 5. Conclusion

The purpose of this paper has been to explain that the AHP and its pairwise comparisons, the most important property of the AHP, are highly effective in human decision-making process assuming that human behavior is based on bounded rationality. The effectiveness has been shown by reviewing behaviors of people who have no knowledge of decision-making theories or AHP from the viewpoint of choosing an alternative and pairwise comparison. The paper maintains that, despite the desirability of selecting the ideal alternative by evaluating all available alternatives in a decision-making process, it is difficult to determine priorities by evaluating detailed attributes of all alternatives because the process can present too big load for the human brain. In order to reduce the load on the brain, the intuitive faculties — pure faculties unique to human beings — are employed



and then pairwise comparisons, which are manageable for the human brain, are performed to decide on an alternative. However, because the use of inherent power of intuition sometimes causes a problem by discarding the most wanted alternative, the AHP is recommended as an effective tool to eliminate such problems by applying pairwise comparisons from the initial stage of evaluating alternatives. Finally, three different mathematical backgrounds along with models are presented in regard to determining the weight from a pairwise comparison matrix of the AHP. This paper solidifies the view that the AHP provides a decision-making process that is analogous to human behavior.

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