Empowering Analytic Hierarchy Process by Habitual Domains Concepts P. L. Yu Distinguished Chair Professor, Institute of Information Management, National Chiao Tung University, Hsin Chu, Taiwan

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Abstract

Analytic Hierarchy Process (AHP and ANP) has provided an efficient ways for people to rank the priority of criteria and alternatives in terms of numerical ordering. More importantly, it has been greatly accepted by exponentially increasing number of scholars and practitioners. This phenomenon has not occurred in traditional utility theory. Utilizing the concepts of habitual domains, we will try to explain why can this phenomenon occur and how to further empower AHP and ANP in theoretical and application arena as to solve practical and complex decision problems more effectively.

1. Introduction

Analytical Hierarchy Process (AHP) was initiated by Saaty in 1971 which decomposes a complex multiple criteria problem into a simpler system in hierarchy. This simple, intuitive approach of comparing alternatives greatly reduces the cognitive demand on the decision maker and provides a means for checking the consistency of the comparisons. The main purpose of this article is to explain the reason why AHP has been greatly accepted from the viewpoint of habitual domain, and to discuss how to further empower AHP through the concepts of HD.

More specifically, in the next section we describe the main concepts of Habitual Domain Theory including the behavior mechanisms (section 2.1) and the common behavior tendencies (section 2.2). In section 3, we utilize the above concepts to explain the phenomenon of its being so popular (section 3.1), and discuss how to empower and expand the habitual domain of AHP (section 3.2 and section 3.3).

2. Habitual Domains Concepts

P. L. Yu, the initiator of Habitual Domain Theory, explains that we have habitual ways of thinking, acting, judging, responding, and dealing with problems, which form

our habitual domain (HD) when taken together. The existence and its impact on our decision making could be demonstrated with the following example [9].

Example 1: Chairman Ingenuity

A retiring chairman wanted to select a successor from two finalists (A and B). The chairman invited A and B to his farm, and gave each finalist an equally good horse. He pointed out the course of the race and the rules saying, "From this point whoever's horse is *slower* reaching the final point will be the new chairman!" This rule of horse racing was outside the habitual ways of thinking of A and B. Both of them were puzzled and did not know what to do. After a few minutes, A got a great idea all of a sudden. He jumped out of the constraint of his HD. He quickly mounted B's horse and rode as fast as possible, leaving his own horse behind. When B figured out what was going on, it was too late. A became the new chairman.

This example shows how HD affects our behavior, attitude, life, or even our future. Usually people expect the faster horse will win the horse race. When the chairman raised a request that did not exist in people's HD, the two finalists were puzzled until one of them expanded his habitual domain and figured out the solution.

Example 2: Try yourself!

Suppose there is a river with 100-meter wide, as shown in Figure 1, how to build up a bridge so that you can walk from point A to point B by crossing the bridge, and make the walking distance shortest? (The straight line from A to B is 300 meters) Note, the river shores are parallel and the bridge must be vertical to the river. Can you figure out the answer? Try to break up the old way of thinking and expand your habitual domain and find out the solution!



Figure 1

2.1 The Behavior Mechanism

The behavior mechanism can be captured through eight basic hypotheses (see Table 1) based on the findings and observations of psychology and neuron science. Each hypothesis is a summary statement of an integral part of a dynamic system regarding to

human behavior.

Table 1: Eight Hypotheses

H1: Circuit Pattern Hypothesis: thoughts, concepts or ideas are represented by circuit patterns of the brain. It will be reinforced when the corresponding ideas are repeated.

H2: Unlimited Capacity Hypothesis: practically every normal brain has the capacity to encode and store all thoughts, concepts and messages that one intends to.

H3: Efficient Restructuring Hypothesis: the encoded thoughts, concepts and messages are organized as data bases for efficient retrieving. They are continuously restructured so that relevant ones can be efficiently retrieved to release charges.

H4: Analogy/Association Hypothesis: the perception of new events, subjects, or ideas can be learned primarily by analogy and/or association with what is already known.

H5: Goal Setting and State Evaluation Hypothesis: each one of us has a set of goal functions and for each goal function we have an ideal state or equilibrium point to reach and maintain. We continuously monitor where we are relative to the ideal state or equilibrium point.

H6: Charge Structure and Attention Allocation: when an unfavorable deviation of the perceived value from the ideal, each goal function will produce various levels of charge. The totality of the charges by all goal functions is called the charge structure. It can change dynamically.

H7: Discharge Hypothesis: to release charges, we tend to select the action which yields the lowest remaining charge and this is called the least resistance principle.

H8: Information Input Hypothesis: humans have innate needs to gather external information. Unless attention is paid, external information inputs may not be processed.

The dynamics and mutual interactions of the eight hypotheses can be depicted as in Figure 2. There are five dimensions of this behavior mechanisms continuously interact with each other as stated below:

(i) Experience, learning, and memory are the bases for interpreting and judging incoming events;

(ii) The dynamic change of charges commands attention allocation and prompts actions; it is created by the dynamics of unfavorable discrepancies between the ideal goal states and the perceived states;

(iii)At any time, dynamic attention allocation to the events perceived as most significant (measured in terms of charges) is the fundamental element in human information processing;

(iv)Human beings release their charges by the least resistance principle, which includes active problem solving or avoidance justification;

(v) External information is essential for human beings to achieve and maintain their ideal goals; it will not be processed until the attention is paid.

In Figure 2, box (1) performs the functions related to the dynamics of dimension (i),

boxes (2)-(5) describe the dynamics of dimension (ii), box (6) performs the function of attention allocation or the dynamics of dimension (iii); boxes (8)-(10) describe the dynamics of dimension (iv), and box (12)-(13) and (7) describe the dynamics of dimension (v). Besides, box (10) (self-suggestion) and box (11) (physiological monitoring) are two important functions of human thinking and information processing. They have a great impact on human behavior.

Through the eight hypotheses of the behavior mechanism infinite many human behavior patterns can be produced.

For further information about the operation and interaction of behavior mechanism, please refer to [8-9].



Figure 2: Behavior Mechanism

2.2 Common Behavior Tendencies

According to the behavior mechanism we have seen, we know that although we may differ from each other in each function of the behavior mechanism, which leads to the uniqueness in our behavior, there are still some common patterns. These common tendencies can be used as an overall observation of macro human behavior which results from the behavior mechanism.

The eight common behavior tendencies shown in Table 2 are eight kinds of people's habitual ways of thinking, judging, reacting and dealing with problems that happen most frequently. Understanding these common behavior tendencies would help us to better know ourselves and others as well.

Table 2: Eight Common Behavior Tendencies

1. Social Comparison: people have an innate drive to evaluate themselves, and in the absence of objective means, they make their evaluation by comparing themselves with other people.

2. Halo Effect: to judge other people, one tends to first classify the subjects into two groups: good or bad.

3. Self-Projection Effect: when we need to judge other people, we frequently tend to project our own judgments onto them and assume that they make the same or similar judgments.

4. Proximity: people are more likely to develop good friendships or intimacy when they live closer together rather than when they live farther apart.

5. Reciprocation Behavior: people tend to like those whom they know like them and dislike those whom they perceive dislike them.

6. Similarity Effects: people with similar backgrounds, attitudes and thought processes are more likely to develop good friendship and intimacy among themselves than are people with different backgrounds, attitudes and thought processes.

7. Scapegoating Behavior: when people are in a state of frustration or anxiety, and whey they don't know the source but do not dare to attack it directly, they often tend to search for a substitute to attack in hopes of releasing their frustrations.

8. Responsibility Diffusion in Group Behavior: when people do something together without a precise and clear assignment of their responsibilities, some of them tend to neglect, to a certain degree, the responsibilities which they would otherwise assume.

Example 3: The Five Monkeys

In the cage, the experimentalists hang a banana on a string and put a set of stairs under it. Before long, a monkey goes to the stairs and starts to climb towards the banana. As soon as he touches the stairs, all of the monkeys are sprayed with cold water. After awhile, another monkey makes an attempt with the same result - all the monkeys are sprayed with cold water. Pretty soon, if any monkey tries to climb the stairs, all the other monkeys will jointly beat him as to try to prevent being sprayed with cold water.

Then, the experimentalists turn off the cold water, remove one monkey from the cage and replace it with a new one. The new monkey sees the banana and wants to climb the stairs. To his horror, all of the other monkeys attack him. After another attempt and attack, he knows that if he tries to climb the stairs, he will get assaulted.

Next, the experimentalists remove another of the original five monkeys and replace it with a new one. The newcomer goes to the stairs and is attacked by all other monkeys. The previous newcomer takes part in the punishment with great enthusiasm as if he is released all his past pains of being attacked on the new one. Again, the experimentalists replace a third original monkey with a new one. The new one makes it to the stairs and is attacked as well. Two of the four monkeys that beat him have no idea why they were not permitted to climb the stairs. After replacing the fourth and fifth original monkeys, all the monkeys that have been sprayed with cold water have been replaced. Nevertheless, no monkey ever dares to approach the stairs.

Now let us look at this example from behavior mechanism's point of view. The banana apparently is the goal-setting object of those monkeys (H5: Goal Setting and State Evaluation Hypothesis), the fulfillment to this goal creates charge, and drive them to keep trying to reach to the banana (H6: Charge Structure and Attention Allocation). But when they are sprayed with the cold water, a new connection between "getting banana" and "being punished" is built up(H4: Analogy/Association Hypothesis), which results in creating another charge structure. In order to release this charge (H7: Discharge Hypothesis), they take avoidance justification, so no one dares to touch the banana, and that becomes a new circuit pattern in their habitual domain (H1: Circuit Pattern Hypothesis). When a new comer comes, all the other monkeys attack this new comer because they are affected by this circuit pattern and allocate their attention (H6) to this external information.(H8: Information Input Hypothesis). They will try their best to prevent the new comer from reaching to the banana (again, H7 is seen here). In the end, their behavior are commanded by the habitual domain, thus a behavior pattern is formed. In fact, we human beings are much smarter than the monkeys, we all have unlimited capacity (H2), if we face some similar situation, we might be able to utilize the capacity we have to restructure our circuit patterns actively and efficiently (H3: Efficient Restructuring Hypothesis) as to solve the problems more effectively.

Note that the one tending to touch the banana is attacked by ALL the other monkeys together. It's a reflection of Responsibility Diffusion in Group Behavior, together with Social Comparison. In this case, no monkey will be left behind because the idea of "if you fight, I will fight, too; otherwise I will be in the lower position" is exactly coincident

with Social Comparison. Also, when the monkeys are sprayed by the water, their reaction is not to combat against the water but instead, to beat the monkey who is getting the banana. The latter obviously becomes the scapegoat, and all the monkeys attack him in hopes of releasing their charges.

In addition, Self-Projection Effect is revealed here when the monkey who was beat by others before facing the same situation, he projects his experience to the new one and attacks him just like the way he has been through.

3. Applying HD concepts to AHP

AHP (Analytic Hierarchy Process) is a multiple criteria decision making technique initiated by T. L. Saaty in 1971. It combines qualitative and quantitative factors for priority setting, ranking and evaluating alternatives and has become increasingly popular among scholars and practitioners for its insightful and comprehensible analysis of complex problems. There are thousands of research and application papers involving AHP in academic and practitioner literature. Reported applications include problems in public policy, marketing, procurement, health care, corporate planning, transportation planning and many other areas. For details about AHP see [2]. We will discuss the key points result in its success in terms of HD concepts. Further more, by using HD we try to empower AHP so that it can solve practical and complex decision problems more effectively.

3.1 Utilization of HD's Behavior Mechanism

The basic steps to apply AHP technique are as follows [4]:

- (i) Lay out the elements of a problem in a hierarchy.
- (ii) Make paired comparisons among the elements of a level as required by the attributes of the next higher level. These comparisons give rise to priorities and through synthesis, to give an overall priority ranking.
- (iii)Perform the consistent and interdependent tests.

The basic idea of AHP is to obtain relevant pairwise comparisons to determine the prioritizing, ranking and evaluating. This concept is exactly consistent with that of the HD's behavior mechanism, especially the Goal Setting and State Evaluation hypothesis. On top of the hierarchy is the overall objective (Goal Setting) and the decision alternatives are at the bottom. Between the top and bottom levels are the relevant attributes of the decision problem for comparing alternatives (State evaluation). Recall what we have discussed in section 2.1, these steps are consequently related to one of

human's behavior tendencies, social comparison:

"People have an innate drive to evaluate themselves, and in the absence of objective means, they make their evaluation by comparing themselves with other people." [9]

Since the operating of AHP is so consistent to human's core circuit pattern of Social Comparison, it could strike the inner core of the decision makers. As a consequence, it can be more easily accepted by scholars and practitioners.

3.2 Empowering AHP

From the previous discussion, we have found that the HD's concept of behavior mechanism has close relation with the rapid growth of AHP. Therefore, to empower AHP, several issues need to be considered.

First of all, we need to create gentle charge to catch people's attention. Once the attention has been obtained, it will be easier to have a better outcome in evaluating and ranking the attributes. Some may criticize that by artificially deriving the weights of importance to represent a decision maker's preference structure can be rejected in practice. It is a relatively subjective procedure. Sometimes there even exists inconsistency in the process. By utilizing the three toolboxes of habitual domain [7], the decision maker can expand his habitual domain and become more open-minded and more skillful in communicating with people. The above problems may be overcome.

3.3 Expanding the HD of AHP

Each human being has his own habitual domain, so is AHP. It has many appealing features in facilitating both analysis of a system and decision process. It provides a single, easily understood, flexible model for a wide range of unstructured problems, and takes into consideration the relative priorities of factors in a system and enables people to select the best alternative based on their goals. It tracks the logical consistency of judgments used in determining priorities and leads to an overall estimate of the desirability of each alternative. From these features we can illustrate the habitual domain of AHP as shown in Figure 3.



Figure 3: The Habitual Domain of AHP

We can further empower AHP by expanding its competence set. The main concept of competence set is as follows [9]:

"For a given problem, there is a set of competence consists of information, skill, knowledge, and resources. Different people might see the needed competence set differently. Actually, competence set for a problem is an HD projecting to a particular problem."

There are four basic elements of competence set for a given problem E, shown as Figure 4:

- (i) The true competence set (Tr(E)): consists of ideas, knowledge, skills, information, and resources that are truly needed for solving problem E successfully;
- (ii) The perceived competence set (Tr*(E)): the true competence set as perceived by the decision maker (DM);
- (iii)The DM's acquired skill set (Sk(E)): consists of ideas, knowledge, skills, information, and resources that actually have been acquired by the DM;
- (iv)The perceived acquired skill set (Sk*(E)): the acquired skill set as perceived by the DM.

For more mathematical treatment about competence set, see [1,3,5-6].



Figure 4: The interrelationships among four elements of competence set

Expanding the competence set of AHP implies that there will be more attractive features been created, so that it will release the decision makers' pain and frustration, or to satisfy their needs. The expansion of competence set results in the expansion of AHP's habitual domain (Figure 4), thus it is empowered and will help to form a win-win strategy for decision problems.



Figure 4: Expanding the HD of AHP

4. Conclusions

AHP has been greatly accepted by exponentially increasing number of researchers and practitioners. This has not occurred in traditional utility theory. In this article we try to explain how this phenomenon occurs by applying the concepts of Habitual Domain Theory to AHP. In addition to introducing the idea of behavior mechanism and the eight common behavior tendencies, we try to use these concepts to facilitating AHP. Finally, the concept of competence set is introduced to help expanding the habitual domain of AHP so that with the empowered AHP, we can solve practical and complex decision problems more effectively.

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