Competence System Management

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Abstract

Competence Set Analysis is a managerial decision analysis theory proposed and studied in 1980's by the distinguished Professor Po-Lung YU of Management Science, USA. In this paper, the recent research results in this field and its applications are reviewed, including behavior and decision mechanism, behavior hypotheses, common behavior tendencies, habitual domains analysis, competence set analysis, competence system management, etc.. Finally, further possible extensions and research problems are discussed.

Key words: Decision analysis; Competence set analysis; Habitual domain; Behavior pattern; Competence system management

INTRODUCTION

Habitual Domain was firstly proposed in the early 80s and lately was widely and systematically studied by the outstanding Professor Po-Lung YU (Doctor) from the Business School of Kansans University in the United States. To form the theory, Doctor YU had made lots of efforts on studies of the latest research findings of social psychology, neuropsychology, system science, optimization theory, management science, knowledge and wisdom exploration, and he had also observed and analyzed the human behaviors and decisions. Its major thought is[1-8]: The encrypted and stored knowledge, experience, thoughts, methods, skills and all kinds of information of one's brain will stay stable after a considerate amount of time, if they are not stimulated by other major events or an entrance of complete information. When the thoughts and ideas (which means brain coding and storing) keep still, they will get a habit in their response to people, matters, problems and information, including knowledge, understanding, judgments, and ways of doing things, etc., in other words, the brain will have a fixed or a formalized frame or model. These habitual opinions, ways of doing things and behaviors are the specific outward manifestations in the habitual domain. Here, habitual domain means two things: The first is the ensemble of the brain coding and restoring information and knowledge, which is called the potential competence; the second is the habit of peoples' understanding and dealing with the problems, called the practical performance. The performance of the habitual domain has double sides, first, it shows that the subject of the habitual behavior has rich knowledge and experience, and its performance is mature and sophisticated, which could improve the efficiency and effects. On the other side, it can also block the entrance to receive the new information. If wrongly conducted, it will produce old thoughts, and it also lacks of creative spirit. The bigger the habitual domain covers, the wider and the more systematically the information that the brain codes will be, and the conflicts among the information will be less, and it will be more adaptable to the new environment and new objects. People will be more able to solve the problems, with a more complete and more exact judgment, one will be easier to succeed.

After the introduction of the habitual domain, the management circle, the behavior circle, and the enterprise

circle from all of the world are excited, and rapidly started the studies on the relevant subjects in a worldwide scale, among which the competence set analysis is the liveliest. At present, competence set analysis has developed to be an independent research field, and its research products have been mainly published on *Journal of Optimization Theory and Applications* in the United States, and *Multiple Criteria Decision Making* of the International academic conferences. The competence set analysis has a wide range of application, including enterprises, human relationships, and daily life. The paper will closely review and summarize the present situation of competence analysis and application, and shows its future research and development outlook.
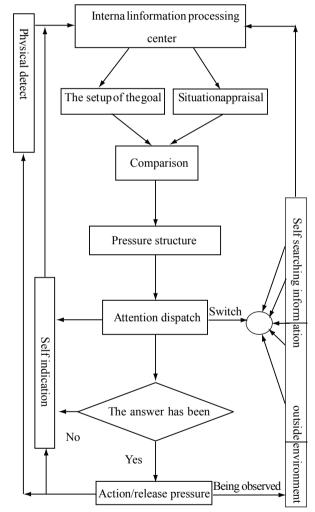
1. STUDIES ON BEHAVIOR AND DECISION MODEL

Psychologists unanimously think that the brain is the center of the internal information processing of human beings. The functions of the computers and the human brain have some similarities. In 1982, Professor Po-Lung YU proposed the basic model of the decision dynamic and studied[1-5, 8-10], which was enlightened by the scientific findings of computer science, applied mathematics, psychology, behaviorism, management, and economics and combining their scientific findings. The theory helps people have a more general concept of human behaviors.

The meaning of the model (Figure 1) is as follows:

The brain is the internal information processing center. After the experience and learning, the brain cell model and changes have formed humans' infinite memories and thoughts. In the memories and the thoughts, there are objective set ups (the balance point or the idea value of the objective) and situation appraisal (subjectively appraising the objectives). After the comparison of the actual value and the ideal value of every objective, if there exist the disadvantageous deviations, there will be pressures which demand the information center dealing with them. The mass of the pressures produced from the different objectives is called pressure structure in general. Pressure structure keeps changing with the entrance of information, perception change and different behaviors, the event which has the most influence on the mass of the pressure structure will get the first attention from the center, that is, the internal information processing center distributes the time resources to the relevant events. Attention dispatch aims at releasing the pressure in the best possible way, including the following three aspects: 1) Search for the outside useful information (self searching information or non self search information) to find the optimized plan. 2) Search for and choose the most effective method through the internal self indication. 3) After the final solution, the actions can be taken, and the pressures can also be reduced or eliminated. At the same time, physical detection is also checking if the physical

organs are in their balanced points, the results of detection, the outside information, and the self indication, actions and pressure elimination, as well as the knowledge that has been observed and explained by others will be sent to the internal information center, the memory structure as a feedback. There is a cross point in attention dispatch, representing the switch, which means that unless it gets attention from the attention dispatch, the outside information will not be attached importance to and dealt with.

Chan, Park and YU[11] used to apply the model above to the research of housing purchase decision process, and its result is that the model can represent the whole process of the human behaviors and decisions. And the model can be used to predict which decision is the final one for the decision maker.
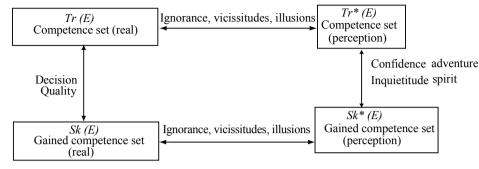

Figure 1
Human Action and Decision Dynamic Model

2. COMPETENCE SET ANALYSIS

For every decision problem, there exists a Competence Set, including the thoughts, knowledge, information and skill that are needed to reach a satisfying explanation. When the decision maker has already had

such Competence Set, or thinks he has mastered this competence set, he will make quick decisions on the the following:

Figure 2
Competence Set and Its Structure

In the figure above, E represents some decision problem; Tr(E) represents the competence set that is really needed to solve the problem (the thoughts and skills needed by E in order to solve the problem.); Tr*(E) means the competence set that the decision makers consider to be required to successfully solve a problem, that also means the perception competence set of the decision maker; Sk(E) represents the competence set that the decision makers have already had actually; Sk*(E) means the competence set that the decision makers have already had in perception. Tr(E), Tr*(E), Sk(E) and Sk*(E) all belong to a habitual domain. If there is no stimulation of a major event, the competence set will tend to be stable.

According to the research of YU and ZHANG[12], Sk(E) is very close to the core of the habitual domain, that is, for the problem E, the possibility of its being triggered during a specific period of time is bigger than the composition of the thoughts, and skills. The Decision Cycle means that the duration of the time from the beginning of the decision problem to the problem solved. If the thoughts and skills can be triggered, the decision cycle will be shortened.

When the competence set Sk*(E) that the decision makers have already had is included by Sk(E), it means that the decision makers underestimate his own capabitlity, otherwise, if Sk*(E) includes Sk(E), it means that he overestimate his own capability. When Tr(E) includes Tr*(E), it means that the decision makers underestimate the difficulties of the decision making, otherwise, he overestimates it. Influenced by such characteristic elements as personality and confidence, the decision makers will underestimate or overestimate his own capability, therefore there should be differences between Sk(E) and Sk*(E). What's more, caused by the unclear recognition of the difficulties of the decision making, there should be differences between Tr(E) and Tr*(E).

According to the capability fields needed to solve the problems (including the thoughts, knowledge, competence, information and skills required to reach a satisfying explanation) and the core of the decision maker

problems, or the decision maker has to expand their competence set by learning.

The competence set has four basic concepts[1, 4, 6, 8, 12] as

habitual domain core, these decision problems can be divided into four groups [1, 4]:

(1) Routine Problems

Tr(E) (or Tr*(E)) is known and Tr(E) is included in Sk(E). To such problems, the thoughts, knowledge, competence, information and skills have been known to the decision makers, and they can directly, intuitively and timely solve these problems.

(2) Mixed Routine Problems

The problems including more than one subsidiary problem are called mixed routine problem.

(3) Fuzzy Problems

TR(E) (or Tr*(E)) are not clear but they are still in the potential domain. The decision makers only have a vague idea of the thoughts, knowledge, competence, and skills required to solve the problems, and they could not clearly define the problems. Therefore, the decision makers lack these competence and skills. Although the competence needed is not clear, but it is still in the potential domain of the decision makers.

(4) Challenging Problems

Tr(E) (or Tr*(E)) is unknown, and it is beyond the potential domain of the decision makers. Decision makers have no or a little knowledge of the thoughts, knowledge, skills, information, and skills needed to solve the problem. No matter how low a level the threshold value has been reduced to, these problems cannot be solved successfully with the core of the habitual domain. Therefore, the competence needed is not only unknown, but it is also beyond the potential domain of the decision makers.

At last, it is worth to point out that the competence unknown to some decision makers can be known to others, therefore, the categories above should depend on the habitual domains of different decision makers.

The objective of competence set analysis[12, 13] is to define the competence set that is really needed, and the competence set the decision makers have already had, thus to help the decision makers expand their own competence set effectively and make better decisions. Here, Expansion

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of Competence Set means when the decision makers make a decision on the problem, the Sk(E), the competence set he already owns, has been expanded to Tr(E), the competence set that is required to solve the problem.

YU and ZHANG[12, 13] introduced the concept of the Expansion of Competence Set with the lowest cost. If only the cost is needed, the Next-Best algorithm can be applied to find the lowest cost expansion process. However, except the cost, the benefits should also be taken into consideration, which can help to form the best expansion process decided by the mere benefits. YU and Zhang compare the cost and benefits of the expansion process of the competence set, and further decided if it is worth expanding.

If Tr(E) and Sk(E) are regarded as vague set, then the membership function can be used to explain their relations. Because of the uncertainties of the actual decision problems, the competence set can be divided into several random sets to be discussed. YU and ZHANG[14, 15] use the expected rewards of the expanding process, and the expanding cost to find the best expanding process.

YU and ZHANG[16] have also researched on the boundary analysis problems of the competence set expansion.

In the research above, the competence set expansion costs are all supposed to be symmetric. However, if the competence set expansion cost is not symmetric, then the Next-Best expanding process is not always the lowest cost expanding process. Therefore, later on, there are scholars committed to the studies on the asymmetric and cost-oriented competence set expansion process.

LI and YU[17] jumped over the above to use the solution of Minimum Spanning Tree, MST and proposed a more practical competence set expanding process, that is to use the Deduction Graph and the 0-1 integer programming to find a solution and thus to find the best competence set expanding process. LI and YU have changed the symmetric limits to including the situation of the asymmetric cases, and it is more suitable for the practical situation. The influences of the intermediate skills (it is not included in the Tr(E), but if it can be acquired through learning, it will be helpful to the acquiring of other skills) and compound skills (the cost of the learning with compound skills is lower than the cost of learning with other single skills.) have also been taken into consideration. Considering some specific situations, the new concepts can be easily gained, therefore, LI and YU[17] think that the cost to acquire new skills are related to the present Sk(E). Moreover, the budget limits should be added to the solution finding process. Meanwhile, LI and YU further considered the multi-levels competence set expanding problems when the skills have different proficiency levels. The rules employed are to reach the lowest cost expanding level and the highest integral proficiency (here, the lowest proficiency cost should be measured by the subsidiary level.), the solution can be got

by 0-1 integer programming. Although this complete new solution has better dealt with the problems caused by the MST solution, it is more complex, and the operation cost will be highly raised, and its efficiency has been reduced if solved by with integer programming when there are too many skills (that means more nodes in the figure.). The MST expanding methods employed by LI and YU[17] has its weakest point of it assuming the inference graph has no circle, which also limits its application.

SHI and YU[18] has expanded the Next-Best methods proposed by YU and ZHANG[12] to the situation of the asymmetric cost expanding, and introduced the Minimal Tree Expansion Process. The process still employed the integer programming methods but it improves greatly the usability of the expanding methods.

Taking the intermediate skills into consideration, YU[19] has expanded the inference figure proposed by LI and YU to the inclusive circle cases in the inference graph, and proposed the concepts and methods of Multiple Stage Expansion Process, and still employs the integer programming model.

Based on the methods of the table, FENG and YU[20] proposed the Minimum Spanning Table Method of the competence set expanding, which can be used to deal with the cost expanding processes of the asymmetric, the circle included, intermediate skills included, the multiple skills, compound skill cases.

Competence set analysis means the competence set expansion, and it is the liveliest subject in the habitual domain theory research.

3. COMPETENCE SYSTEM MANAGEMENT

In recent years, the author has started the research on the enterprise competence system management, sponsored by the Humanity Social Science Plan Fund of the Education Ministration. Here, the "system" is the expanded version of "set" and the management is the expanded version of "analysis". Competence system management is a process of using the system opinions to define, plan, explore, use and update the organization and individual competence, and it is a complete improvement and development of the competence set.

The theory of Enterprise Competence System Management is originated from the Organizational Habitual Domain Theory developed by the appliers in the earlier stage, and the studies on the Competence Set Analysis. Enterprise Competence is an expansion of the Personal Competence in the habitual domain research, "System" is the expansion of the "Set" theory, and the "Management" is the expansion of the "Analysis". Competence is the organic combination of the knowledge, skills, experience and qualities. The enterprise skills are varied and interactively functional, which can be

described in one system, that is, the competence system. The enterprise competences are varied and related to one another organically, which forms a skill system, the system can be managed by the management processes such as the starting, plan, organize, coordinate, control, and ending. "Process Based" means streamlining the management processes, which means to clarify the work basis, premises, and results of the enterprise organizational management, to design the realization methods of the management behavior – the tools and technique design, to clarify the output objective of every management behavior – managing the enterprise competence system according to the process management methods. The project tries to be based on the earlier studies of the appliers, started from the point of view of the habitual theory to build an enterprise competence system management theory and method system, based on the processes, and implement the necessary applied research.

From the view of the management system, the competences that form the competence set are related to one another, in fact they are one competence system, and it can be studied from the view of the system combining the methods of system modeling, optimizing, prediction, decision making, appraisal, and simulation. But the present studies are limited to the competence set analysis, mainly on the competence set expansion. From the view of the enterprise organization, competence system can be managed, but on how to manage it and what to manage, there is not any mature instructions and methods in the habitual domain at present.

Any management decision making needs management decision makers (the main body of the management decision) to master a certain amount of knowledge of recognizing, understanding, and analyzing the management problems, it demands the management decision makers of having a certain personal quality of decision making and experience on management decision. The combination of the knowledge, quality, and experience is called competence. For a detailed decision making case, the competence required to make the decision is varied, multiple, dynamic, instant, and these should be picked up in necessary time and places. Therefore, the competence set analysis is an important dimension in the management decision making research.

Based on the view of the processes, the author combined the studies on the behavior making and habitual domain theory and divided the enterprise system management into the eight process groups: The definition, development, expansion, extending, integration, updating, maintenance and appraisal, employing the tools and techniques of the modern system modeling, optimizing, prediction, decision making, simulation, appraisal, control, hypothesis, expecting to propose a set of proper theories and anaysis methods for the enterprise orgnization competence system management, and choose some representative enterprises to investigate and study.

The relevant studies complete, improve and develop the habitual domain theory and competence set analysis.

The present research findings including:

(1) Having built a scientific enterprise competence system management standardized model frame.[39]

Based on the present findings and habitual domain theory, a model frame of enterprise competence system management has been proposed, as well as a detailed process of the system constructing the enterprise system management, and a new standard system of the enterprise competence system management has been offered from the view of the processing management.

(2) Having raised the detailed optimized methods of the competence system management.[40-45]

By the use of the modern system project and the system analysis tools and methods, multiple competence system expanding method, competence system integration modeling and optimizing methods have been built; the competence system development, updated theory and method system have been studied on, some enterprise competence system management level appraisal mature model and warning model and system have been built studied, and applied.

4. FUTURE RESEARCH OUTLOOK

Competence set analysis is a new analysis theory of decision making. After the studies of more than ten years, it has made great accomplishments, especially in the field of the personal competence expansion, and a great number of its findings are published in different academic journals. After reviewing the previous studies, the competence set analysis still has problems to be studied in the following aspects:

4.1 Organizational Behavior and Decision Model Problem

As an independent person, everyone has their own habitual thoughts and responses to the matters, people, and information. So are the people in the organization. And to extend the idea, every organization, every enterprise, every nation, every different nation and every country has their own tradition, and habits, e.g. letters, languages, culture, laws, institutions, custom habits, management methods, humanity, etc., therefore, there exist the specific outside manifestation in the habitual domain, the habit can be studied as a domain, its formation and expression rules can be studied.

From an abstract view, an organization is also an organic body, therefore, it has its habitual domain. In the research on the organizational habitual domain, the following three are worthwhile noticing:

a. An organization is composed of several formal or informal groups and individuals, the habitual domain of groups and individuals will influence the habitual domain of the organization. What's more, the habitual domain can

also be observed through groups and individuals.

b. The habitual domain of the organization leaders and managers, and their moral style has a great influence on the whole organization and their individuals.

c. Different organizations have different rules to measure their work products, in the case of enterprises, the enterprise attraction and competitiveness are two standards to measure the success of an enterprise. The enterprise habitual domain can be analyzed through the elements such as market, organization, and management, competition, finance, society, politics, and science.

Organization has its own behavior basis and common psychological perception, and it should be researched, summarized and analyzed together with the organization theory and behavior science theory. Therefore, building the proper organizational and enterprise behavior and decision model has important strategic and practical meanings for enterprises to improve their competitiveness, understand the habitual domain of their opponents, and build the enterprise strategic league.

4.2 The Problems of Organizational Competence Set Analysis

The competence set analysis in the traditional habitual domain is mainly used in the expanding analysis of the individual competence set, and it lacks qualitative analysis and quantitative measurements of the competence itself. *The core competence of the corporation*[21, 22] by Prahalad and Hamel in the *Harvard Business Review* in 1990, the article has triggered a worldwide wave of the academic and enterprises studying the enterprise competence theory. However, it is regretted that the studies are still based on the qualitative description and analysis until now, there are no quantitative studies. From a personal view, there is no shrinking in the competence concept, therefore, the traditional habitual domain theory studies on the expansion of the personal habitual competence, and the competence set is to deal with an abstract and limited discrete set. But from the view of the organization and enterprise, in the competition, the competence expansion can be expanded, and the competence shrinking can be employed, and the competition transfer can also be employed. Therefore, the competence set has a very wide range. Otherwise, the traits of the personal competence set qualitative analysis can be referred to study the qualitative analysis and the research on the problems of the organization and enterprise competence. The other way round, the characteristics of the organization and enterprise qualitative analysis can also be used to study on the personal competence, which can be completed mutually.

Therefore, it can be said that the organization and enterprise competence analysis will be a new topic that should be further studied on in the habitual domain.

4.3 Competence Expansion Method Problems

Traditional competence set analysis mainly focuses on the expansion studies on the discrete competence set, and the qualitative analysis. How to use the uncertain inference techniques and theories[22, 23] (probability inference, evidence inference, vague inference, information inference, inclusive inference and so on) to study the competence set expansion problems in the uncertain situations, which is still worthwhile researching in the traditional personal habitual domain theory.

Moreover, the behavior and decision making problems in reality are mostly the problems of multiple objectives[24, 25], the traditional competence set analysis mainly focuses on the single objective problems. How to expand the present competence set to the multiple situations is also worth studying.

What's more, considering the uncertainty of the competence set expansion, how to use heredity algorithm (GA), neuro net (NN) or artificial neuro net (ANN) to study the expansion problem is also a worthy task.

4.4 Application Problems

Competence set analysis, both the personal competence set analysis which has already been built and the organization competence set analysis waiting to be built should be a science of decision making and analysis with strong practicability. It has a great outlook in the leading competence[26], enterprise competence[21, 22, 26], student record management[1, 8], conflict analysis[1, 4, 8, 9, 27-31, 33], dynamic decision making[8, 34-38], win-win strategy making[1, 8], but these fields have not been explored yet.

4.5 Competence System Management Strategy Exploration

The author has not fully and profoundly studied the competence system management methods, and it needs further exploration on the complete, practical and advantageous methods. The standardization of the design of the competence system management has not been completed, either.

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