RECENT RESEARCH ACHIEVEMENTS ON AHP IN CHINA

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ABSTRACT: The main purpose of the paper is to present an overview of research and practice on AHP in China.

1. INTRODUCTION

The Analytic Hierarchy Process (AHP), a multiple criteria decision making approach, was established by T. L. Saaty [1],[2],[3], Pittsburgh university, USA, in the late 1970s. In the approach, factors used for evaluating alternatives are arranged in a hierarchic structure, and the alternatives are ranked from the judgment matrixes which given by decision analysts. Since its theory on hierarchical structure is very suitable for the traditional decision framework in China, especially for those to deal with social or economic decision problems, it has been accepted by our Chinese decision analysts and popularized widely in China. we use it to combine qualitative analysis and quantitative analysis and transfer non-structural problems into structural ones.

From 1982, when AHP was introduced to China, both the research work and the applications in AHP have gotten remarkable progress. It shows that AHP theory has strong power in decision making field.

As organizers in the decision science committee, we are glad to know ISAHP'99 will be held in Japan, Kobe. we have to write a summary on recent research and applications of AHP in China. We regard it as a presentation to the conference and hope everyone who reads it realizes that a big and powerful 'Front Army' working on AHP has grown up in China.

2. GENERAL SITUATION

In 1982, AHP was fist introduced to China during the first symposium on energy development strategy. Initiated by professor Liu Bao, professor Xu Shu Bai and He Jin Sheng conducted a seminar on AHP in 1983, and held study class at Tianjing university in 1936. In addition, senior engineer Jia Hong Xun and Sun Hong Cai, Beijing institute of Engineering equipment, run five courses on AHP in nationwide. Plus the similar kinds of study classes held in different provinces researchers have been trained. Nowadays, nearly one hundred of high schools have open AHP courses, many doctoral and postgraduate students have chosen or are going to select AHP as their research directions and degree essays. with the above endeavor and efficient work, a large academic group engaged in researching and applying AHP has grown up.

1. 1 Societies and . academic activities

In 1988, aiming at coordinating and organizing AHP research in China, a national AHP popularizing term led by Xu Shu Bai was founded at Tianjing university and the First international Symposium on AHP was

held [4].In the same year, an AHP lecture given by foreign scholars (including T. L. Saaty) was held in Beijing. Later, under the leadership of the Society of Systems Engineering of China (SSEC), a specialty academic union on AHP was established with the host of Beijing institute of Engineering Equipment, yang Gui Zhong and Sun HongCai are selected as general secretary and vice-general secretary, respectively.

In 1990, 16 Chinese scholars participated in the second international symposium on AHP in Pittsburgh, USA. In China, the First.Academic Meeting on AHP (AMAHP I) was held by Beijing institute of Engineering Equipment, and its paper collection was published[5].

In 1992, the specialty academic union on AHP was named as Decision Science Committee which is regarded as one of branches in SSEC. Wang Gui Zhong is the director, and Sun Hong Cai is the general secretary. In the later of the year, the AMAHP 11 was held in Tai An City, and its paper collection was published[6].

In 1993, professor Saaty was invited by the committee to give a presentation on 'The recent progress .of AHP' [7]—[10] in Beijing.

In 1996, the AMAHP III was held by Beijing institute of Engineering Equipment, its paper collection was published[11].

1. 2 AHP journal and publications

《Decision and the Analytic Hierarchy Process》is a periodical publication supported by Decision Science Committee. It is the first journal that especially introduces and popularizes AHP in China. It offers Chinese AHP enthusiasts precious chances to present their research work in public and has become an authoritative journal. Started in 1990, it has been published 7 issues and widely influenced the academic field in AHP application and decision science.

In addition, we have published a sires of books[12]—[17] to introduce the fundamentals of decision making with AHP, and translated 《The Analytic Hierarchy Process》 (written by T. L. Saaty and translated by Xu Shu.Bai) in 1989.

Till now, there are more than 240 papers on AHP have been published in many kinds of Chinese journals, such as Journal of Systems Engineering, Theories and Applications in Systems Engineering, Journal of operational Research, Decision and Decision Support Systems, journal of Management Science, Journal of the Soft-Sciences, and so on.

3. RESEARCH WORK ON AHP THEORY

As a new decision theory, AHP inevitably has a lot of subjects to be probed. In the view of this situation, we have systematically conducted a sires of research work that emphasized on demonstrating and completing the general truth system in AHP.

In accordance with the theory of dynamic ranking, we put forward a new model which is different from the original one on constructing judgment matrix. The new model is also suitable for those dynamic judgment matrixes whose ranks are greater than 4. It resolves the problem that the original model could not get solutions of characteristic roots and expanded AHP.

The research on Group AHP (GAHP) is one of the active topics in China. Since decision making is a process in which a group of people will be involved, it is very important that how to synthesize group preferences4 Having widely discussed relative issues, such as handling group judgments, picking extreme preferences, determining reliability of information, etc. , we developed correlative concepts and methods for getting twice sum of weights, calculating geometric average values of elements in the judgment matrixes, synthesizing weights, as well as constructing functions on judgment information from expert panels in the basis of Shannon s information theory. Moreover, based on the Fuzzy theory, we have

put forward some Fuzzy AHP methodologies Which apply Fuzzy theory to build judgment matrixes and infer to comprehensive scales and priority of alternatives .

on the research of ranking theory, we have made some modifications on the gradient eigenvector method (GEM) to get the weight vectors when there is a wide inconsistency in judgment matrixes. In addition, we developed a sufficient condition that is a principle for keeping restrict order of a priority when a set of new elements are introduced to the priority. As for the consistencies of judgment matrixes, we modified the original consistency indexes (C. I. and C. R) by making a test in which the average random consistency indexes related to matrixes withdifferent size from 1 to 15 levels.

Regarding AHP as a complementary method for operational Research (OR) , we explored the applied conditions and approaches and demons t rated their optimization and perfection of applying AHP to Multiple Attributes Decision Making NADM). Furthermore, we have tried to combine AHP with the Data Envelopment Analysis (DEA) to value relative efficiencies of decision making units.

Description of AHP is one of our research work. With the use of tensor analysis, we have given a description and a model of AHP in the form of tensors. We substituted the model for hypermatrix to describe those decision problems with feed back hierarchic systems and simplified the analysis process. Moreover, we have established a sires of patterns of applying AHP to some conventional analyses with respect to costs and benefits, linear programming, dynamic programming and DEA. .

4. APPLICATIONS OF AHP IN CHINA

In China, AHP has been used in many decision activities Which mainly cover economy, energy, management, environment traffic, agriculture industrial, military, and so on. According to a rough estimation more than 600 papers published in public are associated with AHP in the following applications:

In energy development, Le Wei Liang and Wang Ying Luo established a model with AHP-oriented to determine a reasonable proportion which was used to develop different kinds of mining areas in ShanXi province. Xu Shu Bai and He Jin Sheng analyzed costs and benefits of the provision forms of energy for civil use in Tianjin. Zhu Guang Yuan and Ge Chang Yi constructed a model for choosing agricultural energy policies. Wu Jun Hui studied the problems on energy controls.

In strategy planning, Sun Hong Cai made a long-term program on engineering equipment by 2000. Cheng Shou Tao studied a target system in which plans for developing a sires of major weapons were ranked. Yang Jia Ye put forward a model on economic development strategy in Xinyang city. Wang Wen Juan established a model for selection of key industries in Beijing. He jin Sheng researched the industrial construction in Tianjin by using AHP. Yang Jian Mei designed a comprehensive AHP-MLP model for analyzing industrial construction.

In economic analysis and forecasting, Fu Ding De ranked industrial I superiority in Zhejiang province. Meng Zhao Zheng developed a evaluatio model to forecast petroleum resources. Sun Hong Cai combined AHP wit cybernetics theory to construct a model for dispersing the population of a specific city in natural disasters. Xie Guang Bei solved a decision problem that sets different kinds of industries in Tianjin economic development zone.

In systematic evaluation of equipment, Tian Mu Ling developed a hierarchic model to evaluate alternatives for designing a new armed vehicle. Jia Hong Xun established an evaluation model to evaluate the overall performances of engineering equipment by combining AHP with Multiple Attribute Utility Theory (MAUT) .

In management of scientific researches, authors emphasized on constructing criterion systems for evaluating scientific research achievements, selecting scientific research projects and determining regional total scientific and technological strengths.

In operational researches on agriculture, some authors have developed decision models on the national 'Spark Project', and made some analyses including agricultural development classification, crop proportions and their rational scales, livestock products and regional ecological balance.

In talent evaluation and plans, AHP has been used to evaluate multiple objective weights in the model of planing higher education in China. Moreover, some talent assessment and evaluation systems for cardiac and government office workers have applied AHP as a main analysis tool.

5. PROSPECTS FOR THE FUTURE

AHP has become a very active MCDM method not only in the above research on its theory but also in the applications. In China an academic group studying AHP has grown up and played significant roles in wide decision making processes. However, there are still many subjects on AHP need us to probe in deeper fields. Following subjects are what we are going to make further research:

a. Standard forms of GAHP,
b. Simplified description for elements of the judgment matrixes in
dynamic ranking process
c. Theories for keeping order of priority
d. Standard patterns for decision making
e. AHP with feedback systems
f. AHP and OR
g. Combination of AHP and DEA
h. AHP and the information theory
i. AHP and the science of behavior.
j. Describing AHP in tensors
k. Fuzzy AHP and its applications
l. AHP and Decision Support Systems with expert panels
m. AHP and optimization technique
n. AHP and pattern identification
o. AHP and knowledge engineering

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