Application of the AHP to Scientific & Technical Information Research

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1. Introduction

Scientific and Technical Information Research (STIR) which is full of original views, has always been taken into account by government in China. Today the main purpose of Chinese STIR is to help the decision-making process of the government, scientific research and production. With the reforms taking place and the beginning of a new openess policy toward to the outside, STIR has extended its interests to economic development, and to the provision of all kinds of services to science, technology, and society. Because of the growth in variety and function of STIR traditional methods used cannot satisfy the requirements of growth. To make decision-making more scientific and democratic, new methods are needed. This is a question of the first importance for information science and information research in China.

The Analytic Hierarchy Process (AHP), developed by the american professor Thomas L. Saaty [1], has great advantages over traditional methods. It certainly interested Chinese scientific and technical information circles because it is a practical multiple criterion decision-making method, With it, we can improve and synthesize our subjective judgements. A complicated problem can be analyzed as an orderly successive hierarchy structure, and then order it by its strengths. Particularly quantitative and qualitative elements can be considered together. In sum, it is

practical, simple and adaptive, and it has a wide-range applicability to decision-making in society and the economy.

2. Adaptation of the AHP to information research

The AHP can make the most of information research: It is subordinated to decision-making, and it plays a great important role in it. With the help of the AHP, we can start to analyze documents, data and do applied research being aware of the development trends of science and technology, inquiring into the principles of how those developments in science and technology can be coordinates with economic and societal changes. STIR is characterized by being orientational, political, forecasting, scientific, synthetic and social [2].

(1) The AHP deals with the optimization of all sorts of decision-making. The objectives of the decision-maker can be expressed as a hierarchic structure. By quantitative and qualitative analysis, the objectives can be ordered according to their strengths. So it is quite orientational.

(2) Setting the criterion layer, the AHP can reflect the overall policy direction of the country and local area according to the objective, and prevent deviations and faults in decision-making, effectively ensuring that the objective agrees with the overall development policy of the whole country and local area [3].

(3) An elementary function of the AHP is to forecast and evaluate all kinds of decision-making projects according to objectives. In particular, the AHP satisfices, simulates and

systematically integrates qualitative and quantitative information making the forecast easy to justify and validate.

(4) The AHP has a mathematical foundation. It is an objective method to sort out and synthesize our subjective decisions. The main point of it is mass decision-making. So it both includes subjective tendencies of decision-makers, and helps to avoid making arbitrary decisions. With the AHP the researcher's point of view can be objectively reflected ensuring that research is scientific and reproducible.

(5) The principles of synthesis and evaluation of the AHP are fundamental. They help to attain the objectives in the economic, social and technical dimensions by: sorting them out in a hierarchy, helping to find out the elements and the relations between them, assigning weights according to the effect on the whole, and finally, synthesizing quantitative analyses to get a satisfying decision with multiple elements, objectives and criteria.

(6) The AHP can help us not only to make use of the collective wisdom of the masses, coordinating with the others in STIR [4], but also to reach a common understanding, and guaranteeing the quality of information research. This will have a profound effect on the cooperation between information research workers, scientists and technical staffs, and on socializing STIR.

The AHP contains the traditional information research methods: Information research is a developing science. It hardly has its own research methods. The existent ones are introduced directly or indirectly from the natural and social sciences [2]. However, they are not suitable to addresses such a complicated system with

multiple elements, objectives and criteria. To strengthen STIR, it is urgent to select and establish its own research methodology. The AHP appears to be the appropriate choice.

Generally speaking, the traditional information research consists of three kinds of methods: logical, mathematical, and super logical imagination [2]. The first one is good for discussion. Thw second one is good for precision, and the last one is good for creativity. The AHP is good for all of these purposes. Not only can it be used in a complicated system of multiple elements, objectives and criteria, but also keep the traditional style. In this way traditional methods have become more active:

(1) Enhancing rationality and strengthening systematic and logical thought.

The AHP is the extension of basic thinking from our brain. The essential aspect of it is a kind of thinking mode. Complicated problems can be analyzed in several parts, considering the subordination between them. The elements are ordered into a successive hierarchy structure. Compared one by one, we can obtain the relative importance of each element, synthesizing our judgments in order to work out a sequence of decisions that reflect human beings basic principles of analysis, judgments and synthesis [5]. Meanwhile, a series of logical means (used in traditional information research) such as analysis and synthesis, relative comparison, induction and deduction have been made full use of in the whole process of the AHP application.

(2) The AHP integrates quantitative and qualitative analysis.

Quantifying the qualitative dimension is quite difficult in the soft sciences. The AHP has helped to synthesize common methods used in information research such as the expert-inquiring, matrix theory and modeling. Through the establishmentof a model and benchmarks, the AHP specially processed the problem, analyzing the subjective judgments, and providing solutions to qualitative problems in a quantitative manner. This can be proved very well in mathematics. This is the scientific foundation of the AHP.

(3) During the application of the AHP, the structure of the model could differ in thousands of ways, having everyone's advantages, seeking common ground while reserving his differences.

"It is helpful for decision-makers to quantify his deviation on the problem and correct the inconsistency on the deviation during the quantification (of course, the deviation on certain problems could be nonconducting)" [6]. As an art, decision-making has been well shown. Seeking differences, this could lead to an original view, inspiring and supplementing mutually. The AHP is a reasonable approach to elaborate the mass wisdom and mass decision-makings.

The AHP can integrate well with other research methods: With decision-making becoming more scientific and democratic, decision-making is giving more emphasis to the soft sciences in China. The AHP can help us to optimize in many projects. It is simple, it can be easily implemented using one's senses, and it is easily understood by ordinary decision-makers. It's application has become very popular in China. Many scholars have tried it in local area programming, multiple objective decision-making, emphasis in

selecting projects, optimization and synthetic evaluation, and study of counter-measures. Many people have gotten good results. The same as in the operational research circles where people have take the AHP as an effective and simple method for multiple objective decision-making, the other soft sciences are trying to adapt the AHP to their fields as well. This not only resulted in the expanding range of AHP applications, but also promoted the study of the AHP itself. Because the AHP supplements some soft sciences (in the integration of qualitativity with quantitativity), quite a few scholars in China are eagerly initiating its introduction to systems dynamics, operational research, fuzzy mathematics, and fuzzy systems principles [7-9].

3. The application of the AHP in "the spark scheme"

The AHP was used to help provide the scientific basis for and implement a plan called "the spark scheme" to develop vigorously the local economy in the province of Jilin and promote middle and small-size enterprises, the enterpri-ses in small towns. The AHP was used to prioritize the objectives, help the "spark department" to make arrangements, expounding and proving the tentative plan in which the CSTJ invested 250 million yuan, proposing the overall programming of the plan and measures to take.

The target is a huge social and economic system engineering. During the study, we chose the AHP as the main means. The general idea is: taking products as the beginning, market as direction, benefit as purpose, technique as background, and management as guarantee; making technology, industry, agriculture and trade a

coordinated process; making planting, breeding and process in series, providing a complete set of services of investigation, forecasting, scientific research, demonstration in production. Thus we established an AHP model for selecting the main developing field and the main industry [10] [3]. With the help of expert-inquiring methods and other traditional information research methods, we concentrated on developing 10 products inclusive of ginseng and the castor-oil plant. We have investigated, expounded and proved thoroughly. At last the task was finished successfully.

Now, we show our model on which "the spark scheme" is based (See Figure 1):

(1) The objective layer A (the top layer): The purpose of the model is to select the project for "the spark scheme" rationally in order to realize the general conception of our province during 1985--1990.

(2) Criterion layers B1-B5 (the middle layers): Directed by the country's general thought of "the spark scheme," characteristics of products technical conditions, benefit of investment, market requirements and resources are taken as criteria.

(3) Index layers C1-C16, D1-D21 (middle layers): In contrast to the five criteria mentioned above, the particular index could be given.

(4) Project layer (the lowest layer): The projects of "the spark scheme:" The marks of the model is 1 to 9 and its reciprocal. The details are shown in Table 1: The Absolute Evaluation Standard.

4. Results and Conclusions

The "spark scheme" has achieved very good results because of the application of the AHP:

(1) Having concerned the resources, developing rationally, the main developing field of "the spark scheme" was assured, the economy of our province has been promoted and developed steadily.

(2) It carried out the policy of vitalizing the agriculture by science and technology and has promoted the transforming superiority from resources to products and industry and the forming of mainstay industry.

(3) Correctly selected the projects, resulting in a very good economic benefit, promoting and demonstrating for the economy of the whole province. More than 85% of the "the spark scheme" projects which the Task Organization selected by the model were adopted by the "the spark department" at once. They have good benefits after being put into production. For example, by comprehensive utilization of the castor-oil plant, the project selected by the Task Organization, planting, processing and marketing industries went very well in the county of Tong Yu. The exporting of refined castor-oil can be exempted from customs examination. The annual output value was 120 million yuan. The income of peasants in the entire county increased by 300 yuan. The county was taken off the "poverty county" list, and was praised by the leading Committee of Science and Technology of People's Republic of China [11].

By the beginning of 1989, the 10 products had already been under production at large scale. The general conception of the

CSTJ has been realized. Three hundred spark projects have been carried out, two hundred million yuan were invested, and two hundred and fifteen projects have gone into production. The output value was 600 million yuan, and the profit was 200 million yuan. Exporting part of the output yielded a profit of 20 million U.S. dollars. Among the 224 projects which were in the province scale, 105 kinds of products attained the advanced province level, accounting for 46.9% of the project, one hundred kinds of products attained the advanced country level, accounting for 44.6%, nineteen kinds of products attained the world level, accounting for 8.5%. Among the 88 spark projects which have been accomplished, 53 kinds of products were rewarded, 6 in the world, 13 in the country and 8 won "the first national spark prize" in 1988. Another 314 spark projects are on the way, investing 240 million yuan. It is estimated that after being put into production, the output value will be 1.5 billion annually and the benefit will be 460 million. Three years later, the task passed the appraisal in the province. The conclusion of the experts is, "the task has provided the scientific basis for general thought of the development of "the spark scheme" during the period of 1985--1990 or even longer period and for promoting the development of the economy in the country-side. It is the first time that the AHP was used in the "the spark scheme" [12].' The national information circles has firmly approved the results of the task. Nei Monggel drew on the experience of our method. The "spark scheme" there was carried out very well, and made good results.

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