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Application of Analytic Hierarchy Process (AHP) in shipyard project investment Risk Recognition[1]

APPLICATION DU PROCÈSSUS HIÉRARCHIQUE ANALYTIQUE (PHA) DANS L'IDENTIFICATION DES RISQUES DE L'INVESTISSEMENT DANS UN PROJET DE CHANTIER NAVAL

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Abstract: Risk Recognition is an important part in shipyard project risk management. The purpose of this paper is to explain how to identify risks by means of AHP. Firstly, we analyzed briefly the superiority of AHP in shipyard project risk Recognition; secondly, expounded the basic steps of risk Recognition based on AHP in shipyard project investment; then we proposed the principle and tips of applying AHP in identifying project risks by demonstrating a case of shipbuilding base. To prove the validity of AHP, we have identified the risk factors of the Shipyard project that mentioned in the case above, and have also calculated the influence weights taxis of dominating risk factors to the general risk.
Key words: Shipyard Project Investment; AHP; Risk Recognition; Risk Factors

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Résumé: L'identification des risques est un élément important de la gestion des risques dans un projet de chantier naval. Le but de ce document est d'expliquer comment identifier les risques en utilisant les techniques du PHA. Tout d'abord, nous avons analysé brièvement la supériorité de du PHA dans l'identification des risques d'un projet de chantier naval, ensuite, expliqué les étapes de base de l'identification des risques fondée sur PHA dans l'investissement dans un projet de chantier naval, puis nous avons donné quelques principes et des conseils sur l'application du PHA dans l'identification des risques du projet en démontrant un cas de la construction d'un chantier de construction navale. Pour prouver la validité du PHA, nous avons identifié les facteurs de risque du projet de chantier naval mentionné dans le cas ci-dessus, et nous avont également calculé l'influence des facteurs de risque dominants pour le risque général.

Mots-Clés: investissement dans un projet de chantier naval; PHA; identification de risqué; facteurs de risque

1. INTRODCTION

Shipyard project investment is Money committed to the shipyard project for future income, in order that the investor can achieve the prospective return. Due to the complexity of shipyard projects and the uncertainty of its external environment, it is very likely to increase the possibilities of profit loss which caused by inconsistency between actual earnings and expected earnings in the process of operating. Thus make investment projects with larger risk. Therefore, risk management of investment project, it is very necessary, and the important prerequisite for effective risk management is accurately risk Recognition, risk Recognition is the most important part in the processes of risk management .in a project, the biggest risk is that it cannot identify the risk. through investigation, decomposition of risk Recognition, discuss all possible risk factors in a project. each risk factor is an impact factor, each factor for the whole project risk degree of influence is different, the main task of risk Recognition is, in numerous factors, after screening, find out the main factors of these factors ,and to the whole project risk degree of influence. Shipyard investment projects, the technology is complex, broad, is a complex giant system, which makes the shipyard project risk become fuzzy, uncertainty, difficult to definition and quantify accurately, and AHP is of a kind of simple, flexible and practical multi-criteria decision method to complex and fuzzy quantitative analysis of qualitative problem. by combining the characteristics of shipyard project, probes into the project using analytic hierarchy process (AHP), and the risk Recognition shipyard comprehensive as possible steps in identifying risks, the risk factors for projects in accordance with weights was presented.

2. THE BASIC PRINCIPLE AND APPLICATION STEPS OF AHP

The Analytical hierarchy process (AHP) is a structured technique for dealing with complex risk decisions, and also it is a simple and practical method of modeling. The basic principle of it is to disintegrate firstly and then integrated. firstly, according to the nature of the problem and in order to achieve the goal, having the problem analysis hierarchical, divided it into different factors, then according to the relationship between the factors, according to different levels combine factors together, forming a multi-layer analysis structure model, then to sort out and synthesize the experts' subjective judgments, attributed it to the lowest layer (risk factors) relative to the whole project at the highest level (general risk) of the relative importance weights scheduling problem.

2.2 Application of analytic hierarchy process (AHP) in risk Recognition

2.2.1 Model the problem as a hierarchy containing the general risk（goal）, the risk factors（alternatives）for influencing it, and the sub-risk（criteria） for dominating the alternatives

To project risk, as Hierarchy systematically identify risk factors, and methodical, risk factors, according to the hierarchical control subordinate must construct a hierarchical structure model. The model number and problems of complex hierarchical and detailed analysis relevant, not restricted, and each level of each element dominated factor generally can not exceed nine, otherwise it will increase the difficulty of pairwise comparison.

2.2.2 Establish priorities among the elements of the hierarchy by making a series of judgments based on pairwise comparisons of the elements

On the same level of various factors, according to the results of expert consultation, by using 1 ~ 9 scale on the importance of a factor in pairs, any two factors x_i and x_j, will be compared as to how important they are to the decision makers , with respect to the factor they attached to. And a_{ij} is the ratio of x_i and x_j, all comparison results for paired comparisons are judgment matrix $A=(a_{ij})_{n\times n}$. matrix A is reciprocal matrix, match conditions $a_{ji}=1/a_{ij}$,and $a_{ij}>0, a_{ii}=1$.

2.2.3 Establishing the sequence hierarchy and Check the consistency of the judgments

Firstly,work out the characteristic vector W that maximum eigenvalue $\lambda_{\max}$ of judgment matrix corresponds to,*W* normalized processing,Then,we can obtain the relative importance weights of each factor in the same hierarchy to the factors above they affiliated with. It can establish the sequence hierarchy.

However, by using the method of pairwise comparison to structure judge matrix, can objectively reflect the different Impact of a pair of factors, when it comes to Integrated all the results of comparison, there is a certain degree of consistency. Therefore, when maximum eigenvalue $\lambda_{\max}$ was worked out, it is necessary to inspect judgment matrix *A* whether serious inconsistencies by $\lambda_{\max}$, in order to decide whether to accept *A* r or not. The procedures of consistency check are as follows:

(1) According to formula (1) calculate the consistency index *CI*;

$$CI=\lambda_{\max}-n/n-1 \quad (1)$$

(2) Look-up corresponding mean index of stochastic consistency. for *n*= 1... 11, corresponding to the corresponding value as shown in Table 1.

(3) According to the formula $CR=CI/RI$ to calculate the consistency ratio CR, if $CR<0.10$, the consistency of the judgment matrix is acceptable, or to make proper judgment matrix again.

2.2.4 Make hierarchy total taxis and check its consistency

If the hierarchy *B* includes *m* factors $b_{1j},\cdots,b_{mj}$,and the number is,their weight coefficient of hierarchy total taxis are $b_1, \cdots, b_m$. And set the lower hierarchy is *C*, which includes *n* factors,the sequence hierarchy of these factors to B_j is $c_{1j}, \cdots, c_{nj}$ (if C_i ignore B_j, $c_{ij} = 0$), to calculate the hierarchy total taxis of factors in hierarchy *C*,and it is $c_1, \cdots, c_n$,according to formula (2),we can obtained the value of $c_1, \cdots, c_n$:

$$c_i = \sum_{j=1}^{m} c_{ij} b_j \quad (i = 1, \cdots, n) \qquad (2)$$

So that they can get weights of factors in the lowest hierarchy to top target factor, make clear influence degree of risky factors to whole risk, which will provide scientific basis for decision-making in shipyard project risk management.

Hierarchy total taxis should be also consistency checked because if comprehensive investigation, all hierarchys of the consistency is likely to accumulate, in the final analysis results will be serious inconsistency.

Assume the pairwise comparison matrix in Hierarchy C,which its index of sequence hierarchy is $CI(j)$,（ $j = 1, \cdots, m$ ）,corresponding mean index of stochastic consistency is $RI(j)$, ($CI(j)$、$RI(j)$ have been worked out), in that way,the ratio of stochastic consistency can be worked out by formula（3）:

$$CR = \sum_{j=1}^{m} CI(j) b_j \,/ \sum_{j=1}^{m} RI(j) b_j \qquad (3)$$

If $CR < 0.10$, the judgments showed acceptable consistency.

3. APPLICATION ANALYSES

It is not suitable to identify risk factors by using one method only, for a large-scale shipyard project, we should adopt various methods to implement integrated risk Recognition. Firstly, we'd better decompose complex system of shipyard project into small simple systems that easy to identify by the use of the principle of fault tree analysis, this process of decomposing is based on the target of risk Recognition and the character of project. The result of decomposing have to match request of AHP, if this happen then, we form judgment matrix table directly according to the risk factor structure formation. Secondly, by expert scoring, forming a judgment matrix. The following sequence hierarchy, total taxis and corresponding consistency check will be finished by using compute program based on MATLAB. Therefore, in the part of empirical research, the dominating assignment is to comprehensive scientific identify project risk factors and make expert grading accurately.

In order to learn risky factors scientifically and comprehensively in risk Recognition, we follow such a train of thought: firstly, from the horizontal ,we divide shipyard project into two parts of input and output, and collect the risk factors involved in the input and output, Secondly, make an on-the-spot investigation the external risk factors that influence the input and output, such as the policy factors, the exchange rate, etc. Then, in accordance with the vertical sequence of project construction, production and operation period collected various risk analysis, with its comprehensive and systematic project risk factors Recognition.

3.1 Project example analysis

A shipbuilding base locates in the estuary of Yangtze River. The length of its bund line is 1,500 meters, which covering an area of about 207 million square meters. The first-stage construction of Project including two docks that their scale is 300 thousands ton-class and 250 thousands ton-class, and the production capacity in shipbuilding to design is 180 million tons, specific plans of production capacity program is three ships in 250 thousand DWT, five ships in 150 thousand DWT , and three ships in 100 thousand DWT. What's more,the construction period of project is 4 years, the investment of construction is 3.9 billion Yuan,and the investment of circulating fund is 40.3 billion Yuan. The ship orders mainly come from overseas ship-owners.

3.1.1 Risky factors Recognition of shipyard project

The Project construction cycle is long, and makes great demand of capital investment, so the project will undertake great cost of capital, and the complexity of technology of shipyard project, involving widely, total investment is not easy to control, construction project cycle changes, etc are likely to happen ,what's more, the shipbuilding industries coupled with periodic characteristics and shipyard project fixed asset specificity, makes the shipyard project faces great risk in construction process. And in actual operations, shipyard project involves many risk factors, the ship has multiple price fluctuation, orders, prices of raw materials and labor costs, depreciation rates drop, bank interest rate and international exchange rate fluctuations, various cause the boat not pay will influence project expected returns.

According to the information mentioned above, we identify risks as the Table 2 shows.

In Table 2, we list the risk factors involved in the project comprehensively and systematically, but project manager's energy and attention are limited, so we'd better to reduce the cost of risk Recognition as appropriate as possible, thus we neither possible nor necessary to analyze all factors one by one in the project. Based on the evaluation of risk factors, which from *Risk analysis report on the shipbuilding industry Investment* (2006~2008), and *feasibility study for XX Shipyard project*, We screen some factors low degree of risk and some factors can be transfer by means of insurance approach, by Inducting and coordinating the main risk factors, we construct a hierarchical structural model, as shown in Figure1.

Figure 1 doesn't display the potential risks that involved in this project, but it can actually tell the risk factors that directly influence the investment yield. Evaluating the project investment risk is defined as estimate the possibility and the degree of negative deviation between the actual investment yield and planned business benefits. Obviously, in this project, investment inflation risk and production cost risk will immediately influence the inputs condition; marketing risk is directly relevant to project yield; the monetary risk will have an effect on the situation of inputs and outputs: in the process of inputs, a significant portion of shipbuilding equipment as well as quite a big part of raw material and ship Auxiliary equipment in production operation are imported, in the process of outputs, the ships product basically orders by the overseas ship-owners, both will inevitably involve to the exchange rates, particularly in recent years our country started the exchange rate reform, exchange rate fluctuation will inevitably affect the project income greatly because the ship transaction amount is huge.

3.1.3 Construct judgments matrix based on expert evaluating

Firstly, we make the tab of judgment matrix based on the hierarchical structure model of figure 3.1 above, secondly, we invite Ship Technological Economics experts to Fill out the forms. Then, normalize processing the Weights given by experts, and the final judgment matrix to form, as shown in table3 to table 7.

We adopted the compute Program AHPmain.m that based on MATLAB software to calculate the results. The compute Program is written according to the principle and procedures of AHP, if in use, just input the judgment matrix in conformity with corresponding program format, on the Debug menu tap Run then we will get the operation results. It shows from operation that this Program is stable and reliable, and easy for operation. The operation results when input the judgment matrix 3~7, as the figure2, 3 shows.

Results show that risk factors such as Changes in working capital investment (0.0909) Fluctuations in raw material prices (0.1061), Fluctuations in Auxiliary equipment prices (0.0909), Fluctuations in ship prices (0.1705), Fluctuations in ship orders (0.1023), Foreign exchange fluctuation (0.142), had relatively great impact on general risk of project investment, and project manager should give enough attention to them. In production, the project manager should be strict with financial management system, and establish the cooperation relations with the raw material supplier, improve efficiency and reduce the cost of shipbuilding, by these means to prevent and dissolve the risks, if conditions allow, also can through long-term foreign exchange and foreign exchange trading and swaps method to avoid the foreign exchange risk of shipbuilding and unnecessary loss.

3.2 Tips of Application of AHP in Risk Recognition

Apply the AHP method in shipyard project risk Recognition, realized risk factors taxis, make the investor able to hold the key point in the process of risk management, which beneficial to improving the scientificalness of risk administration. However, what must pay attention is, if elects the risk factors is unreasonable, and its definition is ambiguous, or the relations among factors are not in harmony, which will reduce the quality of risk Recognition with AHP, premise even presents wrong Recognition result. Therefore,the premises of identifying project risk by means of AHP, one is make sure the rationality of hierarchical structure, which need us grasps the dominating risk factors when decomposes the system of project, act with a well-defined objective in mind; The other is construct judgment matrix must combine with the characteristic of project, and, It is much better to use the Delphi method to obtain expert evaluation, this is helpful to enhance the accuracy of judgment matrix.

4. CONCLUSION

In this paper, we introduce AHP method in shipyard project investment risk Recognition, and take a shipbuilding bases as case analyses the application of AHP. By using AHP, not only being able to get the quantitative affect weight of each risk factor to the general risk, but also can distinguish out the main risk factors in project, it will establish solid basis for risk measuring and risk management. However, in view of the result of risk Recognition is rough, so in shipyard project risk management, apply AHP to identify risk can be regarded as a basis step, if want to evaluate the risk perfectly, we should better make use of the techniques based on computer simulation.

REFERENCES

LI Wen-ying. Application of AHP Analysis in Risk Management of Engineering Projects [J].*Journal Beijing University of Chemical Technology (Social Sciences Edition)*, 2009, (1):46-48, 66.

Mirela Iloiu, Diana Csiminga. (2007). Investment Risk, Analysis and Decision [J]. *Fascicle of Management and Technological Engineering, Volume VI (XVI)*, 2007, 2438-2441.

SONG Fei, ZHAO Fasuo. (2008). Application of Analytical Hierarchy Process and MATLAB Program for Risk Analysis of Underground Engineering[J]. *Journal of Earth Sciences and Environment, Vol.30 (3)*:292-296.

ZHENG Jian-hua. (2005). Recognition & Measure of Investment Project Risk [J]. *Journal of Jinan University (Philosophy and Social Sciences)*, (4):27-31,140.

TABLES AND FIGURES

Table 1: Consistency index *RI*

N	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**…**
RI	**0**	**0**	**0.52**	**0.89**	**1.12**	**1.26**	**1.36**	**1.41**	**1.46**	**1.49**	**1.52**	**…**

Table 2: Classification of Risks and Risky Factors

			RISKY FACTORS	RESULTS
INPUTS	CONSTRUCTION	PROJECT RISK	NATURAL DISASTERS, PROJECT DESIGN MODIFY	CONSTRUCTION PERIOD EXTENDED EVEN STOPPED
		RISK OF INVESTMEN T INFLATION	COST OF INSTALLING EQUIPMENT, PURCHASE AND MANAGEMENT	PROJECT TOTAL COST INFLATION
		RISK OF PROJECT QUALITY	CONSTRUCTION QUALITY WILL NOT PASS THE APPRAISAL, DISQUALIFICATION IN TRIAL PRODUCTION	DEFER COMMISSIONING
	PRODUCTION RISK	RISK OF PRODUCTIO N COST	FLUCTUATIONS IN THE PRICES OF RAW MATERIALS, AUXILIARY EQUIPMENT, LABOR; INCREASE IN ADMINISTRATIVE COST	REDUCES PROFITS OF PROJECT
		TECHNOLOG Y RISK	LACK IN TECHNICAL RESERVES, LOW LEVEL IN EMPLOYEE SKILL, DEPRECIATION OF EQUIPMENT ACCELERATION	DEFECT IN QUALITY OF SHIP PRODUCT
		RISK OF PRODUCTIO N PERIOD	RAW MATERIALS AND AUXILIARY EQUIPMENT IN SHORT SUPPLY	DELAY IN SHIP DELIVERING
OUTPUTS	MARKET RISK	MARKETING RISK	SHIPS COST AND SHIP ORDERS FLUCTUATE,SUPPLY-AN D- DEMAND DYNAMICS	INFLUENCE PROJECT INCOME
		RISK OF DELIVER THE SHIPS	ABANDON SHIP	INFLUENCE PROJECT INCOME
EXTERNA L FACTORS	FINANCIAL RISK	MONETARY RISK	ROE AND ROI FLUCTUATE	REDUCE PROJECT INCOME
		FINANCING RISK	ENVIRONMENT CHANGE OF SHIP FINANCING	ABANDON SHIP OR NORMAL PAYMENT FAILURE
	INDUSTRIAL POLICY	POLICY RISK	FINANCIAL RESTRAINT、ADJUSTMENTS TO TAX RATES	ADDED TO THE HARDSHIP OF FINANCING
		RISK OF ADMITTANC E	INDUSTRY ACCESS THRESHOLD GO UP、POLICY OF PROJECT ACCEPTANCE TIGHTEN	FOLLOW-UP INVESTMENT AND ALTER THE DESIGN OF PROJECT
		MANUFACT URING TECHNIQUE	STANDARD ON SHIPBUILDING CHANGE, IMO MODIFY PRODUCT STANDARDS AND NORMS OF SHIP	FOLLOW-UP INVESTMENT AND ALTER THE DESIGN OF PROJECT

Table 3: A-B Judging Matrix

A	B1	B2	B3	B4
B1	1	4/7	2/3	4/5
B2	7/4	1	7/6	7/5
B3	3/2	6/7	1	6/5
B4	5/4	5/7	5/6	1

Table 4: B1-C Judging Matrix

B1	C1	C2	C3
C1	1	1/2	1/3
C2	2	1	2/3
C3	3	3/2	1

Table 5: B2-C Judging Matrix

B2	C4	C5	C6	C7
C4	1	7/6	7/5	7/3
C5	6/7	1	6/5	2
C6	5/7	5/6	1	5/3
C7	3/7	1/2	3/5	1

Table 6: B3-C Judging Matrix

B3	C8	C9
C8	1	5/3
C9	3/5	1

Table 7: B4-C Judging Matrix

B4	C10	C11
C10	1	5/3
C11	3/5	1

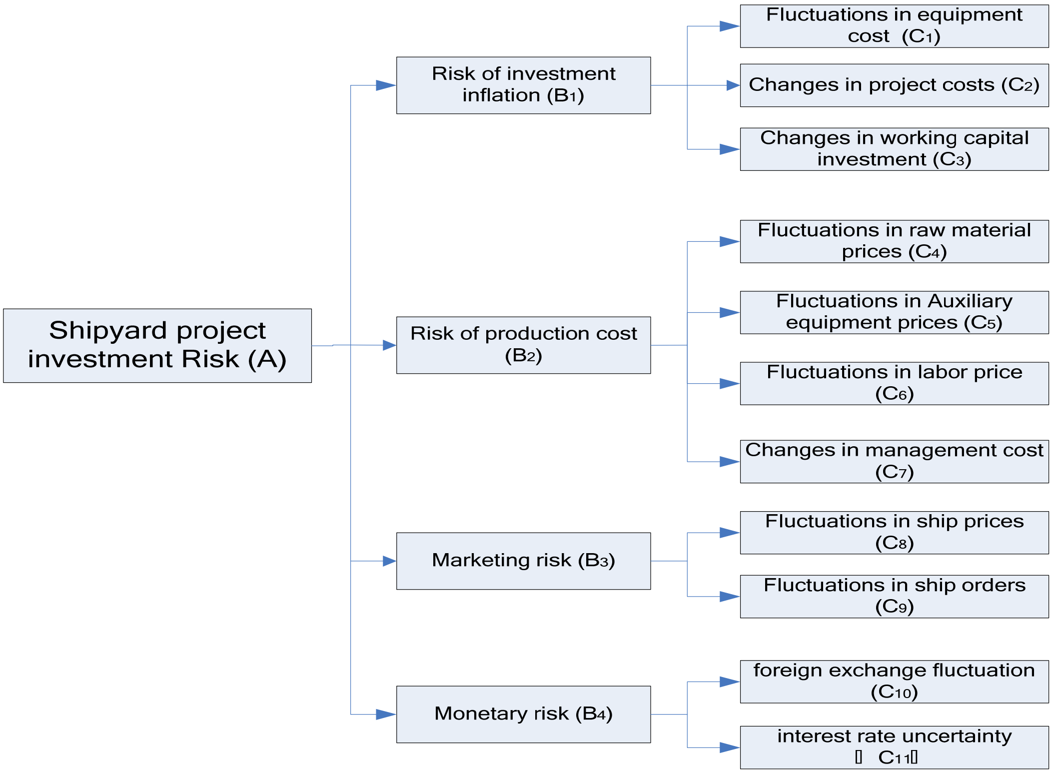

Figure 1: Hierarchical structure of Risk analysis on shipyard project

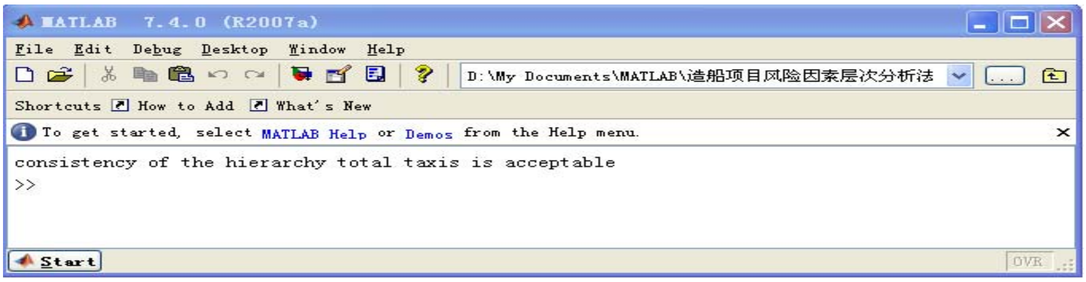

Figure 2: The Result of Consistency Check

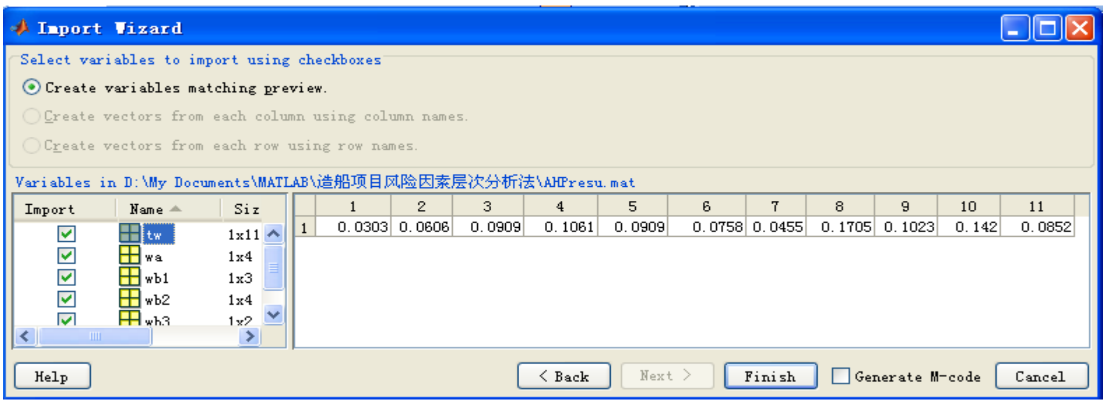

Figure 3: Weights of Risk Factors

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