A Study on Recognition of Willingness to Implement Corporate Ecological Modern Construction

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Abstract — **The shortage of resources and serious pollution make ecological modern constructions a prominent issue faced by enterprises. This paper analyzes the current situation and issues in ecological modern construction of Chinese enterprises, and uses C5.0 algorithm to establish a recognition model of willingness to implement this construction according to the industry standard CRISP-DM. The results show that the main factors influencing the willingness are: i) government regulation, ii) corporate sales revenue, iii) industries involved and business executives, iv) cognitive level of people responsible for ecological modernization, v) staff size and age of managers. The possible causes for weak willingness of ecological modern construction are: i) the responsible persons believe that ecological modern construction should be completed by the government, ii) the cost of ecological construction is too high, iii) lack of government regulation and industry standards, iv) business executives and employees do not have a strong awareness of ecological modern construction. Therefore, national policy guidance, encouragement, support, regulation, industry standards, publicity and education, construction technology and costs of construction have direct bearing on the enthusiasm, initiative and performance management of ecological modern construction.**

Keywords - ecological modern, recognition of willingness, influencing factors, C5.0 algorithm, enterprise

I. INTRODUCTION

Enterprise ecology refers to an organic system arising from surrounding environment with enterprises as the main body [1-3]. Contradictions between social and economic development and ecological environment have worsened. As a major consumer of energy resources and producer of pollutants, enterprises should bear the main responsibility for ecological modern construction. Although China implements the responsibility assessment mechanism, in the process of ecological modern construction, there are some problems: 1) The government proposed a series of mandatory regulations, and companies complied with state regulations passively, lacking of enthusiasm and initiative and having weak awareness of ecological modern construction. 2) No sound environmental quality management system has been established, which is an important reason for the lack of corporate responsibility. 3) Investment in exhaust gas treatment facilities, upgrading production lines, equipment and technological innovation and other measures are huge investment for businesses and increase costs. 4) At present, the lack of professional and technical personnel in the environmental protection seriously affected the development and use of new exhaust gas treatment facilities. Enterprises need to conduct further study on the willingness of ecological modern construction for above-mentioned situation and problems.

II. CURRENT SITUATION RESEARCH OF CORPORATE ECOLOGICAL MODERN CONSTRUCTION

Researches on corporate ecological modern construction at home and abroad are mainly in four aspects. 1) Ecological Modernization: Pataki proposed that ecological sustainability injected new blood into ecological modernization; Janet · Lai studied the relationship between ecological modernization and sustainable development with the case of New Zealand [4,5]. 2) the construction of ecological modern path problem: Eric Meyer from multiple angles Illinois comparative analysis of both weak and strong sustainability paradigm; Zhong Hongwu from the industrial structure and consumption patterns, draw the road map for the construction of ecological modern 2）Routing problem of ecological modern construction: Eric Neumayer conducted a comparative analysis of both weak and strong sustainable development models from multiple perspectives; Zhong Hongwu mapped the constructional path of ecological modernization from the industrial structure and consumption patterns[6,7]. 3) Corporate social responsibility: Zhou Hanxiao studies the construction of corporate ecological modernization from the perspectives of corporate responsibility, behaviors and legal system; Qin Shusheng researched the green technological innovation; Liu Jinping built an assessment index system for ecological modern construction by using cases of coal enterprises; Wang Rusong believed that companies assume ecological responsibility is a key factor to enhance the corporate image. 4) System management problems: Han Lei studied the optimal strategy for ecological modern construction among stakeholders using Nash equilibrium approach; Li Ming discussed innovation and positioning of corporate environmental management mechanism; Liu Dengjuan raised a question of "system trap" in the construction of ecological modernization [8,9].

To sum up, the basic ideas can be summarized as

follows: 1) Most studies suggest that the construction of ecological modernization should explore main routes from the legal system, management system, technological innovation, social responsibility, thinking model, cost control and industrial structure, etc. 2) Some scholars believe that companies should promote initiatively rather than being passively controlled. Therefore, it is necessary to conduct a quantitative analysis of factors affecting the construction of corporate ecological modernization.

III. INFLUENCING FACTORS HYPOTHESIS AND THEORETICAL MODEL OF ENTERPRISES' WILLINGNESS TO CONSTRUCT ECOLOGICAL MODERNIZATION

Studies have shown that people's willingness is influenced by many factors. According to the current division mode proposed by Duncan and Kolter, influencing factors of enterprises' willingness to construct ecological modernization can be divided into internal and external factors, which jointly affect the willingness. Enterprises' external factors mainly discuss the impact of government regulation on the willingness of ecological modern construction; internal factors mainly discuss the attributes of enterprises and responsible persons. The basic theoretical model of willingness is shown in Figure 1.

Three factors were extracted according to stochastic model, and a correlation analysis was conducted between these factors and willingness of ecological modern construction to see whether the factors have an impact on willingness. Hypotheses are as follows:
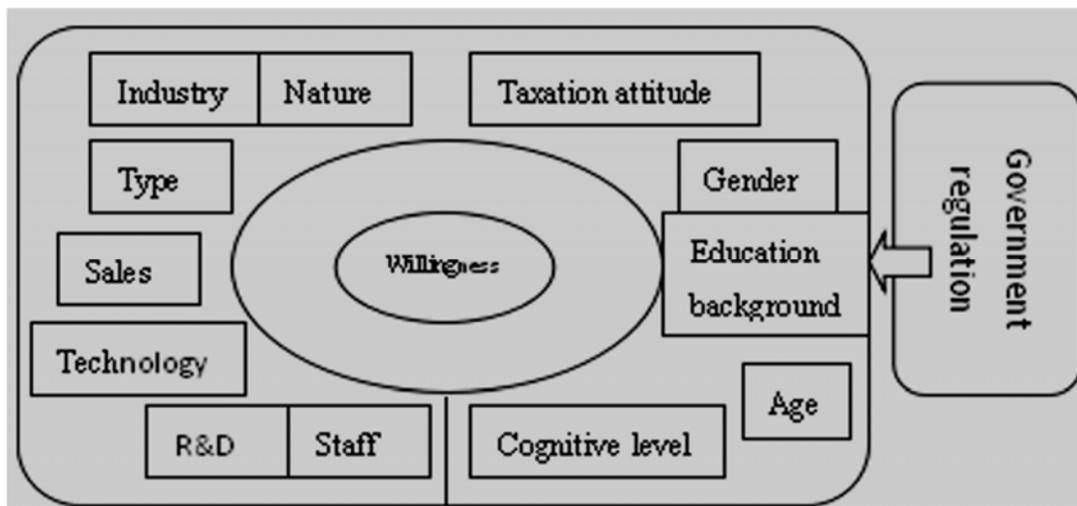

Figure1. The basic theoretical model of willingness.

H1：Government regulation has an impact on the willingness of corporate ecological modernization.

H2：The age of people in charge of the enterprise influences the willingness of corporate ecological modernization.

H3：The sales income of enterprises has an impact on the willingness of corporate ecological modernization.

IV. STUDY DESIGN AND RESEARCH METHODS

A. Questionnaire design and data collection

The questionnaire consists of three parts. The first part is the basic information, including the nature of business, industry, etc; the second part is the basic information of the people in charge of an enterprise, including the gender and age; and the third part is the willingness to implement enterprise ecological modern construction. A total of 15 questions were raised from five perspectives, each perspective includes three questions, and each question has five options.5 Likert-type scales is used to create a score in accordance with the actual business situation and grading accuracy from 5-1, i.e. strongly agree, agree, neither agree nor disagree, disagree and strongly disagree .

Samples this paper include all kinds of enterprises in Beijing, Tianjin and Hebei Province. The survey was completed with the help and coordination of Management Committee of Zhongguancun Science and Technology Park and enterprises in Beijing, Tianjin and Hebei. The sampling method used is stratified sampling. 500 questionnaires were distributed and 320 questionnaires were collected, the response rate was 64%, of which, after handling missing values, outliers and extreme values, 251 valid questionnaires were obtained, and the effective rate of returned was 78.4%.

B Descriptive statistics of sample data

1) Descriptive statistics of basic information of sample enterprises

The sample companies are mainly state-owned

enterprises, private enterprises and limited liability companies, accounting for about 70% of the total sample companies, of which about 65% are non-high-tech enterprises; it can be seen from the industries of sample enterprises, manufacturing, telecommunications and IT industry, education and culture industry take up a significant proportion, which are 22.71%, 20.32% and 15.14% respectively, providing wide coverage of industries with good representative; from staff size of sample enterprises, about 50% enterprises have less than 300 employees. According to *Classification Standards for Small and Medium-Sized Enterprises* issued by the Ministry of Industry and Information Technology, it can be found that SMEs accounted for about 50% of sample enterprises, large and medium-sized enterprises accounted for 25%; from the proportion of R & D personnel, about half of enterprises' R & D personnel accounted for 10% of the total number of employees or less. In addition, of the sample enterprises, technology-intensive and labor-intensive enterprises accounted for 33.86% and 28.29% respectively, while the capital-intensive enterprises accounted for only 11.55% and 26.29% of the companies are not very clear about their type of business.

2) Descriptive statistics of responsible persons of sample enterprises

The basic information of responsible persons of sample enterprises include gender, age, education background, affirmation of main responsible persons of ecological modernization and attitude towards collecting accumulative carbon tax. The responsible persons of sample enterprises are male-dominated, accounting for 81.67%; by age distribution, legal persons of sample enterprises are between the ages of 30-50, accounting for about 70% of the total number of legal persons. It presents a more youthful state in general, but also in line with the age of the dominant group of today's society. At the same time, 30-year-old legal persons account for 18.73%, and 50-year-old legal persons account for 13.55%, indicating that the sampling method is more scientific and reasonable; from the academic structure, most responsible persons are undergraduates and graduates, accounting for about 75% of total responsible persons of sample enterprises; 45.02% responsible persons of sample enterprises believe that the government should bear primary liability for the construction of ecological modernization, 29.48% people claim that it's the responsibility of enterprises themselves; of which, 86.06% responsible persons of sample enterprises agree with collecting carbon tax.

3) Descriptive statistics of sample enterprises subject to government (industry) regulation

In terms of carbon emission (energy saving, environmental protection), the government (industry) regulation is shown in Table 1 below: 57.77% of the sample enterprises are regulated by government (industry), and products have passed international or domestic low carbon certification (environmental certification, energy

saving certification); at the same time, 42.23% sample enterprises said that their products do not pass the relevant certification.

TABLE I. GOVERNMENT (INDUSTRY) REGULATION

Basic information of responsible persons		Quantity of sample enterprises	Percentage
Government (industry) regulation	Yes	145	57.77%
	No	106	42.23%
Total		251	100%

C Variables analysis and index selection

1) Explained variable

This explained variable in the study is the willingness of corporate ecological modern construction, which is measured using 5 first-class indicators and 15 second-class indicators. The first-class indicators refer to enterprise sustainable development factor, ecological modern construction costs, corporate social responsibility, corporate low-carbon preference and attitude towards government support and regulation; the second-class indicators include that the company's products meet low-carbon environmental standards to establish a better corporate social image. In the long run, the environmental protection and ecological products can bring enterprises greater economic benefits, ecological modern construction can promote the transformation and upgrading of enterprises, and improving energy efficiency and environmental protection standards brings more costs than benefits to enterprises. Compared with the expansion of market sales, reduction of pollutants is also very important. The energy-saving emission reduction targets established by the government need to be accomplished by investing a lot of human and financial resources. It is enterprises' social responsibility to protect ecological environment, if a investment project will bring environmental or social benefits, and return on investment of the project can be a bit lower. It is necessary to have training programs on low-carbon environmental protection. Ecological products have a bright future and customers accept green products and are willing to accept a relatively high offer; and if products pass environmental certification, more customers would be attracted. The government should increase the degree of tax incentives and financial support on the energy saving products. The implementation of environmental protection and energy conservation makes the relationship between business and government is more harmonious, and the government should increase the intensity of punishment on enterprises that exceed new carbon emissions standards.

2) Explaining variable

This paper chooses 13 factors that affect the willingness of corporate ecological modern construction as explaining variable，and the definition and description

are shown in table 2 below.

TABLE II. EPLAINING VARIABLE SET

Variables	Type	Value	Description
Enterprise nature	Classification	1-9	Explaining variable; state-owned enterprises, collective enterprises, joint ventures/sino-foreign joint ventures, wholly foreign-owned enterprises, private enterprises, joint stock, limited liability companies, partnerships and sole proprietorship enterprise in proper order.
Industry involved	Classification	1-10	Explaining variable; Agriculture, forestry, animal husbandry and fishery, mining and metallurgy, processing and manufacturing, petrochemical industry, textile and garment industry, telecommunications, IT, logistics, transportation, wholesale and retail industry, real estate industry as well as culture and education.
Type of enterprise	Classification	1-5	Explaining variable; Labor-intensive, capital-intensive, technology-intensive, unclear, and other types.
Average sales revenue	Classification	1-8	Explaining variable: More than 100 million yuan, 50 -100 million yuan, 30-50 million, 10-30 million, 5-10 million, 3-5 million, 1-3 million and less than 1 million.
Sex of responsible person	Classification	1-2	Explaining variable; value=1, male; value =2, female.
Education background	Classification	1-5	Explaining variable; High school (secondary school) or less, bachelor's degree, master's, doctoral and returnees.
Taxation	Classification	1-2	Explaining variable; Mean carbon emissions per unit output of industrial enterprises should be taxed, value = 1 agree to collect tax; Value = 2 disagree
Cognitive level	Classification	1-4	Explaining variable; the cognition of responsibility for ecological modern construction, government, enterprise, consumers and others.
Proportion of research personnel	Classification	1-4	Explaining variable; more than 30%, 20%-30%, 10%-20% and less than 10%.
Age of responsible person	Classification	1-4	Explaining variable; 30 years of age, 31-40, 41-50 and above 51 years of age.
High and new technology	Classification	1-2	Explaining variable；value=1 indicates high and new tech enterprises; value=2 indicates non-high tech enterprises.
Number of employees	Classification	1-4	Explaining variable; including full-time employees and temporary workers of long-term employment, 5,000 people, 2000-5000, 300-2000 and below 300 in proper order.
Government regulation	Classification	1-2	Explaining variable; value=1 refers to government regulation or industry supervision; value=2 refers to no regulation.

V. RESEARCH AND DISCUSSION ON WILLINGNESS OF CORPORATE ECOLOGICAL MODERN CONSTRUCTION

K-Means clustering and C5.0algorithm are used to verify the proposed hypotheses. Statistical software used are SPSS Statistics 22 and Modeller 14.1. All sample data are classified as training data (176 samples) and test data (75 samples) in proportion of 70% and 30% respectively. The training data is used to build willingness recognition model for corporate ecological modern construction; and test data is used to evaluate the model. CRISP-DM industry standard is adopted according to 4 steps of "data understanding - data preparation - model building- model evaluation" to establish a C5.0 tree search model and explore influencing factors of willingness of ecological modern construction and recognition of willingness rules. Specific data flow is shown in Figure 2.
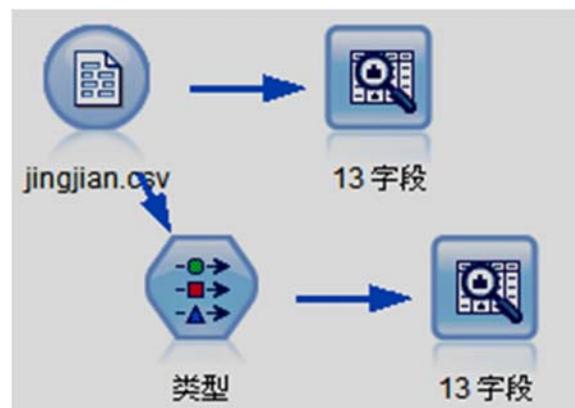
-A.
Figure2. Data Mining Flow
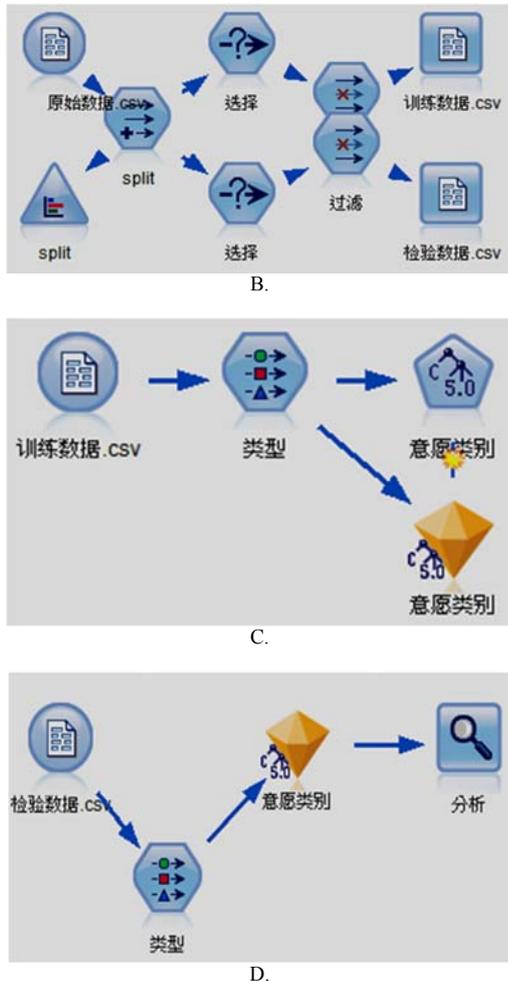(Continues On Next Page)

B.

C.

D.

Figure2.   Data mining flow

The willingness factors of section 3 reflect the intensity of willingness for ecological modernization by 15 second-class indicators. Therefore, this paper conducted K-Means clustering analysis of 15 indicators of 251 enterprises, which are classified according to the degree of willingness (not strong, average and strong). From the analysis results, the data of three class-centers are (5,5,5,1,2,1,5,5,5,5,5,5,5,5,5), (5,4,4,3,3,2,5,4,4,4,3,4,5,4,4) and (4,4,3,2,3,3,4,3,3, 4,4,4,3,3,3) respectively. The indicators of Class 1 are the best, followed by Class 2, and all indicators of Class 3 are not ideal. Table 3 shows the class member of three classes: Class 1 (strong) has 86 companies, Class 2 (average) has 130 enterprises, and Class 3 (not strong) has 35 companies.

TABLE III. NUMBER OF CASES OF EACH CLASS-CENTEE.

Cluster	1	86.000
	2	130.000
	3	35.000
Effective		251.000
Deficiency		.000

According to results of K-Means clustering analysis, the definition of object variable of recognition of willingness of ecological modernization based on C5.0 model is shown in Table 4 below.

TABLE IV DEFINITION OF OBJECT VARIABLE

Variable	Type	Value	Description
Willingness	Classification	1-3	Explained variable; value=1 indicates strong will, value=2 indicates average level, value=3 indicates not strong.

Since most of the input variables are multiple classified variables, multi-way tree structure model is used, and the growth efficiency of the tree can be improved. For multiple categorical variables, the binary tree is likely to cause loss of information and slow growth. C5.0 tree search model is built by taking the willingness to construct ecological modernization as an output variable. The explaining variables to the willingness of ecological modern construction according to the importance ranking from top to bottom are taxation attitude, industry involved, government regulation, the gender of person in charge, corporate average sales of recent three years, type of business, the nature, responsible persons' awareness of the responsibility for the construction of ecological modernization, the age, educational background and gender of the responsible person. Three variables such as the size of workforce, the proportion of R & D personnel and whether a company is a high-tech make no difference to the category of willingness.

The number of samples used to test totaled 75.The correct recognition rate of the willingness of ecological modern construction is up to 84%, as shown in Table 5, indicating a higher recognition accuracy of C5.0 tree search model based on industry-standard CRISP-DM.

TABLE V. MODEL EVALUATION RESULTS.

Comparison of $C-category of willingness and category of willingness		
Correct	63	84%
Wrong	12	16%
Total	75	100%

the following 6 rules are selected that the confidence level of rule set of the willingness of corporate ecological modern construction is more than 60% and sample size is more than 15:

Rule 1: If business executives believe that the option of the main responsible person for the construction of ecological modernization is [1], the option of whether an enterprise is a hi-tech enterprise is [1], and the option of number of employees is [1], then the recognition of willingness of ecological modern construction is [1]. The sample size of Rule 1 is 23, and the confidence level is 75%. That is, the size of employees is large, and the primary responsible persons for the ecological modern construction are large-scale government high-tech enterprises, who have relatively strong willingness to

28.5

construct ecological modernization. It indicates that large-scale government high-tech enterprises are willing to construct ecological modernization dominated by government.

Rule 2: If business executives believe that the option of the main responsible person for the construction of ecological modernization is [1], the option of whether an enterprise is a hi-tech enterprise is [1], and the option of number of employees is [2] or [3] or [4], then the recognition of willingness of ecological modern construction is [3]. The sample size of Rule 2 is 19, and the confidence level is 60%. That is, the primary responsible persons for the ecological modern construction are small and medium-sized high-tech enterprises, who haven't strong willingness to construct ecological modernization. Such kind of enterprises thinks that the construction of ecological modernization should be completed by government.

Rule 3: It indicates that cultural education enterprises show strong willingness to construct ecological modernization. The sample size of Rule 3 is 24, and the confidence level is 92.3%.

Rule 4: Enterprises with lower sales do not show strong willingness to construct ecological modernization. The sample size of Rule 4 is 16, and the confidence level is66.7%.

Rule 5: If there is government (industry) regulation, then non-high-tech enterprises with lower proportion of research personnel have strong willingness to construct ecological modernization. It indicates that industrial standard or government regulation have a major impact on the willingness of non-high-tech enterprises to construct ecological modernization. The sample size is 28, and the confidence level is75%.

Rule 6: If there is government (industry) regulation, then the age of business executives of non-state and high-tech enterprises is less than 50, and they have strong willingness to construct ecological modernization. It indicates that the age of business executives has certain influence in the willingness to construct ecological modernization. The sample size is 20, and the confidence level is99%.

VI. CONCLUSIONS

The objective understanding of the importance and recognition rules of internal and external factors affecting the enterprises' willingness to construct ecological modernization is conductive to high-efficient building of ecological modernization of enterprises and government. Results of this study showed that the model accuracy reached 84%; government regulation, corporate sales revenue, industries involved and business executives as well as cognitive level of people responsible for ecological modernization, staff size, and age of the responsible persons are main factors influencing the willingness of ecological modernization construction; government regulation and industry standards have great impact on the willingness of ecological modern

construction; large enterprises are more willing to carry out ecological modern construction compare to SMEs led by government; cultural and educational enterprises have relatively strong willingness to ecological modern construction; age of business executives has certain influence in the willingness to construct ecological modernization; Enterprises with lower sales do not show strong willingness to construct ecological modernization, and SMEs thought that ecological modern construction should be completed by the government. Therefore, the possible causes of not strong willingness of ecological modern construction are summarized as follows: 1. the responsible persons believe that ecological modern construction should be completed by the government; 2.the cost of ecological modern construction is too high; 3. lack of government regulation and industry standards. 4. enterprise's executives and employees do not have a strong awareness of ecological modern construction. In other words, it is necessary to vigorously carry out the construction of ecological modernization education and raise the level of awareness of business leaders and employees; reduce ecological modern construction costs or take government support measures; improve industrial standards of low-carbon, environmental protection and energy conservation industries and strengthen government regulation as soon as possible.

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