

The Index Research on Technical Innovation Ability of the Coal Enterprise Based on SEM

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Abstract

The coal industry is our country important energy production industry, its technical innovation ability has the important influence on the national overall technical level and the competitive power. But our country coal production and the applied technical are quite backward, the speed of technical innovation is quite slow, therefore, appraising the technical innovation ability level of the coal enterprise correctly to discover its superiority and the insufficiency has the important strategic and practical significance for promoting the construction of technical innovation ability of our country coal enterprise. This article takes the structural equation model as a foundation. It calculates 5 dimensions' path coefficient and various items' loading coefficient of technical innovation ability of the coal enterprise to obtain the model of technical innovation ability index. The paper gives the general reference value of technical innovation ability index of the coal enterprise in order to helping the coal enterprise to appraise its technical innovation ability and discovering its superiority and the insufficiency to propose the corresponding countermeasure and suggestion.

Key words: Coal enterprise; Enterprise technical innovation ability; Enterprise technical innovation ability index; SEM

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INTRODUCTION

Coal resources is an important strategic resource, the operating conditions of the coal economy is directly related to national energy economic development and social stability. But coal enterprises in our country enter the market economy late, coal production and utilization of technical is relatively backward, and the speed of technical innovation relatively slow. Therefore, assessing the level of technical innovation ability of coal enterprises properly and identify its strengths and weaknesses have important guiding significance and practical significance to promote the building of China coal enterprises technical innovation ability.

RESEARCH STATUS OF THE COAL ENTERPRISE TECHNICAL INNOVATION ABILITY INDEX

The Coal Enterprise Technical Innovation Ability

The current understanding on the concept of the coal enterprise technical innovation ability is different. Some scholars believe that the coal enterprise technical innovation ability is a comprehensive range of features facilitating the organization to support the coal enterprise technical innovation strategy. Some of our scholars believe that the resource of innovation is the technical innovation ability, important parts of the coal enterprise technical innovation ability that are person, money, content, which determine the strength of technical innovation ability. The rest of the scholar define the coal enterprise technical innovation ability from the content view. In summary, In this paper, the coal enterprise technical innovation capacity is defined as: The coal enterprise technical innovation ability is an integrated capacity, it is the ability of promoting long-term development of the coal enterprise through the effective allocation of resources, development

and adoption of new technical to meet market demand^[1].

The Coal Enterprise Technical Innovation Ability Index

There is no mature theory on the concept of the coal enterprise technical innovation ability index at present, most researches are still in the exploratory stage. The article asserts: The coal enterprise technical innovation ability index is a scientific tool used to measure the coal enterprise technical innovation ability level through employee satisfaction measure of a number of technical innovation, it is a set of quantitative index system that evaluates the coal enterprise technical innovation efficiency.

CONSTRUCTION OF THE STRUCTURAL EQUATION MODEL OF THE COAL ENTERPRISE TECHNICAL INNOVATION ABILITY INDEX

The Basic Principle of the Structural Equation Model

Structural equation model is a confirmatory analysis model and a statistical method based on variable covariance matrix to analyze the relationship between the variables, it has the advantage of dealing with the measurement error of a plurality of independent and dependent variables and estimating factor relations and the whole model fitting at the same time. The structural equation model is divided into two parts: measurement equation and structural equation, measurement equation describes the relationship between the observed variables and latent variable, structural equation describes the relationship between the latent variable^[2]

Construction of the Structural Equation Model of the Coal Enterprise Technical Innovation Ability Index

According to the domestic and foreign existing literature research conclusion and the relevant knowledge of technical innovation ability, combined with the characteristics of the coal industry. In this paper, the coal enterprise technical innovation ability are divided into innovation investment ability, research and development ability, manufacture ability, marketing ability, and innovative management ability, all the ability are also described through the different measuring variable^[3]. The coal enterprise innovation investment ability (X_1) can use the funds of Science and technical investment intensity X_{11} , innovative personnel input intensity X_{12} , the improved technical investment intensity X_{13} three index to represent. Research and development ability (X_2) can use research and development personnel's overall level X_{21} , research

and development cycle X_{22} , research and development expenses X_{23} , research and development success rate X_{24} five indicators to measure. Manufacture ability (X_3) can use the production equipment level X_{31} , personnel skill level X_{32} , standardization work level X_{33} three indicators to measure. Marketing ability (X_4) includes market research ability X_{41} and marketing level X_{42} two index. Innovative management ability (X_5) includes innovation strategy X_{51} , innovation mechanism X_{52} , organizational coordination ability X_{53} three index. Innovation investment ability, research and development ability, manufacture ability, marketing ability, and innovative management ability are latent variables, the rest are observed variables.

According to the composition of the index system, the paper uses Amos 7.0 to establish the structural equation model of the coal enterprise technical innovation ability index, the specific model is shown in figure 1.

EMPIRICAL ANALYSIS OF THE COAL ENTERPRISE TECHNICAL INNOVATION ABILITY INDEX BASED ON STRUCTURAL EQUATION MODEL

Data Acquisition and Processing

Using a questionnaire to obtain data, the questionnaire includes two parts: the basic personal information and the investigation of the coal enterprise technical innovation ability. including 16 observed variables and six latent variables, and using the measure scale of Likert5 level, "never" counts 1 point, "not often" counts 2 points, "sometimes" counts 3 points, "often" counts 4 points, "always" counts 5 points, the more score, the more you agree with the title. The questionnaire uses 25 large and medium-sized state-owned coal enterprises in Shandong, Anhui, Shanxi and other places as the sample. Respondents include ordinary staff and management personnel in the coal enterprise. 250 copies of the questionnaire are sent by e-mail, and 220 questionnaires are returned, of which 200 questionnaires are valid.

The Model Fitting

The model fitting refers to the estimation process of the model parameters, usually using the least square method to fit model. After Standardization of data, this paper uses the maximum likelihood estimation method of AMOS 7.0 to estimate parameters, obtaining the effect of technical innovation ability index on innovation investment ability, research and development ability, manufacture ability, marketing ability, and innovative management ability five exogenous latent variables on endogenous latent variables, and the path coefficient of observed variables and latent variables. The specific information is shown in Figure 1.

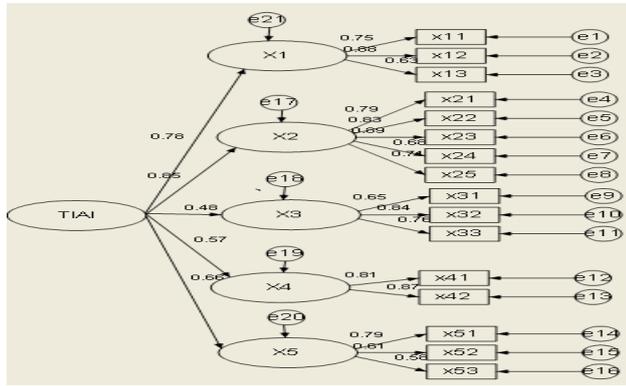


Figure 1
The Structure Equation Model Path Output Figure

The Model Evaluation

The model evaluation is to detect that structural equation solution is whether suitable or not, parameters and the relationship between the model is whether reasonable or

Table 1
Calculation Results of Common Fitting Index

Fitting index	Card square value	GFI	NFI	CFI	RMB	RMSEA	AIC	EVCI
Result	3363(156)	0.899	0.876	0.911	0.047	0.039	1139.37	2.834

The findings are shown: Card square value of fitted data is 336.3, degree of the freedom is 156, the value of GFI, NFI, CFI are more than 0.9, the value of RMR, RMSEA are less than 0.05, which indicates good fit degree of the model.

The Model Modification

If the model evaluation results are not satisfied, the paper can fix or release the parameter based on theoretical assumptions on the basis of the results, then re-estimate the model until it reaches an acceptable level. Parameter estimation coefficients have significant differences, the overall fitting degree of the model is better, and the

not and the entire fitting index of the model.

(1) Significant test of the coefficient. Model evaluation first needs to detect significant test of the path coefficient and the load coefficient to examine whether estimated parameters through the model has Statistical significance. This paper detects significant test of the path coefficient and the load coefficient based on the concomitant probability statistical tests CR p value, the results shows by using AMOS 7.0, the concomitant probability statistical tests CR p value are less than 0.01, so Each there exist significant differences between the path coefficient and zero.

(2) Inspection of Fitting Degree. Inspection of Fitting Degree is used for measuring model availability, the higher the fitting degree, the availability of the higher of the model, the more meaning of the parameter estimation. The main index of fitting degree inspection include absolute fitting degree (χ^2 , GFI, of RMR, RMSEA), value-added fitting degree (AGFI, CFI, NFI) and streamlined fitting degree (AIC, CAIC, EVCI).

model results can be explained by the relevant domain knowledge, which have certain practical and theoretical value. Therefore, there is no need to correct the model.

Determination of the Coal Enterprise Technical Innovation Ability Index

This article takes the average of the 200 sample data as the reference value of the coal enterprise technical innovation ability index. The paper calculates the coal enterprise technical innovation ability index and the reference value of dimensions and items, and the specific results is shown in Table 2.

Table 2
The Coal Enterprise Technical Innovation Ability Index Table

Items	Dimensions	Items average	Items weight	Dimensions average	Dimensions weight	TIAI
X ₁₁	Innovation investment ability	3.0275	0.0721	0.665	0.2188	0.669
X ₁₂		0.0721	0.666			
X ₁₃		2.8168	0.0658			
X ₂₁	Research and development ability	2.8035	0.0656	0.836	0.2907	
X ₂₂		3.0156	0.0668			
X ₂₃		3.2235	0.0698			
X ₂₄		2.3899	0.0397			
X ₂₅		2.6896	0.0488			
X ₃₁	Manufacture ability	3.492	0.0312	0.408	0.1147	
X ₃₂		3.597	0.0438			
X ₃₃		3.568	0.0397			
X ₄₁	Marketing ability	3.279	0.0886	0.601	0.1783	
X ₄₂		3.456	0.0897			
X ₅₁	Innovative management ability	3.443	0.0688	0.643	0.1975	
X ₅₂		3.223	0.0661			
X ₅₃		3.086	0.0626			
Total		47.183	1.585	3.153	1	

The Main Conclusion

According to the discussion above, the paper draws conclusions as following.

(1) The influent path coefficient of research and development ability of the coal enterprise technical innovation ability is 0.85, which shows that large and medium-sized state-owned coal enterprise technical innovation ability come from enterprise independent research and development ability. the load coefficient of the coal enterprise research and development funds to research and development ability is 0.89. This shows that enough research and development funds is the most important material base to improve the coal enterprise technical innovation ability.

(2) The influent path coefficient of innovation investment ability of the coal enterprise technical innovation ability is 0.78, which shows that innovation investment ability of the coal enterprise has a significant effect on the coal enterprise technical innovation ability. The load coefficient of innovation personnel investment to innovation investment ability is 0.88, this shows that human capital is the carrier of Carrying and transformation of knowledge, and is an important component of the enterprise innovative investment ability.

(3) The influent path coefficient of innovative management ability of the coal enterprise technical innovation ability is 0.66, which shows that innovative management provides an important safeguard to enhance the coal enterprise technical innovation ability. Enterprise managers should have prospective, global, systematic the strategic thinking, determining the trend of the coal enterprise technical innovation development, and making effective, practical innovation mechanism.

(4) The influent path coefficient of marketing ability of the coal enterprise technical innovation ability is 0.57. Marketing ability is a sales force, it reflects making consumers accept the new product ability, manifesting the market possession and market development of the innovative product, having certain effect on the enterprise technical innovation ability. The load coefficient of market research ability and marketing level of marketing ability are more than 0.8, the results show that market research ability and marketing level are the key factors for enhancing the coal enterprise marketing ability.

(5) The influent path coefficient of manufacture ability of the coal enterprise technical innovation ability is 0.48. Its influent coefficient is the least in all latent variables. Personnel skill level is the key factor of manufacture ability. Therefore, improving personnel skill level becomes the key way of promoting the enterprise manufacture ability, which still should give consideration on enhancing the level of standardization work and production equipment.

(6) The coal enterprise technical innovation ability index is 0.669. Through the table 2 reference value of the

coal industry, the level of measured enterprises technical innovation ability in the industry can be measured, through comparing scores of items and dimensions, the advantage and deficiency of measured enterprises technical innovation can be measured to provide the scientific basis for the enterprise putting forward effective Suggestions and countermeasures.

COUNTERMEASURES AND SUGGESTIONS FOR ADVANCING COAL ENTERPRISE TECHNICAL INNOVATION ABILITY

Establish Enterprise System that is Advantageous to Technical Innovation

First of all, improve the organization system of the enterprise. Enterprise system established according to the market economy is the most scientific, the most effective enterprise system, the coal enterprise should establish enterprise organizational system that is advantageous to technical innovation and develop complementary measures to adapt to the market. Second, improve the incentive mechanism. The talent is the key of enterprise technical innovation, the last, form a good atmosphere conducive to technical innovation. The coal enterprise technical innovation can't be separated from the enthusiasm and creative of the staff, staff rationalized proposals, technical invention and practical activities are great power to promote the development of technical innovation, therefore, forming a good atmosphere is the protection of the development of technical innovation .

Perfect Independent Research and Development Mechanism of the Coal Enterprise

In order to alleviate the problem of the coal enterprise technical innovation ability weak, the enterprise must build a strong R & D team and independent research and development mechanisms, namely to establish the enterprise technical development center. Coal enterprises should focus on building technology development center to encourage more enterprises to establish a sound technology development agency, and achieve the implementation of personnel and funds in technical development agency, and give full play to the role of technical development center in technical development and promotion, personnel training and technological innovation consulting, coordination, organization and other aspects.

Increase Investment of the Resources of the Coal Enterprise

(1) Innovative personnel investment. Our country has been encouraging large and medium-sized state-owned coal enterprise to establish technical development center, absorbing scientific and technical talents by various measures to improve enterprises technical innovation ability. Technical innovation is a collection including

research and development, production, sales, and other segments. Therefore, according to their needs, the enterprise should absorb technical talents and experts in other departments or enterprises to make up a competitive technical innovation collective.

(2) Innovative funds investment. In view of weak situation of the coal enterprise technical accumulation, the enterprise should make clear rules on science research and development funds from the internal system, used as important assessments to measure coal enterprises performance. The coal enterprise should encourage and support the enterprise hold various technical innovation activities to promote innovative funds investment and create a good external environment for technical innovation.

Strengthen Macro-control of the Coal Enterprise Technical Innovation

Technical innovation is a complex structure including research and development, manufacturing, marketing, therefore, in order to improve the coal enterprise technical innovation ability, enterprise managers should set up effective, practical macroeconomic policies, and strengthen macro-control of the coal enterprise technical innovation with overall strategic vision from the long-term development of the coal industry to consider. Coal enterprises should develop and implement industry policy and put forward the direction of industry technical development clearly. Activities of innovative investment and technical transformation are guided and controlled by economic levers of interest, technical standards, and taxation. Through giving the priority to interest loans of technical innovation project, allowing pre-tax borrowed

of debts formed from technology innovation, and encouraging coal enterprises to introduce new technology and new equipment, the coal enterprise implement and improve Macroeconomic control system and strengthen macro-control of technical innovation.

CONCLUSION

Coal is strategic energy in our country, making a great contribution to economic development. But the overall technical level of coal enterprises in our country is not high, technical innovation ability is weak. This paper puts forward the model of the coal enterprise technical innovation ability index based on structural equation model. It calculates dimensions' path coefficient and various items' loading coefficient, and takes the average value of 200 samples as reference value of the coal enterprise technical innovation ability index, in order to provide benchmarking value for the evaluation of one coal enterprise technical innovation ability, and identify its strengths and weaknesses to put forward effective recommendations and countermeasures.

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