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Risk Management and Research of Large Coal Chemical Projects

Guanghui Xiong

BSIC (Shanghai) Co., Ltd., Shanghai 201103, China
xgh0416@126.com

The development of modern coal chemical projects is exposed to a considerable number of risks. Through the study on the risk management of the modern coal chemical projects, in hope of helping reduce various risks, this paper takes a large-scale coal chemical project of a certain enterprise as the research object on risk management, extends different treatments in accord with the implementation of the project at different stages, applies a variety of analytical methods to conduct a comprehensive evaluation and an analysis on the risk factors by combining the quantitative and the qualitative, identifies the key links of risk management. On this basis, a risk evaluation index system for the modern coal chemical project is established, and specific countermeasures and safeguard measures concerning the comprehensive risk management of the modern coal chemical project are put forward.

1. Introduction

The modern coal chemical industry mainly focuses the production of clean energy and alternative petrochemical products, closely relies on the development of coal resources, combines with other energy and chemical technology, and forms an emerging industry that integrates coal and energy and chemical industry (Xie et al., 2010; Xiang, 2001; Shin et al., 1988; Yan et al., 2016; Xu et al., 2016). The key and major problems in the development of the modern coal chemical industry involve its economic efficiency, competitiveness, the externality of the social environment and the risk of climate change (Perrone and Amelio, 2016; Zhou et al., 2012; Li et al., 2016). As a consequence, there exist a variety of risks in the stages of construction and operation of the modern coal chemical project, and it is an issue in an urgent need to be solved, a hot debate and a key focus of the current modern coal chemical industry to effectively identify these risks, assess risks and conduct scientific risk avoidance (Kou and Yang, 2011; Wang et al., 2015; Li et al., 2015).
Based on the theory and the tools of risk analysis and management, this paper studies the characteristics of a large modern coal chemical project, identifies the main risk factors, constructs a risk evaluation system, analyzes the main risk factors one by one, and puts forward management methods.

2. Theoretical basis

2.1 Project risk management and stage division

Project risk management runs through the entire implementation process of a project, including prior the project, during the project and after the project. The sooner the risks are identified, the sooner the measures are taken, the lower the costs of project risk management are (Liu et al., 2012; Cormos and Cormos, 2011). Project risk management involves risk analysis, risk evaluation, and risk countermeasures and measures for various risk factors (Khoshjavan et al., 2011; Ni et al., 2009).

2.2 Project risk identification and evaluation methods

In the project risk management identification process, project risk identification is usually divided into several stages: the first is to determine the target, followed by identifying the most important participants, and the final stage is to collect risk information and forecast risk trends (Guo et al., 2014). Through the above-mentioned risk identification, the majority of the risks in process of project implementation can be identified. Project risk

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identification and evaluation methods mainly involve expert survey method and sensitivity analysis method (Gagarin, 2008).

3. Project risk identification and evaluation

This paper takes a demonstration project of 4 million tons/year coal indirect liquefaction in a certain enterprise as an example and conducts risk analysis and management research on this project.

3.1 An overview of large coal chemical project in a certain enterprise

The specific scale of the project construction is 4 million tons of oil per year, and the total estimated investment of the project is 55 billion yuan.

Coal chemical project itself is featured with large scale, high investment, complex technology and substantial technological innovations:

(1) From the perspective of project construction scale, this project is by far a coal chemical project with the world's largest scale of construction.

(2) From the point of view of project management, this project is an enormous project cluster with abundant hard constraint conditions and restriction factors, as well as management of large span, wide range and high difficulty.

(3) From the angle of project technology, this project is the most innovative scientific and technological project in China's modern coal chemical industry, with a number of potential technological innovations and a huge quantity of practical technology, business, engineering issues to be solved.

This project has difficulty in organization, integration, implementation and technology as well as high risk concentration. Thus, it is necessary to carry out risk analysis and management research.

3.2 Risk identification and evaluation on the modern coal chemical project

3.2.1 Design of risk evaluation index

Table 1: Risk evaluation index system for coal chemical projects

First grade index risk	Secondary index
setting and deciding risk A1	products sale risk A11
	production load risk A12
	investment risk A13
designing risk A2	design change risk A21
	design delay risk A22
	design quality riskA23
	lack of communication risk A24
purchase risk A3	delay in delivery risk A31
	process control risk A32
	contract risk A33
	arrived quality risk A34
construction management risk A4	safety in construction risk A41
	construction cost risk A42
	construction quality risk A43
	construction schedule risk A44
operation period risk A5	Market risk A51
	price risk A52

The risks in each stage of the project implementation are listed as follows: the risks in the project decision stage, the risks in the design stage, the risks in the purchase stage, the risks in the construction management stage and the risks in the operation period. According to the principle of accuracy, objectivity, comprehensiveness and importance, the risk evaluation indexes of the project are divided into two levels, namely, the evaluation target layer and the evaluation factor layer. The evaluation target is the first grade index, and the evaluation factor is the secondary index. The details are illustrated in Table 1.

3.2.2 Measurement of risk index

Risks are evaluated in view of the risk factors of this project, and the evaluation indexes of various risk factors are designed to make an objective and true embodiment of the content of risk indexes, thereby achieving the role of risk quantification. The quantification process is primarily a measure of a single risk factor, which includes the possibility of risks, the extent of the impact and the possible losses. The measurement of the losses caused by the risks of coal chemical projects is mainly based on the guidance of the modern project risk management theory of IPMP (International Project Manager Professional), American Project Management Association. The losses caused by the risk factors of the coal chemical project are divided into five grades: 5 points is assigned to the largest losses; 4 points is assigned to a considerable amount of losses; 3 points is assigned to an average amount of losses; 2 points is assigned to a small amount of losses; 1 point is assigned to an extreme small amount of losses. The evaluation on the occurrence possibility of multiple risks in the coal chemical projects adopts a five-grade approach: 5 points is assigned to the frequent occurrence of risks; 4 points is assigned to a possible occurrence; 3 points is assigned to an occasional occurrence; 2 points is assigned to a rare occurrence; 1 point is assigned to a unlikely occurrence.

Through the investigation on the occurrence possibility of the risk factors and the losses caused by the accident in terms of 20 relevant participants in the coal chemical project, the weighted average method is applied to the research results to calculate the occurrence possibility of various risks and the caused losses. The corresponding column diagram of risk possibility for coal chemical projects is indicated in Figure 1.

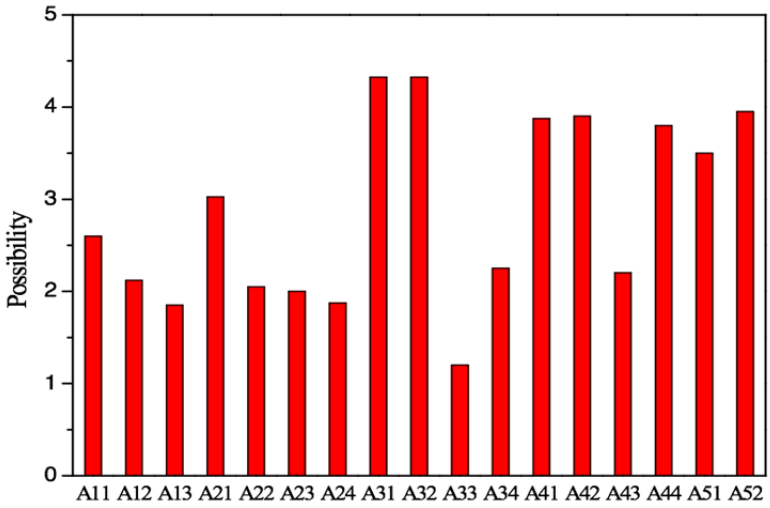

Figure 1: Column diagram of risk possibility for coal chemical projects

As seen from Figure 1, it is straightforward that the indexes with the highest occurrence possibility are delayed delivery risk and process control risk (A31 and A32), reaching 4.325 points, indicating that these risks are likely to occur. The followed indexes are construction cost risk (A42) and market risk (A52), which are 3.9 points and 3.95 points, respectively. The next indexes in order include construction safety risk (A41), market risk (A51) and construction progress risk (A44), and their scores are 3.5 points, 3.8 points and 3.8 points. In terms of the scores of five indexes that lie between 3 points to 4 points, the corresponding risks will occur occasionally, so they also need to be taken seriously in the risk management process.

The column diagram of risk perniciousness for coal chemical projects is demonstrated in Figure 2.

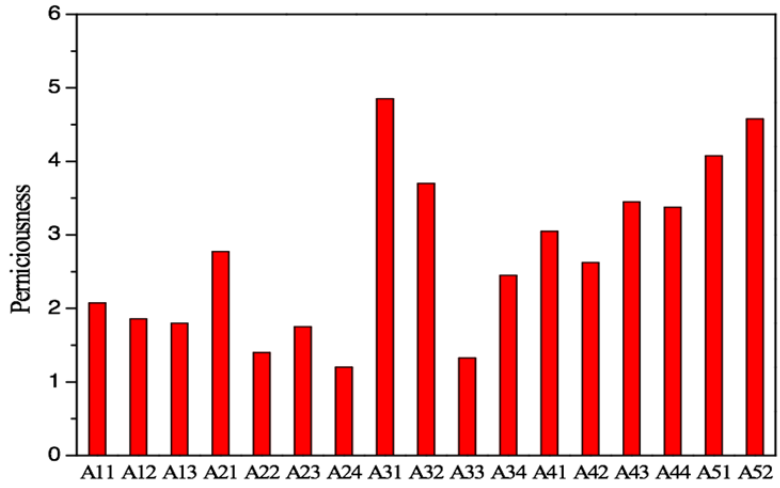

Figure 2: Column diagram of risk perniciousness for coal chemical projects

As seen from Figure 2, the index with the highest risk perniciousness is delayed delivery risk (A31) with 4.85 points, followed by price risk (A52) with 4.575 points and further followed by market risk (A51). The perniciousness scores of these three indexes exceed 4 points, indicating that these risks must cause substantial losses. The indexes with scores between 3 points and 4 points include process control risk (A32) with 3.7 points, construction quality risk (A43) with 3.45 points and construction progress risk (A44) with 3.375 points, indicating that these three types of risks may also cause a certain amount of loss, so they should also be given some attention in the risk management process.

Based on the goal, the accuracy and the relevance of risk management of coal chemical projects, the key points and the difficulties of determining the risk control of coal chemical projects are further identified. The possibility of risk occurrence and the loss caused by the risks after the accident are compared in a rectilinear coordinate graph, and the risk coordinate graph can further reflect the focus of risk management. The possibility score of risk occurrence is expressed as the abscissa, and the vertical coordinate indicates the scores of the loss caused by the risks. Secondary risk indexes are plotted and distinguished in the graph, as shown in Figure 3.

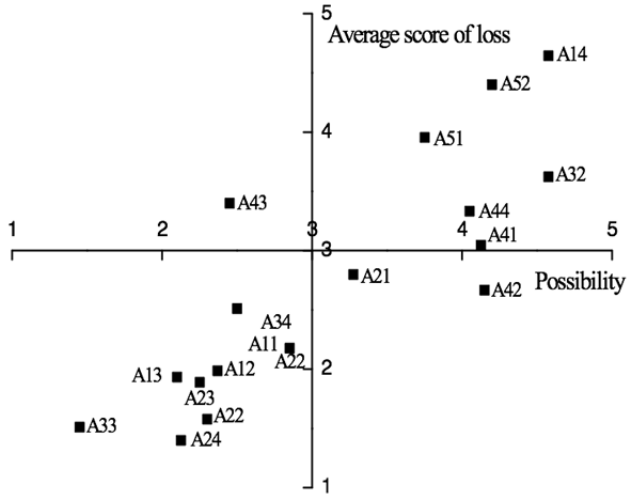

Figure 3: Coordinate graphs of secondary risk index

According to Figure 3, six secondary indexes-A31, A52, A51, A32, A44 and A41, are more prone to risk occurrence in the coal chemical projects. Meanwhile, the loss caused by the risks of such coal chemical projects are significant. Therefore, the focus of risk control of coal chemical projects should lie in delayed delivery risk (A31) and process control risk (A32) in the stage of purchase, construction schedule risk (A44) and construction safety risk (A41) in the stage of construction management, and market risk (A51) and price

risk (A52) in the stage of operation period, which should arouse the attention of risk control of coal chemical projects.

4. Countermeasures for project risk management

4.1 Risk control strategy

In light of the focuses of project risk control that are analyzed previously, the countermeasures of risk management are given respectively.

4.1.1 Risk control strategy at the stage of purchase

(1) Risk management strategy for delayed delivery

When purchase is carried out, a purchase strategy should be first developed. Qualified suppliers are selected through bid, and the processing and the manufacturing of the required equipment and materials are completed at the agreed time, quality and quantity. In this way, the risks of supplier default, deferred delivery and so on could be effectively cut down.

(2) Risk management strategy for process control

The entire process, involving the preparation of purchase documents, the transfer of equipment and materials and the closing should be under control. Meanwhile, an experienced third party with a good reputation in this industry should be hired as the supervisor. A series of manufacturing processes, including the admission inspection of the suppliers' raw materials, the control of the key manufacturing process, the identification of checkpoints and factory discharge and inspection, are tracked in order to timely detect and eliminate the hidden risks.

4.1.2 Risk management strategy at the stage of construction

(1) Risk management strategy for construction progress

From the macro perspective of the project, the control of the key path and the key nodes of the project should be set as the starting point, and the implementation is in accordance with the schedule and the milestone. The project implements the 5-level plan management system.

(2 Risk management strategy for construction safety

Safety risk emergency procedures are established to ensure that the loss caused by the accident is reduced to a minimum after the accident, adhering to the safety concept that all safety incidents can be prevented.

4.1.3 Risk management strategy at the stage of operation period

(1) Management strategy for market risk

The strategies are to optimize internal management, reduce production management costs, respond to national policies, actively carry out supply side reform, locate new economic growth points, increase investment in technology to broaden the diversity of coal chemical products, drive product innovation through product innovation, and create new demand growth points.

(2) Management strategy for price risk

The strategies are to strive for national tax policy for the coal chemical industry, win the support of the national level, and help the modern coal chemical industry to reduce risks from the aspect of national macroeconomic policy.

4.2 Risk control support system

Stage risk management is incorporated into the overall risk management of the project, and these two are dynamically combined to form a whole-process risk management system, which are mainly constituted by the following five parts.

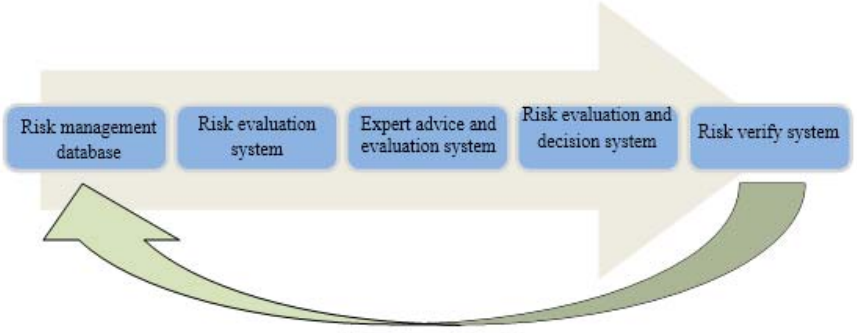

Figure 4: Support system diagram of risk management and control for modern coal chemical project

After the establishment of the whole-process risk management system, the following measures need to be taken: 1. to establish a quality management system for coal chemical projects; 2. to construct a sound risk monitoring and testing system; 3. to improve the safety risk responsibility system; 4. to create a highly efficient risk management team; 5. to develop a scientific and reasonable contract strategy.

5. Concluding remarks

This paper focuses on the modern coal chemical projects in a certain enterprise, applies risk evaluation and other means and methods and draws the following conclusions:

1. Risks are evaluated by means of the expert investigation scoring method. It is argued that risk control of modern coal chemical projects is focused on delaying delivery risk, process control risk, construction schedule risk, construction safety risk, market risk and price risk.
2. In terms of the focuses of project risk control, risk control countermeasures are respectively provided.
3. The establishment of a risk control and support system is proposed.

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