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A review of research related to risk management of EPC engineering projects and future prospects

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Abstract: *EPC general engineering contracting mode is a kind of contracting method widely used in large-scale engineering construction activities at present. This mode provides a new mode for the completion of large-scale projects, which has played a certain role in promoting China's economic development, while its problems are also becoming more and more obvious. At present, with the "Belt and Road" initiative and the establishment of RCEP, a large number of cross-border EPC projects to carry out the implementation of the academic community for the EPC general contracting mode of research continues to be hot, to explore the main risk management mechanism. In this paper, the relevant literature is sorted out according to the chronological order and importance, and the conceptual definition of EPC general contracting model is summarised, and it is also found that the research on risk management in the existing literature is mainly from the four aspects of risk identification, risk evaluation and measurement, risk control and response, and digitalisation of risk management. The results of this paper not only summarise the main literature on risk management in EPC projects, but also clarify the strengths and weaknesses of the relevant research, providing a development direction for future research.*

Keywords: *general EPC contracting model; risk management; digitalisation; optimisation and innovation*

1. Introduction

China's EPC contracting model started in the 1980s and entered a phase of rapid development in 2000. Since then, with the introduction of the "One Belt, One Road" initiative, China's EPC industry has been systematically and strategically promoted to achieve even more rapid development. Relevant data show that China's "One Belt, One Road" strategy is bringing brand new overseas market opportunities for Chinese EPC enterprises, according to the U.S. "Engineering News Report" (ENR) statistics, in the world's leading 250 EPC enterprises, Chinese companies accounted for 26%. The latest data released by the Ministry of Commerce shows that from January to June 2021, Chinese enterprises signed 3,080 new contracts for foreign contracted projects in 61 countries related to the "Belt and Road", with a newly signed contract value of USD 51.45 billion, up 37% year-on-year, accounting for 51.6% of China's new contract value of foreign contracted projects in the same period. As the opening year of the "14th Five-Year Plan" in 2021, the state's implementation of general contracting is gradually increasing, which puts forward higher requirements for construction enterprises to open up the whole industry chain.

Behind these rapid growth figures is the result of the joint efforts of Chinese EPC enterprises and various partners. However, in the global macroeconomic and national new economic situation, although there is the "Belt and Road" policy dividends to help, for China's EPC project contractors as a relatively young general contractor, in front of the opportunity is also facing a lot of challenges, and accordingly about the mode of the unique risk issues have begun to emerge, the academic research on EPC project contracting has also gradually shifted from the initial mode of exploration to risk research. Academic research on EPC project general contracting also gradually shifted from the initial mode of exploration to the risk of research. In this paper, we take time as the main screening point, mainly core journals, and select the literature with high downloads and citations. At the same time, for some classical theories and concepts involved in this model, this paper mainly refers to those classical literature with high recognition.

ISSN 2616-5902 Vol. 5, Issue 20: 25-34, DOI: 10.25236/AJBM.2023.052005

2. Selection of literature

Literature mainly comes from the Chinese literature database Zhi.com, with "EPC" as the keyword to retrieve 15,341 articles, as can be seen from the literature trend graph in Figure 1, scholars for the EPC general engineering contracting model related research gradually hot, reached a peak in 2019, although the research trend has declined during the period from 2019 to 2021, but grows again in 2022.

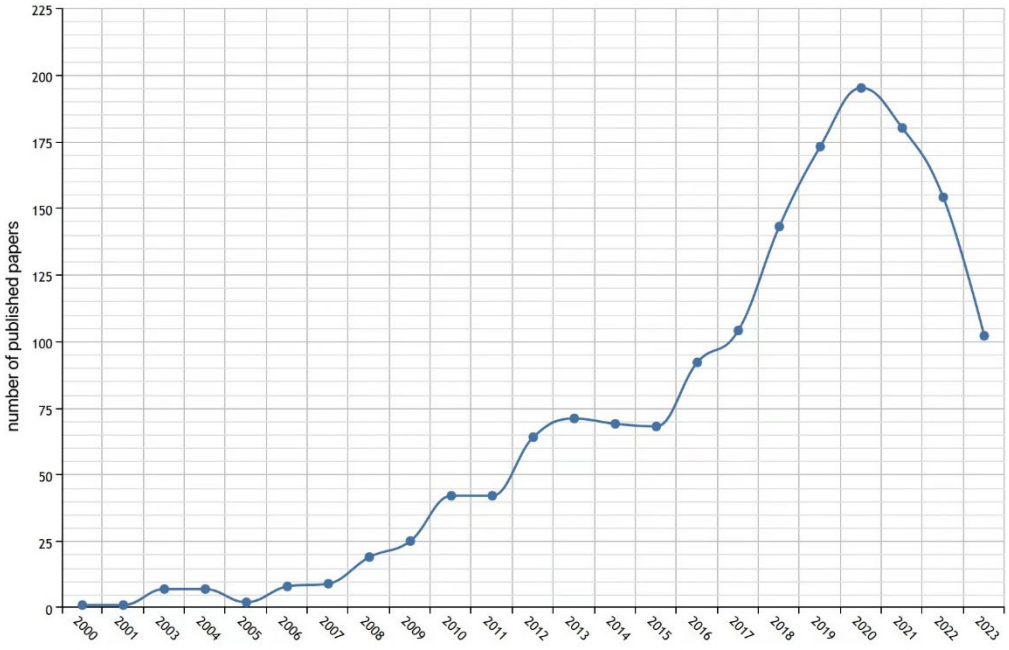

Figure 1: Trend chart of EPC related literature research

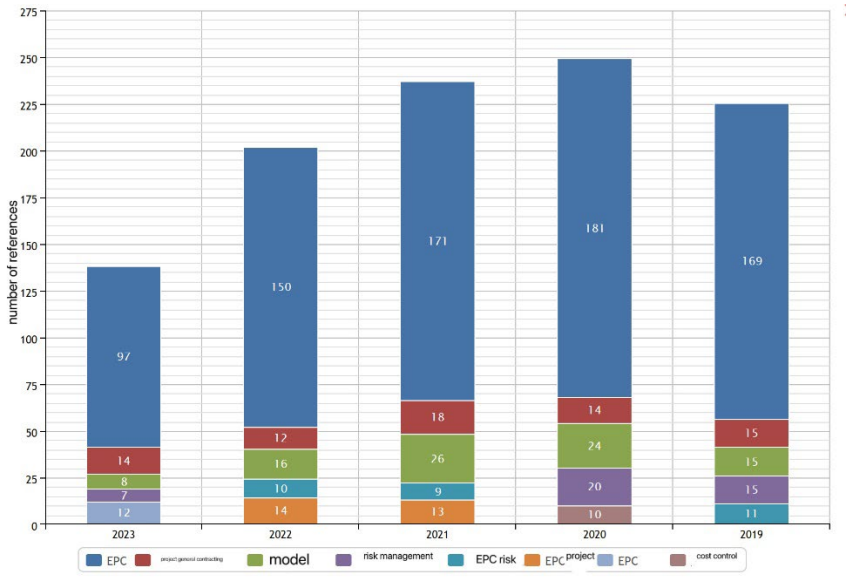

Figure 2: Co-linear graph of keywords in related literature

In order to ensure the accuracy of the search, advanced search was used to search in Knowledge.com, and 4609 articles were searched with "EPC+Risk", of which 316 articles were published in core journals. Then through independent screening, 200 representative documents were finally selected for keyword visualisation analysis. As can be seen in Figure 2, in addition to EPC project and EPC mode, the secondary keywords mainly include tax risk, risk control, risk identification, risk management and so on.

ISSN 2616-5902 Vol. 5, Issue 20: 25-34, DOI: 10.25236/AJBM.2023.052005

3. Study on the Evolution and Mode of EPC Engineering General Contracting

3.1 Traditional construction patterns

Traditional engineering project construction is usually a split construction contracting model, known as the DBB model. The three letters of DBB refer to Design, Bid and Build. Meng Xianhai et al. (2004) pointed out that the traditional construction model is mainly applicable to small and medium-sized housing construction projects, in which the contractor assigns the design and construction tasks to different contractors, and the construction work can only be started after the design work is completed. Wang Wuren et al. (2006) and Zhang Shuibo et al. (2014) pointed out that in the DBB model, design and construction are separated, and the construction unit usually needs to sign a contract with different design units and construction units for cooperation. Construction can only begin when the design part is completed, in which case the leading role of design is difficult to play, which is prone to the problems of difficult to control the progress, high cost consumption, and difficult to guarantee the quality. Xiao Hexu (2017) pointed out that the most important feature of the DBB model is that the implementation of the completion of the project under this model must follow the order of "design - bidding - construction", at the same time, in this process, the owner of the construction bidding only sequential and easy to feel the contract signed by the construction unit, supervisors independently supervise the project.

In summary, this paper argues that the traditional construction model refers to the separation of the design and construction phases of the project were contracted to different contractors, only when the design part is completed to carry out the construction phase, with the regulation of difficult, capital-consuming, inefficient and other characteristics.

3.2 Study on the concept of EPC general engineering contracting

At present, the EPC general contracting model is a widely used contracting method for large-scale engineering and construction activities. The three letters of EPC are the initials of Engineering, Procurement and Construction. Li Xiaoning (2000) summarised the phases of EPC implementation by time phase classification as the moving past, P&ID design, detailed design, bulk material procurement and detailed design closure, construction, start-up and project closure phases. Wang Wuren et al. (2006) stated that the EPC model is a construction project management model that integrates all three phases of design, procurement, and construction under the organisation of a single management body to complete the project. Fifi Wu et al. (2015) stated that the EPC general contracting model arises from the process of contractors providing a package of services to meet the requirements of the contractor. It is divided into EPC (max s/c) and EPC (self-perform construction) based on the degree of subcontractor selection by the contractor. The former refers to the maximum subcontracting of works to subcontractors by the general contractor; the latter refers to the maximum self-performance of the tasks of the project by the general contractor. Yang Rong et al. (2018) [30]pointed out that EPC project refers to the company entrusted by the owner to contract the whole process of design, procurement, construction, commissioning, etc. of the engineering and construction project according to the contract, and the company will be bound by the general contract, and will be responsible for the quality, safety, cost and progress of the project for which it is responsible. Zhang Sherong et al. (2021) pointed out that the EPC general contracting mode as a perfect combination of design and construction management construction mode has the characteristics of design and construction integration, and maximisation of the contractor's revenue.

Comprehensive existing literature can be seen, this paper that the concept of EPC general contracting mode refers to the contractual agreement of the contractor will be the entire project from design to the final completion of the whole process of the task, at a fixed price to the contractor enterprise, project contracting is often in the form of bidding to achieve.

4. Risk management for EPC projects

Risk Management (Risk Management)[3] refers to the management process of how to minimise risk in a project or an enterprise that definitely has a risky environment. It is explained in detail as the management method of choosing the most effective way to deal with risks proactively, purposely and systematically by understanding, measuring and analysing the risks, and striving to obtain the maximum safety assurance at the minimum cost. As can be seen from the above, EPC projects are divided into three main processes: design, construction and procurement. Many risks will be encountered during the whole

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project operation, and we should carry risk management through the whole process of project operation.

The existing literature on risk management for EPC projects mainly focuses on four aspects: risk identification, risk evaluation and measurement, risk control and response measures, and digitalisation of risk management.[1]

4.1 Risk identification studies

4.1.1 Methodology for risk identification

The main methods used by scholars for risk identification are case study summary method, literature research and questionnaire/expert interview method, and indicator construction method. The method of indicator construction.

First of all, the case study summary approach consists of a case study approach and a case study approach based on a particular perspective.

Firstly, for the case study method, Wu Lingfeng et al. (2017)[27] focus on the study of terrorist attack risks encountered in international EPC engineering projects, and summarise the characteristics of terrorist attack risks and put forward corresponding preventive and control measures through the combination of quantitative analysis and qualitative analysis. Dai Jianbiao et al. (2018) classified risk sources into seven categories based on the research of American scholar C. Arthur-Williams, and based on this, risk identification was categorised for the implementation of the Hong Kong-Zhuhai-Macao Bridge (HZMB) island-tunnel project. Song Yuanqi (2022) took large-scale water conservancy projects as a starting point to identify the risks that may be involved in the whole process of EPC general contracting projects. Yang Rong et al. (2018), Li Hao et al. (2020)[10], and Qin Jian (2021)[20] analysed the risks that would be encountered in a multinational situation with specific international EPC general contracting projects as an example, and at the same time put forward effective measures for identifying and avoiding risks in a targeted manner. Yu Ke et al. (2022)[30] analysed the risks that may arise in various aspects from bidding, design, construction to settlement and put forward corresponding risk control measures in the light of the characteristics of such specific and typical EPC project construction of vocational colleges.

Secondly the case study method based on a particular perspective. Shen Zhifeng et al. (2021)[5] and Ye Zhongping (2022)[31] stood in the perspective of governmental EPC projects, analysed interviews and research data by constructing a rooted theoretical approach, analysed the core constituent elements and operation mechanism in line with the scenario of China's EPC project quality supervision mechanism, and sorted out the relevant laws. Yu Hongliang et al. (2021)[33] stood on the perspective of the general contractor to analyse the possible risks of the EPC project contracting mode, and put forward the green management method of green building under the EPC project mode. Firstly, the risks are identified from three aspects: risk source, risk event and risk result to form a preliminary risk chain. Then the causal relationship between these risk elements is explored using structural equation modelling, and finally 11 risk chains are identified. It provides a reference for general contractors to carry out effective risk control in EPC projects. Wang Jin (2021)[7] and Song Yuanqi (2022)[19] analysed the possible risks and countermeasures of university EPC projects from the owner's perspective. Wang Tengfei et al. (2022)[24] stood in the perspective of international partnership and proposed a theoretical model of risk management for international EPC projects based on partnership, and risk identification for international EPC general contracting projects.

Second of all, literature research method and questionnaire/expert interview method.

Zhu Yi et al. (2012)[37]systematically identified and classified the risk factors faced by general contractors in EPC international projects through literature research and expert interviews, applied the AHP method to analyse the weights of the risk factors, and ranked the risks that may be encountered in current international EPC projects. Xu guo (2019)[27], Li Huiling et al. (2020)[12] used the literature synthesis method in collating and summarising 38 typical risk factors that may be faced by the project under the EPC mode, and established the contractor risk indicator assessment system under the EPC mode. In which it divided the risk into policy and regulation risk, environmental system risk, operation system risk, implementation system risk and management system risk.

Third of all, the indicator construction method. This category is mainly a source of innovation points on risk identification for scholars at present. Quan Ji et al. (2014) and Yuan Ximan et al. (2015)[34] pointed out that the common risk identification methods in large-scale multinational projects include brainstorming method, Delphi method, scenario analysis method, sensitivity analysis method, and flowchart method. And the corresponding risks were rated by drawing "risk maps". Xie Liang (2015)

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applied the object element to project management and established a set of quantitative risk identification system for risk identification of EPC projects. Tao Zicheng et al. (2015)[21] established a risk evaluation model of fuzzy comprehensive judgment from the perspective of contractors, analysed the risks that international EPC projects may face from a quantitative perspective, and proposed corresponding strategies to reduce or avoid risks. Based on the combination of interface management theory and the operation logic of EPC projects, Fan Leilei (2018)[5] constructed a three-dimensional analysis framework of interface dimension, element dimension and process dimension of design-based EPC general contractors, and elaborated the cost risk factors existing in all sectors of EPC projects and the corresponding risk countermeasures. Li Hongyu et al. (2021)[11] analysed the contract terms and contract management in EPC projects based on the principle of the triangular conservation of rights, responsibilities and benefits, in which the risk refers to the terms and management methods that may lead to the imbalance of rights, responsibilities and benefits in the contract. Finally, by studying specific cases, it explores how to make these three in the contract to achieve balance. Hu Judan et al. (2021)[6] used COWA method to assign objective weights to the secondary indicators of the risk of BIM technology application, and GI method to assign subjective weights to the primary indicators, eliminating the influence of extreme values on the weights, and established the risk evaluation model of EPC projects applying BIM technology, and analysed the key risks affecting the application of BIM technology to EPC projects by combining the data.

In this type of literature, there is a problem of unclear analysis for the research of risk control perspective of EPC general contracting model. Risk has individual relativity, different subjects for the same kind of risk perception and treatment is different, but the existing literature in the study of risk is mostly from a special case, the study applies to the generality of the case, seldom in the study of the risk of the main body of the contractor or the project or the government, which will lead to the study of the conclusions of the actual bias, can't be better applied in real life.

4.1.2. Project risk classification

For the classification of EPC project risks, different scholars stand under different research perspectives proposed by different classification standards. At present, most scholars are focusing on the risks caused by the mode of operation of EPC projects, from the pre-bidding management issues, contract formulation, to the whole process of risk and quality and financial accounting, dispute resolution and claims mechanism.

The first is the risk arising from the bidding process. Most of the large EPC general contracting projects are carried out through the bidding and tendering method, and the current academic community will combine the actual specific cases to study the management problems in the bidding process. Dai Jianbiao et al. (2018)[3] took the Hong Kong-Zhuhai-Macao Bridge island tunnel project as the main research object, used the hierarchical analysis method to classify the risks encountered in the bidding process of the project at a hierarchical level, and put forward the corresponding preventive and countermeasure measures in an orderly manner. Zhang Guozong et al. (2021) used the ISM model to analyse the interaction relationship between various influencing factors in the bidding process of the general contracting model and summarised the key influencing factors. Yu Chao (2022) shows that the management requirements for EPC project bidding are increasing, and analyses in detail the bidding preparation and planning, preparation of documents and other aspects of the bidding process, and sums up the corresponding procedural management experience.

Secondly, after the bidding work is completed, the project enters into the process of contract formulation and signing, and some scholars study the possible risks of EPC general contracting mode from the perspective of contract formulation. Zhang ShuiBo (1999)[33] comprehensively introduces the key contents such as the background of the creation and the existence of risks of the EPC mode contract, which is the earliest literature that proposes the EPC general contracting mode through the Knowledge Network search. Zhang ShuiBo et al. (2008), Li HongYu et al. (2021), and Nan YiJia et al. (2022) all studied and analysed the risks in contract terms and contract management in EPC projects from the perspective of contract formulation. Li Hao et al. (2020) focussed on the problems arising from claim clauses in contracts.

The third is from the perspective of financial accounting in the whole process of EPC general contracting model. He Yanfang et al. (2017), Jiang Xue (2019), Liu Miaomiao et al. (2019), Cheng Xun (2020)/Li Fujun et al. (2021), and Tu Liqiong (2022) studied the financial and tax risks that may be faced in the EPC project from the new perspective of financial accounting and put forward the corresponding control measures from the perspectives of fund management, tax planning, budgeting and costing.

Fourth, it is mainly studied from the perspective of risk and quality control in the whole process of

ISSN 2616-5902 Vol. 5, Issue 20: 25-34, DOI: 10.25236/AJBM.2023.052005

EPC general contracting model. Zhu Xiaoxiao et al. (2022) and Chen Qiuyun (2022) mainly studied the risks that may exist in the pre-procurement process of EPC projects. Liu Yanping et al. (2022), Song Yuanqi (2022), and Wang Zhuofu et al. (2022) study cost risk and pricing risk from the perspective of the whole process. They pointed out the cost risks that water conservancy projects may encounter in the construction phase of EPC general contracting mode from five aspects, namely, owner management risk, construction drawing (design) risk, equipment and material procurement risk, internal communication risk of the consortium, and the lack of scientific cost management and control methods, and put forward corresponding suggestions to assist in avoiding these cost risks. Yu Ke et al. (2022) and Jiang Xiaodong et al. (2021) comprehensively stood on the perspective of the whole process to study the possible risks of EPC projects.

4.2 Risk evaluation and measurement studies

At present, the risk evaluation methods of EPC general contracting mode are mainly divided into two categories: traditional risk evaluation methods and innovative risk evaluation methods.

The traditional risk evaluation methods are mainly hierarchical analysis (AHP method), cross impact analysis (CIA method), and fuzzy hierarchical analysis. Tao Zicheng et al. (2015) established a risk evaluation model of fuzzy comprehensive judgment from the perspective of contractors, analysed the risks that international EPC projects may face from a quantitative point of view, and proposed corresponding strategies to reduce or avoid risks. Zhu Xiaoxiao et al. (2022) mainly combines the qualitative score of cross-influence analysis method and the quantitative analysis of Markov chain to analyse the procurement risk factors involved in the bidding process of university EPC projects, to run through the intricate logical relationship between each risk factor, and to clarify the risk investigation and control focuses that need to be carried out during the bidding process of university EPC projects so as to provide constructive reference value for the subsequent bidding procurement of EPC projects. people to provide constructive reference value. Liu Xue et al. (2022) used the hierarchical analysis method, the CRITIC method and the Lagrange combination assignment to determine the weight of risk indicators, and constructed a cost risk evaluation model of assembly building in EPC mode under the cloud model. Examples were finally used to test the applicability of the indicator system.

Innovative risk evaluation methods are mainly updated and optimised on the basis of the traditional risk evaluation methods mentioned above. Li Huo (2016), in view of the bidding characteristics of water conservancy and hydropower EPC projects, categorised the risk factors according to the nature of the risk, and established a risk evaluation index system by comprehensively considering social and political risk, natural risk, economic and financial risk, technical risk, management risk and competition risk. The introduction of triangular fuzzy number improves the traditional fuzzy hierarchical analysis method, fully considering the fuzzy nature of the expert judgement to improve the accuracy of the evaluation results, and accordingly establishes a fuzzy comprehensive evaluation model of bidding risk for water conservancy and hydropower EPC projects. The established model is applied to the bidding risk decision-making of a water conservancy and hydropower EPC project in Yunnan Province, which provides a scientific basis for the bidding risk response of the project. Shi Danqing (2021) used the entropy weight method, hierarchical analysis method and fuzzy comprehensive evaluation to construct a risk evaluation system to accurately assess the risk of EPC model led by the design institute. Liu Yanping et al. (2022) innovated the hierarchical analysis method. The triangular fuzzy hierarchical analysis method and anti-entropy method were used to determine the subjective weights and objective weights respectively, and then the game theory was used to assign values to the above weights, and finally a combined assignment-evidence theory-fuzzy comprehensive evaluation model was constructed for evaluating the cost risk of the assembly project under the EPC model. Hu Zhidan et al. (2021) used COWA method to assign objective weights to the secondary indicators of the risk of BIM technology application, and GI method to assign subjective weights to the primary indicators, eliminated the influence of extreme values on the weights, established a risk evaluation model for EPC projects applying BIM technology, analysed the key risks affecting the application of BIM technology for EPC projects by combining the data and put forward the targeted measure suggestions.

4.3 Study on risk control and response measures

The current academic research on risk control and countermeasures corresponds to the categorisation of risks above, and risk control measures have been proposed for different stages of different EPC projects. The main risk control and response measures are risk avoidance and risk sharing.

ISSN 2616-5902 Vol. 5, Issue 20: 25-34, DOI: 10.25236/AJBM.2023.052005

For risk avoidance, Nan Yijia et al. (2022) suggest that the method of contract splitting can be used to reduce the tax risk of the counterparty. Yang Jian (2022) proposes a new EPC project management mode of design unit-led consortium cooperation mode, and analyses the problems that need to be paid attention to in risk prevention of the design unit-led management mode in a targeted way. It also points out that managers can prevent the occurrence of risks by formulating reasonable contract regulations to restrain the responsibilities of both parties and establishing an effective conflict resolution mechanism. Based on the principal-agent theory, Zheng Xiaoyun et al. (2022) analysed the principal-agent relationship between the three main parties in EPC projects and proposed to promote the risk avoidance of the three parties by formulating a reasonable incentive plan. Xu Peng (2021) proposed a risk avoidance strategy for multinational projects.

For risk sharing, Meng Xianhai (2004), Fan Shuqing (2020) pointed out that the owner and the contractor can make the corresponding normative agreement between the owner and the contractor to clearly specify the owner and the contractor need to bear the risk and responsibility, so as to avoid conflicts and problems. Luo Dong (2022) from the perspective of risk-sharing mechanism, put forward to look at the EPC general contracting model in the contractor to further expand the claim space, so as to share the risk as little as possible.

To sum up, it can be seen that the current scholars are not deep enough for the research related to risk control and countermeasures, and most of them stay on the surface of the narrative analysis, and fewer of them are analysed by the literature combined with actual cases. Subsequent research should be further in-depth.

4.4 Digitalisation of risk management

In the context of today's hot research on the theme of digital economy, scholars have begun to combine the two themes of smart manufacturing and digital economy from the perspective of innovation to study the control measures of risk avoidance in EPC engineering projects. Cao Cheng et al. (2016) took large-scale engineering projects as the research object and analysed in detail the five major applications of BIM Cloud Collaboration: respectively, collaborative management of documents and processes, collaborative management of drawings and changes, collaborative management of schedule, collaborative management of quality and safety as well as collaborative application of business management. Ultimately, it illustrates the key role of digital transformation in improving the efficiency of engineering project management. Fan Qixiang et al. (2017) proposed the definition of intelligent management of large-scale engineering and construction projects, that is, the application of intelligent technology in the entire large-scale engineering, construction projects, through the computer and digital network to automatically analyse and deal with the problems in the process of the project, so as to make the entire engineering and construction of the project risk-resistant, high efficiency and high quality. Qin Wei et al. (2019) took the invested overseas EPC project as an example, analysed the financial risk, logistics risk, product risk and special risk, etc. that existed in the overseas procurement process of the contractor, and put forward a risk control strategy based on the BIM technology for the procurement of EPC turnkey EPC procurement of overseas transmission and substation projects in response to these risks, which included the establishment of a risk assessment system based on the theory of the Delphi method, the financial fluctuation-based of engineering cost big database and monitoring system based on 3D collaborative design platform to achieve the avoidance of procurement risks in EPC projects. Hu Zizhidan et al. (2021) proposed the application of BIM technology in the risk evaluation model of EPC projects. Bow Yanjun et al. (2022) pointed out that the current construction safety management system in China is not perfect enough, and due to the insufficient degree of intelligence, many risk negligence can not be avoided. Therefore, the paper proposes to use digital technology to popularise the application of BIM + FM in the whole life cycle of EPC projects, and to build a database cloud platform with the Internet as the core, so as to achieve an effective reduction of the risks of traditional EPC projects in the later operation and maintenance management.

At present, the research related to the digitalisation of risk management in EPC projects is in full swing in academia, and it is a popular research in recent years. With the continuous development of the Internet, the application of digitalisation in risk management will gradually expand. However, the current research on this topic is still shallow and remains in the preliminary stage of digitalisation, and the research on software or functional websites with popular attributes that can be applied to the risk management of most EPC projects is not deep enough.

ISSN 2616-5902 Vol. 5, Issue 20: 25-34, DOI: 10.25236/AJBM.2023.052005

5. Conclusions and future outlook

In this paper, a series of studies on risk management of EPC projects are sorted out. The purpose of this paper is to sort out the whole process of risk management research from risk identification to risk evaluation to risk control of EPC project, to find out the deficiencies of the research, and to provide new ideas and methods for the subsequent research.

With the proposal of the "Belt and Road" initiative, the research on EPC general contracting mode is gradually hot, and the research results of scholars in this field should not be underestimated. At present, the research on risk management of EPC project has experienced the following stages, the first is to compare the difference between it and the traditional engineering project construction mode to summarise the advantages and feasibility of EPC mode, and in the process gradually clarified the concept of EPC mode and the connotation of EPC mode. After clarifying the relevant concepts, the scholars start according to the process of general project risk management. Firstly, they identify the risks that may exist in the implementation of projects using the EPC mode through case study summary method, literature research method, questionnaire survey method/expert interview method, indicator construction method and other risk identification methods. Then the identified risks are quantitatively evaluated by hierarchical analysis method (AHP method), cross impact analysis method (CIA method), fuzzy hierarchical analysis method, etc., and targeted risk response measures are given according to the corresponding quantitative results, among which the common risk response measures are risk avoidance and risk sharing. Finally, at present, the most cutting-edge related literature is to combine the current high-speed development of the Internet, the digital economy booming background, from the perspective of innovation combined with smart manufacturing and digital economy, research EPC engineering project risk management update and improve the method.

However, there are still some shortcomings and areas for improvement in the research in this field. Firstly, the academic research on the risks related to EPC projects is not precise enough, without considering the characteristics of the risks themselves, and most of the literature is only general, and analyses the risks encountered by the projects under the EPC general contracting mode under the transnational situation in a superficial way. Subsequent research can be conducted through questionnaires, interviews, field visits and other ways to investigate and analyse the completed EPC projects and conduct detailed studies, so that the risks that may be encountered in the implementation of multinational EPC projects can be classified in more detail, which can put forward more practically meaningful measures to solve the risks and the corresponding risk avoidance methods. The second is that the existing literature in the study of the digitisation of EPC general contracting mode, the research object is mostly based on domestic large-scale engineering projects, for foreign large-scale engineering projects and cross-border large-scale engineering projects are not too much research. Subsequent studies can focus more on the research object on cross-border mature large-scale EPC projects.

In addition, this paper also has some problems due to the lack of research time, research resources and the author's own knowledge. In terms of literature review and screening, this paper mostly selects the literature of domestic scholars, and the understanding of foreign scholars' research content is not deep enough and comprehensive. At the same time, this paper only uses Zhi.com as the source of literature, the database is relatively single, there are still limitations in the search and selection of literature. As for the content of the study, this paper only summarises the theoretical content of the relevant literature, but does not do much research on the research process, such as the selection of the relevant research samples, data testing and analysis, etc., and the degree of refinement of the study is insufficient. If the follow-up research can be further analysed, the results obtained should be higher.

References

[1] Chen Qiuyun. Research on EPC procurement risk control strategy based on BIM technology [J]. Residence, 2022(05):149-151.
[2] Cheng Xun. Research on tax differences and risks of EPC projects under the new revenue standard [J]. Construction Economy, 2020, 41(10):38-41.
[3] Dai Jianbiao, Gao Xinglin, Zhang Mingkong. Risk evaluation and response to the bidding of design and construction general contracting for Hong Kong-Zhuhai-Macao Bridge island tunnel project [J]. Tunnel Construction(in English and Chinese), 2018, 38(07):1138-1148.
[4] Fan Shuqing. Risk Sharing and Response of Owners and Contractors under EPC Mode[J]. Urban Architecture, 2020, 17(06):178-180.
[5] Fan Leilei. Analysis of design-based EPC cost risk factor identification based on interface

ISSN 2616-5902 Vol. 5, Issue 20: 25-34, DOI: 10.25236/AJBM.2023.052005

management [J]. Construction Economy, 2018, 39(10):86-89.
[6] Gong Yanjun, Han Yanfeng. Efficient safety management in the whole life cycle of EPC+O construction projects through BIM+FM technology [J]. Intelligent Building and Smart City, 2022(11):57-59.
[7] Hu Judan, Tang Shuang, Yang Minjie. Risk evaluation of BIM technology application in EPC projects [J]. Engineering Economy, 2021, 31(04):68-73.
[8] Jiang Xiaodong, Liu Jia. Legal Risks and Preventive Measures of Construction Enterprises under F+EPC Mode [J]. Construction Economy, 2021, 42(S2):24-27.
[9] Jiang Xue. Analysis of the financial risk of general engineering contracting project[J]. Finance and accounting monthly, 2019(S1):95-96.
[10] Li Hao, Tang Wenzhe, Shen Wenxin, Wang Yunhong. Research on claim management of domestic EPC project--Taking Yangfanggou hydropower station as an example[J]. Construction Economy, 2020, 41(04):59-63.
[11] Li Hongyu, Zhang Hao, Wang Yuxin, Cheng Sujuan. Contract risk analysis and countermeasures of EPC project based on the principle of responsibility and right[J]. Construction Economy, 2021, 42(S1):128-131.
[12] Li Huiling, Mou Yonglin. Research on risk management of general contracting project under EPC mode [J]. Construction Economy, 2020, 41(S1):103-107.
[13] Liu Miaomiao, Yao Xiaoqiu, Li Huiping. Tax risk prevention in the contract signing stage of international EPC engineering projects [J]. Finance and Accounting, 2019(17):54-56.
[14] Liu Xue, Guo Haibin, Zhao Ranran. Evaluation of cost risk of assembly building under EPC mode based on cloud model [J]. Journal of Heilongjiang Engineering Institute, 2022, 36(05):38-43.
[15] Liu Yanping, Wang Wenzhong, Pu Wanli. Cost risk evaluation of assembly construction project under EPC mode based on portfolio assignment-evidence theory-fuzzy comprehensive evaluation method [J]. Science, Technology and Engineering, 2022, 22(11):4562-4571.
[16] Nan Yijia, Dong Guanhua. EPC Contract Splitting Risk and Response[J]. Project Management Review, 2022(04):68-71.
[17] Qin Wei, Zhang Lili, Shao Kangjie, Zhang Zhuoqun, Wang Quan. EPC procurement risk control strategy based on BIM technology [J]. Value Engineering, 2019, 38(12):73-76.
[18] Shi Danqing. Research on risk evaluation of design institute-led EPC model based on entropy right-FAHP [J]. Construction Economy, 2021, 42(S1):132-135.
[19] Song Yuanqi. Cost risk identification and control in construction phase of EPC general contracting for water conservancy project[J]. People's Yellow River, 2022, 44(S1).
[20] Qin Jian. Discussion on the prevention of operation risk of water conservancy EPC project--Taking Nan'ao Island water supply project as an example [J]. People's Yangtze River, 2021, 52(S2):255-258.
[21] Tao Zicheng, He Yanfang. Application of fuzzy comprehensive judgement risk management technique in bidding decision of EPC project[J]. International Economic Cooperation, 2015(09):83-86.
[22] Tu Liqiong. Discussion on whole process tracking audit of engineering construction projects under EPC mode [J]. Finance and accounting newsletter, 2022(11):118-122+176.
[23] Wang J. Risks and responses faced by university project owners under EPC mode[J]. Construction Economy, 2021, 42(S1):139-142.
[24] Wang Tengfei, Wang Yunhong, Shen Wenxin, Tang Wenzhe. Partnership-based risk management for international EPC projects[J]. Journal of Tsinghua University (Natural Science Edition), 2022, 62(02):242-249.
[25] Wang Zhuofu, Tao Xiaoping, Ding Jiyong, Li Qichang, Tian Junrui. Optimisation of transaction governance structure for major water conservancy and hydropower projects EPC[J/OL]. China Rural Water Conservancy and Hydropower:1-9[2022-11-20].
[26] Wu Lingfeng, Gan Lisheng. Exploration on the allocation optimisation of anti-terrorism resources in overseas EPC projects[J]. Construction Technology, 2017, 46(S2):724-727.
[27] Xu Zao. Research on risk assessment of overseas EPC project based on system dynamics--Taking the EPC project of Lania oil field construction in Chad as an example [J]. China Safety Production Science and Technology, 2019, 15(S2):52-57.
[28] Xu Peng. Avoidance strategy of market risk in EPC contract management of overseas projects[J]. Heilongjiang traffic science and technology, 2021, 44(05):238-239.
[29] Yang Jian. Management thinking of consortium cooperation mode led by design unit in EPC project [J]. Construction Economy, 2022, 43(10):43-48. 3.
[30] Yang Rong, Zhang Weifang. An overview of common problems in the architectural design of international power EPC projects--Taking the 1×20 MW coal-fired power plant project in Iligan, Republic of the Philippines as an example[J]. Journal of Wuhan University (Engineering Edition), 2018, 51(S1):360-363.

ISSN 2616-5902 Vol. 5, Issue 20: 25-34, DOI: 10.25236/AJBM.2023.052005

[31] Ye Zhongping, EPC mode contractor investment control problems and countermeasures [J]. Construction Economy, 2022, 43(05):23-29.
[32] Yu Ke, Qiu Mingke, Wei Mingkun. Risk and control of substitute construction for EPC project of new campus of vocational college [J]. Construction Economy, 2022, 43(S1):682-684.
[33] Yu Hongliang, Chen Jialuo. Research on risk chain of green building project under EPC mode based on SEM [J]. Science and Technology Management Research, 2021, 41(17):199-205.
[34] Yuan Ximan, Gao Xing, Li Jingjing. Risk identification of highway projects under BOT+EPC mode based on "risk map"[J]. Transport Enterprise Management, 2015, 30(10):55-57.
[35] Zheng Xiaoyun, Chen Zhenxing, Chen Jinyan. Research on EPC incentives based on two-layer chained principal-agent[J]. Journal of Engineering Management, 2022, 36(02):103-107.
[36] Zhu Xiaoyu, Wang Sheng. Research on risk factors of EPC project bidding and procurement in universities based on cross-influence method [J]. Experimental Technology and Management, 2022, 39(04): 249-254
[37] Zhu Yi, Li Jiqin, Wei Yan, Li Hui, Nan Song, Li Xiaodong. A study on risk factor classification of EPC international projects based on the perspective of general contractors[J]. Journal of Engineering Management, 2012, 26(05):1-6.