Risk Logical Framework and Typical Cases of Highway PPP Projects

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Abstract. PPP investment projects have emerged in China since 2010, changing the original investment and financing model dominated by government budget funds. However, China's policies are relatively immature, so there are many hidden dangers in project participants' risk identification and allocation methods, which have always been the core issue of PPP investment decisions. Based on the COSO theory + SWOT analysis method, this paper constructs the logical framework of highway PPP projects, combs out the risk points in highway PPP projects based on actual cases in western China, and constructs a clear risk list and grade division of highway PPP projects, to provide a reference for project participants' risk management.

Keywords: COSO theory; PPP projects; SWOT analysis; Risk identification.

1 Introduction

The PPP investment and financing mode has changed government budget funds, as the financing platform carrier and the exceptional transportation fund support changed the former financing mode[1], which quickly won the government's and investors' favor. Although PPP projects have been widely used throughout the Country, the complexity of transportation infrastructure construction, the scale of investment, and the long-term operation of the policy support system still need to be improved[2-4]. The difference between the pursuit of profit of capital and the quasi-public welfare of highway infrastructure makes it difficult for the government and private parties to achieve common interest goals in the PPP model, which gives rise to many doubts about private capital and leads to the slowdown of the expected effect of PPP projects. Therefore, constructing a theoretical logical framework for PPP project risks and conducting practical case analysis to strengthen the awareness of PPP project risks by private capital[5] is the key to enhancing the confidence of private capital in PPP projects and increasing the participation of private capital in PPP projects.

Combined with SWOT and COSO theory, this paper constructs a relatively complete risk framework analysis idea for PPP projects. On the one hand, highway development is directly related to the national economic development conditions, and SWOT is used to analyze the

PMBDA 2023, December 15-17, Nanjing, People's Republic of China

DOI 10.4108/eai.15-12-2023.2345296

environmental change requirements of construction to clarify the environmental situation of investment risks of construction enterprises. On the other hand, the streamlined and dynamic internal risk management and control system established by COSO theory further refines the accuracy of internal risk identification of enterprises and projects. Taking the G3018 Jinghe to Alashankou section as an example, this paper verifies the theoretical logical framework of PPP projects, constructs a risk identification and analysis process, and can provide a reference for similar enterprises.

2 Theoretical basis of highway PPP project

The PPP is a new financing model for infrastructure, the main participants are government departments and private capital, the government The government grants concessions to private capital, and private capital carries out the construction and operation of projects within a certain time frame.

2.1 External environmental factors—SWOT analysis

Through SWOT analysis, the external factors of highway PPP projects are discussed from the four aspects of risk advantages, disadvantages, opportunities, and threats; combined with the SWOT structure matrix, a more comprehensive analysis can be carried out in combination with the conditions for risk setting, and the characteristics and requirements of the times for the existence of highway PPP project risks are discussed from the two dimensions of national economic development level and highway leading modernization development requirements, which is in line with the essential starting point and new characteristics of PPP project setting under the characteristics of the times. It is also in line with the significance and value of PPP projects. Therefore, using SWOT analysis to identify PPP project risks can make the PPP project risk logical framework more professional and targeted from the perspective of the development of the times[6].

2.2 Internal Project Factors—COSO Theory

In-depth analysis of the implementation risks of highway PPP projects requires clarifying the project implementation conditions and their influencing factors and accurately identifying the unique conditions for the risk development of PPP projects at each stage, which is the premise of constructing the risk theory framework of PPP projects. Therefore, based on COSO risk management theory, this paper proposes to provide reference and reference for the refinement of risk factors of highway PPP project enterprises and project level through the risk management framework of three objectives and five elements in the theory[7-8].

3 Theoretical logical framework and risk analysis of the PPP project

3.1 The theoretical logical framework of PPP projects

The full name of PPP is Public-Private-Partnership, which refers to the government's introduction of private capital to participate in the investment and operation of urban infrastructure and other public welfare undertakings through concessions, reasonable pricing,

financial subsidies, and other pre-disclosed income agreement rules characterized by benefit sharing and risk sharing, giving full play to the advantages of both parties and improving the quality and supply efficiency of public products or services[9]. The existing mature Western theories make it difficult to provide adequate theoretical support and practical solutions for the development of China's highway PPP projects, and the key is to ignore the deep-seated causes of highway development, such as traffic guidance, economic differences, and administrative segmentation. Given this, this paper attempts to combine the characteristics of regional development economic operation and propose a theoretical logical framework of PPP projects with highway-leading development as the core and supported by three primary mechanisms, conditions, and factors to provide adequate support for the corresponding risk identification and analysis,as shown in Figure 1.

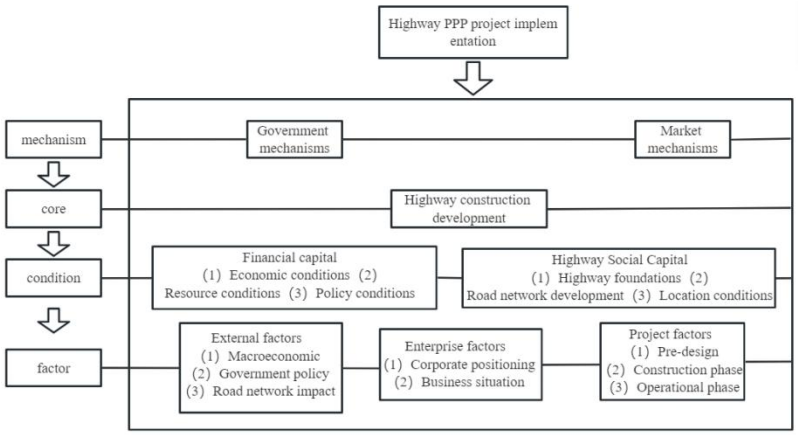

Fig. 1. Logical framework for the implementation of highway PPP projects.

From the above theoretical logical framework, (1) the implementation of highway construction is the core because the fundamental service goal of PPP project implementation is to serve the development of highway construction, and the essence is to improve and drive the circulation capacity of modern economic level through highway construction and development, and then further support the construction of a transportation power. (2) The government and market mechanism is the superior requirement, is the overall environmental element of the implementation of highway PPP projects, whether the development and improvement of Chinese and Western transportation infrastructure is inseparable from the guiding requirements of government policies, as well as the supporting role of market mechanisms, therefore, the organic integration of government mechanisms and market mechanisms is an essential guarantee for the implementation of highway PPP projects. (3) The conditions are the carrier of the role of the government and the market in the implementation of highway PPP projects, and the PPP projects include social capital and financial capital, and financial capital is limited by economic conditions, resource conditions, and policy conditions, and highway social capital includes highway development foundation, road network development conditions, and location conditions. (4) Factors mainly refer to the extension performance and essential components of PPP project risks, including external, enterprise, and project factors. External factors are divided into macroeconomics, government policies, and road network impacts; enterprise factors mainly include enterprise positioning and development situation;

project factors include early design, construction stage, and operation stage. In between, external factors are the premise, enterprise factors are the key, and project factors are the carrier.

3.2 The theoretical logical framework of PPP projects

Based on the analysis of the above theoretical logical framework, combined with the situation of highway construction and development in the new era, the SWOT method is used to deeply explore the advantages, disadvantages, opportunities, and threats of highway PPP project development to provide external factor support for PPP project risk identification.

(1) Advantages of highway construction and development

In 2022, the State Council promulgated the "14th Five-Year Plan for the Development of Modern Comprehensive Transportation System"[10], which made an overall plan for China's transportation layout and transportation development, which mentioned strengthening the construction of main roads, upgrading highways, and making road transportation and other modes of transportation work together to form a comprehensive transportation network. The National Highway Network Plan[11], jointly issued by the National Development and Reform Commission and the Ministry of Transport, proposed that a high-quality road transport network with comprehensive coverage, fast transportation, intelligence, and efficiency will be completed by 2035.

The national planning of highway construction reflects the importance of road transportation, and the highway construction industry has good development prospects; highway construction enterprises can interpret real-time policies, formulate enterprise development plans, and complete industrial structure transformation[12]. In addition, in recent years, many PPP project policy documents have promoted the application of the PPP model in highway construction projects, and the operation mode of PPP mode provides good preliminary references.

(2) Disadvantages of highway construction and development

During the "Thirteenth Five-Year Plan" period, China has completed the construction of national highways, built a highway network structure that meets the needs of people's daily life and transportation, and highway construction tends to be saturated, resulting in a decrease in highway construction projects compared with previous years[13], the development of highway construction enterprises has been affected, and the enthusiasm of the highway construction industry has decreased.

(3) Opportunities for highway construction and development

In recent years, PPP projects have received the attention of the state, and relevant PPP policies have been continuously promulgated, providing policy guarantees for enterprises. Highway construction enterprises can take advantage of the PPP project policy dividend period to actively participate in the construction of highway PPP projects[14-15], accumulate experience in highway PPP projects, and do an excellent job in the development planning of enterprise projects[18].

(4) The threat of highway construction and development

National policies will be adjusted in real-time according to the current situation of national development, for highway construction-related policy changes will affect the development of highway construction enterprises in order to ensure the excellent development of enterprises, highway construction enterprises need to always understand the policy trends, according to the policy orientation, and timely change the direction of enterprise development.

The PPP model has entered a stage of diversified development in China, but the PPP model has not yet formed a perfect system; PPP project risks are uncertain, so highway construction enterprises in the construction of highway PPP need to carry out risk analysis, identification, and evaluation of PPP projects[16-19], PPP project risks in advance, to ensure that the interests of enterprises are not lost, highway construction enterprises SWOT analysis structure is shown in Figure 2.

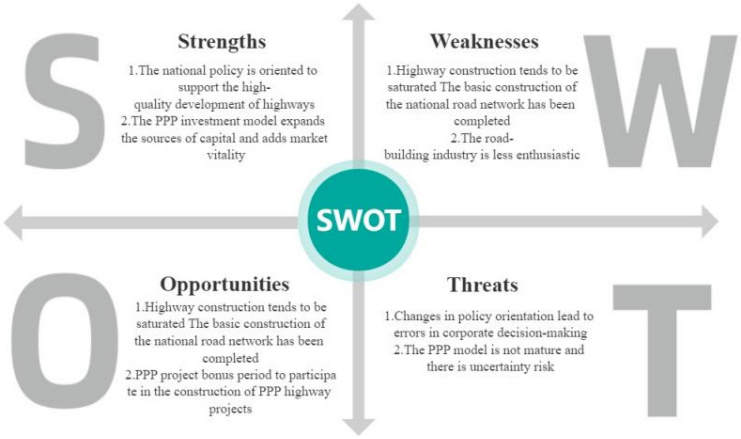

Fig. 2. SWOT analysis structure diagram of highway construction enterprises

3.3 Analysis of internal risk factors

Based on the risks of the PPP mentioned above, projects of highway construction enterprises, the construction process of PPP projects are analyzed, including risk analysis in the project identification stage, risk analysis in the project preparation stage, risk analysis in the project procurement stage, risk analysis in the project implementation stage, and risk analysis in the project handover stage[20-24].

(1) Risk analysis in the project identification stage

The main task of the project identification stage is to identify and screen new highway projects, highway reconstruction projects, and existing highway projects, evaluate the value for money and financial affordability of these projects, and include the evaluated highway projects in the PPP project library for project preparation. The risks at this stage mainly come from the adjustment of the state's policies for PPP projects, the formulation of laws and regulations for PPP projects, the state's long-term planning for the highway industry, and the demand of the highway construction market. The evaluation criteria for value for money of PPP projects and the scope of financial affordability of the project are affected by national policies, laws and

regulations, and the national planning for the highway industry is the orientation of highway development, so it is necessary to understand the policy orientation of PPP projects in the project identification stage[25], the control of PPP projects by laws and regulations, and the national highway construction planning[26-27], and the risks at this stage include legal and regulatory risks, fiscal policy risks, industry policy risks, and market demand risks.

(2) Risk analysis in the project preparation stage

The main task of the project preparation stage is to prepare a plan for the project implementation, including the project overview and the basic framework of risk allocation. The risk at this stage mainly comes from the choice of highway construction path and the impact of highway construction on surrounding residents; the choice of highway construction path needs to consider the impact on the surrounding environment and surrounding buildings, try to avoid areas with cultural monuments and more residents when choosing the construction path, and also need to consider the impact of topography and geology on highway construction. The risks at this stage include path planning risks and natural environment risks.

(3) Risk analysis in the project procurement stage

The main task of the project procurement stage is to procure the materials required for the project through open bidding and competitive consultation. The risks at this stage mainly come from the uncertainty of deposit and loan interest rates, market interest rate levels, material prices, and the supply of purchased materials, the adjustment of deposit and loan interest rates, and the rise and fall of highway construction material prices affecting the cost of highway construction. The uncertainty of the supply of purchased materials will affect the project's construction progress, and serious situations will lead to the project's completion or failure. The risks at this stage include inflation, currency interest rate, and material supply risks.

(4) Risk analysis in the project implementation stage

The main tasks in the project implementation stage are for private capital to set up a project company, the government to designate relevant institutions to participate in the shares, start project financing, and carry out project construction and operation management after the financing is completed. The risks at this stage mainly come from the financing process of highway construction projects, the construction process of highways and the operation and management after the completion of construction, whether the project can be successfully financed needs to consider the economic strength, credit and financial market trends of social capital, insufficient economic strength of social capital or lack of social credit will lead to project financing failure, and low mood in the financial market will lead to inactive funds will also make project financing fail; Problems such as construction safety, equipment damage, project progress, and project quality in the process of highway construction will cause the project to fail to complete or fail on schedule; After the completion of highway construction, the project company will carry out operation and management, if the highway cannot meet the operating conditions or improper management occurs during operation, it will also make the highway unable to operate normally and lead to project losses, and the risks at this stage include project financing risks, engineering construction risks[28], operation management risks, etc.

(5) Risk analysis in the project handover stage

The main task of the project handover stage is to recover the project that has ended the concession period by the representative office designated by the government, and the project transfer method is divided into two types: termination of the transfer at the end of the period and early termination of the transfer. The risks at this stage mainly come from the process of accepting the project, and there are problems such as excessive use of highways and improper maintenance during operation when the project does not meet the acceptance conditions. The risk at this stage is the risk of project handover.

3.4 Risk inventory

Combined with those mentioned earlier, theoretical logical framework and external/internal risk analysis, the risk list of highway PPP projects is summarized, and four classification indicators are formed, as shown in Table 1.

Table 1. Highway PPP project risk list

First-level classification	Secondary classification	Tertiary classification	Four-level classification	Brief description of the content
Project external factors, risk	Macro risk	Regulatory and regulatory risks	Regulatory and regulatory risks	Amendments and changes to laws and regulations related to land use and environmental protection lead to the inability of the project to operate normally and cause losses
		National policy risks	Industry policy risks	The state's planning for highway construction and the adjustment of policies affect the development prospects of the highway industry
			Fiscal and tax policy risks	The adjustment of the national fiscal and taxation policy makes whether the government's financial subsidies for highway construction enterprises and projects can be stabilized and whether tax revenue is increased
		Economic condition risk	Inflation risk	The rise in the price of raw materials needed to build roads has increased the cost of highway construction and increased investment in highway projects
			Currency interest rate risk	Affected by bank deposit and loan interest rates and market interest rates, the interest rate of project loans increases
	Micro risks	Market supply risk	Material supply risk	The supply of materials required for sand and gravel and asphalt raw materials in the construction of traffic engineering and project operation is insufficient and the supply is not timely

Project internal factors, risk	Other impact risks	Travel demand risk	Changes in urban population size, people's living standards and economic conditions have led to changes in the choice of travel modes
		Market competition risk	The scale of national highways continues to expand, and there are multiple roads in the same destination that can be passed, and the competition in the highway market has increased
		Path planning risk	The existence of cultural monuments around the planned path of the highway or the presence of a large number of residents makes it impossible to build the road
		Natural environmental risks	Adverse weather such as heavy rainfall, heavy snowfall, and mudslides and the surrounding natural environment led to highway construction
	Project construction risks	Project financing risks	The financing failure of the private party due to insufficient economic strength or unfeasible projects
		Project tender risk	The winning unit is not familiar with the status of highway implementation, and the potential construction risks caused by insufficient technical reserves
		Geological exploration risks	The geological survey in the early stage of highway construction is not in place, and the geological data required for road construction is inaccurate
		Engineering construction risks	Engineering management risks, engineering quality risks, engineering technology risks, etc. during the construction of highways
		Construction safety risks	Safety problems caused by lax management of problems such as staff wearing work clothes, wearing safety helmets, and whether the use of equipment is standardized
	Project operational risk	Operational management risk	Expressways cannot meet the basic conditions required for operation, and the management mechanism for highway operation is backward and the technology is immature
		Operations and maintenance risks	The maintenance and maintenance of the highway is not in place, resulting in serious damage to the road and impassability

	Project handover risk	Project handover risk	The highway was overused, improperly maintained during operation, and did not meet the conditions for handover

4 Theoretical logical framework and risk analysis of the PPP project

4.1 Project Overview

G3018 Jinghe to Alashankou project is the liaison line of Lianhuo Expressway G30 in China's expressway network. The construction of the G3018 Jinghe to Alashankou project is to respond to the development of the national "Silk Road Economic Belt" and the traffic volume forecast of the road section to meet the construction requirements. The G3018 Jinghe to Alashankou project adopts the standard of a four-lane expressway and four-lane first-class highway with a 100km/h design speed.

4.2 Project risk framework

4.2.1 Project PPP model transaction structure

The local government investment enterprise designates the project and co-funded to establish the project company, the local finance bureau pays the corresponding fees to the project company, the project company lends to the financial institution, the local transportation bureau grants the concession to the project company, the project company undertakes the project financing, construction and operation services, due to the public welfare characteristics of the highway, the highway provides services to the public at the same time, the public can supervise and feedback the project operation through the use of the project, after the end of the concession period of the project, The project company handed over the project to the local government, and the PPP mode transaction structure of the G3018 Jinghe to Alashankou project also reflects the COSO as mentioned above management theory, which requires the consistency of management objectives and strategic performance. See Figure 3 for details.

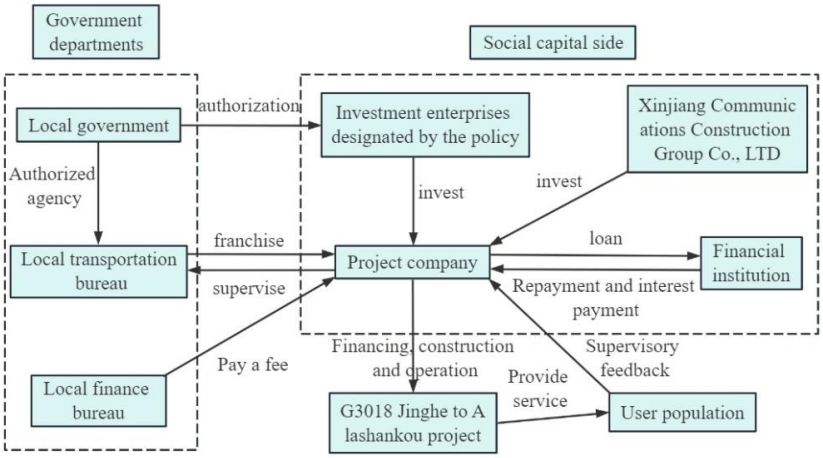

Fig. 3. G3018 Jinghe to Alashankou project PPP mode transaction structure diagram

4.2.2 Basic framework for risk allocation

According to the three risk allocation principles of optimal risk allocation, benefit and risk reciprocity, and risk tolerance, the characteristics of government departments and private parties, and the risk list of PPP projects summarized in Chapter 2, the fundamental risk allocation framework of government departments and private parties are divided, as shown in Table 2.

Table 2. The basic framework of risk allocation between government departments and private parties

Risk classification				Allocation of responsibilities		
First-level classification	Secondary classification	Tertiary classification	Four-level classification	Government departments	Social capital	common
Project external factors, risk	Macro risk	Regulatory and regulatory risks	Regulatory and regulatory risks	√		
		National policy risks	Industry policy risks	√		
			Fiscal and tax policy risks	√		
		Economic condition risk	Inflation risk			√
			Currency interest rate risk			√
	Micro risks	Market supply risk	Material supply risk		√	
			Travel demand risk			√
			Market competition risk			√
		Other impact risks	Path planning risk		√	
			Natural environmental risks			√
Project internal factors, risk		Project construction risks	Project financing risks		√	
			Project tender risk		√	
			Geological exploration risks		√	
			Engineering construction risks		√	

		Construction safety risks	√
	Project operational risk	Operational management risk	√
		Operations and maintenance risks	√
	Project handover risk	Project handover risk	√

5 Theoretical logical framework and risk analysis of the PPP project

This paper uses analytic hierarchy to analyze the weight of risk factors to construct the risk influencing factor level.

5.1 Build a risk hierarchy.

Combined with the analysis mentioned above, the definition process, according to the risk category of a typical case, the tree structure diagram required for the analysis hierarchy is established. 142 professionals were invited from inside and outside the enterprise to conduct questionnaire surveys. These professionals include managers in the highway construction industry, staff of construction units, and operation and maintenance personnel of highways after they are put into use. The number of effective questionnaires reached 92.35%, and the relative importance of all risk identification objects was compared and assigned, forming a weight assignment link requirement.

5.2 Risk level weights

The weights of each risk are calculated, and the calculation results are obtained, as shown in Table 3. Among them, the top three risks are approval process risk and contract conflict risk with a weight of 0.1383, charging standard risk with a weight of 0.1316, and the lowest risk is construction safety risk with a weight of 0.004. Combined with this project, it shows that the risks of highway PPP projects are mainly based on external factors, and in the future, it will mainly enhance the confidence of social investors and improve the support of toll collection and contract policies.

Table 3. Risk weight coefficients

First-level classification	Secondary classification	Weight coefficient	Tertiary classification	Weight coefficient
Project external factors, risk	Legal policy risks	0.1121	Regulatory and regulatory risks	0.0961
			Fiscal and tax policy risks	0.0160
	Market supply risk	0.1579	Minimum demand risk	0.0263
			Fee standard risk	0.1316
	Approval	0.2766	Risk of late approval	0.1383

	process risk		Risk of contract conflicts	0.1383
	Risk of force majeure	0.0224	Natural environmental risks	0.0149
			Unexpected event risk	0.0075
	Project construction risks	0.1121	Project design risks	0.0080
			Project financing risks	0.0510
			Project budget risk	0.0111
			Project management risk	0.0047
			Engineering quality risks	0.0162
			Project schedule risk	0.0088
			Construction technical risks	0.0080
			Construction safety risks	0.004
Project internal factors, risk	Project operational risk	0.1680	Operations and maintenance risks	0.0519
			Risk of changes in traffic volume	0.0519
			Social capital exit risk	0.0544
			Risk of excess benefit returns	0.0099
	Project handover risk	0.1508	Project data handover risk	0.0377
			Equipment technology handover risk	0.0377
			Risk of Transfer of Liability for Defects	0.0754

5.3 Breakdown of risk indicators

Combined with the various analyses in Table 3, the risk indicators are divided according to the weight coefficients. In the secondary risk classification, risks with a weight coefficient between 0-0.1 are defined as general risks, risks with a weight coefficient between 0.1-0.15 are defined as more severe risks, and risks with a weight coefficient of 0.15 or more are classified as severe risks; in the tertiary risk classification, risks with a weight coefficient between 0-0.025 are designated as general risks, risks with a weight coefficient between 0.025-0.05 are defined as more severe risks, and risks with a weight coefficient of 0.05 or more are defined as severe risks, as shown in Table 4.

Table 4. Level 2/3 risk grading

Risk category	General risks	More serious risks	Serious risks
Secondary risk	Risk of force majeure	Legal policy risks, project construction risks	Market supply risk, approval process risk, project operation risk, project handover risk

Tertiary risk	Fiscal and taxation policy risk, natural environment risk, accident risk, project design risk, project budget risk, project management risk, project quality risk, project progress risk, construction technology risk, construction safety risk, excess benefit return risk	Minimum demand risk, project data transfer risk, equipment technology transfer risk	Risks of laws and regulations, charging standards, delays in approval, contract conflicts, project financing, operation and maintenance, traffic volume changes, social capital withdrawals, and defect liability transfers

6 Conclusion

The PPP model is significant in promoting highway construction development as a financing model. China's highway PPP projects in the new era have the unique characteristics of solid government and high-quality development orientation. They must not simply copy the contract model of Western countries. However, they should continue to explore efficient risk identification at the practical level and accelerate the construction of a risk theoretical framework and risk exploration of PPP projects that conform to the implementation of typical cases and characteristics. Given this, the main conclusions of this study are as follows:

First, with highway construction and development as the core and "mechanism, elements and dimensions" as the support, build a risk theory logical framework for PPP projects that conforms to the characteristics of highway development in the new era.

Second, combined with the theoretical logical framework, the typical cases in the western region are analyzed, represented by the actual development of the region, and social investors pay more attention to the project's environmental risks, such as the risk of the approval process. With the deepening of operations, private investors consider the risk of traffic volume changes, social capital withdrawal, and defect liability transfer risk.

However, the advantages of China's PPP model have been continuously improved in the process of exploration[29], which not only includes the behavior of central and local governments, strengthens the participation of social investors, and carries out corresponding institutional design in combination with the organizational behavior of social investors, which should also be an essential research direction for highway PPP project policies in the future.

Acknowledgments. This study was supported by Xinjiang Key R&D Program Projects (grant numbers 2022B03033-1); Xinjiang Uygur Autonomous Region "Dr. Tianchi" Project; Xinjiang Transportation Department planned project "Research on Risk and Prevention in the Implementation Process of PPP Projects in Xinjiang Transportation Construction Enterprises" (2022-ZD-011).

References

[1] Ma D.(2019)Basic Experience in and Future Prospect of Transportation Infrastructure Investment and Financing.Macroeconomic management,08:39-44.

[2] Yu H, An R. (2019)Correction of ppp Project Alienation as a Local Financing Platform and Lega Countermeasures.Yellow River,41(02):161-162.

[3] Ke H, Wang M, Du Y.(2018) Text Analysis of Public-Private Partnership Policies from the Perspe ctive of Policy Tool: Based on PPP National Policy during 2014-2017.Journal of Information,37(11): 81-88.

[4] Wu J,Cheng Jg,Qin To,Jiang Xl. (2019)Research on Financial Support Mode in the Construction o f National Reserve Forest Taking Fujian Nan ping PPP National Reserve Forest Project as an Exampl e. Forestry Economics,41(05):83-88.

[5] L.U. P.(2020)Management and Control Analysis of Large-scale Infrastructure Enterprises Investm ent Business.Construction economics,41(S2):33-35.

[6] SHU W, ZUO R, CHEN Y.(2018)New Development and Enlightenment of the COSO Risk Mana gement Framework.Journal of Xi'an Institute of Finance & Economics,31(05):41-47.

[7] Cheng Q, Gu X.(2015)A Research on the Risk Prevention of the Knowledge Chain During the Kn owledge Transforming Based on the Risk Management of COSO.Researches in Library Science,05:4 5-48+34.

[8] Government Work Report.(2015) Annotation to the acronym of the Government Work Report .htt ps://www.gov.cn/xinwen/2015-03/11/content_2832629.htm.

[9] State Council. (2022)Notice of the State Council on issuing the 14th Five-Year Plan for the Devel opment of a Modern Integrated Transportation System.http://www.gov.cn/zhengce/content/2022-01/1 8/content_5669049.htm.

[10] National Development and Reform Commission, Ministry of Transport. Notice of the Ministry o f Transport of the National Development and Reform Commission on the issuance of the National Hi ghway Network Plan[EB/OL].http://www.gov.cn/zhengce/zhengceku/2022-07/12/content_5700633.h tm.

[11] Xia X, Tang L, Yuan J, Zuo J, et al.(2022)Exploring social impacts of urban rail transit PPP proj ects: Towards dynamic social change from the stakeholder perspective: environmental Impact Assess ment Review,93:112-134.

[12] Nur S, Burton B, Bergmann A.(2023)Evidence on optimal risk allocation models for Indonesian geothermal projects under PPP contracts.Utilities Policy,81:42-57.

[13] Deborah D, Zhu D, Quayson M, et al. (2023)A multicriteria decision framework for the governa nce of PPP projects towards sustainable development.Socio-Economic Planning Sciences,87:22-34.

[14] Anbil S, Carlson M, Styczynski M.F.(2023)The effect of the Federal Reserve's lending facility o n PPP lending by commercial banks.Journal of Financial Intermediation,55:11-34.

[15] XU H, XU X.B, AN Y.F.(2021)Total Factor Productivity Measurement and Improvement Path o f State-owned Toll Road Enterprises.China Journal of Highway and Transport,34(03):216-224.

[16] M.A. S.H, WANG Y.Q, YUE M, CHEN X.F, YANG T.(2022)Theoretical Study and Practical E xploration of Modernization of Expressway Construction Management.Highway traffic technology,39 (12):239-246.

[17] LI R.M, WANG C.J. (2022) Developing advanced traffic management systems.Journal of Tsing hua University (Natural Science Edition),62(03):509-515.DOI:10.16511/j.cnki.qhdxxb.2021.26.023.

[18] REN Q, XUE XJ, WANG Z, et al. Research on investment prediction of highway construction pr ojects based on data mining.Highway,2022,67(05):220-223.

[19] Ding JW, Wang JC.(2023) Research on the Influencing Factors and Decision-Making Mechanism of PPP Project Supervision. Modern Economic Discussion,06:51-59.
[20] JIN L.F. P(2022)Practice and Suggestion of Investment and Financing Management of Railway PPP Project: Take Hangzhou-Shaoxing-Taizhou Railway as an Example.Construction economics,43(06):48-55.
[21] WANG L,WANG D,WANG XG. (2021)Subsidizing and pricing PPP transportation projects based on two-period quality. Journal of Industrial Engineering and Engineering Management,35(05):173-183.
[22] Wang H.Q, Li S.R, Zhang Yi.J.(2019)Study on the Difference of Maturity of PPP Development Environment in China, Journal of Industrial Engineering and Engineering Management,39(06):69-74.
[23] Tan YY, Zou MQ, Zhang YY.(2019)The Identification of Government Debt Risks in PPP Projects.Fiscal research,2019(10):47-57.DOI:10.19477/j.cnki.11-1077/f.2019.10.005.
[24] GUO JY, TANG ML, JING ZZ, et al.(2016) Identification and Survey Research on Social Risk Factors of Traffic PPP Project.Journal of Civil Engineering and Management,33(06):88-93.DOI:10.13579/j.cnki.2095-0985.2016.06.017.
[25] Zou MQ.(2018)Research on identifying and quantifying risk factors of PPP projects based on the perspective of private capital.Learning Forum,34(01):65-70.DOI:10.16133/j.cnki.xxlt.2018.01.013.
[26] SUO WL, ZHANG J.(2022)Study on Identification of Financing Risks for Transport Infrastructure Construction under a Pluralistic Integrated Mode.Chinese Management Science,30(10):25-34.DOI:10.16381/j.cnki.issn1003-207x.2020.1207.
[27] LIU XT, CHAI J, DONG JC.(2018)Risk and Subsidy Analysis of Transportation Infrastructure Based on PPP in Shaanxi Province[J].Science and technology for development,14(06):473-481.
[28] Chen C, Li D.(2017)Policy Change and Policy Learning in China's Public-Private Partnership: Content Analysis of PPP Policies between 1980 and 2015[J]. China Administration,(2):102-107.
[29] Shen Q, Huang XM, Bian FL..(2009)Study on Debt Warning System of Toll Highways Based on Loan Repayment.Highway traffic technology,2009,26(06):138-141+146.