Construction and Evaluation of Risk Index System for Intelligent Transportation System Development Project

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Abstract. This article defines and analysis the risks of intelligent transportation systems that are different from the traditional IT project development process, it combines the types of risks in the development process of traditional IT projects, and forms a two-tier risk index evaluation system suitable for intelligent transportation system development projects. The analytic hierarchy process calculates the weights of the risk indicators at each level, and then sorts and groups all the risk indicators based on the Pareto analysis, and propose different coping strategies for different grades of potential risks. And put forward specific countermeasures based on the impact of risks, so as to provide a basis for decision-making for risk identification and prevention of intelligent transportation system development projects.

Keywords: Intelligent transportation system · Risk identification · Analytic hierarchy process · Coping strategy

1 Introduction

The transportation system plays an irreplaceable role in the normal operation of the city. In order to improve its efficiency and performance, traffic information technology has been increasingly used in transportation. The development and construction of intelligent transportation systems is an important development Status, the development process of the intelligent transportation system will face a series of possible risks. In order to better prevent the risks, how to more accurately identify and evaluate these risks becomes crucial.

Relevant scholars have also done a lot of research on project risk management. Chen Xinming and others reviewed the risk identification and evaluation monitoring process in the IT project management process, and summarized its external, cost, schedule, technical and operational risks [1]. Feng Nan and others built an IT project risk evaluation system and a comprehensive evaluation model, and used neural networks for verification analysis [2]. Yang Shanlin et al. used the theory of evidence to solve the problem of uncertainty in the risk, simplified the risk factors and evaluated their levels with expert

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methods, and proposed corresponding preventive measures [3]. Chen Tao et al. Proposed a real option risk assessment method based on fuzzy theory, and combined with relevant examples for application analysis [4]. Yuan Quan and others constructed a risk assessment model based on fuzzy comprehensive evaluation, and based on the risk assessment, established an optimal risk control model combined with an example for verification [5]. Based on the development status and trends of IT project risk management in the 21st century, Wang Lin and others analyzed the risk identification and management of IT projects [6]. Liang Changyong et al. Carried out a comprehensive risk assessment of IT systems by constructing a risk hierarchy system and corresponding to multiple evaluation indicators, and applied the examples [7]. Wang Yuchen et al. Divided the life cycle of IT projects into multiple stages, identified project risks in different stages, and verified them with application examples [8]. Chen Jianbin and others analyzed successful IT projects and used a questionnaire survey to study the importance of risks based on the initial determination of risk categories [9]. The above research mainly focuses on the analysis and evaluation of the risks of the development process of traditional IT projects, and there is less research on the risks of intelligent transportation system development in emerging fields.

This article focuses on the characteristics of intelligent transportation systems that are different from traditional IT projects, and combines the risk types of traditional IT projects to define and classify the risks of intelligent transportation system development projects. Risks are graded, and coping strategies and measures are proposed to provide decision-making basis for intelligent transportation system risk prevention.

2 Risk Characteristics of Intelligent Transportation System Development Projects

The intelligent transportation system development project refers to the transfer of knowledge in the fields of information technology, electronics, and control theory to the transportation system. The three elements of transportation, vehicles, and roads are harmoniously and closely coordinated to better serve transportation. The system's administrators and users make it easier for users to enjoy fast, convenient and safe transportation services, so that managers can better manage the transportation system from the perspective of social impact, and thus build a Safe, environmentally friendly, highly efficient transportation system.

Project risk refers to some uncertain events that occur during the process of project management, and the occurrence of types of events will adversely affect the project. This reflects the two aspects of risk occurrence and degree of impact. Therefore, risks Analyzing may be encountered in the project management process, it is necessary to carry out analysis and comprehensive consideration at the same time, in order to finally have a reasonable evaluation of the priority and priority of risks.

Intelligent transportation system development projects belong to the scale of IT projects, but it is different from traditional IT project development. Similarly, any intelligent transportation system development project has some unavoidable risks in the process of implementation. Similarly, the risks in the development process of its projects have their own characteristics compared with traditional IT projects: (1) Intelligent transportation system includes different development projects, although it can be summarized as a whole. (2) The preliminary work of the intelligent transportation system development project is very important. The risks have a high probability of occurrence and a large degree of influence; (3) The risks are overcome and some risks have a large degree of impact in the development of intelligent transportation system projects, generally adopting more economical risk prevention measures can greatly reduce the risks of the project. Good control; (4) Due to the continuous theoretical demonstration process and the long time to solve the problem in the early stage of the intelligent transportation system development project, the early stage risk accounts for a higher proportion of all risks. Through the implementation of the project, the probability of subsequent risks is relatively small.

3 Establishing a Risk Evaluation Index System for Intelligent Transportation System Development Projects

The premise of risk evaluation is to accurately identify the risks, and then to conduct a single analysis of the possibility and impact of different risks based on some foundations, as well as weight analysis and classification of all risk indicator systems, so as to propose targeted Coping strategies and measures to ensure the stable operation of intelligent transportation project development.

According to the statistical data of related IT projects [10], the main risks in the IT project development process are concentrated in three major areas: project scope, project progress, and project resources. This article draws on the results of its analysis of project risks in the project development process, from intelligent transportation Based on the actual situation of the system development project, and using the risk identification methods such as the expert review meeting method determined by the project, the risks of the intelligent transportation system development project are divided into five major parts: environmental risk, decision risk, management risk, technical risk, and personnel risk. The specific risk identification list is shown in Fig. 1.

4 Risk Evaluation of Intelligent Transportation System Development Project Based on Analytic Hierarchy Process

Based on the construction of the foregoing risk evaluation index system, it is a qualitative division and identification of risks. However, if further evaluation of the importance of risk indicators is required, quantitative evaluation of sub-insurance must be performed. The analytic hierarchy process is an efficient and practical method. The comprehensive evaluation method that converts qualitative analysis to quantitative analysis has strong systematic and has strong adaptability to the aforementioned multi-layered risk evaluation index system. Therefore, it is based on the analytic hierarchy process to choose intelligent transportation systems, and comprehensive evaluation of development project risks.

Firstly, based on the above-mentioned intelligent transportation system risk evaluation index system, based on the theory of analytic hierarchy process, a hierarchical

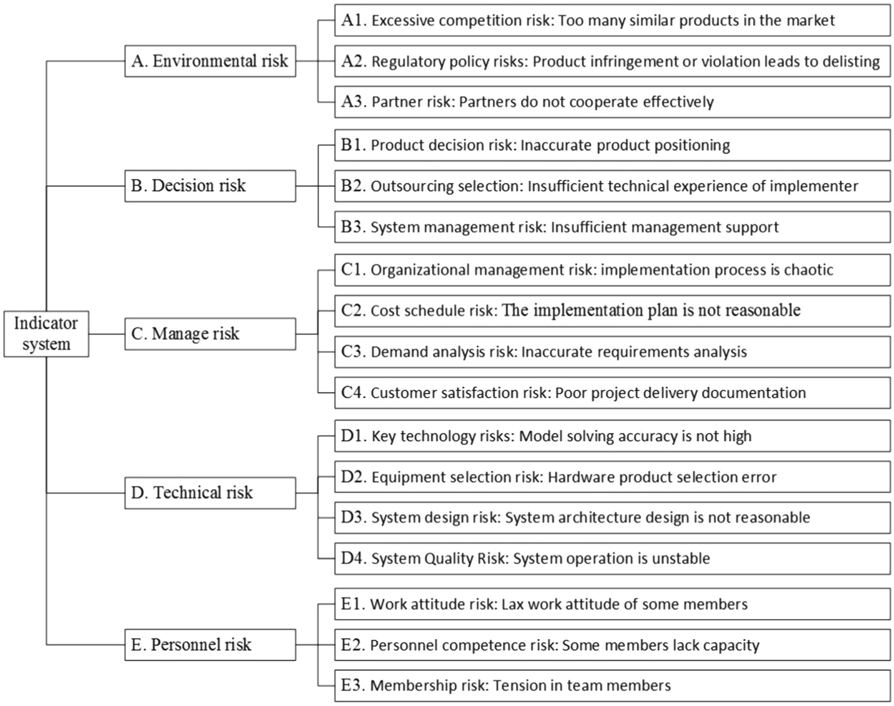

Fig. 1. Risk evaluation index system

structure is established by applying a tree structure. The first level of risk indicators is five, namely environmental risk, decision risk, management risk, and technical risk. Primary risks are recorded as A, B, C, D, E, the second level is A1, A2, A3, B1, B2, B3, C1, C2, C3, C4, D1, D2, D3, D4, E1, E2, E3, total 17 secondary indicators.

According to the risk evaluation indicator layer model, the weights of all the first-level indicators and the second-level indicators are then weighted to determine the relative severity of each risk, so that countermeasures can be proposed in a targeted manner. Based on the principle of analytic hierarchy process, the 9-scale principle of Table 1 is applied, and the comparison matrix between the first-level index and the second-level index is constructed by the expert consultation method. See Tables 2, 3, 4, 5, 6 and 7 for details.

On the basis of the above comparison matrix, the relevant parameters of the comparison matrix and the weights of each index are obtained by programming calculations using MATLAB software. The specific calculation results of the first-level index comparison matrix are as follows:

The maximum eigenvalue is 5.1127, and the corresponding normalized eigenvectors $U = [0.4219, 0.1524, 0.0601, 0.2836, 0.0821]^T$, $CI = 0.0282$, $CR = 2.7841e\text{-}05$, $CR < 0.1$. It shows that the comparison matrix constructed meets the requirements of consistency check, that is, the degree of inconsistency of the comparison matrix is within the

Table 1. 9-scale of comparison matrix values

Relative relationship	Scaling
Equally important	1
More important	3
important	5
Very important	7
Incredibly important	9
Median	2, 4, 6, 8

Table 2. Comparison matrix of primary risk

	A	B	C	D	E
A	1	3	5	2	5
B	1/3	1	3	1/2	2
C	1/5	1/3	1	1/4	1/2
D	1/2	2	4	1	5
E	1/5	1/2	2	1/5	1

Table 3. Comparison matrix of A secondary risk

	A1	A2	A3
A1	1	1/3	2
A2	3	1	5
A3	1/2	1/5	1

Table 4. Comparison matrix of B secondary risk

	B1	B2	B3
B1	1	4	6
B2	1/4	1	3
B3	1/6	1/3	1

allowable range, and its feature vector can be used as the weight vector, otherwise the comparison matrix does not meet the requirements and needs to be adjusted.

Table 5. Comparison matrix of C secondary risk

	C1	C2	C3	C4
C1	1	2	1/4	1/2
C2	1/2	1	1/3	1/2
C3	4	3	1	3
C4	2	2	1/3	1

Table 6. Comparison matrix of D secondary risk

	D1	D2	D3	D4
D1	1	8	6	5
D2	1/8	1	1/4	1/5
D3	1/6	4	1	1/2
D4	1/5	5	2	1

Table 7. Comparison matrix of E secondary risk

	E1	E2	E3
E1	1	1/3	1/2
E2	3	1	2
E3	2	1/2	1

In the same way, the weight set of the secondary index is: A = $[0.2297, 0.6483, 0.1220]^T$; B = $[0.6910, 0.2176, 0.0914]^T$; C = $[0.1494, 0.1141, 0.5136, 0.2229]^T$; D = $[0.6423, 0.0466, 0.1216, 0.1895]^T$; E = $[0.1634, 0.5396, 0.2970]^T$.

Finally, the weights corresponding to the first-level indicators are multiplied with the corresponding second-level indicators, and the final comparable weights of all the second-level risk indicators are shown in Table 8.

Table 8. Final weights of secondary risk indicators

index	A1	A2	A3	B1	B2	B3	C1	C2
Weights	0.097	0.274	0.051	0.105	0.033	0.014	0.009	0.007
index	C3	C4	D1	D3	D4	E1	E2	E3
Weights	0.031	0.013	0.182	0.034	0.054	0.013	0.044	0.024

5 Formulating Risk Response Strategies Based on Pareto Classification

Based on the weights of all risk evaluation indicators, sort all risk indicator weights from large to small and calculate their cumulative percentage. Use the Pareto classification method to classify all risk indicators into three levels: I, II, and III. Type I sub-insurance is the risk with a cumulative percentage of less than 80%, which occupies the most important position. Type II risk is a risk between the cumulative percentage of 80% to 95%, and the rest are type III risks. The classification results are shown in Table 9.

From the above classification results, it can be seen that Class I risks, which are also the most important risks, are mainly concentrated on environmental risks and technical risks, which involve decision-making risks and personnel risks. Type II risks are mainly concentrated on decision-making risks, which involve personnel and management risks. III The type of risk mainly focuses on managing risks, and these results have a good agreement with the actual development of the project.

The focus of project risk management should not be to solve the problems caused by risks after they occur, but to adopt a proactive preventive strategy based on risk identification and quantitative evaluation before project execution. Therefore, it is possible to prevent risks in advance with a smaller cost, thereby replacing the larger losses caused by the passive response after the risks occur.

Table 9. Risk evaluation index level table

Risk code	Weights	Cumulative percentage	Risk level
A2	0.274	27.35%	I
D1	0.182	45.57%	
B1	0.105	56.10%	
A1	0.097	65.79%	
D4	0.054	71.16%	
A3	0.051	76.31%	
E2	0.044	80.74%	
D3	0.034	84.19%	II
B2	0.033	87.51%	
C3	0.031	90.59%	
E3	0.024	93.03%	
B3	0.014	94.42%	
E1	0.013	95.77%	
C4	0.013	97.10%	III
D2	0.013	98.43%	
C1	0.009	99.32%	

Active risk prevention mainly includes the following four countermeasures: (1) Avoiding risks: Avoiding or solving risks; (2) Transferring risks: Transferring risks to third parties; (3) Mitigating risks: Reducing the probability or impact of risks; (4) Accept risk: apply this strategy only when the above three strategies cannot be applied, but do not do nothing in advance, but formulate a certain plan for the risk, and can react as soon as the risk appear.

For the types of risks of intelligent transportation system development projects, due to their different degrees of importance, the response strategies adopted will also focus on: (1) Type I risks have a decisive impact on the success or failure of the project, so it is necessary to take the initiative before the risks occur Strategies focus on prevention and control, and actions that cannot be prevented can be transferred. (2) Category II risks are all internal risks of the project, and they also have a high degree of importance. Similarly, risks should be avoided as much as possible, and mitigation strategies can also be adopted in consideration of costs. (3) Category III risks are mainly management risks, which are relatively less important, and risk retention strategies can be prioritized.

After proposing corresponding countermeasures for different types of risks, it is also necessary to propose corresponding countermeasures for secondary risks to more accurately prevent the risks of project development in advance. The specific countermeasures for each risk are shown in Table 10.

Table 10. A Risk Response Measures for Intelligent Transportation System Projects

Risk level	Risk Name	Risk strategy	Risk explanation	Responses
I	Excessive competition risk	avoid	Too many similar products in the market	Legal advice in advance to avoid conflicts of law
	Regulatory policy risks	Mitigate	Product infringement or violation leads to delisting	Preliminary audit verification
	Partner risk	avoid	Partners do not cooperate effectively	Strengthen leadership communication and guide correct decisions
	Product decision risk	avoid	Inaccurate product positioning	Modify in a timely manner and fully evaluate the entire project
	Outsourcing selection risk	Mitigate	Insufficient technical experience of the system implementer	Develop standard inspection system functions and test

(*continued*)

Table 10. (*continued*)

Risk level	Risk Name	Risk strategy	Risk explanation	Responses
	System management risk	Transfer	Insufficient management support	Negotiate with partners
	Organizational management risk	Mitigate	Project implementation process is chaotic	Advance training or recruitment of competent personnel
II	Cost schedule risk	avoid	The implementation plan is not reasonable	Provide a complete plan and evaluate according to requirements
	Demand analysis risk	Transfer	Inaccurate requirements analysis	Learn more about the qualifications and experience of each supplier
	Customer satisfaction risk	Mitigate	Poor project delivery documentation	Communicate and identify requirements with written confirmation
	Key technology risks	Mitigate	Model solving accuracy is not high	Correct in time to improve team collaboration
	Equipment selection risk	Mitigate	Hardware product selection error	Strengthen leadership communication for maximum support
	System design risk	Mitigate	System architecture design is not reasonable	Control key personnel on time
III	System Quality Risk	avoid	System operation is unstable	Specification delivery documents
	Work attitude risk	Mitigate	Lax work attitude of some members	Detailed comparison of customized metrics
	Personnel competence risk	accept	Some members lack capacity	Formulate sound management rules and regulations
	Membership risk	accept	Tension in team members	Timely correction

6 Conclusion

This article analyzes the characteristics of intelligent transportation system development projects and combines the risk research basis of traditional IT projects to build a set of risk indicator systems suitable for intelligent transportation system development projects, and calculates the weights of risks based on the analytic hierarchy process. Ranking From the ranking results of various risk indicators, it can be seen that environmental, decision-making, and technical risks play a major role in risk management. The impact of management and personnel risks on the project is small, which is in line with the actual situation of project development process management. It also implements classified management of project risks based on risk identification and classification, and proposes targeted strategies and measures to improve the risk prevention effect of intelligent transportation system.

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References

1. Chen Xinming, "Wen Ning. Research on Risk in IT Project Management (Periodical style)," China Collective Economy, 2008 (16): 81–82.
2. Feng Nan, Li Minqiang, Kou Jizhen, et al. "IT Project Risk Assessment Model Based on ANN (Periodical style),"Computer Engineering and Applications, 2006, 042 (006): 24–26.
3. Yang Shanlin, Lu Wenxing, Liang Changyong. "Evaluation method of IT project risk factors based on evidence theory (Periodical style)," Journal of Hefei University of Technology: Natural Science Edition, 2006 (12): 7–10.
4. Chen Tao, Zhang Jinlong, Liu Shan. "Comprehensive Evaluation Method for Risk and Value of IT Projects Based on Real Options under Uncertainty (Periodical style)," Systems Engineering Theory and Practice, 2009 (02): 32–39.
5. Yuan Quan, Long Ziquan. "Research on Project Risk Assessment and Its Optimization (Periodical style)," Theory Monthly, 2010, 000 (001): 103–106.
6. Wang Lin. "Analysis of IT Project Risk Management (Periodical style)," Modern Business Industry, 2009, 21 (22): 40–41.
7. Liang Changyong, Chen Long, Yang Shanlin. "Evaluation of Risk of Enterprise IT System Integration Based on Fuzzy Comprehensive Evaluation (Periodical style)," Value Engineering, 2006, 025 (004): 78–81.
8. Wang Yuchen, Zhang Jinlong, Lu Xinyuan, et al. "Research on Risk Identification of IT Projects under the Whole Life Cycle (Periodical style)," Chinese Journal of Management, 2005 (S2): 5–9.
9. Chen Jianbin, Wu Gang, Lu Mei, et al. "Empirical analysis of key success factors for IT project risk management (Periodical style)," Anhui Agricultural Sciences, 2010 (03): 424–426.
10. Tom Kendrick, "Identifying and Managing Project Risk: Essential Tools for Failure-Proofing Your Project (Book style)" AMACOM, 2003