Risk Assessment and Control Strategies in Construction Project Management under the Wave of New Quality Productive Forces

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Abstract: The logic of development in the construction industry is being changed by technological innovation with the rise and evolution of "new quality productive forces". They help the industry improve resource efficiency such as overcoming resource constraints to meet the "dual carbon" goals, thus driving project efficiency and becoming a key engine for high-quality development of construction projects. Nevertheless, the new features of office productive forces and mode reconstruction provide a broader space for improvement of construction project management with challenges. This article will specifically explain risk assessment and control strategies in the management of construction projects under the tide of new quality productive forces, so that construction projects can be implemented smoothly, which is also one of the specific requirements to promote the high-quality development of the construction industry in a new era.

1. Introduction

At present, new quality productive forces driven by technological innovation are improving the construction project management modes. The implementations of some technologies such as BIM full-process applications are helping the construction industry to transform intelligently and leanly, and the opportunities for improving project efficiency have been provided. Transformations also bring about certain risks that slow down the progress of industries. But in this stage, analysing the new risk characteristics in construction projects under the emerging quality productive forces and the corresponding measures to analyse and control risks have very important practical significance.

2. Risk Assessment Methods in Construction Project Management

Risk assessment is one of the most important phases in risk management in construction project management which identifies the likelihood of a risk happening and the consequences if they do happen. This involves choosing suitable evaluation methods based on the complexity of the technology and the size of the project. In terms of practical applications, the mainstream risk assessment methods can be divided into qualitative assessment, quantitative assessment and comprehensive assessment. These methods have different roles in risk management and must be adapted to the technological evolutions of new quality productive forces.

2.1 Qualitative Assessment Methods

Qualitative assessment: This type of methodology is based on experience summary and subjective judgment while taking into account risk classification to guide risk management. They are best for the early stage of projects. Two common methods are as follows:

Risk Matrix Method: This method combines the probability and degree of risk impact from a two-dimensional perspective to obtain the risk order of priority between various project risks. For a practical use case, it first involves setting up an assessment team of supervisors, technical experts, etc. Hazard assessment therefore includes things like material shortages — a concern based on historical cases and construction plans. After that, you give each risk a rank from 1 to 5 based on its likelihood and impact. Finally, you risk level is based according to probability * impact, and countermeasures are prioritized for high risk items.

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Delphi Method: The delphi is for reducing inherent biases, moreover with the help of anonymised questions and rounds of inquiry, it could be used in conditions where there are complex risk factors involved. The specific process is to select approximately 10 industry experts from various fields such as supply chain and law. They are sent anonymous questionnaires — a list of risks that these experts might give them. These experts are asked to provide information about the probability and impact of risk. Following this, the first-round outcomes are synthesised and statistical feedback is given to the experts which enables them to amend their judgments based on group views. Consensual risk thresholds are set when experts find agreement. When for instance, evaluating on the quality level of pass or fail for a specific type of green building material with respect to standards, several iterations of feedback can be undertaken in order to quantify the quality risk probabilities or likelihoods and how they compare across different brands of green building materials.

2.2 Quantitative Assessment Methods

Quantitative assessment techniques are established on numerical computations and data modelling They express quality, schedule etc. vs the impact of costs, so they provide basis for reference between risk and are adapted to big and complex projects. At a very high level, there are two ways:

Monte Carlo Simulation Method: this method uses a large number of simulations and random sampling to calculate risk probabilities and distributions; as such, it is recommended for use in cases where there are many simultaneous risks. For running it in real life, you will need professional software. The first step is to identify risk factors and their distributions from historical data. Second step is to specify number of simulations. At every simulation, random values were drawn for each variable and project cost was computed. The third step is to analyze the simulation results statistically, and then let the result to obtain the probability of cost overruns, thus providing data support for risk response.

Sensitivity Analysis: The sensitivity analysis method is applied in risk management to identify key factors. The steps are as follows: Step 1 → Be clear on the main project goals. After that, choose variables that can influence the undertakings and fortify different components. When a single factor is altered, compute the variation range of the objectives. Finally, the sensitivity coefficient is determined by the factor variation range divided by the objective variation range. Higher sensitivity coefficients imply that the factor necessitates increased effect on objectives.

2.3 Comprehensive Assessment Methods

Comprehensive assessment methods combines the merits of both qualitative and quantitative methods, mainly applicable for projects with potential risks under new quality productive forces. The most commonly used representatives are Analytic Hierarchy Process (AHP). Its application logic is based on the idea of breaking down complex risk problems into a tree structure with multiple layers, using rational comparisons to ascribe weights and then using factors to rank risks quantitatively [1]. The procedures for this are: Working with the aim layer, criterion layer and plan layer accordingly, Second, ask experts to compare each factor at the same level with others and establish the judgment matrix using the "1-9 scale method", which is a commonly used method for constructing decision matrices and is effective in testing consistency. Third, count each factor by weight. First, quantify the parts of the risk evaluated based on quantitative data and compute value at treatment for the complete risk in order to access its contribution level. In a digital twin project, AHP can be used to perform qualitative judgments on data security risks while also performing quantitative calculations on equipment cost overruns without the limitation of just using one method.

3. Risk Control Strategies in Construction Project Management under the Wave of New Quality Productive Forces

3.1 Strengthen Risk Prevention and Control Awareness

Innovation and technological changes of new quality productive forces have added new characteristics to risks in construction project. Professional technologies empower the application of intelligent equipment. Without a proper understanding of technology risks involved and familiarity with equipment performance, project delays can occur by managers. On the other hand, digital management you share and store enormous amount of data. Potential safety hazards are introduced in the project if some of the managers stick to traditional way of thinking. So enhancing the awareness of risk prevention and control is required:

The first step what enterprises should take is to strengthen publicity and education. It is possible to hold regular construction project case analysis meetings, invite industry experts to give interpretation on new risk characteristics formation, so that managers can realize the importance of risk prevention and control, change the idea of risking for progress.

In the second place, should integrate risk prevention and control awareness into daily management. This is oriented to instruct the Manager to make active identification of risks in the project preparation, construction, and acceptance phases. Such as managers should participate in technical training activities before the introduction of new intelligent construction technologies, fully understand the potential risk of technology application and also formulate suitable response plans.

Third, establish a risk prevention and control incentive mechanism. Performance evaluations should involve managers on their performance related to risk prevention and control. Reward identification and success in avoiding new risks not punishment for ownership of project loss from more risk illiteracy With this reward-and-punishment mechanism, managers are urged to improve their risk prevention and control awareness, and an atmosphere of always talking about risks and preventing risks is formed. In summary, new quality productive forces are injecting new vitality into the construction industry as it develops, and at the same time also bringing about both opportunities and risks. This is really only possible if the risk management awareness of managers can be continuously improved, so that we can fundamentally make sure construction projects are completed under good-quality development.

3.2 Improve the Risk Management System

The conventional fragmented methods of risk management are not well-suited to meeting the demands posed by new risks. Thus, the comprehensive risk management system can provide necessary guarantee for the smooth implementation of construction projects [2]. Three steps to identificationEstablish a Dynamic Risk Identification MechanismNo matter how well the existing quality productive forces are, the sources of risk in construction projects are becoming more and more diverse. Beyond conventional risks such as safety, cost and schedule, new disruptions have been introduced, including volatile availability of green building materials in the market. Enterprises should form a highly professional project risk mining team and use technical research, case reviews, data monitoring methods to achieve an end-to-end cover of the entire project life cycle. For instance, with the analysis of fault cases of similar intelligent projects during project preparation,the potential risks of collaborative operation between intelligent construction robots and traditional equipment can be predicted in advance. It has become very important to leverage the digital management platform perfectly, so that it can monitor all data pertaining to fluctuation of community prices in real time and capture risk of supply chain in a timely manner. Establish a Triage System for Clinical Risk Management: This is the central component that links to risk management. Assessments of new quality productive forces are not just quantitative, enterprises must use qualitative/quantitative analysis together. In this context one can bring in experts and specialist fields who have the track-record to qualitatively judge previously identified risks in terms of their likelihood of occurrence as well as impact if encountered. On the contrary, with big data technology, its advantages can be used to construct risk assessment models, calculate failure rates of

intelligent equipment accurately as well as losses caused by data leakage appropriately and scientifically classify risk levels [3]. Take, for example, risks related to network security in the digital management platform. Hackers can simulate attacks scenarios on the system and determine the maximum loss caused by the paralysis of the security system, which can provide data support for effective responses to your risk events. Strengthen risk response and monitoring mechanisms: Respond plans should be differentiated by nature of levels of risk. For high-level risks, backup equipment should be prepared in advance (for example, for core technology failures of intelligent equipment). For multi-supplier cooperation mechanism: for medium-level risk such as delays in green building material supply chain. For low-level risks like minor snag in digital platforms, a dedicated maintenance personnel should maintain the time adoption of repair.

3.3 Design Risk Transfer Schemes

In the wave of new quality productive forces, the construction industry is moving towards digitalization and intelligence, and projects face new risks such as data security leaks and failures in the application of green technologies. In such cases, relying solely on internal prevention and control cannot fully avoid losses. Scientifically designing risk transfer schemes can reasonably transfer some risks to third parties, making them an indispensable risk control measure in construction project management [4].Use Insurance Tools to Transfer New Technology Risks: This is the premise and foundation of risk transfer schemes. Under new quality productive forces, traditional engineering insurance cannot fully cover new risks such as those in digital systems. Enterprises need to selectively purchase special insurance products. For example, "comprehensive insurance for intelligent engineering equipment" can be purchased for high-cost intelligent equipment such as BIM technology platforms to cover repair or replacement costs caused by equipment failures. Before purchasing insurance, it is necessary to fully communicate with insurance companies to clarify the scope of insurance liability for new risks and avoid subsequent claim disputes [5].

Transfer Partner Risks through Contract Clauses: Construction projects involve multiple cooperation entities such as suppliers and construction subcontractors. Risk responsibilities of all parties should be clearly defined in contracts to improve the rationality of risk allocation. For example, when signing contracts with intelligent equipment suppliers, technical adaptation clauses can be added. If equipment compatibility issues lead to project delays, the supplier should bear the losses caused by the delay and equipment modification costs. For risks such as fluctuations in the green building material supply, "price adjustment and alternative supply clauses" can be set in contracts with suppliers. That is, when building material prices rise significantly, the supplier is responsible for coordinating alternative resources or bearing part of the additional costs.Transfer Technology Application Risks through Strategic Cooperation Models: For risks in the application of cutting-edge technologies such as green building technologies, enterprises can establish risk-sharing mechanisms with technology leading enterprises. For example, when using new prefabricated building technologies, a joint application agreement can be signed with technology research and development enterprises, stipulating that both parties jointly invest resources to support technology application. If technology application fails and causes project losses, the costs should be shared according to the agreed ratio.

3.4 Improve the Risk Network Information System

In the era of innovation and development of new quality productive forces, construction projects have typical dynamic characteristics. Manual risk management can no longer give even the most basic of high efficiency. Fully automated transparency of project risks throughout the process: A well-functioned risk network information system relying on artificial intelligence technology to building an end-to-end project full-process risk management platform is one of the essential approaches to improving project risk control capacity. Constructing a global data integration system. This is the basis for improving network risk information system. Enterprise Group should tear down information silos and adopt a unified data interface standards, in order to upgrade the information scattered in all links into a centralized management platform[6]. For instance, intelligent sensors

measure the real-time stress of structures and combine it with BIM model data so one can monitor the safety of building components holistically. A data cleaning and standardization mechanism needs to be established to achieve the consistency, authenticity, and credibility of the risk data accessed by the system so that data support can be provided for subsequent risk analysis.

An Intelligent Risk Early Warning Module: using an artificial intelligence algorithm, it automatically analyzes the integrated risk data from many aspects and can pre-warn risks into different levels by grading. New risk areas of new quality productive forces should be subject to a special close warning mechanism. More specifically, intelligent construction robots can use this data through the machine learning algorithm, submit forecasts of the types and times of possible faults to workers, and push maintenance reminders from time to time according to historical fault data [7]. Build a Cross-Agent and Cross-Departmental Collaborative Response Resolution: The risk network information system must be equipped with collaboration functions across entities and departments, so that it can help achieve efficient linkage in risk disposal. The system should create a process of graded response. Site managers of project sites automatically get assigned general risk warnings. When intelligent system paralysis and other major risks occur, relevant information is pushed to the enterprise risk control department, insurance companies, etc. in parallel to quickly initiate a collaborative emergency response plan among multiple parties.

4. Conclusion

In conclusion, the new quality productive forces of the wave brought by the wave have both opportunities and challenges to construction project management. Risk assessment and control shouldnasser up to the new trend in contemporary times. Promoting awareness of risk, designing risk transfer components, and developing information systems can effectively address risks. In the future, in order to grasp risks and assist the construction industry:New quality productive forces wave sustainable development, need continuous innovation strategies and deep integration of technology and management.

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