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Study on Influencing Factors of the Elasticity of Safety Management System of Prefabricated Construction Project

Pengfei Zhang*, Hui Sun, Xuemei Liu, Ming Liu

School of Economics and Management, Liaoning University of Technology, Jinzhou, Liaoning, 121001, China
**Corresponding author*

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Abstract: Safety is the primary goal of construction project management and the key link to ensure the continuous progress of the project. Traditional safety management methods mainly emphasize the effective avoidance or reduction of risk factors by taking preventive measures, while the system elasticity theory can improve the adaptability of construction project safety management to external risk changes to a certain extent, and promote the improvement of site safety management level. This paper mainly analyzes the resiliency of assembly-type building safety management system from three dimensions, and proposes a series of safety management measures; provide ideas to promote the development of assembly-type building safety management in our country.

1. Introduction

With the rapid development of modern industrial technology, construction industrialization process is speeding up; construction industrialization gradually becomes the main trend of the development of construction industry. Under the traditional construction mode, Chinese urban construction and urbanization have been very rapid development. However, a large amount of waste of resources, environmental pollution, labor cost increase and other factors are constantly restricting the development of the construction industry. At present, traditional building mode cannot meet the needs of green construction and high quality development. The construction industry must break the traditional way of development and gradually realize the transformation and upgrading of the construction industry. Compared with traditional building modes, prefabricated buildings have advantages such as short construction period, high resource utilization rate, and green environmental protection [1]. However, due to the addition of component transportation, component hoisting and installation in the construction process of prefabricated buildings, safety risks of prefabricated buildings are immaterially increased, making the advantages of prefabricated buildings unable to be brought into full play[2].How to strengthen the prevention of various risks in the construction process of prefabricated construction projects is particularly important. The safety management system of prefabricated construction project regards each link of construction project implementation as a whole, and all factors in the system are related to each other, so it has certain

elasticity when dealing with the risks in the process of project implementation. Improving the elasticity of project safety management system can effectively reduce the economic losses and casualties caused by construction risks. Therefore, it is of great significance to accurately identify the factors affecting the elasticity of project safety management system and explore effective ways to enhance the elasticity of the system, so as to scientifically evaluate the construction safety of prefabricated buildings and effectively improve their safety level.

2. Theoretical Research Status

Safety is the primary goal of construction project management and the key link to ensure the continuous progress of the project. Safety management of construction projects has always been a topic of concern for many scholars. Francisco et al. [3] proposed a new construction site assessment tool for prefabricated buildings (CONSRAT), which can effectively identify potential risks at the construction site and propose corresponding preventive measures, which is conducive to improving the safety management level of prefabricated construction projects. Ying, L. et al. [4] believe that building design risk prevention (CHPtD) is a proactive safety management method, which can effectively eliminate or reduce the safety risks of prefabricated buildings. Yingpan, L. et al. [5] established an early warning model based on correlation vector (RVM) from the perspective of lifting of prefabricated components and construction process, which could effectively monitor and improve dangerous behaviors in construction process. Jieling, W. et al. [6] emphasized the importance of information strengthening technology in the project construction process based on the safety management of the whole process of prefabricated buildings. Wenlong, L. et al. [7] believed that assembly and hoisting problems should be paid attention to in project safety management based on the characteristics of high altitude operations in prefabricated construction projects. Through the construction of relevant indicators of safety accident inducement, combined with the structure entropy weight method to build a model, accurately assess the safety risk in the process of construction project assembly and hoisting.

Traditional project safety management methods mainly emphasize the effective avoidance or reduction of risk factors in the project process by taking preventive measures, while the introduction of system elasticity theory in the project will improve the adaptability of construction project safety management to external risk changes to a certain extent, and promote the improvement of site safety management level. System resilience refers to the ability of the system to resist external interference and restore the original operating state by scheduling its own functions. It emphasizes the ability of timely and effective analysis and response to the impact of future risks and the iteration of the existing system in a systematic way to promote the safety management system to adapt to the ongoing changes and quickly restore to the original state after the occurrence of extreme events. Elastic engineering theory provides a new concept for solving safety accidents in complex situations. Introducing the concept of elastic engineering into construction projects can significantly improve the ability of safety management system to absorb interference and recover itself, and make up for the defect that traditional safety management methods are difficult to effectively deal with safety risk changes in complex situations. Lang, H. et al. [8] defined the concept of safety elasticity as the system's ability to maintain, restore and optimize when the system responds to risk shocks within a certain time and space, which promoted the research and practice of elasticity engineering theory in the field of safety science. Trinh, M.Y. et al. [9] proposed from the perspective of safety culture management that elastic engineering could solve emerging and unforeseeable safety risks related to the complex nature of construction projects. The results showed that elastic engineering played a regulating role in the complex construction environment, and when the project had a higher level of elasticity, the negative impact of project complexity on safety performance

became insignificant. Majeed and Faisal [10] believe that the engineering system has three kinds of elastic capabilities: absorption, adaptation and recovery. Based on this, three kinds of elastic capabilities and time functions are constructed by using Bayesian networks and verified by the Fukushima Daiichi nuclear power plant accident. The results show that adaptive capability contributes the most to the system elasticity, followed by absorption capacity and recovery capacity. It can be seen from the existing literature that the current research on the project safety management of the construction industry mainly focuses on the individual and organizational management level, ignoring that the construction project is a multi-party project management system with certain resilience. Therefore, based on the existing research, this paper conducts in-depth research on the factors affecting the elasticity of the safety management system of prefabricated construction projects, so as to effectively guarantee the overall quality of prefabricated construction projects.

3. Main Influencing Factors of Safety Management System Elasticity of Prefabricated Construction Projects

The elastic level state span of safety management includes the whole process of the project construction emergency, which is reflected in the ability of the system to recover normal operation from adverse conditions as quickly and effectively as possible and maintain the steady progress of the project, and reflects the response degree of the system to emergencies at different stages. At the same time, the continuous function optimization of elastic engineering requires that the system, after actively responding to and changing its own structure and function through adjustment, can surpass the past at the functional level and establish the corresponding "recovery", so as to make adjustments more quickly in the face of risk crisis in the future and form a closed loop. Therefore, this paper divides the factors affecting the elasticity of the safety management system of prefabricated construction projects into three dimensions: defense, response and optimization.

3.1 Influencing Factors of Defense Capability

System defense capability refers to the ability of engineering project safety management system in preparation and mitigation of adverse impact, which is used to indicate whether the safety management system can actively cope with the disturbance of disturbing factors when adverse conditions occur, and whether it can effectively use the advance preparation and planning of building safety efforts and resources, in order to restrain the potential damage in the future. Factors affecting the system defense capability include: (1) the level of attention and investment of top management to security management: When the top management pays much attention to and invests in the safety project, that is, in the early stage of the project, the safety awareness training of the management and technical personnel and the operation ability training of the construction personnel are strong, the risks in the process of the project will be reduced correspondingly, and the ability to resist safety accidents will also be enhanced.(2) Monitoring effectiveness: In the process of the project, real-time safety monitoring should be conducted on the problems, needs or changes in each link, and timely feedback of monitoring information can effectively reduce the occurrence of safety accidents.(3) Project personnel allocation: Assign the security responsibility to competent people, and pay attention to the pairing of new employees and experienced old employees for collaborative work. The better the project personnel configuration is, the stronger the security management system can defend against risks.

3.2 Influencing Factors of Coping Ability

Coping ability refers to the ability of the system to cope with and recover from shocks, and the

ability to take control measures to ensure the stable operation of the system. The response capacity should be flexible, mainly to reflect the rapid recovery ability of the system when it is affected by unsafe factors, that is, whether it can respond quickly and implement rescue activities. Since the occurrence of site risk accidents in construction projects is often uncertain and sudden, rapid and effective emergency rescue capability can reduce the vulnerability of organizational system and improve the overall stability of the system. (1) Quality of safety information communication: When a safety accident occurs, a concise and efficient information transmission path can effectively reduce the time of information transmission, so as to respond to safety accidents quickly and reduce unnecessary losses. (2) Rescue rapidity: that is, it can quickly deploy and dispatch resources and professional forces to grasp the best rescue opportunity when safety accidents occur.

3.3 Influencing Factors of Optimization Capability

System optimization ability mainly refers to the level at which the system can cope with the impact of future adverse conditions through learning of safety accidents and a series of internal adjustments, changes and innovations after the occurrence of safety accidents. Although the effect of system optimization ability is not obvious in the short term, in the long term, it has a great impact on the next risk cycle, namely the resistance to potential adverse conditions. Factors affecting the system optimization ability include: (1) Summary of safety management experience: that is, the management learns lessons from previous safety accidents and summarizes experience, and puts forward effective improvement measures, so as to make up for the shortcomings of existing management measures and enhance the stability of the system.(2) Safety incident handling measures: During incident investigation, focus on improving failed system defenses to prevent similar incidents rather than placing blame on individuals. (3) Safety culture: Create an atmosphere of safety knowledge learning among participants in each link of the project process and strengthen everyone's safety awareness.

4. Safety Management Countermeasures of Prefabricated Construction Projects

4.1 Pay More Attention to Security Issues

It is more urgent to enhance the importance of construction enterprises to safety production, comply with the relevant construction standards, formulate rules and regulations in line with the relevant construction projects, timely and comprehensively carry out publicity, and hire professional construction safety management personnel for training when necessary. Prevention is the main task. Check potential safety accidents regularly and make corresponding safety accident plans in advance.

4.2 Optimize the Security Management Mode and Improve the Flexibility of the Decision-Making System

Accidents often occur unexpectedly, and project safety management needs a simple and effective decision-making system, that is, staff can make timely decisions on emergencies, and have the right to refuse work when facing unclear risks related to work tasks, so as to respond to the changing environment and reduce the occurrence of unsafe behaviors. However, the excessive flexibility of the decision-making system will inevitably lead to the instability of the system. Therefore, facing the changes of the external environment, the key to achieve flexible security management of the project needs to find a new organizational management system suitable for the project's own situation, so as to solve the imbalance of the management system caused by the dynamic changes of the internal and external environment. Make the stable development of the project system and the

external environment to achieve the best match state. Therefore, the project organization should consider the balance between flexibility and stability, that is, the new system balance between the changes required by the sudden changes of the external operating environment and the changes to be made by the project combined with its own capacity, so as to establish a strong horizontal organizational network. Under the condition of ensuring the stability of the system, allow cross-functional departments to find the best solution under the condition of considering different options, so as to improve the overall response ability of the system and maintain the continuous resilience of the project organization.

4.3 Establish a Comprehensive Emergency Rescue Plan and Mechanism

The project should actively improve the emergency rescue capability. When emergencies occur, the flexible and efficient emergency rescue plan can effectively reduce the losses caused by emergencies. Therefore, all stakeholders should establish an effective rescue cooperation mechanism, enrich the diversity of rescue forces, and ensure that rescue personnel, materials and facilities have a high level of redundancy. At the same time, the functions of all stakeholders and the organization and command relationship are clearly defined to ensure the efficient and orderly rescue, constantly improve the project rescue command and decision support system, and improve the supporting ability of information and data resources of the emergency rescue system. Post-recovery and after-treatment plans should be refined, internal exercises of policies and emergency rescue activities that can promote the sustainable development of personnel's professional skills should be regularly carried out, the organization's continuous optimization ability should be improved, to avoid personnel and property losses caused by inadequate rescue capacity.

4.4 Strengthen Safety Training and Education, and Establish Scientific Reward and Punishment Mechanism

The project unit should conduct safety education and training for all the participants of the construction project before the implementation of the project. It is necessary to reasonably arrange the training time, place and content. The training content is mainly based on the safety production and construction, so as to ensure the high-quality training effect. At the same time, the establishment of scientific reward and punishment mechanism is a magic weapon to promote safety management. By encouraging safe construction and production, project construction participants are guided to pay attention to safety and improve subjective initiative. In part of the special funds from the economic input of construction projects shall be used for project construction safety management.

5. Conclusion

Building industrialization is the inevitable trend of the development of market economy construction industry, and also strongly promotes the prefabricated building into a new development period. There are many factors affecting the elasticity of the safety management system of prefabricated construction projects. This paper mainly analyzes the influencing factors from three dimensions: defense capability, coping capability and optimization capability, and does not use quantitative analysis method to analyze and compare the influencing factors. This is the shortcoming of this paper and also the focus of the next research.

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