Statistical Analysis and Risk control of Civil Engineering Safety Management Accidents

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Abstract. The management of civil construction safety must start from understanding the causes of construction safety accidents. For this reason, experts and scholars at home and abroad have conducted a lot of investigation and research, and have come up with a series of good analysis theories of the causes of construction safety accidents. This article aims to study the statistical analysis and risk control of civil construction safety management accidents. This paper is based on the safety risk assessment model of construction projects, and uses it to discover potential construction risk factors. The experiment in this paper mainly uses statistical analysis method to estimate the probability of each possible event by observing the occurrence times of each potential construction safety risk. Experimental data shows that construction safety risks are mainly caused by certain uncertain reasons during the construction process, and then the future state of the construction of the project can be accurately judged based on historical data or statistical data. The results show that after the classification of 400 accidents occurred in the investigation area, 150 of them fell from high places and 140 people died. 87 electric shocks, 75 deaths; 73 collapses, 65 deaths; Objects struck 38 times, killing 22 people; 43 mechanical injuries, 36 persons. It is the government's responsibility to reduce construction safety and quality accidents, and it is also the minimum requirement of construction enterprises. The safety issues of civil construction must be strictly managed.

1. Introduction:
With the rapid development of science and technology, the living standards and quality of life of domestic residents are constantly improving. With all kinds of uncontrollable risk factors, it threatens the safety of human life and property. With the rapid development of the construction industry, it is bound to bring many security risks. Generally speaking, there are many unpredictable risk factors in construction, these risk factors will threaten the safety of human life and property [1-2]. Architectural modeling has the characteristics of diversity and complexity, causing frequent safety accidents in buildings. In the construction of construction projects, construction workers need to work in the open air for a long time, which undoubtedly has a high risk [3-4]. At the same time, the construction will be affected by the natural environment, especially in the later stage of the project operation planning and project implementation, which are often determined by natural conditions. Therefore, it is difficult to predict the probability of the occurrence of risks, and it is also difficult to predict the impact of risks.

This paper identifies the risk sources in the construction project, and divided the types of safety accidents in the construction, so as to determine the main risk sources of the construction, and used systematic and scientific risk indicators to evaluate the construction of the project. According to the safety risk level in the process, the corresponding safety risk management system is finally created.
based on the assessment result and safety level, and the safety risk assessment activity is carried out through the fuzzy analytic hierarchy process [5]. Finally, the feasibility of the research is scientifically demonstrated, and the deficiencies and prospects in the research are put forward. This paper presents personal strategies and suggestions for improving this problem [6].

In the entire civil construction project, safety risks run through it. It is obviously impossible to eliminate all safety risks. However, construction companies should control safety risks as much as possible and minimize the construction risk factor [7-8]. Construction companies should attach great importance to safety risk management, improve the safety risk management system, improve the quality of construction materials and mechanical equipment, and improve the safety risk assessment mechanism. In addition, a large number of civil construction talents can be trained with high quality, so as to carry out and reduce construction projects more safely and smoothly. Based on this hot issue, this paper focuses on the analysis of civil construction safety accidents and risk management [9-10].

2. Statistical analysis and risk control of civil engineering safety management accidents

2.1 Principles for the Identification of Safety Risks in Civil Construction

The safety risk identification of civil engineering construction should follow the principles of comprehensive, systematic, scientific and focused:

(1) Comprehensive
The principle of comprehensiveness refers to the analysis, judgment, and identification of construction safety risks from different perspectives in terms of contract, construction environment, application technology, management difficulty, social environment, cultural environment, etc. Different analysis of different building construction safety risks, master more information, and have a comprehensive understanding and understanding of safety risk management in the construction process.

(2) Systematic
In fact, risk identification is the beginning of all risk management, and construction safety risk management is no exception. Construction safety risk identification is the premise and foundation of construction safety risk management. The accuracy of identification determines the effect of risk management to a certain extent. Good or bad. In order to ensure the accuracy of building construction safety risk identification, a systematic investigation and analysis should be carried out from the overall and overall perspective of the project and in accordance with certain rules. First of all, the risks of the engineering project should be decomposed and gradually refined to obtain a specific understanding of the safety risks of construction, thereby obtaining the initial risk list; second, the safety risks of construction should be based on the experience of similar projects and the specific conditions of the proposed project As the main risk, analyze different points to find out important hazards, etc. According to the rules of system identification, the specific project management personnel have a comprehensive understanding of the construction safety risks of the project, so as to use risk management techniques to reasonably select risk response, monitoring and control measures.

(3) Scientific
The scientific principle emphasizes that there must be a certain scientific method and theoretical basis for the identification of construction safety risks, and the establishment of a scientific risk identification method system. The identification of construction safety risks should combine qualitative and quantitative methods. From the statistics of construction safety accidents, there are certain rules to follow when construction safety accidents occur. Therefore, in the process of identifying construction safety risks, a scientific and reasonable risk identification system should be established according to the specific conditions.

2.2 Safety Risk Assessment Model for Civil Construction Projects

In the process of construction of a project, the evaluation of the risk of operating conditions has the advantages of strong operability and simple application. It can be used to discover potential
construction risk factors. The specific analysis process is as follows:

1. Operational hazard is derived from the product of three factors: the probability of an accident, the time that a person is exposed to a hazardous environment, and the possible consequences after the accident, represented by the letters E, L, and C, and D represents the operational hazard. Formula (1):

   \[ D = L \times E \times C \]  

   In the above formula, L is the probability of occurrence of a risk event, E is the duration of the risk, and C is the impact caused by a safety accident.

2. Efficiency evaluation index. Generally speaking, the formula of efficiency evaluation index is shown in formula (2).

   \[ \text{TEINDEX}_{DMU} = \frac{\sum_{i=1}^{m} u_i y_{rj}}{\sum_{i=1}^{n} v_i x_{mj}} \]  

   Where \( x_{mj} \) is the value of the m-th input index of the j-th DMU; \( v_i \) is the weight of the i-th input index; \( y_{rj} \) is the value of the r-th output index of the j-th DMU; \( u_r \) is the value of the r-th output index Weight; \( j=1,2,...,n \). This method must give weights to the input indicators and output indicators of all decision-making units, which is very easy to be affected by subjective factors, and it is not easy to be accurate and objective. However, the DEA method can solve this problem. In the DEA model method, we only need to use the weight as a variable. Therefore, we can combine the characteristics of DEA and efficiency evaluation index to evaluate the relative efficiency of each DMU.

3. The weight coefficients formed by all the metric values are \( v=(v_1,v_2,...,v_m)^T, u=(u_1,u_2,..,u_s) \), and each decision-making unit has its corresponding efficiency Evaluation index:

   \[ h_j = \frac{\sum_{i=1}^{m} u_i y_{rj}}{\sum_{i=1}^{n} v_i x_{mj}}, j = 1,2,3,...,n \]  

   In formula (3), the higher the value of \( h \), it means that the j-th decision-making unit can pay relatively lower input and get relatively higher output. Therefore, we can change the values of \( u \) and \( v \) to find the maximum value of \( h \), so that we can evaluate whether the DMU is effective.

4. Selection of evaluation methods for construction engineering safety risk management

   The first step is to calculate the consistency index C.I.

   \[ C.I. = \frac{\lambda_{\text{max}} - n}{n - 1} \]  

   In the formula, \( n \) is the order of the judgment matrix.

5. Risk is "the uncertainty of the occurrence of adverse results or loss of an event", which has the duality of probability and consequence. The risk \( R \) can be expressed by the function of the probability of accident \( P \) and the severity of accident loss \( S \):

   \[ R = P \cdot S \]  

   In the formula, \( R \) is the amount of risk, \( P \) is the probability of an accident, and \( S \) is the severity of the accident loss.

3. Statistical analysis and risk control experiment of civil construction safety management accidents

3.1 Experimental Method

   (1) Statistical analysis method: Under basically the same conditions of engineering projects, the probability of each possible event can be estimated by observing the number of times each potential construction safety risk has occurred. This estimation is the occurrence of each event Frequency of.
(2) Theoretical probability distribution method: When the construction safety manager does not have enough historical information and data to determine the probability of a project construction safety risk event, it can be supplemented and modified according to some theoretical probability distributions to establish a risk Probability distribution chart.

3.2 Experimental Risk Assessment Strategy

The estimation of construction safety risk loss is divided into deterministic risk loss estimation and uncertain risk loss estimation. Generally speaking, construction safety risks are caused by certain uncertain factors in the construction process. If the future state of project construction can be accurately judged based on historical data or statistical data, various construction safety risks can be predicted. Factors cause losses to construction enterprises. In this case, the estimation of risk loss is a definite risk loss estimation, such as compensation for the dead and repair of engineering damage. Deterministic risk loss estimation needs to meet the following conditions:

(1) A clear goal that the decision maker always hopes to achieve, such as the largest profit or the smallest loss;
(2) There is only a certain natural state of construction safety risk;
(3) There are two or more action plans for decision-makers to choose.

4. Statistical analysis of accidents in civil construction safety management and discussion on risk control

(1) After categorizing the 400 accidents in the survey area, 150 falling from height and 140 deaths accounted for 37.5% and 40.5% of the total; 87 electric shocks and 75 deaths accounted for 21.7% of the total; 73 collapses and 65 deaths accounted for 18.2% of the total; 38 object strikes and 22 deaths accounted for 9.5% of the total; 43 mechanical injuries and 36 deaths accounted for 10.8% of the total accidents. It can be seen from Table 1 and Figure 1 that the focus of the prevention of construction safety risks should be placed on the five types of accidents such as fall from height, electric shock, collapse, object strike and mechanical injury. Both the number of accidents and the death toll of the five types of accidents account for the vast majority of construction safety accidents. It can be considered that these five types of accidents are the focus of prevention of construction safety risks.

| Type of accident          | Minimum | Death toll |
|---------------------------|---------|------------|
| Fall from height          | 150     | 140        |
| Electric shock            | 87      | 75         |
| Collapse                  | 73      | 65         |
| Object strike             | 38      | 22         |
| Mechanical damage         | 43      | 36         |
| Poisoning and suffocation | 4       | 3          |
| Drown                     | 1       | 1          |
| Explosion fire            | 4       | 3          |
| Total                     | 400     | 345        |
Figure 1. Classification and statistics of construction safety accidents

(2) The experimental investigation found that the average life span of China buildings is only 25 years, which is much lower than the life span of foreign projects, which also caused great waste. In the experimental investigation of the local area in the first half of 2020 due to safety accidents caused by the quality of the project, an average of more than 100 new houses were demolished and nearly 20 million yuan was lost. Every year, the direct losses caused by engineering quality and safety problems are huge, and the indirect losses may be even greater. For example, the maintenance of municipal roads. The direct losses caused by quality problems are the cost of re-maintenance, and the indirect losses caused include traffic and passers-by. Such as causing traffic inconvenience and economic losses. Table 2 shows the local monthly losses caused by security incidents in the first half of 2020.

Table 2. Losses caused by security incidents each month in the first half of 2020

| Month | Loss (w) |
|-------|----------|
| 1     | 2235     |
| 2     | 1678     |
| 3     | 1834     |
| 4     | 1946     |
| 5     | 2133     |
| 6     | 2310     |

5. Conclusion
With the rapid development of society, the scale of urban construction is also expanding, and the number and scale of construction projects are increasing rapidly. However, the existence of hidden quality hazards and quality accidents has seriously hindered the smooth development of the construction industry, and construction quality management has become particularly important. This paper uses historical investigation methods to analyze the probability and consequences of construction safety risks. After categorizing the 400 accidents in the survey area, the number of accidents and deaths in the five categories of falling from height, electric shock, collapse, object hit, and mechanical injury accounted for 97.8% and 98% of the total accidents.

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