1. Introduction

We all know that all kinds of things (related to nature or man-made) will not cause harm to human beings, will not cause danger, will not cause losses, will not have accidents, function is normal, and progress is smooth. This state is called safety [1-2]. Nowadays, the construction industry has become an important supporting industry of the national economy. However, the safety of construction has not been solved, and there are still frequent safety accidents. As a result, the construction safety accidents in China are second only to mines and hazardous chemicals, which seriously affect the sustainable development of the construction industry, and have become the focus of attention [3-4].

Generally speaking, construction engineering has its own characteristics, such as complex operation procedures, hard manufacturing environment and interactive multi type processing. When workers are engaged in work activities, the existence of these characteristics may lead to risks [5-6]. Accident causation theory is a theory that can reflect the law of accidents, thus providing a scientific and complete theoretical basis for qualitative and quantitative analysis of accident causes, and can effectively improve the prevention of accidents and improve safety management [7-8]. Therefore, it is of great significance to apply the theory of accident causation to construction safety management to reduce safety accidents [9-10].
In this paper, firstly, the accident causing theory and the fuzzy comprehensive evaluation model of safety are elaborated, and two unfinished projects in the construction site are selected as the cases, and the "4M" theory is applied to the construction management for analysis.

2. Accident Cause Theory and Safety Fuzzy Comprehensive Evaluation Model

2.1. Accident Causing Theory
The occurrence of accidents is the result of internal or external joint action. In the initial stage of accidents, there is no specific form of accidents. However, if there are safety problems, these potential dangers will gradually appear in the development period over time and eventually lead to the occurrence of accidents by sudden changes. The purpose of establishing safety evaluation method is to take effective measures to eliminate potential problems and prevent them from mutating into accidents before accidents occur. Then, it is necessary to master the process of accident evolution, in order to do a better job in prevention and ensure the safety of work. Therefore, mastering the theory of accident causation is the premise of our preventive work.

The whole analysis process of accident causation theory mainly includes four factors: human, machine, material and environment. Through various experiments and current events, it is finally found that as long as any two factors exist at the same time, the accident will occur. When three or more factors exist at the same time, the probability of accidents is higher. The analysis of the theory leading to accidents can provide an effective basis for the formulation of measures to prevent accidents, as well as a basis for safety management.

2.2. Safety Fuzzy Comprehensive Evaluation Model
The safety fuzzy evaluation model is based on the fuzzy mathematics theory. Through the quantitative processing of some uncertain and difficult quantitative factors, the membership degree of each evaluation index to the evaluation grade is obtained. The maximum membership principle is selected to evaluate the safety status of construction. The model construction mainly includes the following steps:

(1). Set up evaluation grade set:

\[ V = \{v_1, v_2, \ldots, v_n\}, (n = 1, 2, \ldots) \]  

(2). Set up the evaluation factor set:

\[ U = \{U_{1i}, U_{2i}, \ldots, U_{pi}\}, (i = 1, 2, \ldots, P) \]  

(3). Establish evaluation matrix:

\[
R = \begin{bmatrix}
B_1 \\
B_2 \\
M \\
B_p
\end{bmatrix} = \begin{bmatrix}
b_{11} & b_{12} & \cdots & b_{1m} \\
b_{21} & b_{22} & \cdots & b_{2m} \\
\vdots & \vdots & \ddots & \vdots \\
b_{p1} & b_{p2} & \cdots & b_{pm}
\end{bmatrix}
\]  

(4). Fuzzy comprehensive evaluation:

\[ B' = TR \]

Among them, \( B' \) is the comprehensive evaluation result of all factors.

For the construction safety evaluation, the advantage of the traditional fuzzy comprehensive evaluation model is that it can quantify some uncertain and uncertain factors, use the membership
degree to express the fuzziness of the construction safety level, and reflect the safety situation of the construction site objectively and not blindly; the disadvantages are that the selection of the construction safety evaluation index is not comprehensive, and the determination of the weight is one-sided, Comprehensive evaluation is easy to lose data.

3. Application Analysis

3.1. Theoretical Analysis of Accident Causes

3.1.1. Causal chain theory of Heinrich accident
According to this theory, each event in turn leads to safety accidents, which is a chain process, which should include genetic and social environment, human shortcomings, human unsafe behaviors or natural unsafe conditions. The root of accident prevention lies in avoiding unsafe behavior or unsafe conditions and stopping the chain process. From the construction safety management level, people and material factors are the most important. In this process, if people's unsafe behavior and the unsafe state of objects can be interrupted, then the safety will be improved. Among them, the technical level, work experience and safety quality of construction management personnel as well as the status of equipment and materials also play an important role. The application of Heinrich's accident theory in architecture is to carefully check the machinery and materials on the site every day and ensure the safety of the construction and site management personnel.

3.1.2. Theory of accidental release of energy
In this theory, abnormal or unnecessary energy is accidentally released in the production process, acting on human body or equipment, exceeding the tolerance limit of human or equipment, causing damage to people or objects. In the production activities, people must carry out energy conversion, flow and work according to the rules, control the accidental release of energy caused by some reasons, avoid the contact between people or objects and energy, and reduce the occurrence of safety accidents.

3.1.3. Trajectory crossing theory
In this theory, it is believed that there are two ways to develop things: people or things. If there are unsafe behaviors in human development or mistakes in material development, which will lead to unsafe situations, then the two will cross, and reverse energy will enter the human body, resulting in safety accidents. From the aspect of construction safety management, people will have unsafe behaviors because of poor management and social environmental impact. Mechanical equipment and other objects will also be unsafe due to long-term use, poor structure and other uncertain conditions. Therefore, we should try our best to avoid the occurrence of both.

3.1.4. "4M" theory
This theory can be divided into man, machine, media and management.

From the aspect of construction safety management, people's physical causes are caused by fatigue, insufficient sleep, and problems in physical condition, and professional reasons are caused by psychological reasons such as anxiety, forgetting and feeling, and by factors such as communication ability, leadership ability, team spirit and interpersonal relationship; The main causes of the equipment are the loopholes in the design of mechanical equipment, the imperfection of safety operation regulations, and the defects and insufficient supply of safety protection equipment. The main causes of operation are the bad working environment and space, and the operation information does not conform to the reality. There are many kinds of management causes. Generally speaking, there are incomplete safety rules and regulations, insufficient safety management plan and safety supervision guidance, unreasonable personnel allocation, imperfect occupational health management, etc.

From the perspective of building safety management, the human side is the professional reasons of anxiety, forgetfulness, sense and communication ability, leadership, team spirit and interpersonal
relationship caused by fatigue, lack of sleep, physical problems and other factors. The equipment reasons mainly include the gap in mechanical equipment design, imperfect safety regulations, defects and insufficient supply of safety equipment. The main reason for the work is that the working environment and space, as well as the information about the work are inconsistent with the actual situation. There are many reasons for management. Generally speaking, imperfect safety rules and regulations, inadequate safety management plan and safety supervision guidance, unreasonable personnel and imperfect occupational health management are all influencing factors.

The advantages and disadvantages of the four theories are shown in Table 1.

| Theory name                          | Advantage                                                                 | Shortcoming                                                                 |
|--------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| Causal chain theory of Heinrich accident | It was first put forward that the occurrence of accidents is due to people's unsafe behavior and the unsafe state of objects | It is believed that the accident was entirely due to human shortcomings.     |
| Theory of accidental release of energy | Analysis of safety accidents from the perspective of accident occurrence physics | There is no specific description of the specific process of the accident.    |
| Trajectory crossing theory           | It is suggested that the accidents should be happened according to the two development ways of human and material | The occurrence of accidents is more complicated than that of human and material development. |
| "4M" theory                         | This paper analyzes the causes of the accident from four aspects of people, equipment, operation and management. | There is no longitudinal revelation of the process of the accident.          |

It can be seen from Table 1 that each of the four accident causing theories has its own advantages and disadvantages. Comparatively speaking, the "4M" theory has more advantages. Therefore, this paper selects the "4M" theory to apply to the construction safety management for research.

3.2. Characteristics Analysis of Construction Safety Accidents

This paper analyzes the characteristics of construction safety accidents, then the characteristics of construction safety accidents are as follows:

3.2.1. Objectivity
In the system, the hazard sources exist objectively, and the existing regional scope varies according to the changes of the system. Because of the objective existence of hazard sources, the occurrence of safety accidents as probability events is an objective existence.

3.2.2. Randomness
The time, place, severity and cause of the accident are uncertain. The occurrence of the accident is a random event. Therefore, mathematical statistics can be used to study the accident process.

3.2.3. Causality
The hidden danger is the direct cause of the accident, which is unsafe, defective and causal in nature.

3.2.4. Systematicness
The causes of accidents are not single, but multi-level. Some of them are not the direct causes of accidents, but they have internal relations with the occurrence of accidents. All kinds of factors causing accidents are systematic, so they can not be analyzed singly or independently, and the results are often one-sided.

3.2.5. Preventability
In the whole process of building construction, the participation of construction personnel is the first, which can not lack the objective existence of human factors. In this way, accident prevention can be carried out by controlling human factors. At the same time, equipment and machinery are involved in the construction process to face the test of the environment, and orderly management is required in the
whole process, Therefore, it is possible to improve the safety of each construction and production process through the standardization of safety production behavior, so as to minimize the probability of accidents and realize zero occurrence of accidents.

3.3. Application Analysis of Accident Causing Theory in Construction Safety Management

In this paper, taking a construction site as a case, the "4M" accident causing theory is used for analysis, and the four factors of human, material, management and environment are taken as safety evaluation indexes for evaluation. The initial values of safety evaluation index scores of the two projects are shown in Figure 1.

![Figure 1. Initial value of safety evaluation index scores of two projects](image)

According to Figure 1, the human factor index score of project 1 is 84, the material factor index score is 71, the management factor index score is 78, and the environmental factor index score is 82. The human factor index score of item 2 is 83, the material factor index score is 73, the management factor index score is 75, and the environmental factor index score is 79. From the point of view of the score, the safety of the two projects is average.

Then, after applying the accident cause theory, the safety evaluation index scores of the two projects are shown in Figure 2.
Figure 2. Analysis of accident cause theory in project application

It can be seen from Figure 2 that after applying accident causation theory in construction management, the human factor index score of project 1 is 91, the material factor index score is 86, the management factor index score is 89, and the environmental factor index score is 91. The human factor index score of item 2 is 90, the material factor index score is 85, the management factor index score is 86, and the environmental factor index score is 88. In terms of score, the safety of both projects is safe. It can be seen that the application of accident cause theory in construction management can effectively improve the safety.

Acknowledgments

Nowadays, construction safety accidents occur frequently, which seriously threaten the life and health of employees, bring economic losses to enterprises and unstable factors to society. Based on this, this paper studies the application of accident causing theory in construction safety management. In this paper, the theory of accident causation is applied to the safety management of construction, and two unfinished projects are taken as examples for application analysis. The research shows that the application of accident cause theory in construction management can effectively improve safety.

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