Cause Analysis and Countermeasures of Falling Accident in Building Construction

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Abstract: Falling accidents from high places have the characteristics of high frequency and great harm, which will bring serious economic losses and social impacts to enterprises. In this paper, the falling accidents in building construction are taken as the research object, and 50 cases of falling accidents in recent years are studied by using 24Model-AHP accident cause analysis method, and various causes leading to accidents are statistically analyzed. Then, according to the results of statistical analysis, the main factors affecting the falling accident in building construction are screened out, and the weight of these factors is analyzed to determine the importance of each factor. Finally, according to the results of the weight analysis, this paper puts forward targeted countermeasures and suggestions for accident prevention, aiming at cutting off the accident chain and preventing the occurrence of accidents, thus reducing the number of accidents and reducing casualties and economic losses.

Keywords: Construction; Falling from a Height; 24Model-AHP; Cause Analysis; Preventive Measures

1. Introduction

1.1. Research Background

Since the reform and opening up, with the strong support of the national economic policy, the scale of the construction industry has been expanding and developing. China's construction industry has the characteristics of high density, high mobility, many overlapping jobs, strong labor and complex working environment, so there are many complicated safety problems in the production process [1].
In the data reported by the national security department, the accident of falling from a height always ranks first, which has the characteristics of high probability and great harm [2]. Therefore, it is necessary to study the causes of falling accidents in construction, and the application of accident cause analysis method plays a key role in the prevention measures of accidents in construction projects, so as to control the internal causes of accidents and reduce the number of accidents.

1.2. Foreign Research Status

Foreign scholars usually use program design and data simulation to analyze the cause of accidents, focusing on personal fall prevention equipment to prevent high-altitude falling accidents. S.G.Sheina, Girya L V established a model from the practical aspect to analyze the relationship between external and internal factors in the accident process, so as to analyze the causes of various problems in various environments according to the percentage of correlation, and improve the working environment according to the situation [3]. Marcin Milanovicz established an active numerical human model to reproduce the process of falling accident [4].

1.3. Domestic Research Status

At present, domestic scholars have done a lot of research on accident cause analysis by using different data sources, variables and sample sizes [5]. Jia Xiaoshan proposed to use FTA to analyze the causes of falling accidents from high places, and concluded that the main causes of falling accidents from high places are unsafe factors of things and unsafe behaviors of people [6]. Liu Haozhen used accident tree analysis to analyze the accident of falling from a height, clarified the accident mechanism and made clear the accident prevention measures [7]. Zhao Jinna put forward the brittleness analysis of falling accidents from high places based on the brittleness theory of complex systems [8]. Tan Qinwen put forward the three-factor expansion model of accident tree "man-machine-environment", and analyzed the main influencing factors leading to the accident [9]. Zhang Hong proposed to use the "2-4" model of accident cause to analyze the falling accident in construction [10].

2. Introduction to the Analysis Method of the Cause of Falling Accident from a Height

2.1. Introduction of Accident Cause Analysis Method

Accident cause analysis method is an accident mechanism and accident model extracted from the analysis of the essential causes of a large number of typical accidents, which reflects the regularity of accidents and is used to reveal the causes, processes and results of accidents [11]. At present, the popular accident cause analysis model is based on system theory, which describes the accident process as a complex and interrelated event network.

2.2. Introduction of Accident Cause Analysis Method 24Model-AHP

Based on the statistical analysis of a large number of accident investigation reports or accident cases, this paper draws some summary conclusions about the causes of accidents, thus providing reliable data support for the prevention countermeasures of falling accidents in the field of construction. In this paper, the "2-4" model of accident cause is combined with analytic hierarchy process, and the 24Model-AHP model diagram of accident cause analysis method is obtained (see Figure 1).

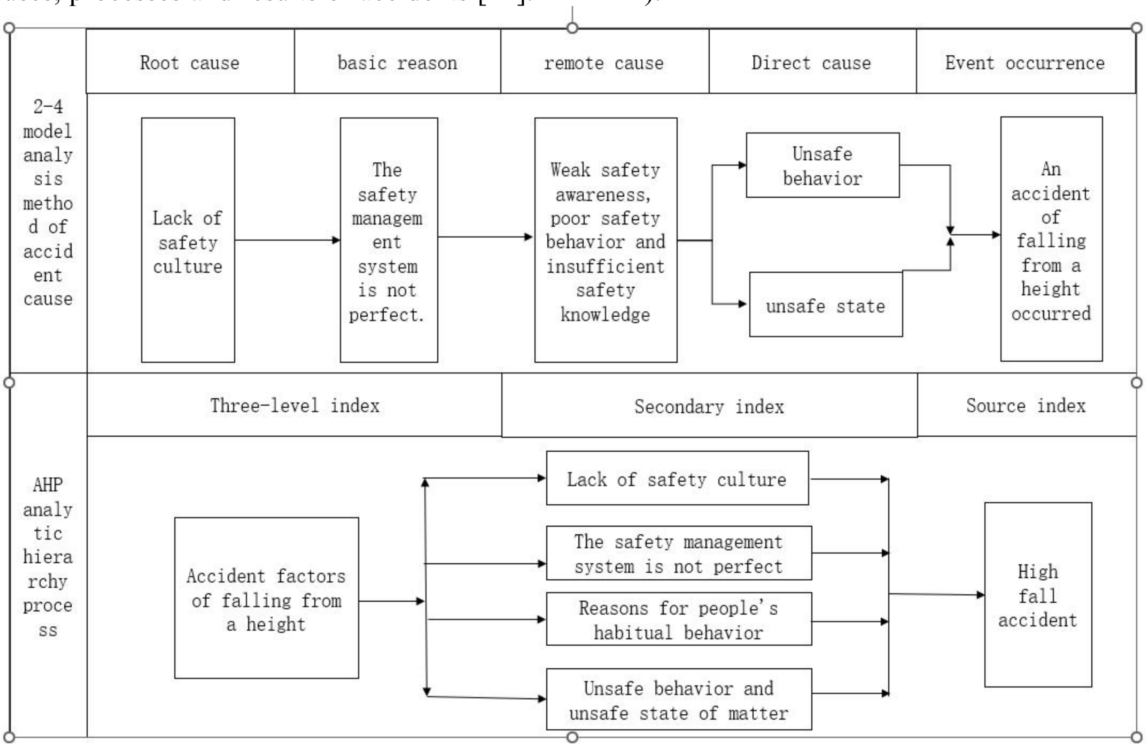

Figure 1. Cause Analysis Method of Falling Accident from a Height 24Model-AHP Model

3. Analysis of the Causes of Falling Accidents in Building Construction

3.1. Use the "2-4" Model for Accident Cause Analysis

The "2-4" model analysis method of accident cause is a reliable means for the cause analysis of falling accidents in construction. The direct cause of falling accidents in high places is caused by indirect causes, which are caused by root causes, which are developed from root causes [12]. The accident analysis of the "2-4" model is divided into four aspects: (1) direct cause analysis (2) indirect cause analysis (3) root cause analysis (4) root cause analysis.

3.1.1. Direct Cause Analysis: Unsafe Behavior and Unsafe State

(1) Unsafe behavior

The "2-4" model takes the unsafe action in the accident as the direct cause, which shows that an action of the operator violates the relevant operation regulations and safety standards during the construction period, which leads to the occurrence of a high-altitude fall accident. In this paper, the 2-4Model analysis method is used to study the causes of accidents, and 50 falling accidents in construction are sorted out and analyzed, and 15 unsafe actions are obtained, with a total frequency of 345, as shown in Table 1.

Table 1. Unsafe Action Analysis Table of Falling Accident in Building Construction.

serial number	type	Unsafe behavior	frequency	Incidence rate%
1	Violation of regulations	Do not have job qualifications	22	44
2	Violation of regulations	Hidden trouble investigation and management has not been carried out or hidden trouble investigation and elimination is not complete.	35	70
3	Violation of regulations	On-site safety inspection and supervision are not in place	29	58
4	Violation of regulations	No safety training and education.	34	68
5	Violation of regulations	Unauthorized entry into dangerous areas	23	46
6	Violation of regulations	No safety technical disclosure was made.	28	56
7	Illegal command	Arrange unqualified personnel for operation.	24	48
8	Illegal command	Contract or subcontract works in violation of regulations	10	20
9	Illegal command	Illegal start-up	10	20
10	operation against rules	Failure to take safety protection measures or unreliable safety measures.	33	66
11	operation against rules	Not in accordance with the construction plan.	11	22
12	operation against rules	Adventure homework	33	66
13	operation against rules	Labor protection articles are not equipped or used incorrectly.	32	64
14	operation against rules	Use equipment with hidden dangers or unsafe products.	12	24
15	No violation of regulations	Failing to discover and stop employees' unsafe behaviors in time	8	16

According to the definition of unsafe action, it can be divided into four categories: illegal action, illegal command, illegal action and non-illegal action. Among them, the frequency of illegal action is 171 times, illegal operation is 122 times, followed by illegal command for 44 times and non-illegal action for 8 times, which shows that illegal action and illegal operation occupy the main position in unsafe behavior.

(2) Unsafe state of things

The "2-4" model of accident causes takes the unsafe state as another direct reason. According to the Classification Standard for Casualty Accidents of Enterprise Employees, this paper divides the unsafe state into three aspects: defective equipment and facilities, inadequate safety protection facilities or safety warning signs and bad environmental conditions.

In this paper, the unsafe state factors mainly refer to three aspects: poor bearing capacity or balance of platforms or construction tools, lack or defects of safety protective railings, and lack or defects of safety nets, and make clear the unsafe state that should be controlled emphatically in the process of building construction. In this paper, 50 falling accidents during building construction were analyzed, among which 88 were unsafe. The specific data are shown in table 2.

Table 2. Unsafe State Analysis Table of Falling Accident in Building Construction.

serial number	type	Unsafe state of matter	frequency	Incidence rate%
one	Safety protection devices or signs are defective.	The safety fence is missing or defective	20	40
2	Safety protection devices or signs are defective.	The safety net is defective or missing.	13	26
three	Safety protection devices or signs are defective.	No safety warning sign is set.	9	18
four	Equipment and facilities are defective.	The hoisting equipment is defective.	11	22
five	Equipment and facilities are defective.	Scaffolding is not standardized	10	20
six	Equipment and facilities are defective.	Bearing capacity of platform or construction tools Or poor balance.	19	38
seven	Bad environmental condition	Bad natural environment or working environment	6	12

3.1.2. Indirect cause analysis: insufficient safety knowledge, low safety awareness and poor safety habits.

The "2-4" model of accident causes classifies the indirect causes of accidents into five aspects: knowledge, consciousness, habits, physiology and psychological state of workers. However, two factors of safety psychology and safety physiology cannot be reflected in the report, so most of them analyze this factor from three factors: safety knowledge, safety awareness and safety habits.

Therefore, this paper only analyzes the causes of falling accidents in construction from three aspects: lack of safety knowledge, low safety awareness and poor safety habits. By analyzing 50 cases of falling accidents in construction, we can get the frequency and incidence of insufficient safety knowledge, low safety awareness and poor safety habits, as shown in Table 3.

Table 3. Indirect Cause Analysis Table of Falling Accident in Building Construction

serial number	Description of reasons for habitual behavior	frequency	Incidence rate%
1	Lack of safety knowledge	38	76
2	Safety awareness is not high.	45	90
3	Poor safety habits	14	28

3.1.3. Root cause analysis: lack of safety management system

The "2-4" model of accident causes takes the imperfect safety management system of construction enterprises as the root cause of the accident. In this paper, the safety management system of 50 falling accidents in building construction is analyzed, and the following table 4.

Table 4. Analysis on the Root Cause of Falling Accident in Building Construction.

serial number	The safety management system is not perfect	frequency	Incidence rate%
1	The safety management system is not perfect.	38	76
2	Enterprise organization is unqualified.	11	22
3	Failure to implement the responsibility system for safe production	40	80
4	Safety operation procedures are not perfect.	20	40
5	For safety technical disclosure	19	38
6	No construction qualification	15	30
7	No construction organization scheme or imperfect scheme.	13	26

It can be seen from the above table that the frequency of "failure to implement the responsibility system for safety production" and "imperfect safety management system" is 40 times and 38 times respectively. This reflects the confusion of safety management in the accident of falling from a height in the construction of an enterprise or project, and the phenomenon that managers failed to fulfill their corresponding management responsibilities and did not play their due role in safety management.

3.1.4. Root cause analysis: lack of safety culture

The "2-4" model of accident causes takes the imperfect management system, inadequate ideological understanding and inadequate safety culture construction as the root causes of accidents. In this paper, the root causes of 50 falling accidents in construction are analyzed, and the analysis table of safety culture deficiency is obtained. The specific values are shown in Table 5.

According to the data in the following table, the top three factors in the incidence rate are the lack of safety attention, the lack of leadership responsibility and the unclear responsibility of the main body of safety production.

Table 5. Analysis Table of Root Causes of Falling Accidents in Building Construction.

serial number	Lack of safety culture	frequency	Incidence rate%
1	Insufficient attention to safety	45	90
2	Lack of leadership responsibility	38	76
3	The degree of enterprise safety management is insufficient	46	92
4	Insufficient implementation of the safety system.	11	22
5	Insufficient demand for safety training	36	72
6	Failure to comply with safety laws and regulations	17	34
7	The main responsibility of production safety is not clear.	41	82
8	Insufficient investment in safety	4	8
9	Insufficient degree of accident prevention	36	72
10	Insufficient emergency capacity	25	50

3.2. Use Analytic Hierarchy Process to Analyze the Cause of the Accident

3.2.1. Building a hierarchical model of falling accidents from high places

The second and third levels need to be established in order to make the ranking system of importance serve the objective and scientific quantitative analysis. Among them, the second level, as a second-level indicator, consists of four reasons: lack of safety culture, lack of safety management system, habitual behavior, unsafe actions and unsafe physical state in the "2-4" model. The third level is a three-level indicator, but because there are not too many influencing factors under a single two-level indicator, the number should be less than nine, so it is necessary to preliminarily screen and select safety culture factors and unsafe action factors of people (see Table 6, Table 7, Table 8 and Table 9 for specific level models.

Table 6. Hierarchical Model Table of Unsafe Behavior and Unsafe State.

Source index	Secondary index	Three-level index		
The accident of falling from a height in construction occurred.	People's unsafe behavior	Did not carry out the investigation and management of hidden dangers or did not completely eliminate hidden dangers.	On-site safety supervision and inspection are not in place	Did not carry out safety education and training.
		No safety technical disclosure was made.	Safety protection measures are not adopted or unreliable.	Adventure homework
		Labor protection articles are not equipped or used incorrectly.		
	Unsafe state of things	Safety protection railing is missing or defective.	The safety net is missing or defective.	Poor bearing capacity or balance of platform or construction tools
		The hoisting equipment is defective.	Scaffolding is not standardized	No safety warning sign is set.
		Natural disasters or harsh working environment		

Table 7. Hierarchical Model Table of Habitual Behavior Causes.

Source index	Secondary index	Three-level index		
The accident of falling from a height in construction occurred.	Habitual behavior reasons	Lack of safety knowledge	Lack of safety awareness	Poor safety habits

Table 8. Hierarchical Model Table of Safety Management System Factors.

Source index	Secondary index	Three-level index		
The accident of falling from a height in construction occurred.	Lack of safety management system	The safety management system is not perfect.	Safety organization is unqualified.	Operating procedures are not perfect.
		The responsibility for production safety has not been implemented.	No safety technical disclosure was made.	The construction organization plan is not perfect
		No construction qualification		

Table 9. Hierarchical Model Table of Safety Culture Factors.

Source index	Secondary index	Three-level index		
The accident of falling from a height in construction occurred.	Lack of safety culture	Insufficient attention to safety	Insufficient demand for safety training	Insufficient emergency capacity
		Lack of leadership responsibility	Failure to comply with safety laws and regulations	Insufficient degree of accident prevention
		The degree of enterprise safety management is insufficient	Subject of safety production Unclear responsibility	Insufficient implementation of the safety system.
		Insufficient investment in safety		

3.2.2. Calculation and analysis of factor weight of falling accident from a height

The consistent matrix method can well establish the weight coefficient. For the four secondary index factors analyzed by the "2-4" model, the yaahp hierarchical decision analysis software is used to construct a contrast matrix, and the factor weight analysis is completed by comparing the judgment matrices. The matrix elements are scaled by "1-9", as shown in Table 10.

In order to confirm that the ranking results of factors can be used effectively, it is necessary to test whether these matrices are consistent. After the test meets the standard, the obtained weight values can provide corresponding data support for the next importance ranking.

1-9 Scale Definition Table

Table 10. 1-9 Scale Definition Table.

scale	Scale definition
1	Both factors are of equal importance.
3	The former factor is slightly more important than the latter.
5	The former factor is obviously more important than the latter.
7	The former factor is more important than the latter.
9	The former factor is more important than the latter.
2、4、6、8	2, 4, 6 and 8 represent the intermediate values of the above adjacent judgments.
reciprocal	If the ratio of the importance of factor I to factor J is Aij, then the importance of factor J and factor I is Aji=1/Aij.

The following is the index formula (1) corresponding to the consistency matrix:

$$CI = \frac{\lambda_{\max} - N}{N-1}\lambda_{\max} \quad (1)$$

When the consistency index formula λmax is the sum of the matrices used, and n is the rank number of the matrix, generally speaking, when n is greater than 3, the value of CI should be used to illustrate the feasibility of judging the matrix, so the value of CI should be introduced into the consistency random index RI, as shown in Table 11.

Table 11. RI table of Consistent Random Index.

N	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

In this way, the consistency ratio formula can be used to determine whether the judgment matrix is feasible, as shown in Formula (2).

$$CR = \frac{CI}{RI} \quad (2)$$

In formula (2), if the consistency ratio Cr < 0.1, it is considered that the judgment degree of these matrices is basically consistent, and they can continue to be used within the allowable range. If the consistency ratio CR value is ≥0.1, it is necessary to find out whether there is any error in the judgment matrix and re-establish the judgment matrix with the adopted index factors.

According to the statistical analysis results of 2-4 model and the calculation test of analytic hierarchy process software, the judgment matrix Hn is constructed based on the hierarchical hierarchical model of falling accidents. H1, H2, H3, H4 and H5 respectively represent pairwise factor judgment matrices under each secondary index.

$$H_1 = \begin{bmatrix} 1 & 2 & 1 & 3 & 1/2 & 1/3 & 1/2 \\ 1/3 & 1 & 1/3 & 3 & 1/3 & 1/3 & 1/3 \\ 1 & 3 & 1 & 5 & 3 & 1 & 1/2 \\ 1/3 & 1/3 & 1/5 & 1 & 1/2 & 1/2 & 1/3 \\ 2 & 3 & 1/3 & 2 & 1 & 1/2 & 1/3 \\ 3 & 3 & 1 & 2 & 2 & 1 & 1 \\ 2 & 3 & 2 & 3 & 3 & 1 & 1 \end{bmatrix}$$

$$H_2 = \begin{bmatrix} 1 & 2 & 3 & 3 & 5 & 4 & 2 \\ 1/2 & 1 & 1 & 2 & 4 & 3 & 1/3 \\ 1/3 & 1 & 1 & 3 & 4 & 3 & 1 \\ 1/3 & 1/2 & 1/3 & 1 & 4 & 4 & 1/2 \\ 1/5 & 1/4 & 1/4 & 1/4 & 1 & 2 & 1/6 \\ 1/4 & 1/3 & 1/3 & 1/4 & 1/2 & 1 & 1/3 \\ 1/2 & 1/3 & 1 & 2 & 6 & 3 & 1 \end{bmatrix}$$

$$H_3\begin{bmatrix} 1 & 4 & 1 \\ 1/4 & 1 & 1/3 \\ 1 & 3 & 1 \end{bmatrix}$$

$$H_4=\begin{bmatrix} 1 & 3 & 1/3 & 3 & 2 & 2 & 3 \\ 1/3 & 1 & 1/4 & 1/2 & 1/2 & 1/3 & 1/2 \\ 3 & 4 & 1 & 3 & 3 & 2 & 3 \\ 1/3 & 2 & 1/3 & 1 & 1 & 1/2 & 1/2 \\ 1/2 & 2 & 1/3 & 1 & 1 & 1/2 & 1/3 \\ 1/2 & 3 & 1/2 & 2 & 2 & 1 & 2 \\ 1/3 & 2 & 1/3 & 2 & 3 & 1/2 & 1 \end{bmatrix}$$

$$H_5=\begin{bmatrix} 1 & 2 & 1 & 1/2 & 1/3 & 1 & 3 \\ 1/2 & 1 & 2 & 1/2 & 1/3 & 2 & 3 \\ 1 & 1/2 & 1 & 1/2 & 1/2 & 2 & 3 \\ 2 & 2 & 2 & 1 & 1 & 2 & 3 \\ 3 & 3 & 2 & 1 & 1 & 4 & 3 \\ 1 & 1/2 & 1/2 & 1/2 & 1/4 & 1 & 2 \\ 1/3 & 1/3 & 1/3 & 1/3 & 1/3 & 1/2 & 1 \end{bmatrix}$$

Check the consistency of the judgment matrices of each hierarchical model to obtain the CR value of each judgment matrix, as shown in Formula (3):

$$\begin{aligned} CR_{H1} &= \frac{CI_{H1}}{RI} = \frac{0.0942}{1.32} = 0.0714 < 0.1 \\ CR_{H2} &= \frac{CI_{H2}}{RI} = \frac{0.0780}{1.32} = 0.0591 < 0.1 \\ CR_{H3} &= \frac{CI_{H3}}{RI} = \frac{0.0510}{0.58} = 0.0088 < 0.1 \\ CR_{H4} &= \frac{CI_{H4}}{RI} = \frac{0.0549}{1.32} = 0.0416 < 0.1 \\ CR_{H5} &= \frac{CI_{H5}}{RI} = \frac{0.0550}{1.32} = 0.0417 < 0.1 \end{aligned} \quad (3)$$

Since the judgment matrix CR value of each hierarchical model is less than 0.1, it can be known that the judgment matrix is correct. Therefore, the weights of each judgment matrix and the weight ranking of each factor index are obtained, as shown in Table 12, Table 13, Table 14 and Table 15.

3.2.3. Analysis results of hierarchical model of falling accidents in building construction.

According to the above calculation, the following results are obtained: According to the data in Table 12, it is known that the safety protective railings are missing or defective in unsafe conditions, and the labor protection articles are not equipped or used incorrectly in unsafe actions, and the weights of these two items are 0.2970 and 0.2432 respectively, indicating that these two items are important factors leading to falling accidents.

By analyzing the data in Table 13, it can be seen that the indirect influencing factor of accidents ranked first is insufficient safety awareness, with a weight of 0.2135, which indicates that most high-altitude falling accidents are caused by people's weak safety awareness and negligence of safety protection measures.

According to the data in Table 14, the weight of failure to implement the responsibility system for production safety is 0.3077, ranking first, indicating that the responsibility system for production safety is the key influencing factor of enterprise safety management and plays an important role in the occurrence of accidents.

From the data in Table 15, it can be seen that the ambiguous weight of the main responsibility of safety production is 0.2715, ranking first in the safety culture index, indicating that the lack of emphasis on the importance of safety responsibility culture in enterprises is the main root cause of falling accidents.

Table 12. Index Weight Table of Unsafe Actions and Unsafe States.

Index layer	weight	sort	Index layer	weight	sort
Safety protection railing is missing or defective.	0.2970	1	Failing to carry out the investigation and treatment of hidden dangers or the hidden dangers have not been completely eliminated	0.1196	8
Labor protection articles are not equipped or used incorrectly.	0.2432	2	Safety protection measures are not adopted or unreliable.	0.1176	9
Adventure homework	0.2079	3	The hoisting equipment is defective.	0.1033	10
Scaffolding is not standardized	0.2051	4	On-site safety supervision and inspection are not in place.	0.0665	11

Did not carry out safety education and training.	0.1994	5	No safety technical disclosure was made.	0.0507	12
Poor bearing capacity or balance of platform or construction tools	0.1655	6	No safety warning sign is set.	00442	13
The safety net is missing or defective.	0.1414	7	Natural disasters or harsh working environment	0.0435	14

Table 13. Tables should be Placed in the Main Text Near to the First Time They are Cited

Index layer	weight	sort
Insufficient safety awareness	0.4579	1
Lack of safety knowledge	0.4161	2
Poor safety habits	0.1260	3

Table 14. Index Weight Table of Safety Management System.

Index layer	weight	sort	Index layer	weight	sort
In order to implement the responsibility system for production safety	0.3077	1	No safety technical disclosure was made.	0.0808	5
The safety management system is not perfect.	0.2036	2	Safety operation procedures are not perfect.	0.0808	6
No construction qualification	0.1576	3	Safety organization is unqualified.	0.0543	7
No construction organization scheme	0.1152	4			

Table 15. Index Weight Table of Safety Culture.

Index layer	weight	sort	Index layer	weight	sort
The main responsibility of production safety is not clear.	0.2715	1	Enterprise safety management issues	0.01209	5
Insufficient demand for safety training	0.2190	2	Insufficient degree of prevention of safety accidents.	0.0848	6
Insufficient attention to safety	0.1260	3	Insufficient emergency capacity	0.0520	7
Lack of leadership responsibility	0.01260	4			

3.3. 2-4Model-AHP Analysis Results

In this paper, the 2-4Model-AHP accident cause analysis method is used to make statistical analysis and weight analysis of 50 falling accidents in construction in recent years. The analysis results show that, among unsafe actions and unsafe physical factors, the failure to investigate and treat hidden dangers or the incomplete elimination of hidden dangers has the highest frequency, which is the most important direct factor for the accident. However, in the weight analysis, the lack or defect of safety protective railings ranks first, which can be considered as the most important influencing factor for the accident.

The discussion of this phenomenon shows that the accident factors with high incidence rate are not necessarily the most important factors that cause accidents. Although there are differences in the degree of influence on accidents between two factors, they are related to each other to some extent and are all components of the causes of accidents.

4. Preventive Measures and Countermeasures of Falling Accidents in Building Construction

4.1. Measures Against Unsafe Actions and Unsafe States

(1) Through hierarchical weight analysis, it is concluded that the first factor is the lack or defect of safety protective railings, which is reflected in the accident investigation report that safety protective railings are not set. On-site safety management personnel should do a good job in daily safety inspection, check whether there are defects in safety protective railings, and report and rectify them as soon as possible.

(2) Through the analytic hierarchy process, it is concluded that the second factor is that labor protection articles in unsafe actions are not equipped or used incorrectly. Enterprises should regularly distribute labor protection articles to workers, replace long-term use or unqualified labor protection articles, and

record the use of workers' labor protection articles.

(3) In the result of hierarchical weight analysis, the weight of risky operations in unsafe actions ranks third. In order to prevent such factors, the actions and operations of personnel at the construction site should be strictly regulated, and it is forbidden for operators to work at heights during the rest period of construction projects, and it is forbidden for operators to enter and exit and pass through areas with high construction risks.

4.2. Measures against Habitual Behavior

(1) The results of hierarchical weight analysis show that the lack of safety awareness ranks first, followed by the lack of safety knowledge. Therefore, construction enterprises should formulate scientific, reasonable and effective training programs, and regularly organize employees to learn safety rules and regulations and conduct regular assessments, enhance their professional skills, establish the safety awareness of enterprise employees, and do not take up their posts without training.

(2) Bad safety habits are the last in the hierarchy weight analysis, but it is also an indirect personnel behavior that causes accidents. In order to cultivate good safety habits of workers, enterprises should not only supervise the activities and behaviors of workers in daily safety management, but also draw closer the relationship between workers and safety work, so that they can realize that their safety habits can promote the development of safety work, thus gradually forming good safety behavior habits and safety culture atmosphere.

4.3. Measures for Safety Management System

(1) From the analytic conclusion of hierarchy weight, we can see that the failure of enterprises to implement the responsibility system for production safety takes the first place. Implementing the responsibility for production safety in an all-round way means that all employees of all departments participate and supervise each other. Everyone should sign the responsibility book for production safety and manage their own production activities to ensure production safety.

(2) The imperfection of safety management system ranks second in hierarchical weight analysis. In order to avoid the confusion of safety management institutions, enterprises should establish and improve the safety production management system and improve the existing safety production management system according to the actual situation of construction projects.

(3) Lack of construction qualification and imperfect safety operation procedures rank high in the hierarchy weight analysis, indicating that these two factors are more important influencing factors in the imperfection of safety management system. Construction projects of enterprises should organize the formulation of construction schemes and construction planning policies, carry out periodic investigation and management of hidden dangers of accidents in various stages of construction in a planned way, constantly improve safety operation procedures and formulate corresponding safety technical regulations.

4.4. Measures against Safety Culture

(1) In the hierarchy analysis of safety culture index factors, the first priority is that the main responsibility of safety production is not clear. The countermeasures for accident prevention put forward in this situation are to establish and improve the responsibility system for production safety, implement the main responsibility of the project leader in the form of responsibility contract according to the requirements of laws and regulations, formulate the policy of project safety production plan, and truthfully record the operation behavior and production activities of the operators before and after each high-altitude operation as evidence for determining the responsibility for accidents in the future.

(2) The second place in the hierarchy analysis of safety culture indicators is the lack of safety training demand. This enterprise should attach importance to safety training and education, strengthen safety technical disclosure, and create a learning atmosphere of safety culture.

(3) The lack of leadership responsibility and the lack of enterprise safety management rank third and fourth in the index weight. According to the analysis results, enterprise leaders should attach importance to and support safety work and provide reasonable safety investment.

5. Summary

From the above analysis, it can be seen that China's construction industry needs to pay attention to site safety, especially the safety of working at heights, take targeted measures from the aspects of people, materials, environment and safety management to prevent and reduce the occurrence of falling accidents at heights, do a good job in site safety management and improve the safety management level of enterprises.

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