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RESEARCH ARTICLE

Development of Safety Assessment Framework for Industrialised Buildings Construction in China Using Analytic Hierarchy Process (AHP)

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ABSTRACT - This study focuses on the safety assessment of industrialised buildings in China. Given the marked differences in safety risks between industrialised and traditional buildings, this paper uses a literature analysis method to identify factors affecting the safety of industrialised buildings. These risk factors are further verified through interviews and questionnaires. Using the Analytic Hierarchy Process (AHP), this research establishes a safety rating framework that analyses the impact of people, materials, machinery, technology, management, and environment on the safety of industrialised buildings and assigns appropriate weights to these factors. The findings suggest that management plays a critical role in the success of industrialised building projects and that environmental factors, although less considered in current practice, also have an impact on the safety of industrialised buildings. There are some differences in the importance attached to these criteria by professionals from different backgrounds, and therefore the management of safety in industrialised buildings needs to take sufficient account and balance the perspectives and needs of different stakeholders.

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1. INTRODUCTION

Industrialised buildings are crucial to the future development of the construction industry, as they can significantly improve the efficiency and quality of buildings, while contributing to the achievement of sustainable development goals, particularly in terms of energy efficiency, emissions reduction and efficient use of resources [1]. Industrial buildings are characterised by the use of prefabricated components, an emphasis on standardised and modular design, and the achievement of efficient and rapid construction. This type of buildings improves building quality and construction efficiency by producing components in the factory, while reducing the time and cost of on-site construction [2]. Compared to traditional buildings, the safety problems of industrialised buildings are mainly related to the safety risks during the transport and assembly of prefabricated components, and to the higher skill requirements for construction workers operating highly standardised and automated equipment [3]. Furthermore, as industrialised buildings are designed and manufactured with great precision, any design or manufacturing defects can potentially lead to safety hazards. Consequently, it is necessary to implement more rigorous quality control and inspection procedures to ensure the safety of the public [4].

The current safety assessment of industrialised buildings faces a series of issues. Firstly, it is important to note that the characteristics and risks associated with industrialised buildings are very different from those of traditional buildings. This is due to the use of prefabricated components, factory production and on-site assembly, among other factors. Consequently, it is evident that these unique risk points are often not adequately taken into account in existing safety assessment methods [5]. Therefore, the safety assessment methods and criteria system of traditional buildings cannot be fully suitable for industrialised buildings, causing the assessment results to not reflect comprehensively and accurately the safety status of industrialised buildings [6]. Secondly, there is a lack of uniform standards and criteria for safety assessment in the field of industrialised buildings. This means that different assessment methods and standards may be used for different projects, making it difficult to effectively compare assessment results and to develop safety assessment guidelines that are generally accepted in the industry. The lack of such standards and norms not only affects the accuracy of safety assessments, but also hinders the improvement of safety management in the industry [7]. The current methods employed for the assessment of safety tend to rely excessively on qualitative analyses, with inadequate quantitative analysis support. These results in safety assessment outcomes that may be influenced by subjective judgments, making it challenging to provide an objective reflection of the safety risks associated with industrialized buildings. Furthermore, these methods tend to overlook the safety risks associated with the entire life cycle of industrialised buildings. This includes the safety concerns that arise at each stage of the design, manufacturing, transportation, assembly, and utilisation processes [8].

Compared with the traditional model, industrialised buildings' safety assessment features include the whole process, all-round and dynamic safety management strategy, hazard source identification, evaluation and analysis of safety influencing factors, analysis of comprehensive safety assessment system and construction of safety assessment model [9].

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All these features are designed to ensure the quality and safety of the project, reduce the probability of safety accidents in the construction phase of industrialised buildings, and promote the successful achievement of quality objectives. These measures likewise help to improve work efficiency, reduce labour intensity, reduce environmental pollution and improve work safety [10]. Therefore, in order to improve the scientificity and accuracy of the safety assessment of industrialised buildings, there is an urgent need to develop and improve the safety assessment methods and index system applicable to the characteristics of industrialised buildings. This includes the establishment of uniform safety assessment standards and norms, the introduction of more quantitative analysis tools, and the consideration of safety risks throughout the life cycle of industrialised buildings. Through these measures, the safety risks of industrialised buildings can be assessed and managed more effectively to promote the healthy and sustainable development of the field. Based on this, the objective of this study is to identify and rank the safety issues and their influencing factors in industrialised buildings, and then to construct a safety assessment framework for industrialised buildings based on Analytic Hierarchy Process（AHP）.

2. LITERATURE REVIEW

2.1 Accident theory and the "4M1E" theory

The development of accident theories has its origins in the early 20th century, when the main focus was on analysing the causes of industrial and traffic accidents [11]. Over time, these theories evolved and included more complex and diverse elements. Early theories, such as H.W. Heinrich's Domino Theory, mainly emphasised the importance of individual behaviour and serial errors. Then, with the introduction of Systems Theory, it began to be recognised that accidents are not just the result of individual errors, but are also related to interactions in complex systems. James Ritson's Swiss Cheese Model further developed this theory by highlighting the alignment of vulnerabilities and systemic failures in multi-layered defence systems [12]. In addition, Man Factors Theory and Multiple Causation Theory, among others, have explored the complexity of accidents in greater depth, stating that accidents are usually the result of a combination of man error, technical failures, organisational management problems and environmental factors [13]. The development of these theories has not only enhanced our understanding of the causes of accidents, but also provided a solid theoretical basis for modern safety management and the development of preventive measures.

The "4M1E" theory of modern construction safety management also provides us with a comprehensive framework for analysing and understanding the safety of industrialised buildings. The "4M1E" theory points out that the safety and efficiency of any production system are influenced by five elements: man, machine, material, method and environment [14]. In the field of industrialised buildings, the impact of these elements on safety management is particularly significant. However, the "4M1E" approach places both technology and management in the "method" category. Technology mainly refers to factors related to the construction process, etc., and management mainly refers to factors related to construction organisation, system, etc. They have different characteristics, degrees of influence, and preventive measures that need to be analysed and processed separately [15]. The separation of technology and management is conducive to clarifying the responsibilities and obligations of all parties and improving the efficiency and effectiveness of construction safety management.

2.2 Industrialised buildings safety issues and risk factors

According to the accident theory and the "4M1E" theory on the division of safety risk, the safety risk issues affecting industrialised buildings are divided into six issues: man, machine, material, technology, management, and environment.

This research used literature analysis to identify safety risk factors in industrialised buildings. In order to ensure that the industrialised construction safety risk factors identified by the literature analysis method were representative, literature with higher citation frequency should been used as much as possible when selecting literature. In this research, a total of 32 industrialised buildings safety risk factors were identified from the literatures, as shown in Table 1.

Table 1. Safety risk factors in industrialised buildings in the relevant literature

No.	Issue	Factor	Literature sources
1	Man	Poor physical and mental health of worker	[16];
2		Weak safety awareness among worker	[17], [18];
3		Lack of responsibility among worker	[19];
4		Low education level of workers	[20];
5		Short experience of construction worker	[21]; [22];
6		Worker's low skill level	[23];
7		Worker's operational errors	[23];

Table 1. (cont.)

No.	Issue	Factor	Literature sources
1	Material	Low precision of prefabricated components	[24] ; [25];
2		Insufficient strength of prefabricated components	[26]; [25];
3		Inadequate quality control of incoming construction materials	[26];
4		Unqualified quality of materials	[26]; [25];
1	Machines	Mismatch between machinery and equipment and work	[27];
2		Unstable temporary support equipment	[27]; [28];
3		Improper selection of hoisting machinery	[27]; [28];
4		Inadequate maintenance of mechanical equipment	[28];
1	Technology	Improper selection of mechanical equipment and auxiliary spreaders	[28];
2		Overloaded lifting	[28];
3		Improper positioning of lifting points	[29];
4		Unreliable prefabricated component installation connections	[30];
1	Management	Lack of safety protection measures	[31];
2		Inadequate configuration of safety warning signs at construction sites	[15]; [10]
3		Lack of safety education and training	[10];[32]
4		Lack of management responsibility of site managers	[33];
5		Inadequate safety inspection and supervision	[34];
6		Lack of emergency management mechanism	[34]; [35];
1	Environment	Impact of natural disasters	[36];
2		Narrow working area for construction workers	[37];
3		Collision of component transport vehicles	[37]; [38]
4		Overturning of component vehicles	[38];[39]
5		Poor lighting conditions	[38];[39]
6		Impact of climatic conditions	[36];
7		Poor working conditions in the work area	[37];[38];

3. METHODOLOGY

This research used the interview method to validate the risk factors affecting the safety of industrialised buildings identified through the literature review. The importance of the identified risk factors for industrialised buildings safety was analysed by the questionnaire survey method. Analytic Hierarchy Process (AHP) was used to construct a safety assessment framework for industrialised buildings and give the corresponding weights for each indicator.

3.1 Interview

The interview involved 20 managers of prefabricated factories, managers of industrialised buildings contractors, scholars, and government policy makers. Respondents came from Fujian Province in the east, Hubei Province in the centre and Shaanxi Province in the west of China. The purpose of the interviews was to validate the safety risk factors in Table 1 and to ask the interviewees to make a judgement on the importance of the above safety risk factors affecting industrialised buildings projects based on their past experiences and their opinions. The interview time for each respondent was approximately 20–30 minutes. The information about the interviewees is shown in Table 2.

Table 2. Interview experts' composition

No.	Position	Background	Number	Proportion
1	Managers	Manufacturers	5	25%
2	Managers	Contractors	6	30%
3	Professor	Scholars	6	30%
4	Policy makers	Government	3	15%

Through interviews, it was found that " Short experience of construction worker," " Worker's low skill level," and " Worker's operational errors," " Inadequate quality control of incoming construction materials " and " Unqualified quality of materials," " Lack of safety protection measures " and "Imperfect allocation of safety warning signs at the construction site," "Lack of management responsibility of site managers " and " Inadequate safety inspection and supervision," " Narrow working area for construction workers," " Poor lighting conditions," and "Poor working conditions in the work area," " Collision of component transport vehicles " and "Overturning of component transport vehicles" are among the 14 factors that at least seven experts believe share similarities and should be merged. After reorganisation, there are 24 factors affecting the safety risks of industrialised construction. Based on these 24 risk factors, corresponding safety evaluation indicators have been developed as shown in Figure 1.

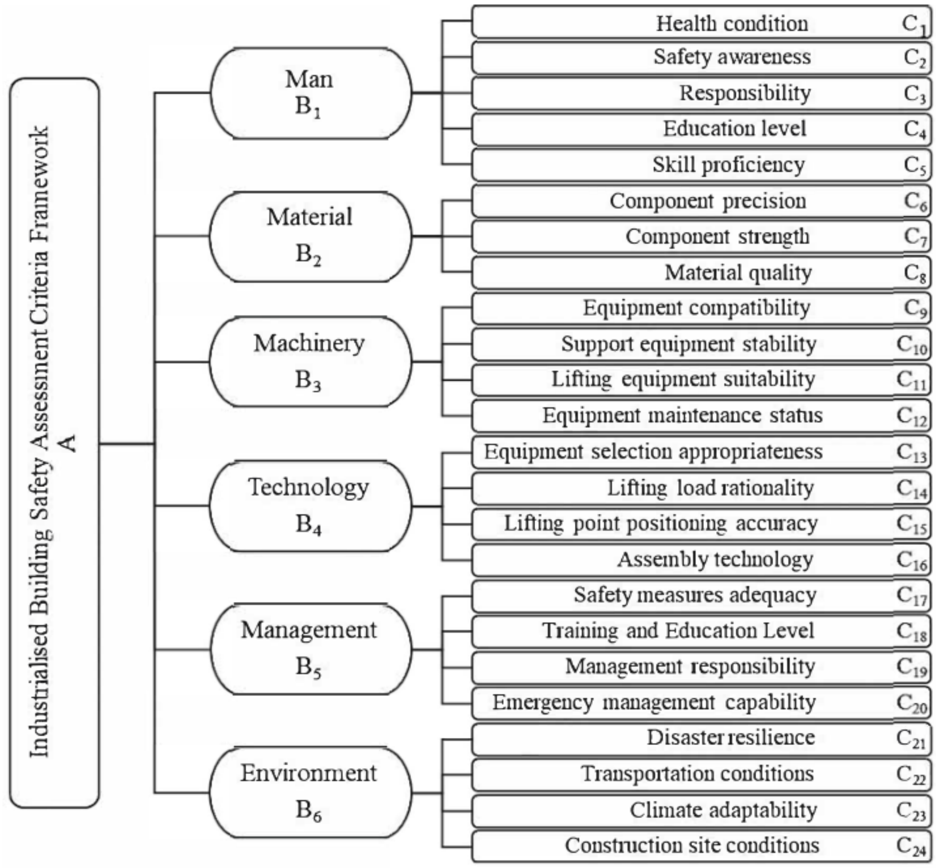


Figure 1. Industrialised buildings safety assessment criteria framework

3.2 Questionnaire

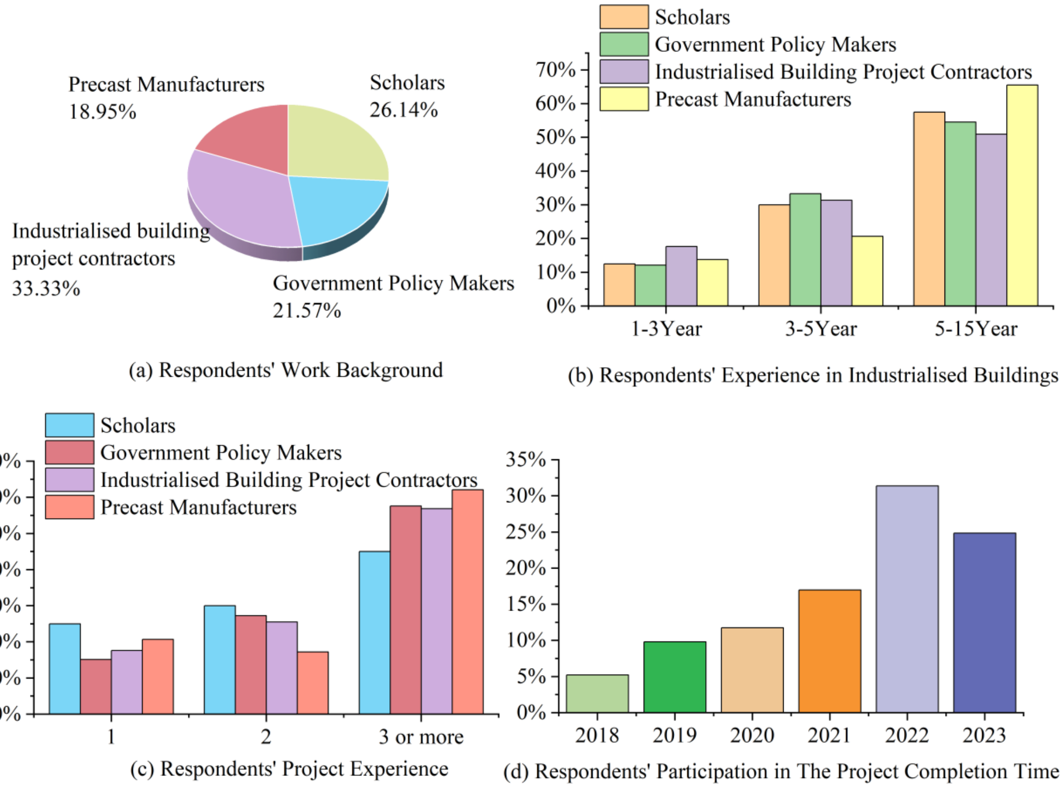
Based on the identified safety risk factors affecting industrialised buildings, a questionnaire was used to conduct the study. The questionnaire was designed in three parts. The first part collects and analyses information about the research respondents, with the aim that the questionnaire should be addressed to a specific group of people with relevant experience in industrialised buildings projects. The second section was designed to collect the respondents' perceptions of the importance of the identified influencing factors using a 5-point Likert scale, which was designed to collect the respondents' perceptions of the importance of each safety risk factor. The third part is about "Developing a new safety assessment criteria framework for industrialised buildings", which uses Saaty's 1-9 scale to compare the importance of the main criteria and sub-criteria such as man, material, machine, technology, method, and environment of industrialised buildings projects in Figure 1 according to AHP requirements, so as to collect the data for the calculation of the weights of each criteria.

Industrialised buildings projects from completed or under construction between 2018 and 2023 were selected for this study to ensure the timeliness and relevance of the data. The questionnaire was selected to be distributed to prefabricated component plant managers, industrialised buildings contractors, academic researchers in the field of industrialised buildings, and government safety policy makers. This selection was based on a deep understanding of the specialised nature of industrialised buildings projects and ensured that representative and authoritative information was obtained from the main participants.

4. RESULTS

4.1 Analysis of the Questionnaire Sample

In this study, 172 questionnaires were returned, of which 153 were valid samples. Among the respondents of this questionnaire, a wide range of working backgrounds, such as Precast component manufacturers, industrialised buildings project contractors, scholars, and government policy makers, were covered, with the largest proportion of contractors in industrialised buildings projects. In terms of experience, the vast majority of respondents had 5 to 15 years of experience in the industry, accounting for 67.32% of the total sample, indicating that the participants generally had a wealth of practical work experience. Regarding participating in projects, participating in three or more projects is dominated, representing 55.2% of the total sample. In addition, the majority of the participating projects' assembly rates are spread out at less than 30%, accounting for 46% of the projects, reflecting the sample group's broad experience with projects of varying assembly rates. The project completion time is mainly concentrated in 2021-2023, a figure that reflects the active development trend of assembly building projects in recent years. The relevant situation is shown in Figure 2.



(a) Respondents' Work Background

(b) Respondents' Experience in Industrialised Buildings

(c) Respondents' Project Experience

(d) Respondents' Participation in The Project Completion Time

Figure 2. Statistics on Respondents to the Questionnaire

In this research, SPSS was used to test the variables in the validated questionnaire, and the results are shown in Table 3. The Cronbach's alpha coefficient of this questionnaire is greater than 0.8, and the data collected by the questionnaire are reliable and trustworthy, with good internal consistency. The higher the reliability, the higher the internal consistency.

Table 3. Statistics of risk factor reliability

Cronbach's Alpha	Item	Indication
0.883	24	Good

KMO and Bartlett were used to test the validity of the collected questionnaire data. The results are shown in Table 4, demonstrating a high correlation between the criteria set for the questionnaire and the fulfilment of the validity requirements.

Table 4. KMO and Bartlett sphericity tests for risk factors

KMO		0.826
Bartlett's Test of Sphericity	Chi-Square	2640.605
	df	300
	p	0.000

Exploratory factor analysis (EFA) was also conducted in this research. For easy viewing, only the maximum loading values for each factor and principal component were retained in the rotated matrix (Table 5). The results indicated that the safety risk factors of industrialised buildings were downgraded to six principal factors with a cumulative variance contribution of 76.926% (>60%), which indicated that the downgrading of 24 factors to six principal factors was justified, and that the classification of the safety risk factors of industrialised buildings into the six dimensions of man, machine, material, technology, management and environment was reasonable.

Table 5. Rotation component matrix

Items	Factor Loadings					
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Workers' poor physical and mental health	0.871					
Worker personnel's weak safety awareness	0.632					
Workers' lack of responsibility	0.882					
Workers' low level of education	0.873					
Workers' low technical level	0.812					
Precast components with low precision						0.814
Precast components are not strong enough						0.887
Material quality is not up to standard						0.878
Machinery and equipment not matching the work		0.857				
Temporary support equipment unstable		0.867				
Lifting machinery improperly selected		0.853				
Machinery and equipment maintenance are not in place		0.899				
Mechanical equipment and auxiliary spreaders are not properly selected			0.866			
Overloaded lifting			0.835			
Lifting points improperly positioned			0.869			
Unreliable prefabricated component installation connections			0.821			
Lack of safety protection measures					0.857	
Lack of safety education and training					0.849	
Lack of management responsibility of site managers					0.844	
Lack of emergency management mechanism					0.861	
Natural disaster impacts				0.871		
The components are transported in poor conditions				0.802		
Climatic conditions				0.859		
Working areas with poor construction conditions				0.862		

Table 6 shows the ranking of the 153 samples on the importance of safety risks in industrialised buildings in Part II of the questionnaire. As can be seen from the Table 7, the average score for each of the 24 safety risk factors was more than 3, indicating that the level of importance of these factors falls into the more important and very important categories. By analysed the mean scores and standard deviations of the factors, we were able to identify the factors that were considered to be the most critical in the management of safety in Industrialised buildings. Specifically, the lack of safety education and training (mean 4.314) and the lack of emergency management mechanisms (mean 4.320) were identified as the most important factors affecting Industrialised buildings projects, which emphasises the importance of better safety education and effective emergency management mechanisms in preventing accidents and improving safety. In addition, low skill levels of workers (mean 4.246) and overloaded lifting (mean 4.288) were also seen as important factors and respondents felt that skills training for workers and regulation of lifting operations were very necessary. At the medium level of concern, weak safety awareness among worker personnel (mean 4.183) and low precision of prefabricated components (mean 4.170) scored relatively high but slightly lower than the most critical factors. Respondents felt that the areas of improving worker safety awareness and improving component quality needed continued attention. Factors of relatively low concern included mismatch between mechanical equipment and work (mean 3.366) and instability of temporary support equipment (mean 3.359). However, the standard deviation of these two factors was the highest among all the factors at 1.056 and 1.074 respectively, indicating that there were wide variations in the perception of the importance of these two factors among different respondents.

Table 6. Mean and standard deviation of safety risk factors in industrialised buildings

Items	Mean	Standard Deviation
Lack of emergency management mechanism	4.320	0.802
Lack of safety education and training	4.314	0.782
Overloaded lifting	4.288	0.848
Workers' low technical level	4.246	0.868
Worker personnel's weak safety awareness	4.183	1.009
Precast components with low precision	4.170	0.817
Lack of safety protection measures	4.158	0.864
The components are transported in poor conditions	4.153	0.782
Workers' poor physical and mental health	3.641	1.004
Workers' low level of education	3.634	0.998
Precast components are not strong enough	3.634	0.998
Lifting points improperly positioned	3.634	0.992
Material quality is not up to standard	3.575	0.971
Workers' lack of responsibility	3.562	1.025
Working areas with poor construction conditions	3.529	0.939
Natural disaster impacts	3.529	0.974
Lack of management responsibility of site managers	3.523	1.007
Unreliable prefabricated component installation connections	3.516	0.918
Mechanical equipment and auxiliary spreaders are not properly selected	3.516	0.981
Climatic conditions	3.510	0.947
Machinery and equipment maintenance are not in place	3.425	1.005
Lifting machinery improperly selected	3.379	1.020
Machinery and equipment not matching the work	3.366	1.056
Temporary support equipment unstable	3.359	1.074

4.2 AHP Analysis

According to the AHP method, this research developed and calculated the judgement matrix for each criterion level based on the data from the third part of the questionnaire, and the consistency ratio of the matrix is less than 0.1, which showed that the results were satisfactory. The weights of each criterion and its ranking are shown in Table 7.

Table 7. Industrialised building safety assessment criteria weights

Items			Weights（%）			
			Scholar	Government Policy Maker	Industrialised building project contractor	Precast Manufacturer
Criteria						
Man		B_1	18.2	18.1	17.1	17.1
Material		B_2	14.5	14.1	14.4	14.7
Machinery		B_3	15.9	17.0	16.6	16.1
Technology		B_4	18.6	18.6	18.2	18.5
Management		B_5	20.1	19.5	19.6	18.5
Environment		B_6	12.7	12.7	14.2	14.9
Sub-Criteria						
Man	Health condition	C_1	15.0	11.9	13.8	14.2
	Safety awareness	C_2	20.6	26.2	22.8	23.1
	Responsibility	C_3	16.9	25.5	20.3	20.6
	Education level	C_4	15.6	12.9	14.5	14.3
	Skill proficiency	C_5	31.9	23.5	28.6	27.8

Table 7. (cont.)

Items			Weights（%）			
			Scholar	Government Policy Maker	Industrialised building project contractor	Precast Manufacturer
Material	Component precision	C_6	34.2	33.5	39.4	30.9
	Component strength	C_7	32.1	32.3	35.2	34.9
	Material quality	C_8	33.7	34.2	25.4	34.2
Machinery	Equipment compatibility	C_9	21.1	24.3	22.4	22.6
	Support equipment stability	C_{10}	22.1	30.5	25.5	26.1
	Lifting equipment suitability	C_{11}	34.7	28.7	32.2	31.8
	Equipment maintenance status	C_{12}	22.1	16.5	19.9	19.5
Technology	Equipment selection appropriateness	C_{13}	31.6	37.8	35.2	34.8
	Lifting load rationality	C_{14}	20.2	21.7	20.6	20.8
	Lifting point positioning accuracy	C_{15}	25.9	22.9	24.6	24.6
	Assembly technology	C_{16}	22.3	17.6	19.7	19.8
Management	Safety measures adequacy	C_{17}	20.3	21.4	20.7	20.8
	Training and Education Level	C_{18}	35.7	27.9	26.3	26.5
	Management responsibility	C_{19}	18.8	16.7	18.0	17.8
	Emergency management capability	C_{20}	25.2	33.9	35.0	34.9
Environment	Disaster resilience	C_{21}	33.1	34.5	15.5	31.1
	Transportation conditions	C_{22}	34.8	33.4	34.5	37.9
	Climate adaptability	C_{23}	14.9	15.1	15.5	14.0
	Construction site conditions	C_{24}	17.3	17.0	34.5	17.0

5. DISCUSSION

An analysis of the weighting of the criteria in Table 8 shows that there is general agreement among the different professional bodies on the six criteria for safety assessment of industrialised buildings: man, material, machinery, technology, management, and environment, but there is some disagreement on the specific criteria. There was a general consensus on the significance of human resources in the main factor. Regarding materials, there was a common acknowledgment of the critical role that material quality and precision play in safety, despite varied opinions. The machinery factor is valued by all parties for ensuring construction safety and efficiency. The importance of the technology domain is closely associated with construction methods and innovation. Management is considered the most critical factor for the smooth progression and risk control of industrialised construction projects. Although environmental factors are generally given lower weights compared to other criteria, industrialised construction contractors are more sensitive to them because environmental conditions directly affect the safety and process of on-site construction. The similarities and differences in these viewpoints reflect the diverse perspectives and emphasis levels on the safety assessment standards of industrial construction.

In the criteria of industrialised construction safety assessment, "skill proficiency" and "responsibility" are highly prioritised, reflecting the crucial role of high skill levels in ensuring construction safety. Skilled workers possess a better understanding and execution of complex construction tasks, thereby facilitating the completion of construction assignments more effectively [23]. Government decision-makers place a higher emphasis on "safety awareness," highlighting their significant role in promoting safety culture and elevating public safety consciousness. As governmental institutions are usually responsible for establishing safety standards and policies, their focus on the dissemination and enhancement of safety awareness is integral to ensuring adherence to industry safety norms and effective accident prevention.

Within the materials category, "component precision" and "component strength" receive considerable emphasis, underscoring the importance of material manufacturing. The high weights assigned to "material quality" by prefab manufacturers and government decision-makers demonstrate their concern for product quality. In the machinery category, the "suitability of lifting equipment" is highly valued across all groups, indicating a universal belief in the importance of selecting appropriate lifting equipment for the safety of industrialised construction projects.

Regarding technology, contractors and prefab manufacturers assign high importance to "assembly technology." This focus likely stems from their pursuit of precision in component products and construction processes, as well as considerations of market competitiveness [40]. In the management category, "emergency management capabilities" and "training and education level" are recognized as important by all parties, with scholars particularly emphasizing the latter, indicating a strong interest in elevating industry standards [41].

In the environmental category, contractors pay special attention to "construction site conditions," reflecting a deep understanding of the impact of the site environment. Conversely, "climate adaptability" generally receives lower priority, suggesting that in the field of industrialised construction, adaptability to climate factors is considered a secondary concern. These findings reveal the diverse emphases of different professional groups on safety assessment criteria based on their roles and needs, underscoring the importance of integrating multiple aspects in safety management practices [42].

6. CONCLUSION

This study focuses on assessing the safety of industrialised buildings in China and presents a comprehensive framework. Starting with a literature review, the study identifies safety risk factors in terms of people, materials, machinery, technology, management and environment. Expert interviews validated these factors and questionnaire results measured perceptions of the importance of these factors. Finally, a safety assessment framework was constructed using the Analytical Hierarchy Process (AHP), which enhanced the systematic nature of the study and provided a quantitative analysis tool. The findings emphasise the key role of management in security and call for increased attention and investment. Environmental factors, although often overlooked, have a significant impact on safety, suggesting that more consideration is needed. The varying importance attached to safety by professionals highlights the importance of balancing the different perspectives of stakeholders. An analysis of the various criteria for safety assessment in industrialised buildings shows that there was a general consensus among different professional groups on the six main criteria (man, materials, machinery, technology, management and environment), but disagreement on the relative importance of specific criteria.

Generally, the man factor of skill proficiency and responsibility was highly valued, as high skill levels and a sense of responsibility were critical to ensuring construction safety, with particular emphasis on safety awareness by government policy makers, reflecting their important role in promoting a culture of safety and raising awareness of public safety. For materials, component accuracy and strength were focussed on as a priority, and the attention given to material quality by prefabricated manufacturers and government policy makers demonstrates the importance they place on product quality. In mechanical factors, the suitability of lifting equipment was generally recognised as critical to ensuring construction safety. In the technical area, contractors and precast manufacturers placed particular emphasis on fabrication techniques, reflecting their quest for precision in the construction process and competitiveness in the marketplace. In management, emergency management capabilities and levels of training and education were recognised as important factors by all groups, with academics paying particular attention to the latter, demonstrating a strong interest in raising industry standards. Of the environmental factors, contractors paid particular attention to construction site conditions, reflecting a deep understanding of the impacts of the on-site environment, while climatic adaptation was generally given lower priority, suggesting that adaptation to climatic factors was considered to be a secondary concern in the field of industrialised construction. The above findings reveal the diverse emphasis of different professional groups on safety assessment criteria based on their roles and needs, highlighting the importance of integrating multiple aspects in safety management practices.

The research provides a theoretical framework and practical methodology for safety assessment of industrialised buildings, to the benefit of policy makers, manufacturers and builders. Shortcomings include the reliance on a limited sample and subjective judgement in the AHP methodology. Future research could focus on expanding the sample, incorporating quantitative data, considering industry dynamics, and analysing the interaction of safety standards to enhance safety management strategies.

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AUTHOR CONTRIBUTIONS

Xue Chen: Original draft preparation, Conceptualization, Methodology

Mohamed Nor Azhari Azman: Supervision and Editing

DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are included within the article.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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