Research on the Extraction of Evaluation Index of University Dormitory Fire Safety

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Abstract: Colleges and universities are an important position of personnel training in China. With the continuous expansion of college enrollment in recent years, the problem of fire safety evaluation in college dormitories is particularly prominent. This paper is based on how to select the evaluation index of university dormitory fire safety through scientific analysis. Based on the analysis and comparison of various kinds of university dormitory fire accidents at home and abroad over the past years, this paper selects the significant data, and combines the relevant high-level literature, studies and analyses the three elements of the accident and the surrounding environment of the University dormitory, and constructs the evaluation system of university dormitory fire safety. Finally, the research is summarized, and the corresponding opinions and suggestions are given for the college dormitory fire safety management.

1. Introduction

College dormitory is one of the places where talents are concentrated in our country. Data show that the number of students enrolled in Chinese universities reached 37 million in 2015, ranking first in the world. China has 2,852 universities of all kinds, ranking second in the world [1]. With the increase of the enrollment of students and the increase of the investment of school building infrastructure, the safety of dormitory has become the focus of campus safety. Especially in recent years, the frequent occurrence of dormitory fires in colleges and universities has aroused wide attention from students, parents and all walks of life. Therefore, in order to effectively guarantee the safety of college dorms and timely suppress the accidents before they happen, it is necessary to conduct relevant fire accident evaluation research on college dorms. Therefore, it is of great significance to develop a scientific evaluation index system for the accurate evaluation of efficient dormitory fire accidents.

At present, there are few researches on the fire evaluation index system of college dormitory in China, but a few scholars have started to explore it. For example, Tian Haomin and Sun Guangcan analyzed and obtained the fire risk evaluation index system of college students' dormitory mainly from three aspects: management system, external factors and internal factors. Through the analysis of accident tree, Wang Shaqiang and Wang Rumeng summarized the comprehensive evaluation index system of college student dormitory building fire. Jiang Yunyou accident is formed by the joint coupling of defects in the four factors of “people-things-ring-management”, and then the first-level index which directly affects the fire risk level of high-rise student apartments in colleges and universities is obtained by combining the expert opinions. When the above scholars studied the fire risk evaluation index system of college dormitory, they were in line with the general idea of research and applied scientific research methods. However, there were still some problems. For example, they did not consider the real data of college dormitory fire, and they lacked specific methods and reasons to establish secondary indexes.
The fire safety evaluation index system of college dormitory is similar to the index system of multi-storey, middle-level or high-rise buildings, but it has different evaluation indexes from ordinary buildings because of the particularity of the place serving college students. This paper collected a large number of college dormitory fire data at home and abroad for many years, analyzed the main factors leading to college dormitory fire, and summarized the first-level index of the evaluation system by referring to a large number of literature. The scientific establishment of the college dormitory fire risk evaluation index system can provide a reasonable reference for the later fire safety evaluation and prediction, and make the college dormitory fire research have practical significance.

2. Construction of fire safety evaluation index system of college student dormitory

Different from other multi-storey and high-rise buildings, the particularity of service group of college dormitory determines its particularity of safety evaluation index, as well as the difficulty of fire safety evaluation and operation and maintenance management of college dormitory. It is necessary to collect enough data of dormitory fire safety evaluation index system to set up scientifically. Through a series of data processing, according to the basic elements of security accidents, figure 1 is obtained.

![Figure 1: Statistics on the Fire Situation of College Dormitories at Home and Abroad in Recent Years](image)

Without considering the unascertained reasons, it can be seen from the figure that the main cause of the fire in the dormitory of college students is the unsafe behavior of people, followed by the unsafe state of things, and the defects in management are also one of the main reasons. According to the above research, and through the relevant experts and teachers to explore analysis, literature query, finally according to the design specification for design of building fire protection will be college students' dormitory fire safety evaluation indicators to consider is: Behavioral factors (A), The state of things affect (B), The management defects (C), Peripheral environment influence (D).

2.1. On the selection of influencing indicators of behavioral factors

In the investigation and research on the fire situation in colleges and universities at home and abroad in recent years, the proportion of accidents caused by people's unsafe behaviors is the largest, which is 57%. Some of the data are shown in table 1. It can be seen that unsafe behaviors are mainly caused by students’ illegal use of electrical appliances, flammable chemicals and smoking in dormitories.
| The cause of fire                      | Proportion |
|--------------------------------------|------------|
| Improper handling of cigarette butts | 3%         |
| Cook over an open flame              | 6%         |
| Privately-introduced wire            | 11%        |
| Use of high power appliances         | 60%        |
| Use of flammable chemicals           | 9%         |
| Others                               | 11%        |

2.1.1. Improper handling of cigarette butts. According to the above data, dormitory fires caused by improper handling of cigarette butts account for 3% of the total fires caused by unsafe behaviors. A survey of 3,716 college students in some universities in Beijing in 2011 shows that the smoking rate of college students is 36.6%, while the current smoking rate is 25.8% [2]. Because of the complex environment with many inflammable materials in the dormitory, once students improperly dispose of cigarette butts after smoking, it is very easy to cause a fire.

2.1.2. Cook over an open flame. The use of open fire is mainly in the dormitory candles, burning debris. For example, when students celebrate their birthdays, they light candles in the dormitory, burn waste paper, cloth and other sundries directly in the dormitory, or light mosquito repellent incense in the dormitory to repel mosquitoes due to excessive mosquitoes in summer. For example, in 1996, a university burned a person due to the use of alcohol stove, and the medical expenses in the early stage were as high as 20,000 yuan [3].

2.1.3. Privately-introduced wire. The following accidents or injuries will be caused if wires are pulled in dormitories without proper safety regulations:

- The electric wire is dragged on the ground, which may be crushed or injured by something hard, thus damaging the insulation;
- Randomly pull wires in inflammable and explosive places, and lack of fire prevention and explosion protection measures;
- Random pulling of the wire is often to avoid people's eyes and ears, tools, materials and other working conditions are poor, wiring often do not use reliable wire clips, but with iron nails or wire binding, the results wear out insulation damaged wire;
- Do not look at the thickness of the wire, arbitrary increase of electrical equipment, make the wire overload heat and so on.

These situations, most can cause a short circuit, spark or heat fire, some will also lead to combustion, explosion, and even cause electric shock casualties. Too much connection of electric wires is likely to generate heat to melt the insulation on the outer layer of the wires and lead to fire accidents. It is necessary to use electrical equipment in accordance with the specifications to reduce the connection of electric wires. At the same time, the power plug nearby should not pile up too much goods, put an end to all kinds of fire accidents.

2.1.4. Use of high power appliances. Some college students randomly load electricity in dormitories and classrooms, causing campus fires and causing heavy losses of personnel and property [4]. Overload use of high-power electrical appliances (e.g. rice cookers, hair dryers, heaters) will make the equipment unable to withstand such high voltage and cause burning or even fire.

2.1.5. Use of flammable chemicals. Under normal circumstances, inflammable chemicals will not be brought to the dormitory by students in violation of regulations. Usually, fire accidents caused by inflammable chemicals occur in laboratories or teaching buildings. However, due to students' curiosity,
they will try to bring chemical experiments back to the dormitory, which will increase the probability of fire accidents and cause unnecessary loss of personnel and property.

To sum up, the secondary indicators to be determined for the influence of behavioral factors are: A1 Improper handling of cigarette butts; A2 Cook over an open flame; A3 Privately-introduced wire; A4 Use of high power appliances; A5 Use of flammable chemicals.

2.2. Selection of the Index of the Impact of the Insecurity State of Things

Most dormitories in Colleges and universities, especially those that have been built for a long time, have been used for more than several decades. The building structure cannot meet the requirements of fire prevention. The building equipment is old and there are many factors causing fire in buildings. Referring to the literature [5], it is concluded that the unsafe state of dormitories in Colleges and universities is mainly as follows:

2.2.1. Electrical equipment is old. The old distribution equipment in some colleges and universities leads to many hidden dangers, especially during the peak load period, which can easily lead to fire or damage of electrical equipment. Therefore, the old electrical equipment has become an important factor in evaluating the fire risk of University dormitories.

2.2.2. Fire facilities are not complete. The incompleteness of fire fighting facilities is mainly reflected in the absence and failure of fire extinguishers, the absence of smoke spray and the absence of fire doors. No matter what kind of situation, it will lead to the failure to take effective rescue measures in time after the disaster happened, and the fire situation cannot be controlled in time, resulting in greater loss of personnel and property.

2.2.3. The form of building structure is not up to standard. Most university dormitories belong to the old buildings of the last century. Their compact structure, narrow evacuation passages and too few evacuation outlets are far from satisfying the situation of large enrollment expansion in Universities after the new century and the rising number of residents in dormitories. Once a fire occurs, it is often difficult for people to evacuate in time, so the building structure of university dormitories should be taken as an evaluation factor.

Therefore, various unsafe things in university dormitories can be used as the elements of fire risk assessment, namely: B1 Old electrical equipment; B2 Incomplete fire fighting facilities; B3 Building structure form is not up to standard. These three items basically cover all the forms of unsafe state of things, and have the basic requirements of selecting risk evaluation indicators.

2.3. Selection of Management Defect Impact Indicators

With the rapid development of social economy, the logistics management of colleges and universities has been reformed, which makes the safety management of students' dormitories more difficult. The common problems of dormitories in Colleges and universities are: large population density, backward safety supporting facilities, unprofessional safety management personnel, lack of professional safety training for dormitory staff, immature psychology of dormitory staff, impulsive work, lack of necessary social security awareness, etc. These problems will lead to problems. There are some potential safety hazards [6].

In addition, the occurrence of dormitory fires in Colleges and universities is mostly due to the lack of safety personnel, resulting in inadequate safety inspection, which makes many things in dormitory buildings unsafe. Therefore, the Influencing Indicators of defects in dormitory management in Colleges and universities can be chosen as follows: C1 Population density is large; C2 Security management personnel are not professional; C3 Security inspection is not in place; C4 Resident students lack training exercises; C5 Students' security awareness is immature.
2.4. Selection of Environmental Impact Indicators

2.4.1. Impact of climate and environment. In college fire prevention work, especially in winter, students' heating must be the focus of dormitory fire prevention work [7]. In winter, the climate is relatively dry, students have more indoor activities, and the use rate of heating appliances increases. These conditions make the incidence of campus fires increase. Once disasters occur, it is very difficult to evacuate.

2.4.2. The influence of inadvertent use of fire by neighbouring residents. The early universities in our country are generally located in the center of the city. The surrounding residential areas are complex, the residential areas are relatively old, and are prone to various kinds of fires. In addition, there are various kinds of snack stalls around universities, mostly using traditional cooking utensils such as gas cans and alcohol stoves, coupled with poor supervision by the relevant local departments, which easily cause fires to be linked to the dormitory areas of nearby colleges and universities.

2.4.3. Influences of combustibles around school buildings. College dormitories are mostly buildings, with roads, trees, grasslands and power distribution equipment (such as power distribution boxes), so when a fire happens outside the building, it will spread quickly to the dormitory building, which will lead to the fire damage to the dormitory.

Therefore, according to the above summary, the impact indicators of the surrounding environmental factors can be divided into: D1 Impact of climate and environment; D2 The influence of inadvertent use of fire by neighbouring residents; D3 Influences of combustibles around school buildings.

3. Establishment of fire safety evaluation index system for university dormitories

In summary, under the guidance of the first-level indicators, a total of 16 secondary indicators have been established, which basically includes all the factors needed for the fire safety evaluation of University dormitories. Specific indicator system can be seen in Table 2.

| First-level indexes       | Second-level indexes                                      |
|---------------------------|----------------------------------------------------------|
| Behavioral factors (A)    | Improper handling of cigarette butts A1                  |
|                           | Cook over an open flame A2                               |
|                           | Privately-introduced wire A3                             |
|                           | Use of high power appliances A4                          |
|                           | Use of flammable chemicals A5                            |
|                           | Old electrical equipment B1                              |
|                           | Incomplete fire fighting facilities B2                    |
|                           | Building structure form is not up to standard B3          |
|                           | Population density is large C1                           |
| The state of things       | Security management personnel are not professional C2     |
| affect (B)                | Security inspection is not in place C3                    |
|                           | Resident students lack training exercises C4              |
| The management defects (C)| Students' security awareness is immature C5              |
| Peripheral                | Impact of climate and environment D1                     |
4. Summary
The selection of fire safety evaluation index for university dormitories has always been a major problem in the industry. This paper establishes a fire evaluation index system for university dormitories based on the three factors of accidents and the surrounding environment of University dormitories, and summarizes the following points according to the relevant factors:

4.1. In order to effectively reduce the rate of fire accidents in Colleges and universities, it is necessary to start with the unsafe behavior of people, the unsafe state of things, the defects in management and the surrounding environment of the school buildings, reduce the threshold of relevant elements, ensure the safety of people's behavior norms, the state of things, strengthen management and reasonably reduce the occurrence of environmental accidents around them.

4.2. Among the four first-level indicators, the biggest accident rate is the unsafe behavior of students, so in order to reduce the accident rate, first of all, students should be given necessary ideological education, and secondly, regular safety training should be carried out to effectively control the fire incidence.

4.3. In unsafe behavior, the biggest factor causing accidents is the use of high-power electrical appliances by students. Therefore, in the management of school buildings, students should be strictly controlled to use all kinds of high-power electrical appliances, or put forward other ways to enable students to actively use low-power electrical appliances.

4.4. This article mainly draws the corresponding conclusion based on the accident three elements, a large number of data and literature experience, which is relatively scientific and reasonable.

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