

Construction of Evaluation Index System for Comprehensive Management of University Laboratory Safety

Dawei Zhang*

College of Information Engineering, Liaodong University, Dandong, China
zhangdawei@elnu.edu.cn

*Corresponding author

Abstract: University laboratory safety management is an important part of laboratory construction, but also the premise of other work, and more closely related to the life safety and health of teachers and students. Based on the ideas and methods of system engineering, this paper constructs a first-level evaluation index system consisting of "safety management rules and regulations, hazardous chemicals management, instruments and equipment management, waste management, emergency and first aid management, safety education management, laboratory health management" through comprehensive literature analysis and investigation. Each level 1 indicator contains four level 2 indicators, and a brief description of each level 1 indicator is given. The research results of this paper solve the key problems in the evaluation of laboratory safety comprehensive management in universities, and have important significance for improving the level of laboratory safety comprehensive management in universities.

Keywords: laboratory safety; comprehensive governance; evaluation index system; structural model

1. Introduction

University laboratory refers to the places and facilities affiliated to universities engaged in teaching and scientific research and other experimental training and other teaching activities. Safety management is through a series of management means such as laws and regulations, departmental rules and local policies, to ensure that the situation is in a safe state of function, the purpose is to protect public property from damage, to protect workers in the process of labor events personal safety is not harmed, and then promote the organization to optimize management and improve efficiency. University laboratory safety management is an important part of laboratory construction, but also the premise of other work, and more closely related to the life safety and health of teachers and students. University laboratories undertake dual tasks of teaching and research, and laboratory safety management is complex and difficult. How to ensure the routine and systematic management of laboratory safety is a crucial subject for universities at the present stage [1].

At present, there are many problems in the safety management of university laboratories [2,3], including the lack of sufficient demonstration and detailed planning for laboratory construction, non-standard management of dangerous goods and waste disposal, weak safety awareness of teachers and students, poor ability to deal with emergency accidents, lack of detailed safety management according to the specific characteristics of the laboratory, and difficult implementation of safety hazard analysis and closed-loop management. University laboratory safety management aims to use modern management methods to ensure the personal safety of teachers and students, equipment integrity, and normal and orderly teaching and scientific research activities in university laboratories. Through the analysis and research of various unsafe factors in university laboratories, corresponding and effective measures are taken to eliminate all kinds of unsafe factors in laboratories and prevent laboratory safety accidents.

With the continuous development of economy and science and technology, the Ministry of Education has higher requirements on the teaching quality and scientific research ability of institutions of higher learning. In order to improve the ability of scientific research and promote the development of scientific research and teaching activities, we have increased the investment in all kinds of laboratory funds and purchased more advanced experimental equipment. The scale of the laboratory continues to expand, the function of the laboratory is constantly upgraded, but the ensuing laboratory

safety problems such as experimental drugs and liquid waste gas are not properly dealt with, which has laid a hidden danger for the laboratory safety management. The hidden danger of laboratory safety will not only affect the normal scientific research and teaching progress, but also have a very adverse social impact. Therefore, according to the actual situation and development requirements of the laboratory, a reasonable and effective laboratory safety standardization management system is established by summarizing the current situation, use and existing problems of the laboratory, which plays an important role in the smooth progress of scientific research, the life and health of researchers and the safety of laboratory property [4]. The comprehensive management and evaluation of university laboratory safety is an important content of safety management, and the construction of evaluation index system is the basic work of the evaluation. Based on the principles and methods of system engineering, this paper constructs the evaluation index system of comprehensive management of laboratory safety in colleges and universities, which is conducive to the implementation of the basic safety requirements of laboratories, and speeds up the scientific research and standard construction of laboratory safety.

2. Construction Principles of Evaluation Index System for Comprehensive Management of University Laboratory Safety

Evaluation principle is the principle, criterion and requirement that evaluation activity must follow. Only clear evaluation principles can ensure the normalization and scientific evaluation work. According to the understanding of the essential law of evaluation and the characteristics of the comprehensive management of university laboratory safety, combined with the needs of the comprehensive management of university laboratory safety, the construction principle of the evaluation index system of the comprehensive management of university laboratory safety was drawn up.

2.1 Systematic Principle

A system is an organic whole with specific functions, which is formed by the combination of several interacting and interdependent components. Therefore, the systematic principle is also called the integrity principle, which is one of the most basic attributes or characteristics of a system. "Systematism" requires global consciousness and holistic concept. All aspects of the evaluated object are an inseparable organic whole. When establishing the comprehensive evaluation index system, it is necessary to comprehensively consider the interrelation, interaction and mutual restriction between each index and the surrounding environment, as well as the operation law of the system. All indexes are comprehensive reflections of the characteristics of the system.

2.2 Comprehensiveness Principle

In order to ensure the objective and accuracy of the comprehensive evaluation results, when the index system is preliminarily established, as many evaluation indexes should be selected that can summarize the basic characteristics of all levels of things to be evaluated, so that after the index weights are determined, the index system can be properly screened according to the weights. This study should comprehensively consider the rules and regulations of comprehensive management of laboratory safety in universities, dangerous chemicals, instruments and equipment, waste, emergency and first aid, safety education and other aspects. The compatibility between indexes should be avoided while following the comprehensiveness.

2.3 Dynamic Principle

The interconnectedness of the whole is manifested in the dynamic. The systems, connections, and orderliness that exist as reality are changeable, and invariable things do not exist. The society is a large system with dynamic development and changes. The evaluation indexes of laboratory safety comprehensive management in universities also change with the development of economic society. In order to improve the accuracy of evaluation results, the index system should be adjusted in time.

2.4 Scientific Principle

Science is to judge whether something conforms to the objective facts of the standard, rich in scientific basis, scientific principle is a kind of universal principle. First of all, we should have

scientific theory as guidance, grasp the essence of the evaluation object, the basic concept is clear, the logical structure is rigorous. Then, the theory should be combined with practice, and the index system should be established under the guidance of the theory. Finally, the scientific evaluation criteria is that the more clear, concise and realistic abstract description of objective reality, the more scientific.

2.5 Comparability Principle

Comparability includes horizontal comparability and vertical comparability. Horizontal comparability refers to the comparability between different indicators in the same period. Vertical comparability means that the same index is comparable in different periods. When establishing the evaluation index system, attention should be paid to the statistical scope of the index and the horizontal and vertical comparability of the accounting methods. Statistical caliber refers to the standard adopted by statistical data, including statistical method and statistical scope. The accounting method is the method used to reflect and supervise the index continuously, systematically and comprehensively.

3. Structural Model of Evaluation Index System for Comprehensive Management of University Laboratory Safety

As there are many indexes involved in the decision-making of complex problems and there are complex relationships among indexes, it is an effective method to construct a hierarchical index system structure model by organizing and hierarchizing the indexes involved in the problem. When constructing the index system, the actual problem is usually decomposed into several factors, and the factors are divided into several groups according to different attributes. The hierarchical structure can be generally divided into the top level, the middle level and the bottom level. The top layer, also known as the top layer or target layer, has only one element that represents the overall goal of the system. The intermediate layer, also known as the criterion layer, represents the intermediate link involved in the realization of the overall goal of the system. According to the size and complexity of the problem, there can be multiple layers. The bottom layer is also called the scheme layer or the measure layer, which represents the various measures, decisions and schemes to be selected to achieve the goal. On the basis of full investigation and analysis, combined with previous research results [5-7], the hierarchical structure model of the evaluation index system of comprehensive management of laboratory safety in colleges and universities is built, as shown in Figure 1.

4. Brief Description of Evaluation Index System for Comprehensive Management of University Laboratory Safety

4.1 Safety Management Rules and Regulations

The establishment of effective safety rules and regulations is the foundation of laboratory safety management, including four secondary indexes. Among them, the standard operating procedures, safety into each step of the experimental operation, so that laboratory personnel develop the habit of safe operation. Safety management organization, used to standardize the organization and management procedures of the laboratory. Safety inspection is an important means to supervise the implementation of laboratory rules and regulations. Safety files, through the laboratory accident records, to find possible sources of risk in the laboratory.

4.2 Hazardous Chemicals Management

Hazardous chemicals refer to highly toxic chemicals and other chemicals that are toxic, corrosive, explosive, combustible and combusting and are harmful to human body, facilities and the environment. In order to meet the experimental needs of teaching and scientific research, hazardous chemicals are frequently purchased and used in university laboratories [8]. Dangerous chemicals not only have a wide variety of types, but also have various ways of safety risks, which are highly risky, easy to cause safety accidents, and even lead to chain reaction. Therefore, it is very important to strengthen the whole process evaluation of the purchase, storage, use and disposal of hazardous chemicals in university laboratories.

4.3 Instrument and Equipment Management

University laboratory equipment, as an important fixed asset of laboratories, carries functions such as scientific research, personnel training and social service [9]. The normal operation of instruments and instruments directly affects the accuracy, rationality, scientificity and scientific progress of experimental data. And the efficient equipment management system helps to realize the sharing of instruments and equipment, avoid idle waste of equipment, improve the effective use of experimental equipment time and space, laboratory safety can be effectively supervised, and improve the comprehensive management level of university laboratories. (Figure 1)

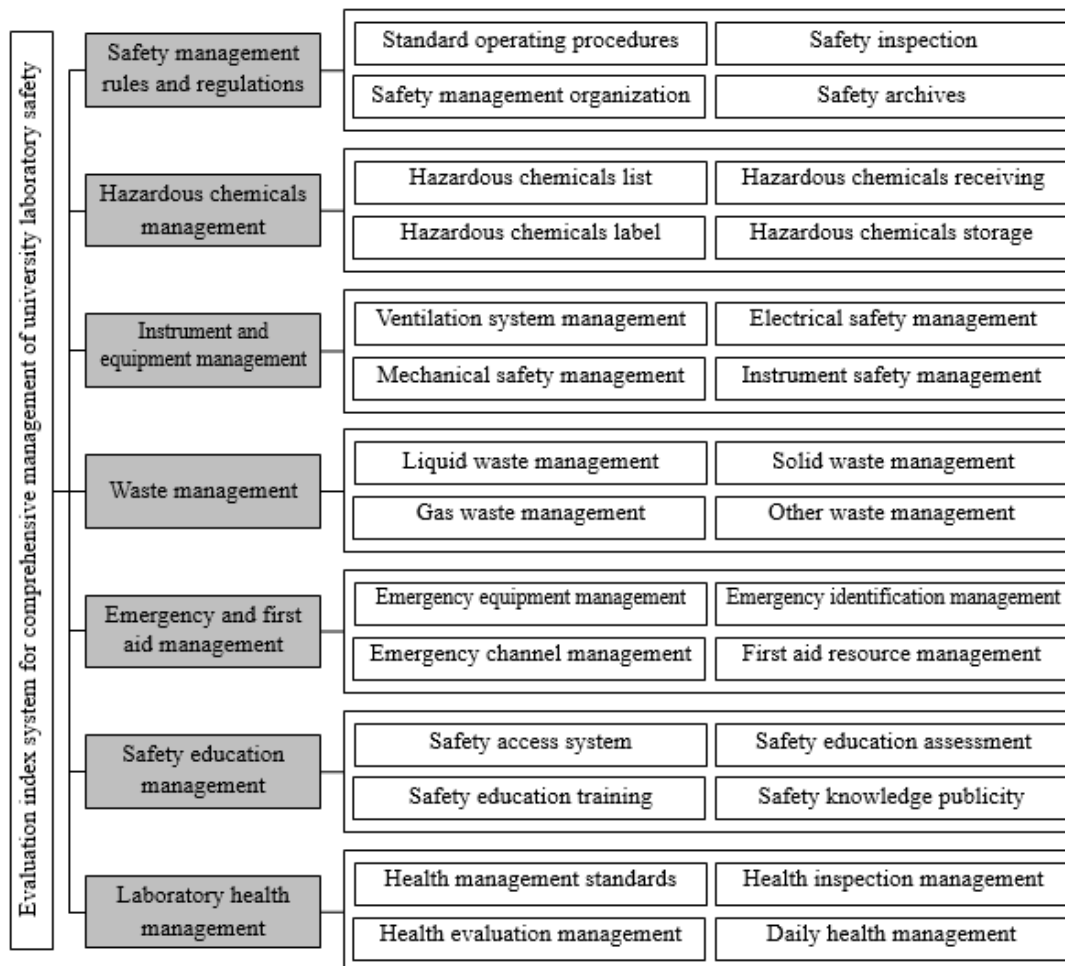


Figure 1: Structural model of evaluation index system for comprehensive management of university laboratory safety

4.4 Waste Management

Laboratory hazardous waste is generally characterized by inflammability, corrosion, toxicity, reactivity and other dangerous characteristics. If it is improperly stored and disposed, it may cause fire and human poisoning and other dangerous accidents [10]. Laboratory hazardous waste may also pollute the environment through different ways, causing water pollution and air pollution, seriously affecting public environmental health, and even endangering human health. Therefore, the treatment and disposal of chemical waste has become an important part of university laboratory management. Through waste management, the standardized and scientific management of chemical waste in university laboratory is promoted.

4.5 Emergency and First Aid Management

Laboratory emergency management system is an important part of university safety emergency management system, which is the basic supporting conditions for the whole process of laboratory

emergency management before, after, during and after the incident. The emergency management mechanism should run through the whole process of emergency management and establish an emergency mechanism covering prevention, preparation, response and recovery [11]. The main energy of university laboratory emergency management should be put on daily prevention and rescue preparation stage, reduce the risk of accidents through prevention, adequate rescue preparation to improve the emergency response ability. Formulate an emergency plan system to ensure adequate emergency preparedness, guide the rapid and smooth progress of emergency rescue activities, and prevent accidents or reduce losses from accidents.

4.6 Safety Education Management

Strengthening laboratory safety education can effectively improve the safety awareness of teachers and students, and enhance the initiative and enthusiasm of safety prevention work [12]. In order to achieve this goal, we must attach great importance to laboratory safety education. This requires universities to proceed from the actual situation of their own laboratories, combined with the corresponding rules and regulations, formulate targeted safety management methods and safety education measures, establish a perfect laboratory safety security system, help teachers and students to master more safety knowledge, standardize experimental operation, reduce the occurrence of safety accidents.

4.7 Laboratory Health Management

Modern analytical techniques provide highly reliable and accurate results provided that samples are stored under prescribed environmental conditions and care is taken to prevent other samples, foreign dust, or cross-contamination due to the proximity of other chemicals. Laboratory cleaning and hygiene greatly improves the overall efficiency of laboratory operations, reducing the movement of instruments and equipment between tables. Perform regular cleaning in sensitive areas to ensure no pollution, otherwise the analysis results will be seriously affected. After use, clean burette, pipette, measuring cylinder, flask and other glassware and place them on designated supports to minimize breakage.

5. Conclusions

As the investment in university laboratory construction increases year by year, the number of experimental instruments and equipment surges, the opening hours of the laboratory are extended, the number of experimental personnel and the mobility is enhanced, and various hazard sources and safety hazards are also increased. In recent years, due to the aging of equipment and improper experimental operation caused by explosion and fire and other safety accidents occur from time to time, college laboratory safety risks cannot be ignored. The key of laboratory safety management lies in source management, with prevention as the first. Through the prior evaluation, the existing problems should be found out in time, and targeted measures should be taken to improve or make up for the weak links and hidden parts of safety so as to prevent them from happening. The evaluation index system of university laboratory safety comprehensive management constructed in this paper solves the key problems of university laboratory safety comprehensive management evaluation and is of great significance for improving the level of university laboratory safety comprehensive management.

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References

- [1] X. R. Liu, J. Zhou, Y. Y. Zhang, et al. *Research on the problems and optimization strategies of universities laboratory safety management*[J]. *China High and New Technology*, 2023, 7(02): 112-114.
- [2] M. Y. Deng, W. Q. Wang, H. M. Wang, et al. *Current situation and exploration of the laboratory safety management in colleges and universities*[J]. *Laboratory Science*, 2023, 26(02): 190-192+196.
- [3] J. Zeng, Y. H. Zhang, Z. S. Wu, et al. *The Current Situation and Countermeasures of Laboratory*

Safety Management in Universities under the Background of New Engineering[J]. *Journal of Higher Education*, 2023, 9(15): 149-152.

[4] B. Y. Zhang, S. Li. *Research on the Standardization of University Laboratory Safety Management in the new era* [J]. *Technology Wind*, 2023, 36(05): 148-150.

[5] J. J. Chen. *Research of Laboratory Safety Management Assessment System in University*[D]. East China University of Science and Technology, 2013.

[6] Y. T. Zhang, Y. Lin, J. Qian, J. F. Zhou. *Research on Higher Vocational College Laboratory Safety Management Evaluation Based on DHGF Algorithm*[J]. *Research and Exploration in Laboratory*, 2016, 35(02): 300-303.

[7] J. Yang, D. Z. Qiu, J. W. Shi. *Research and Application of Improved Group—AHP Safety Evaluation in University Research Laboratories*[J]. *Research and Exploration in Laboratory*, 2022, 41(05): 296-300.

[8] M. L. Yu. *Research on Information Management System of Hazardous Chemicals in University Laboratory*[J]. *Research and Exploration in Laboratory*, 2022, 41(05): 164-168+201.

[9] Y. J. Qin. *Discussion and Analysis on Laboratory Equipment Management in local University and Colleges in the New Era*[J]. *Shandong Chemical Industry*, 2021, 50(12): 208-209.

[10] S. B. Zhao, Z. X. Wang, B. G. Lv. *Study on the safety management of hazardous waste in university laboratories*[J]. *Laboratory Science*, 2022, 25(03): 217-220.

[11] Y. M. Yi, W. H. Wang. *Construction of Emergency Management System for University Laboratory*[J]. *Research and Exploration in Laboratory*, 2022, 41(11): 282-286.

[12] D. Chen. *Analysis on effective measures of laboratory safety education in colleges and universities*[J]. *Journal of Changchun Normal University*, 2022, 41(12): 128-130.