



Recent Developments and Trends in Security Science Research in China

Jiang Shuwei

School of Safety Science and Engineering, Henan Polytechnic University, Jiaozuo Henan 454000, China

Abstract: For a long time, safety science has been a marginal discipline and has always been on the edge of academic discourse. However, since the 20th century, especially since the 21st century, we have gradually entered an era of risk, and the research and development of safety science is the call of the times. In the long-term accumulation of disciplinary research practice and knowledge production process, safety science has gradually formed its own unique research object, research field, and research paradigm, and has also gradually become an independent new discipline recognized by the academic community. With the changes of the times, the main contradiction in the field of safety science, namely the growing need for safety and health among people and the imbalance of insufficient safety resources, has become increasingly prominent. Various new safety issues continue to emerge, and the connotation, scope, extension, research object, focus, research purpose, basic theory, research methods, and technical means of safety science are also constantly changing. Obviously, the discipline of security also needs to keep pace with the changing times and continuously develop. This article summarizes and analyzes the main research content, basic theoretical research progress, and research trends of safety science in China in recent years. It briefly elaborates on the research hotspots and future development trends of safety science research, providing a reference for identifying new directions, hotspots, new starting points, new fields, and the latest trends in safety science theoretical research.

Keywords: safety science; Research trends; Progress in Basic Theoretical Research

1. Introduction

Safety is an ancient issue, but studying safety as a science is a new one. Safety science emerged mainly with the arrival of the Industrial Revolution [1]. As one of the fundamental human needs, safety is the most indispensable guarantee for human production, life, and development. It is a scientific field with profound connotations and huge exploration space, and a sunrise industry that is poised to take off [2]. Adhering to problem orientation is an important methodology and distinctive feature of Marxism [3]. Problem-oriented innovation in safety science means not only starting from reality, but also returning to reality, responding to and solving actual safety problems, and extracting new safety science problems from the perspective of safety science. Guided by new safety science problems, we continuously create new safety science theories. At this major turning point in the development of safety science, it is extremely necessary and important to review and evaluate the main research trends and progress of safety science. This is of great significance for effectively conducting safety science research, targeting the significant needs of human society for safety science, and promoting the development of safety science itself. In view of this, this article explores the research hotspots and shifts in safety science in recent years, in order to identify the new trends, hotspots, directions, and new starting points in the development of safety science in the new era, which will help safety researchers and practitioners grasp the research dynamics and cutting-edge topics in the field of safety science.



2. The main research content of safety science

Identifying the research object of the discipline can effectively divide the fields of theoretical exploration activities and the division of labor and cooperation in research activities. If there is no clear understanding of the research object of a discipline, the researcher's research content may not belong to the discipline, and there may be a large number of research blind spots, making it impossible to establish a complete theoretical system of the discipline, and to produce research methods that are associated, targeted, and specific to the discipline [4].

Post hoc research content

Major accidents

In 1794, an explosion occurred at the Paris explosives factory, resulting in 1000 deaths and significant damage to the buildings. Napoleon ordered the French Academy of Sciences to investigate the cause of the accident, pioneering safety science research. Modern production has a large scale and highly concentrated energy and hazardous substances. Once an accident occurs, it will cause catastrophic consequences.

Ordinary accidents.

The National Transportation Safety Board of the United States believes that any findings from accident investigations are only "possible causes" rather than "exact causes". This limitation is usually compensated for by statistical methods.

Occupational diseases.

Long term exposure to harmful factors such as dust, toxic substances, noise, and radiation can harm health and even lead to occupational diseases. The mechanism of occupational hazards is different from accidents, mainly including occupational hazards, occupational diseases, protection of female and underage workers, labor intensity, health care, physical examination, rehabilitation treatment, etc., which constitute another important research content of safety science. The research on major accidents, general accidents, occupational diseases, etc. belongs to post event research, with strong passivity and high cost, and it is urgent to carry out pre event prevention research.

Preventive research content

After the 1960s, systems theory, control theory, information theory, reliability theory, management science, psychology, risk theory, and other methods were successively introduced into the field of safety science, leading to the emergence of theoretical methods such as system safety engineering, ergonomics, risk assessment, safety goal management, and management systems. Preventive research became the main research content of safety science.

- 1) Hazard source. System security engineering focuses on the study of hazards [5]. A hazard refers to the source or state that may cause injury or illness, property damage, damage to the work environment, or a combination of these situations.
- 2) Human factors. Statistics show that most accidents are related to human error factors. Reference [6] analyzed the papers published in Safety Science from 1991 to 2012, and the top 10 keywords were safety, accidents, injuries, performance, accident causation models, risk, management, design, behavior, and evaluation.
- 3) Risk and safety. In the process of research and practice, safety and risk are regarded as homogeneous, and safety issues are transformed into risk control issues.
- 4) Hidden dangers. Hidden dangers refer to the hazardous state of objects that may lead to accidents, unsafe human behavior, and management deficiencies. Some scholars consider hidden dangers as the second type of hazard source [7]. Hidden dangers and hazards are two categories of concepts, and clearly dividing them is more conducive to research and practice [8].

3. Progress in Theoretical Research of Safety Science

Research progress on safety science principles

At present, most scholars tend to focus on the application research of known safety theories in accident prevention and safety guidance for safety science principles. However, there are very few articles that explore the connotation, level, and system construction of safety science principles from a high perspective. Reference [10] studies the preliminary construction of the principle system of safety science from the perspective of overall security, providing direction for the extension, development, and deepening of safety science principles.



On the basis of reference [9], the principles of safety science can be defined as the fundamental scientific laws with universal significance derived from observation, practice, induction, abstraction, and generalization, with the focus on safeguarding the body and mind from adverse external factors in human life, production, and survival processes. The principles of safety science originate from reality and can also be used to guide people's safe living and production practices.

Research progress on safety science methods

In the face of many unresolved security issues, what people urgently need is to find the correct and effective scientific methods for security. To conduct research on safety science, the first step is to use safety science methods as a breakthrough point. Scholars have subsequently conducted a series of studies on safety science methods and achieved the following phased results:

- 1) Conduct methodological research on security systems. The theoretical foundation of security discipline is systems science, and in order to develop the theory of security systems science, it is necessary to explore security systems from a methodological perspective.
- 2) Conducted research on the methodology of safety science principles. To guide the development of research on safety science principles, this article explores the research on safety science principles from a methodological perspective.
- 3) Conducted research on risk management methodology. The methodological foundation of risk management research is based on philosophical methods, mathematical methods, systems theory methods, information theory methods, and other methods. The theoretical basis of these methodologies constitutes the methodological system of risk management research.
- 4) Conducted research on the methodology of safety materials science. In order to improve the theoretical system of safety materials science, guide and promote the research and application of safety materials science, the definition and connotation of safety materials science methodology are proposed, and the disciplinary and theoretical basis of safety materials science methodology are discussed.
- 5) The methodology of safety science is a science that focuses on solving safety problems, using the ways, means, and approaches that people apply to understand and transform the world as research objects. While studying the content, characteristics, functions, and rationality of various safety science methods through original and combined innovation, it also studies the interconnection and penetration of these methods as a whole and summarizes the laws that exist between them.

Research progress on new theories of safety science

- 1) Conducted research on safety science. Safety science is a discipline that studies the discipline of safety, with safety as its research object. The research aims to understand the nature, characteristics, relationship structure, movement laws, and social functions of safety science, and to study the general principles, principles, and methods that promote the development of safety science based on this understanding.
- 2) Conducted research on safety science axioms. The axioms of safety science examine the attributes of the safety discipline from the perspective of safety science and summarize the following axioms through multidimensional analysis.
- 3) Ten axioms of safety work have been proposed.
- 4) Conducted research on secure chaos theory. Security chaos science is based on the comparison of the basic characteristics of chaos science and security science and applies modern knowledge from chaos science to the theory and practice of security science.
- 5) We have conducted research on the establishment of a disciplinary system for safety materials science.

4. Security Science Research Trends

Wu Chao et al. [10] first classified safety science principles into safety life science principles, safety natural science principles, safety technology science principles, safety social science principles, and safety system science principles. At present, the research topics of safety science can be roughly divided into safety human factors science, safety natural science, safety technology science, safety social science, and safety system science. In view of this, the following will examine and reflect on the main development trends of safety science research in recent years around the five themes mentioned above.



Research Trends in Safety Human Factors Science

In terms of preventing and controlling accidents caused by human factors. From focusing on the prevention and control of unintentional accidents, gradually shifting towards the prevention and control of malicious terrorist activities. The risk of unintentional errors by an operator in a certain position is relatively low under rational circumstances, but when the operator engages in malicious destruction, the security risk will increase significantly.

Key points and responsibilities of safety work. In the future, occupational safety personnel will implement the goal of enhancing individual and collective security as a safety engineering objective in all fields, and improving security will also become a new area of development in safety science.

Research Trends in Safety Technology Science

In terms of safety risk prevention and control. From focusing on direct security risks to focusing on indirect security risks, the branches of security disciplines such as security risk awareness, security risk assessment, and security risk prediction will inevitably receive further research, attention, and development.

Mechanism or theoretical aspects of accident causation. From the traditional theory of accidental release of energy causing accidents, to the development that accidents can occur with both accidental release of energy and information. In terms of accident prevention and control. Shift from focusing on explicit accidents to focusing on implicit accidents. In terms of specific security technology research and development. Information technology, artificial intelligence technology, big data technology, and cognitive technology will give rise to a series of new security technologies, thereby promoting the gradual trend towards intelligent security management.

In terms of technical security research. From focusing on current technological security to emphasizing future technological security. Therefore, future technological security will be a cutting-edge and significant topic in future security science research.

Research Trends in Security System Science

From studying relatively simple low-risk system security management to focusing on studying complex and high-risk giant system security management. Therefore, the research on the principles and methods of security management for complex giant systems will receive greater attention and application.

Shift from a focus on security entity centric theory to a focus on security relationship centric theory. In the field of safety science, there used to be a great emphasis on the strength, reliability, and lifespan of individual components. Now and in the future, more attention will be paid to the adaptability of the interface of a certain component and the reliability of its connection with other components, as well as the proper safety function of a certain component in the system. Therefore, security system thinking, security correlation, and security big data will be more widely applied, and disciplines such as security system engineering, security correlation, security big data, and security science will develop rapidly.

From not recognizing security as a comprehensive interdisciplinary subject to recognizing the major interdisciplinary nature of security, shifting from questioning the purposefulness, orderliness, organization, and agency of security systems to re-accepting these concepts, from simply recognizing security as a technical science to recognizing security as a complex science.

5. Summary and Outlook

The development direction of safety life sciences. The research directions of this discipline mainly include safety anthropology, safety ergonomics, safety physiology, safety psychology, and safety biomechanics. In the field of human safety, future research should focus on the impact of human safety on safety behavior; Key research on human-machine matching in safety ergonomics; Safety physiology mainly studies the maximum labor load of the human body, as well as the impact of work environment factors, occupational abilities, and other factors on it; Safety psychology mainly studies the psychological and material basis of human unsafe behavior, as well as the impact of extreme work environments on human psychological fluctuations; Safety biomechanics mainly studies the response matching mechanism between human muscle and bone structure and work intensity, especially the mechanical state and limits of the human body under various hazardous working conditions.



The development direction of safety natural science. Natural disasters are natural phenomena that deteriorate the human living environment, and natural disasters are natural phenomena caused by human activities that transform nature and lead to the deterioration of the living environment.

The development direction of safety technology science. The development of technology cannot be separated from the support of scientific theories, methods, and principles. There are many directions for the development of safety technology science. Based on the characteristics of various types of disasters and accidents, the hazards of different types of disasters are identified and determined. The key disaster indicators for disaster monitoring and detection are studied and analyzed. Combined with multiple disciplines such as automation, information theory, control theory, mathematical logic, and computer science, the automatic collection, acquisition, and storage of safety monitoring and detection data are achieved, and the automation and intelligence of safety monitoring and detection are improved.

The development direction of safety social science. Society is composed of people, and it is an organic whole formed by the interaction of people in social practice activities according to certain purposes and methods. Safety is a basic human need, fundamentally referring to human safety, including the three-dimensional safety of human body, psychology, and rights.

The development direction of security system science. Due to its comprehensiveness and interdisciplinary nature, security system science has evolved from traditional system theory to more complex modern system theory based on its fundamental theories; The research object has shifted from simple systems to large-scale systems, and then to mega scale and increasingly complex systems; And the application scope has gradually moved from the fields of security system organization and management, technical engineering applications, etc. to the fields of social economy, natural system and social system integration; Moreover, security systems are gradually evolving from conventional engineering systems to soft engineering systems, and from micro analysis to macro strategic direction.

References

- [1]. Wu Chao. Research progress of basic theory of Safety Science in China in recent 10 years[J]. Chinese Journal of nonferrous metals, 2016, 26 (8) : 1675-1692.
- [2]. Wu Chao, Wang Bing. Recent research trends and theoretical progress of safety science[J]. Journal of safety and environment, 2018, 18 (2): 588-594.
- [3]. Han Xiping. Adhere to the problem orientation of Marxism[N]. Guangming Daily, 2016, 08-01 (002).
- [4]. Cai Jiandong. Further discussion on the research object and nature of educational technology [J]. Modern educational technology, 2008, 18 (5): 70-72.
- [5]. LIU Xue-tao. General situation of system safety engineering[J]. Nuclear Power Engineering, 1985, 6 (6) : 87-90.
- [6]. NTSB. The investigative process at NTSB[EB/OL]. [2015-10-11]. <http://www.Ntsb.gov/investigations/process/pages/default.aspx>.
- [7]. WU Zong-zhi. Discussion on control of major hazards and of major accident potential[J]. China Safety Science Journal, 2003, 13 (9) : 20-23.
- [8]. SUI Peng-cheng, CHEN Bao-zhi, SUI Xu. Safety principles [M]. Beijing: Chemical Industry Press, 2005 : 18-19.
- [9]. WU Chao, YANG Mian. Study of safety science principle and their constructions [J]. China Safety Science Journal, 2012, 22(11): 3-10.
- [10]. China Occupational Safety & Health Association. Report on advances in safety science and engineering[M]. Beijing: China Press of Science and Technology, 2008.

