Research on the Transformation of Safety decision Driven by Major Accidents Based on Big Data Mining

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Abstract. In recent years, major accidents have occurred in China, causing extremely heavy loss of personnel and property. Unsafe human behavior is the direct cause of accidents, while corporate security behavior has a deeper impact. This paper first reviews the research status of major security incidents and corporate security behaviors, and expounds the research gap between current social security behaviors and major security incidents. By describing the governance framework and driving force of corporate security behaviors, we can explore the content and path of social security decision driven by major security events. Based on this theoretical basis, the 8.12 Tianjin Binhai New Area explosion accident was cited. Through the network reptiles, the policy and industry trends of the China Chemical Safety Association were studied, and the NLPIRParser text search and mining method was adopted. The results show that the regulations before and after the accident have undergone major changes. As the regulations become more stringent, the company's safety has also been steadily strengthened.

1. Introduction

In the past ten years, with the continuous improvement of the national safety management system, the safe production environment has been extremely improved, the organization has also experienced a transition from individual safety behavior constraints to overall safety culture management, but special major accidents still occur from time to time, causing serious casualties or property damage. In the face of these major disasters, people not only need to understand the direct cause of the accident, but also hope to be able to reflect from the disaster (learning from catastrophes), investigate the hidden institutional factors behind the accident so that similar tragedies no longer occur. International Journal "Safety Science" from the first in 2012 on learning from accidents (Learning from Incidents, LFI) has been paying attention to this topic since its publication and focused on 2018. The current status, challenges and opportunities of LFI illustrate the importance that the global academic community attaches to this area of research.

The occurrence of an accident is inseparable from the unsafe behavior of people, the unsafe state of things, and the unsafe conditions of the environment, in which people are the mainstay of production activities. The occurrence of most accidents is related to people's unsafe behaviors. Managing people with great freedom in production activities and reducing unsafe behaviors are the key to safe production. The security behavior of an enterprise is an environmental factor in the organization that has a direct impact on individual behavior but is often overlooked in the accident analysis. For example, the security atmosphere of the organization can greatly affect the personal safety behavior, from the perspective of past major safety events. Through reflection, the improvement of corporate

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safety behavior can reduce accident rate and mortality to a certain extent. The core of this paper is to learn the mechanism for managing corporate security behavior from accidents.

2. Overview of research status

At present, a large number of researches on safety accidents by domestic and foreign scholars mainly focus on the cause of accidents. Many scholars use traditional mathematical statistics methods to study the causes of safety accidents based on various theoretical models. The first is a security model based on the “reverse construction” paradigm, such as the accident causal chain model proposed by HW Heinrich [1], the Searley model proposed by J. Surry [2], and the “disturbance” model proposed by Benner [3], J. .Reason [4] proposed the "Social Cheese Model" (Swiss Cheese), J. Rasmussen [5] proposed the social technology system accident cause model, JMStewart [6] proposed a new chain accident cause model, Leveson[7]. The systemic accident causes the STAMP model, etc.; the second is the security model based on the “intermediate construction” paradigm, such as the system risk theory proposed by Misumi and Sato [8].

Significant safety accident after another important area of research is to reflect on the accident, and Kunreuther Useem masterpiece "learning from catastrophes" reveals the study from the disaster, establish an effective emergency response strategy idea [9]; Not only can we learn from past accidents and predict the possibility of future accidents, but also we can learn from engineering failures and introduce them into engineering education. How to learn from similar disasters and establish a normal mechanism has been a hot topic of academic research. Many scholars at home and abroad draw lessons through reviewing major disasters and accidents in the past and critical reflection on social behavior and current situation. For example, Zablotska and Lydia B found that the mental health impact was the most important public health consequence caused by the chernobyl nuclear power plant explosion, and timely and clear communication with the affected population became the main lesson of the consequences of chernobyl nuclear accident [10]. Moura R et al. classified 238 major accidents from different industry backgrounds under a common framework, and believed that improving the robustness of system design and dealing with surrounding factors and trends that may cause human errors could effectively solve industrial safety problems [11]. Koradecka and Dryzek analyzed the occupational safety and health pressure in the process of economic transformation in Poland, and proposed that the sustainable improvement of occupational safety and health needs support from relevant social parties in addition to government regulation, and establish an economic guidance mechanism to stimulate enterprises' investment in safety production [12]. From the perspective of social responsibility, Maria analyzed the normative mode of enterprise production safety behavior and proposed that the public and media should be included in the management system of enterprise production safety behavior [13].

How to make the governance of enterprise safety violations effective, strengthen supervision and enhance the effectiveness of regulation has become the object of fierce debate among scholars. Through empirical research or follow-up investigation, some scholars have concluded that government regulation is the main means to control risks and reduce the violations of production safety in enterprises, and it plays a positive role in improving the safety performance of enterprises. Gray and Mendoloff, two scholars who have studied occupational safety regulation in the United States for a long time, found through tracking industrial injuries in the manufacturing industry from 1979 to 1998 that safety regulation had a more obvious impact on the safety production behavior of small and medium-sized enterprises, while in some large enterprises, the effect of safety regulation was not obvious [14]. Asche pointed out that since enterprises regard regulation as a constraint on their behaviors, only when the regulatory power is strong enough can it serve the purpose of restricting enterprises' violations of production safety [15]. Tappura further considers production safety as part of its corporate development strategy and has been recognized by more and more enterprises [16].

Major disasters and accidents can arouse the emotional response of stakeholders in a short period of time, reduce the public's risk tolerance through risk perception, and then affect the safety behavior of enterprises from two aspects, one is the safety inspection in a short period of time, and the other is
the change of risk regulation from a long term perspective. In the revision of regulation, Danny and Louis (2016) discussed how decentralization reform and power relations between government agencies at all levels affect the results of disaster risk [17]. In addition, inertia, lack of political foresight and willingness, scattered decision-making power and other factors will hinder the establishment of effective regulation to varying degrees. Maciejr believes that both before and after disasters, the thinking on disaster management has paid more and more attention to deliberation and dialogue. A leading safety management model emphasizes the inclusiveness and influence of different stakeholders in risk communication, public participation and government decision-making [18]. In recent ten years, more and more scholars, such as Gerard, began to pay attention to the bridging role of service agencies between government regulation and enterprise safety production, and a series of services were provided by service agencies authorized by the government to replace the direct control of the government [19]. Zwetsloot points out that the government is increasingly using methods such as third-party certification and testing to replace traditional regulatory means, and helping enterprises evaluate the commercial value of occupational safety work in the process of making safety decisions, so as to promote enterprises to adopt safety production behaviors [20].

3. The content and path of major security incidents driving social security decision-making

It can be learned from the above literature that how to effectively constrain corporate security behavior is a complex governance problem, involving not only the application of regulatory agencies, industry regulation, policies and tools, but also multiple stakeholders in the process of security risk management. Apply different influences that affect the choice of corporate safety behavior. Using major security incidents as a trigger point, revealing the impact of the concept of interest, emotions and regulatory demands, driving the reconstruction of security behaviors, embedding them into enterprise management procedures, and constraining organizational security behavior decisions, or research blank.

After a major security incident occurs, the accident investigation procedure is initiated, not only to reveal the cause of the accident, but also to propose countermeasures against similar accidents. Event System Theory (EST) mainly explains the dynamics and multi-levels of less research in organizational science. In the study of enterprise safety behavior, there are also few studies that focus on how the properties of accident intensity change or produce results. There is no literature to explore, so it is of great significance to use EST to study the mechanism of major safety accidents driving the safety behavior of enterprises in space and time.

3.1 Corporate Security Behavior Governance Framework

According to the event system theory, not all accidents have an impact on the enterprise, and the intensity of the accident affecting the safety behavior is different, and the effect is not the same. The major safety accidents are characterized by three aspects: the novelty, subversiveness and keyness of the intensity, the direction, origin, diffusion and proximity of the space, the duration of time, the timing and the intensity change. Influence and drive the transformation of their safe behavior. Major safety accidents have a direct impact on the safety behavior of enterprises and change their behavioral trajectories or habits. The characteristics of novelty, subversiveness, and critical have different degrees of impact on the safety behavior of enterprises, mainly through the reflection after the accident, such as the 7·23 Yong-wen line special major railway traffic accidents show all three characteristics of the accident intensity, the direct impact of the accident on the enterprise is the management of the research and development of high-speed rail technology equipment manufacturing enterprises, high-speed rail safety. The rules and regulations and standards of operation have been improved and improved; the indirect impact on industrial enterprises has been generated through regulation, including laws and regulations, industry standards, and still take the railway traffic accidents of the special temperature line as an example. After the accident, the high-speed rail is comprehensive. Speed reduction is an indirect effect of an accident. In the end, we formed a path of major accident-driven enterprise safety behavior change. We believe that major accidents are conducive to promoting the company's safety
behaviors, thereby changing security decisions, and propose a corporate security behavior governance framework, as shown in Figure 3-1.

![Fig.3-1. Corporate Security Behavior Governance Framework](image)

### 3.2 Two drivers of corporate safety behavior change

Factors driving changes in behavior include major security incidents and updated knowledge bases. The two promote the evolution of corporate security behavior from different time levels and impacts. The distrust of the system is the common influencing factor of the two driving behavior changes. The trust in the system is the psychological basis for people to obey the system, and the system has The dynamic mechanism of vitality, no matter which kind of driving factor, first goes through the process of breaking or suspecting existing regulations.

#### 3.2.1 Event driving force

When a regulation does not prevent some highly visible disasters, or political opponents subvert their legitimacy, then the modification of this policy is forced by the event. The large-scale, novelty, complexity, cross-border and cascading effects of major disasters require regulators to reconsider whether policy instruments can cope with the impact of major events. Sometimes, crisis events may rapidly reduce the risk tolerance of different ideologies in the short-term, which will stimulate strong public opinion pressure and encourage the “authority” of policy formulation to learn from the crisis. The European Union's Seveso Directive is a classic example of the development and evolution of major security incident-driven regulations. The Seveso Directive attaches great importance to the management of major hazard sources and sets up classified management. In terms of risk assessment, the Seveso Directive requires companies to identify risks and develop preventive measures as well as safety analysis, and as an important means of risk management for high-risk enterprises. The directive requires industrial companies to develop safety reports.

#### 3.2.2 Knowledge Base Driver

An updated knowledge base is another factor driving risk regulation. The rapid development of science and technology, the methods used for risk assessment and control are also advancing with the times. Therefore, the knowledge base includes the advancement of laws and regulations, the improvement of industry standards, the advancement of technology, etc. The updated knowledge will constantly negate the previous regulations and concepts. Through the media to change the public's risk perception, thereby exerting pressure on decision makers, or directly by the setters to organize research or production. This is undoubtedly a more moderate way, that is, the progress of regulation is guided by "good". For example, the US Clean Air Act stipulates that the statutory standards for six pollutants must be subject to new scientific review every five years. The detection criteria for inhalable particulate matter range from the visible black smoke to the invisible diameter. 10 μm of
respirable particulate matter, modified to current inhalable particulates less than 2.5 μm in diameter [21].

4. Model construction and case analysis of major security incidents driving enterprise security behavior governance

4.1 Construction of the research model
The research significance of this paper is to find out the content and path of the major security accident-driven security decision-making transformation. By clarifying the driving mechanism of the accident to the enterprise's security behavior, the governance framework and two driving forces are proposed. Based on the theory that the above-mentioned major security incidents drive enterprise security behavior, this paper first establishes the important position of enterprise security behavior in enterprise security management, and believes that major security incidents are the key to affecting security management and performance. Then according to the event system theory, we find the factors that indirectly affect the security behavior of enterprises between major security incidents and corporate security behaviors. We believe that this dimension of regulation can effectively explain the change of corporate security behavior. Finally, a driving path for major safety incidents has been formed, and it is believed that major safety incidents are conducive to promoting corporate safety behavior.

As an organization that aims to obtain specific interests, its security behavior is not only affected by internal factors, but also the social environment affects organizational security behavior. Internally, although most major accidents cannot be separated from the unsafe behavior of employees, the failure theory suggests that any unsafe behavior of employees is only a necessary but not sufficient condition for accidents. They are only triggers of accidents. The potential failure path, that is, the path from the organizational process to the system defense defect is the root cause of the accident. The behavior of employees is the inevitable result of the enterprise management system, and it is also the most common path leading to accidents. Therefore, domestic and foreign scholars are increasingly emphasizing the importance of organizational factors in corporate safety behavior. Traditionally, the causes of employee unsafe behavior from the perspective of organization include security management, security investment, safety culture and security atmosphere. Therefore, these aspects will be most directly affected when a major accident occurs. Secondly, the external factors of the enterprise are mainly divided into three categories. First, the influence of laws, regulations and policies is mandatory, and the second is the industry norms and atmosphere. It is the default rule of the industry. It may be a substitute rule before laws and regulations. It is a public opinion, including public opinion supervision and pressure from the media and the public. The impact of these factors will ultimately be reflected in the social security decision. Based on the above literature research, this paper proposes the system dynamics model shown in the following figure.

![Causal relationship diagram of major safety accidents driving corporate safety behavior](image-url)
This paper selects the August 12 Tianjin Binhai New Area explosion accident as a major safety accident case. It conducts web crawling on the industry dynamics and climbs the industry dynamics one year before and after the accident. In order to study the change and influence of the regulation, it has climbed the accident before and after. The data and semantic analysis were carried out after the integration of the regulations issued by the National Supervision Administration and the China Chemical Safety Association.

4.2 Case Introduction
On August 12, 2015, a fire and explosion accident occurred in the dangerous goods warehouse of Ruihai Company in Tianjin Port, Tianjin Binhai New Area, causing 165 people to be killed, 8 missing, 798 injured, 304 buildings, 12,428 commercial vehicles, and 7533 The container was damaged. As of December 10, 2015, according to the “Statistical Standards for Economic Loss of Enterprise Workers' Casualty Accidents” and other standards and regulations, the approved direct economic losses were 6.866 billion yuan. After the accident, the Party Central Committee and the State Council attached great importance. On August 18, 2015, with the approval of the State Council, the State Council Tianjin Port “8ꞏ12”, which was composed of the Ministry of Public Security, the General Administration of Safety Supervision, the Ministry of Supervision, the Ministry of Transport, the Ministry of Environmental Protection, the National Federation of Trade Unions and Tianjin, was established. The Investigation Team of the Special Major Fire and Explosion Accident of the Dangerous Goods Warehouse of Ruihai Company invited the Supreme People's Procuratorate to send personnel to participate, and invited experts in the fields of explosion, fire, criminal investigation, chemical industry and environmental protection to participate in the investigation. The investigation team found out that the direct cause of the accident was: the nitrocellulose in the container on the south side of the dangerous goods warehouse of Ruihai Company was partially dry due to the loss of humectant, and accelerated by the high temperature (weather) and other factors. The heat spontaneous combustion causes the long-term large-scale burning of nitrocellulose and other dangerous chemicals in adjacent containers, causing explosion of dangerous chemicals such as ammonium nitrate deposited in the delivery area. The investigation team determined that Ruihai Company seriously violated relevant laws and regulations and was the main responsible unit responsible for the accident. The company ignored the responsibility of safety production, seriously violated Tianjin's overall urban planning and the control detailed planning of Binhai New Area, illegally built dangerous goods yards, illegally operated and illegally stored dangerous goods, and the safety management was extremely chaotic, and the safety hazards persisted for a long time.

4.3 Experimental process
Compare the safety behaviors of enterprises before and after disasters, and analyze the process and effect of major disasters driving the safety behavior of enterprises. This paper selects the Tianjin Binhai New Area explosion accident that occurred on August 12, 2015, and analyzes the policy and industry dynamics one year before and after the accident.

8ꞏ12 The Tianjin Binhai New Area explosion accident is a particularly serious accident in the field of hazardous chemicals. Therefore, this article uses the regulatory standards and industry dynamics published by the China Chemical Safety Association website. The time is one year before and after the accident, that is, August 2014. From the 12th to the 12th of August 2016, a comparative analysis was conducted.

The regulatory standards issued by the China Chemical Safety Association Network are closely related to the industry. They use python crawlers to crawl documents from August 12, 2014 to August 12, 2015, 59 documents, August 12, 2015 to 2016. 74 documents on August 12th. The industry dynamics released by China Chemical Safety Association Network is a hot topic in the domestic chemical industry. A total of 2,291 documents from August 12, 2014 to August 12, 2015 were collected. August 12, 2015 to August 8, 2015 2,298 documents on the 12th of the month.
This paper uses NLPIRParser to extract keywords from the above materials, and then analyzes the transformation of corporate safety behavior. The basis of keyword extraction is the weight index. The calculation of weight by NLPIR discards the traditional IDF (Inverse Document Frequency) method, but uses information entropy as the extraction result, as shown in formula (4-1). Represents information entropy, w stands for the word, p stands for the number of different words appearing around the word, and calculates left and right information entropy for all words. If the left and right information entropy of a word is large, the word is a keyword.

$$H(w) = -\sum p \cdot \log(p)$$  \hspace{1cm} (4-1)

4.3.1 Analysis of the Standards and Regulations of China Chemical Safety Association

Based on the August 12, 2015 accident as the base date, the company moved forward and backward for one year to analyze the changes in the regulations of the China Chemical Safety Association. A total of 3,518 keywords were generated in the material one year prior to the accident. A total of 3053 keywords were generated in the material of the year after the accident. The weights were sorted in descending order, and the first 20 keywords were selected for comparative analysis. Among the two materials, there are 12 repetitions in the top 20 keywords. The top 10 keywords after the accident occurred in the top 20 keywords before the accident. The chemical production and operation itself is a high-risk industry, so Before and after the accident, the main keywords are still the safety production and safety supervision of the business unit or organization. The degree of change in the weight value fully indicates that the major safety accidents affect the standard changes of the association's laws and regulations, and the system is gradually tightened. The accidents have caused the legislative and regulatory agencies and the entire hazardous chemicals production and management industry to reflect and have made a different perspective. Introspective behavior, the regulatory body has strengthened the formulation of safety production standards and the review of enterprises, requiring enterprises to proceed from their own safety behaviors, to investigate and manage hidden dangers, to manage major hazards, and to gradually improve the level of safety management and safety awareness of enterprises.

The weight values corresponding to the same keywords before and after the accident have changed significantly, indicating that the policy environment has undergone major changes and promoted the transformation of corporate safety behavior. It is more common that the keyword weight after the accident is greater than the keyword weight before the accident. For example, the pre-accident weight value of "safe production" is 145.21, and the weight value after the accident increases sharply to 251.72, an increase of 73.4%. The weight value changed from 120.34 to 191.37, the increase rate reached 59.0%, the "hazardous chemicals" weight value changed from 65.63 to 132.29, the change range reached 101.6%, and the "accident" weight value changed from 75.37 to 107.54, the change range reached 42.7%. The "Organization" weight value changed from 76.01 to 107.54, and the change range reached 41.5%. In addition, the "significant hazard source" was listed for the first time after the accident, and the weight value was 74.27.

| Keyword             | Weights | Frequency | Keyword             | Weights | Frequency |
|---------------------|---------|-----------|---------------------|---------|-----------|
| Safe Production     | 145.21  | 1213      | Safe Production     | 251.72  | 1868      |
| Production unit     | 138.5   | 320       | Enterprise          | 191.37  | 914       |
| Enterprise          | 120.43  | 495       | Production unit     | 135.62  | 176       |
| Oil and gas pipeline| 99.26   | 114       | Hazardous Chemicals | 132.29  | 382       |
| Standard            | 91.99   | 445       | Accident            | 113.49  | 767       |
| Management          | 90.91   | 541       | Management          | 109.6   | 854       |
| Construction project| 86.14   | 168       | Organization        | 107.54  | 408       |
| Undercover          | 76.78   | 57        | Unit                | 90.07   | 700       |
| Organization        | 76.01   | 238       | Law enforcement     | 86.98   | 319       |
| Accident            | 75.37   | 539       | Safety supervision  | 82.57   | 469       |
| Unit                | 69.79   | 963       | General Administration of Safety Supervision | 81.65 | 244 |
4.3.2 Industry Dynamic Analysis of China Chemical Safety Association

In order to more intuitively display the obvious information changes before and after the accident, the key words of the industry dynamics before and after the accident are physically extracted, and the entity map is formed for comparison. It can be seen that the enterprise behavior before the accident is mainly to carry out safety management and cooperate with the inspection of the Safety Supervision Bureau. Focus on safe production. Relatively speaking, after the accident, the focus of corporate safety behavior changes. In addition to the fundamental purpose of safe production, corporate safety behaviors also draw lessons from the explosion accidents in Tianjin Binhai New Area to investigate major hazard sources of hazardous chemicals. Management, indicating that major security incidents have led to a shift in corporate security behavior and a side shift in the Security Management Center.

| Practitioner                          | Standard                               |
|--------------------------------------|----------------------------------------|
| Safety instrumented system           | Hidden trouble investigation and management |
| Hazardous Chemicals                  | Emergency plan                         |
| Safety supervision                   | Major hazard                           |
| Examination                          | Practitioner                            |
| Employer                             | Implement                              |
| Occupational disease risk factors    | Evaluation                             |
| Regulation                           | Supervision                            |
| General Administration of Safety Supervision | Emergency Rescue             |

| Practitioner                          | Standard                               |
|--------------------------------------|----------------------------------------|
| Safety instrumented system           | Hidden trouble investigation and management |
| Hazardous Chemicals                  | Emergency plan                         |
| Safety supervision                   | Major hazard                           |
| Examination                          | Practitioner                            |
| Employer                             | Implement                              |
| Occupational disease risk factors    | Evaluation                             |
| Regulation                           | Supervision                            |
| General Administration of Safety Supervision | Emergency Rescue             |
5. Conclusion and Outlook

5.1 Discussion of results
From the results of the China Chemical Safety Association's regulatory standards and industry dynamics of web crawler data, analyzing the weights (information entropy) of each group of keywords and new words, we can get a change in the safety behavior of major safety accidents, and draw the following conclusions.

1) The occurrence of major safety accidents can significantly promote the change of safety management and safety culture of enterprises. The short-term transformation is affected by accidents; in the long-term transformation, the importance of safety culture is relatively reduced, and the focus of safety management changes. Significantly improved safety behaviour, from safe prevention to direct investigation of similar sources of danger.

2) Policies and regulations have also confirmed this change. The requirements for corporate safety behaviors have shifted from the safety design, safety assessment and review of construction projects, and even to unannounced investigations, to the direct need for enterprises to hazards of major hazards. Troubleshoot and even take administrative penalties. The change of the keyword fully demonstrates that the major security accidents drive the security behavior of the enterprise to change, and thus evolve to a new stage, that is, security vulnerabilities before governance.

5.2 Research Outlook
The purpose of this paper is to explore the governance mechanisms of major safety incidents on corporate safety behavior. A major safety incident is a case library that is worthy of further investigation. Previous analysis focused on the causes of accidents and how to reduce people's unsafe behaviors, ignoring the impact of organizational safety behaviors. In recent years, organizational safety behaviors have become safe behavior management. In the frontier research field, there are few researches on the influence and role of organizational safety behavior in accidents. Therefore, this paper mainly studies the driving mechanism of major safety accidents on corporate safety behavior governance. Limited to the author's limited ability, there are still many work that needs further research and improvement to assist in emergency management decisions:

1) In the face of the uncertainty of major security incidents, how to establish an implementable driving model and regulation.

2) How to better combine corporate safety behaviors with personal safety behaviors, and learn the lessons of major safety incidents, and further build case libraries.

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