Analysis of the reflection case of major hazardous chemicals safety accident based on LFI

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Abstract. After the occurrence of major safety accidents, the key to prevent similar accidents from happening again is whether all sectors of society can get deep reflection from the investigation and accountability of accidents, and then improve the level of safety awareness and safety management and control through the process of learning from incident (LFI). Taking "Tianjin Port 8.12 major dangerous chemical explosion accident" as an example, 610 articles related to the accident were exported from CNKI as samples. The topic classification of the abstract text was carried out by using LDA topic model. Finally, based on the theory of learning from incident (LFI), the evolution trend and content of the topic of reflection were analyzed. The results show that: (1) the content of reflection mainly includes the following four topics: (I) Risk of hazardous chemicals and safety of enterprises; (II) Emergency management and rescue; (III) Government public crisis management; (IV) Public opinion crisis in emergencies (2) the proportion of research on topic II is lower than that of other topics, and there may be insufficient reflection on individual issues. As it has the function of reducing accident harm, it is of great significance and should be given enough attention.

1. Introduction
In recent years, a lot of hazardous chemical safety accidents have happened in different areas of our country, which bring people life safety and property problems. Among them, accidents such as "explosion accident in Tianjin Binhai New Area" and "major explosion accident in Zhangjiakou" have attracted wide attention from all walks of life. After experiencing a large number of safety accidents, how to make full use of accidents to learn has become the focus of attention. People are eager to learn lessons from incidents and improve safety level. Learning from incident (LFI) has always been the direction of safety management research. It is expected to achieve the goal of fundamentally eliminating the recurrence of similar accidents through profound reflection on the causes and responsibilities of accidents. However, the ruthless reality tells us that the learning effect of major safety accidents in the current stage is not obvious and the effective application of LFI theory is lacking.

Reflection is an important means to acquire safety knowledge. The carding and induction of reflection content is also a process of refining and accumulating safety knowledge. High quality reflection content is the basis of completing the follow-up link of incident learning. The correct interpretation of the key points and context of knowledge in the reflection content is the necessary prerequisite for effective learning from the incident. Based on this, combined with the theory of LFI, this paper analyzes the contents of major hazardous chemicals safety accident reflection by examples,
selects the relevant newspapers and literatures that can display the safety knowledge obtained from accident reflection as the research samples, and divides the reflection content into different topics and calculates the proportion of each topic in different stages based on the classification results of abstract texts. Then, the evolution rules of each topic in different stages are analyzed, so as to improve the knowledge system and the quality of incident learning. Finally, the knowledge in the content of reflection is condensed and combed to complete the accumulation of knowledge and lay the foundation for the follow-up link of the accident learning process.

2. Related concepts and research status

2.1. Learn from incident

Learn from incident (LFI) refers to the process in which the organization draws lessons from incidents and transforms them into measures and behaviors to avoid accidents in the future[1]. The theory of LFI is developed on the basis of organizational learning theory and learning organization theory. It originated from high-risk industries such as energy field, and was applied to manufacturing, construction, transportation, aviation, marine and health care industries[2]. Referring to the factors that affect the level of organizational learning, combined with relevant learning theories, Littlejohn[3] constructed a framework to guide the research ideas of LFI problems, including five key factors that affect the effect of accident learning, namely: learning context, learning participants, learning process, type of incident and type of knowledge.

The end of crisis is not the end of crisis learning. Instead, we should summarize, reflect, evaluate and learn from experience and lessons, find out our own problems and accumulate knowledge[4]. In the industrial field, learning from incident is considered to be an important way to improve the safety level[1]. According to the study of LFI, only obtaining accident information is not enough to achieve the learning effect. The effective accident learning process should include four links: acquisition, accumulation, dissemination and application of knowledge[5]. Among them, whether the incident learning process can ultimately improve the safety level depends largely on the quality of knowledge acquisition and accumulation stage. One of the ways to acquire safety knowledge from accidents is to reflect on the problems exposed in accidents. Grasp the knowledge context of the content of reflection, sort out the key points of knowledge in the results of reflection, and then complete the condensation and accumulation of safety knowledge. This process is not only the basis of knowledge dissemination and application, but also the necessary prerequisite for effective learning from incidents.

2.2. Research status

At present, the research on effective learning by using the theory of LFI mainly includes two aspects: (1) how to improve the ability of accident investigation and analysis; (2) how to develop more effective accident learning tools and methods[6].

First of all, for the research on improving the ability of accident investigation and analysis, Vanpoule[7] analyzed more than 600 mountain sports accident reports, and divided the promotion factors into environment, equipment, group resource dynamics, and behavior events. By using the bow tie model, the fault tree and event tree were linked, and the existing safety barrier was defined. Moura[8] provided a new mode of accident analysis, in which multi-attribute events were represented and analyzed in a graphical way, strengthening the risk communication process in the learning process of major accidents. Tao Zhang[5] analyzed the social factors affecting the effect of accident investigation, and put forward suggestions to improve the effectiveness of accident investigation from the perspective of system.

Secondly, research on the development of accident learning tools and methods. Rollenhagen[9] analyzed 106 incident investigation reports, interviewed the incident investigators, discussed the role of experience feedback in safety management, and provided insights on how to find and implement effective remedial measures. Littlejohn[3] developed a tool, namely, learning from incidents questionnaire (LFIQ), which is used to evaluate the process and learning quality of LFI. Silva[10]
discusses the practice process of organization's LFI in the whole information cycle, compares the learning strategies of different organizations. In addition, Stemn[11] studies the case of "failure to learn from incidents", combs the relevant literature of failure to learn from safety accidents with the aid of bow tie model. Chen Zhao[12] chose some rare incidents as the object of incident learning, and explored the influence mechanism of attention quality on the effect of accident learning from two aspects of stability and divergence.

2.3. LDA topic model
Latent Dirichlet Allocation (LDA) topic model was proposed by Blei in 2003. It is a document topic generation model, also known as a three-tier Bayesian probability model, which includes three-tier structure of words, topics and documents. The main idea of the algorithm is based on a basic assumption that a document contains multiple topics, and these hidden topics are composed of their own specific characteristic words[13]. Document $d$ generates topic $z$ with a certain probability, and then topic $z$ generates word $w$ with a certain probability, so the probability of a word in a document can be obtained by multiplying the probability of word $w$ in topic $z$ by the probability of topic $z$ in document $d$[14], and the calculation formula is:

$$P(w|d) = \sum_z P(w|z) \cdot P(z|d)$$

The words in each topic $z$ and the topic in each document $d$ are subject to the Dirichlet distribution[15].

3. Data and method
This research selected the typical domestic hazardous chemical safety accident case "8·12 Tianjin Port Explosion" as the research object. According to the investigation team of the State Council, this explosion accident is a particularly serious production safety liability accident, which has a huge social impact. The research results on this accident are abundant, covering a wide range, with high reference value.

The research content of accident related literature is taken as the carrier to show the safety knowledge obtained by reflection. With CNKI database as the data source, the retrieval subject words include "Tianjin", "explosion" and "accident". The types of literature we selected included "newspaper", "journal", "master's and doctoral dissertations". The time is from August 12, 2015 to September 2018. After retrieval, we removed the irrelevant literature and got 610 literatures as experimental samples. In order to analyze the process of reflection, we counted the number of literatures published in each month after the accident and divided the reflection process into three stages according to the time node. And then, we used Python 3.7 as the experimental tool to mine the topics of the abstracts of 610 literatures by LDA topic model. Finally, we draw a histogram to show the number of literatures on different topics in three stages by percentage.

4. Analysis of the practice process of reflection

4.1. Distribution of number of literatures issued
To some extent, the change trend of the number of literatures can reflect the change of the intensity of reflection in the process of incident learning. The statistical results of the number of literatures issued in each month from 2015 to 2018 after the accident are shown in Figure 1. According to the analysis, the whole system can be divided into three stages according to the time nodes. The first stage (2015.8.12-2015.12) is the initial stage after the accident. During this stage, the number of monthly publications is relatively high, accounting for 38% of the total number of literatures. The second stage (2016.1-2016.12) is the medium-term stage. Except for may, the number of literatures issued in each month is significantly lower than that in 2015, and the overall trend is gradually reduced. The third stage (2017.1-2018.8) is the final stage, with the number of issues in each month at a low level, accounting for 25% of the total.
4.2. Text topic mining

In order to get objective and clear information that reflects the topic of reflection content and its evolution law, the content of sample literature is deeply mined, and the abstract text is processed by LDA topic model, and the high-frequency topic words and the corresponding number of literature in different topic categories are obtained. First of all, base on Python 3.7, we use the Jieba algorithm to segment the continuous text into independent words with different meanings, and using stopwords vocabulary to remove irrelevant words. Then we set the number of topics $k = 4$, the number of iterations $n = 1000$, analyze the preprocessed text by using LDA model. Get the top 10 words with the highest weight in each topic, as well as the number of documents in different stages of each topic category. Finally, according to the analysis of the key words of each topic, the name of the topic grouping category is obtained, and the number of documents of different topics in each stage is counted, and the results are listed in Table 1.

| No. | Topic                                      | Topic words                                                                 | Number of documents |
|-----|--------------------------------------------|-----------------------------------------------------------------------------|---------------------|
|     |                                            | risk; analysis; dangerous; research; production; chemical; factor; enterprise; model; system; | Stage 1 | Stage 2 | Stage 3 |
| 1   | Risk of hazardous chemicals and safety of enterprises |                                                                                   | 142   | 61     | 42     |
| 2   | Emergency management and rescue            | dangerous goods; Warehouse; fire; rescue; company; site; production; logistics; personnel; extra large; | 50    | 27     | 13     |
| 3   | Government public crisis management        | government; crisis; network; public; public opinion; society; management; response; reply; analysis; | 15    | 47     | 57     |
| 4   | Public opinion crisis in emergencies       | Media; communication; report; micro blog; information; public opinion; research; news; emergency; analysis; | 30    | 72     | 54     |

Table 1. Topic classification results
Based on the theory of LFI - analyze the evolution trend and content of the reflection topics

5.1. Analysis the evolution trend of reflection topic
According to the analysis of the changing trend in figure 2, topic I accounts for the highest proportion in the early stage after the accident, and the number of abstract texts accounts for 59.92%. It shows that the sudden outbreak of major accidents prompted the practitioners of the accident related industries and experts reflect on the accident in a period of time. The proportion of topic II in each stage is at a low level, between 10% and 20%, which reflects that the reflection on emergency management and emergency rescue is slightly weaker than the other three topics. It should be emphasized that the key to effectively reduce the harm of accidents is to improve the emergency plan and efficient rescue actions. Therefore, as an important part of accident safety knowledge, topic II should be given full attention. The proportion of topic III and IV in each stage shows a rising trend. It can be seen that, with the exposure of many problems in the process of accident handling, reflection on the defects and shortcomings in public crisis management has become the focus. In addition, public opinion crisis is one of the main forms of public crisis faced by the government in the Internet era, which makes the content of reflection no longer limited to crisis Product accident itself, but gradually turned to the discussion of topic III and IV.

5.2. Analysis the content of reflection topic
5.2.1. Topic I - Risk of hazardous chemicals and safety of enterprises
The main content of topic I includes two aspects: hazardous chemicals risk and hazardous chemicals enterprise management. In view of hazardous chemicals accidents, analyze the accidents from direct causes to root causes, individual cognition to system environment, internal management to external supervision, and establish effective supervision on the safety risks of hazardous chemicals. Secondly, combine with the topic words, the key points of reflection are risk factor identification, risk assessment model and risk control measures.

5.2.2. Topic II - Emergency management and rescue
The emergency management of hazardous chemical accidents often involves many departments and organizations. There are many problems, such as unclear division of responsibilities, irregular
administrative behaviors, and imperfect emergency plans, which increase the difficulty of emergency management. Emergency rescue includes emergency evacuation, treatment of the wounded, accident rescue, epidemic prevention and control, etc. It needs to be emphasized that, due to the characteristics of various types and properties of hazardous chemicals, in case of fire, explosion and other accidents, rescue and rescue will face great challenges. The lack of professional rescue technology and special equipment, as well as the imperfect rescue plan, will lead to the aggravation of accident hazards. To sum up, the perfect emergency management system and scientific emergency rescue plan are the important guarantee to reduce the hazard of hazardous chemical safety accidents.

5.2.3. Topic III- Government public crisis management
Public crisis management refers to the process that the government or other public organizations prevent or solve the crisis through prevention, early warning, emergency response and other management means. Effective public crisis management methods and perfect public crisis management mechanism are the important embodiment of the government's public crisis response ability. In the face of the public crisis caused by hazardous chemicals accident, due to the lack of efficient coordination mechanism and perfect information disclosure mechanism, coupled with a single crisis management mode, the current public crisis management effect is not good. To improve the response ability to the public crisis caused by hazardous chemicals accidents, we can improve the public crisis management mechanism, establish professional and efficient emergency response agencies and make full use of multi platform information dissemination mode.

5.2.4. Topic IV- Public opinion crisis in emergencies
Public opinion crisis refers to the public opinion state that, after the occurrence of accidents, relies on Internet media and social platforms to disseminate relevant information and discussions about emergencies in a short period of time, and causes certain social repercussions and social panic after expansion and fermentation. Major impact of the accident, diversified public opinion environment, lagging official information and improper emergency response are all the possible causes of the secondary public opinion crisis after the accident. If the public opinion crisis is not dealt with timely and effectively, it may lead to unnecessary social panic, affect social stability. Combined with the current diversified public opinion environment in which new media and traditional media coexist, the authoritative information can be spread timely and accurately by means of improving the guiding force of accident report, improving the information release mode, optimizing the information dissemination mechanism, so as to realize the effective control of public opinion crisis.

6. Conclusion
This research introduced the concept and research status of LFI theory, and integrated the concept of LFI into the reflection process of major hazardous chemical safety accidents to improve the level of reflection. Taken the "8·12 Tianjin Port Explosion " as an example, this research analyzed the evolution trend and core content of the topic of reflection on hazardous chemical safety accidents. The results show that: (1) the content of reflection mainly includes the following four topics: (I) Risk of hazardous chemicals and safety of enterprises; (II) Emergency management and rescue; (III) Government public crisis management; (IV) Public opinion crisis in emergencies (2) the proportion of research on topic II is lower than that of other topics, and there may be insufficient reflection on individual issues. As it has the function of reducing accident harm, it is of great significance and should be given enough attention.

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