Big data-based applied research on hazardous chemical safety regulation

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Abstract. With the rapid development of modern industry in China, a large number of hazardous chemicals are put into the production and use of chemical enterprises, increasing the probability of hazardous chemical accidents to a certain extent. Because hazardous chemicals are extremely dangerous and destructive, timely and efficient regulation of hazardous chemical safety is of particular importance. The application of China's Beidou satellite navigation system for safety supervision is of great significance, with its advantages of high accuracy and all-weather weather, and the rapid development of related technologies and applications in recent years, has been widely applied in the field of safety monitoring of bridges, earthquakes, dams and other areas. Based on the investigation and analysis of emergency management of critical chemical enterprises, this paper explores the construction of an innovative application system for the safety supervision of critical chemicals based on big data of Beidou positioning system, including a platform for dynamic supervision and traceability of the whole process of critical chemicals based on big data, a platform for dynamic supervision of critical chemical transport safety based on big data, a prediction and early warning application of social public big data in the critical chemical industry, and a platform for emergency information mining and analysis of critical chemical incidents based on social media big data to form a more scientific safety supervision system for critical chemicals.

1. Introduction
As an important material for people's production and life, raw materials, auxiliary materials and products, with the rapid development of China's economy and society, the demand and use of hazardous chemicals has increased dramatically, and it has the characteristics of large-scale, complex equipment, process operation and transformation [1]. According to the data, more than 300 million tons of dangerous chemicals are moved on the road every year, accounting for more than 30% of the total annual freight volume, and the trend is on the rise [2]. The number of inland river transportation is also close to 300 million tons. In recent years, serious and major accidents of hazardous chemicals in China, such as "8.12 Tianjin Binhai Tianjin port warehouse fire and explosion"[3], "7.19 Shaoyang Shanghai Kunming high speed transport truck explosion", "11.22 Qingdao economic and technological development zone oil pipeline leakage and explosion"[4] and many other heavy accidents have caused a large number of casualties, great social impact. With the promotion of national regional economic development strategy, the safety supervision of hazardous chemical industry is more urgent.

Due to the lack of safety supervision and emergency management of hazardous chemicals by the government and enterprises, the occurrence of hazardous chemicals accidents often results in a wide range of destructive adverse consequences, so it is particularly crucial to strengthen the intelligent
management of hazardous chemicals and assist enterprises and government departments to carry out timely and efficient emergency management. At present, the research on the safety supervision of hazardous chemicals in China is still in the primary stage [5]. The existing system of safety management of hazardous chemicals needs to be improved and the standards have not been unified, lacking of effective means of coordination, local supervision with ability insufficient, the weak main responsibility awareness of enterprises, and weak safety management ability [5][6]. Therefore, it is urgent to use modern information technology means such as Internet of Things (IoT), big data and cloud computing to build a comprehensive regulatory information platform with unified standards, nationwide coverage and reliable operation, which conducts the whole process supervision of hazardous chemicals, eliminates regulatory blind spots and dead corners, shares and seamlessly connects with existing management platform information of various departments, and realizes the recyclable sources and directions of hazardous chemicals tracking, state control, timely response and collaborative disposal of emergencies, effectively inhibits the occurrence of major accidents.

Based on the modern big data thinking, this paper uses the Beidou and other monitoring sensors independently developed by China to acquire the detection data, constructs the big data cloud platform for hazardous chemicals, breaks the information island, realizes the dynamic supervision, traceability of the whole process of hazardous chemicals, emergency information mining and analysis, so as to promote the application of hazardous chemical safety supervision to plat-form, system and intelligence.

2. Innovative application system of hazardous chemicals big data

This paper focuses on the production, storage, transportation, usage and destruction of hazardous chemicals in the fields of traffic, public security, administration for market regulation, emergency management, environmental protection, health, tax, customs and other hazardous chemicals safety supervision. Under the constraints of the hazardous chemicals safety operation system and the standard specification system, an innovative application system of big data safety supervision of hazardous chemicals based on Beidou is constructed, using IoT, cloud computing and big data and other advanced technologies to collect and supervise the data of various links of hazardous chemicals production, storage and management, build a cloud platform for hazardous chemicals supervision, and carry out application services for various industries and departments. The innovative application system can realize the closed-loop application of "monitoring perception—prediction warning—emergency disposal", and support the seamless supervision of hazardous chemicals safety. The overall structure is shown in Figure 1.

The construction ideas and objectives of the platform are as follows:

(1) It makes use of IoT, cloud computing, big data and other advanced technologies;
(2) It collects, monitors and supervises the data of production, storage, management, transportation supervision, usage, operation, import and export of hazardous chemicals;
(3) It includes enterprise registration, license approval, credit evaluation, management supervision, reporting and complaint, tracking and traceability, emergency response, real-time monitoring, punishment and law enforcement, analysis and statistics, collaborative governance and other functions.
(4) The goal of "hazardous chemicals being sourced, traced, accountable and followed" is finally achieved.

The hazardous chemicals supervision platform includes two aspects:

(1) A supervision cloud for hazardous chemicals was built. The aim was to provide a unified and standard model for the regulatory cloud services which are used to provide high-speed and effective information channels for all kinds of hazardous chemicals information, aiming to reach the sharing and effective exchange of data, information and resources.
(2) Creation of "two systems" to provide "two types of services". To build a comprehensive safety supervision application system and four types of systems, namely "administration", "dynamic supervision", "emergency rescue" and "public service", so as to fill in and improve the gaps and overlaps in the existing supervision process and build an application system with a clear interface and complete coverage. At the same time, it provides enterprises and the public with services such as
information inquiry, policy interpretation, training and education, etc., and enhances the ability to guide public opinion.

Figure 1. Architecture of Beidou safety monitoring application.

"Two systems" include identification, tracking traceability system and application system. The identification, tracking and tracing system establishes the management system and supervision platform for the electronic labels of hazardous chemicals, and the electronic labels containing the safety supervision code of hazardous chemicals are used in the process of production, storage, transportation and use. The life cycle of the safety supervision code is up to being consumed, abandoned or exported, to realize the collection, tracking and monitoring of the whole life cycle of information such as the types and quantities of hazardous chemicals. In each link, the code scanning method is used to record and report the operation data of hazardous chemicals, the system records its circulation information, and identifies and alarms the violations and illegal behaviors in the process.

The application system builds a complete regulatory application network through the transformation, upgrading and supplementary construction of existing business applications, covering
the whole life cycle of hazardous chemicals from generation to extinction. It provides hazardous chemicals regulatory services to all ministries and local governments at all levels, and improves the capacity of cross level, regional and sector regulatory coordination and emergency response.

"Two type services" include enterprise services and public services. Enterprise services provide safety management services in line with national regulations and standards for hazardous chemicals enterprises, strengthen the main responsibility of enterprise safety management, and improve the ability of enterprise safety management and risk prevention and control. At the same time, regulatory data is reported to government departments as required. The content of enterprise service mainly includes security system and organization management, security business management, security assessment and improvement, security knowledge, etc.

Public services use portal, WeChat, microblog and other means to publicize hazardous chemicals policies and hazardous chemicals knowledge, provide information query, broadcast accident trends, and reduce and control social impact caused by accidents. Knowledge base, case and training courseware of hazardous chemicals are established to provide policy standard inquiry, occupational safety education and technical training services for hazardous chemicals enterprises and employees.

2.1. Hazardous chemicals supervision cloud

Dangerous chemicals supervision cloud not only provides basic support and business services for various applications of safety supervision, but also is the "nerve centre" of the whole platform, which plays an important role in data upload and release, processing and transformation, storage and exchange, analysis services, etc., and is the core of the whole supervision platform. The hazardous chemicals supervision cloud is composed of national supervision data centre and comprehensive supervision service system. As the basis of the regulatory platform, the national regulatory data centre mainly stores the data exchange standards of hazardous chemicals and the main data of all dimensions, such as emergency management, public security, administration for market regulation, environmental protection, transportation, health, post, and other departments related to the safety supervision and industry management of hazardous chemicals, including laws and regulations, physical data, accidents, enterprise information, personnel information, devices and facilities, emergency resources, etc.

The integrated supervision service system supports the operation of the application system and ensures the stability, reliability and expansibility of the supervision platform, including supervision data collection and integration, basic security supervision services, operation services, application security services, etc. The service application system converts, integrates, processes and orders the data of all hazardous chemical production, usage, storage, operation, transportation, disposal and disposal in a unified way, strengthens the deep integration of data, and controls the whole process of hazardous chemicals, and monitors the information sharing channels between departments.

2.2. Big data innovation application of hazardous chemicals

2.2.1. Dynamic supervision and traceability platform for the whole process of hazardous chemicals

Hazardous chemicals regulatory big data analysis and regulatory traceability uses the massive heterogeneous data processing capabilities provided by cloud computing to achieve high-risk area mining, hazardous chemicals circulation net-work tracking, hazardous chemicals consumption scale analysis, case event distribution and risk analysis, historical data trends and public opinion hot spots. The data of hazardous chemicals purchase, storage and circulation among different enterprises is recorded by the regulatory platform. By creating a regulatory closed-loop through the whole chain of data, any data can be verified through the up-stream and downstream regulatory data, to avoid the falsification of enterprise data. Through the data of the whole chain, we can also restore the association relationship between enterprises, the flow information of hazardous chemicals, re-store the real dynamic storage, and trace the whole process flow direction of the types and quantities of hazardous chemicals from the terminal to the source step by step, to achieve "traceable source,
traceable destination and clear stock”. The dynamic regulatory framework for the whole process of hazardous chemicals is shown in Figure 2.

2.2.2. Dynamic supervision platform for hazardous chemicals transportation safety. The dynamic management and control of hazardous chemicals transportation safety firstly realizes the qualification examination and information entry of hazardous chemicals transportation from the loading stage; secondly, monitors the positioning and path tracking of the transportation stage, and gives an early warning of the violation of the planned path; finally, verifies and records the un-loading stage of hazardous chemicals transportation.

The dynamic supervision data of hazardous chemicals transportation is typical multi-source heterogeneous data, with different data sources, including vehicle and road monitoring video data of functional departments, driver and escort data of public security departments, and quality inspection data of hazardous chemicals transportation equipment of quality inspection departments. Therefore, multi-source data integration, linkage and integration are the core of hazardous chemicals safety transportation and intelligent control. This paper adopts the idea framework model of data standard integration, location-based service and time node linkage, and business-oriented model to realize application integration, as shown in Figure 3.

**Figure 2.** Framework for the whole process of hazardous chemicals dynamic supervision.

**Figure 3.** Dynamic management and control system for transportation of hazardous chemicals.
2.2.3. Application of public big data in the prediction and early warning of hazardous chemicals supervision. Hazardous chemicals supervision and mass prevention and control App is developed to support enterprises and the public in two aspects.

- For enterprises, it realizes self-inspection and self-reporting of hazardous chemicals, enterprise plan management and inquiry and learning of hazardous chemicals related knowledge, laws and regulations.
- For the public, it is mainly to take photos at will, report risks, violations and other dangerous chemical hazards; in addition, it can also learn relevant knowledge of dangerous chemicals and laws and regulations.

The application of social public big data in the prediction and early warning of hazardous chemical industry mainly refers to the collection of massive information of the public, such as text, audio, video, pictures, etc., and the acquisition of effective data of hazardous chemical safety by distributed calculation, fuzzy clustering and correlation analysis of different types of data, so as to realize the beneficial supplement to hazardous chemical safety supervision by using social public information.

2.2.4. Emergency information mining and analysis platform for hazardous chemicals based on social media big data.

In emergencies, social media data contains a lot of emergency information such as theme, time and space. Through the classification of real-time and massive emergency information, we can identify the real-time, rescue, event impact and other thematic information, which is conducive to understand the situation of emergencies. According to the characteristics of microblog and other data such as short text, diverse themes, high timeliness and rich spatial information, a real-time classification and positioning model of emergency themes based on social media text stream is proposed [7], and its flow is shown in Figure 4.

The real-time screening and location model of emergency information is to realize the classification and location of real-time micro blog data. In this paper, the topic model (LDA) and support vector machine (SVM) are combined. Firstly, the theme model is used to discover the theme hidden in the acquired microblog data text; then, on the basis of these discovered themes, SVM is used to supervise the learning, so that every newly acquired microblog data can be classified in real time. On the other hand, due to the short and sparse text, a large number of forwarding of microblog data leads to high repetition and obvious colloquialism. Therefore, data pre-processing is required in the process of model construction.

![Figure 4](image-url) - Identifying and locating real-time emergency information.
3. Conclusion
According to the requirements of hazardous chemicals safety supervision, this paper has carried out an innovative application research based on big data of Beidou, introduced the cloud platform innovative application system of hazardous chemicals supervision. The innovative application system realizes the platform and systematization of hazardous chemicals safety supervision, which can meet the application of cross regional and cross industry system safety supervision. In the era of big data, the mode of hazardous chemical safety supervision should also be innovated to solve the problems of modern hazardous chemical safety supervision. Based on big data thinking, the construction of hazardous chemical safety supervision cloud platform plays an important role in China's hazardous chemical safety supervision in obtaining accurate information, comprehensive online safety management and control, scientific prediction and early warning, reasonable allocation of emergency resources, implementation of joint emergency rescue and other aspects.

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