Research and Application of the Architecture of the Full Process Supervision Information System for Hazardous Chemicals

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Abstract: The safety of hazardous chemicals is a key focus of safety production work, involving a large number of enterprises, multiple industry sectors, multiple regulatory departments, high potential safety risks and easily affecting public safety. There are safety hazards that cannot be ignored in various links such as production, operation, storage, transportation, usage and disposal. The research purpose of the whole process supervision information system of hazardous chemicals is to make full use of information and intelligent means and combine big data, cloud computing, artificial intelligence, Internet of Things, mobile Internet and other technologies to build a full coverage and whole process supervision information system of hazardous chemicals. This system plans to establish a hazardous chemical supervision information exchange platform based on the government data resource management platform, create a hazardous chemical data lake and use the entire life process of hazardous chemical operation, storage, transportation, use and disposal as the data bus. Through data aggregation, data governance, data integration, data verification and data presentation, it will achieve the full network interconnection of regional hazardous chemical data and establish a new mode of hazardous chemical data exchange and sharing among joint units.

Keywords: Internet of Things; Data Security; Data Analysis; Business Collaboration; Contingency Management; Knowledge Base

1. Introduction

Due to the inherent and newly added accident risks of hazardous chemicals in our country, they have existed for a long time. However, the information construction and intelligent application related to the safety management of hazardous chemicals are seriously insufficient, which seriously hinders the further improvement of the safety supervision level and comprehensive governance ability of hazardous chemicals. Therefore, there is an urgent need to establish a unified information system for the entire process supervision of hazardous chemicals in the entire region to enhance the technical capacity of the entire process supervision of hazardous chemicals in the region. This article focuses on the construction of an integrated hazardous chemical full process supervision information system, with the aim of improving regulatory efficiency and response speed and ensuring public safety.

This study will rely on existing laws, regulations and technical means to analyze and design a suitable system architecture, focusing on key technologies such as data collection, processing, analysis and display, in order to create an efficient and intelligent regulatory tool. Through this study, it is expected to provide scientific and information-based technical support for the entire process supervision of hazardous chemicals in China, enhance the ability to prevent and handle related accidents and better protect the safety of people's lives, property and environment.

2. Overall Architecture of the Construction of a Full Process Supervision Information System for Hazardous Chemicals

In response to the current problems of insufficient resources, lack of unified management and scheduling methods, scattered image resources and insufficient intelligent application in the construction of video points and pan perception data for hazardous chemical enterprises and in accordance with the requirements of the "Opinions on Strengthening the Safety Production of Hazardous Chemicals in All

Aspects" issued by relevant state departments and the "Guiding Opinions on Accelerating the Construction of Risk Monitoring and Early Warning System for Safety Production of Hazardous Chemicals" issued by the Ministry of Emergency Management, as well as the relevant technical requirements and specifications such as the "Public Security Video Image Information Application System", "Public Security Video Image Analysis System", and "National Public Security Video Image Information Database Construction Networking Overall Technical Plan (Draft for Comments)" issued by the Ministry of Public Security, this study conducts an overall planning and design for the construction of video and pan perception data aggregation and forwarding platforms

3. Basic Backend Support

Basic backend support refers to the infrastructure required to build a full process supervision platform for hazardous chemicals, including networks, software and hardware equipment and safety equipment.

(1) Network system: refers to the basic network involved in this project, including: government extranet, emergency command network, Internet and enterprise special line.

Based on the video image platform, achieve unified management of all video resources and video on demand. When you actually need to view videos, you can directly obtain them from the enterprise end through this platform. At the same time, the video management platform supports real-time access to video information by higher-level departments.

Each access enterprise deploys explosion-proof cameras, NVRs and other equipment to access the video image forwarding platform through dedicated lines or VPN links. Unified management is carried out by the video image forwarding platform and the access protocol complies with the GB/T 28181-2016 standard.

Each enterprise simultaneously deploys data collection equipment as a collection node for enterprise information perception data, collecting enterprise alarm and process parameter data. The collected data is connected to the district level platform through dedicated lines for automated transmission and reporting of data, alarm data and video data.

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District level platforms achieve data exchange with city level platforms through emergency command private networks

(2) Software and hardware equipment: refers to the software and hardware equipment required for the deployment of the entire process supervision platform for hazardous chemicals. Includes hardware devices for perception data collection and video access required for online monitoring and monitoring of district level platforms.

(3) Security equipment: It is designed to ensure the security of data transmission, including boundary access control security equipment, to ensure the transmission security of enterprise security data and monitoring resources from the chemical park, enterprise boundaries to the emergency bureau.

The enterprise boundary deployment remote access device - enterprise boundary gateway device, realizes the conversion of national standard video protocols and addresses, identifies abnormal behavior attacks based on video and image traffic models, session connections and new connections, effectively protects against virus propagation, zombie networks, Trojans and other security threats to the video monitoring network. Implement secure access to video surveillance data for various enterprises.

The video data of each enterprise is connected to the district bureau through dedicated lines, government networks and other channels and the data is uploaded to the cloud and stored; The district bureau can directly access local enterprise video data, or access it through the district government cloud; The Municipal Bureau and the Emergency Management Department retrieve video data through the emergency command network.

All enterprises accessing videos first need to go through the enterprise boundary gateway for national standard protocol recognition and conversion, while preventing virus attacks and Trojan horse transmission; when the enterprise camera is attacked by viruses, intrusions, or DDOS, the enterprise boundary gateway

device can effectively block the attack. The Municipal Bureau and the National Emergency Management Department retrieve video surveillance data from various enterprises through dedicated lines from the government cloud and all data is securely accessed through the border gateway for L4-7 layers to ensure that the data uploaded to the department is legal and compliant.

Through the security capability of the remote enterprise boundary gateway, L2-7 layer three-dimensional and deep level security protection can be achieved, ensuring the security and reliability of the private network boundary and meeting the requirements of national policies, regulations and level protection.

4. Middle Platform Support System

The middle platform support system refers to the business information system required to support the construction of a hazardous chemical full process supervision information system, including comprehensive emergency management data and data related to hazardous chemical systems.

(1) Comprehensive application data of emergency management

The emergency resource data and accident data of a certain district level area are integrated with the urban transportation center through application integration. At the same time, based on an emergency management map, relevant professional layers of hazardous chemicals are overlaid to form a map of hazardous materials.

(2) Government and enterprise hazardous chemical related data

Based on the government extranet, emergency command network, Internet, and enterprise special line, the data of the associated hazardous chemicals information system within the jurisdiction of a certain area is docked, including basic data, business data, perception data, etc. Data classification mainly includes structured data and unstructured data. [1]

5. Application Front-End and Decision Support

The application front-end and decision support include a hazardous chemical safety production risk monitoring and early warning system and a hazardous chemical full process supervision information system. [2, 3]

(1) Risk monitoring and early warning system for hazardous chemical safety production

a. Major accident risk warning

Establish a major accident risk warning mechanism, including key areas where accidents may occur, accident prone areas, road checkpoints, etc., as the main monitoring subjects for major accident risks. Through on-site data collection, real-time monitoring of accident risk points is achieved to achieve early warning of major accident risks.

b. Emergency support for accidents

Integrate hazardous chemical resource information, locate the location of accidents based on GIS maps, provide emergency resources and disposal plans around the accident, and provide decision-making support for emergency command at the accident site.

c. Comprehensive analysis of key risks of hazardous chemicals

By integrating and colliding data, a comprehensive analysis system for key risks of hazardous chemicals is formed, and multidimensional analysis is conducted and visually displayed based on dimensions such as risk points, risk levels, hazardous chemical categories, and hazard levels.

d. Dynamic analysis of risk situation

Visualize and track existing risks, and combine big data analysis models to predict risk situations, helping emergency management departments fully grasp changes in major accident risks. Through real-time warning information push, urge streets, towns, parks, and enterprises to timely reduce risks.

e. Monitoring and early warning of major risks of hazardous chemicals

By using a data collection system, data collection and transmission of safety parameters, video signals, and alarm information for key facilities and equipment of major hazard sources in enterprises can be achieved. This enables centralized monitoring, management, and monitoring of hazard source videos and various parameter alarm information for physical production enterprises in the Yangpu area. Real time information on major hazard source sites can be accessed at any time through permission authentication based on actual work conditions.

(2) Full process supervision information system for hazardous chemicals.

a. Special Database on Hazardous Chemicals

Supervision

The specialized database for hazardous chemicals can provide a window for data display in the form of a data directory by constructing a distributed data exchange network. Multiple modes of data exchange tasks can be configured and operated, and a well-defined data publishing, revocation, and acquisition process based on user role authorization can be defined to ensure the validity and safety of data. At the same time, comprehensive operation and management can be carried out to solve the problem of multi-level, cross regional, and multi departmental data resource exchange and sharing and business collaboration support between governments and enterprises, truly realizing data circulation and creating greater data value. [4-6]

The topic of hazardous chemicals supervision can also crawl and collect the public information, public opinion information, and perception data of the Internet of Things related to hazardous chemicals on the Internet, so as to grasp all kinds of information about hazardous chemicals in the city in an all-round, multi-level, and multi angle manner.

b. Comprehensive analysis subsystem for supervision and management of hazardous chemicals

The comprehensive analysis subsystem for hazardous chemical supervision and management is mainly based on big data intelligent analysis and judgment, mainly targeting the transportation, use, and storage of hazardous chemicals. Based on a GIS map, it displays, tracks, and alerts the entire process of hazardous chemical production, storage, transportation, operation, use, and disposal. It is possible to automatically alert the risk sources and factors of hazardous chemicals, and provide auxiliary decision-making for warning disposal based on warning indicators, warning levels, and warning disposal plans. Once the warning is resolved or disposed of, the system will also give a prompt to clear the corresponding warning.

The comprehensive analysis subsystem for supervision and management of hazardous chemicals mainly automatically corrects indicators based on the actual effect of hazard warning, and combines with the management of manual warning thresholds to ensure the accuracy of warning.

c. Monitoring and early warning of hazardous chemical circulation information, connecting with the electronic waybill and other information systems of the city platform, and analyzing the dynamic information of hazardous chemical transportation links based on a GIS map in a certain jurisdiction.

The hazardous chemical circulation information monitoring subsystem is based on a GIS image for circulation information monitoring, including: visual tracking and warning of hazardous chemical operation, closed inspection of hazardous chemical flow quantity, warning of excessive hazardous chemicals, monitoring and warning of hazardous chemical transportation routes, tracking and warning of hazardous chemical transportation personnel, tracking and warning of hazardous chemical flow tools, tracking and warning of hazardous chemical surrounding environment, monitoring and warning of hazardous chemical transportation supervision, tracking and warning of abnormal changes in hazardous chemical flow, and tracking and warning of spatiotemporal aggregation of hazardous chemical transportation flow.

d. Analysis of hazardous chemical flow information, integration with hazardous chemical registration systems, highly toxic, easy to produce, and explosive systems, as well as existing systems of various committees and bureaus involved in the use of hazardous chemicals, combined with a GIS map in a certain jurisdiction to analyze and verify information data on the production, operation, use, storage, and disposal of hazardous chemicals.

The hazardous chemical flow information analysis subsystem is based on a GIS image for analysis, including functions such as visual tracking and warning of hazardous chemical flow, closed verification of hazardous chemical business usage quantity, warning of excessive waste in hazardous chemical enterprise business usage, tracking and warning of abnormal changes in business usage waste, and tracking and warning of spatiotemporal aggregation of hazardous chemical life cycle.

6. Access Users

The access layer can display daily business information, intelligent analysis and warning information, emergency events and other

aspects of production, operation, storage, transportation, use and disposal. At the same time, information can be pushed through mobile apps, SMS, or client agents according to the usage needs of various joint business units and enterprise levels, to meet the needs of users at different levels [7-9].

Users mainly refer to the users targeted by the construction of this system and government users include district emergency management, district urban transportation centers, various joint units, etc; Enterprises refer to enterprises involved in the production, operation, storage, transportation, use and disposal of hazardous chemicals; The general public refers to citizens, news media and other members of society.

7. Safety. Technical and Management Standards

Safety, technology, and management standards: Starting from the perspective of e-government informationization application construction, platform construction involves the informationization achievements of hazardous chemical information systems of various line units. At the same time, the aggregation and implementation of various data must be based on overall planning, and unified standards and construction must be carried out. Under the guidance of various regulatory standards and the national e-government standard system, research, analysis, and compilation work will be carried out on data management standards and related technical standards during implementation. Standards and specifications will be established for new data applications and services, and unified data standards and security management will be ensured throughout. At the same time, promote the construction of emergency response linkage mechanisms and fully ensure the application effect of the system after its completion. [10-11]

8. Conclusions

The research and application of the information system architecture for the full process supervision of hazardous chemicals, through big data and other technical means, constructs a district level hazardous chemical risk warning system, screens risk control indicators under the risk warning system, and establishes corresponding threshold models to dynamically monitor data information in real time. Once warning information appears, it is promptly released to government regulatory departments and involved enterprises such as public security, fire protection, transportation, environmental protection, and health, and the evaluation results are included in the daily assessment system of safety inspections. Breaking down the information barriers between various regulatory departments of hazardous chemicals, ensuring the sharing and interoperability of regulatory information on hazardous chemicals, integrating and utilizing safety regulatory information from various links of hazardous chemicals, providing strong technical support for the regulatory work of hazardous chemicals to achieve traceable sources, traceable destinations, and controllable states. By constructing a three-dimensional regulatory system that combines horizontal integration of departmental regulatory functions with vertical linkage of enterprise safety management information, the integration of hazardous chemical regulatory data is achieved, and ultimately achieving "real-time dynamic supervision of hazardous chemicals throughout their entire lifecycle" on the basis of industry and local managementt.

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