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Design and Implementation of Logistics Application Platform for Hazardous Chemicals Based on Internet of Things

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The logistics safety of hazardous chemicals is of great social impact. Use IOT technology to reduce logistics risks, improve logistics efficiency and reduce costs, and increasing efficiency is the focus of hazardous chemicals logistics management. Based on the current situation of the management of dangerous chemicals logistics in large petrochemical enterprises, this paper puts forward a solution to the logistics application platform of dangerous chemicals based on the technology of Internet of things. It helps to accelerate the pace and process of informatization construction of hazardous chemicals logistics, enhance the level of construction of hazardous chemicals logistics information system, and provide practical reference for logistics informatization of hazardous chemicals.

1. Introduction

The main reason for the frequent accidents of hazardous chemicals logistics comes from the problems in the supervision and operation of hazardous chemicals logistics activities.There are many departments involved in the supervision and management of hazardous chemicals logistics, and lack of effective connection in policy-making between various departments and unified standard supervision and management mechanism leads to the fact that the hazardous chemicals logistics cannot be properly regulated and operated; lack of effective market access mechanism and logistics supervision results in low-level and repetitive input of hazardous chemical logistics and low quality of employees (Bu et al., 2013). In terms of technology, lack of perfect dynamic tracking and monitoring system makes it hard to grasp dynamic information of hazardous chemicals in the logistics process in time. Various problems in the logistics activities of hazardous chemicals have become the bottleneck to limit the development of hazardous chemicals logistics, and are also the main causes of frequent accidents (Gherardi et al., 2011). The supervision and operation of logistics activities of hazardous chemicals should focus on the inherent particularity of hazardous chemicals and seek practical and reliable methods and means on the basis of the full understanding of their own characteristics (Jabr, 2011). This study will focus on the design of the early warning and monitoring platform of hazardous chemicals logistics based on the Internet of Things, according to the national three-level supervision and management model of transport vehicles and chemical transport equipment. By collecting and processing real-time data such as leakage of hazardous chemicals, state of transport media and state of transport carriers, the study fully explores data resources of sensing layer, analyzes threshold value of accident occurrence state parameters, provides vehicle operation report, environmental parameter report of hazardous chemicals and alarm and warning of safety hazard, and establishes a targeted variety of data analysis and application functions. In combination with other application systems, this study provides relevant data for vehicle emergency alarm, driving accident and vehicle violation behavior.

2. Analysis of the structure and key problems of the logistics intelligent monitoring system for dangerous chemicals

2.1 Analysis of the logistics characteristics of hazardous chemicals

With the emergence of logistics concept, people have a new understanding of hazardous chemicals logistics. Besides the basic transportation and storage functions of hazardous chemicals, the production, procurement,

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processing, distribution and sales of hazardous chemicals are also included in the management of hazardous chemicals logistics. The logistics of hazardous chemicals covers complicated processes and links. In addition, hazardous chemicals is of various types, special nature, complex logistics process and operation specialty, so that the intelligent monitoring and application of hazardous chemicals logistics requires for finer information management of hazardous chemicals. How to comprehensively and accurately grasp the basic information of hazardous chemical logistics is the key to the construction of information management and information system (Lee et al., 2016). Based on the full understanding of classification and characteristics of hazardous chemicals, with critical factors of hazardous chemicals triggering for risks as reference, the objects of information collection of hazardous chemicals logistics are selected according to the specific logistics form of different classifications of hazardous chemicals.

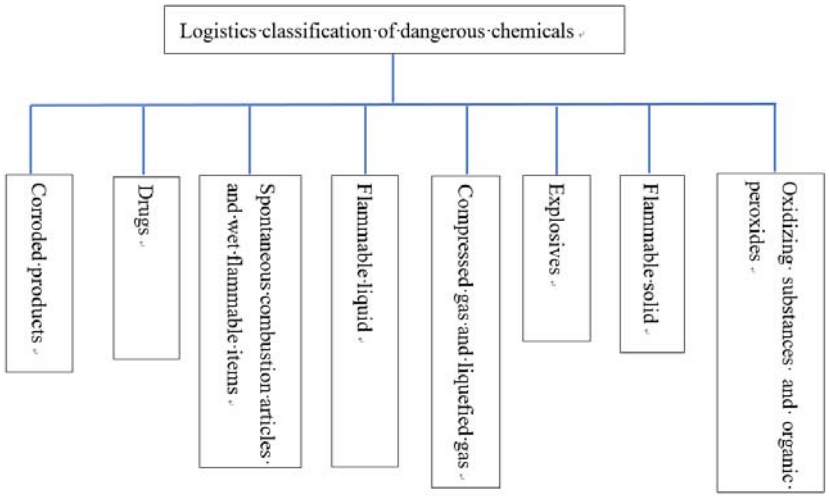

Figure 1: Classification diagram of dangerous chemicals

2.2 Logistics form of hazardous chemicals

According to the classification, the hazardous chemicals have different physical and chemical characteristics. During the logistics process, the hazardous chemicals of different types have different logistics forms. According to the different storage or transportation forms, the selection of information collection objects will also be different. According to the classification of hazardous chemicals, the type and form of hazardous chemicals warehouses are shown in Table 1.

Table 1: Classified storage environment and form of dangerous chemicals

Classification standard	Category	Storage environment	Storage form
Ⅰ	Explosives	Storage Room	Normal, box
Ⅱ	Compressed and liquefied gas	Storage Room	Tank assembly, tank assembly
Ⅲ	Flammable liquid	Storage Room	Tank container
Ⅳ	Flammable solid	Yard	ISO tank
Ⅴ	Spontaneous combustion articles and wet flammable items	Storage Room	Tank container
Ⅵ	Oxidizing substances and organic peroxides	Storage Room	Special container
Ⅶ	Have drugs	Storage Room	Drum
Ⅷ	Corroded products	Yard	Tank container

2.3 Selection of information collection objects for logistics of hazardous chemicals

The information collection objects are selected first according to the classification and dangerous characteristics of hazardous chemicals, the storage and transportation of different kinds of hazardous

chemicals logistics should be considered, and then the intelligent monitoring information collection objects should be summarized according to different kinds of hazardous chemicals in different logistics forms (Mascolo et al., 2004). Conventional information refers to the information related to the basic physical and chemical characteristics of this kind of performance, that's, the information contained in hazardous chemicals safety technology book; management information refers to the information of storage and transportation links; real-time status information refers to monitoring information of environment and equipment status. The real-time status information is the environmental monitoring information and the status information of facilities and equipment in the process of storage and transportation of hazardous chemicals. The real-time status information of explosives is shown in Table 2.

Table 2: The real-time status information of explosives

Logistics link	Operation form	Logistics facilities or equipment	Information collection object
Storage	Normal, packing	Storage Room	Fire source detection information, indoor temperature, indoor air relative humidity, indoor impurity concentration, video surveillance, exhaust ventilation equipment
Transport	Normal, packing	Van explosives	Temperature in the container, air relative humidity inside the container, concentration of impurities in the container, exhaust ventilation equipment, vehicle position, speed, azimuth, acceleration
		Wooden bottom boxcar, iron bottom boxcar	The temperature in the carriage, the relative humidity of the air in the carriage, the concentration of the impurities in the car, the exhaust ventilation equipment, the position of the vehicle
		Aero craft	Temperature in cargo hold, concentration of impurities in cargo hold, concentration of impurities in cargo hold, exhaust ventilation equipment, aircraft position
		Special ship	The temperature in the cargo hold, the concentration of impurities in the cargo hold, the concentration of impurities in the cargo hold, the ventilation and ventilation equipment, the position of the ship, the speed, and the direction of the cargo

2.4 Analysis on intelligent monitoring system of hazardous chemicals logistics

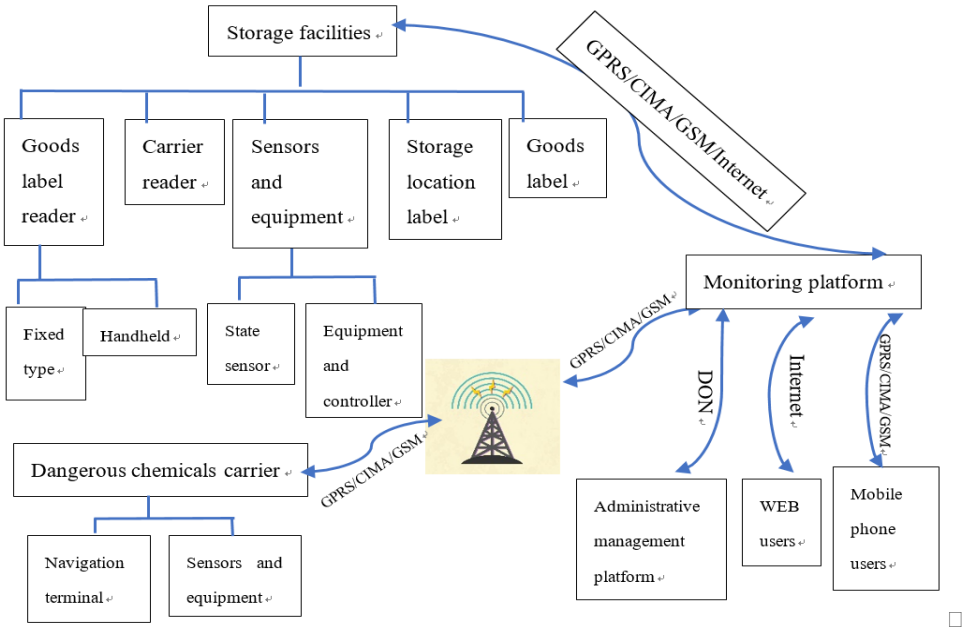

Figure 2: Conceptual framework of Logistics Intelligent Monitoring Scheme for dangerous chemicals based on RFID and WSN Technology

According to the foregoing description of the logistics characteristics of hazardous chemicals, in the field of hazardous chemicals logistics, the introduction of RFID and WSN technologies can not only improve the management quality and service level and save the business and operation processing time in the logistics link, but also improve the accuracy and timeliness of information transmission, and increase the operation safety of hazardous chemicals logistics (Pearson and Schaik, 2003). The operation links of transportation and storage business are respectively equipped with front-end monitoring terminals. In the transportation link, the terminal of satellite navigation system is installed on the transport means. The front-end monitoring terminal may receive and record information including sensors, automatic identification terminals, satellite navigation terminals, related databases, status of environment regulating devices and video monitoring, filter and integrate the useful information and process the information, and store the information into the database. Personnel and institutions related to hazardous chemicals logistics can access and query the information related to hazardous chemicals through the Internet. The conceptual framework of intelligent monitoring scheme for hazardous chemicals logistics based on RFID and WSN technologies is shown in Figure 2.

3. Design of logistics application platform for chemical dangerous chemicals

3.1 Construction of cloud computing platform for logistics network

The cloud computing technology to be adopted in this project provides large-scale computing capability. Each logistics warehouse uses various cloud devices to call the cloud computing platform to process the high-capacity, high-complexity safety state information of hazardous chemicals in transit (Poddubnyi et al., 2012; Sophie et al., 2015). Through the configuration of a series of resources in the management center, these resources can be dynamically allocated according to the needs of the safety state information processing of the hazardous chemicals in each sub-warehouse, and the users can access it through a simple service call interface, so that the management center can uniformly process and store all kinds of information.

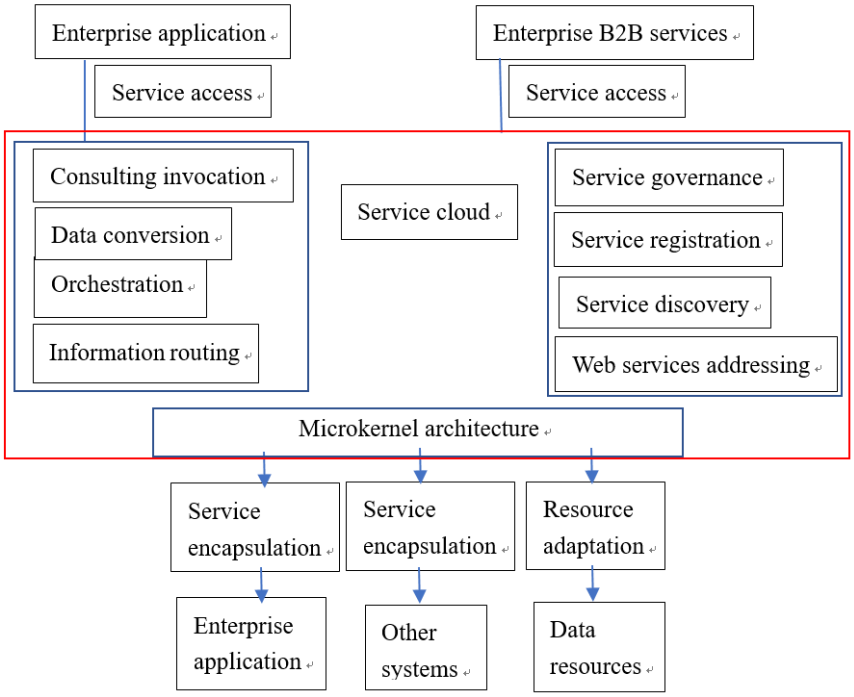

Figure 3: Construction of cloud computing platform for logistics network

3.2 System management

In order to realize the above function requirements, the design of the platform introduces the concept of "user role," which includes two meanings of function role and resource role. The function role defines which functional authority the user can have on the platform (Lunn and Sansone, 1989; Renfrew, 1990). The resource role defines which hazardous chemicals logistics transport vehicles the user can carry out appropriate authority management operations. The model can be obtained by describing the storage business

process of hazardous chemicals logistics according to modeling of the warehouse operation flow, as shown in Figure 4.

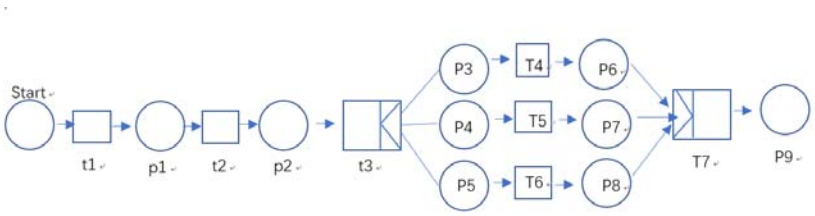

Figure 4: Warehousing business process details network

t1 refers to the acceptance of storage business, t2 refers to the filing of storage business application, T4 refers to the filing review of storage business, T5 refers to the starting form of storage procedures for storage, and T6 refers to the financial filing of storage business.

3.3 Platform display

Carry on the system test of the main function item of "hazardous chemicals logistics monitoring and warning platform" and do the simple demonstration for the specific function. Figure 5 is a real-time positioning and tracking display window for the logistics equipment of hazardous chemicals. After obtaining the GPS information of the hazardous chemicals storage and transportation equipment, the system analyzes it, points the hazardous chemicals storage and transportation equipment to the geographic image according to the longitude and latitude data, and sets up to refresh the data according to a certain period to realize the real-time dynamic display of the hazardous chemicals logistics storage and transportation equipment on the map. In addition, the system uses different color graphic identifiers to distinguish and display different operating states of the vehicle, as shown in Figure 5, the yellow vehicle graphic identifier indicates that the vehicle is currently in a suspended state and the green vehicle identifier indicates that the vehicle is currently in an operating state. Click the vehicle identifier to pop up the general information window of the vehicle: current detection time, front longitude and latitude of the hazardous chemicals storage and transportation equipment, current positioning location, vehicle speed, vehicle running distance, etc., and also give some environmental parameters of the hazardous chemicals storage and transportation equipment.

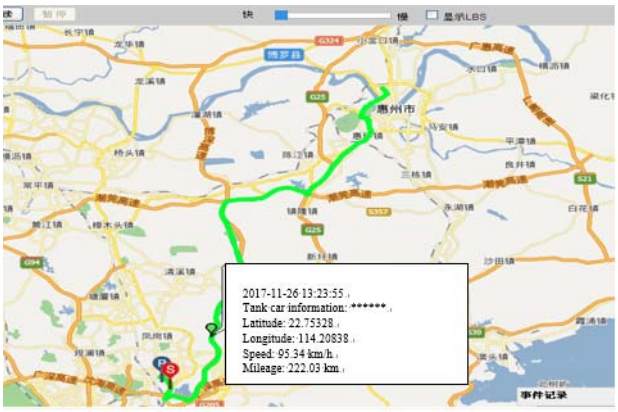

Figure 5: Device trace

3.4 Case analysis

Select a chemical logistics company as an example, and obtain the corresponding node and line data of the hazardous chemicals transportation network through investigation. The abstract hazardous chemicals transportation network is shown in Figure 6.

Where, V1=1 indicates the output node of the hazardous chemicals, V1={2,3,4,5,6,7,8} represents a transit node in a hazardous chemicals transport network, and V2={9,10,11,12,13,14} indicates the target node for transportation of hazardous chemicals. Divide a day into the following periods: T=[3,6,…,21].

In the whole transportation network of hazardous chemicals, there are two modes of transportation of hazardous chemicals, k1 indicates railway transportation, and k2 represents highway transportation. The thick line in the figure represents that there are two transportation modes of railway and highway between the two nodes, and the thin line and the dotted line represent that there is only road transportation between the two nodes.

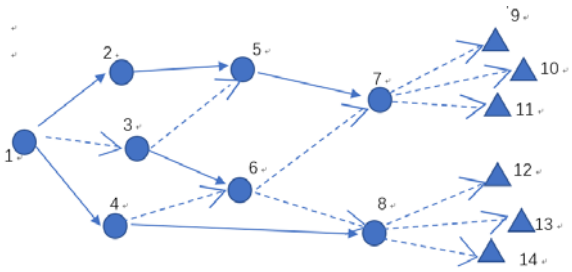

Figure 6: Diagram of a transportation network of hazardous chemicals in a certain area of chemical logistics limited liability company

4. Conclusions

This paper studies the application of Internet of things technology in hazardous chemicals logistics safety industry, designs and develops a hazardous chemicals logistics monitoring and warning platform based on the application layer of the Internet of things. After the contents of the summary, the basic task of this paper to achieve the established objectives are as follows: firstly, build a cloud computing platform, and use AESB enterprise service to achieve large-scale processing of various types of hazardous chemicals logistics equipment operation state parameter data, hazardous chemicals, environmental parameters data, and to realize the danger of time, goods logistics the multi direction equipment remote monitoring and analysis; establish the transportation vehicle running route safety evaluation mechanism, and on the basis of the route set a high safety coefficient for logistics transport vehicles in advance; establish safety state evaluation model and warning decision model, and provide guidance support strategy for the alarm triggering.

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