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Application of RFID in Chemical Storage and Logistics Management

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According to the object-oriented analysis method, the demand analysis of intelligent monitoring system for hazardous chemicals logistics based on RFID and WSN is carried out, which analyzes the essential use cases of the system, the performance requirements for system design and other requirements. Also, the functional framework and module of the software system and the logical frame of the hardware system are constructed. The composition and structure and the internal logical relationship are introduced; the intelligent decision-making function module is introduced and the overall structure is given, which highlights the key role and composition of the model base and analyzes the core issues of the intelligent decision-making of hazardous chemicals logistics. The warehouse distribution method of hazardous chemicals based on rolling time domain optimization strategy is studied. Considering the drive of the uncertainty of transportation process and arrival time and for the warehouse storage capacity, the storage and distribution model of hazardous chemicals is established based on rolling time domain optimization strategy with the goal of maximizing warehouse utilization efficiency under the constraints of the limited storage conditions of hazardous chemicals, storage capacity of the target warehouse, external environment of the warehouse, warehousing and transportation conditions to solve the problem identification of target warehouse and the distribution of storage capacity in the storage and distribution of hazardous chemicals.

1. Introduction

Chemicals are a mixture of various mixtures and pure substances, which can be divided into artificial products and natural products. In the storage and logistics management of chemicals, it may face problems such as heavy metal pollution, inflammability, explosibility and toxic gases, thus increasing the difficulty of logistics management. RFID technology is a radio frequency identification technology that can automatically identify the information of the target object. In the aspect of the storage and logistics management of chemicals, RFID technology has high application value, which is beneficial for management personnel in the classification and management of chemicals. Relevant preventive measures are taken to reduce the risk of logistics management.

Based on this, this paper mainly studies RFID technology and logistics monitoring system, understands the application effect of radio frequency identification technology in the logistics management of chemicals and explores the application value of this technology.

2. Literature review

There are a wide variety of hazardous chemicals with special physical and chemical properties (Borbála Antal et al., 2016). Therefore, it is extremely easy to cause emissions, ingestion hazards, and more dangerous safety accidents such as burning, explosion, and poison gas in all aspects of the whole life cycle of logistics. Accidents caused by hazardous chemicals can be seen as a disaster (Singh et al., 2016). According to the survey, in the decade from 2005 to 2015, 9% of China's hazardous chemical accidents occurred in the warehousing phase. However, the warehousing phase has the characteristics of large memory and centralized storage. Therefore, the hazards caused by accidents in the storage phase are still far greater than in other stages (Skurlatov et al., 2017). Therefore, more attention should be paid to the storage management

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of hazardous chemicals. Due to the special nature of hazardous chemicals storage, after years of research and exploration, an RFID technology was developed (Ng et al., 2017).

The study found that the planned results based on the RFID hazardous chemicals warehouse management development system can greatly improve the ability to identify hazardous chemicals and containers (Zhou et al., 2016). Current labels for hazardous chemicals are based on paper barcodes or QR codes. However, paper labels are fragile. Lifespan is limited and the recognition distance is short (Gong et al., 2016). In the event of an accident, the nature of the hazardous chemicals cannot be judged because the label is not identified, which leads to delays in the rescue. Radio frequency tags just make up for the defects of paper labels. It has the advantages of long recognition distance, strong anti-interference ability and large information storage capacity. If a hazardous chemical accident occurs, the tag information can be remotely identified to save time for rescue work. In addition, the inventory of hazardous chemicals is efficiently completed (Zhong et al., 2016). Radio frequency technology successfully solves the problems of cumbersome warehouse inventory and long time (Chai et al., 2016). The wireless radio frequency technology is integrated into the warehouse inventory work, and only one handheld terminal PDA can be configured for each storage inventory personnel. The person in charge of the inventory uses the handheld terminal PDA to approach dangerous chemicals that need to be counted. The handheld terminal automatically identifies the basic information on the passive label of the hazardous chemical and uploads it to the computer system. The inventory information can be completed by comparing the basic information of the uploaded hazardous chemicals with the information stored in the system and generating a checklist of inventory information. In this way, the work that would have taken nearly a day to complete is now only one hour. Finally, it is easier and faster to query hazardous chemicals in the warehouse (Chen et al., 2016). Radio frequency technology can effectively improve the difficulty of querying hazardous chemicals. At the time of storage, each hazardous chemical is posted with a passive tag that records their basic information, and the computer system has a corresponding record. When a hazardous chemical is queried, the computer automatically retrieves its area. After that, only the warehouse staff can scan the area using the handheld terminal PDA for scanning of the dangerous chemicals (Poma et al., 2017). In this way, the query time is reduced, and the terminal system knows the inbound and outbound information of each dangerous chemical in real time.

In summary, the application method of the hazardous chemicals storage management system based on RFID technology is studied. Based on the previous hazardous chemicals storage management system, RFID technology was introduced. This technology is used as the main means of information to ensure that the real and effective data in each link can be grasped in a timely and accurate manner. The real-time storage status of each hazardous chemical is obtained. Therefore, in the hazardous chemicals storage management system, advanced technology has been introduced, which has important practical significance.

3. Method

3.1 RFID technology

RFID is a radio frequency identification technology that can identify a specific target by radio signals and reads and writes related data. It can communicate via the coupling or propagation of space electromagnetic waves to achieve the purpose of automatically identifying and acquiring the information related to the identified object. It has been widely used in many fields such as industrial automation, commercial automation and transportation control management. RFID is mainly composed of electronic tags, readers and application software. The RFID tag consists of chips and antennas and each tag has a unique electronic code. The basic structure is shown in Figure 1.

The basic working principle of the RFID system is that after the tag enters the magnetic field, if it receives the special RF signal from the reader, it can send out the product information stored in the chip by the energy obtained by the induced current (namely Passive Tag), or actively send a signal of a certain frequency (ie Active Tag). After the reader reads and decodes the information, it will be sent to the central information system for data processing. According to the power supply mode, it can be divided into passive RFID, active RFID and semi-active RFID and the main difference is reflected in the difference of electronic tags. The characteristics of RFID of different power supply mode are shown in Table 1.

The structure of the intelligent decision support system adds a knowledge base and an inference engine based on the traditional three-base DSS structure model, including the database, model base and method base. Also, a language processing system is added in the human-machine conversation interface, thereby forming a four-base system structure. The human-machine conversation interface is an interface that the DSS interacts with the user or the knowledge engineer, the function of which is to acquire knowledge from the knowledge engineer, receive various needs of users and provide various decision-making information to decision makers. The language processing system is a bridge between the user and the system. All the questions raised by the user need to be described and responded by this system. The problem-solving system is an indispensable part of IDSS, which mainly completes the dynamic problem solving process of the system. That is to say, it receives the questions raised by the user and uses the expert knowledge in the knowledge base to obtain the solution. The inference engine is the implementation of the component based on knowledge inference in the expert system in the computer, which mainly includes two aspects, inference and control. The knowledge base is used to access and manage the acquired expert knowledge and experience for the inference engine. It has many functions, such as knowledge storage, retrieval, arrangement, addition, deletion, modification and expansion. The architecture of the intelligent decision support system is shown in Figure 3.

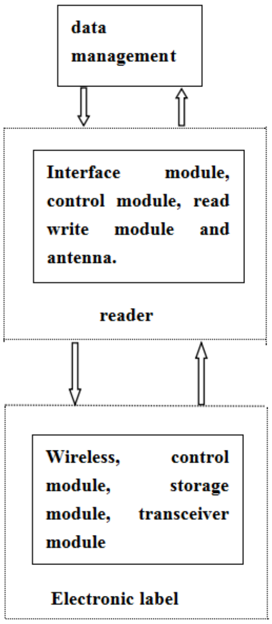

Figure 1: RFID system structure diagram

Table 1: Characteristics Comparison of RFID with different power supply modes

Power supply mode	Passive REID	Active REID	Semi active RFID
Label power	No battery	Inner battery	Partially installed batteries
Action distance	finite	Far away	commonly
Service life	longer	Shorter	commonly
Label cost	Lower	higher	commonly
Adapt to harsh environment	suitable	Unsuitable	commonly

3.2 Intelligent Monitoring System of Chemicals Logistics

The classification of chemicals is shown in Figure 2 below:

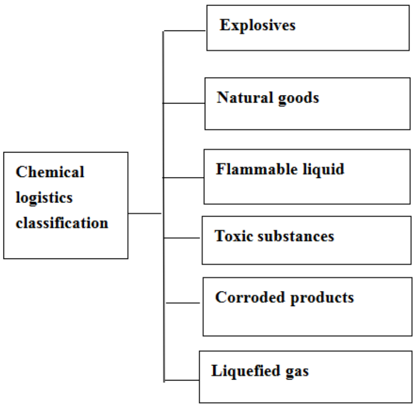

Figure 2: Chemical logistics classification

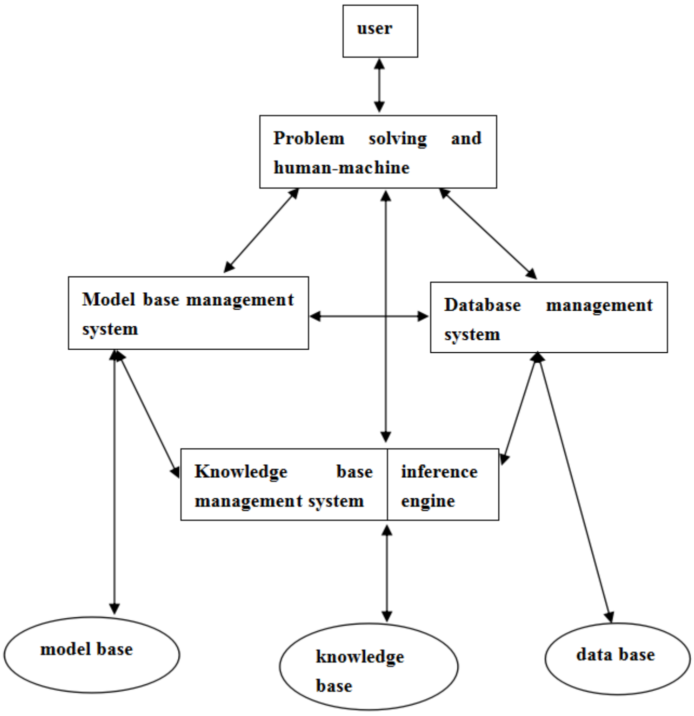

Figure 3: Architecture of intelligent decision support system

4. Result Analysis

In the modeling process, after weighting the sub-performance of each system, the overall performance index of the system can be obtained. By modifying different task links, the structure can be changed and reorganized, and the whole logistics process can be restricted under the normal state and mode. The bottleneck of restraining the optimization of the entire logistics process under normal state and mode can be found, thus improving the entire logistics process. Taking the chemicals logistics process as an example, the first thing to do is to define two performance indexes considered in the entire logistics process: risk (normalized) index and time index. The weight of the changed index of each task is αi1 and αi2 is the overall performance measurement of the simplified logistics process. The performance index of each task takes the same weight α1, α2. The corresponding experience value is obtained through the expert scoring method and the same time, the relevant historical data corresponding to the chemical logistics project is integrated, thus obtaining the mean value of the sub-performance of each task, as shown in Table 2.

Table 2: sub scale of main business processes of chemical products logistics

Weight	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11	t12	t13	t14
λγ1	0.2	0.0	0.2	0.6	0.2	0.0	0.0	0.3	0.2	0.2	0.8	0.2	0.0	0.0
λγ2	0.6	0.0	0.4	0.5	0.5	0.0	0.0	0.4	0.5	0.5	0.6	0.3	0.0	0.0

The information exchange of multiple departmental agencies is achieved through the computer system and also it can realize the transparency of information. For example, the status of the chemical transportation process can be fully understood by the regulatory authorities and law enforcement departments. The computer system enables the information that is originally operated by people and paper to be faster, safer and more reliable. Especially when there are many cases of transportation, the processing speed can be greatly improved. Also, the efficiency can be improved and the order and reliability of information can be guaranteed. For the logistics process of special items such as chemicals, special attention should be paid to the safety and measures should be taken timely after an accident, so as to reduce the damage. RFID and WSN technology are adopted in the entire logistics process to monitor all chemicals in real time. Also, some parameters, such as temperature, humidity, smoothness of operation should be controlled and alarms should be given after an accident, which can improve the safety of the entire process.
With the increase of evolutionary algebra, the target value of the obtained transportation decision-making scheme gradually becomes better. When it evolves to about 90 generations, the algorithm converges to obtain

an optimal solution. The transportation route, mode and volume of chemicals in each flow are shown in Table 3.

Table 3: the result of each flow path selection

Flow to	Choice of route and mode of transportation	Departure time	cost
1→9	1→ (Railway) →2→ (Railway) →5 (Highway) →7	[8,9)	782
1→10	1→ (Highway) →2→ (Railway) →5 (Railway) →7	[5,6)	544
1→11	1→ (Highway) →3→ (Highway) →5 (Highway) →7	[4,5)	363
1→12	1→ (Highway) →4→ (Highway) →6 (Highway) →8	[2,3)	675
1→13	1→ (Highway) →3→ (Highway) →6 (Highway) →8	[5,6)	390
1→14	1→ (Railway) →4→ (Railway) →8	[7,8)	576

5. Conclusion

This paper proposes the intelligent monitoring system framework of chemicals logistics based on RFID and WSN, including the requirements and functions of software system, system hardware architecture and intelligent decision-making function module structure. The system changes the information collection and transmission mode in the chemicals logistics process, so that the dynamic information in the operation and monitoring link of chemicals logistics can be timely grasped. Also, it achieves the timely and rapid transmission and mastery of the real-time status information of chemicals in the logistics process, which improves response speed of emergency rescue, effectively enhances the safety management of chemicals logistics and reduces the probability of accidents in the logistics process. On the basis of summarizing the risk, time, cost and capacity of the chemical transportation network, the time-varying multi-objective decision-making model of chemicals logistics network with the goal of minimizing social risk and transportation cost under the constraints of the transportation capacity of the road and the time window of the transportation route.

With the in-depth research and evolution of intelligent decision-making issues related to chemicals logistics management, it will propose more detailed and precise requirements for the information collection object and transmission mode of the intelligent monitoring system of chemicals logistics. The storage and transportation decision-making of chemical and the relationship and function mechanism between the optimization model and the intelligent monitoring system framework based on RFID and WSN will be the focus of follow-up research.

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