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Smart Logistics Management of Hazardous Chemicals Based on Internet of Things

Guoping Xie

Wuxi Institute of Technology,Jiangsu 214000, China
guopingxie38491@126.com

The purpose of this study is to explore the smart logistics management of hazardous chemicals (HC) based on Internet of Things (IoT) technology. To this end, the smart logistics management system for HC was established. Then, the feasibility of this system was discussed by taking the Group L in Yiwu as the example. The research results show that the HC smart logistics management must be systematized soon, and the resources support and technical equipment research must be increased to ensure the modern logistics development of HC. Finally, it's concluded that this study is of certain research value, which is worthy of reference for related researchers.

1. Introduction

Hazardous chemicals (HC) are flammable and explosive materials. As one kind of resource used in people's daily lives, it's involved in such fields as petroleum, chemical industry and agriculture. In the development of modern logistics, smart logistics management integrates high technologies such as intelligence and information technology etc. Many logistics companies have explored this management method. In the era of the IoT, the IoT technology has had a greater impact on the development of HC modern logistics industry. However, the smart logistics is a kind of foreign product. It's not long for the domestic research on smart logistics, with insufficient research depth. Therefore, logistics companies for HC etc. will inevitably encounter problems with technology, resources and equipment in the actual smart logistics management. Based on this, by mainly using the HC logistics company as the research object, this paper combines the IoT technology to conduct research on the HC logistics management system.

First of all, the study was carried out on the construction, functions and support of logistics management system for HC, and related information technologies and functions involved in the system were introduced. Then the application of system functions was explored, with Yiwu Group L as the research object, to verify the function and application of the HC smart logistics system. Finally, the research results show that this system is conducive to the optimal allocation of human resources in logistics company. It is of great significance to the development of HC logistics industry.

2. Literature review

In today's society, logistics has become one of the important ways to accomplish the redistribution of social resources and social products. It is an important source of profit for the social economy. This is called the source of the third profit. The logistics industry has developed rapidly, but the traditional logistics system is still not mature enough. The traditional logistics system has high cost and low efficiency. The direct performance is that the total cost of logistics accounts for 17.8% of GDP, which is twice as high as that of developed countries. Indirect performance is the phenomenon that goods are often lost and goods are stolen during the transportation of goods. In the process of handling, violent loading and unloading often occur. The goods are damaged or lost. In warehousing process, the inventory of goods is time-consuming and laborious. It is difficult to get accurate information about the quantity and location of goods. Intelligent systems based on Internet of things, such as intelligent therapy, smart home and smart city, have brought more and more convenience to life. With the rapid development of e-commerce in recent years, the logistics industry in the same supply chain

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is also facing great opportunities and challenges. The time and scale of the logistics industry or its logistics system are at the leading level. The logistics system will be an important part of the plan. With the strong support of the government, Yiwu has tried to run the portal of the Yiwu intelligent logistics information platform, which is also in the forefront of the industry in the construction of the intelligent logistics system. The changes brought by the "Internet of things +" intelligent logistics system to traditional logistics are analyzed. The performance of logistics enterprises has been improved.

The Internet of Things (IOT) is a hot topic in recent years. According to the Internet of Things, various types of information-aware devices are embedded in objects to obtain real-time object status information. Then, these object sensors are interconnected by a communication network. Through intelligent processing of perception information, the management and control of objects can be realized (Hao et al., 2015). The Internet of Things can effectively integrate communications infrastructure and industry infrastructure resources. The information and communication infrastructure resources of business systems in various industries are fully utilized to improve the informatization level of various industries (Oughton et al., 2015). The application of IoT technology is mainly concentrated in vertical industry chains, especially in a series of typical fields promoted by sensor technology. It includes smart grid, smart transportation, smart logistics, precision agriculture, public safety, smart medical care, environmental protection, smart home, etc. (Kim et al., 2017). Smart logistics is an inevitable trend in the development of modern logistics. The concepts of low-carbon, environmental protection, green, and resource recyclability have become more and more popular in the society and are increasingly being applied in various industries. The concept of green logistics and low-carbon logistics in modern logistics has also been valued by more people (Gil et al., 2016). The realization of the form of integrated organization, the rapid development of the Internet of things technology, the introduction of management and management concepts such as industrial linkage and supply chain, indicate that the intelligent logistics is the inevitable trend and final destination of modern logistics development, which includes information, network, integration, intelligence, flexibility, agility, visualization and automation. As the current pillar industry e-commerce and the rapid development of chain operations, enterprises and consumers increasingly rely on modern logistics, and the market has unprecedented demand for logistics. As a new type of flexible sales model, Internet companies have created a huge new wave of online shopping among consumers through various promotional activities. However, the level of China's logistics industry at this stage is far from meeting the high demands of e-commerce and consumers on their efficiency and quality (Min et al., 2015). The inefficiency of logistics will cause more energy consumption, create more carbon emissions, and bring huge hidden dangers to the environment. These are all greatly detract from the social requirements for energy saving and emission reduction (Buregio et al., 2015). The unreasonable allocation of energy also increases the operating costs of logistics companies and reduces corporate profits (Trab et al., 2018). According to the market's demand for quantity and quality of logistics, the background of green environmental protection and the pressure of corporate costs, various factors have promoted the development of modern logistics toward intelligence (Dener, 2017).

On the basis of communication networks such as the Internet and mobile communication networks, various types of information in the physical world are automatically acquired using intelligent objects that have the ability to sense, communicate, and calculate. All independent physical objects are interconnected. Comprehensive awareness, reliable transmission and intelligent processing are implemented. An intelligent information service system in which people and objects, things and things are interconnected is constructed. Compared with the traditional Internet technology, the Internet of Things technology has three characteristics: strong processing, reliable transmission, and comprehensive sensing. The four core technologies of the Internet of Things include radio frequency identification technology, bar code technology, communication technology and remote sensing technology. The continuous updating of intelligent information equipment is the core motivation that really promotes the rapid development of the Internet of Things. With the continuous innovation and development of the Internet of Things, the Internet of Things has the characteristics of comprehensiveness of perception, reliability of information, and intelligence of information processing. These characteristics provide a key technical support for the formation and development of smart logistics, so as to achieve logistics information, digital and intelligent.

To sum up, the above research work mainly gives full explanation to the Internet of Things technology. At present, the application of Internet of Things technology is mainly concentrated in the vertical industry chain, especially in the application of sensor technology in a series of typical areas. It includes smart grids, intelligent transportation, smart logistics, precision agriculture, public safety, smart medical care, environmental protection, and smart homes. Smart logistics is an inevitable trend in the development of modern logistics. Therefore, based on the Internet of Things technology, the intelligent logistics management system for hazardous chemicals was studied to improve the development of the logistics industry.

3. Methods

3.1 Construction of smart logistics management system for hazardous chemicals

The role of the perception layer is mainly to upload information such as user information, employee information, management personnel information, and product information etc. that may be involved in the personnel, goods, and the environment information of HC smart logistics platform through the IoT technology to the database or server. The perception layer in the hazardous chemicals logistics system is mainly composed of data acquisition layer and access layer. The network layer is the link that connects all major components of the logistics information system, as the basis for realizing information sharing and real-time communication. The basic communication network of logistics information system can be divided into three major parts: network of logistics park, urban logistics information network, and wireless communication network. The network of logistics park serves the logistics management department and the logistics companies of the Park, connecting their respective management information systems and accessing the urban logistics information network to provide timely, smooth and effective logistics information services for enterprises in the park. Urban logistics information network refers to the urban backbone network that connects the logistics park, logistics public information platform, logistics trading platform, industry management subsystem, and enterprise logistics information system, and realizes the organic integration of information resources for all major subsystems. The wireless communication network is the key to realize communication of on-site subsystems, on-board subsystems, vehicle tracking and dispatching system etc. with other logistics information system; it can be established by combining conventional mobile communication technologies with wireless cluster communication technology.

3.2 Functional architecture of smart logistics system for hazardous chemicals

The major functional modules of the HC smart logistics system are similar to the traditional e-commerce system. The difference is that the supplier in this system is the logistics company. Figure 1 depicts the general process. The customer or sales staff submits the cargo delivery request through the foregropund system, uploads it to the background management system through the sales system, and then the background operator assigns the invoice to the logistics companies through the background management system. The logistics company receiving the shipping order leave for the goods, and after receiving the order goods, they hand in the goods receipt to the background system, and finally the background management system will automatically update the goods information and upload it to the database to keep the file after receiving the goods receipt.

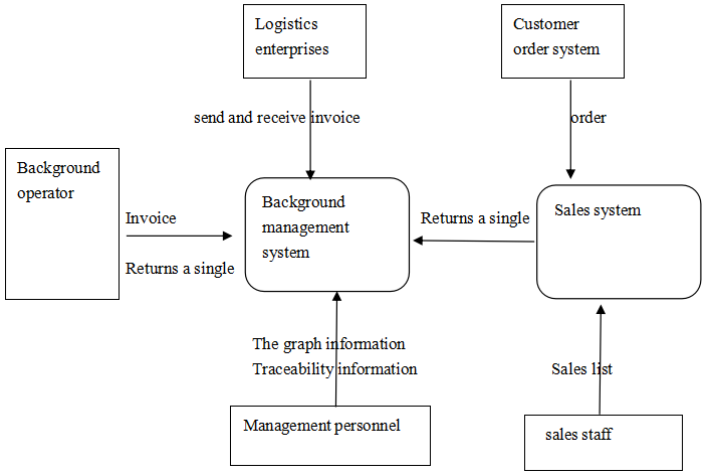

Figure 1: Smart logistics functional system architecture

The background management system is the core system of the HC smart logistics functional system. On one hand, it is to meet the management personnel's requirements for business operations, so the background management system is required to provide sales performance, customer satisfaction and other operational related data and decisions; on the other hand, it is necessary for the operator to operate the distribution order without barriers and achieve good operating experiences (Functional architecture of background management system is shown in Figure 2)

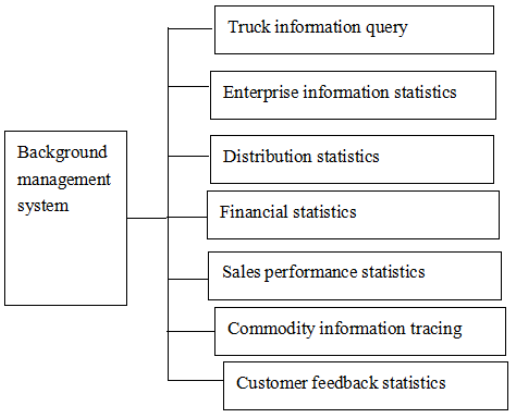

Figure 2: Function architecture of background management system

3.3 Support system of smart logistics system for hazardous chemicals

After deciphering the samples and then processing the categories according to the method in Chapter 3, the main elements of the support system for the HC smart logistics system are extracted: policy and regulations, and the overall planning are the macro-elements; key technology, facility and equipment, industry standard, and construction methods are technical elements; development direction, operation mode, and theoretical perspectives are the theoretical support elements; in addition, human resource and capital market are the supporting elements of the support system for HC smart logistics. Therefore, according to the grounded theory method, the key elements of the support system include: macro condition, technical condition, and human resources condition. The macro condition is the guidance for the construction of the smart system, technical condition is the basis, and the human resources condition is the driving force for the sustainable development of the smart logistics system of hazardous chemicals. This support system determines the method, direction and extent of the smart logistics development for HC. The specific architecture diagram is shown in Figure 3.

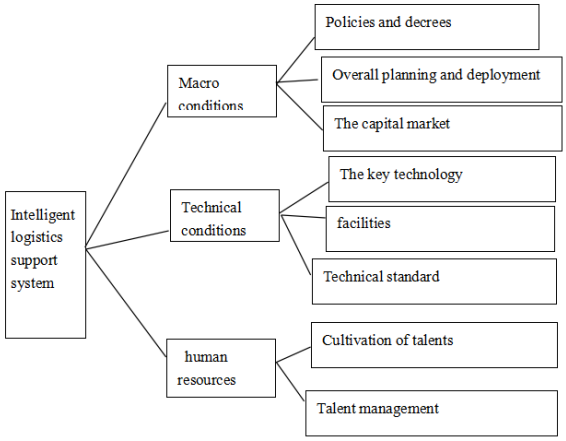

Figure 3: Architecture diagram of smart logistics support system

4. Results and discussions

4.1 System function management

The sales system is mainly for sales staff to understand their sales situation and the company's carrying capacity through the system. In addition, through digitization operations such as sales accounting and sales statistics, it can effectively support the sales personnel of logistics companies to complete their sales tasks for each indicator quickly and conveniently. The sales system monitors the commodities and can effectively manage and control the transport capacity and traffic volume, thereby rationally adjusting sales plans to avoid waste of transport capacity or lose credibility. The sales system includes sales applications, goods packaging, order generation, and goods storage, cargo aboard, customer feedback, sales history query and other functions (Sales system function is shown as in Figure 4)

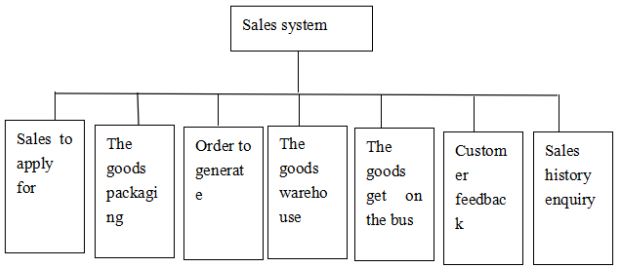

Figure 4: Sales system functions

The foreground system is displayed in the form of an APP on the customer's hand-held mobile or PC terminal. The customers log on to the foreground system through network to understand the logistics company's information, on-line orders, real-time delivery of the delivered goods, and comments and feedbacks in real time at any location. They can log in to the system to select services, purchase service and order, direct payment through the third party or off-line payments, inquire order status to understand the dynamic condition of cargo etc. Receiving personnel through the foreground system can view the orders; after receipt of goods, through the bar code technology, they can upload cargo orders information, and manually or automatically update the real-time status of goods etc. The foreground system mainly includes the login system, order management system, payment management system, cargo inquiry system, and statistical system. (Foreground system function shown in Figure 5)

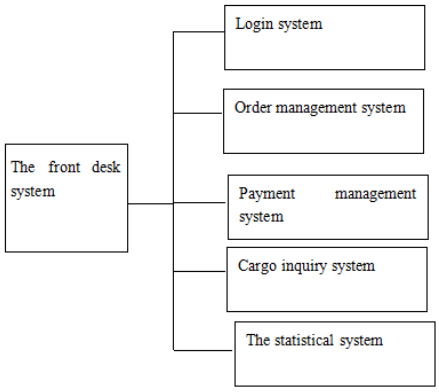

Figure 5: Foreground system function

4.2 Analysis for system implementation

In this paper, to construct the HC smart logistics system based on the IoT technology, the grounded theory was applied to subdivide it into system architecture, functional system and support system. Firstly, through reviewing the domestic and international research on IoT technologies and HC smart logistics systems, the relevant research on IoT technologies and industry was elaborated, and the structure, characteristics, and development status of HC smart logistics were introduced to lay the groundwork for the following research. Secondly, based on the grounded theory, sampling was performed in important domestic journal articles and academic papers, where 18 samples were obtained, the processing of the samples according to grounded theory was applied; through open decoding, spindle decoding, and selectivity, 72 concepts were deciphered, and 15 types were categorized from 72 concepts; then 16 types were reorganized through relevant theoretical foundations, to obtain the main system architecture of the HC logistics system, that is, the system architecture, function system and support system, followed by designing the elements of the three systems selected by grounded theory and expounding each system; finally, based on the example of Yiwu L Group's construction process of HC smart logistics system, the analysis was conducted on the structure of the HC logistics system in Yiwu L Group, which provides some inspirations and references for the construction of hazardous chemicals smart logistics system. Here, the special project team for modern logistics development was established, and experts from relevant industries were hired to form one leading group for overall planning. Besides, in view of the local logistics related policies, the targeted short-term, medium-term, and long-term plans for the construction of HC logistics systems were proposed. It also made full use of its strong financial

advantages to provide capital support for the establishment of its own and other companies' hazardous logistics systems. The talent training model with its own characteristics was built, which was closely linked with the Yiwu Research Institute of Zhejiang University of Technology to form a good school-enterprise cooperation model by integrating the logistics talents training of the government and social organizations, academic education and training of logistics talents in universities, and internal employee training of logistics enterprises effectively; in terms of the talent team construction and talent management, the talent introduction mechanism, training mechanism, talent discovery mechanism, and "flow" and "stay" mechanism were established to ensure the development of modern logistics industry on Ningbo Port. In this paper, the process of login system design is: the user enters the account password to submit the server and check the information database for information check; after the verification passes, the user logs in directly to the main interface of the foreground system and selects the corresponding function according to the account authority and the user's demand; If the verification fails, an account or password error message is displayed. And then they can end the operation or re-enter the account or password. The closed-loop design of the login system is roughly the same.

5. Conclusions

In view of the research on HC smart logistics, China is still limited in certain aspects of management system and technology research, lacking systematic research on the smart logistics of HC. Based on the IoT technology, this paper designs and studies the smart management system of HC logistics, and then conducts the system function research by taking the Yiwu Group L as research object. Finally, it's concluded that this system is of certain practicality, which is beneficial to the data collection and analysis related to HC smart logistics. It's of great significance to the enterprise logistics management.

This study mainly focuses on the smart logistics system of HC without any quantitative analysis of related data, so it is more made for theoretical research. Due to the limited professionalism and expression level of the author, the research on the HC smart logistics management may be insufficient and the research content not strict enough. The sample data of this study is mainly based on academic papers which is the second-hand materials, and then the actual content is still to be verified. Therefore, the practicality of the hazardous chemicals smart management system should be further verified.

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