Design of Medical Waste Reverse Logistics System Based on RFID Technology

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Abstract

Reverse logistics is a hot topic that scholars at home and abroad have been paying attention to in recent years. The research on reverse logistics is also abound, especially in the reverse logistics of electronic products. However, the research on reverse logistics of medical waste is relatively rare, and most of the existing research on reverse logistics of medical waste is based on the determination of the number of recycling centers, location selection and path optimization, and based on information technology. There are not many optimized designs for the reverse logistics system of medical waste. Considering the specificity of medical waste - toxicity, indirect toxicity, infectivity, danger, etc., it is correctly, effectively and conveniently classified, recycled and Processing is very necessary. Based on this, this paper studies the design of medical waste flow system based on RFID technology.

Keywords

RFID technology, medical waste, reverse logistics,system design.

1. Introduction

1.1 Research and Development of Medical Waste Reverse Logistics

At present, domestic and foreign scholars have studied the reverse logistics, especially the research on reverse logistics of electronic products. However, there is not much research on the reverse logistics of medical waste[1]. Some scholars have used quantitative and hypothetical methods to quantitatively study and analyze the optimization design of the network structure of the recovery system under certain circumstances. The focus is basically on the number determination, location location and path optimization of the members of the reverse logistics network system. Ma Zujun et al. expanded the product recycling reverse logistics network based on the traditional forward logistics network. Based on the mixed integer linear programming method, a single product and limited product recovery reverse logistics network optimization design model was established. Based on this, the logistics network was determined. The quantity and location of various facilities, and rational distribution of material flows on the various logistics paths thus formed, so as to minimize the sum of investment and operating costs of various facilities, and give a Benders decomposition algorithm to improve the efficiency of model solving[2]. The validity of the model and algorithm is verified by an example. Huang Yulan established a mixed integer nonlinear programming model with the minimum total cost as the objective function, and based on the basic principle of the artificial bee colony algorithm, how to determine the address of the centralized reverse logistics center and the recycling amount of discarded and discarded medical materials[3]. Corresponding algorithms are designed based on the characteristics of the network model. On the basis of the original forward logistics network, Dong Jingfeng proposed a multi-level reverse logistics network including initial collection points, centralized recycling centers and recycling facilities[4]. With the goal of minimizing the total reverse

logistics cost and taking into account the convenience of product recycling of each customer group, a 0-1 mixed integer programming model was established to solve the problem of location/distribution of the reverse logistics network, and the genetic algorithm was applied to solve the model[5].

It can be seen that most of the research on medical waste is concentrated on the site selection and path optimization problems. Few scholars are concerned with the design of medical waste reverse logistics system. Since the recycling of medical waste is a very large and complicated work involving different types and different waste levels, and the recycling center needs to classify these wastes, the corresponding reverse logistics system design is carried out. It is very necessary to facilitate the recycling of medical waste.

1.2 Correlation Analysis of Radio Frequency Identification (RFID) Technology

1.2.1The Composition of RFID

Radio Frequency Identification (RFID) emerged in the mid-20th century and entered the practical stage after the 1990s[6]. The non-contact two-way communication between the RFID tag and the reader utilizes induction, radio waves or microwave energy to realize tag identification information identification and data exchange. The application of radio frequency identification (RFID) technology in logistics will greatly promote the automation and modernization of the logistics process, and thus it is one of the important supporting technologies to promote the continuous development of modern logistics.

Radio frequency identification (RFID) system generally consists of three parts: electronic tag, reader and antenna[7]. The basic working principle is that the reader sends a certain frequency of radio frequency signal through the antenna. After the electronic tag enters the magnetic field, it is sent by the reader. The RF signal emits product information stored in the chip by the energy obtained by the induced current, or actively emits a signal of a certain frequency; the reader reads the information and decodes it, and sends it to the central information system for processing related data.

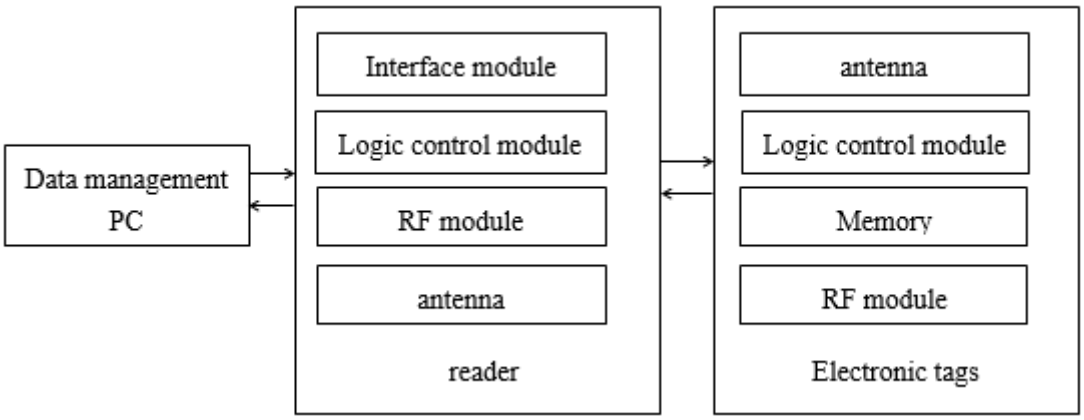

Fig. 1 RFID system working principle diagram

1.2.2 How RFID Works

The electronic tag and the reader form a channel for transmitting electromagnetic waves through the antennas of the two, and mutually transmit information according to an agreed communication protocol. The working principle of the system is as follows: the information to be sent by the reader is encoded and loaded on the carrier signal of a certain frequency and sent out through the antenna. The electronic tag entering the working area of the reader receives the pulse signal, and the relevant circuit in the chip in the card This signal is modulated, decoded, decrypted, and then judged by command requests, passwords, permissions, and the like. If it is a "read" command, the logic control module reads the relevant information from the memory, encrypts, encodes, modulates and transmits it to the reader through the antenna inside the card, and the reader demodulates, decodes, and decrypts the received signal. After being sent to the central information system for data processing, if it is a "write"

command to modify the information, the internal charge pump caused by the logic control raises the working voltage, provides the content in the erasing to be rewritten, and if it judges its corresponding password and authority If it does not match, an error message is returned.

2. Analysis of Reverse Processing of Medical Waste

2.1 Definition of Medical Waste

The US Environmental Protection Agency first defined a medical infection waste in a document in 1978. It believes that medical infection waste refers to waste from various departments or laboratories of the hospital[8]. Unless it is autoclaved, it is considered to be infected waste. . However, with the vigorous development of the medical industry, the concept of medical waste has also been improved. In the end, the United States Environmental Protection Agency, the World Health Organization and other units have defined "medical waste": medical waste refers to medical institutions engaged in medical activities for humans or animals, as well as medical research institutions or medical institutions engaged in medical research. After the various wastes produced, such as gloves, needles, etc.

Although China's medical treatment started relatively late compared to developed countries, the pace of medical development is very rapid. Laws and regulations in all aspects of the field have been continuously improved. On June 4, 2003, China officially announced and implemented the Regulations on the Administration of Medical Services, which defines medical waste as: medical waste refers to medical care, prevention, etc. Wastes that are toxic, indirect, infectious, and hazardous during the activity.

In the literature on the analysis of related medical wastes, the understanding of medical waste is: medical waste refers to the medical institutions after medical activities for humans or animals, and after medical research in medical colleges or medical institutions. The various wastes produced.

2.2 Classification of Medical Waste

Classification of medical waste is a prerequisite for recycling it. Medical waste is broadly classified into two categories: low-risk medical waste and high-hazard medical waste. Among them, low-risk medical waste mainly comes from the hospital departments, non-infectious departments, domestic garbage, and pharmaceutical equipment packaging, mainly including paper waste and pharmaceutical packaging. The main categories of high-hazard medical waste are as follows: Drug waste - obsolete drugs, including expired, deteriorating drugs, mainly drugs, vaccines, over-the-counter drugs. Chemical waste - Corrosive, flammable, toxic, and other chemical-quality wastes, mainly laboratory acid and alkali reagents, disinfectants. Pathological waste—Abandoned tissue or organ of the human or animal body obtained during surgery or other conditions. Damaged waste - medical equipment that has potential damage to the human body, mainly scalpels, needles, glass test tubes, etc. Infectious waste - medical waste that carries pathogenic microorganisms and causes infectious diseases to spread, mainly disposable medical supplies, such as masks used by patients and specimens of pathogens.

Due to the special nature of medical waste, there are many problems to be aware of when recycling it.

2.3 Medical Waste Treatment Process

The treatment process of medical waste is generally divided into two categories: one is the internal processing process of the hospital, and the other is the process outside the hospital. Here, we mainly analyze the out-of-hospital treatment process of medical waste, which is a process of recycling and processing medical waste by third-party enterprises.

The medical waste treatment process includes four important aspects: classified collection, testing, transportation, and waste disposal.

Classified collection: The wastes generated by medical institutions shall be classified and collected in strict accordance with the relevant national standards. This process shall prevent medical wastes from

causing pollution or infection. When a collection point is set up near the hospital, the collection point needs to classify the waste from the hospital, separate the non-toxic and harmless waste from other waste, and classify the infectious waste strictly according to the relevant national regulations. And as soon as possible transport to the processing center for harmless treatment and other processes.

Testing: testing medical waste, classifying its toxicity and infectivity, and conducting rigorous disposal.

Transportation: Medical waste will be transported to the treatment center through specialized medical waste transportation vehicles. The transportation process should be strictly in accordance with relevant national regulations, such as the use of professional medical waste recycling vehicles to prevent the leakage of pollution.

Waste disposal: It is harmlessly treated by a specialized medical waste disposal agency. Finally, whether the waste is recycled or whether it is used as waste is determined according to whether the waste used for the relevant treatment has a use value. The processing center should meet the requirements of the state for this type of unit before it can operate normally.

3. Analysis and Design of Medical Waste Reverse Logistics Management System Based on RFID Technology

3.1 Demand Analysis

Due to the special nature of medical waste, there are many things to be aware of in the process of recycling, sorting, transporting and disposing of medical waste, such as the correct classification and disposal of infectious medical waste. Recycling (needle, etc.) waste recycling and transportation, etc., require great attention. However, if you only rely on labor to carry out these tasks, the workload is very large. Therefore, this paper analyzes and designs the reverse logistics system of medical waste based on RFID technology to improve the efficiency of medical waste recycling.

Moreover, RFID technology has its own special advantages: first, it does not require a light source, and can even read data through the external material of the article; second, it has a long service life and can work in a harsh environment; third, it can be easily Embedded in or attached to different types of products; fourth, the distance to read data is farther, and does not need to read vertically; fifth, the content of the label can be dynamically changed; sixth, can handle multiple labels at the same time Seventh, the object attached to the RFID tag can be tracked and positioned; eighth, the data access of the tag is password protected, and the security is higher. Therefore, considering the particularity of this reverse logistics and the advantages of RFID technology itself, this paper designs a medical waste reverse logistics management system based on RFID technology. At the heart of the system is the addition of electronic tags to each piece of recycled medical waste, and accordingly an RFID reader is placed at each entrance to the waste sorting department. When the medical waste passes through the reader, the reader can obtain critical information about the waste through the electronic tag on the medical waste. A number of handheld readers or wireless in-vehicle data terminals are also set up in each internal processing link to track and update the information of the medical waste in the classification process, and realize the automatic identification of medical waste from the recycling of the medical waste reverse logistics management system. Identification, update, and classification of all operations during classification, inspection, transportation, pre-processing, and processing. The system is based on technology, fully utilizes computer network technology and wireless communication technology, integrates advanced hardware equipment and perfect software system, and focuses on the source of data collection, which can guarantee the timely and accurate data collection. The operation efficiency is greatly improved, and the information management of reverse logistics of medical waste is realized.

3.2 Medical Waste Reverse Logistics Business Process

This paper takes the medical waste hospital's external treatment process as an example to design the business process.

Assume that the medical waste reverse logistics has four levels: recovery point, integrated processing center, reprocessing enterprise and disposal site. The following is a brief introduction to each level.

Recycling point: Medical waste reaches the collection point directly or indirectly from various city medical institutions in a paid or unpaid manner. The collection point is a classification and storage of the collected medical waste according to the risk classification. For some simple and easy-to-handle medical wastes, they should be directly treated in a harmless manner and sent to a reprocessing enterprise or disposal site according to the utilization value of the materials after disposal; for some operationally complicated medical wastes, they should be classified. Then send it to the integrated processing center.

Integrated processing center: It detects medical wastes from the collection point of the integrated processing center, and carries out strict and harmless treatment of dangerous medical wastes, and transports valuable materials that have been harmlessly processed to processing. The enterprise will also transport waste without any use value to the disposal site.

Reprocessing enterprises: Processing and transformation of treated wastes that have been transported from collection points and integrated processing centers, and continue to be used as raw materials.

Disposal site: Incineration or landfilling of waste that has been transported without harm and is harmlessly transported from collection points and integrated processing centers.

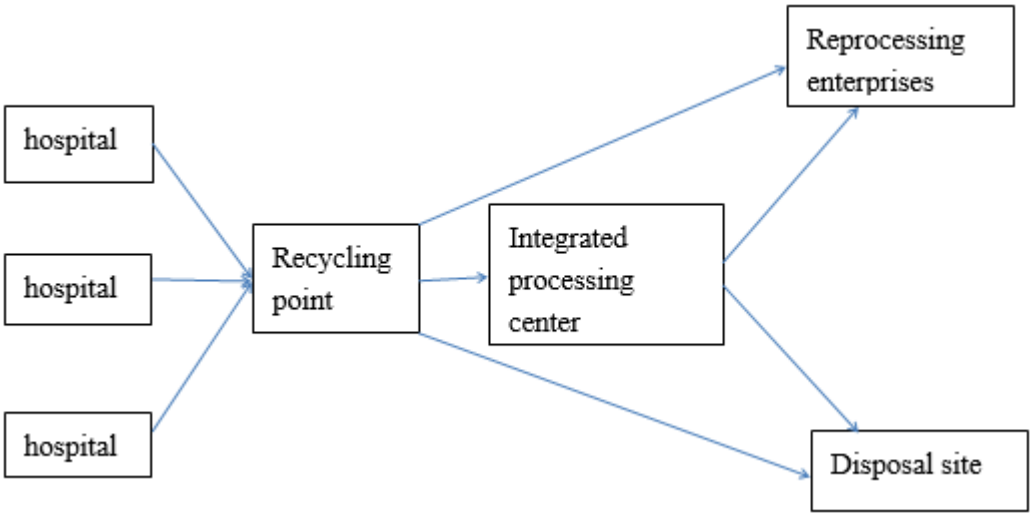

Fig. 2 Medical waste reverse logistics processing flow chart

3.3 Design of Medical Waste Reverse Logistics System Based on RFID Technology

3.3.1 The Basic Principle of RFID Technology in the Reverse Logistics of Medical Waste

The process of reverse logistics of medical waste involves the steps of sorting, detecting, transporting and disposing of waste, so it is necessary to know the information of waste throughout the product life cycle. At this time, if RFID technology is introduced, the electronic data carried by the product itself can be used to automatically record various data in the life cycle of the product, accurately record and easily read data related to the product "life and death", thereby having various treatments for medical waste. the process of. The method is implemented by setting an electronic tag for recording product life cycle information in each structural module, and realizing data rewriting and reading through the reader.

There are two main types of related data for each electronic label. The first category is basic information provided by the manufacturer, such as the name of the medical product, date of manufacture, function, precautions, etc., which is entered by the manufacturer when the product leaves

the factory; the second category is the use of medical products. Information, ie operational information, is automatically recorded by the system's sensors when the medical product is in use. These independent physical and chemical sensors automatically capture data on the time the medical product is being used and the relevant parameters of the work environment. Analysis of these parameters can help determine the use of medical products, whether they are hazardous or the magnitude of their hazards. When the medical product is recycled after being discarded, the reader reads the relevant data of the medical waste from these electronic tags, thereby determining the current state of the medical waste - whether it is harmful or the magnitude of the harmfulness. And then classify and process medical waste based on relevant information read by the reader. The use of RFID technology can not only improve the efficiency of medical waste recycling and classification, but also save most of the manpower, and improve the accuracy of medical waste classification and processing, and also make a relatively large green environmental protection. contribution.

3.3.2 Architecture Design of Medical Waste Reverse Logistics System Based on RFID Technology

According to the characteristics of reverse logistics management of medical waste, combined with the general business process of reverse logistics management system of medical waste, this paper designs the system structure of this system.

The two main interfaces of the interface layer of the system are the input interface and the query interface. The input interface includes code comparison settings, recovery record entry, salesperson information entry, medical waste information entry, and factory record entry. The query interface has a relatively complete query function, multi-keyword query, fuzzy query, which can quickly query the electronic waste dynamic and static information, and can also search the entire recorded keyword and quickly find related records.

From the perspective of the business layer, the main business content of the system includes code comparison settings, label management, recycling classification and detection management, and comprehensive processing information management.

From the perspective of the data layer, the main data content of the system includes code comparison, detailed records of waste in and out of each level of facilities, and operator change tables.

3.3.3 Business Process Design of Medical Waste Reverse Logistics System Based on RFID Technology

In the process of medical waste recycling, RFID tags are used to record various classification, detection and comprehensive processing information. In the process of transporting medical waste from the point of collection to the integrated processing center, reprocessing company, disposal site, etc., the RFID tag is used to track the product in real time, and the information is read and written into the RFID tag in time. Identification, collection and exchange of dynamic information in the reverse logistics of medical waste; at the integrated processing center, the medical waste transported from each collection point is tested again, and then preliminary treatment is carried out to determine whether the product can Entering the next step of medical waste treatment - reprocessing: For the waste that has the value of using the reprocessing enterprise, first read the processing information on the label, and modify the status information after the inspection, pay attention to the detection. The date and time, after the rework order is released, complete the rework operation and paste a new work label for the reworked product according to the rework recommendation and the planning of the system design planning module. In the whole process of reverse logistics, the application of RFID tags can not only improve the efficiency of operations such as warehousing, storage, picking, inventory, etc. in inventory management, but also track medical waste in real time during transportation. Pay attention to timely modifying the location information of medical waste to maintain dynamic tracking. According to the above-mentioned introduction to the basic process of medical waste, the RFID business technology flow chart can be obtained by using RFID technology in each link:

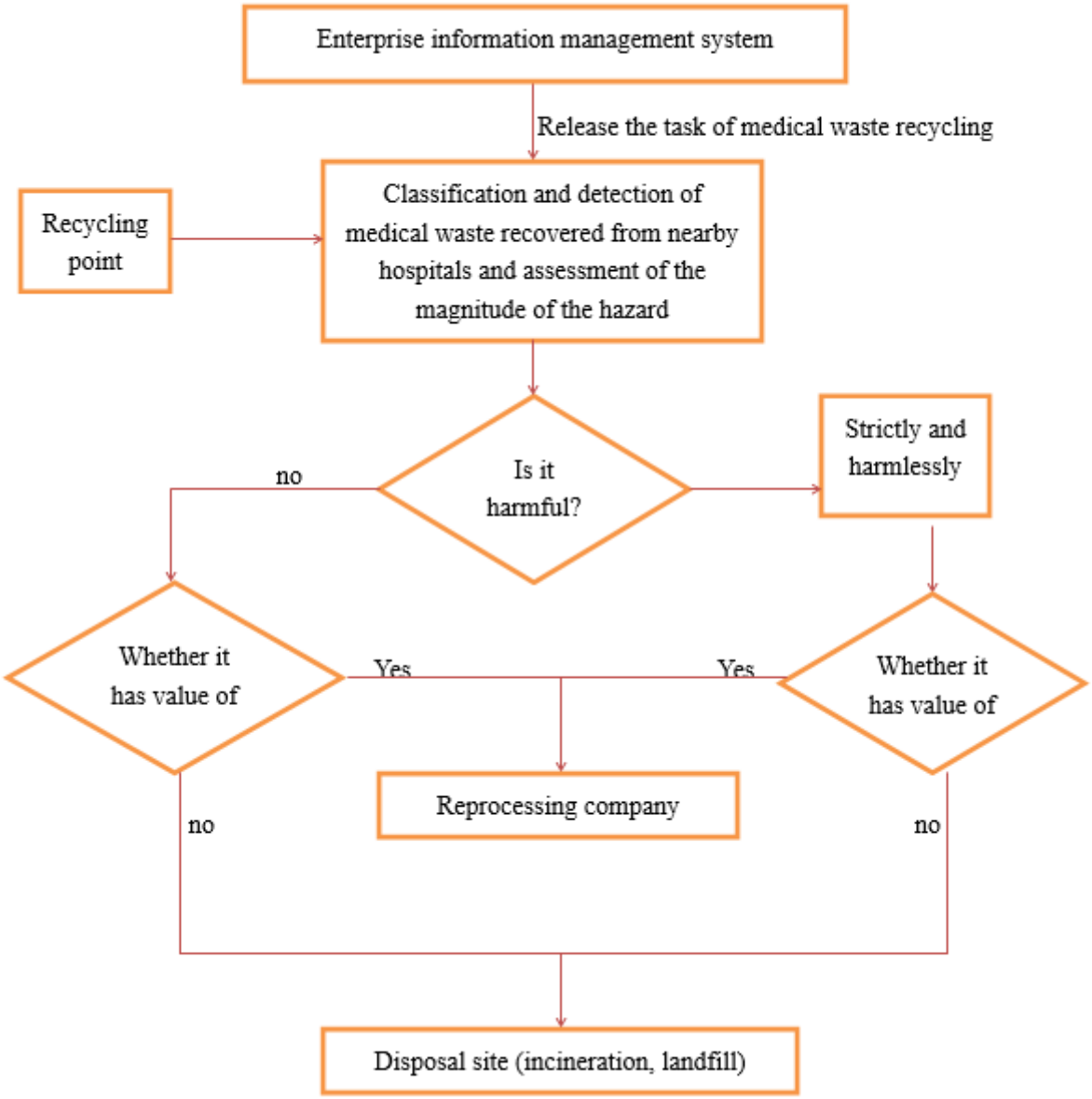

Fig.3 System business flow chart based on RFID technology

4. Conclusions and Deficiencies

According to the above analysis, the introduction of RFID technology in the medical waste reverse logistics management system solves a series of problems in the traditional medical waste recycling: First, the traditional medical abandoned reverse logistics mainly adopts manual methods for recycling and classification. And the detection of the hazard of waste, this manual recycling method is not only a lot of work, but also the error rate of the whole work is high; Second, after the introduction of RFID technology, the entire medical waste reverse logistics system can be established An information system to control the processing of the entire reverse logistics, and the RFID tag has the advantages of small size, various shapes, embedability, corrosion resistance, etc., which meets the requirements for corrosive, liquid medical waste recycling. Demand; third, traditional manual entry of data or the use of bar code technology to record medical product information, the product can not be dynamically tracked after leaving the factory; Fourth, the current medical waste recycling and reprocessing process between Most of them are in a state of independent operation, and information between them cannot be shared. The lack of effective communication, so the efficiency of medical waste reprocessing is relatively low, and even many medical wastes with reusable value cannot be reprocessed, and only

simple incineration and landfill operations can be carried out. RFID-based medical waste reverse logistics provides its reliable information to collection points, integrated processing centers, and reprocessing companies through RFID's status and source history.

Although RFID technology is very convenient and efficient to apply, one of the most important aspects of limiting RFID applications today is its relatively high cost. However, the reusability of an RFID tag will reduce its cost as the frequency of use increases.

The shortcoming of this paper is that the medical waste reverse logistics system is designed based on RFID technology alone, and there is no related system development for the design. In the future study, I will work harder to develop the relevant system. In this regard, the system design of this paper is put into practice.

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