Chain Management for Fireworks Industry Based on Rfid

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ABSTRACT: *Security risks exist in fireworks production and storage and there have been many accidents in the past few years. The introduction of chain management for fireworks industry is currently a new exploration and it is the new development trend of this industry. Using environmental monitoring system and the indoor positioning and tracking system based on RFID technology for real-timely monitoring the people walking paths and production environment, the processes among production and storage would be safer and easily avoid accidents. At the same time, it can improve the management style and increase the profits of enterprises, for improving the quality of products and reducing the administration cost.*

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1. Introduction

In major holidays, setting off fireworks in many countries has become people's habits and it even has turned into global tradition and customs. By the end of 2009, Chinese fireworks production and consumption have accounted for 90 percent of those in the whole world and export has accounted for more than 70 percent of those. At present, the proportion is still on the rise. But in different countries, fireworks production or storage have occurred light or heavy fires and explosion disasters. Since China is the state on behalf of this field, the following introduction of industries would regard China's companies as the template. According to the statistics showed that, the outbreak of fireworks fire and explosion is about 450 among the year between 1985 and 2003, nearly 480 people dead, and it was considered the peak of the outbreak. The government increase supervision and regulation since 2003, consequently, the number of firework accidents reduced year by year. But since 2006, with increasing market demand and expanding production, fireworks accidents rebounded sharply, mainly caused by illegal production.

Fireworks are Chinese traditional handicrafts products. Due to simple production processes, it is usually produced by few people in shabby houses without complex production equipment. With the advent of the Information Age, there have certain technological progress in the fireworks industries and following are outstanding ones. The first improvement is refining processes and the processes of the detailed division of labor. The second is technical progress and mechanization of produc

tion. But in terms of China, the problems still exist. To begin with, according to statistics, only 1 of 9 companies in average has independent warehouses which achieve the C level and the rest are all old rental depots with serious security problems. Furthermore, though the chain operations have become a trend, most small companies in the markets complete the processes of production and consumption all by themselves. Even companies in nearby cities and towns do not communicate regularly and have not established strategic cooperative relationship with each other. This situation makes the products difficult to put into international markets and would seriously damage export. Moreover, since the capacity constraints of the product storage and production, the small enterprises cannot make full use of network transactions and mass transport.

In order to solve the problems above, some senior managers of large firms in the main production bases through consultations reach a consensus that their companies would be bigger and stronger only if establishing strategic partnership. That refers to using management style of intensive production and storage to build unified market and establishing an improved transportation system to convey goods. Consequently, they form the chain corporations and make the corresponding reforms. With the passage of time, this program obtains good results and makes a lot of small local companies imitate their reforms. Taking Hunan Province as an example, many firms take the corresponding measures to promote the formation and development of chain corporations. The statistics reported in recent years revealed that their profits have increased to a large extent, but the accident rate decreased only slightly. Through field investigation and interviews, it is found some merchandise produced by subsidiaries and warehouses don't meet the rigorous safety standards and exist security problems, in that they have no unified management and no real-time system to monitor its production environment. Meanwhile it is difficult to detect the hidden danger and the emergency personnel are difficult to timely obtain accident information. Since lacking effective environmental monitoring of production processes, it may cause the increasing defective rate and also export decreasingly for not up to exporting country's standard.

Therefore, according to the fireworks' production process and its safety standards, a management system of production and storage based on RFID has been proposed and designed [8]. This system can not only effectively avoid accidents to occur, but it can also detect the production environment and improve the quality of products. More-over it can also scientifically provide delivery solutions for companies to improve the efficiency of their transport. Through using RFID, it can manage employee absences, attendance and analyze staff efficiency, easily finding the reasons of the accidents.

This paper will be introduced in the following parts. In the second part, it will introduce the background of the system. The third part will focus on the overall architecture and detailed processes of the system, including methods and services used and in the last part, it will get the conclusion.

2. Backgroud

2.1 RFID and Chain Operation Mode

Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data. Its purposes are automatically identifying and tracking tags attached to objects [5]. It is widely used in the asset management, product identification, security and other fields, especially prominent in personnel positioning and logistics industry, which covering the processes from production, distribution, transportation, etc. [1] The core function of RFID application system is data collection, processing, conversion and analysis after the entities identified.

Chain operation model for fireworks industries is that the existing industries forming a new chain corporation which unifying the existing certification marks and labels and set a new management company to work out the companies' rules and regulations. Meanwhile, the subsidiaries must operate according to the rules of the chain corporation. This mode can also let the new chain corporation establish their unified standard warehouses and set multiply distribution centres. It also means building a unified chain of distribution network, promoting the efficiency and speed of logistics.

This system can manage the fireworks production and storage intelligently, in that it uses the active RFID equipment to carry out positioning inside and real-time monitoring on production and storage environment. Consequently, it provides a standardized and formalized management for providing informational support of safe storage and powerful monitoring methods.

2.2 System Architecture

Since using chain operation mode, the data center is required to be placed in the headquarters and for the operation of the database, use the web service to realize data synchronization and exchange [4]. This can ensure the security of data.

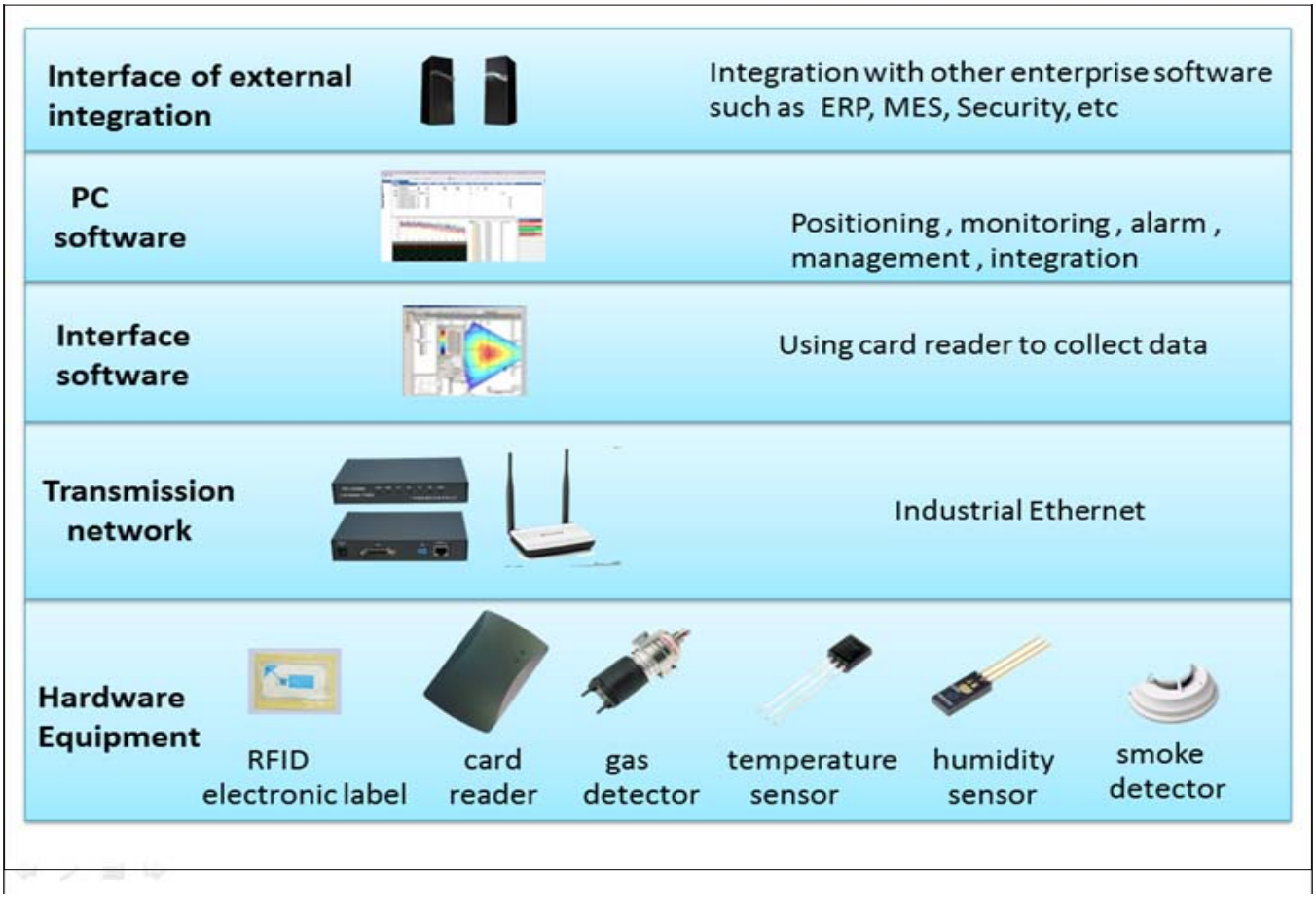

Figure.1 System architecture diagram

The system is divided into five levels as follows: hardware equipment, transmission network, interface software, PC software, and interface of external integration. The overall architecture is shown in figure 1.

System principle: the hosts connect to the hardware equipment in the factory and warehouse through communication cable. And the system requires workshop, warehouse entrances or important positions of certain areas to set stations for detection signals. When staff carries identification cards into the detection areas, the receiving signal devices can receive the carrier wave from the cards. Then the stations will carry out some simple analysis and processing. After that, it will send signals to the communication devices through the communication network and finally send the relative data to the information centers where store the whole data. [2] The system software will process and analyze the data from each station and get whole staff attendance, positions, each employee action paths and the display of the accident information.

2.3 Technology Architecture

According to the business requirements, the system of technical architecture is designed in figure 2. System software includes four parts, the background software (data communication interface, unified data access), database, computer software and mobile client.

3. Introduction of Processes

3.1 Production Management

According to different production environments, the workshops of fireworks conpanies install different sensors and detectors. For example, in the workshops of filling fireworks with gunpowder and primers, the companies install temperature and humidity sensors, gas detectors and smoke sensors, for the production environment must be anti-thunder, anti-static, low-temperature

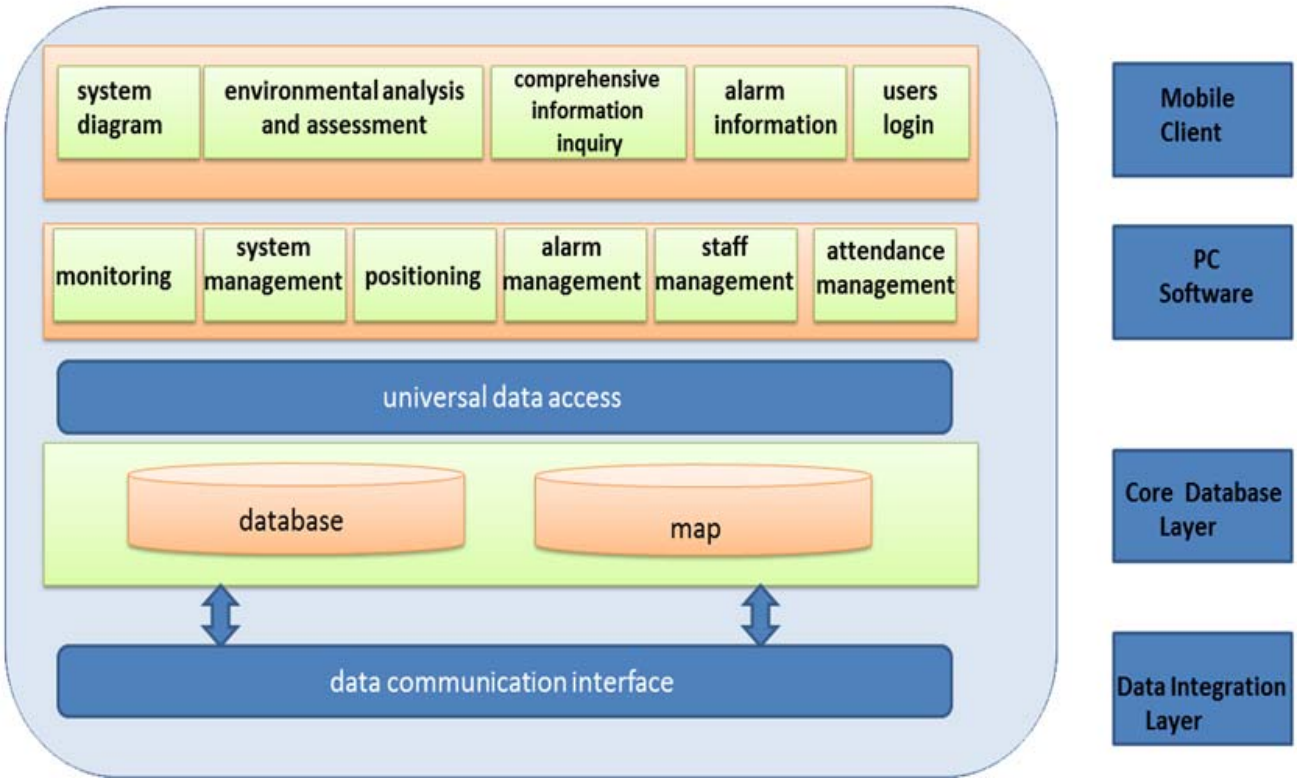

Figure 2. System technical architecture diagram

and against dampness and moisture. When detecting the air containing a lot of toxic gas or too high ambient temperature, probably fire breaking out, the system reminds administrators and opens the alarm signals or sirens to remind workshop staff. The relative personnel can take corresponding manners timely according to the status information of the workshops through the system.

The system requires employees to punch in and this can record the employee attendance. It can be used as the basis for evaluating employees' performance. For each staff has a unique identifier, namely the RFID electronic tag, the system can obtain the employee everyday walking routes by their ID card when walking through the card readers. However, walking can easily bring static electricity and may lead to explosion and fire. Recording the walking paths of the employees can not only protect the security of employees and be more easily to find out the cause of the accidents. Factories are equipped with emergency alarms and the staff can ring the alarm bell when emergency accidents occur. Rescuers and relative people can quickly know the positions and relative information of the accidents through the system and then adopt the effective measures to deal with them.

3.2 Storage Management

Due to the use of chain operation mode, production produced by various factories can be stored in the same standard warehouses and can use joint management. According to the regulations and rules worked out by governments that a naked flame cannot be broken out 15 meters away from the warehouses, the smallest distance to probably have explosion or fire, the walls around the warehouse must be equipped with sensors to detect environment around them [9]. This module also requires the employees who oversee and charge warehouses and inventories to punch in and this can guarantee that every day the warehouses have someone responsible for them. Meanwhile, it can be records to evaluate the employees' performance. Since there are requirements of fireworks' storage, such as storage temperature, humidity and so on, the warehouses must install temperature and humidity sensors and gas detectors. The areas around warehouses must be equipped with alarm bells to avoid exceptional conditions occurring. For excessive storage may bring huge hidden danger, the warehouse administrators must record the quantity of each product type or use the system manually to change the quantity. And the system would check the quality changed by caretakers of the warehouses and delivery staff to guarantee the correct number of the goods. And in the following survey, we will choose the best distribution algorithm to logistics, especially in the actual problem of multi-warehouse and multi-task, helping the logistic employees to choose the cheapest route to send their goods.

3.3 Design of Algorithm for Multi-warehouse and Multi-task Based Logistic Assigning

Due to using chain operation mode, corporations become larger and the distribution of tasks become heavy. The places that are needed to distribute often turn out to be hundreds or even thousands every day and the warehouses locate in different geographical areas. Consequently, how to allocate the logistic tasks has become an urgent problem and it needs the optimized assigning of multi-warehouse and multi-task [3] [6]. Faced this problem, the system is going to use an algorithm for multi-warehouse and multi-task based logistic assigning and this module is now entering the testing phase. This algorithm combines sweep algorithm, saving algorithm and virtual task point to present a method [7].

First of all, the sweep algorithm employs the nearby principle and calculates every task's ratio from the minimum distance of the warehouse to the distribution center to the distance of the second closest. Then arrange the ratio orderly and allocate the tasks according to this order. The main advantage of this logistic mode is simple, quick calculation and can quickly get the required results. While for saving algorithm, it is similar to the TSP saving algorithm. In the beginning, it will assign the tasks to the nearest distribution sites and then adjust or modify the initial data to get the smallest saving. The distance saving is defined as follows. When two routes (0,…, *i*, 0) and (0, *j*,…, 0) can feasibly be merged into a single route (0,…, *i*, *j*,…,0), a distance saving *sij* = *ci*0 + c0j"*cij* is generated. And this calculating method can also be regarded as C-W calculating way [6] [7]. Its basic idea is to find every path to transport from source sites to distribution sites and constitute the whole route. Then calculate saving values on every path to those distribution sites and gradually adjust the routes to reduce the cost of transport according to the saving values. Thus it can decompose the multi-warehouse problem into mono warehouse problem and easily choose from what warehouses to transport the goods to the consumers. Then work out a more detailed and accurate delivery routes on the whole route using saving algorithms and considering the constraints of actual transportation time. The optimal delivery solutions are made in the balance consideration of production volume, weight, categories and so on.

4. Conclusion

As far as the current firework condition that the storage or production sites are dispersed and do not cooperate to face the international competition market. Using the chain operation mode can expand production and improve production's quality, easily introducing new technology. However, it brings the pressure of increasing management cost. The system caters to this trend and reduces the management cost by monitoring subsidiary companies' production and storage processes. It can manage the attendance of employees by using RFID and timely provide accident measures when faced emergency conditions. It detects the production and storage environment and guarantees the security of staff to some extent.

In face of market demand, the fireworks industry needs such a system to guarantee the secure production processes and need have better management methods with larger scale of the firms, due to the trend of chain operation mode. And at present, the system is in development and some functions are in test. According to reports from experiments that it has good effect and some features are in line with the trend of development of this industry.

At present, the system is still needed to communicate with company managers and change some modules, such as providing logistics route to cater for market requirements and standards that accord with rules drafted by administrations. And it also needs to strengthen the information collection and feedback in real-time application. Some custom modules are also needed to make according to different requirements, constantly improving and extending the functionality, aimed at achieving profit-maximization realization.

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