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Research on the Architecture of Intelligent Manufacturing System in Daqu Production Workshop

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Abstract

With the development of science and technology and the application of a new generation of information technology, the traditional manufacturing industry is gradually developing in the direction of digitization, informatization, and intelligence [1]. Some manufacturing industries have designed intelligent manufacturing to meet their own needs based on their own production conditions. System to adapt to the development of the manufacturing industry in the future. This paper aims at the serious islanding of equipment data information, the inability to visualize the production process and quality data, the poor equipment management, and the confusion of personnel management in the Daqu fermentation workshop of a Luzhou-flavored winery in Yibin, combined with the future development needs of the Daqu production workshop , Built an intelligent manufacturing system for Daqu production workshop based on intelligent manufacturing. The system mainly focused on the functional modules of production, management and logistics system in Daqu production workshop.

Keywords

Daqu production workshop intelligent manufacturing system research.

1. Introduction

With the development of science and technology, the manufacturing industry is no longer satisfied with the traditional production mode. A new generation of information communication, sensing, artificial intelligence, software development systems and other technologies are applied to the manufacturing industry. The integration of various new technologies with the manufacturing industry, Form a new manufacturing model-intelligent manufacturing. At present, intelligent manufacturing is leading the transformation of the manufacturing industry. It has changed the traditional manufacturing methods, the production patterns of enterprises, the communication mode between the same industry and between different industries, making factory manufacturing more intelligent, informatized and networked[2].

The report of the 19th National Congress of the Communist Party of China clearly pointed out that the transition from rapid economic growth to high-quality development should not only shift the measurement standard from “has it” to “good or bad”, but also extend the connotation from “growth” to “development”. Higher level, better structure, more efficient, fairer and more sustainable development [3]. Combined with the rapid growth of the liquor economy to the high-quality development, the solution is to transform from the "quantity era without alcohol shortage" to the "quality era without good alcohol", plus the pursuit of product quality with the improvement of consumers' living standards Also getting higher and higher. Therefore, under the premise of ensuring quality, safety and reliability, alcohol products need to be upgraded and developed in the direction of high-end, diversification and individualization to meet people's growing material needs.

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Liquor brewing companies that contain strong flavor substances belong to the traditional production methods, among which Daqu production workshops are representative. The workshop currently has problems such as low automation of the production line, serious islanding of equipment data information, inability to visualize the production process and quality data, poor equipment management, and confusion in personnel management. Combining the needs of intelligent manufacturing and the future development of Daqu production workshops, build Daqu production workshop intelligence The manufacturing system has certain significance for the intelligent, informatized and networked transformation of Daqu production workshops and brewing enterprises.

2. Status of Daqu production workshop

At present, the production of Daqu still adopts the traditional production methods: raw material to make Daqu, natural inoculation of microorganisms, and indoor fermentation of Daqu. In the Daqu production workshop, only raw material making Daqu has realized mechanized production. Figure 1 shows part of the mechanical equipment for raw material making Daqu in the Daqu production workshop. Figure 2 shows the transportation process of Daqu production workshop and Daqu fermentation room.

(a) Wheat crushing machine in Daqu production workshop

(b) Daqu pressing machine in Daqu production workshop

Figure 1 Some mechanical equipment in Daqu production workshop

(a)The worker pushes the cart with Daqu

(b)Inside the Daqu fermentation room

Figure 2 The transportation process of Daqu production workshop and Daqu fermentation room diagram

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3. Business requirements of Daqu production workshop

At present, the production process of Daqu in the Daqu production workshop is raw material→pressing of Daqu→indoor fermentation of Daqu→out of Daqu→indoor fermentation of Daqu→out of Daqu→indoor fermentation of Daqu→out of warehouse. According to the Daqu technology, the Daqu production workshop can be divided into three areas, namely the raw material storage area, the Daqu production area, and the Daqu fermentation area. The raw material area is mainly to store raw materials. Daqu production area is responsible for Daqu's process from raw materials to Daqu compression molding. The fermentation area is responsible for the fermentation and turning process of Daqu. According to the division of Daqu production workshop, the business requirements of Daqu production workshop are shown in the figure below.

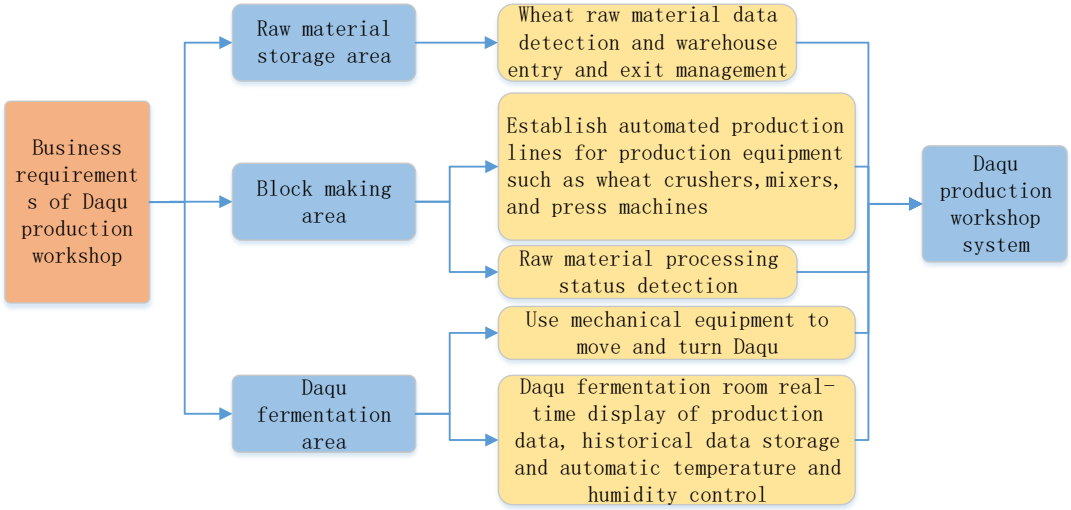

Figure 3 Business requirements of Daqu production workshop

As can be seen from the above figure, the business requirement of the Daqu production workshop is to build an intelligent manufacturing system for the Daqu production workshop. The system is divided into three parts, namely the raw material storage area and the Daqu production area Daqu fermentation area. The raw material storage area is mainly wheat. The needs of raw material inspection, warehouse entry and exit management, etc. The needs of the Daqu production area are mainly the establishment of an automated production line for the entire production area, and the inspection of the processing status of each process on the production line. The Daqu fermentation zone mainly uses mechanical equipment to transport and turn Daqu, and at the same time realize the real-time display and recording of Daqu fermentation room data and automatic control of temperature and humidity in the Daqu fermentation room.

4. Functional requirements of Daqu production workshop

According to Daqu's production process, combined with the business requirements of Daqu's production workshop system, the production workshop system functions are built according to the three systems of production, management, and logistics. As shown below.

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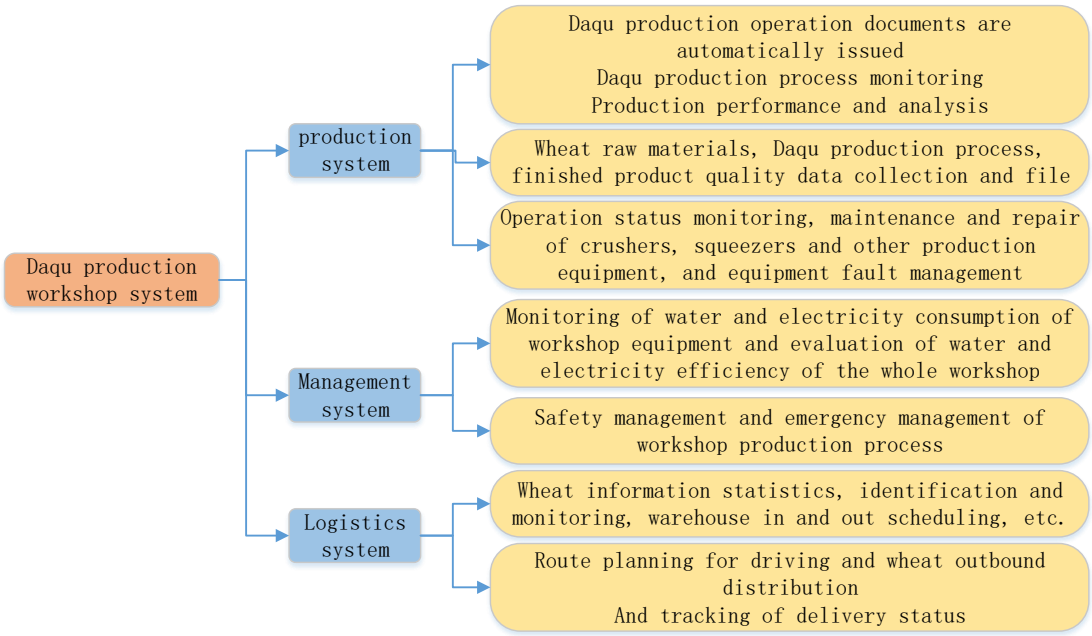

Figure 4 Functional requirements of Daqu production workshop

As can be seen from the above figure, the production system functions include Daqu production schedule and visualization of production tasks, Daqu job files are automatically issued to each process and real-time monitoring and management of production data, quality monitoring and management of Daqu's entire production process, various production equipment, testing equipment Operating status and maintenance. The management function includes workshop hydropower energy monitoring and management, energy efficiency assessment, workshop safety production management and emergency response. The logistics function includes wheat inbound and outbound information and identification monitoring, workshop driving and wheat inbound and outbound route distribution planning and status tracking.

5. Construction of Intelligent Manufacturing System for Daqu Production Workshop

According to the production process, functions and business requirements of the block in the Daqu production workshop, the production equipment, instruments and various subsystems in the workshop are connected through the Daqu production workshop system network to form an intelligent manufacturing system in the Daqu production workshop. According to the "Guidelines for the Construction of National Intelligent Manufacturing Standard System" [4], the intelligent factory construction standards and the actual production of Daqu production workshops are combined. This paper divides the Daqu production workshop intelligent manufacturing system into one module and three subsystems, which are the user management module, Intelligent production system, intelligent management system, intelligent logistics system. The user management module manages the users of the entire system, and the intelligent production system guides workshop production execution, quality control, and equipment operation and maintenance. The intelligent management system mainly includes two modules: energy management and safety management. Smart logistics includes smart warehousing and smart distribution modules. Its system function architecture is shown in the figure below.

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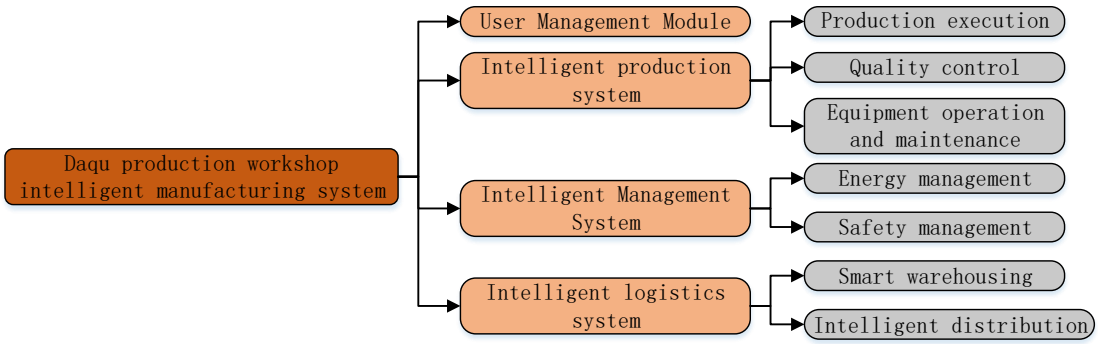

Figure 5 Functional architecture diagram of intelligent manufacturing system in Daqu production workshop

5.1. The user management module of the intelligent manufacturing system in the production workshop of Daqu

The user management module in the Daqu production workshop intelligent manufacturing system is the system manager's identity verification and authority assignment to the workshop production personnel, which mainly includes the following functions: The production workshop system manager creates a list of Daqu production workshop personnel through background operations , Delete and permission initialization function. It has the function of real-time modification of workshop personnel's role authority. It has the function of resetting workshop personnel's authority and role when the system functions are expanded or upgraded.

5.2. Functions of Intelligent Production System in Daqu Production Workshop

As the core of the entire workshop system, the production system in the Daqu production workshop intelligent manufacturing system plays a vital role in the system. The three modules are production execution, quality control, and equipment operation and maintenance. The intelligent production function of Daqu production workshop is shown in the figure below.

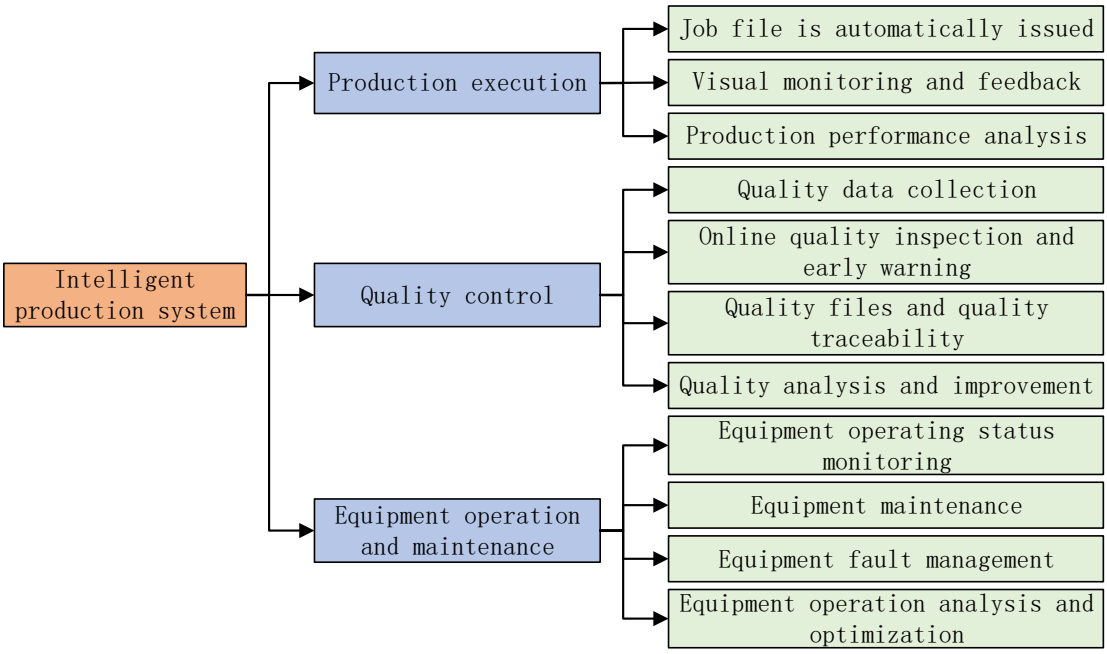

Figure 6 Intelligent production function module of Daqu production workshop system

1. Production execution function

The production execution function module mainly includes the automatic issuance of job files, visual monitoring and feedback, and production performance analysis.

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(1) Automatic job file issuing module: workshop managers quickly decompose production tasks through the Daqu production workshop intelligent production system, automatically generate job plans, and generate corresponding equipment execution files, and transfer the execution files to the equipment through the workshop network , Establish the equipment production task table, which contains the planned production, production, pending production, and production information of the workshop equipment and real-time update of the production progress data of each equipment.

(2) Visual monitoring module: Establish a database of Daqu production process information and equipment operating status. The database contains two parts. One part is data such as various sensors, FRID tag reading, production equipment information and operator information during the production process, and the other One part is a video taken by a workshop camera. Read the database of Daqu production process information and equipment operating status, and display and store product production process data information and display equipment operating status in the form of charts according to the workshop production area and equipment division in the area. After the product enters the production area of the production process, FRID identifies the product information card, and at the same time uploads the card information, process equipment and location information to the database, and reads the real-time database and updates the monitoring interface in real time. For processed products, through sensors, increase the processing equipment, operator, time and other information in the product information card, increase the number of completed processing equipment on the equipment side, and clear the product information on the equipment.

(3) Production performance analysis: Input the Daqu production qualification rate, wheat warehouse receipt, qualified Daqu warehouse receipt, personnel attendance, department performance appraisal and other reports into the performance appraisal system, and use the Daqu production workshop department evaluation criteria as the judgement basis.

2. Quality control function

(1) Quality data collection and display module: Read the Daqu production process information and equipment operating status database, and extract the current Daqu production quality data during the Daqu production process according to the production area and equipment in the area, including the temperature and humidity of the wheat in the koji making area, Test data such as the thickness of wheat crushing, the hardness of wheat flour mixing process, moisture, etc., the temperature and humidity of the air in the fermentation area and the temperature and humidity of the fermentation of the koji, and the identification of the koji product, and according to the information read according to the production area and equipment in the area Form Daqu production process product inspection statistical table, production process inspection statistical table, product quality report, etc.

(2) Online quality inspection and early warning module: real-time extraction of process parameters, product quality, equipment operating conditions and other information in the quality data collection module, display the production quality information of each process in Daqu in the form of charts, and compare the collected data and product standards Process parameters and product evaluation standards are compared, all information is recorded, reports are generated, and abnormal information is warned.

(3) Quality files and quality traceability module: establish Daqu product quality card library, including production time, batch, quantity, quality judgment, storage and delivery status of Daqu finished products, and operator information for each process in the production process, etc. . According to the quality card information of the input Daqu, the information of the whole production process of the Daqu can be checked, and the quality of the product can be traced back.

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(4) Quality analysis and improvement module: The workshop management personnel conduct statistical analysis of the quality data in the production process of Daqu by reading the quality data collection library, and conduct dynamic monitoring to realize the graphical analysis of Daqu production data and form a quality trend chart, Dynamically generate statistical reports from various angles such as production personnel, administrators, and products.

3. Equipment operation and maintenance function

The operation and maintenance function of the equipment is mainly to comprehensively manage the operation status, maintenance and repair, and fault management of the equipment, so that the management personnel can understand the equipment information in real time, and make appropriate adjustments to the information, thereby ensuring the normal progress of production tasks. It mainly includes the following functions:

(1) Equipment operation status monitoring module: monitors and displays the current production equipment involved in the Daqu production workshop, such as mixers, pulverizers, squeezers, mechanical arms, curved rooms and other equipment operating status and operating time (fault, idle, Operation, debugging), current equipment parameters and preset parameters (temperature and humidity in the room, the thickness of the crusher, the number of pieces of the squeezing machine, etc.). Develop a reasonable production scheduling plan based on the monitoring of equipment status to improve equipment utilization and Daqu's production efficiency.

(2) Equipment repair and maintenance module: Establish an equipment database in the Daqu production workshop. The equipment information includes the name of the equipment, equipment number, equipment model, equipment manufacturer, location, use section, service life and its use manual and maintenance manual. Establish a real-time equipment maintenance table, including maintenance personnel, maintenance times, maintenance early warnings and warnings, maintenance time and other information, to provide early warning reminders for equipment to be maintained, and warning reminders for equipment that has not been maintained on time. Through real-time monitoring of the equipment's operating status, early replacement or repair of equipment that has exceeded the service life or equipment parts failure.

(3) Equipment failure management module: establish a database of equipment failures in the Daqu production workshop, analyze and judge the causes of equipment failures through the information obtained through equipment operating status monitoring, and take corresponding measures for the results to ensure equipment safety Run and flash the equipment alarm light. Send the fault code of the faulty device to the human-computer interaction interface to give an alarm and display the cause of the fault.

(4) Equipment operation analysis and optimization module: According to the information of equipment operation status monitoring, by analyzing the operation status and time of each equipment in the Daqu production workshop, and displaying it in the form of charts, the production decision-makers can make corresponding adjustments and decisions. Optimize the number and utilization of equipment to save energy.

5.3. Daqu production workshop management system architecture

Daqu production workshop management system mainly includes two functions: energy management of workshop water and electricity and workshop safety production management. The specific workshop management module is shown in the figure below.

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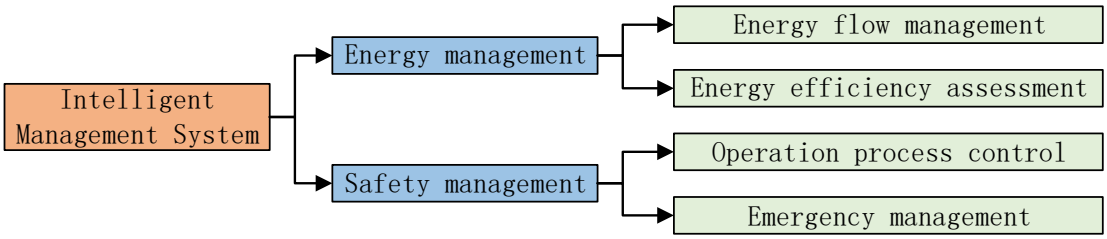

Figure 7 Intelligent management function module of Daqu production workshop system

1. Energy management function

Establish a workshop energy management system, including two modules, energy monitoring and energy efficiency evaluation. The main energy required for the Daqu production workshop is electricity and water.

(1) Energy monitoring module: Collect and upload the consumption of electricity, water and other energy for workshop equipment to the energy database. The energy management interface reads the data in the database and realizes the energy consumption of workshop equipment (single equipment consumption, production of individual parts) Energy, etc.) visualize, and generate a query record table of energy consumption of each device.

(2) Energy efficiency evaluation module: The workshop management personnel evaluate the energy consumption by reading key energy-consuming equipment and product unit consumption such as Daqu fermentation room, pressure Daqu machine, and robotic arm in the workshop energy monitoring database to make suggestions for optimization and improvement. , Improve energy efficiency.

2. Safety management function

Safety management is mainly to ensure that the products in the workshop can be produced safely, and correct measures and emergency measures can be taken in the event of danger.

(1) Operation process control and control module: by monitoring the operating status of workshop equipment and product production data, and real-time display of equipment operating status and product production data information, by comparing the process parameters of Daqu and the operating parameters of production equipment, the production The abnormal data in the process is regulated in time, and an early warning is given.

(2) Emergency management module: including plan management, plan query, plan recommendation intelligent processing, emergency command and dispatch, emergency resource dispatch and other modules. The system is classified and managed by level, category and type, forming a unified plan library, according to different risk levels , Different types of events recommend corresponding handling plans for leaders and staff to choose. The emergency dispatch command can add linkage units, subordinate units, units in the jurisdiction and personnel of the unit, support manual modification of the dispatch plan, and generate dispatch instructions. Combined with network communication means, the instructions will be notified to the command staff, relevant departments and rescue teams simultaneously.

5.4. Logistics system architecture of Daqu production workshop

The logistics system of Daqu production workshop mainly includes the storage function of wheat and Daqu finished products and the logistics distribution function in the production process of Daqu workshop. The specific modules of the system function are shown in the figure below.

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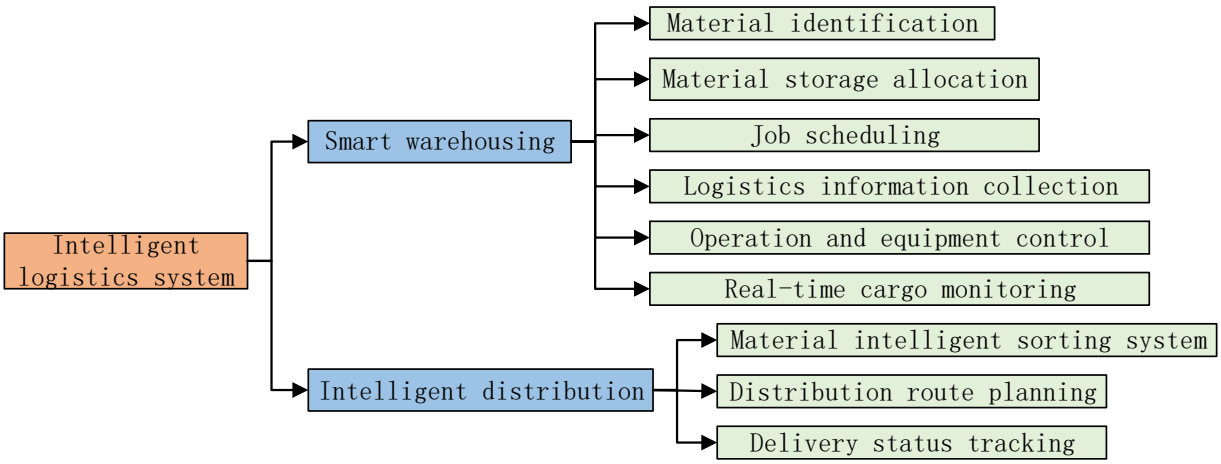

Figure 8 Intelligent logistics function module of intelligent Daqu production workshop

1. Smart warehousing function

The storage system mainly serves two parts: wheat and Daqu finished product storage. It mainly includes material identification module, material location allocation, job scheduling, logistics information collection module, job status and equipment status control module, and real-time cargo monitoring module.

(1) Material identification module: Enter the quantity, batch, storage time, quality and other information of wheat and Daqu finished products and generate a product information card, and display the product information card library in the storage product entry information table, and perform classification statistics.

(2) Material and storage allocation: When there are products in the warehouse, the workshop management personnel will formulate a scheduling plan according to the availability of the warehouse and the classification of the products, and determine the storage location of the products according to the scheduling plan.

(3) Job scheduling: When the wheat or Daqu finished product scheduling task is issued, the workshop management personnel inquire about the storage situation of the wheat and Daqu finished product in the warehouse, and timely feedback to the management personnel when the product quantity is not enough, and give a reminder. And dispatch the scheduling tasks to the warehouse logistics equipment and operators, and dispatch them according to the information of the type, quantity, inbound and outbound routes, inbound and outbound equipment, and target locations of the scheduled products. At the same time, the type and quantity of products in the warehouse and the free space information of the warehouse are updated in real time, and displayed in the warehouse storage information table.

(4) Logistics information collection module: the delivery time, delivery route, name and number of the delivery equipment, target location and operator information involved in the delivery of wheat and Daqu products from the warehouse to the storage location, and generate wheat and Daqu product warehousing information table. In the same way, a product outbound information table is generated based on the information involved when the wheat and Daqu finished products are out of the warehouse. At the same time, the product entry and exit label is generated in combination with the entry and exit information table for product traceability.

(5) Management and control of operation status and equipment status: When scheduling tasks are issued, the workshop management personnel check the storage status of the product (storage, waiting to be shipped out, and out of the warehouse), as well as the operating status of the equipment (operation, stop, maintenance) information, Manage and control product in and out information, transportation routes, etc. by dispatching equipment to the equipment.

(6) Real-time monitoring of goods: Read in real time information including the name, warehousing time, batch, model, quantity, location and other information of the goods stored, establish a storage storage information table, and display the storage screen in real time.

2. Intelligent distribution function: real-time collection of workshop Daqu raw material distribution process data and station production status data, and display the data on the interface in the form of visual graphics and icons, which is convenient for managers to grasp the operation of the workshop [5]. The distribution function in the Daqu production workshop is mainly in the sorting module during the quality inspection of Daqu finished products, the path planning of the crane lifting the curved room, and the tracking module of the raw materials in the Daqu production process.

Dynamically adjust the workshop material distribution plan to realize the workshop material management control. And establish the material distribution resource data model to optimize the material distribution strategy.

(1) Material intelligent sorting system: According to the Daqu finished product quality database, through the image recognition function of the robotic arm, the quality of Daqu is recognized, and the data stored in the database is compared with the actual measurement data. For unqualified Daqu, the operator will artificially identify the product the quality of. At the same time, upload the product information of Daqu qualified and unqualified products, and display the progress of production tasks in the production system, which is convenient for the workshop management personnel to control and control according to the quality of Daqu.

(2) Distribution path planning module: After the distribution task is issued, the crane will plan the distribution path of the curved room and issue the distribution path according to the workshop management personnel or the system back-end algorithm system, combined with the current situation of the curved room and the distribution priority.

(3) Delivery status tracking module: upload real-time information such as the name, number, route, time and other information of the delivery equipment, as well as the batch number and quantity of Daqu delivery to the delivery status tracking module, and display Daqu's delivery status information (delivery in progress) Medium and undelivered).

6. Concluding remarks

Based on the analysis of the current problems facing the Daqu production workshop and the future development needs, this thesis builds a functional framework of the intelligent manufacturing system of the Daqu production workshop, and does a specific research on the functional modules of the production, management, and logistics system in the framework. In the future, the intelligent, networked and informatized transformation of Daqu production workshops will have certain guiding significance.

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