Design of AIS control movement of raw materials in the industrial enterprise’s warehouse

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Abstract. The article presents one of the possible solutions to the problem of controlling the movement of raw materials in the warehouse of an industrial enterprise. A solution to the problem is proposed by designing an automated information system for controlling the receipt and movement of raw materials in the warehouse, which will greatly facilitate the work of employees, provide an opportunity to reduce management costs by freeing up human resources, allow monitoring the process of accepting and storing raw materials, and storing and analyzing data for any period time, search for the necessary information according to various selection criteria. Testing of the research results was carried out by introducing AIS control of the movement of raw materials in the warehouse of an industrial enterprise.

1. Introduction

There are many automated information systems on the market that provide comprehensive accounting and documents storage, document flow of commercial and state enterprises [1].

Briefly consider the features of the most popular office automation systems: Terrasoft CRM, DIRECTUM and MOTIV.

Terrasoft CRM software product is a full-featured CRM system that covers the main areas of customer relationship management and organization of the company’s internal processes [2]. The module "workflow automation" allows registering any kind of documents circulating in the company: commercial offers, acts of work performed and much more. There is no need to manually duplicate the same information in the document-related accounts or contracts; the system provides a convenient tool for quickly creating document chains. Terrasoft CRM allows managing the list of products included in the document and to endorse the documents. Due to the ability to conveniently structure documents in the system and attach files to them, we can easily find the text, urgently needed document.

Terrasoft CRM implements a full-fledged contract database management system. All types of contracts (contracts, contracts with customers, suppliers, etc.) will be securely stored in Terrasoft CRM. If a standard set of fields is not sufficient for any type of contract, we can easily add an additional field, thanks to a special custom fields’ mechanism. Productivity of work with contracts is provided by high speed of the necessary document’s search, simplicity of modification, possibility of the interrelations with accounts, specifications and other documents. Compliance monitoring has been taken to a new level. The electronic repository of internal documentation ideally contains the most popular templates, marketing, commercial and technical documents, provides instant access to all materials important to the company [3].
DIRECTUM system is a system of electronic document management and interaction management aimed at improving the efficiency of all organization’s employees in different areas of their joint activities. System DIRECTUM conforms to the ECM concept (Enterprise Content Management) and supports full lifecycle of document management [4]. At the same time, the traditional paperwork organically fits into the electronic document flow. DIRECTUM provides effective organization and control of business processes based on workflow: document approval, processing of complex orders, preparation and holding of meetings, support of sales cycle and other interaction processes. Integrating with business systems modeling, including: acts as the runtime business processes within a single cycle process management (BPM in DIRECTUM). Working with DIRECTUM on a variety of mobile devices and tablets allows ensuring business continuity and provide the user with the ability to comfortably work with documents and system data, regardless of location or technology used. Reliance on Russian standards in the field of office management, continuous improvement of technologies and partnership with leading developers and integrators guarantee the maximum effect from the introduction of electronic document management system DIRECTUM [5]. The solution of the described tasks is provided by the modules of the DIRECTUM system.

The automation of office work based on the MOTIV system will ensure effective management of electronic document flow and will become not just an organizer for secretaries, but a daily working tool that increases the efficiency and decision-making speed. The system of office work and electronic document flow MOTIV is designed to create flexible, customizable and effective solutions: automation of office work and control of documents consideration; control of documents and orders execution; document flow automation - organization of business and business processes management; electronic archive of documents. The MOTIV system provides the necessary tool for managing electronic document management in the enterprise, which is necessary for employees.

The cost of these systems ranges from 50,000 to 80,000 rubles. It is worth noting that, given serious deficiencies in automated information systems is inability to finalization by the staff specialists of the enterprise, the inability for remote access via the web interface, the inability to develop integration modules for the previously installed software. In addition, it is necessary to take into account the need for personnel training, configuration and installation of each copy of the program, system improvements for individual characteristics of the enterprise, the cost will increase several times. The purpose of this study is to develop an automated information system for monitoring the movement of raw materials in the warehouse of an industrial enterprise.

2. Material and research methods

As research methods we used observation; structural and functional analysis; functional modeling of business processes; structural, object-oriented, process methodological approaches of AIS design.

In an industrial enterprise, it is necessary to automate the control of raw materials’ movement in the warehouse of the enterprise. At the moment, the company has an automated system that is not responsible for the entire enterprise, but for individual points of reception and raw materials’ movement. Based on the technical and economic characteristics of the industrial enterprise and the existing automated systems’ analysis, it was decided to develop new AIS to automate the control of the raw materials’ movement in the warehouse of the enterprise [6]. The context diagram "accounting for the raw materials’ movement in the warehouse of the enterprise" is shown in figure 1.

The decomposition of the model is used in business process modeling in order to provide a more thorough description of the blocks [7]. In figure 2, the main function is decomposed into three functional blocks: receipt of raw materials; shipment of raw materials; formation of summary reports.
Figure 1. Context chart "Accounting for the raw materials’ movement in the warehouse of the enterprise".

Figure 2. Decomposition of the main function "Accounting for the raw materials’ movement in the warehouse of the enterprise".

Next, we decompose these function blocks into smaller actions. The functional block "Receipt of raw materials" decomposes into several actions:
- checking for compliance with the number, quality and range of incoming raw materials;
• preparation of the act;
• preparation of the receipt order;
• posting of raw materials from the shop;
• preparation of invoice for raw materials subject to laboratory testing;
• check raw materials of the past laboratory research;
• formation of a report on the receipt of raw materials.

The functional block "shipment of raw materials" decompose into three actions:

• preparation of expenditure documents for production needs;
• shipment of raw materials to replace materials;
• formation of the raw materials’ shipment report.

The functional block "formation of summary reports" is decomposed into four actions:

• filling in statements;
• formation of raw material residues movement statement;
• analytical accounting;
• preparation of summary reports.

The developed AIS should provide the following main functions:

• maintaining the nomenclature of cases;
• centralized storage of all documents of the organization in electronic form on a dedicated file server;
• registration, systematization and accounting of internal, incoming and outgoing documents;
• storage of document details: type of document, author, date of creation, registration number, shelf life, etc;
• separation of access rights to the system and documents and user authorization;
• formation of output documents.

The important decision taken in the development of an automated information system is the choice and justification of the methodology and technology of AIS design [8]. This makes it possible to solve the problem with minimal cost.

Nowadays, there are two main methodological approaches to business process modeling: structural and object-oriented. The structural approach is based on the principle of functional decomposition, in which the functional elements of the system are isolated and a strict order of actions is established [9]. The object-oriented approach relies on object decomposition. In this case, the objects containing both data and methods of their processing are selected. The objects have their characteristic properties and interact with each other, providing the overall behavior of the system. There is also a third methodological approach – process, which carries the features of both structural and object-oriented approaches [10].

When designing our AIS, we will use the following diagram techniques:

• goal tree (to describe the strategic and tactical goals of the enterprise);
• IDEF0 (to create a functional model);
• Ishikawa diagram (to create a cause and effect diagram);
• use case diagram (to determine user requirements);
• IDEF1(x) (to create an information data model).

Our choice is due to the fact that this series of charts most fully and comprehensively allows displaying the business processes of the enterprise [11].

We carried out creation of our AIS according to GOST 34.601-90 "Information technologies. Automated system. Stages and phases of AIS creation" [12].

The developed automated control system of receipt and raw materials’ movement in warehouses of the industrial enterprise is intended for control of acceptance and iron ore raw materials (IORM) warehousing process. The system is three-level, distributed, with the possibility of structural expansion and integration into higher-level processes.

The first level of the system consists of field sensors, drive mechanisms, switches, etc. Equip a microprocessor control devices and motor protection Simocode with expansion modules to electric...
conveyors. Such modernization will allow monitoring parameters of the drives and to collect and transmit data on the condition of the pipelines (the position of the limit switches, keys ban, the relay of the cut strips, relays, speed monitoring, etc.) to the central processor via Profibus.

The second level of the system is equipped with remote peripherals cabinets based on ET200 remote peripherals modules and CPU cabinet based on Siemens Simatic S7–300 controller. Data from the sensors are received via control cables in the form of discrete signals in the cabinets of remote peripherals and then transmitted to the CPU cabinet via the Profibus network. Data on the operation of the actuators are fed into the CPU cabinet via the Profibus network. The CPU receives this data, processes and transmits it to the Scada-system and InSQL server (the third level of the system) via Ethernet.

The third level of the system is a personal computer on which WonderWare SCADA-system InTouch and InSQL server are installed. All data on the operation of the system, according to the approved list, enter the InSQL database and are available in the corporate network of the industrial enterprise.

Automated systems as components include: technical, information, software, technological, organizational support [13].

Technical support of our AIS includes a set of technical means intended for the information system operation, as well as relevant documentation for these means and processes [14]. The complex of technical means consists of: computers; data transmission devices and communication lines; office equipment and devices for automated information retrieval; devices for collecting, accumulating, processing, transmitting and displaying information.

AIS information support should be sufficient for maintaining all automated functions of the facility; to encode information will be used accepted classification systems; will ensure compatibility with information systems that interact with the system under development; will provide means of monitoring the input and scoring information, updates the data in data arrays, control the information integrity, protection from unauthorized access.

The justification of design solutions for software includes the choice of operating system and database management system for the development and subsequent operation of an automated document management system [15].

The implementation of the technological process includes work on accounting for input information, as well as maintaining an information base and generating reports on relevant database queries [16].

Organizational system support includes direct executors responsible for the proper system functioning and the network administrator, as well as their interaction in solving the document automation problem [17].

3. Results and discussion
At the industrial enterprise the developed automated system of receipt and raw materials movement control in its warehouses consisting of four independent subsystems was introduced: "Control system of loading in reception bunkers", "Control system of conveyor paths", "Control system of unloading on a warehouse No. 2", "Control system of unloading on a warehouse No. 3". Data on the operation of these subsystems are received in the enterprise control room and displayed in the Scada-system in the dynamic mimic form.

Manager of the enterprise enters data into the system on the composition of iron ore (number of cars, chemical composition and the order of unloading). Further, the system controls the process of unloading iron ore from wagons: the time of each wagon unloading, the degree of the enterprise receiving bins filling, the iron ore movement on conveyor paths and a place of unloading iron ore in stockpile warehouses of the company subject to transport delay. According to these data will be formed passport stacks in real time. The structure of the raw material movement control system is shown in figure 3.
Figure 3. Structure of raw material movement control system.

Additionally, the system will monitor the electric drives of conveyors operation (load, current, time, operating time, etc.). These data will be stored in the technological archive for emergency forecasting and organization of planned stops, maintenance and repairs.

4. Conclusion
The implementation of the developed automated control system for the receipt and raw materials movement at the warehouses will enable the industrial enterprise to introduce automatic control of the carriages amount with iron ore entering facility; to monitor the work of the conveyor paths of flow for iron ore in the warehouses of the company in real time; to promptly convey information about the quantity and quality of shipped raw materials to the manager of the enterprise; to improve the efficiency of the enterprise.

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