Modeling an automated production control system as part of a reengineering project

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Abstract. Nowadays, the operation of production systems common in Russia is no longer relevant. They are already outdated and cannot adequately respond to turbulent global changes, make effective decisions. Also, databases in such systems are isolated and do not interact with other systems. Currently, for enterprises of any industry, automation of information processing and management systems are becoming increasingly relevant. The article presents the project of the enterprise production processes reengineering and its implementation as exemplified by one of the leading enterprises of the Krasnoyarsk Territory, Russia. The procedure includes the development of an automated management system using software products and CASE-tools, the construction of structural-functional models of business processes in AllFusion Process Modeler (BPWin), and simulation using the Arena product. Using the complex of models presented in the article, it is possible to calculate the optimal version of the workflow of the automated control systems under consideration by setting the parameters of the document flow. The introduction of an automated control system allows you to effectively allocate time when processing documents, increase the turnover of funds, and not waste time transferring documents between departments of the branch; less human and material resources are required for the development and maintenance of software. Modeling of production processes reengineering allows us to evaluate the effectiveness of the project before making direct changes in the business-core.

1. Introduction

Existing production systems in Russia are equipped with outdated technologies that require high costs to maintain their functioning. Therefore, the question arises of creating a model of an integrated automated control system (ACS) that would integrate the database into a single information space and work in real time [1].

The main obstacles to the transition to more flexible management systems are the relatively high cost of its implementation, the insufficient justification for the need to introduce such a system, and sometimes the skepticism of management towards new management concepts [2]. However, despite this, enterprises make attempts to solve this problem, which in the future allows one to receive and use

the information necessary for making managerial decisions and ensuring accounting for the activities of the entire enterprise [3].

2. Automation of information processing systems and business process management

The purpose of the implementation of ACS is to improve the quality of management due to the possibility of finding the most rational solutions for individual management tasks, while ensuring the effectiveness of the functioning of the entire management system. When developing it, the task is to create a new man-machine control system designed to replace the existing one [4]. The development and implementation of ACS require the use of significant temporary, financial and human resources.

The designed model of an automated control system for catering at the plant provides timely information, reduces the time it takes to create and approve documents, controls the repayment of accounts payable and receivables, controls the execution of received orders / applications, creates a unified information database, quickly monitors new incoming information, interacts with various industry management systems of the enterprise. Such a model is complex, relevant and unique. To successfully recognize the results of the work, the wishes of all automation participants have been identified and accepted [5].

The following basic information technologies are used to develop new software products and design systems: ASP.NET – for the development of WEB applications; C ++ Builder – for object-oriented programming; ERWin – for the development and design of databases; BPWin and Microsoft Office Visio – for the visual design of information systems, etc.

Figure 1 presents a diagram of the interaction of this system with others.

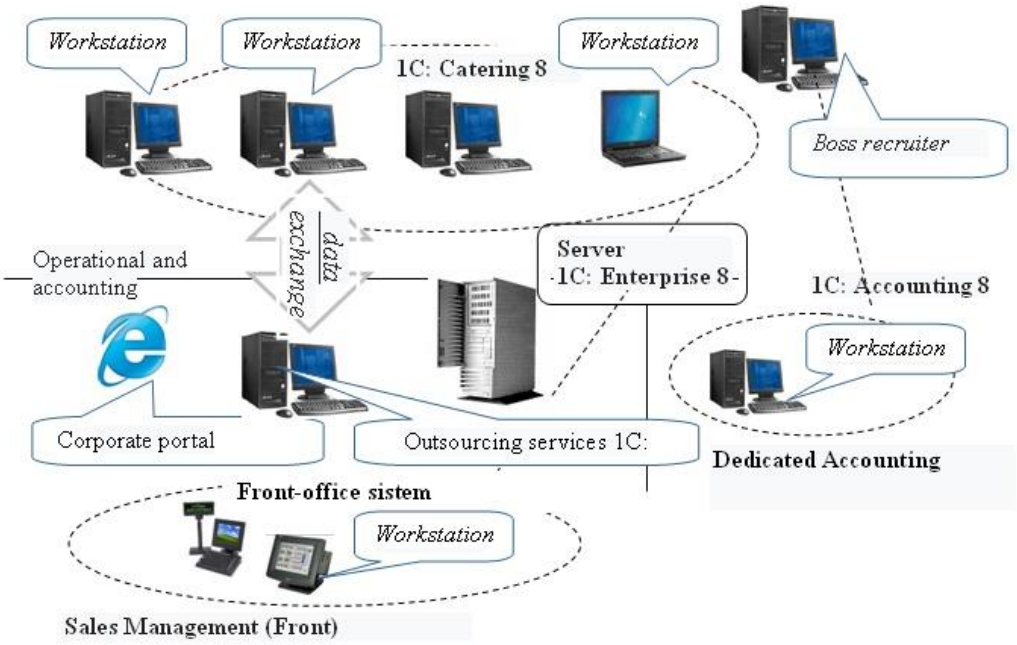

Figure 1. Scheme of interaction of the designed system with the enterprise management structure.

The largest amount of inefficient time consumption occurs in accounting, since here one person processes a lot of information in paper form. The accountant is liable for all operations on the receipt and expenditure of goods and cash. It is the accountant who conducts payment transactions with suppliers. Operations of this nature must be performed at specific times. Therefore, the implementation by the accountant of work on processing and conducting documents should be effective and economical in time [6].

After analyzing the time spent on staff performing their duties, it was proposed to reorganize the processing of documents, since it is this work that takes a lot of time. However, not only the speed of processing documents is the "weak link" in the work of the branch "Food Plant", but also the correctness of the preparation of documents is an important aspect.

Previously, in order for the accountant to be able to post documents such as invoices, receipts and expenditures, it was necessary to wait for warehouse staff to generate reports on receipts and expenditures (using MS Office Excel). After checking these documents, the accountant needed to form a document for the transaction, pay for services and post the documents [7]. Thus, managerial decision-making was late. Therefore, there is a need to expedite the accountant's access to documents coming from outside, for timely payment and management decisions.

3. Designing a business process system with structural-functional and simulation (dynamic) modeling tools

At the initial stages of creating an information system, one needs to understand how the company works. To describe the work of the enterprise, it is necessary to build a model that should be adequate to the subject area; therefore, it should contain the knowledge of all participants in the organization's business processes. Using the CASE-tool for structural and functional modeling of business processes All Fusion Process Modeler (BPWin), a scheme of the automated system of the branch of OJSC "Krasmash" - "Food Combine" was developed (Figure 2).

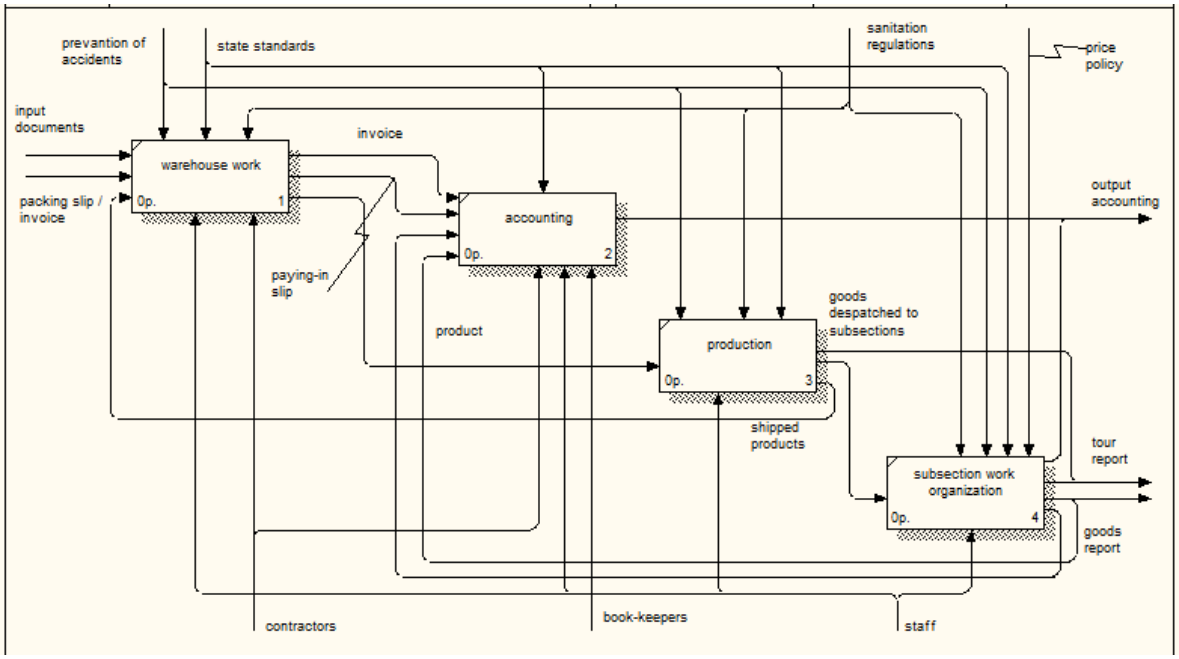

Figure 2. Structural and functional model of business processes at ACS JSC "Krasmash".

The structural and functional model of the business process of the production enterprise of JSC "Krasmash" is made in the software environment All Fusion Process Modeler (BPWin) (IDEF0 standard), which allows analyzing the problems of the unit's activity, identifying data flows in the form of internal documents. The integration of this product with the Arena simulation tool, designed to build dynamic models and optimize them, is carried out by transferring the model from the IDEF0 standard to IDEF3, which is designed specifically for modeling documentation processes and collecting information about business processes.

IDEF3 shows cause-effect relationships between situations and events in a form understandable to an expert using a structural method of expressing knowledge about how a system, process, or enterprise functions.

After analyzing the shortcomings in the work of structures, a more rational option for the reorganization of the business processes is proposed. The model shown in the figure is needed to analyze alternative methods for organizing the work of structures. Automation will reduce time and human resources in the formation of documents. When posting goods to the warehouse, documents (waybill, invoice, etc.) are entered directly into the program and stored in the database.

To pay for the services of suppliers, it is enough that the accountant enters under his individual password, checking the documents, pays for the services and holds the documents. A turnover sheet is generated automatically for any selected period. Warehouse workers also generate reports automatically, which takes a minimum of time. Since previously the warehouse staff did not have time to fulfill their duties, there was a need for another employee. But the data on staff expansion, the Krasmash branch - Food Plant could not realize. With the introduction of the automated management system, the need for another employee has disappeared, since inventory accounting has been simplified.

Next, we export the converted model to Arena 8.0 for calculation and comparative analysis of the document flow in the existing (real) model of business processes and its ideal version (the "as it should be" model, Figure 3). Models in the Arena system are process-oriented, the graph of the model shows the path of an individual transaction. A transaction is created, waits in line, captures resources, is processed, frees resources, and is destroyed. Other transactions can go the same way, but the system takes on the process control task. Queuing systems (QS) are often used as a mathematical model of IP. These are systems that serve the incoming flow of applications. At the exit, we have a stream of server applications.

The study of processes in discrete systems with a stochastic nature of functioning is carried out in the framework of queuing theory (TMT) and the theory of random processes. Moreover, many models of real systems are built on the basis of queuing models (MMOs), which are divided into basic models in the form of queuing systems and network models in the form of queuing networks, which are mathematical objects described in terms of the corresponding mathematical apparatus.

Models in Arena 8.0 are also based on Petri nets, a mathematical apparatus for modeling dynamic discrete systems. The Petri net is a bipartite oriented multigraph consisting of vertices of two types - positions and transitions interconnected by arcs. Vertices of the same type cannot be connected directly. Positions can place tags (markers) that can move around the network.

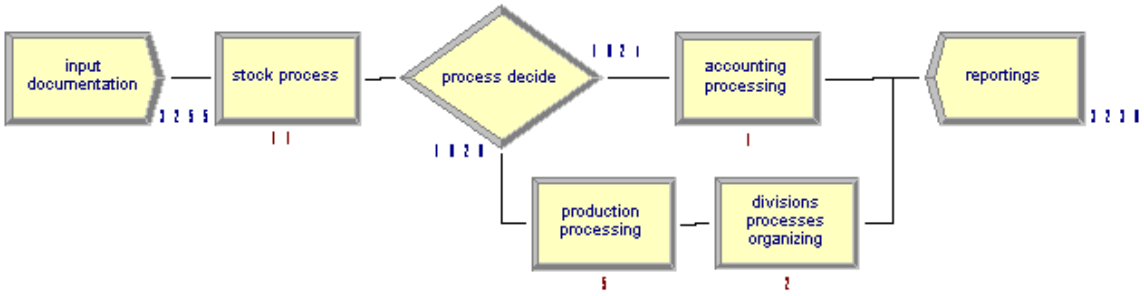

Figure 3. Simulation model of business process reengineering of ACS of JSC "Krasmash" in Arena 8.0 environment.

A set of events distributed over time is called a stream. If the event is the appearance of applications, we have a stream of applications. The simplest flow is often called a Poisson flow, since the number of applications k arriving over a given period of time t is distributed according to the Poisson law:

$$P(k) = \frac{\lambda^k}{k!} e^{-\lambda}, \quad (1)$$

where: *P(k)* is the probability of receipt of k applications for a certain fixed time interval; λ is the mathematical expectation of a random variable (average number of events over a fixed period of time); *k!* – factorial of a number.

Using the presented model, it is possible to calculate the optimal document flow option for the ACS object under consideration by setting the parameters of the document flow (Figure 3). The introduction of the automated management system of the branch of JSC "Krasmash" - "Food Combine" will allow one to effectively allocate time when processing documents, increase the turnover of funds, and not to waste time on transferring documents between the divisions of the branch; less human and material resources are required to develop and maintain software, and it becomes possible to automate accounting and tax accounting, due to which there is an optimization of costs.

4. Restructuring of the automated management system of the branch of Krasmash JSC

At the time of the development of the project, it took at least two weeks to complete the basic operations (posting of goods, dispatch of goods into production, direct production of products and their sale, shipment of products by departments, settlement with suppliers and generation of output reports). After reengineering, the time to complete basic operations is about a week. Such temporary savings can increase the turnover of funds by accounting and analysis of production and additional costs, timely settlement with contractors, analysis of the supply of goods, etc. Saving the execution time of operations by the branch "Food Plant" is presented in Figure 4.

The exchange is configured between the automated module of the 1C: Public Catering system and existing technical solutions; due to this, the data of the block of each system are synchronized. To generate and obtain financial statements, an exchange of information on fixed assets and intangible assets takes place with 1C: Accounting of the enterprise.

To calculate wages, other cash payments and reference information on the employees of the branch, data are exchanged with the BOSS: Personnel system. For the rental of vehicles, applications are generated on the corporate portal. The provision of motor vehicle services is carried out using the 1C software system: Motor Vehicle Management.

Which receives through a web - service software system. Similarly, the data exchange systems 1C: Catering with BOSS: HR and 1C: Bookkeeping. Transmission data are presented in .XML format. This data transfer method is unique, developed exclusively for Krasmash JSC.

Data exchange occurs between the automated management system of the branch of OJSC "Krasmash" - "Food Combine" and existing technical solutions; due to this, the data of the block of each system are synchronized. To generate and obtain financial statements, information is exchanged on fixed assets and intangible assets with 1C: Enterprise Accounting.

For payroll, other cash payments and reference information on the employees of the branch, data are exchanged with the Boss-Kadrovik system. To receive services of the car fleet of the plant, an interaction occurs with the corporate portal and the 1C: UAT software system. As a result, from several separate control units, one common one is obtained, which during operation is updated for the relevance of the enterprise.

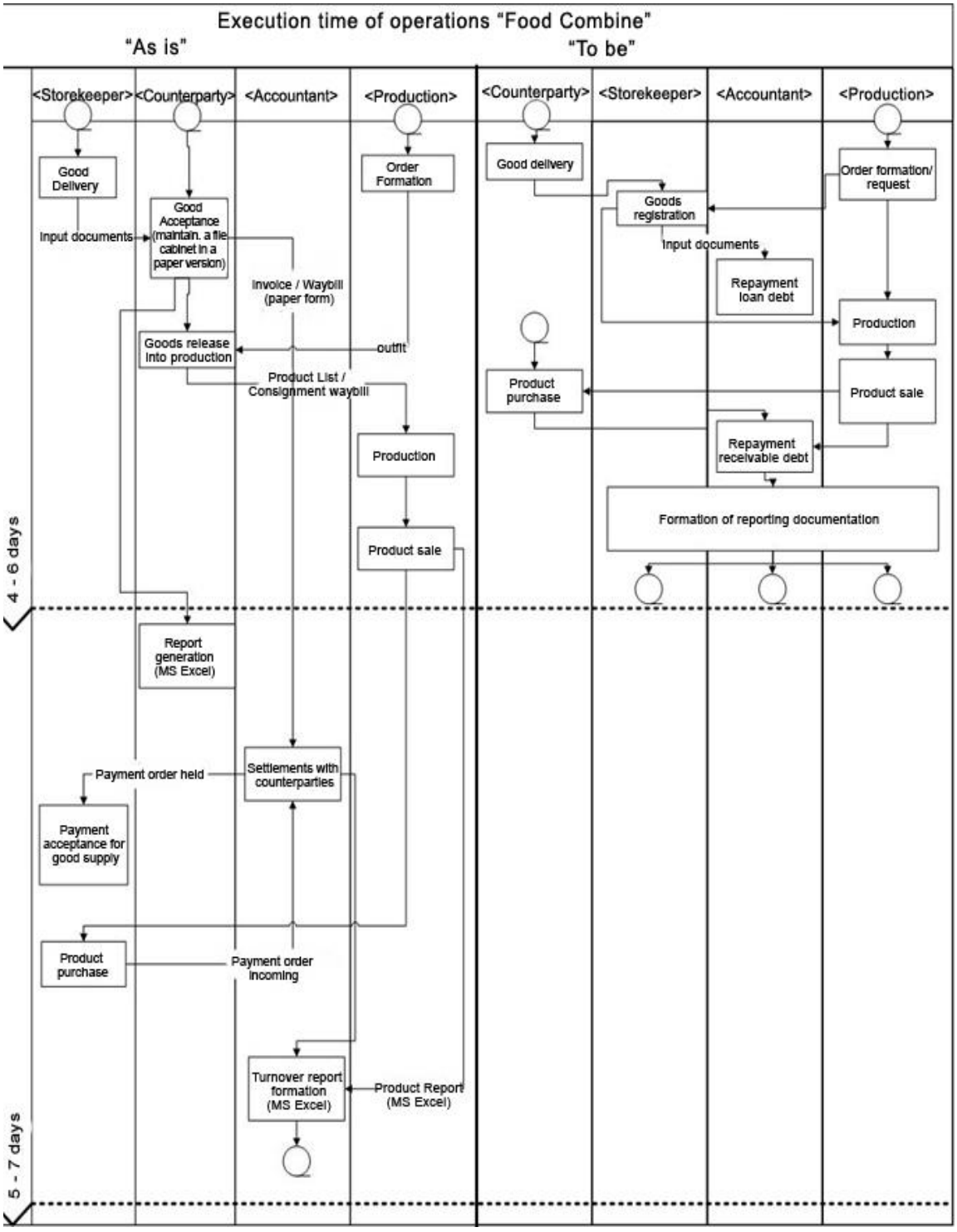

Figure 4. Saving time for the execution of business processes by the branch "Power Plant"

5. Conclusion

Creating an effective multi-system model leads to the interaction of all system blocks with each other, the operational tracking of incoming information. The developed automated system is unique in its convenience and simplicity. And most importantly, it carries economic benefits, since it requires less human and material resources for the development and maintenance of software, it becomes possible

to analyze and account for goods in the warehouse, the necessary reports are generated automatically, due to which costs are optimized, and time is not wasted on transferring documents between business units.

The implementation of the project shown in the article confirms that the use of business process reengineering in the implementation of ACS in a manufacturing enterprise can significantly improve the efficiency of the business process system, labor productivity, internal and external competitiveness of all types of activities.

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