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Use of ERP System to Manage the Economy of Agricultural Complex

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Abstract*: The article deals with the issues of the practical application of industrial information system, namely, Enterprise Resource Planning (ERP) in the management of the economy of a diversified agro-industrial complex in the risk farming area. Features of ERP system application are considered taking into account both multidirectional activity of the agricultural enterprise (crop production, animal husbandry, and industrial production), and the complex system of taxation: the presence of a common taxation system and taxation of various activities. Particular attention is paid to the mechanism of closing accounts, and the formation of the actual cost in terms of agricultural production, which is not so much complicated as a laborious and routine task. A huge number of transactions, multiple calculations of the costs distribution bases, the complex structure of the divisions of the very enterprise make the task of automating of process closing period extremely important. The article presents the experience of both the use of ERP system and the training method of specialists in the use of such industrial information systems for automated accounting and management accounting, payroll and personnel accounting, tested at St. Petersburg State University. In consequence of the implementation of the algorithms described in the article, one managed to achieve an increase in both quantitative economic indicators of the agricultural complex, and qualitative indicators, related to the training of specialists in the field of application of ERP systems in agro-industrial complexes.

***Keywords*: Modeling, dynamic systems, ideal sign models, management methods, Industrial Information systems, Manufacturing Execution Systems, Enterprise Resource Planning, On-Line Analytical Processing, 1C:Enterprise 8.**

I. INTRODUCTION

Modern society is characterized by the global application of information technologies that have penetrated almost all spheres of human activity. Many technical systems can no longer exist, let alone develop without these technologies.

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The development of industrial and agricultural enterprises, trade enterprises and services, on the one hand, stimulates this development for further success in business, and on the other hand, becomes impossible without the use of new achievements of these technologies. When choosing a model that describes the operation of the enterprise, one must first determine the phase space, effective functions, and acceptable management methods to achieve the performance of these effective functions. Modeling, both in itself and as one of the cognition methods of the surrounding world, always was and will be of scientific and practical interest. The issues of the third level of sensory perception, when one cannot not only control or affect the dynamic system directly but also observe the changes in all its parameters are currently solved by means of scientific knowledge, whose important component is modeling. In this article, the model will be understood as any system, which is in a certain relationship with another system (called the original), so that a number of conditions are met. Such conditions include the following: 1. there should be clearly expressed and accurately recorded similarities between the model and the original; 2. in the course of scientific knowledge the model is the substitute of the studied object; 3. studying the model will provide additional information about the original. Thus, any model is both an object of study and an experimental tool. The models can be divided into ideal (mental) and material (real). Unlike the second, the first ones are constructed mentally in human consciousness. Ideal models, especially sign models, are widely used in science. The difference between material and ideal models is purely epistemological in nature and is related to the fact whether the models are material analogs of the studied phenomena, or they represent mental images of the latter. In the material models, used in medicine and biology, there is a problem of scaling, due to the fact that the real dynamic systems, i.e. the originals, have quantitative parameters, which are poorly observed or not observed at all. It may be that due to the complexity of the observation, the researchers did not take into account some of the parameters of the original object, which take precedence in the practical application of a full-scale object. In the course of managing the agricultural holding, when choosing a model and an effective function, the authors, among other things, are following the ideas of Joseph Schumpeter about the economic system as an evolutionary one [1]. In addition, to manage the agricultural holding in terms of describing the information systems used in production processes, in the sign models, a difference between mechanical and organizational dynamic systems is not distinguished.

The problem of adequacy of the constructed models to real originals, i.e. dynamic systems and equivalence of different models of the same original, constructed in different ways is beyond the scope of this article. These issues are covered in more detail in [2, 3].

II. LITERATURE REVIEW

As examples of the use of ideal sign models to describe the functioning of entire classes of dynamic systems, consider the mathematical expression of the dependence of physical quantities or other parameters in various fields of application of construction methods of control actions on such systems. Application areas will be determined by the classes of problems to be solved. First, we consider the problems of stabilization of program motions and kinematic trajectories of dynamic systems. Examples of solving these problems are considered in the works [4-8].

When solving optimization problems in the dynamic systems control, questions about the values that should be optimized may arise. The fact is that in many organizational systems, intangible criteria are used as such quantities, which are often characterized by poor-satisfactory-good or varying degrees of gradation of extreme estimates. Therefore, many dynamic systems require the introduction of certain types of measures for further optimization. Different types of measures in dynamic systems, as well as how to define them are discussed in [9-12].

The problem of dynamic systems stability in some cases is considered as the presence of some quality in the solutions of mathematical equations of sign models of these systems or the presence of such quality in the system itself. In both cases, one should pay attention to the publications [13-17], where the examples of solving such problems are presented.

Apart from the tasks of determining the measure for further assessment of the dynamic system operation quality, general optimization problems should be considered. In the mechanical system, the main quality criterion is the distance to the kinematic trajectory or program motion, while in the economic system – minimizing costs and (or) maximizing profits. In the case of the agricultural complex management under consideration, in addition to economic issues, there are problems of effective long-term use of agricultural land, training of the workforce, conservation of breeds of farm animals, and many others, often poorly formalized. Examples of solving optimization problems are given in [5, 18-21].

In the course of dynamic systems control, oscillations can occur both about some average values of the parameters and about the required modes of their operation. Therefore, the issues of the study of oscillations and waves in such dynamic systems are very necessary. Certain examples are considered in the works [22-25];

While considering mathematical methods to describe and subsequent study of ideal sign models, one should focus only on those that serve to solve the problems of sustainable functioning of dynamic systems. This refers to determining the conditions for the existence of stable regimes or the creation of such conditions by means of control actions on the dynamic system [26-29].

III. METHODS

A. Selection of phase space, model, and definition of the effective function

The space of quantitative parameters by which the industrial enterprise is managed (materials, costs, and services) will be considered a phase space. A software package 1C:Enterprise-8 is selected as a managed industrial information system. The use of exactly this ERP system is determined by its wide prevalence as a program of accounting, management accounting, payroll, and personnel accounting, as well as the acceptability in terms of the purchase price and subsequent maintenance cost. More than 1,500,000 accounting departments of CIS, Baltic, and other countries work with the use of this ERP system. The software package 1C:Enterprise currently is the accounting automation standard in the Russian Federation. Knowledge of the basic configurations of 1C:Enterprise is a requirement of the employer to the accountant or the manager when recruiting. This determines the high demand in the labor market for programmers working with 1C:Enterprise, who are able to support this program. Therefore, they are the most demanded in Information and Communication Technology with regard to enterprise automation. Therefore, effective function, whose optimization must be achieved in the management of the dynamic system, includes parameters related to training of specialists for the implementation and maintenance of the ERP system 1C:Enterprise in agricultural enterprises. The quality criteria for them in the overall effective function will be defined below in the relevant section dedicated to staff training.

B. Models and optimization methods of ERP system in agricultural holding management

The authors consider the practical application of the ERP system in a diversified agro-industrial association, built on the principle of holding based on the Agricultural Production Cooperative Shushary (hereinafter referred to as APC Shushary) [30]. The ERP system implementation object is the largest producer in the St. Petersburg and North-Western regions of Russia of ecologically clean vegetables in the open and protected ground. There are fruits and vegetables processing departments, which produce salted, pickled, dried vegetables and herbs. The APC Shushary is also one of the leading manufacturers of meat and dairy products in these regions, supplying consumers with milk, pork, beef, and veal. APC Shushary has three main areas: crop and livestock, industrial production, and distribution system to sell finished products (cabbage, carrots, potatoes, flowers, herbs and other, as well as purchased products). The cooperative consists of dozens of subdivisions, which are involved in various activities subject to individual taxation in addition to the general taxation. Types of ERP system accounting include the following: bank, cash, advance reports, products and sales, purchase of services from other organizations, material accounting, fixed assets accounting, accounting of water and energy supply, receipt, transfer and sales of milk, transport works, accounting of productive livestock and animals (transfer of animals to the main herd,

moving animals between groups, and in the main herd, the offspring and the weight gain of animals, the slaughter of livestock and animals, the shipping and sale of cattle and animals), the receipt, transfer, shipment, and realization of plants, as well as receipt, transfer, shipment, and sale of industrial production.

C. Models and optimization methods of ERP system of training specialists

The ideal verbal model-representation will be taken as a model of a complex organizational educational system. This model-representation focuses on the construction (description) of the effective function. The model itself, as well as the system under consideration, and the effective function, or quality criterion, will be chosen as figurative in nature. The criteria to assess the quality of the training system will include the achievement of the following requirements by graduates: 1. Knowledge and understanding of the subject area; 2. Ability to configure and support the software product; 3. Ability to develop new configurations or modifying existing ones; 4. Creation and improvement of new forms; 5. Consultation of other users; 6. Support of several companies; 7. Patience and endurance in the course of developing and debugging the program; 8. Quick adaptation; 9. High-stress resistance.

The presence of certificates of the 1C company is welcomed by the employer at recruitment. There are two main types of certification: 1C:Professional and 1C:Specialist. 1C:Professional certificate is issued by 1C based on the results of testing. This certificate is an official confirmation that its owners can effectively use in their work the full range of features of the most common automation programs of accounting, operational trade and warehouse, management accounting and payroll [31]. The presence of the 1C:Specialist certificate evidences that its owner can independently develop application solutions based on the 1C:Enterprise platform at the programmer level [32]. In order to pass the exam for the 1C:Specialist certificate, one must first obtain a 1C:Professional certificate. The exam is held in various configurations, such as accounting, salary and personnel management, trade management, and others.

D. Algorithm

The specialists training algorithm for the use of 1C:Enterprise ERP system for agro-industrial enterprises has been tested for a long time using different platforms of 1C:Enterprise at the Department of applied mathematics and control processes of St. Petersburg State University. The aim of the course is to prepare trainees for 1C:Professional certification in the configuration of salary and personnel management, and accounting of the enterprise. Trainees, who have successfully completed training and certification, are engaged in the implementation and maintenance of these programs at the enterprises of St. Petersburg and the region, as well as in other regions of the Russian Federation.

1. Studying the theoretical course;
2. Learning Part 1. Developing user modes of 1C:Salary and personnel management 8, 1C:Accounting 8 configurations, as well as skills to implement user tasks by regular configuration means;
3. Learning Part 2. Mastering the basic functionality of the 1C:Salary and personnel management 8, and 1C:Accounting 8 configurations;
4. Learning Part 3. Working with the domain-specific database, and the basic configuration objects;
5. Learning Part 4. Working with the document flow of the enterprise and the organization of accounting with its help;
6. Learning Part 5. Working with all the program tools;
7. Learning Part 6. Conducting practical work based on the methodology of applying the standard operations program for accounting, personnel records, and payroll;
8. Learning Part 7. Conducting practical work on monitoring the status of critical accounting sections;
9. Combined Test;
10. Issuance of the 1C:Professional certificate and the end of the training.

Features of the course:

1. Classes are held in the ICT room with multimedia equipment and access to the Internet;
2. Class sessions have a cross-cutting example for accounting;
3. Each trainee is provided with a training platform and 1C:Salary and personnel management 8, and 1C:Accounting 8 configurations, as well as a set of 1C:Professional tests for self-examination at each stage of the practical acquiring of the course sections.
4. Trainees, who have attended at least 90% of theoretical studies, are admitted to practical sections of the course (Part 1 – Part 7).
5. Trainees, who have given at least 10 correct answers to 14 questions to the tests within each practical section of the course (Part 1 – Part 7) are allowed passing the final Combined Test.
6. The Combined Test contains 14 questions; each question offers five answers.
7. The Combined Test is conducted in writing and requires also solving a practical example.
8. The combined Test is limited to 30 minutes.
9. The combined Test is considered to be passed if at least 12 correct answers out of 14 questions are given by the trainee, and the practical task is solved correctly.

E. Flow Chart

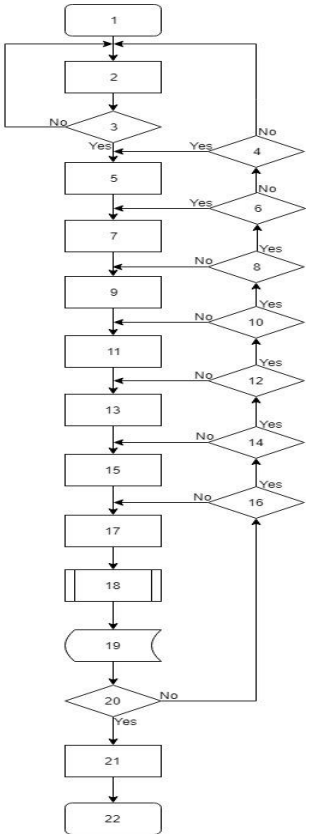

Fig. 1. Flow Chart of Algorithm

The functional purposes of the circuit blocks are as follows:

1. Beginning
2. Studying theoretical course
3. Is the number of attended theoretical class sessions more than 90%?
4. Are there any more incorrect answers in Part 1?
5. Learning Part 1
6. Are there any more incorrect answers in Part 2?
7. Learning Part 2
8. Are there any more incorrect answers in Part 1 – Part 2?
9. Learning Part 3
10. Are there any more incorrect answers in Part 1 – Part 3?
11. Learning Part 4
12. Are there any more incorrect answers in Part 1 – Part 4?
13. Learning Part 5
14. Are there any more incorrect answers in Part 1 – Part 5?
15. Learning Part 6
16. Are there any more incorrect answers in Part 1 – Part 6?
17. Learning Part 7
18. Combined Test
19. Stored Data
20. Is the test passed?
21. Handing over the Professional Certificate
22. End.

IV. RESULTS

As a result of the work on the implementation of the ERP system in the agricultural holding of the APC Shushary and training of the staff for the subsequent maintenance of this system, certain progress has been made in optimizing the effective function of the dynamic system in terms of both increasing the quantitative parameters and radically changing the quality characteristics associated with the training of personnel, who have started working on supporting the system immediately and for the long term. In consequence of the implementation of the network version of the ERP system 1C:Enterprise and the network version of the component of Management of distributed information databases (a joint product of 1C and Rarus companies), the following advancements were achieved:

1. Twenty accounting workspaces were fully automated in the Central Manor of APC Shushary, and three accounting workspaces – in the subdivisions.
2. The network ERP system 1C:Enterprise with the distributed database configured for resources accounting and management had been implemented at the agricultural enterprise.
3. At the time of implementation of the ERP system, electronic document management in APC Shushary amounted to 180 documents per day.

In consequence of the successful implementation of the ERP system, the following tasks have been solved:

1. Automated accounting of cash and non-cash funds has been implemented;
2. The two-way exchange of payment documents with the Bank-Client program has been set up and implemented;
3. Automated accounting of supply services has been implemented;
4. Automated registration of animal husbandry, crop production, and industrial production has been implemented;
5. Documents for the standard configuration of the crop, livestock, and industrial production have been developed and implemented;
6. Reports on checking the shipment of returnable containers have been developed and implemented;
7. The automated accounting of the sold agricultural products and purchased goods, for both retail and wholesale trade has been implemented;
8. An automated system to calculate the cost of production has been introduced;
9. Automated preparation of tax reporting in electronic form with the upload of 1C:Enterprise and subsequent download of the Komita-Report program for the exchange of information with CJSC Certification Authority, and the subsequent transfer to the Tax Service of the Russian Federation has been implemented.
10. Qualified personnel able using currently and in the future the ERP system 1C:Enterprise have been trained for all automated workplaces of APC Shushary.

The implementation of the ERP system 1C:Enterprise at the APC Shushary, as well as related activities, has resulted in increased productivity of the dairy herd by 1.5 times, the gain of young cattle has increased by 20%, while the amount of manual labor has significantly decreased. In addition, the cost of delivery of primary documents to the Central Manor was reduced, while the released workers were repurposed for other works.

Depreciation of equipment and costs of fuel and lubricants earlier allocated for the delivery of documents were reduced.

The decrease in the proportion of manual labor in crop production did not result directly from the implementation of ERP system 1C:Enterprise, but indirectly through the use of the latest equipment and technologies, as well as the improvement of seeds. All manufactured products of APC Shushary are checked by certification bodies for compliance with the state standard of Russia:

1. Soils, vegetables of the open and protected grounds, potatoes, and production of the processing plant are checked by the Center Agrochimzem;

2. Dairy and meat products are checked by LLC Center for certification and research of St. Petersburg.

According to the test results, a certificate of conformity, declaration of conformity, and veterinary certificate are issued, while during the validity of the certificate, planned inspection control is carried out. In addition, both products and facilities are monitored by the Center for Hygiene and Epidemiology in St. Petersburg and the Federal Service for the Oversight of Consumer Protection and Welfare (Rospotrebnadzor). In accordance with the Russian standards, APC Shushary is a highly mechanized economy, having in its potential modern sowing, processing, and harvesting equipment, tractors, cars, farm and greenhouse equipment, as well as shops for processing in-house and purchased products. Obsolete and worn-out equipment is updated every year. In crop production, due to the latest technology, high-yielding seeds, improved sowing, growing, and harvesting technologies, higher yields of vegetables and forage crops are achieved.

V. CONCLUSION

The implementation of only one ERP system 1C:Enterprise would not have given such an effect if the APS Shushary would not have carried out other activities to implement high technologies and production equipment, high-yielding seeds, and high-calorie feed. Use of just client-server technology and the distributed databases would have given a minor effect in the area of actual agricultural production. Talking about the optimization of the effective function of the concerned dynamic system would have made no sense, since, most likely, all the efficiency of the ERP system would have fit into the statistical error.

Without reconstruction of a dairy complex, which was associated with the transfer of dairy cattle in loose housing; the implementation of new milking technology and computerization; improvement of animal feeding technology, preparing total mixed ration, their setting, and distribution, the achievements of the implementation of the technology would have also been invisible.

The implementation of ERP system 1C:Enterprise at APC Shushary, which uses client-server technologies and distributed databases, allows connecting the Central Manor with individual offices and workshops located remotely. The first stage of implementation consisted in the establishment of such a connection with the Sales Department, located at a certain distance from the Central Manor. In the peripheral database of this department, documents, such as invoices, waybills, etc., on the sale of crop production, livestock, industrial production, and purchased goods, are filed. Subsequently, it is planned to allocate at least two more peripheral databases to exchange data with the Central Manor. This will include an independent spare parts warehouse and a materials warehouse since until recently the materials were recorded not in warehouses, but in the central information base. The set long-term goal of the APC Shushary to achieve the minimum use of manual labor is supported by the personnel policy which was implemented within the framework of this project.

The study of the constructed ideal verbal model with the above-noted quality criteria related to staff training allows building an educational process management system in the form of ERP system, which in the course of training adjusts to trainees having different capabilities. This contributes to training the graduates at a high professional level and preparing specialists, who will be able to obtain certificates 1C:Professional issued by 1C company.

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