ISSN 0798 1015

REVISTA ESPACIOS

Vol. 41 (Issue 05) Year 2020. Page 27

Improving the enterprise resource planning system based on digital modules of the "industry 4.0" concept

Mejora del sistema de planificación de recursos empresariales basado en módulos digitales del concepto de Industria 4.0

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Received: 12/11/2019 • Approved: 02/02/2020 • Published 20/02/2020

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ABSTRACT:
The article is devoted to the improvement of the multi-component enterprise resource planning system based on the use of digital modules included in the technology concept "Industry 4.0". The authors of the article consider the basic principles of building the technological concept of "Industry 4.0" in the theoretical analysis, following which the leaders will be able to successfully implement the scenarios of the fourth industrial revolution in the activities of their high-tech enterprises. The article research part is based on the analysis of the modules of the ERP enterprise resource management system (SAP-S / 4HANA). The authors presented the sequential process of introducing the modified ERP system into the activities of the high-tech enterprise in the conclusion of the article.
Keywords: industrial digitalization, updating the ERP system, high-tech innovations use, production processes transformation, improving the production processes efficiency, concept of "Industry 4.0".

RESUMEN:
El presente artículo está dedicado a la mejora del sistema de planificación de recursos empresariales de múltiples componentes basado en el uso de módulos digitales incluidos en el concepto de tecnología de Industria 4.0. Los autores del documento toman en consideración los principios básicos de la construcción del concepto tecnológico de Industria 4.0 en el análisis teórico, lo cual permitirá que los sectores líderes puedan implementar con éxito los escenarios de la cuarta revolución industrial en las actividades de sus empresas de alta tecnología. La parte del artículo dedicada a la investigación se basa en el análisis de los módulos del sistema de gestión de recursos empresariales ERP (SAP-S / 4HANA). Los autores presentan el proceso secuencial de introducción del sistema ERP modificado en las actividades de una empresa de alta tecnología a modo de conclusión del artículo.
Palabras clave: digitalización industrial, actualización del sistema ERP, uso de innovaciones de alta tecnología, transformación de procesos de producción, mejora de la eficiencia de los procesos de producción, concepto de Industria 4.0.

1. Introduction

The changes that occur in the industry under the influence of information technology help significantly increase the quality of products and services. This increases customer loyalty and satisfaction. The manufacturers also do not remain at the loss, as the new approaches and

business models that are born in the concept of "Industry 4.0", allow them to earn more, and therefore, invest in improving products. The digital technologies enable businesses to analyze sales, stocks, state of production facilities and operational processes at the new level of granularity. This leads to qualitatively new conclusions regarding company products in turn, the interaction with suppliers and customers, and the organization of processes. The digital transformation of the enterprise can be viewed from two perspectives. The first is to digitalize the existing business model, i.e. the transformation of the customer interaction model, the transition from traditional sales to the "smart" product model, complemented by the digital service for the client. The second is based on the mechanisms of operational digitalization and involves the implementation of unique digital tools to improve the efficiency of the enterprise, within the existing business model. Companies need the an integrated strategy to achieve really good results today. It should be flexible enough to allow the company to develop according to the technological trends and take into account the number of associated risks at the same time. Creating such the strategy is impossible without the a deep understanding of the phenomenon of digital transformation.

2. Theoretical analysis

The concept of enterprise digitalization is associated with the implementation of new technologies that have become available for business in recent years: big data analytics and machine learning, artificial intelligence, robotics, augmented reality, Internet of things (IoT), 3D printing, cloud computing. The prerequisites for the development and penetration of digitalization are the reduction in the cost of technology and computing power, as well as the increase in the availability of high-speed data transmission. The fourth industrial revolution means the increasing automation of absolutely all processes and stages of production (Kondratiev, Lyubimtsev, Merkulov, 2015; Korrespondent, 2017), namely the following:

- digital product design;
- creating the virtual copy of products;
- joint work organization of engineers and designers in a single digital design bureau;
- ability to remotely configure equipment at an enterprise for technical requirements for the release of a specific "smart" product;
- automatic ordering the necessary components in the right quantity;
- component delivery control;
- monitoring the path of the finished product from the warehouse to the end customer.

The manufacturer does not forget about his product after the sale, as it was before in the classic model: he controls the conditions of use, can change settings remotely, update software, warns the client about possible breakdowns, and he can take the product for disposal at the end of the use cycle. The material world is successfully connected to the virtual world today, as a result of which the new unique cyber- physical complexes appear, combined into the single digital ecosystem. The experts formulated the several basic principles for building the concept of "Industry 4.0", following which the leaders will be able to successfully implement the scenarios of the fourth industrial revolution at their high-tech enterprises (Yashin, Grigoryan, 2015).

1. Compatibility, which means the ability of machines, devices, sensors and people to interact and communicate with each other through the IoT. Designing IoT solutions is creating the right solutions for connecting the number of devices to the Internet. The global infrastructure provides the a unique opportunity for virtual and real equipment to establish high-quality contact and organize their interconnection. You need to understand this to do this how to create the technological chain that will function smoothly and efficiently. The IoT can be used to serve consumers at various levels, from simple individuals to large business projects. The basic infrastructure in the form of fixed and mobile networks has already been created for the IoT application. All this is additionally provided by platforms, sensors, applications that are available to everyone. The main goal is to reduce costs and increase functionality, which is achieved as follows (Eurostat, 2019):

- cost identification and service analysis;
- study of the conditions for creating a radio channel;
- channel modeling taking into account the chosen technique;
- economic efficiency definition.

It is necessary to determine the method of connecting devices to each other, their collection technology, the processing information method to make the right decision for the implementation and development of IoT.

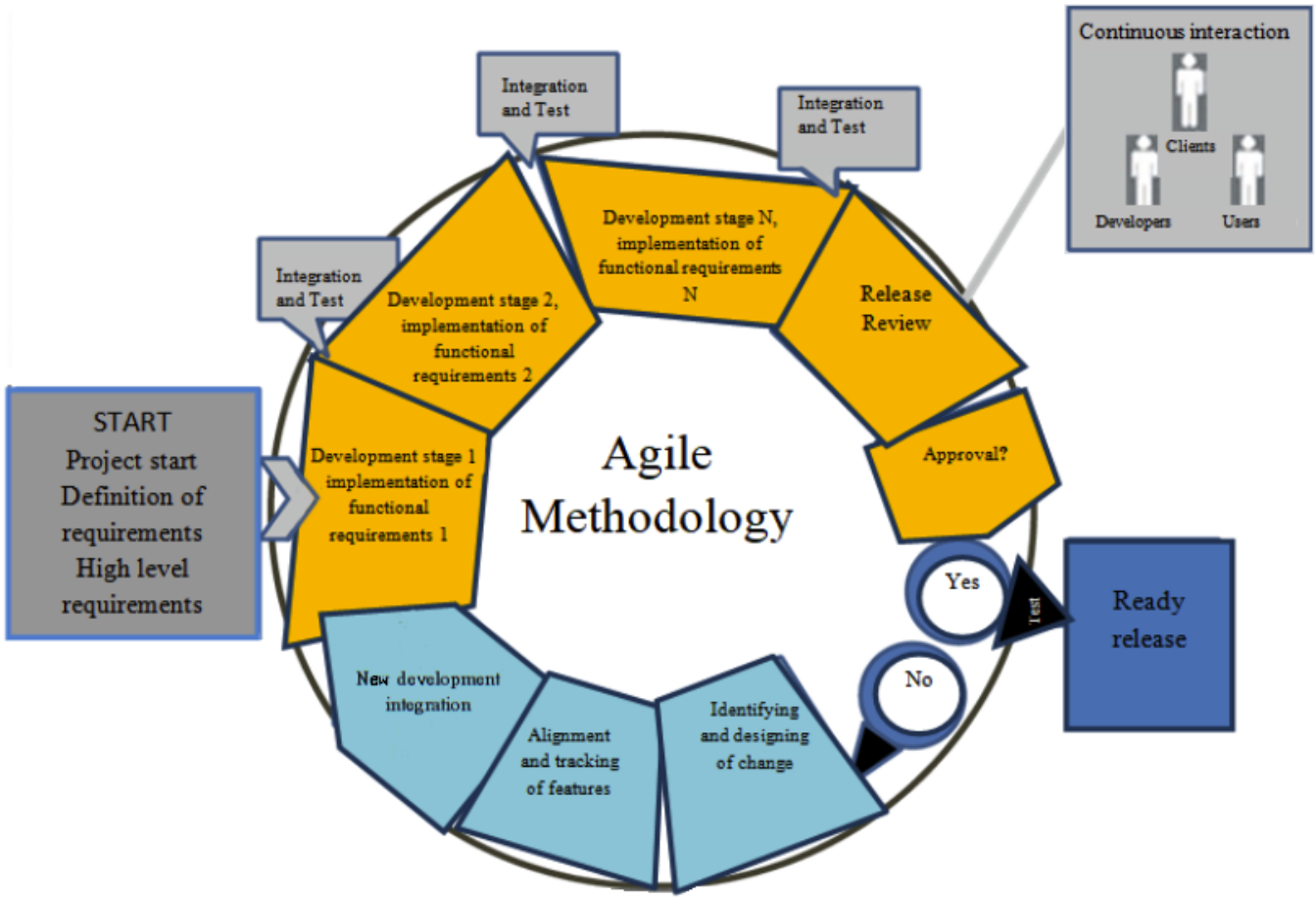
2. Transparency. The digital copy of real objects is created in the virtual world, the systems of functions, which accurately repeats everything that happens with its physical clone. As a result, the most complete information is accumulated about all processes that occur with equipment, "smart" products, and production in general, and so on. This requires the ability to collect all this data from sensors and actuating device and take into account the context in which they are generated.

3. Technical support. The essence of this principle is that computer systems help people make decisions through the collection, the analysis and the visualization of all the information mentioned above. This support can also consist in the complete replacement of people with machines during dangerous or routine operations.

4. Decentralization of management decisions, i.e. delegation of some of them to cyber-physical systems. The idea is that the automation to be as complete as possible that is wherever the machine can operate efficiently without human intervention, sooner or later, human substitution must take place. The employees are assigned the role of controllers at the same time that can connect in emergency and non-standard situations.

There is also the change in business models as a result of the industry switching to these principles. Thus, the enterprises are striving to introduce production of personalized mass products according to the "Agile" principles and switch to production of batches the size of the single product (Figure 1) instead of focusing on the lean manufacturing. The principle of economy is preserved at the same time, i.e. robotic high-tech production is more energy- efficient, accompanied by less waste and scrap.

Figure 1
Methodology, philosophy of the organization of the working process according to the "Agile" principles



The flexible method of project management "Agile" consists of several work stages defined as rigid deadlines (sprints), allowing the team to constantly evaluate the results of the work done and receive the feedback from the customer and the other project participants. This approach allows you to make instant product changes when new requirements arrive. The flexible "Agile" method can be implemented under the following conditions:

- The project value is clearly indicated;
- The client is actively involved throughout the project;

• step-by-step execution of the total project volume is possible;

• the result is more important than documentation;

• a working group is no more than 7-9 people.

Implementation of the "Industry 4.0" principles provides the number of advantages which are not available in traditional models of the past. For example, the enterprises can achieve now the individual approach and personalize orders according to personal preferences of customers, which dramatically increase their loyalty. Old factories are successfully turning into "smart" ones and begin to produce literally piece products for individual orders. Unit costs per unit of production are reduced at the same time, enterprises are able to produce the unique, to some extent, the personalized product at the cost of the mass standardized product. The transition to smart manufacturing is long and rather complicated process, and if the company also uses the old version of the ERP system, this may turn out to be "bottleneck" when implementing the "Industry 4.0" principles. If individual configuration is required in the production of tens thousands of finished products, then the amount of data increases by several orders of magnitude, and only the specially created system can support this amount of information. There is SAP-S / 4HANA, for example, i.e. the new generation ERP system, the corporate solution for enterprise resource management. The system was developed taking into account the most modern technologies: support for the IoT, machine learning, processing of large amounts of data in RAM. The system is able to solve business problems that previously were difficult to implement due to insufficient technology development or unreasonably high costs of human resources.

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3. Analysis of the modules of the intelligent enterprise resource management system ERP SAP-S/4HANA

ERP system was the result of the development of simpler concepts: MRP (Material Requirement Planning - planning of material needs) and MRP II (Manufacturing Resource Planning - planning of production resources). The implementation of software allows for the production planning, simulating the orders flow and evaluating the possibility of their implementation in the services and the units of the subordinate organization. All ERP systems are united by the following single architecture (Figure 2):

Platform. There are basic features and environment for the operation of modules and components. Only the developer can make changes to the platform code. Users and implementation specialists do not have access to this program code. The platform includes the following: core, i.e. software environment in which work will be performed for which you can write some add-ons and components; basic functionality, list of directories and functions, without which no company can work.

Data management. There is database, including storage and processing (interpretation) of data. This category includes data storage on the server, software for working with databases (SQL or any alternative), tools for interpreting and processing data and sending them to program modules.

Modules. There are components that connect to the platform as needed. All of them work with the single database and use the basic functionality (as needed). The rest of the modules work independently of each other can be "seamlessly" connected and disconnected without problems if the need for them has disappeared. Such the modular structure is the important distinguishing feature of ERP systems. Modules are divided into the following several types:

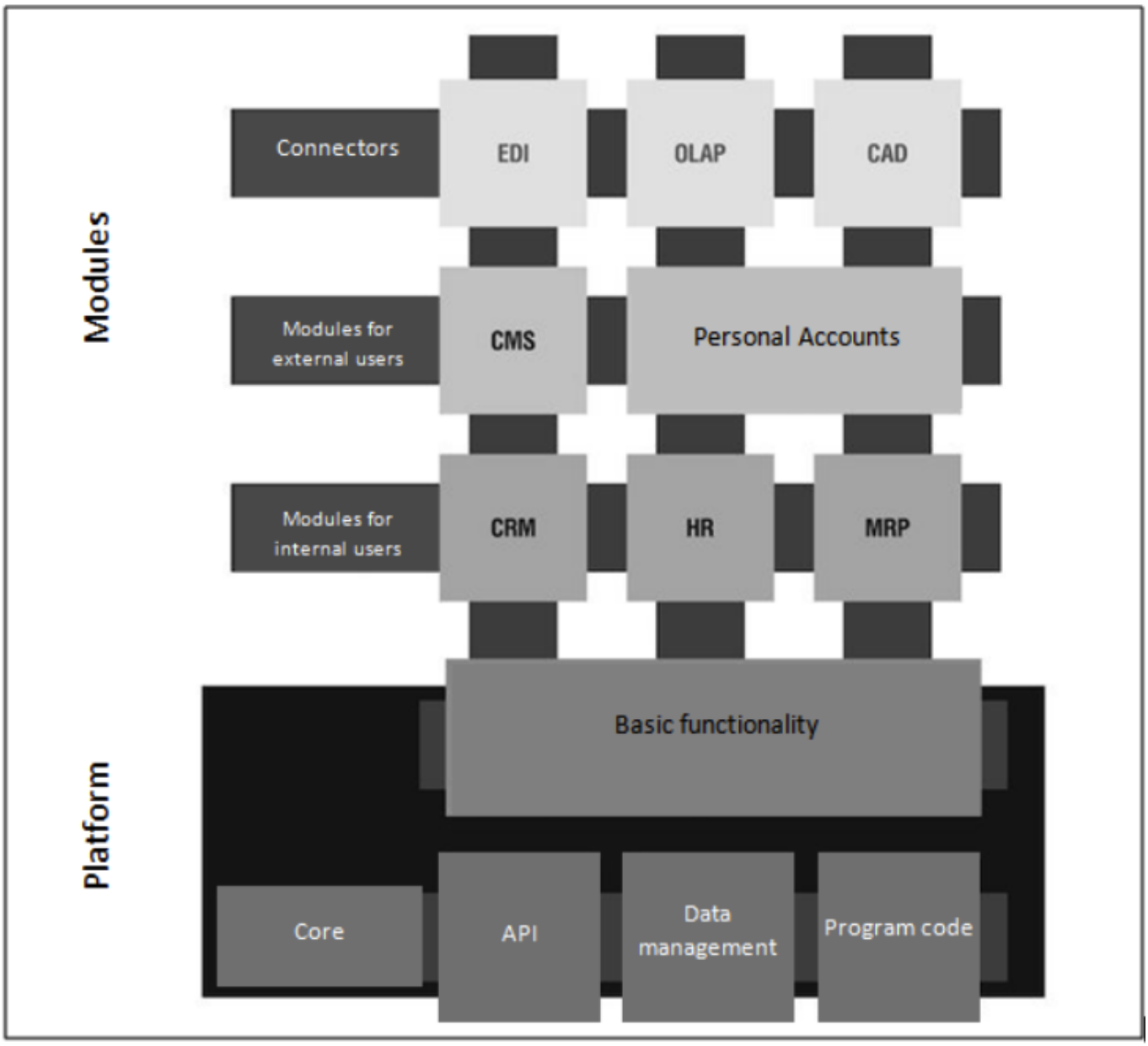
1. Modules of internal use. This level is the plug-ins that are used by company employees. These are warehouse management, production, accounting, CRM, etc. Modules can be connected, disconnected, configured by the implementation specialists. The standard set usually includes MRP, HR, CRM, Procurement and Purchasing Management.

2. Modules for working with external users. This layer contains the modules necessary for interaction with external users, potential and real customers of the company, partners, product users, suppliers and buyers. It can be the online store, personal accounts for suppliers and customers on the corporate website, and the like.

3. Connectors are turnkey solutions for communicating with third-party applications. They use the API from the platform kernel most often. Connectors allow you to integrate telephony, configure the data exchange with the site or any software products and systems. Connectors are intended only for data exchange and are usually used for data exchange with EDI, CMS, CAD, BI, OLAP, etc., i.e. with those systems that are not part of ERP, but are used in the

enterprise. The result is unmatched flexibility and speed through the use of the significantly simplified data model.

Figure 2
Platforms and modules included
in the intelligent ERP system



The flexibility, speed and analytical capabilities of the intelligent ERP system SAP-S / 4HANA make it possible to use it both for solving current problems and for realizing potential opportunities in the future. SAP-S / 4HANA is the intelligent ERP solution that allows companies to use all the capabilities of the modern digital world without already familiar limitations of previous generation ERP applications, such as waiting for the completion of background processing, complexity of landscapes and non-automated processes. SAP S / 4HANA is designed to take full advantage of the industry's most advanced "in-memory" computing platform, i.e. SAP HANA. Consider the following key features of the advanced system SAP-S / 4HANA ERP (Shevela, Drobotova, 2013; Business engineering group, 2019; Eurostat, 2019):

1. Digital financial processes. They allow you to analyze financial indicators in real time in order to optimize all financial processes, i.e. from planning and analysis to closing financial periods and financial management.

2. Supply chain control. It enhances transparency and flexibility across the entire digital supply chain with machine learning technologies for logistics, manufacturing and asset management.

3. Timely satisfaction of procurement needs. It uses machine-learning applications to improve supplier management, optimize procurement, and implement collaborative vendor selection and contract management.

4. Effective product lifecycle management. It makes it possible to create the agreed product portfolio that allows you to manage life cycles, control production costs and efficiently allocate resources both within the organization and beyond.

5. Obtaining valuable information in all structural divisions of the enterprise. It provides the complete picture of operational activities, and uses client analytics to optimize the work of marketing, sales and service departments, increase revenue and quickly use of favorable opportunities.

6. Development of industry functionality. The specific needs of the organization can be implemented in the base system through customization. The usual problems associated with integrating and writing custom code will not arise.

We analyze the main advantages obtained by high-tech enterprises from the implementation of the improved ERP system SAP-S / 4HANA (Skoltech, 2014; Decree of the President of the Russian Federation, 2016):

Process synchronization. It is possible to streamline the data receipt and the data exchange at all interconnected stages of the organization's activity, due to the implementation of the improved ERP system. This will positively affect the efficiency of each unit in turn, because the overall picture of the productivity of production processes depends on the totality of the results.

Process control. The ERP system implementation allows you to control literally all the work processes that occur in the subordinate organization: from the simplest operational functions to the strategic regulation of the entire enterprise.

Reporting unification. All financial and statistical reports are displayed according to the single sample using software, which greatly facilitates the aggregate analysis of the current results of the departments work of the organization.

Standardization of information systems. The use of all modules of the ERP system eliminates the need to install and maintain other computer programs and information systems.

Extended range of leadership functions. The ERP system implementation allows you to actively use the corporate knowledge management bases of the company, increasing the functionality of the leader.

Integration with contractors. It provides for the possibility of participation of the organization’s customers. For example, they can independently form the order, track its status, analyze the availability of inventories, replenish them if it is necessary, etc.

Adaptation to the needs of the enterprise. The ERP system implementation can be full or partial, since its modules work both autonomously and in conjunction with the entire system. The project choice should be based on the needs of the particular enterprise.

The key principle in organizing the digital transformation process is the organization of systemic interaction at three levels: preparation, management and automation of production. The integrated automated enterprise management system (IAEMS) is based on Product Life Management (PLM) and ERP. There is the control system in the center, which includes the PLM module, which is located in the main design office and allows real-time to organize the process of obtaining various data (including engineering) about the products manufactured by the enterprise, as well as receiving information about the developed product projects. Another component that is part of the core of the control system is the ERP module, which is located in the parent company. Its direct functions include the organization of the project management system, i.e. tools for connecting financial and logistics areas. It is important to note that the ERP system uses the single program that performs many different functions from process control to accounting. The maximum efficiency of the ERP system is achieved if it is used in tandem with the CRM system, as well as the quality control system (Fedyaev, Fedyaeva, 2015; Decree of the President of the Russian Federation, 2017).

4. Process of implementation and analysis of digital technologies

The digitalization of extractive and processing industries around the world is relatively low at present. Technology "Industry 4.0" should change this situation. “Industry 4.0” is the opportunity to make the quantum leap and catch up quickly with leaders for our key industries. It is necessary to act quickly in order to fully realize this potential. Russian companies in the number of sectors, including financial and telecommunications, have achieved much in the field of automation and implementation of industrial-scale information systems since the early 2000s. The share of

organizations that have implemented ERP class systems has grown 1.8 times from 2010 to 2015, according to the Federal State Statistics Service, the share of organizations that have implemented CRM class systems has increased over the same period by 2.4 times, and the share of organizations using electronic data exchange between their and external IT systems has increased 1.9 times since 2011 (Tadviser, 2019).

The ERP system (SAP-S / 4HANA) implementation plan can be divided into the seven main parts: organizational work, organization survey, methodology choice, designing the system, installation of workplace programs, system start into operation and maintenance (Fedyaev, Fedyaeva, 2015; Business engineering group, 2019).

1. Organizational stage. It includes the working group creation in the enterprise. It includes the following, as a rule:

leader (it is better to choose among the top managers of the organization). He must be aware of all the business processes taking place in the enterprise. In addition, the project leader of the ERP system implementation should have the authority to solely make decisions on any issues.

specialists who monitor the compliance of the implemented system with current regulatory legal acts and corporate standards. It can be the executive director, the chief accountant or the head of the IT service.

heads of all divisions who will use new software in the future. They will have to advise specialists on implementation during the study of the latest business processes of the enterprise, as well as organize the work of subordinate employees after automation is completed.

IT specialist of the wide profile. Its main task will be the technical support of the plan for the ERP system implementation.

2. Enterprise survey phase. The next stage of the plan comes after the end of all organizational activities, and this is the study and analysis of the main business processes of the company. This is necessary in order to accurately determine the timing and cost of the ERP system implementation. The IT integrator offers the customer the following two plans for the enterprise inspection focusing on the scope of the upcoming work and the goals (Shevela, Drobotova, 2013; Yashin, Grigoryan, 2015):

express survey. It takes from 1.5 to 2 months. The survey result is the “Pre-project analysis”, which describes the all nuances of automated accounting and the list of tasks to be solved during implementation;

full survey. It lasts for 3 to 5 months. The “Terms of Reference” is formed as the result of the thorough examination, the business processes of automated accounting are being prepared, and the list of necessary software adjustments is also indicated.

3. The methodology choice for ERP system implementation. There are three main options for implementing ERP solutions on the “1C: Enterprise” platform:

subscriber "Time and material". The IT integrator conducts the express survey of the organization, forms the plan for the implementation of the ERP system and calculates the maximum possible cost of work;

phased implementation technology. It implies the full examination of the enterprise and the definition of all automated business processes with the subsequent development of the technical specifications;

technology quick result. The plan for implementing the ERP system at the enterprise in this case is similar to the example of subscription service, i.e. the maximum cost of implementation work is calculated and the hour of the IT specialist’s work is estimated on the basis of the express survey.

4. Designing the ERP system. The programmers determine the basic requirements for the basic modules of the ERP system, the need to download the initial data, as well as settings for moving information from the programs used by the organization after examining the organization. The modules of the system are programmed in accordance with the basic business processes of the enterprise; the necessary adjustments are made to the software functionality.

5. ERP system implementation in the enterprise. The ERP system programs are being installed at the workplaces of personnel in accordance with the implementation plan at this stage. Access rights and reports are configured. Data is downloaded from previously used by the enterprise computer programs.

6. System start into operation. User training is carried out after the end of automation processes, as well as the development of instructions for working in the system.

7. Maintenance of the implemented system. Uninterrupted operation of the ERP system on the "1C: Enterprise" platform is possible provided that it is supported after implementation.

The largest Russian companies have successfully mastered systems of customer interaction, financial and procurement management, operations and production management, which contributed to the large-scale growth of the domestic market of system integrators and service companies. More than a thousand projects for the electronic systems implementation of various levels of complexity are implemented annually in Russia. The proportion of organizations using ERP and CRM systems remains extremely small and amounts to about 10% of the total, despite high growth rates, according to official statistics. This may indicate that medium and small enterprises are slowly mastering the new technologies, or that some of the information systems are not taken into account in official statistics. Practice shows that it is difficult for industries lagging behind in digitalization to subsequently bridge the gap with leading industries. This is due to the fact that companies with the low digital culture are unattractive for relevant specialists. In addition, lagging companies lack the skills and resources to develop, implement, and deploy large-scale new digital tools, products, and services.

5. Conclusion

The digitalization growth of enterprise business processes has brought with it the significant transformation of the business models themselves in recent years. The enterprises are beginning not only to use network technologies as the additional commercial channel, as a rule, but also as the additional means of communication with both their suppliers and customers. The use of web and IT technologies is the technical basis for new types of entrepreneurial activity of enterprises at the same time. This process is based on technological components such as server technologies, database management systems (DBMS), high-speed telecommunications and electronic logistics systems. However, the latest IT trends are not limited to these technologies and open up new possibilities with help of cloud technologies, Big Data technologies and working with data calculation directly from the computer's main memory (DRAM) due to the power of the central processor (In-Memory Computing). The enterprises need to consider the fast pace of development of information technologies in their industries, i.e. integrate them into your business activities at the first opportunity. The priority should be given to those people in the recruitment of specialists who have experience and knowledge related to information and network technologies for managing enterprise resources. It must be remembered that the choice of the integrated enterprise management system is not the simple event. And this is often not the matter of money, i.e. it is necessary or not to invest the large amount of resources in the ERP system implementation, but it is the matter of maintaining the company's competitiveness and leadership in the market. The return on investment in the system comes from the company's ability to be better with new business processes, and the ownership cost must be planned and taken into account.

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Revista ESPACIOS. ISSN 0798 1015
Vol. 41 (Nº 05) Year 2020

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