# DEVELOPMENT OF FOOD SYSTEM AUTOMATION MANAGEMENT TECHNOLOGIES

# DESENVOLVIMENTO DE TECNOLOGIAS DE GESTÃO DE AUTOMAÇÃO DE SISTEMAS ALIMENTARES

# DESARROLLO DE TECNOLOGÍAS DE GESTIÓN DE AUTOMATIZACIÓN DE SISTEMAS ALIMENTARIOS

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**Abstract**
Currently, there is an objective need for the development of information interaction (integration) based on the formation of a special management technology – information management as one of the fundamental foundations for the effective development of the Russian agro-food system following the Strategy of Digital Development in the Russian Federation, as well as with the modern requirements of digital transformation of the economy. The materials for the research are the works of Russian and foreign scholars on the management of the development of the food supply system, as well as the significance and mechanisms of the functioning of information systems for managing food production, both in Russian and foreign practice. The essence of information management of the food system of the region has been revealed, the structuring of the processes of information and analytical management of the food supply system has been carried out, a set of requirements for the information and analytical model of management of the processes of the production and consumption cycle in the agro-food system has been formulated. The article examines the methodological issues of the formation of the mechanism of information management of food supply processes following the requirements of the development of the digital economy.

**Keywords:** information management, food supply, information resources, information economy.

**Resumo**
Atualmente, há uma necessidade objetiva para o desenvolvimento da interação de informações (integração) com base na formação de uma tecnologia de gestão especial – gestão da informação como um dos fundamentos fundamentais para o desenvolvimento efetivo do sistema agroalimentar russo seguindo a Estratégia de Desenvolvimento Digital na Federação Russa, bem como com os requisitos modernos de transformação digital da economia. Os materiais para a pesquisa são os trabalhos de estudiosos russos e estrangeiros sobre a gestão do desenvolvimento do sistema de abastecimento de alimentos, bem como o significado e os mecanismos do funcionamento dos sistemas de informação para gerenciar a produção de alimentos, tanto na prática russa quanto estrangeira. A essência da gestão da informação do sistema alimentar da região foi revelada, foi realizada a estruturação dos processos de gestão da informação e analítica do sistema de abastecimento alimentar, um conjunto de requisitos para a informação e modelo analítico de gestão da processos do ciclo de produção e consumo no sistema agroalimentar. O artigo examina as questões metodológicas da formação do mecanismo de gestão da informação dos processos de abastecimento de alimentos seguindo as exigências do desenvolvimento da economia digital.

**Palavras-chave:** gestão da informação, abastecimento alimentar, recursos de informação, economia da informação.

**Resumen**
Actualmente, existe una necesidad objetiva para el desarrollo de la interacción de la información (integración) basada en la formación de una tecnología de gestión especial: la gestión de la información como una de las bases fundamentales para el desarrollo efectivo del

sistema agroalimentario ruso siguiendo la Estrategia. de Desarrollo Digital en la Federación Rusa, así como con los requisitos modernos de transformación digital de la economía. Los materiales para la investigación son los trabajos de académicos rusos y extranjeros sobre la gestión del desarrollo del sistema de suministro de alimentos, así como la importancia y los mecanismos del funcionamiento de los sistemas de información para gestionar la producción de alimentos, tanto en la práctica rusa como en la extranjera. Se ha develado la esencia de la gestión de la información del sistema alimentario de la región, se ha realizado la estructuración de los procesos de gestión de la información y analítica del sistema de abastecimiento alimentario, un conjunto de requisitos para el modelo de información y analítica de la gestión de la procesos del ciclo de producción y consumo en el sistema agroalimentario. El artículo examina las cuestiones metodológicas de la formación del mecanismo de gestión de la información de los procesos de suministro de alimentos siguiendo los requisitos del desarrollo de la economía digital.

**Palabras clave:** gestión de la información, suministro de alimentos, recursos de información, economía de la información.

## 1. INTRODUCTION

It is necessary to identify, respectively, problem areas, challenges of various nature in the functioning of ICT, the formation and implementation of an information management mechanism (specific territories, economic entities, industries, and complexes) despite the obvious relatively positive trends and a certain degree of differentiation in the development of informatization processes in the regions of the country.

The modern information economy should be considered as a stage and condition of socio-economic development capable of providing not only a certain effect but, above all, a production result, a positive contribution to the business, the formation of appropriate enterprise architecture (especially information architecture) in the context of optimizing the reproduction process as a competitive advantage, the solution of structured tasks at various hierarchical levels of management.

It is possible to identify the dominant and most attractive trends in the development of the Russian information economy:

- formation of updated methodological tools for the implementation of ICT, considering the possibilities of information integration, information, technical and software compatibility;

- development and implementation of project documentation for the organization of information support – information management with a reflection of the subject area of the use of information tools and resources, optimization of information flows;
- formation of a system of information services for commodity, financial markets, industry integrated complexes, information needs of enterprises and organizations, especially in terms of automation of analytical and management processes;
- improvement of ICT models focused on forecasting socio-economic performance and the formation of information business (information entrepreneurship);
- formation of the world information space considering the requirements of modern globalization of socio-economic processes;
- development of new forms of competitive interaction in the IT industry (technological competition, Internet competition, competition of industry standards, competition of software versions, cost competition, etc.);
- actualization of information risks and justification of their management methods in the information security system and considering the requirements of the Information Security Doctrine, state information policy;
- integration of information processes into the enterprise management system and the manifestation of an objective need for the development of a specialized functional strategy – IT strategy of the enterprise and, accordingly, the formation of a special management technology – information management (IT management);
- intensive expansion of the use of ICT in the implementation of project management in the IT-sphere, strengthening of import substitution of software products and technical and technological means of informatization, strengthening the position of software exports in the global economic space;
- improving the level of training of IT personnel following international requirements, able to use the opportunities to overcome organizational, managerial, technological, and software imperfections of the IT industry.

Therefore, it is necessary to form an information management mechanism, since its tools in the current economic situation cannot positively affect the improvement of information

assets and the strengthening of the information capacity of enterprises due to negative manifestations in the functioning of informatization processes:

- the state information policy bodies are insufficiently coordinating the updating of information technologies, as well as the practice of their systematic implementation in process state and municipal management is weakened;
- insufficiently relevant forms of information interaction dominate in the development of the Russian ICT market;
- there is a significant differentiation both in the use of information technologies and in the optimization of information resources by regions, there is no search for innovative and strategic solutions in the development of IT infrastructure;
- there is a high probability of IT risks in ensuring the security of the national information fund, the preservation of progressive trends in the development of information processes in management;
- regulation of informatization processes does not sufficiently provide for motivation of development in the field of applied software and training of IT personnel for its actualization.

Objective advantages in the development of the IT industry indicate the need to develop practical approaches to ensure its innovative development based on progressive information technology platforms following the requirements of the digital economy. It is necessary to specify the processes for its formation, among which it is advisable to single out the most preferred ones, considering the possibilities of their transformation into an information management system by certain production and economic formations. The purpose of this study is to structure the processes of information management of the food supply system, as well as the formation of requirements for information and analytical model for managing the processes of the production and consumption cycle in the agro-food system.

## 2. LITERATURE REVIEW

Information systems play an important role in the context of managing the development of the food supply system and ensuring food safety, within the framework of which information

is collected, stored, analyzed, systematized, and disseminated. Efficient information systems allow making decisions as quickly as possible in a short time.

Information systems can, for example, be used in the identification of pathogens in food, in their identification, in the preparation of predictive models. A significant advantage in integrating information systems into the production process is the possibility of forming so-called "expert systems" that can combine databases on microbial characteristics of products, food composition, and processing information with the resulting "model compliance" indicating problems that may arise as a result of changes in product composition or processing conditions. In addition, there are many other ways to use information systems that are more conducive to ensuring food safety on a global scale. All these aspects are confirmed in studies conducted by foreign authors (McMeekin et al., 2006).

Article by S. Aitkhal, P.K. Paul, and A. Bhuimali (2017) This refers to the food informatics as a practical area for organizing information, building infrastructure, including the design and development of information systems, enterprise resource planning, decision support systems, decision documentation, and the use of electronic technology for systematization various characteristics of food products. So far, food informatics has not gained wide popularity, but it has good opportunities to become a significant interdisciplinary subject. It is possible to combine many aspects of the development of food systems within the framework of food informatics, including the possibility of food processing, the development of a marketing strategy, the use of network technologies, and much more.

The relevance and necessity of creating food management information systems are closely related to the problem of food safety and, as a consequence, the preservation of public health. This provision is justified in sufficient detail in the work of Xingkai C. (2015).

The need to create an information system for food management is due to the fact that food products go through several levels during their production, which implies the inclusion of many participating organizations in the production process. Any problem that has arisen in one link or organization in the production of food or processing can lead to incidents related to food safety. The effective functioning of information systems can significantly reduce the possibility of such risks. The food management information system should track information about the entire process in the food chains, which is considered a feasible scheme for the implementation

of the entire food quality and safety management. Food information management information is of great importance for the implementation of food safety management.

The Food Management Information System is an important part of the food quality and safety control system, which is the key to the realization of information exchange for the implementation of the food management information system between consumers, enterprises, and the government. The creation of a food management information system based on the exchange of information is very important for solving the problem of food quality safety, reducing social costs, and protecting the interests of consumers. In support of the information exchange technology system, with the cooperation of each economic entity, it can create a comprehensive food management information system and achieve a good effect.

Scholars of the Copenhagen Business School in their research have attempted to determine the factors that influence the development of information systems in the food industry, as well as to investigate the mechanisms of integration of information systems into the production process in more depth (Hedman, Henningsson, 2012; Lehmann, Reiche, Schiefer, 2012). It should also be noted that the issues of integration of information systems have been and are one of the urgent problems of modern managers of various industries and spheres of activity. Existing studies have generally found a positive relationship between integration and labor productivity (Salin, 1998; Barki, Pinsonneault, 2005). Studies that report on the business benefits associated with the integration of information systems are quite numerous (Bhatt, 2000; Henningsson, Carlsson, 2011), however, there are still many unresolved problems and unexplored issues, and the concept of integration of information systems has been studied very limitedly. Conceptualizations of such aspects as the degree of integration, the intensity of integration, and the type of integration have not yet been developed and investigated (Markus, 2000; Konsynski, 1993).

Even though the technical problems of integrating information systems into production activities may be similar (Carroll, Swatman, 2000) regardless of the intra-organizational or inter-organizational context, organizational and managerial problems in the industry integration of information systems require special attention, since they represent a different context of integration (Neureuther, Kenyon, 2008).

The study of the works of several Russian scholars also confirms the importance of forming a system of information support for the activities of economic entities of the food supply system. Thus, for example, A.A. Fomin, D.A. Shapovalov, and P.P. Lepekhin (2019) in their work determine the possibilities for ensuring the modernization of the agrarian sector of Russia through the creation of modern information infrastructures for land management, as well as the level of readiness of participants in land relations to use in practical activities, information technologies for land management in agricultural production. The work of N.S. Kurnosova (2018) presents a set of problems describing "a set of organizational and technological problems that limit the development of the information support system for agricultural production management" and also defines the conditions for the effectiveness and efficiency of the information support system. L.N. Usenko, O.A. Kholodov (2019), and N.N. Yurina (2018) confirms the high importance of the digitalization of the agricultural sector. In particular, N.N. Yurina (2018) speaks about the need to coordinate the actions of all participants in agricultural production and formulates the stages of digitalization of the Russian agro-industrial complex, which will allow the Russian economy to move to a new stage of development in the future and provide it with competitive advantages. Other authors present the results of the evaluation of the use of digital technologies in agricultural enterprises of the Rostov region and form a scientific and methodological approach to assessing the integrated level of informatization of agricultural enterprises in the region in the conditions of digitalization. Despite this, some methodological issues of informatization of the management of the agro-industrial complex are considered in the work of several scholars (Karpuzova et al., 2018). However, the issues of informatization of the production process management system in the agricultural sector are considered very fragmentary and therefore many theoretical and methodological aspects remain ignored.

## 3. METHODS

The materials for the research were the works of Russian and foreign scholars on the management of the development of the food supply system, as well as the significance and mechanisms of the functioning of information systems for food production management. Their generalization and critical analysis revealed the need for the development of a specialized

information system, including the creation of an information database focused on the calculation of indicators of sustainable development of the agro-food system and which should be oriented to work on the principle of omnichannel.

We analyzed several projects within the framework of the study (the national project "Digital Economy", involving the development of information and analytical systems in various fields, including agri-food; projects "Digital Agriculture", "System of monitoring and forecasting of food security of the Russian Federation"), and also studied the automated information system "Agricultural subsidies", "Systems of state information support in agriculture", "Unified Federal Information System on Agricultural Lands", the State Information System "Information and analytical system for operational monitoring and risk assessment of the state and risks of scientific and technical support for agricultural development". The study showed that all these programs are project-oriented, they accumulate information in a specific area. In particular, a "specialized information system "Geo-Analytical Management Center of the Agroindustrial Complex of the Republic of Mordovia" is being formed in the Republic of Mordovia, designed for informational and scientific-analytical support for monitoring, analysis, and control of the use of agricultural land and the implementation of programs and projects for the effective use of agricultural land" (Zinina, Kharitonov, 2020).

## 4. RESULTS

"The information mechanism in a broad sense can be represented as a management technology based on the formation and implementation of specialized information support, relevant information systems and information technology infrastructure, promising business informatization models" (Zinina, Kharitonov, 2020), the business architecture of the enterprise and its IT architecture focused on the development of a functional IT strategy, the implementation of appropriate information processes, modeling management decisions that strengthen the competitive positions of enterprises of various organizational and legal forms.

It is advisable to take into account the following initial positions when forming an information management mechanism when developing and implementing specialized tools for information management impact:

- alternative management decisions that take into account the structuring of information from external and internal sources, its integration, strategic analysis of positive or negative factors influencing the choice and implementation of the most acceptable or optimal information management option;
- the focus on improving management technologies by creating a technologically efficient information environment that determines the expediency of choosing and using management methods and tools;
- substantiation of the prospects of business models created based on an architectural approach to management, methods, and means of information management that determine economic growth.
- Strategic priorities in the functioning of the food system are defined in our previous publications (Zinina, 2015; Zinina, Sokolov, 2015). The following should be additionally designated considering the intensive processes of informatization of agribusiness:
- development and organization of an innovative management system and its tools for the processes of formation, distribution of food resources, organizational and structural transformation of food supply subsystems, as well as their information interaction based on the creation of a digital service;
- actualization of the functions of the agro-food system based on its bioeconomic and production essence, ensuring its production and economic self-sufficiency, justification of appropriate parameters and their quantitative assessment through monitoring based on the use of information and communication technologies;
- identification and transformation of production-technological and natural-resource potentials of the agro-food system with an emphasis on territorial and natural-economic zoning;
- finding opportunities to ensure food sovereignty, competitive reproduction of food raw materials based on organic agriculture, and its ecological improvement at all stages of the production and consumption cycle.

Therefore, it is advisable to define the food supply system of the region as an independent specialized object of information management. We consider the mechanism of

information management of the food supply system of the region as a management category, assuming a set of methods, tools in the organization of information and analytical content of food supply management processes, as well as components of the IT infrastructure and directed:

a) to optimize the production and consumption cycle, the structure of consumption and food balances, the formation of funds of strategic food resources by their basic types;

b) at increasing the territorial potential for the production of food raw materials, the integration effect of participants in production and marketing activities, ensuring the reproduction of food resources with the involvement of existing territorial natural, economic, and resource advantages;

c) to the formation of integrated information and technological environment that takes into account the bio-economic essence of the agro-food system and the socio-economic demand for its final products.

We propose to consider the structural and functional content of information and analytical support for the processes of the production and consumption cycle in the agri-food system (Figure 1).

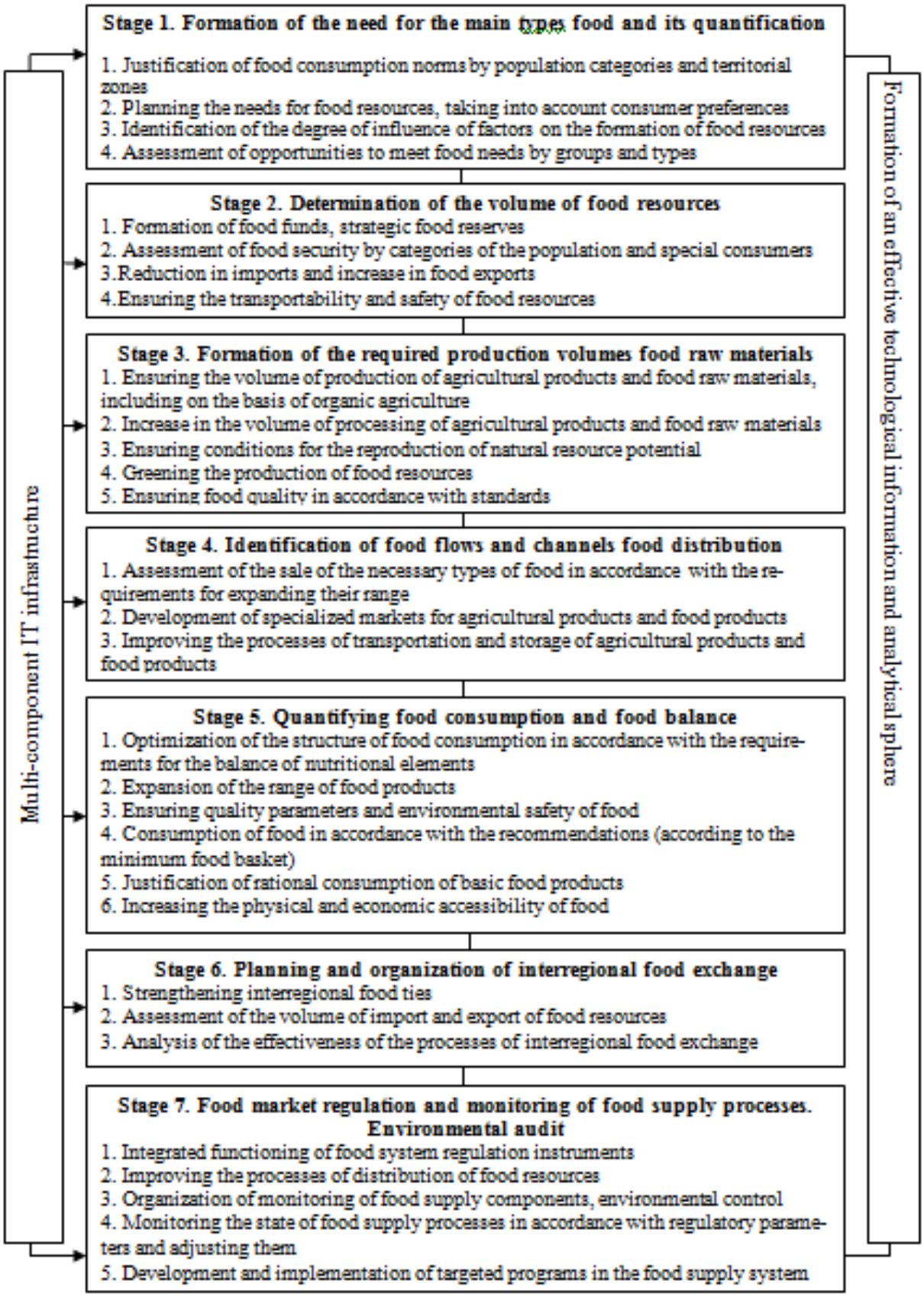
Stage 1. Formation of the need for the main types food and its quantification
1. Justification of food consumption norms by population categories and territorial zones
2. Planning the needs for food resources, taking into account consumer preferences
3. Identification of the degree of influence of factors on the formation of food resources
4. Assessment of opportunities to meet food needs by groups and types
Stage 2. Determination of the volume of food resources
1. Formation of food funds, strategic food reserves
2. Assessment of food security by categories of the population and special consumers
3.Reduction in imports and increase in food exports
4.Ensuring the transportability and safety of food resources
Stage 3. Formation of the required production volumes food raw materials
1. Ensuring the volume of production of agricultural products and food raw materials, including on the basis of organic agriculture
2. Increase in the volume of processing of agricultural products and food raw materials
3. Ensuring conditions for the reproduction of natural resource potential
4. Greening the production of food resources
5. Ensuring food quality in accordance with standards
Stage 4. Identification of food flows and channels food distribution
1. Assessment of the sale of the necessary types of food in accordance with the requirements for expanding their range
2. Development of specialized markets for agricultural products and food products
3. Improving the processes of transportation and storage of agricultural products and food products
Stage 5. Quantifying food consumption and food balance
1. Optimization of the structure of food consumption in accordance with the requirements for the balance of nutritional elements
2. Expansion of the range of food products
3. Ensuring quality parameters and environmental safety of food
4. Consumption of food in accordance with the recommendations (according to the minimum food basket)
5. Justification of rational consumption of basic food products
6. Increasing the physical and economic accessibility of food
Stage 6. Planning and organization of interregional food exchange
1. Strengthening interregional food ties
2. Assessment of the volume of import and export of food resources
3. Analysis of the effectiveness of the processes of interregional food exchange
Stage 7. Food market regulation and monitoring of food supply processes. Environmental audit
1. Integrated functioning of food system regulation instruments
2. Improving the processes of distribution of food resources
3. Organization of monitoring of food supply components, environmental control
4. Monitoring the state of food supply processes in accordance with regulatory parameters and adjusting them
5. Development and implementation of targeted programs in the food supply system
Multi-component IT infrastructure
Formation of an effective technological information and analytical sphere

**Figure 1.** Structuring of information management processes for the food supply system

**Source:** research data

"The information and analytical model of food supply management processes should include basic components for the development of a functional strategy for the informatization of the agro-food system under study" (Zinina, Kharitonov, 2020), in particular:

- survey of the current functioning of the IT provision of the food sector;
- justification of the target variant of the IT infrastructure of the food processes under study;
- development of a portfolio of IT initiatives in the field of food security;
- modeling of scenarios of the informatization process;
- development of budgeting schemes for IT processes in the food system;
- monitoring of IT strategy processes and their improvement.

The formation and use of specialized information resources determine the effectiveness of the production process management system in the conditions of the information economy. Information flows, integration links between the spheres and elements of the agro-food system should be clearly defined.

The information mechanism should ensure the formation of objectively required managerial resources, while having the potential to transform the processes and results of reproduction of informatization subjects into a more technological state, to promote the implementation of prerequisites for influencing business efficiency in conditions of uncertainty and risks.

However, it is necessary to indicate the presence of certain barriers in the implementation of information integration models in the management process:

- insufficiently developed system of "project financing, lack of specialized funds for researching business informatization and management processes" (Zinina et al., 2019);
- low physical and economic accessibility of foreign ICTs, suitable for use from the standpoint of contribution to the business, user perspective, long-term orientation, operational efficiency;
- incomplete technological environment of information systems, especially in terms of the formation of information assets;

- insufficient software and technological base that counteracts the growth of intellectual capital in the IT-sphere;
- differentiation of regions by the level of information technology support of management processes, development of IT infrastructure, and state information systems.

An objectively necessary process of effective information management is the development and implementation of an IT strategy, the essence and content of which should be viewed through the prism of a) formation of an information mechanism that positively affects the competitiveness of the system under study and its information space; b) modernization of ICT and IT infrastructure; c) information integration of participants in IT processes.

In particular, the information mechanism for managing food supply processes needs to be formed and consistently updated considering its complexity, including structural elements:

- systematization and updating of indicators, coefficients, quantitative and qualitative parameters following the requirements of the regulatory framework and standardization;
- development of algorithmic structural and functional models of management processes of the regional food supply system;
- creation of a regional model of state support for the agro-food system following the provisions of the Food Security Doctrine of the Russian Federation;
- modeling of the regional food balance and the processes of interregional food exchange;
- Generalization of information and its analysis from the standpoint of characteristics of elements of the food supply management system;
- consolidation of information flows in the field of food supply.

Apart from that, regulatory authorities in the field of food supply should be focused on the implementation of the following tasks of information management:

- control business processes within the boundaries of regional subsystems;
- analyze current data and summary information on the state of food security and food independence of the country and its regions;
- regulate food supply processes considering regional peculiarities and consumer preferences;

- generate reports and forecasts on the dynamics of changes in the structure of food supply.

Based on this, it is advisable to designate the development of specialized software tools for the formation of an information management mechanism as a priority position in the structure of the food supply management system and the creation of the following subsystems:

- current and strategic monitoring of food supply processes at the regional and federal levels;
- identification and analysis of trends in the food supply system;
- assessment and forecasting of the food balance, etc.

To solve these issues, it is necessary to use target subsystems, including functions of an applied nature, in particular,

- identification of uncertainties, risks, and threats in food supply processes;
- substantiation and evaluation of the target parameters of the regional food supply system;
- analysis and forecasting of socio-economic indicators of food security;
- formation and evaluation of interregional food balances and food funds.

## 5. CONCLUSION

It should be noted that according to the modern socio-economic needs of social development, the food supply system should be considered from the standpoint of its transformation into a high-tech and competitive reproductive system of Russian food resources, the actualization of digitalization tools considering the requirements of the Food Security Doctrine of the Russian Federation and the complication of trends in international food exchange.

The construction of an information database at different levels of management focused on the calculation of indicators of sustainable development of the agro-food system, should be oriented to work on the principle of omnichannel. Appropriate organizational changes are needed for its implementation, which must be synchronized with changes in information technology and reengineering processes in all areas of the development of the food supply system. This will allow for the centralized implementation of a significant part of the processes through operational and strategic monitoring. Phased implementation of the information support process will allow obtaining the necessary statistical data in automated mode on the

state of the spheres of the food system; their study and interpretation will allow responding promptly to possible changes. It should be the basis that will combine information from various sources, communication channels, and thus its formation and implementation will take into account the requisites for all software products available in this area, as well as specify the processes of specialized information and analytical support. Effective interaction of business, the scientific and educational community, the state, and citizens in the formation of an effective information mechanism for managing food supply processes should be ensured.

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