

# **IMPROVING MANAGEMENT OF MINING ENTERPRISES ON THE BASIS OF MODERN INFORMATION TECH- NOLOGIES FOR THE PURPOSE OF OPTIMIZING THE USE OF RESOURCE POTENTIAL**

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**Abstract.** An important problem in the production activities of mining enterprises operating in complex areas is the need to ensure the necessary technical and economic results of their production activities, which is primarily determined by the efficiency of use and the rationality of the use of production resources. An effective way to solve this problem is to automate the management processes of enterprises based on the use of specialized information management systems. The implementation of these systems in enterprises with a specific type and nature of production is associated with a number of difficulties, the main one of which is the creation and effective use of the information space of the enterprise, corresponding to the nature and specifics of its production activities.

The authors described the principles and basic approaches to the creation of such an information space, described its necessary structural elements, their purpose and the nature of the functions. In the work, a flow chart of information containing the main resource of the enterprise Knowledge is formed, on the basis of which the structure and procedure for managing information flows and a specific professional nature of production resource flows between business units should be developed. The main tasks of the information systems of enterprise management in the conditions of the Information Economy are formulated: the transformation of the organizational structure of the enterprise; implementation of strategic planning based on the forecast of the state of national, international, global markets; decentralization of enterprise management; staff motivation to increase personal competence and efficiency. Based on the described approaches, specific information technologies and management systems should be developed in the future, improving and developing

the information space of an enterprise to bring this space to the level of ensuring the solution of strategic enterprise management tasks in ensuring rational use of resources, competitiveness, and expanding areas of interaction with resource suppliers and the production system and consumers of products of the enterprise.

**Introduction.** Currently, the mining enterprises of Ukraine operate in difficult conditions, which are characterized by: high dynamism; the influence on the production process of a large number of factors having a stochastic nature; tough market competition; institutional instability; increase in the cost of resources; the difficulties of ensuring the stability of the supply of enterprises with productive resources. The peculiarity of the production activities of mining enterprises in terms of their provision and use of resources is that they have two types of resources. The first type includes the resources that are necessary for the implementation of the production process itself (explosives, compressed air, electricity, drill bits, explosives, etc.), the second type of resource is the natural mineral reserve itself, which also represents the subject labor and production resource, the extraction and processing of which leads to the production of marketable products of the mining enterprise.

This situation leads to the emergence of a particularly acute task for the implementation of the production activities of a mining enterprise, in which the maximum rationalization of the use of production resources must be combined with the rational use of natural resources, which together represent the resource potential of the mining enterprise.

Under such conditions, one of the main methods for solving this complex task is the automation of the management processes of the mining enterprises, since it is the management system that solves all the tasks of rationalization and optimization of the use of resources.

Effective management is one of the most difficult tasks of production management. This is due to the specifics of modern mining production, which includes a large number of interrelated elements (divisions, shops, services, non-production units, direct and reverse links between them). The functioning of this structure requires interaction with a large number of external elements (suppliers, repairmen, consumers).

The organization of a balanced operation of this system with the fullest use of the potential of the resource potential requires the speed of control actions; making management decisions based on a detailed analysis of emerging situations at the system level of production; solving complex planning tasks, designing, organizing, monitoring, correctly assessing the production and commercial activities of an enterprise.

This function is assigned to the *Enterprise Management System* (EMS - *Enterprise Management System*) [1], which represents one of its most important divisions. Automation of EMS (adoption and implementation of management decisions) provides the opportunity to achieve maximum efficiency of the enterprise, in which the optimization of the use of its resource base is one of the main aspects. This is achieved through the use of operational management tools that implement object-oriented *information technology* (IT) forming the *enterprise management information system* (PMIS) [2].

At present, a large number of PMIS based on different principles have been developed; allowing to solve different types of management tasks; ways to implement management functions; the specifics of the formation of the information space of the enterprise.

Along with this, it should be noted that the introduction of these PMIS is associated with one serious *problem*, the essence of which is as follows. The implementation of the PMIS is a complex and lengthy process that requires serious preparation, transformation of the information environment of the enterprise, changes in the principles of the formation and management of information flows, and training specialists in the use of the PMIS.

All these questions relate to the field of formation of the *Information space of the enterprise* [3], which represents the basic component of the PMIS. All information processes in the process of the enterprise are carried out precisely in the information environment using specialized means of work in this space, which are also its elements.

Along with this, the theory of the development and functioning of the PMIS presents, and especially these systems in the field of specific mining production is developed extremely insufficiently, which creates more problems in the field of the functionality of such systems.

**Analysis of recent research and publications.** A review and analysis of available literature on the theory of functioning of the

PMIS in the field of organization of the information space of enterprises and the management of its elements showed that there is very little information on this issue. The available publications are non-systemic, scattered in nature and mainly boil down to describing the functions and capabilities of the PMIS, but not the functioning of the enterprise information space. Therefore, the issues of structural changes in the enterprise management system, due to the use of the PMIS, remain obscure. This makes it difficult to fully implement the capabilities of existing PMIS and expand their functionality for implementation in specific areas of production.

**Objective.** In order to eliminate this drawback, the author of this publication conducted research on theoretical issues of implementation and practical implementation of the EMIS capabilities that change management approaches and technology, and allow improving, on this basis, the methodology for managing enterprises in the direction of streamlining resource use.

**The presentation of the main material of the work.** One of the features of the current stage of development of social production is the formation of the so-called *Information Economy* [4]. This concept implies a form of economic activity, in the management of which modern information and communication technologies lie.

**Decentralization of enterprise management, as an element of the information economy.** The main direction of the reorganization of the management structures of enterprises in the information economy is primarily to maximize decentralization of management, that is, increasing the role of middle and lower levels in making management decisions, and in the field of mining production the management structure is extremely complex and ramified. This removes the need for solving local tasks (tasks of a relatively low level in the hierarchical structure of management) from top-level authorities, allowing them to focus on solving strategic problems [5].

Such an approach enhances the management flexibility and adaptability of enterprises to rapidly changing conditions while minimizing the losses caused by the process of such changes, and gives greater freedom to the management apparatus of the middle and lower levels in the manifestation of management initiative. However, this also imposes a great responsibility on the effectiveness of the decisions made.

Management processes in the information economy are based on integration processes that ensure interaction between elements of the management structure not only vertically (the head is a slave), but also horizontally (between employees of different departments of the same hierarchy level). These processes generate a new structure, defined by the notion *Enterprise without borders*. This approach transforms the management system from a closed (closed system) using traditional management methods (bureaucratic, hierarchical, mechanistic) to open systems based on *Network methods and management technologies* [6].

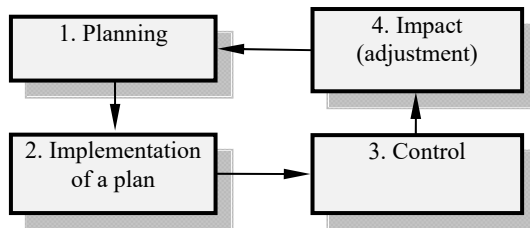
**The basic task of the PMIS.** The purpose of the development and implementation of the PMIS is to automate the solution of tasks related to production management, the rational allocation and use of resources.

Among the enormous aggregate of these tasks, there is one, which by its nature is basic. The special role of this task consists in the fact that the success of the enterprise and the solution of all other tasks absolutely depend on the success of its solution.

This task is to develop a plan of production activities of the enterprise, which must be correct, accurate and realistic to perform.

The development of such a plan and the determination of its parameters should be carried out on the basis of the implementations the provisions of the so-called Deming-Shewhart cycle (PDCA, Plan-Do-Check-Act—planning→action→verification→adjustment) [7] for managing complex systems with the function of continuous improvement activities.

A simplified diagram of the PDCA cycle is shown in Fig.1. This cycle is an algorithm for managing the process and achieving its goals.



**Fig.1.** Deming-Shewhart management cycle structure

The PDCA cycle includes a series of sequentially executed processes. Let us explain the essence of the work that should be performed in the PMIS when implementing the PDCA and the tasks that should be solved using this system.

1. Planning of the production process consists in developing a plan in the form of a network model and a Gantt chart and also its mathematical and semantic description.

This process is quite complicated. The scope of work for the development of a network model of the plan is as follows. Before building a model, the entire planned production process should be studied and analyzed.

In the analysis should be taken into account: the purpose of the process for its desired result; the parameters to which the executions result of the process should correspond (the volume of production, the productivity of production, the cost of production, profit, profitability, etc.); scope of work that must be performed to achieve the goal; structure of work (their interrelationship and interdependence).

Then, based on the results of the analysis, a network model of the process should be developed. The network model includes a graphical model (sequence of work and the relationship between them) and a mathematical description of the process (in numerical form – time, material, labor, financial costs). On the basis of the network model, a Gantt chart is being developed - a linear model of time parameters for the implementation of the plan and work. In the PMIS, the Gantt chart is developed automatically based on the network plan already developed, the role of a specialist in the development of this type of model is reduced only to checking the correctness of the chart elements and making the necessary corrections if necessary.

Planning is one of the most difficult stages (according to the nature of the tasks to be solved) and responsible for the results of the implementation of the plan. The complexity of this process is explained by the fact that it is necessary to use the method of variations when forming the network model of the plan. This method consists in shaping the structure of the model by means of “tests” and “errors”, that is, making decisions on specific elements of the plan, calculating the expected results of the plan based on these decisions and checking them for compliance with certain criteria.

Successfully and quickly solve the problem of planning can only be using specialized software tools that allow you to visually form, calculate and test solutions.

At the next stage, the resulting network model should be analyzed and optimized according to the time parameters of the plan implementation, resource costs, and the dynamics of their spending. In this operation, information systems play an especially important role, since the solutions to optimization and resource-use problems are complex due to the specifics of mathematical methods of multi-criteria optimization. Solving the problems of optimizing the use of the resource potential of an enterprise is possible only by automated information and analytical tools.

After receiving the results of optimization and the formation of the final version of the plan with its parameterization, specific tasks are set for the plan's implementers.

It should be noted that the planning process does not end there. Planning operations, or rather plan adjustments, will also need to be carried out at the implementation stage. In this part, the specifics of the work of the PMIS is as follows. During the implementation of complex processes, deviations from the original planning model are usually identified. Such deviations are taken into account, their influence on the general planned model is revealed. If deviations are critical, rescheduling the model.

The revised network model is again analyzed and optimized, and new tasks are brought to the performers. Thus, the planning and management stage continues from the beginning of the implementation of the complex of works to the moment the plan is fully implemented.

**Functions of the PMIS.** The introduction of a full-scale PMIS consists in the reorganization of the structure of enterprise management with mastering the model of electronic management of production and business. The basis of the management strategy is the expansion and development of communications, as well as new organizational interactions. In this situation, besides the standard functions of ERP and CRM, the following is implemented: EDI (*Electronic data interchange*); the formation of a single chain "supplier - production - consumer"; B2B, B2C, B2G technologies (*commercial relations management systems*); conducting electronic trading (Smart

Tender); electronic payments Internet banking, and the introduction of AMM (*Advanced Manufacturing Management, production management system*) is especially important. Under this option, the management functions are changing and expanding the information space of the enterprise. This approach allows you to create a fully functional automated enterprise management system - *the Automated Enterprise Management System* [8], which is already characterized by a clear specialization.

**The role of PMIS in the modernization of production.** It is necessary to emphasize the role of the PMIS in addressing such an important issue as the modernization of production [9].

Modern enterprise should not represent a frozen production structure that has mastered a certain technology, technology, organization and management methods, but a dynamically developing and improving system. This need is explained by the fact that a modern enterprise operates in a dynamic environment with ever-increasing demands on consumer properties of products, the tendency of its obsolescence and obsolescence of the means of production, and fierce competition in the market.

Ensuring the competitiveness of enterprises in such conditions requires its periodic modernization based on more advanced technologies, means of mechanization and automation, improving the organization and improving management efficiency, one of the main goals of which is to optimize resource consumption. Lagging behind in this area can have extremely negative consequences, including the crowding out of an enterprise from the market by competitors who more fully control its trends, the development of technology, technology, tools and management methods. Such activity requires the collection, systematization and analysis of huge amounts of information in different directions coming from various sources, which predetermines the scale of the information space of the enterprise.

Problem-oriented PMIS in this area are an indispensable means of operational management, ensuring the possibility of a timely response to changes in environmental conditions.

**Network information communications in the PMIS.** One of the most important elements of the information space of an enterprise is information communications. The basis of these communications is provided by information networks of different levels [10], namely:



– global networks (*Internet; GENnetwork; WideArea NetWork; Global network*) provide an opportunity for the enterprise to operate at the level of the international division of labor, with global coordination of its work, finding new markets, suppliers, and investors, thus ensuring broad business opportunities on a global scale;

- regional networks (*Datapacnetwork; EURONETnetwork, Fido-netnetwork*) provide coordination of the enterprise's work within a closed structure, for example, within the state, region, industry;

- internal network of the enterprise (*Ethernet*) joint, brigade work, coordination of work outside the boundaries of individual structural divisions of the enterprise, thus reducing the cost of operational management;

- distributed computing network - related working groups, each of which has the necessary knowledge and information tools. Their goal is to streamline business processes and support an optimal level of decentralization of management;

- portable computing (*VO - Virtual Organization*) their work is not tied to a specific location and is mobile. Knowledge and information are delivered to where they are needed at a specific time.

**Stages of development and implementation of PMIS.** One of the important aspects of the information environment of enterprises is the issue of composition and interaction with information technology (IT), which are implemented in it. The development of this interaction and the change in the composition of information media goes through several stages.

As practice shows, the presence of these stages is explained by the fact that such a complex system as a PMIS cannot be developed and implemented at one time. The development of the PMIS software in its entirety for a particular enterprise, its adaptation to the working conditions of this enterprise and the development of this system by the enterprise personnel requires a certain time and gradual (stage-by-stage) implementation and development by the employees of the enterprise. This is especially manifested in the fact that as you master the understanding of the intricacies of the PMIS and its elements, specialists will become more interested in solving problems of an ever higher level, requiring more complex solution methods, as well as subsystems with greater functionality, which may not be original versions of the PMIS. Thus, there is a tendency

to the development of the PMIS and the expansion of their functionality and information space.

The essence of these stages and the level of tasks is as follows.

- at the first stage, the enterprise uses the PMIS, as a rule, only at the level of obtaining operational information about the state of the enterprise and the course of its processes. This information is analyzed by employees of the management system and make management decisions on the tasks of maintaining and developing the future activities of the enterprise;

- at the second stage, the PMIS is already used to analyze situations (in production, market, resource supply) and to propose solutions in specific situations. Management personnel make decisions based on the evaluation of these options, that is, the PMIS is already used in the management decision-making mode [11];

- at the third stage, the PMIS are already oriented toward solving strategic problems in order to ensure the competitive advantage of the enterprise, its adaptation to changing conditions, and monitoring of processes in the external environment. Management employees perform the function of monitoring and adjusting decisions made by the system at the level of an expert in management and for this purpose there are already expert IT [12].

**Principles of development and operation of the PMIS.** The development and improvement of the management system and the development of the information space of an enterprise should be based on certain principles that take into account the information and communication component of management. These principles are as follows:

1. Information integration, mastering integrated management models.

2. Transformation of the administrative structures of enterprises from structures with vertical integration into structures with horizontal integration, with the minimum number of levels between top management and performers.

3. Decentralization of management functions. Semi-autonomous or autonomous subsidiaries, strategic business units responsible for their production and financial and economic activities are being created.

4. Network forms of interaction between the enterprise and other enterprises, for example, by creating internal markets (network methods of interaction).

5. Standardization of business processes, products, services avoiding narrow functional specialization in the content and nature of management activities and management style.

6. Increasing the competence of staff by equipping them with innovative methods and means of carrying out professional activities and their theoretical and practical training.

The implementation of these principles requires the formation of a single information space of the enterprise, which contributes to the interaction of a large number of subjects involved in the management of the organization of the enterprise.

#### **Information resources and information products of the PMIS.**

Forming the information space of an enterprise, the PMIS implies the emergence of such a concept as *Information Resources* (IR) of an enterprise [13]. IR is what should circulate in the information space and is subject to processing and management: search, analysis, logical and mathematical processing, transfer, accumulation, storage. PMIS, providing information services to employees of the enterprise, converts the information resources into *information products* (IP). This process should occur systemically. It is the organization of such a system (strict functional sequence and structuredness of the information processing process) that is provided by the PMIS [14].

Thus, the PMIS is a multifunctional cybernetic system that combines control, production and communication services and provides interaction between it. These services are occupied by employees whose activities are subject to management. The management of the services is carried out by the management system of the enterprise, and the PMIS provides for this means and information resources, as well as the means of implementing management decisions.

**The structure of the PMIS.** One of the most important issues that arises in the process of creating an PMIS for a particular enterprise is the development of the structure of this system. This structure must comply with the scheme of the enterprise management system and take into account the organization of relations within the enterprise and with the external environment. The task of the PMIS

is to ensure the functioning of these links at the necessary level of automation.

In fig. 2. shows, developed by the authors, the general scheme of the structure of enterprise management, taking into account the above provisions and demonstrating the work of the PMIS in the field of management of the mining enterprise.

The main element in this structure is the *Enterprise Management System* (EMS), which has its own internal structure and hierarchy.

The EMS solves strategic problems, which requires knowledge and data that are already accumulated in the knowledge base of the information center of the enterprise, as well as information from the external information space. Obtaining all this information and communication is provided by the *Enterprise Information Center* (EIC) and its *External and Internal Information Management Subsystems* (this information may be confidential).

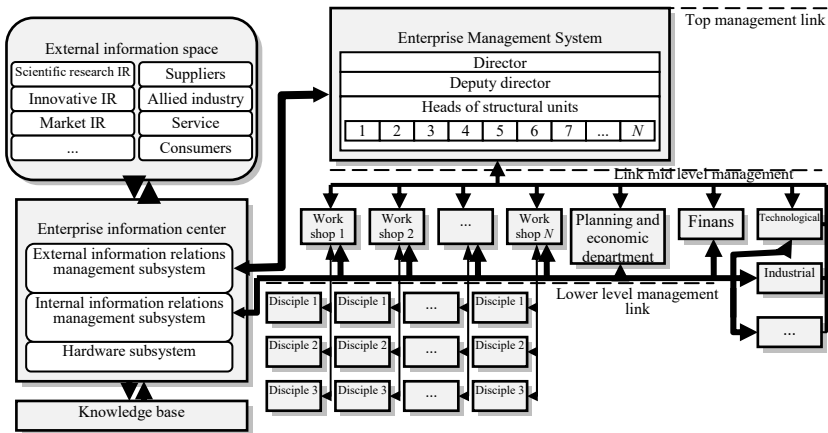
According to the results of information processing in the EMS, a decision is made, on the basis of which the heads of structural divisions form the tasks of their divisions. These tasks are brought to the attention of employees of the link of *the middle management level* (heads of workshops, services, departments). The transfer of this information is also organized by the information center. The leaders of this link themselves must develop the composition and content of the tasks of their units.

It should be noted that they must have access to the external information space and the knowledge base in accordance with the scope of their professional activities in the conditions of decentralization of management and obtaining large rights in management.

After making management decisions at the middle management level, information about these decisions is communicated to the managers of the lower management level (section heads, groups). At this level, management decisions are also made and communicated to the executives.

The task of the information system does not end there. This is explained by the fact that in the process of implementing management decisions, it becomes necessary to monitor the implementation of tasks in accordance with the plans; management decisions adjustments.

This task requires the organization of feedback between the lower level and higher level management link.



**Fig. 2.** Scheme of the enterprise information system

Feedback represents a stream of reporting documents, which requires appropriate standardization of documents, timing and procedure for their transfer.

Thus, on the whole, this entire structure, consisting of its elements, types of information being transmitted, the nature of direct and reverse links, opportunities and modes of access to information resources, means of receiving and processing information, forms a full-scale information system of an enterprise and its information space.

Now let's stop another important aspect of the PMIS, which is that these systems are, above all, a powerful tool for knowledge management. It is knowledge that represents the basic resource and the basis for ensuring the competitiveness of an enterprise [15].

The tasks of knowledge management of the PMIS consist in providing each employee with the opportunity to gain corporate knowledge; their preservation; sharing current and retrospective knowledge; providing tools for processing and knowledge management.

Naturally, the PMIS, as a system for managing knowledge and actions determined by the results of their processing (these results

also represent knowledge), has a certain basic flow of information containing knowledge. On the basis of this scheme, the ICIS develops traffic patterns for information of a specific professional nature and its movement control subsystem. The structure of the basic scheme is shown in Fig. 3

In accordance with this scheme, the PMIS acts as an intermediary link between the Communicator, generating a certain type of information, the Knowledge Base in the system memory, the External Environment and the Recipient (information consumer). The management system outlines the following contours: A – processing (filtering and entering information into the knowledge base), B – providing information (notification and advertising), D – preparing documents. The knowledge base represents the field of knowledge of employees.

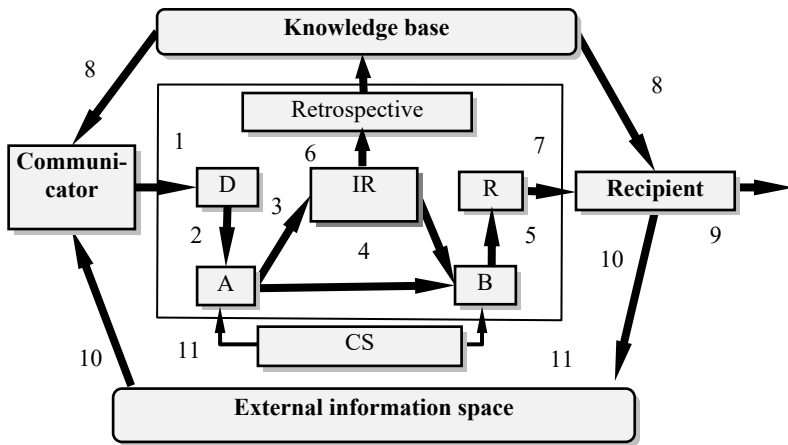


Fig. 3. Information flows diagram representing corporate knowledge

The external environment serves as an object of control and cognition, which is carried out by an employee acting as a Communicator (information flow 10). In order to make their knowledge and conclusions from the analysis of the state of the environment available to workers who need this information, the Communicator draws up its knowledge in a form convenient for familiarization (electronic document) with the means of subsystem D and sends it to the information processing service A (streams 1, 2). Service A in accordance

with its algorithm and instructions of the control system (CS) (vector 11) selects the further direction of the document. If the content of the document is recognized as important for the enterprise, the document is recognized as IR (stream 3).

Processing services have hardware and software for automated processing and replication of documents, which are carried out in accordance with the professional knowledge of the staff of this service and instructions of the management body (stream 11). As a result, the processing of documents appear IR for public use (stream 6). IR form the information environment of the enterprise. The socialized information circulates in the contours of the enterprise (streams 8), reaching employees. In if the AI at the moment does not matter much, then it gets into the archive (Retrospective memory) and waits for its actualization. Another information flow is formed by the publication service B. The IR is the object of study (stream 4) by service staff B, who, in accordance with their knowledge and directives of SS (vector 11), form intermediary products (P) (catalogs, abstracts, lists). (stream 5). After that, the service delivers this information to the Recipient (stream 7).

As a result of studying the PI, the Recipient receives new knowledge and generates control solutions that are sent to the appropriate services (9). Thus, there is an increase in intangible assets of the enterprise by generating IR and IP.

Risk management in PMIS. In conclusion, we note the following. Information processing in the PMIS and the content of information flows are associated with two types of events – planned and sudden. Planned events - their type and time of occurrence, as well as the company's reaction to them are planned as planned. Sudden events – it is impossible to foresee. However, under certain conditions, the degree of risk of their occurrence can be determined and even managed by these risks, for this there are special mathematical methods, and corresponding information systems, for example, KGRisk.

What is important in the PMIS is that they allow the enterprise to respond quickly to unforeseen situations and for which, using such information tools, the necessary reserve of resources (financial and material) can be calculated. Addressing issues related to risks in production and business activities currently represents a whole scientific and practical direction [17].

**Conclusions and directions for further research.** Based on the results of the studies performed, the following conclusions can be drawn:

1. One of the important problems that arise in the process of production activities of industrial enterprises operating in difficult modern conditions is the need to ensure the necessary technical and economic results of their production activities. An effective way to solve this problem is to automate the management processes of enterprises based on the use of specialized information management systems.

2. The implementation of these systems in enterprises with a specific type and nature of production is associated with a number of difficulties, the main of which is the creation and effective use of the information space of the enterprise, corresponding to the nature and specifics of its production activities.

3. The author describes the principles and basic approaches to the creation of such an information space, describes its necessary structural elements, their purpose and the nature of the functions.

4. The work contains a flow chart of information containing the main enterprise resource Knowledge, on the basis of which the structure and procedure for managing information flows of a particular professional nature should be developed by departments of the enterprise and ensuring efficiency and activity.

5. The main tasks of the information systems of enterprise management in the conditions of the Information Economy are formulated: the transformation of the organizational structure of the enterprise; implementation of strategic planning based on the forecast of the state of national, international, global markets; decentralization of enterprise management; staff motivation to increase personal competence and efficiency.

6. Based on the described approaches, specific information technologies and management systems should be developed in the future, improving and developing the information space of an enterprise to bring its information space to the level of solving the tasks of strategic enterprise management to ensure its competitiveness and expand areas of interaction with suppliers, the production system and consumers.



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