ENTERPRISE INFORMATION RESOURCES: MODERN APPROACHES TO FORMATION AND OPTIMIZATION

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DOI: https://doi.org/10.30525/978-9934-26-268-5-2

Abstract. The approaches to interpretation of the essence of "information resources" category have been analyzed. The conditions of the efficient use of information resource components in the conditions of increased requirements for organization of an enterprise's information environment have been investigated. The advantages of using modern information systems allowing to optimize all enterprise business-processes grounding on formation of a unified consolidated information base have been considered. The status and advantages of using ERP-systems at Ukrainian enterprises as well as the factors having an impact on making decisions regarding their implementation or replacement by more perfect ones have been evaluated. The issues of using enterprise information resources in the conditions of martial law have been studied. The measures taken to ensure information security of enterprises have been provided. The market of modern equipment and software used to open up the opportunities for improving quality of enterprise information resources has been analyzed.

Keywords: information resources, information systems, information technologies, cloud technologies, the martial law, information resource security.

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1. Introduction

Enterprise information resources formed within the modern enterprises with the use of modern information systems and technologies (IST) based on the data of external and internal environment, are the basis for making management decisions by enterprise management at the operational and strategic levels.

Information resources, as well as other resources such as financial, material, labour resources, play a crucial role in the development of an enterprise full of management functions realization, provision of stable operation in the conditions of crisis phenomena.

The efficiency of creation and application of information resources within an enterprise depends on the ways of their receipt, information processing and storage technologies, transition of information to interested users being both inside and outside an enterprise. Nowadays important is involvement in the global information space that ensures an opportunity of information exchange and building information systems based on general principles and rules, which contribute to the improvement of the enterprise management level and its competitiveness due to the choice of a perfect information model.

Enterprises create an adequate to set goals mechanism of formation and use of information resources, achieve a number of advantages comparing to competitors, first of all due to increasing their employee competence by means of timely, high quality and comprehensive information, which in the case of applying modern methods of its processing, analysis and generalization, turns into a productive system of knowledge.

The conditions of pandemic and martial law exacerbated the existing problem – application of measures on security of enterprise information resources to store their confidentiality, effectiveness, integrity and completeness.

2. The essence and features of formation of enterprise information resources

An information resource was initially interpreted in the Law of Ukraine "On scientific and technical information" as a complex of "information and reference funds with required reference and search engine and relevant technical means of storage, processing and transmission that is in possession,

disposal, use of state bodies and scientific and technical information services, scientific and scientific-technical libraries, commercial centers, enterprises, institutions and organizations" [1].

A generalized definition of an information resource provided in the Law of Ukraine "On national information program" refers to its understanding as a set of documents in information systems [2].

In studies of scientists the concept of information resources is considered from different points of view: 1) as a reflection of processes occurring at stages of information resource formation: (collection, processing, storage, transmission of information); 2) as a result of the work of people capable to intellectual activity with the purpose of fulfilling economic and social tasks; 3) as a set of scientific-technical and scientific-humanitarian knowledge gained by the mankind in the course of social development.

When giving definition to enterprise information resources scientists take into account their value for reducing risks to an enterprise activity and increasing the effectiveness of a business-process formed due to the use of knowledge adapted to specifics of production, financial, marketing and other enterprise operation goals.

Teslenok I.M., Kucherenko M.O. consider information resources as accumulated information related to surrounding reality, which is fixed by means of material and other carriers to transform it to interested users and due to which scientific, production, managerial and other tasks are solved [3]. Lozovytskyi D.S. understands under the information resource a set of technological elements including methods and procedures providing an opportunity to collect, store, process, transmit and bring information to user awareness. The author focuses his attention not only on technical tools and equipment involved, but also on a significant role of the human factor, which cannot be regulated or formalized [4].

Netreba I.O. interprets information resources as a collection of data, the sources of which are external environment and data on enterprise activity forming its information infrastructure and serving as a basis for making management decisions by enterprise managers [5]. Sydorenko O. defines the information resource as a source of information, which is definitely organized and can be used if necessary [6].

Analysis of provided in legislative acts and researches of scientists interpretations of an information resource permits to distinguish its two

components: information itself and an information system, which creates an opportunity of efficient use of information through the formation of mechanism of running information processes by an enterprise.

It is obvious that to be transformed into an information resource information has to: 1) possess definite properties providing its value and significance in solution of practical tasks of an enterprise activity; 2) be organized as a database or a data bank, a data storage or an information system.

Information used by an enterprise is classified, first of all, by its belonging to a definite subject area. Depending on activities realized, enterprises can feel a need in scientific-technical, economic, legal and other information. Economic information serves as a source of obtaining information for making decisions when managing production and non-production spheres, quantitively characterizes processes realized in production-economic and financial activities of an enterprise through a system of indicators having natural and value character. The use of economic information does not only provide a reflection of the condition of an enterprise economic area, but also permits to discover mechanisms of interaction between its various links that creates an opportunity of planning, accounting, control and regulation of processes of their activity and development.

A special role in operation of modern enterprises belongs to accounting and analytical information. Accounting information is a sub-type of economic information and in its traditional sense refers to three types of economic accounting: operational, statistical and bookkeeper accounting, the later of which includes financial and administrative accounting.

Application of operational accounting has a purpose of observation and control of the performance of financial and economic operations that creates an opportunity of operational control of processes existing at an enterprise. Statistical accounting operates with information used for the performance of economic analysis and forecasts in short term and long term prospects. To statistical accounting tools refer formation of statistical samples, calculation of average indicators and coefficients.

The performance of bookkeeper accounting ensures obtaining of synthetic accounting information regarding an activity of a business entity and its structural subdivisions in terms of a definite period of time: the data on the condition, structure and movement of an enterprise's property and sources of its formation; running economic processes; financial results of activities.

The use of financial accounting, first of all, provides information to subjects of the external environment – investors, creditors, customers and suppliers, as well as the bodies performing control and regulatory functions, public circles etc. As a result of administrative accounting is formed information intended for internal users (company management, owners), which differs from the information received through financial accounting by a degree of its depth and extent of detailing.

The role of the analytical component lies in ensuring a possibility of conducting qualitative and quantitative evaluation of changes in the subject researched and reveling positive and negative trends. Due to the use of analytical information company management obtains the grounds for making and realization of efficient management decisions by ensuring stability of an enterprise activity through carrying out financial, administrative and strategic analysis.

Unlike accounting information, which reflects the condition of financial and economic area of an enterprise, analytical one characterizes the activity effectiveness and allows defining the directions of its rise.

Accounting and analytical information creates the conditions for solving the following tasks:

– evaluation of a business entity status by using a comprehensive system of indicators, to which refer primary, summarized, analytical and synthetic indicators, and distinguishing factors having an impact on its activity results;

– identification of features proving the occurrence of crisis phenomena within an enterprise and analysis of the extent of risk impact on its financial and economic activity with the purpose to prevent bankruptcy;

– analysis of business partner and competitor status to understand potential threats and opportunities, which can be created due to enhancement of their positions at the market or vice versa;

– implementation of consistency of actions of enterprise structural subdivisions to ensure the appropriate level of achieving its tactical and strategical goals;

– formation of a consolidated information base, which could meet the demands of external environment subjects, who the company interacts with during its operation.

Accounting and analytical information (AAI) has to meet a number of requirements ensuring its high quality level and contributing to the efficient management decisions making (Table 1).

Table 1

Requirements for accounting and analytical information quality level

Feature of AAI quality	Essence of a requirement
1	2
Value	The ability to ensure realization of enterprise goals. Dependent on specifics of an enterprise activity and the environment where it operates. Characterized by impermanence – dependent on the time of use it can be evaluated as both maximum and minimum compliance level.
Reliability	The property to reflect the essence of real events and phenomena with a sufficient degree of accuracy. It is important that there are tools for cleaning data from potential effects of noises of physical, semantic and pragmatic origin.
Meaningfulness	Ensuring an opportunity for the employees using AAI for decision making to correctly interpret the ties of this phenomenon with others.
Susceptibility	Maximum compliance with the level of user understanding of main notions, terms, the ability to define logical and formal interrelations.
Opportuneness	The property to satisfy currently actual needs of an enterprise. Reflects regularity and rhythmicity of providing information to persons who make decisions and sufficiency of time for its processing and analysis.
Sufficiency	Reflects "gold fine line" between an insufficient volume, content incompleteness and excessive information that in both cases do not meet user requests and can lead to mistaken decisions.
Unambiguity	Provided by the use of generally accepted regulatory framework and avoiding differences in the applied conceptual apparatus.

Source: created by the authors according to [7–10]

During formation of accounting and analytical provision of an enterprise activity the following factors have to be taken into account:

– actual and anticipated needs of accounting and analytical information;

– ways and methods to be used to satisfy consumer needs in accounting and analytical information;

– minimization of expenditure of time and efforts when using accounting and analytical information;

– tools for making and implementing management decisions based on applicable analytical procedures.

3. Information systems as a condition of effective formation and use of enterprise information resources

The effectiveness level of formation and use of enterprise information resources depends on a degree of excellence of information systems, which allow to arrange information in the form acceptable for interpretation by users and promote the achievement of enterprise goals.

When using enterprise computer information systems, which are the organic combination of components, such as people, information technologies, complexes of technical programs, mathematical, linguistic, legal and ergonomic support, there appears an opportunity of realizing collection, storage, analysis, processing and transmission of information.

Information systems, like any other systems, have an inherent interrelation with their structural elements, to which refer input (digital data, facts, events and phenomena), output (information and useful knowledge) and transformation process (input data processing). The quality of information obtained at the output, its compliance with user needs depends on both input data and excellence of technologies transforming data into full-fledged information.

The backbone of any information system is an information technology, which is considered to be a set of methods, ways and tools ensuring implementation of all consecutive stages of information process running – obtaining, processing, storage and provision of information that leads to the creation of new quality information on the features of objects, phenomena or processes.

As defined by the UNESCO, information technologies have to be considered as a set of disciplines, such as scientific, technological, engineering, which ensure study of methods of effective arrangement of employees involved in processing and storage of information. As components of information technologies, the following ones can also be distinguished: computer equipment and methods allowing to realize an effective interaction with employees and production equipment. Attention is drawn to practical applications and social, economic and cultural issues associated with the processes run.

To the criteria of choosing information technologies (IT) should be referred:

1. Level of financial expenses on acquisition (development) and implementation of IT.

2. Profitability.

3. Effectiveness in terms of achieving goals set by the organization.

4. Risk degree and uncertainty of consequences of IT implementation.

5. IT compliance with the system of values and norms of behavior existing inside an organization.

6. Difficulty of mastering IT by the staff.

7. A possibility of painless return to the previous practice of operation in the case of implementation failure.

In the course of implementing information technologies it is necessary to take into account a number of factors that can contribute to the process of "diffusion" of information technologies or restrain it. To the first group of factors having an impact on unimpeded implementation of information technologies refer structural factors, the effect of which is related to an organization size, a volume of available resources, features of organizational structures (bureaucratic or adaptive). The second group of factors is formed depending on top-management and employee qualification level, the level of favourable psychological climate in the staff, corporate culture and staff's focus on transformation (the availability of innovative consciousness). The third group of factors defines the extent of staff's awareness of implementing information technologies by other enterprises, both domestic and foreign, which are operating in similar branches of industry.

One of the conditions for effective application of information technologies is the availability of appropriate equipment at enterprises – servers and data storage systems. The global IT market, the size of which is nowadays more than $2 trillion, is characterized by the increased number of information processing centers and the use of cloud solutions, as evidenced by the growth in demand for network equipment. The demand for personal computers and monitors is decreasing; at the same time, there can be observed a growth of mobile devices market and a stable demand for printing and copying equipment.

According to the experts, the increased interest in creating data centers (DC) that carry out processing, storage and dissemination of information, has been dictated by the needs of corporate clients in solving problems of obtaining high quality information services. A DC is characterized, first of all, by a high level of information processing and storage processes at all stages of its lifecycle, excluding the possibility of its integrity and confidentiality.

Due to consolidation of information in DC, the increased level of efficiency of technical support and software application, the expenses on creation and maintenance of IT-infrastructure operation are reduced, simplicity and transparency of centralized administration, high level information system security, controlled access to data processing processes, convenience of computational power scaling are ensured.

DC (data centers) are characterized by a high degree of channel bandwidth determining high quality services based on the priority criterion of evaluating the effectiveness of a data center operation – the length of server accessibility period.

Active development as also inherent in software segment concerning both domestic and global markets – in the recent year this market has annually been growing by 6%. A larger share of the segment belongs to applications, another part is covered by software and development tools. The greatest growth relates to applications, the purpose of which is to organize joint activity, primarily intra-company social networks and collaborating on files; the annual growth of this segment is by 20% and higher. The intensive growth is also typical for the fields, such as database management and analytics (8% growth per year), optimization of resource management processes, customer relations and the increase of information resource security level.

The analysis of modern trends in the development of information technologies of local purpose of applying the technologies allowing fully optimize all business-processes run at an enterprise. To these ones refer comprehensive enterprise resource planning systems – ERP (Enterprise Resource Planning System), which form the unified information base for all sites of an enterprise. ERP-systems constitute a set of programs united by a single technological platform and use a single database that can be formed from databases, which are obtained from different sources and systems and synchronously operate in the real time mode.

ERP-systems create an opportunity to carry out:

– operational monitoring of production processes;

– analysis of needs and formation of production and sales plans;

– operational response to changes in conjuncture and needs of the consumer market;

– management of resources and their optimization;

Table 2

ERP-systems used in Ukraine

Name of ERP-system	Characteristics of ERP-system
1	2
Microsoft Dynamics 365	It belongs to the class of CRM/ERP-systems characterized by a familiar interface. It uses tools for optimization of activities in all enterprise areas: sales, marketing, finances, service, business-processes, analytics.
OneBox	This is the platform produced by domestic developers, an operating system baring a complex character, includes 300 programs and applications, among which there are: CRM system, ERP system, formation of enterprise business-processes, telephony, warehouse and commodity accounting operations, implementation of electronic document flow. It ensures an opportunity of creating own cloud boxes, where applications can be placed. If necessary, the services of official developers can be used.
IT-Entreprise	The platform of a Ukrainian supplier of solutions in the field of business management. It allows to form flexible enterprise business-processes, obtain complete and reliable information regarding the status of the production process and financial activity. It ensures the conditions for operational control of an enterprise financial status, reduction of expenses, efficient resource management, increasing a level of coordinating actions of enterprise departments.
Universal	A software product produced by domestic company SoftPro, intended to automize business-processes at medium enterprises. It is used by 500 enterprises – corporations, distribution businesses, enterprises of food and energy industries, the insurance sector, plants and factories. The contours of the system allow to manage supply, production, warehouse accounting and sales, accounting, finances and document flow.
Oracle ERP	A cloud system by American developers based on the module principle that enable to plan the use of enterprise resources, optimize risk control solutions in the field of finances, supply, orders, interrelations with customers, logistics and staff. To specific features of the system refer: an ability of adaptation to enterprise specifics; the availability of a single data model for a whole enterprise, built-in analytics without using a data storage; Excel integration. It can be applied by small, medium and large enterprises.
IMOOX	A domestic system providing a cloud solution to solve the following tasks: sets-off with customers, carrying out of warehouse, commodity and cash accounting, expenses tracking, business-processes management and connecting telephony.

Source: created by the authors according to [11–14]

– enterprise assets management;

– receipt of necessary information regarding an enterprise status in a short period of time to make relevant management decisions.

The analysis of ERP-systems used in Ukraine has proved their sufficient variety, great functionality, flexibility in settings that creates the conditions for satisfaction of enterprise's needs in its activity optimization (Table 2).

The decision on implementation of ERP-system or replacement of already used one to a more perfect one has to be made by an enterprise grounding on the analysis of its effectiveness at the present moment. The main factors being able to have an impact on these decisions are as follows:

– conclusions on limited capabilities of this system as regards the compliance with the needs of enterprise development dictated by the state of the modern market;

– simultaneous use of several systems characterized by solution of tasks in separate fields of an enterprise operation that does not allow to evaluate an enterprise status as a whole, a process of their integration requires great forces and does not lead to a desirable result;

– revealing insufficient compatibility of the resource planning system with the tools used by employees or customers;

– insufficient level of security of enterprise internal information environment that dictates the necessity of taking a solution regarding the use of cloud or hybrid technologies.

4. Problems of using enterprise information resources in the conditions of martial law

Russian aggression against Ukraine is accompanied by massive cyber attacks on the information space of the state, state information systems, objects that make up critical information infrastructure and enterprise information resources.

Forced evacuation of many enterprises to territories of other countries caused searching for solutions to provide their information resource security and primarily pushed to the use of cloud technologies.

The tasks of resisting threats to information systems operation require increased attention to creation of efficient comprehensive information security system (CISS). The components of such system have to be technical and organizational comprehensive measures fixed in orders,

plans, instructions, procedures of an enterprise and have to comply with current legislative acts on information security. It is also possible to use the European standards of ISO/IEC 27 series.

One of the main legislative acts regulating information systems security processes and the effect of which continues during the martial law is The Law of Ukraine "On information security in information and communication systems" [15]. This law stipulates that information system security issues are taken care of by the system owner based on terms and conditions established in the agreement concluded with an information owner.

As for the state information resources or information with limited access, their security has to meet the existing information security standards providing for the use of a comprehensive information security system (KISS) of confirmed compliance. To confirm the compliance of KISS state expertise is carried out that takes into account branch requirements and information security regulations.

The legally established right of state information resources owners (during the period of martial law in our country and during six months after its termination) regarding the conclusion of agreements in the field of technical administration of definite registers. When concluding agreements as the second party can act foreign companies and organizations rendering services on using cloud resources and their subsidiaries and representative offices working at the territory of Ukraine.

During the martial law KISS is formed in compliance with the previously existing procedure; the conditions of receiving the compliance certificate are not changed. The cost of services on creating information resource security tools depends on the volume of works and is formed by the market method due to the presence at the market competing companies providing similar services.

To issue of a compliance certificate a state expertise has to be carried out according to the Regulations on state expertise in the field of technical protection of information on contractual terms with respective registration of the certificate by The State Special Communications Service of Ukraine [16].

If KISS is transferred to a cloud operation at the territory of Ukraine or a foreign cloud, in the event of changes in an information processing technology or changes in a program component, the review and modernization of security systems is required. Regardless the martial law,

the availability of the KISS compliance certificate or the certificate on conformity to standards ISO/IEC 27 is an obligatory requirement.

In the conditions of martial law, when there are constant threats to information resources from the side of Russia in cyberspace, taking into account that not only online resources of ministries, state institutions become the objects of cyber attacks, but also those of banking institutions, business entities, companies have to be ready for the occurrence of cyber risks to avoid or minimize financial or image loses.

For information systems security enterprises carry out permanent monitoring of status of their own information systems and define the probability of threat occurrence and potential degree of their impact on safe operation. As a guide on approaches to countering threats from the side of cyberspace it is expedient to use a self-control checklist published by the American State Organization CISA [18].

The main steps to ensuring information security can be considered as follows:

1. Systematization of information resources, evaluation of quality control of provided services and information security; this process can be realized within the frame of ITSM (Information Technology Service Management).

2. Revelation of abnormal situations through permanent monitoring of information security status; efficient if the use of SIEM (Security Information and Event Management).

3. Evaluation of a degree of vulnerability to cyber attacks on information systems of business partners, especially in the event of joint use of integrated information systems.

4. Establishing the availability of cyber security certificates at your business partners, their system of permanent protection of their own information space, reliability of infrastructure, including the “cloud” one.

5. Adherence to strict rules of processing, storage and provision of corporate information to interested subjects of external environment based on the use of modern technologies of remote collaboration, multi-factor authentication, information labeling and encryption.

6. In the event of using “cloud” technologies, following the controllability principle that means making timely decisions regarding the expediency of using definite elements of information resources; the use of secure cloud access brokers to control access to resources; evaluation

of changes in infrastructure regarding the absence of negative impact on information security.

7. Constant update of cyber security measures not only with the use of classical testing and security audits, but also modern ways of checking cyber security status and development of respective recommendations on its enhancement. It refers to the actions of a team of specialists, who are not the enterprise employees, involved in evaluation of threats and development of recommendations.

Actions of each team can be aimed to imitation of predicted behavior of potential cybercriminals in order to develop the resistance to potential cyber threats. Combination of actions of representatives from both teams makes it possible to focus on the main problems of cyber security and to develop a plan of required actions to resist potential threats in the field of cyberspace.

As evidenced by the events of the entire period of Russian aggression, solution of the information resource security issues, regardless of territorial location of enterprises, is for them an urgent problem taking into account the key role of business entities' activity in maintenance of the level of economic live in the country.

It is also important for enterprises to solve the issues of purchasing modern equipment and software in the post-war period that will allow to optimize processes of formation and using of information resources.

At the global market acts a number of companies referring to generally recognized in this field:

1. Microsoft – a leading multi-national company in the field of information technologies, production of software and provision of IT-services.

2. Cisco Systems – an American technological company holding the leadership in the field of network technologies development and being focused on large organizations and telecommunication enterprises.

3. Fortinet – a company that produces software and relevant solutions in the field of information security, including antivirus programs, access control systems.

4. Hewlett-Packard – an American technological company, which is the world leader in production of personal computers, printers, scanners, laptops, servers, data storage systems; the company also renders IT-services. In March 2022 the company stopped its business in the Russian Federation and Belarus.

5. Commvault – a company specialized in the development of software in the field of data security and information control, provides solutions for increasing possibilities of hybrid clouds. Recently it has begun cooperation with company Oracle.

6. BMC Software – a company producing software and rendering services on enterprises' transition to digital processes. To software functions refer to: DC automation, management of "cloud processes", services, performance.

7. Vmware – an American company specialized in production of software for virtualization processes; it dominates in this field at the market since its inception.

8. Sophos – a British company proposing means of ensuring information security, virus fighting, spam filtering, phishing resistance.

5. Conclusions

Information resources play a significant role in enterprise management, in creating the conditions for its financial stability maintenance, ensuring its further development.

For correspondence of information resources to both the needs of today and those in the prospect, enterprises have to use the existing domestic practice as well as foreign experience of efficient use of two components of information resources: information ensuring efficient realization of enterprise activities and information systems implementation processes for transforming data into new high quality information.

In the conditions of increased requirements for providing enterprises with information, information resource management processes are becoming more complicated that requires searching for more perfect forms of enterprise information environment organization. Enterprises have to apply information systems based on modern information technologies taking into account a number of criteria, which allow to evaluate their implementation. It is urgent to make a decision on the priority of using information technologies, which are of complex nature to replace the local ones and be able to optimize all business-processes run by an enterprise.

In the conditions of martial law, it is important to pay special attention to information resource security issues to prevent criminal intervention into information environment of enterprises by using cyber space, that does not

only concern state institutions and enterprises of critical infrastructure, but also all business entities.

It is necessary to follow recommendations of information security specialists regarding the sequence of actions when organizing prevention of threats from the side of cyber space even in the event of using "cloud" technologies and to comply with legally established responsibility for protecting information of information system owners.

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