

ENTERPRISE INFORMATION PLANNING – A NEW CLASS OF SYSTEMS IN INFORMATION TECHNOLOGIES OF HIGHER EDUCATIONAL INSTITUTIONS OF UKRAINE

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Наведені особливості побудови нового класу інформаційних систем – систем управління інформаційними ресурсами підприємства (EIP). Розкриті переваги і особливості застосування EIP. Описано застосування EIP для вищих навчальних закладів України. Продемонстровані структура, алгоритми і особливості реалізації EIP в Київському національному університеті імені Тараса Шевченка

Ключові слова: цифрова екосистема, вищий навчальний заклад, система управління інформаційними ресурсами

Приведены особенности построения нового класса информационных систем – систем управления информационными ресурсами предприятия (EIP). Раскрыты преимущества и особенности применения EIP. Описано применение EIP для высших учебных заведений Украины. Продемонстрированы структура, алгоритмы и особенности реализации EIP в Киевском национальном университете имени Тараса Шевченко

Ключевые слова: цифровая экосистема, высшее учебное заведение, система управления информационными ресурсами

1. Introduction

The problem of the Ukrainian educational sphere and higher educational institutions in particular, is that by training professionals to work under conditions of modern world, the system itself does not correspond to these conditions, but is also a “splinter” of the Soviet education. This causes the problems, linked to rendering poor quality educational services, which make the graduates noncompetitive in the world business arena.

A quality higher education requires significant accumulation of funds and resources and, above all, competent administrative approach, strategic planning, control and transparent financing. However, today not all Ukrainian educational institutions have such opportunities. This is caused by the fact that educational process in the majority of higher educational institutions in Ukraine is archaic: instructors read lectures and their students make notes, the timetables are made by hand as well as the applications and

the examinations are taken in writing. This situation does not correspond to world trend of informatization of educational sphere. Therefore, for the adaptation of the Ukrainian educational sphere to the modern world realities and for the improvement of education quality in Ukraine, the informatization of higher school is a necessity.

The informatization of higher school implies the transition to a large-scale complex application of information technologies in different spheres of university activity. In the process of informatization of higher education sphere, the problems connected with the organization and improvement of educational process are becoming increasingly important. Contemporary educational technologies with their considerable potential offer great prospects.

The diverse approaches and means of informatization of higher educational institutions lead to an increase in the complexity and expenditures for creating, introducing and integrating these means into uniform information system of a higher educational institution. To solve this problem, it is

necessary to typify the processes of information interaction of users with the IS software as well as the processes of information interaction between the IS. Therefore, the problem of developing uniform digital ecosystem of higher educational institutions, which will be a managing superstructure of the program-information tools of the information systems and will ensure standardization of the processes of interaction between both the information systems themselves and between the information systems and users, is topical.

2. Analysis of scientific literature and the problem setting

Let us analyze the role of information technologies on the example of a higher education system of some western countries.

We will examine innovations of the academic process of Polish institutes of higher education.

Modernization and innovation of the educational process of Poland includes several projects:

1. A digital library of scientific publications ACADEMICA [1].
2. A system of distance learning of the Silesian Technological University [2].
3. Polish Virtual University (PUW) [3].
4. Educational and scientific center in Warsaw for open and multimedia education [4].
5. The USA-Poland Innovation Program (PLUS-IP) [5].

The studies of educational sphere of the USA showed that the main problems of universities are in the ineffectiveness of the state educational policy (uselessness of obtained education, expensive and ineffective higher educational institutions, nonconformity of curricula to the market needs) [6].

Speaking about informatization of the higher school in the USA, we should say that the electronic universities are no longer the innovative solution for the country. For example, such higher educational institutions of the USA as Western Governors University, Harvard University, Stanford University, the University of California and others have their Internet platforms, which unite educational processes of a university into the uniform all-accessible system.

The next step in the development of higher school will be splitting higher education into smaller units. This means that the universities of different states will be integrated into one digital ecosystem with common curricula, teaching staff and students. With this approach, educational process will generally take place not on the campus, but in a place providing a student with access to the Internet [7].

Examining the publications of Great Britain [8–10] on the problem of informatization of higher educational institutions, the main trends were distinguished. Nowadays, the tendencies of informatization of higher education of Great Britain are directed toward the virtualization of educational environment.

For example, free Open Online Courses (MOOCs) have become a well-known aspect of using information technologies in education in recent years. Free access to the courses for all those willing to receive education is provided from 142 universities. The universities of Great Britain transfer to teaching on-line through the virtual media of instruction such as Blackboard and Moodle [11, 12]. These virtual media are used mainly for conducting a course, storing the

content of a course and additional resources, necessary for conducting the course. One more additional technological innovation of Great Britain is digital dissemination, storing, analysis and the open access to reviewed scientific studies. Digital technology gives researchers some new tools to facilitate collecting, analyzing and disseminating the data while students now have an access to increasingly wide spectrum of online resources for studying.

As it was shown earlier, development of higher school is sure to lead to the creation of the unified digital ecosystem with the common curricula, instructors and students [7]. This important trend in the development of education, and namely, the creation of global educational digital ecosystems led the authors to conducting the studies, which will create conditions for uniting the information systems of the institutes of higher education into this ecosystem.

Based on the experience of building up information systems for managing labor force and material and technical resources [13–16], it appears worthwhile developing a system of managing of enterprise information resources – Enterprise Information Planning (EIP), which can be used for the informatization of higher educational institutions of Ukraine. Such systems must become the core of educational sphere of higher educational institutions.

3. The purpose and the tasks of the study

The purpose of this work is the development of the concept of building up the EIP as the core of digital ecosystem of higher educational institutions.

To achieve the set goal, it is necessary:

- to present informatization medium of higher educational institution based on the digital ecosystem;
- to reveal special features of creating a digital ecosystem at higher educational institutions;
- to propose a structure of the information management system of a higher educational institution and to show practical result of its application.

4. Digital ecosystem of a higher educational institution

The informatization of educational system of a higher educational institution is a task, the relevance of which has been noticeably increasing lately. This is connected with a number of reasons.

Firstly, nowadays the policy of development of Ukraine is directed toward the transition of educational system to the European values, which requires compliance of higher educational institutions with the world standards.

Secondly, a constant growth of computers' role in the life of the society, the enterprise, the state as a whole and individual people in particular, cannot leave the educational system outside of information progress.

Thirdly, the need for processing large information volumes stimulates higher educational institutions to introduce information technologies, which makes it possible to increase the efficiency of educational activity.

Informatization of a particular educational institution is a set of measures, aimed at application of information technologies for increasing the efficiency in data processing in all kinds of activity of modern institution of higher education without any exception [17].

For example, at higher educational institutions of the USA a question of informatization is not an innovation but the accepted standard of the educational process management [18].

If we consider Harvard University (the USA), the structure of its information technologies (IT) will take the following form (Fig. 1):

Another good example of the informatization of a higher educational institution is Cambridge University (Great Britain). At Cambridge University, for the IT infrastructure maintenance and development, there are University

Information Services, the scheme of which is represented in Fig. 2.

There is a service desk to help solve current problems. The service managers are experts in their services and deal with the solution of more complex problems. The relationship managers work with the users for improving the services, while the service owners work with the departments and the subdivisions on the services improvement problems. Overall, eight divisions, the basic functions of which are given in Table 1 [19], provide information services operation.

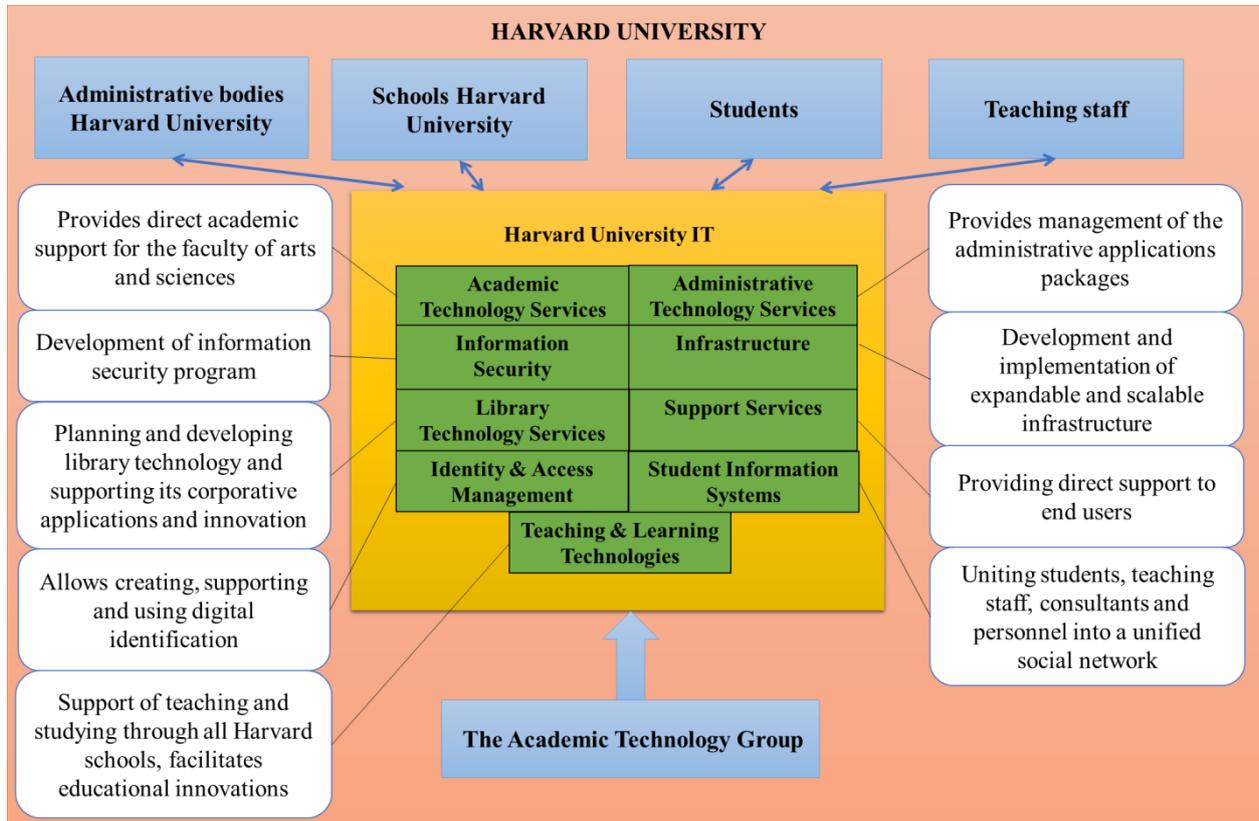


Fig. 1. Harvard University IT

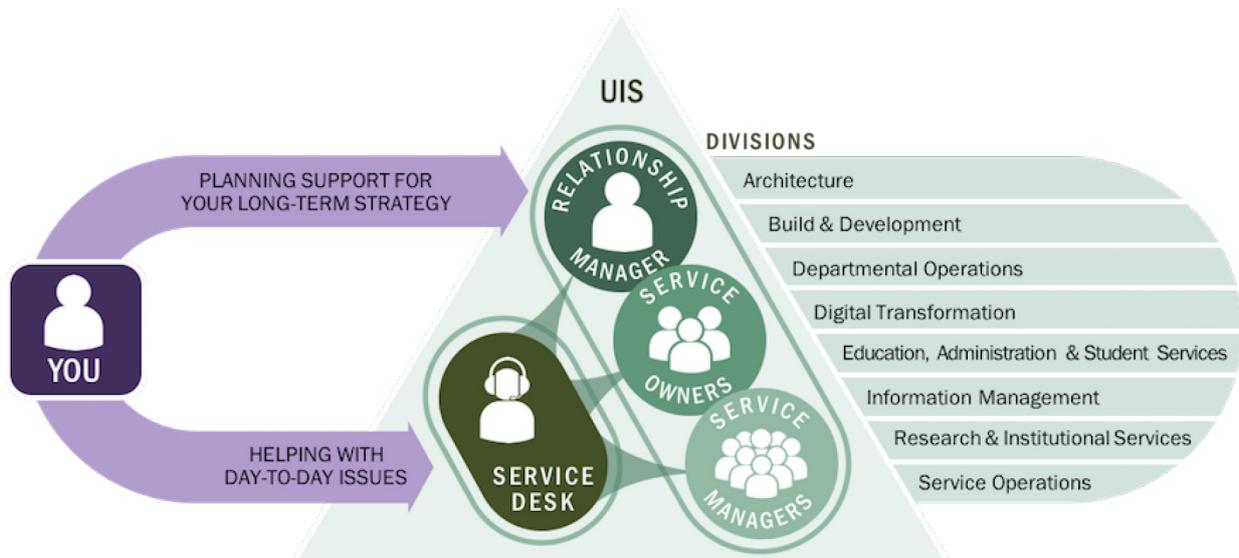


Fig. 2. Cambridge University IT [19]

Table 1
Functions of Cambridge University IT divisions

Division	Core activity
Architecture	Designing IT architecture of the key objects, developing the principles of IT objects construction
Build & Development	Designing new services and updating the existing ones
Departmental Operations	Responsible for services operation at the departments
Digital Transformation Consultancy	Search and designing potential opportunities for innovations
Education, Administration and Student Services	Responsible for the interaction of administrative services with other services. End-to-end IT service
Information Management	Helps the university to manage the data connected risks. Responsible for the university data and the IT security
Research and Institutional Services	Provide connection among the institutions. Computational services
Service Operations	Responsible for rendering and maintaining all services around the university

After analyzing the situation in Poland, it can be concluded that the management system of educational process of the institutes of higher education in Poland is built on innovative designs, supplementing traditional educational system. Since 2002, the State Accreditation Committee (Państwowa Komisja Akredytacyjna) has worked in Poland [20]. This committee exercises quality control and checks if the education meets the quality standards in the institutes of higher education. Państwowa Komisja Akredytacyjna of the Polish Republic closely collaborates with similar organizations in other countries. The system of quality provision of Poland corresponds to the standards and meets the requirements of ENQA [24].

Desire to reach the best world results and understanding of the need for the educational sphere informatization make the administration of institutes of higher education of Ukraine create the information systems (IS), which provide solution to administrative, academic, scientific and other problems of these institutions.

The information systems implemented in the Institutes of Higher Education can be divided into four classes (Fig. 3):

1. *Information systems for academic process (ISAP)* are used for providing and maintaining educational process in a higher educational institution.

2. *Administrative information systems (AIS)* are used for providing and maintaining the work of a higher educational institution.

3. *Information systems for scientific studies (ISSS)* are used for providing and maintaining scientific research activity of a higher educational institution.

4. *External information systems (EIS)* are used for maintaining educational process, but are not its part (for example, a united state electronic base on education problems – USEBE).

The interaction between information systems is shown in Fig. 4.

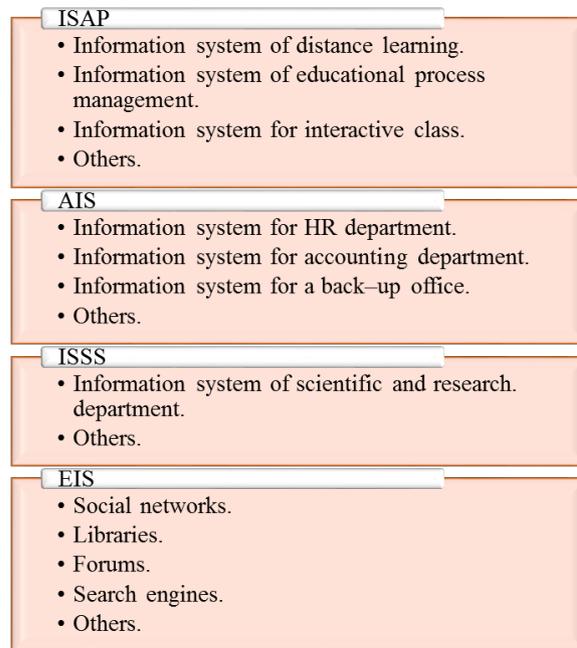


Fig. 3. Information systems of a higher educational institution

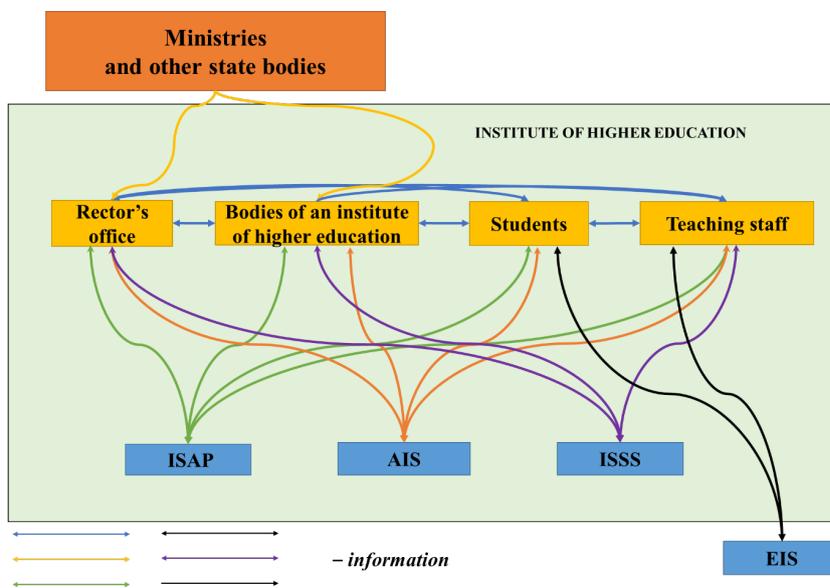


Fig. 4. Interaction in an institute of higher education by means of information systems

Functioning of the information systems of an institute of higher education is characterized by existence of many interactions (information influence and reactions to the influence). The greater such interactions, the higher the probability of an error and the longer it takes for the information to reach the end user (or it may not reach him at all or not in due time).

Let us examine a special case (Fig. 5). It is necessary for the Rector's office of a higher educational institution to obtain the information D, which consists of the documents d_1, d_2, d_3, d_4 . To get the information D (d_1, d_2, d_3, d_4), they act on the worker S_1 . Since the information system, the worker S_1 interacts with, can provide only information d_1 , the worker S_1 acts on the workers, who work with the systems S_2 and S_3 for obtaining the information d_2 and d_3 , respectively. Since the information system, the worker S_3 interacts with, has no information d_4 , to obtain it, the worker S_3 acts on the worker S_4 . Further, S_4, S_3, S_2, S_1 interact in the reverse order, giving each other the information D.

With this form of interaction, the time of obtaining information will be equal to:

$$T_1 = \sum_{i=1}^n t_i^z + \sum_{j=1}^m t_j^o, \tag{1}$$

where T_1 is the total time of obtaining information, t_i^z is the time, necessary for delivering the request for obtaining document d_i to the performer; t_j^o is the time, necessary for processing the request for obtaining document d_i and giving the information to an initiator (answer); n is the number of requests; m is the number of answers (in general case $n \neq m$).

The risk of providing incorrect information is proportional to the probability of error in understanding of at least one request:

$$P_1 = 1 - \prod_{i=1}^n \prod_{j=1}^{m_i} p_{ij}, \tag{2}$$

where P_1 is the probability of error in understanding at least one request; p_{ij} is the probability of correct understanding of a request for obtaining document d_i by performer R_j ; n is the number of requests; m_i is the number of the performers in the chain of processing a request for obtaining document d_i ; i is the number of the document; j is the number of a performer.

Consequently, the more workers are involved in providing the information, the later it will be obtained by the end user, and the higher the probability of error.

The influence of external environment and the instability within the environment should also be considered. Such factors as a large load on workers, a large number of influences on one worker, breakdowns in information systems and many other factors can considerably increase the time T and probability of the error P . But obtaining the information in due time plays an important role in making administrative decisions.

It follows from the stated above, that to increase the efficiency of the work of an institute of higher education, it is necessary to shorten the way from the information requester to the specialist who obtains it, as well as in the opposite direction. For this, the information systems must "understand" each other's requests and know how to realize them with the significant degree of automation. The main problem lies in the fact that some of the given information systems are connected logically, but physically they are located in different departments of a higher educational institution. They are also created at different time and by different developers, which leads to problems not only during information exchange, but also during design of a uniform information technology of higher educational institutions.

If we speak about united information technology of a higher educational institution, it is necessary to determine which program information core of the technology should be used, in which different systems can easily exchange information. To solve this problem, the information technology of IHE (Institute of Higher Education) should be considered as the totality of people, policies, methods and the tools, realized by the *digital ecosystem of a higher educational institution (DE IHE)*.

Digital ecosystem is an artificial complex, which includes software, the medium of its development, operation, support and recycling, which are connected together by program products and knowledge exchange [22].

Then it is possible to present informatization of institutes of higher education by the diagram shown in Fig. 6.

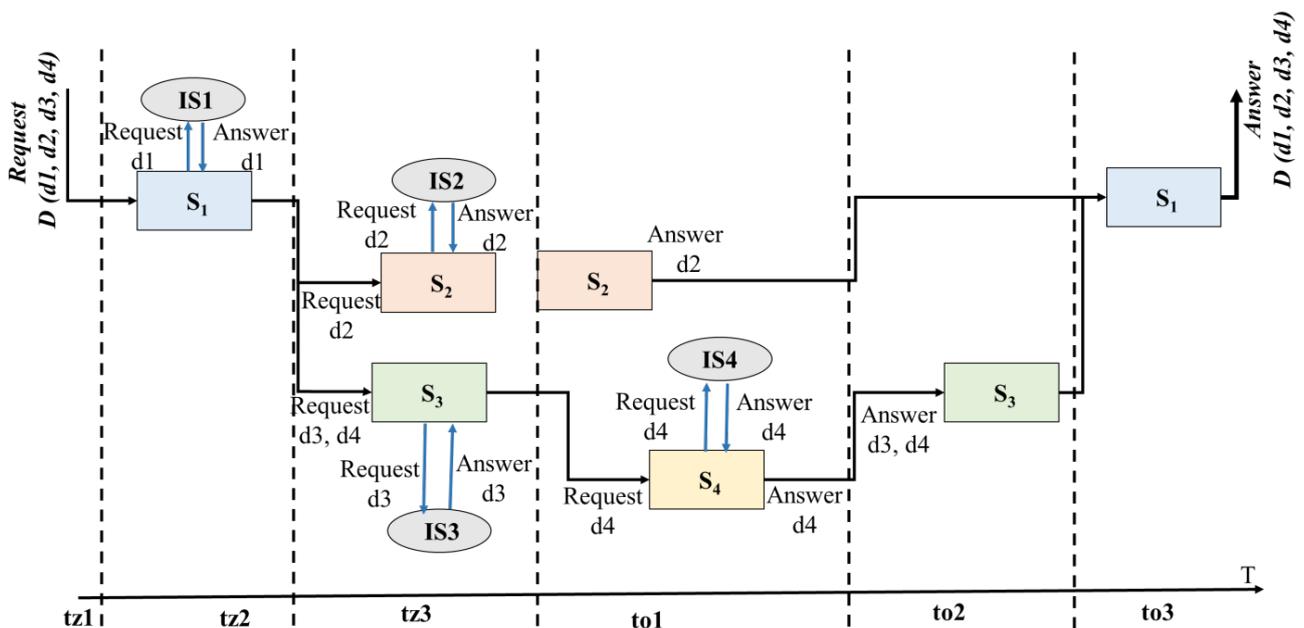


Fig. 5. Chain of interactions between the information systems for obtaining the necessary information

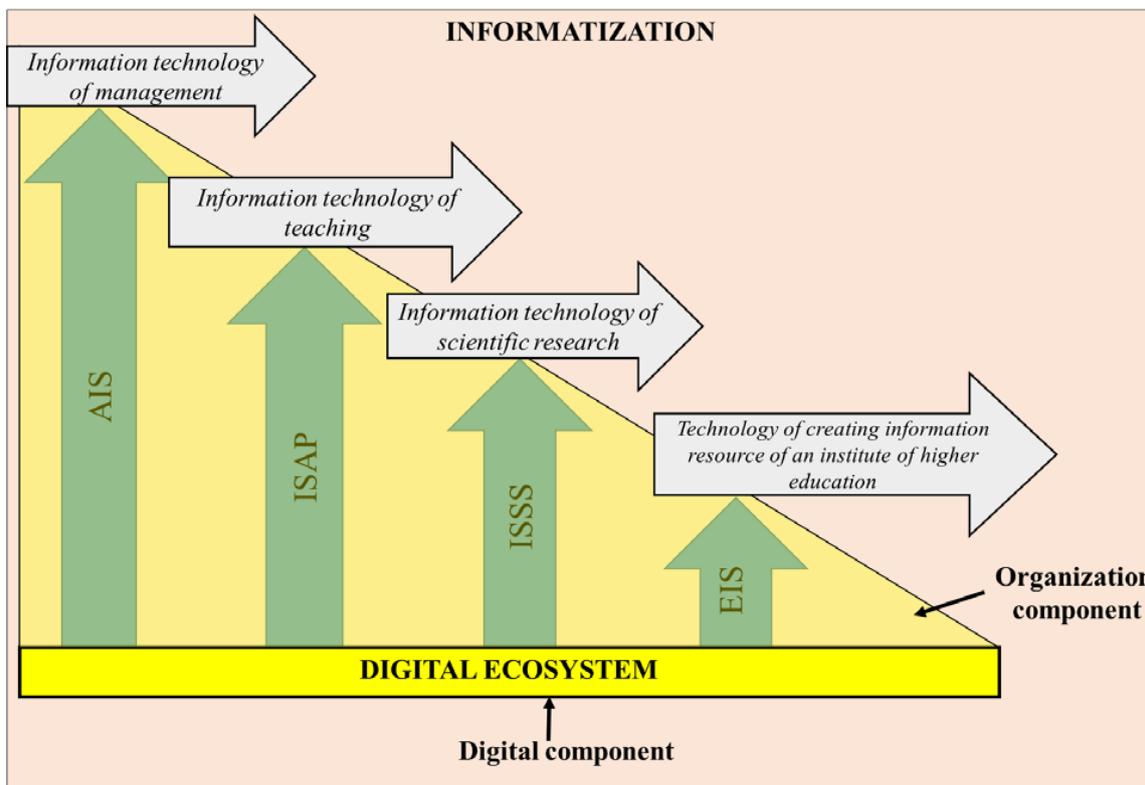


Fig. 6. Digital ecosystem as the core of the informatization processes of higher educational institutions

In the scientific work [23], it is emphasized that in the IT sphere there is a tendency toward the use of the concepts of complex ecosystems for the designation of social-technical systems of software (further – SW). It is explained by the structure of contemporary software package systems, the dynamic interrelations of independent and competing components in the complex system of environment. This system is the totality of people, computers and organizations. Complexity, decentralized control, difficult-to-forecast effects of specific types, complexity in monitoring and evaluating results, competition in groups, stability, adaptability and viability [24] characterize the concept of the ecosystem as a complex system.

The transition from one institute of higher education to another requires the adaptation of this software to new conditions. Therefore, one of the reasons of applying an ecological approach to the studies of software is the necessity of considering software as an organized system in the context of real world [25].

The functioning of the described information systems with the transition from one institute of higher education to another will be set not only by a software structure, but also by settings, reference books, standards and regulations. That is why, not only software but also information support will be related to the digital ecosystem. This will make it possible to set the system for functioning under the conditions of any institute of higher education.

That will ensure the creation of not only industrial DE IHE, oriented for particular institutes of higher education, but also of its commercial versions.

We will present the digital ecosystem of higher educational institution consisting of the following entities:

1. *Environment (E)* is the medium of DE IHE functioning, the objects of the living and non-living nature of an institute of higher education.

2. *Actor* is the subject of an institute of higher education who interacts with the ecosystem.

3. *Information systems* (further – IS) are the organizational and technical objects, which interact with the environment and the actor.

4. *External environment (EE)* is the medium, in which an institute of higher education functions.

The entities of the digital ecosystem are represented in Table 2.

Table 2

Entities of the digital ecosystem of an institute of higher education

№	Element	Entity
1	Environment	institute of higher education
2	Actors	– Rector’s office; – students; – teaching staff; – bodies of an institute of higher education
3	Information systems	– information systems for academic process; – information systems for maintaining process; – information systems for scientific and research activity; – information systems outside an institute of higher education
4	External environment	– Ministry of Education and Science of Ukraine; – newspapers, radio, TV, the Internet; – National Academy of Sciences; – other departments and organizations

Digital ecosystem is a complex system, and therefore, timely and coordinated interaction of all of its elements is necessary for its efficient functioning. It is impossible

without a quality control of the information resources. It is known that the problem of interaction between the ecosystem components is always connected with the quality of information support of its processes.

Digital ecosystem is a program information system, in which both the subject-oriented functions of the given systems of an institute of higher education (the intersection of DE IHE with other information systems) and the functions, which are common for these systems, are realized (Fig. 7). The common functions include:

- in the part of designing the methods and the means of informatization – informatization program management (the core of development);
- in the part of informatization – information resources management of an institute of higher education (the core of realization).

Taking into consideration that the common functions are concentrated on management, development and operation, it is expedient to introduce one additional concept into the sphere of creating digital ecosystems. This is the concept of information management.

Information management is the administrative technologies, the components of which are the documented information, personnel, technical and software means of provision of information processes as well as regulatory established procedures of formation and usage of information resources [26].

For the realization of the functions of information management in a digital ecosystem, it is proposed to create a link for the information systems and actors – *information management system of an institute of higher education (EIP)*.

EIP is a system of planning, collecting, storing, processing and controlling electronic information.

5. Information management system of an institute of higher education

EIP is the development of the systems of managing document circulation in any information representation. In contrast to the traditional systems of document circulation management, EIP manages any information, produced by information systems of an institute of higher education and used beyond the borders of these systems. Its main purpose is to manage the processes of creating and using electronic information at a higher educational institution.

The functions of EIP:

- planning information obtaining;
- planning information exchange;
- electronic accounting of in-coming documents (including electronic, produced by the IS);

- fast search of necessary information;
- monitoring information operations (including giving and fulfilling assignments);
- controlling the information flow.

The structure of the system includes three components:

1. *Organizational component of the information management system:*

- creation of informatization center (subdivision responsible for the information of an institute of higher education);
- change in the functions of subdivisions of a higher educational institution connected to the creation of informatization center and to the centralized information management;
- change in the priorities of subdivisions and leaders.

2. *Technological component of the information management system:*

- change in the document circulation technology, connected to the introduction of EIP;
- development of the interaction structures in the information management process;
- introduction of the technology of the IS product management.

3. *Components of the project of creating an information management system of a higher educational institution:*

- creation of new business processes;
- re-engineering of business processes;
- redistribution of the functions of subdivisions and staff.

After the introduction of EIP, a digital ecosystem of an institute of higher education will take the following form (Fig. 7).

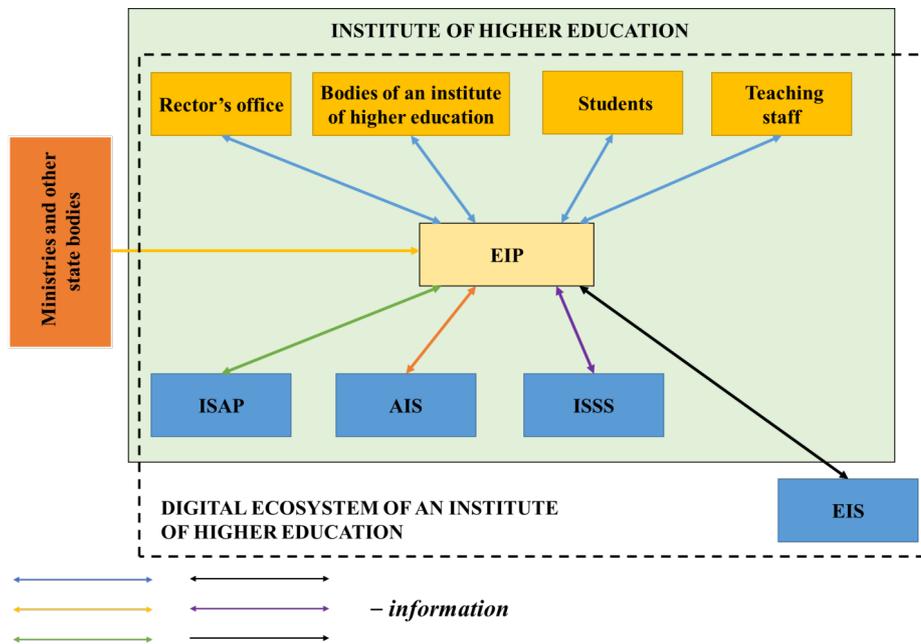


Fig. 7. Obtaining information in higher educational institutions through EIP

This structure allows any participant of the educational process to obtain necessary information (through administrator or independently by a request, or by the standards of information interaction, described in EIP).

Let us take the example with obtaining information D (d₁, d₂, d₃, d₄) through EIP (Fig. 8).

With the use of EIP, the time of obtaining information is defined as

$$T_2 = \sum_{j=1}^m (t_j^z + t_j^o), \tag{3}$$

where T_2 is the time of obtaining information with the use of EIP; t_j^z is the time, necessary for delivering the request to obtain document d_j to the executor; t_j^o is the time, necessary for processing the request to obtain document d_j and providing the information to the initiator (answer); m is the number of documents.

Similar to the formula (2), the risk of providing incorrect information is proportional to the probability of error in understanding at least one request. In this case, each request chain consists of one element:

$$P_2 = 1 - \prod_{i=1}^n p_i, \tag{4}$$

where P_2 is the probability of error in understanding at least one request in EIP; p_j is the probability of correct understanding of the request to obtain document d_j ; n is the number of requests.

If we examine the values, obtained in the formulas (1), (3) and (2), (4), it is possible to draw a conclusion that EIP in a general case decreases the time and lowers the risk of obtaining incorrect information. Actually, from (1) and (3)

$$T_2 \leq T_1.$$

And from (2) and (4)

$$P_2 \leq P_1.$$

Let us consider the example. It is necessary to obtain a number of documents. The time of their obtaining is set in Table 3.

The time of the interaction while delivering requests for obtaining information is shown in Table 4.

Delivering the obtained information to the user is achieved in the reverse order.

The time of interaction while providing the requested information by the IS is shown in Table 5.

Table 3

Example of the sources and the time required for obtaining information with the use of IS

Document designation	Document	Source designation	Source	Time for obtaining the document (min)
d_1	Number of applications for entry to an institution of higher education	S_1	The head of the information computer center (IS «Applicant»)	10
d_2	Number of vacant places at the dormitory	S_2	Campus (IS «Dormitory»)	240
d_3	Number of vacant places in the second course	S_3	Educational and methodological center (IS «Management of academic process»)	60
d_4	Date and place of the Admission Committee sitting on considering transferring and education resuming issues	S_4	Responsible Secretary of the Admission Committee (IS «Event Calendar»)	5

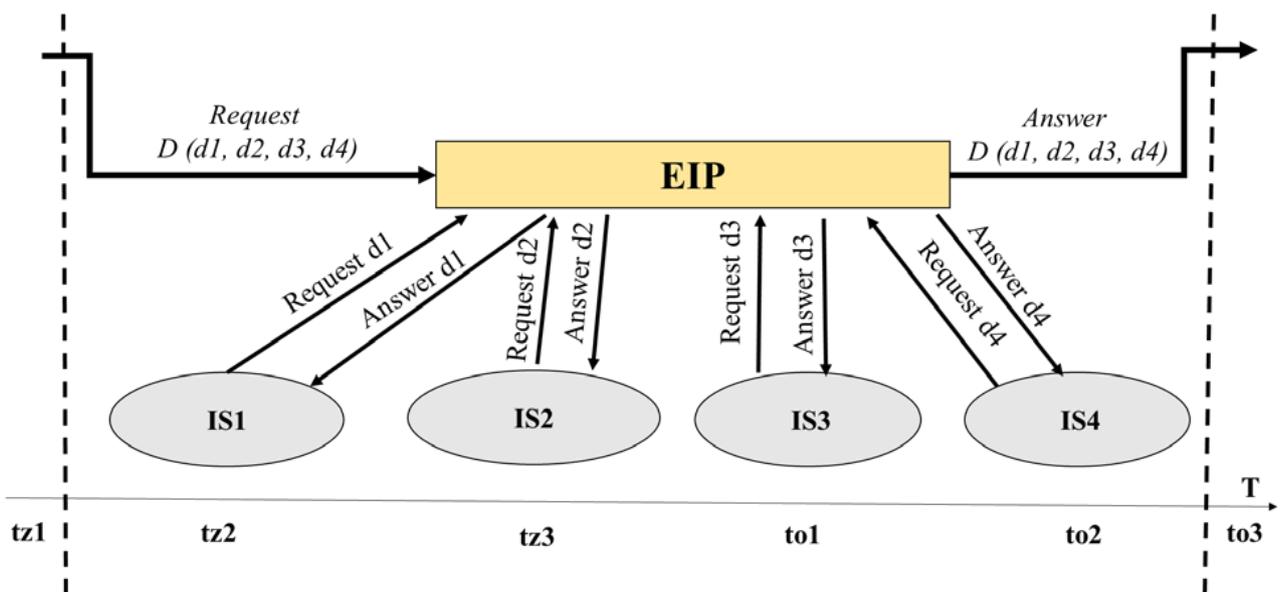


Fig. 8. Information interaction in the digital ecosystem through EIP

Table 4

Time (min) of interaction while delivering requests for obtaining information to traditional IS

Requesting/ Requested	Rector's Office	S ₁	S ₂	S ₃	S ₄
Rector's Office	–	–	–	–	–
S ₁	t ₁ ^z =20; t ₂ ^z =25; t ₃ ^z =30; t ₄ ^z =10	–	–	–	–
S ₂	–	t ₂ ^z =25	–	–	–
S ₃	–	t ₃ ^z =30; t ₄ ^z =10	–	–	–
S ₄	–	–	–	t ₄ ^z =10	–

Table 5

Time (min) of interaction while providing the requested information by the IS

Receiver/Source	Rector's Office	S ₁	S ₂	S ₃	S ₄
Rector's Office	–	–	–	–	–
S ₁	t ₁ ^z =20; t ₂ ^z =20; t ₃ ^z =20; t ₄ ^z =20	–	–	–	–
S ₂	–	t ₂ ^z =30	–	–	–
S ₃	–	t ₃ ^z =20; t ₄ ^z =20	–	–	–
S ₄	–	–	–	t ₄ ^o =5	–

Certainly, this time includes the time of waiting for counterparty; his/her being busy with other matters is also considered. If the information is delivered by electronic mail, then the counterparty may not immediately see a letter and so on.

We will estimate the probability of correct understanding a request by the values, represented in Table 6.

Table 6

Probability of correct understanding of a request to obtain the information with the use of traditional IS

Receiver/Source	Rector's Office	S ₁	S ₂	S ₃	S ₄
Rector's Office	–	–	–	–	–
S ₁	p ₁ =0,99; p ₂ =0,90; p ₃ =0,80; p ₄ =0,98	–	–	–	–
S ₂	–	p ₂ =0,99	–	–	–
S ₃	–	p ₃ =0,90; p ₄ =0,95	–	–	–
S ₄	–	–	–	p ₄ =0,99	–

If EIP is used, we will obtain other characteristics of the interaction (Tables 7, 8).

We will estimate the probability of correct understanding a request during the interaction by the values, represented in Table 9. An increase in the probability of correct recognition of the request by EIP, in comparison with their recognition by the traditional IS, is explained by the fact that EIP comprises professionals working with information,

managers and specialists, who are engaged in the work with users in the information management sphere.

Table 7

Time (min) of interaction while delivering requests to obtain information to EIP

Requesting/ Requested	Rector's Office	EIP	S ₁	S ₂	S ₃	S ₄
Rector's Office	–	–	–	–	–	–
EIP	t ₁ ^z =5; t ₂ ^z =5; t ₃ ^z =5; t ₄ ^z =5	–	–	–	–	–
S ₁	–	t ₁ ^z =15	–	–	–	–
S ₂	–	t ₂ ^z =25	–	–	–	–
S ₃	–	t ₃ ^z =20	–	–	–	–
S ₄	–	t ₄ ^z =10	–	–	–	–

Table 8

Time (min) of interaction while delivering the obtained information through EIP

Receiver/ Source	Rector's Office	EIP	S ₁	S ₂	S ₃	S ₄
Rector's Office	–	–	–	–	–	–
EIP	t ₁ ^z =25; t ₂ ^z =25; t ₃ ^z =25; t ₄ ^z =25	–	–	–	–	–
S ₁	–	t ₁ ^z =5	–	–	–	–
S ₂	–	t ₂ ^z =5	–	–	–	–
S ₃	–	t ₃ ^z =5	–	–	–	–
S ₄	–	t ₄ ^z =5	–	–	–	–

Table 9

Probability of correct understanding a request to obtain the information with the use of EIP

Requesting/ Requested	Rector's Office	EIP	S ₁	S ₂	S ₃	S ₄
Rector's Office	–	–	–	–	–	–
EIP	p ₁ =0,99; p ₂ =0,90; p ₃ =0,80; p ₄ =0,98	–	–	–	–	–
S ₁	–	–	–	–	–	–
S ₂	–	–	–	–	–	–
S ₃	–	–	–	–	–	–
S ₄	–	–	–	–	–	–

Then, if we put the values from Tables 5–9 to the formulas (1)–(4), we will receive:

$$T_1 = (20+25+30+10+25+30+10+10) + (20+20+20+20+30+20+20+5) + (10+240+60+5) = 630 \text{ min.}$$

$$T_2 = (5+5+5+5+15+25+20+10) + (25+25+25+25+5+5+5+5) + (10+240+60+5) = 525 \text{ min.}$$

$$P_1 = 1 - 0,99 \cdot (0,9 \cdot 0,99) \cdot (0,8 \cdot 0,9) \cdot (0,98 \cdot 0,95 \cdot 0,99) \approx 0,415.$$

$$P_2 = 1 - 0,99 \cdot 0,95 \cdot 0,90 \cdot 0,99 \approx 0,162.$$

As can be seen from this example, EIP decreases the time and the risk of obtaining incorrect information.

Of course, EIP is not DBMS (Data Base Management System) that realizes requests to databases. EIP fulfills requests to the actors who work with different IS and obtain various information for performing their functions. On the other hand, EIP realizes automated technology for obtaining information. When a request for the information is an element delivered to the information management sphere, it is planned, forwarded to a necessary addressee; its fulfillment is controlled and all the actions with information are recorded.

6. Practical testing of the information management system at an institution of higher education

Realizing EIP in full at an institution of higher education is the task requiring a large amount of resources and time. Such a system is being field-tested at the Taras Shevchenko National University of Kyiv (Ukraine).

The purpose of EIP is the management of all the information at an institute of higher education that is contained in electronic form.

The capabilities of EIP:

1. Work with different information representations: e-letters, scanned documents, announcements and reports (external, internal and those obtained from other IS).

2. Work planning (priority, authorities and terms) and appointing those in charge of working with information representations.

3. The concept of a backup (one user can substitute for another while working with documents).

4. Parallel forwarding of information representations with processing according to the principle “the first to obtain the information will process it without sending it to the other” (for example, if either Rector or the first Deputy-Rector is free, s/he will get acquainted with the information and re-forward it).

5. Personal work in the system.

6. Restricted access for users to various parts of the system.

7. Data encrypting in the system.

8. Information caching on customers.

9. Recording all actions.

The main functions of EIP:

1. Planning information processes.

2. Keeping electronic base of information representations and searching within it.

3. Tracking the information flow and actions of users.

4. Control of the set terms.

The architecture of EIP is represented in Fig. 9.

The server part consists of two parts: the database server PostgreSQL, in which all information is

stored and the file server ftp for storing information representations. The selection of PostgreSQL as the database server was predetermined by the developers’ experience of working with this program product, good documentation, multi-functionality, open license and a large community.

Client application is a desktop application with a local cash of information. In other words, a user always works with his/her local copy of information, which then is synchronized with the server.

At the launch of the client application, a welcome message is displayed where a user enters a login and a password (Fig. 10).

The main screen of the system opens after that (Fig. 11).

The upper line of the main screen contains the entrance date and the name of the user.

The system interface is divided into several tabs: “Registration”, “Administrator”, “Archives”, “Documents”, “University” and “Tasks”. In Fig. 11, the tab “Registration” is represented, in which the information representation is registered, a number assigned, and the users to who it is forwarded are defined (either individually or in groups).

Only the users with administration rights have the access to the tabs “Administrator” and “Archives”.

The tab “Documents” is necessary for the leaders who forward requests to performers. The tab “Tasks” shows the tasks of the users, in which a user is a manager.

The tab “University” contains user statistics: ongoing tasks, fulfilled requests, forwarded requests and a number of incomplete tasks.

The algorithm of the system operation is shown in Fig. 12.

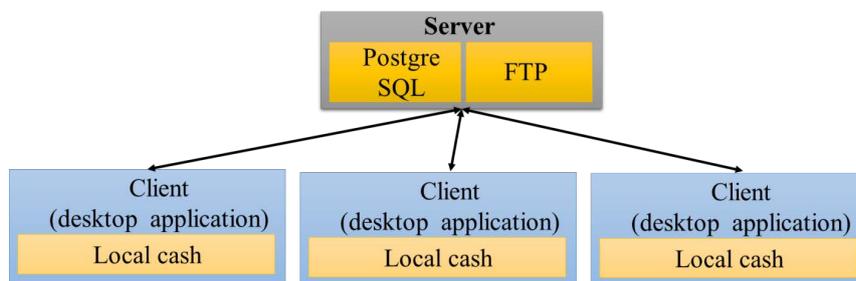


Fig. 9. Architecture of EIP



Fig. 10. Welcome message of EIP

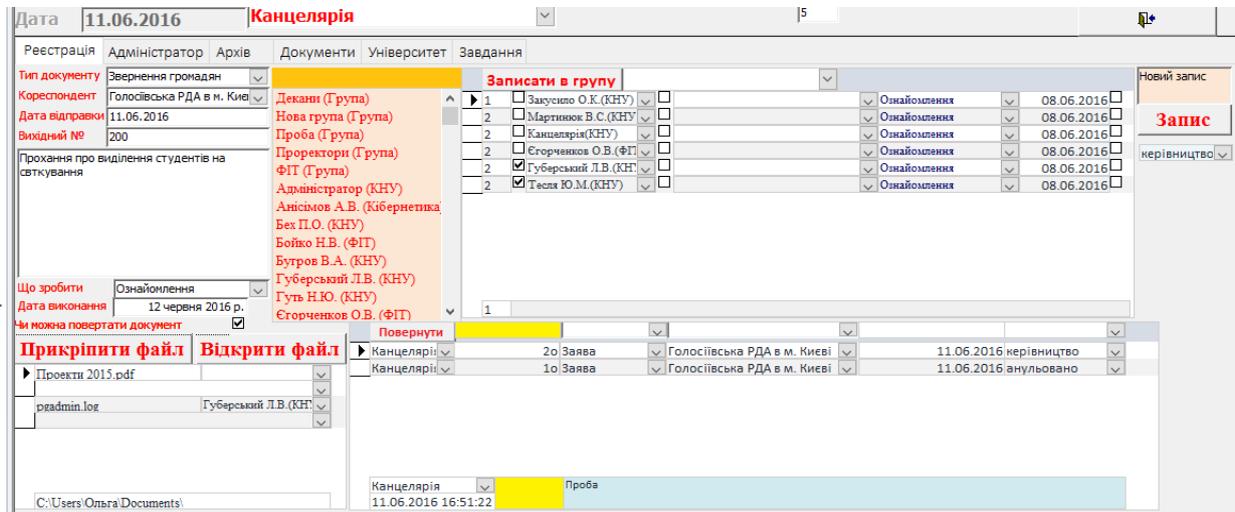


Fig. 11. Main EIP screen

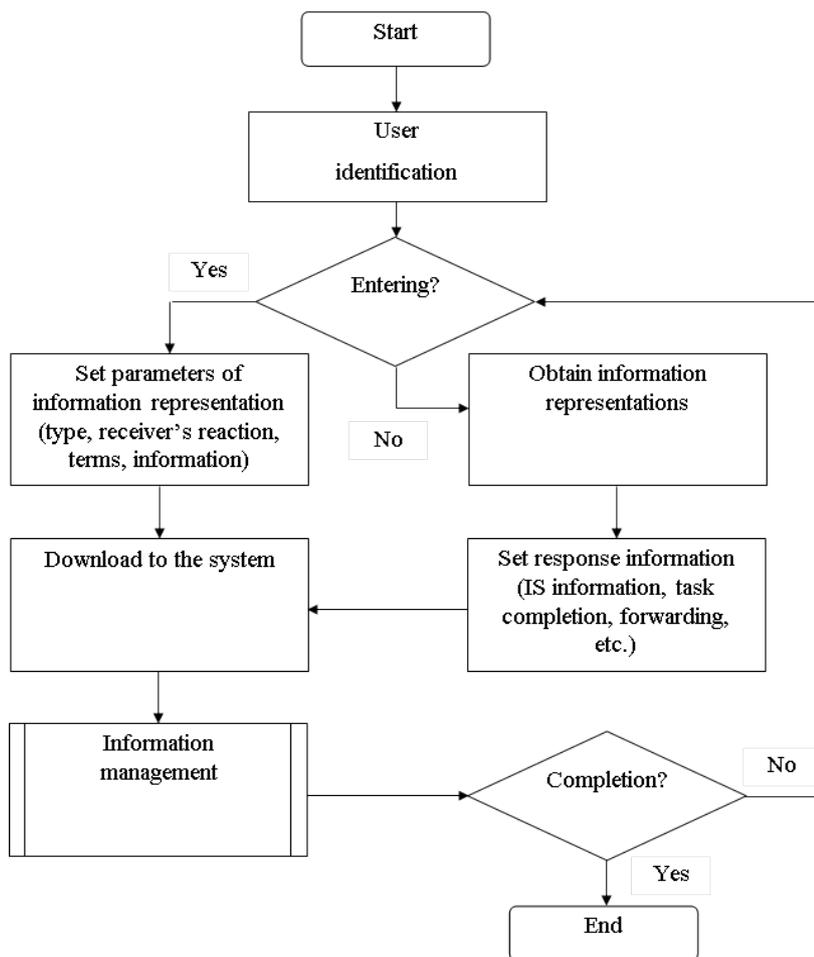


Fig. 12. Algorithm of EIP operation

The solution to the information management problem is original in the system. The information management functions are concentrated on the actor "Administrator". They include:

- organization of information interaction of the system users;
- planning of information processes;
- information interaction control;

- realization of interaction in the pair "leader-backup";
- provision of the use of information representations of e-mails, information;
- systems, external and internal documents in the uniform information technology of an institute of higher education);
- control of fulfillment of the tasks, initiated through EIP;
- general information distribution;
- fighting spam;
- providing information security;
- recording all the actions and changes in the information system;
- system upgrade.

The information management module of the system maintains all these functions. Using it, the administrator sees and knows everything that goes on in the system, plans and controls its work, accumulates the EIP usage experience and takes measures for its upgrade.

7. Discussion of the results of creating information management system for institutions of higher education in Ukraine

EIP fills its niche in the information technologies of higher educational institutions. EIP itself does not solve functional problems, but creates functional medium of the information management in all systems used by a higher educational institution. The problem of the integration of all information systems of a higher educational institution is urgent for the informatization projects leaders. However, the traditional way to integration, creation of a uniform information base and development in the united medium with uniform management frequently fails to deliver because of the complexity of such integration. Here a new method is proposed. This involves the creation of a system that is the information functional superstructure above all other systems. It is not

necessary for users to have a good command of working with the systems 1C “Accounting”, “Schedule”, “Staff” and “Academic load”.

Therefore, creation of a new concept of the information systems integration based on the digital ecosystem of a higher educational institution, the core of which is the system of information control, is promising.

The main advantages of EIP are:

1. Localization of the information control functions of IS in EIP, which makes it possible to easily adjust entire information medium of an institute of higher education to the needs of users.

2. Newly created and implemented IS are not adjusted to the databases and knowledge bases of other IS. Their integration is achieved based on macro-description of the information technology of an institute of higher education, carried out in EIP.

3. Without knowing what information and where it is located, a user can form requests to obtain it in the uniform functional EIP medium.

The disadvantages of EIP may include additional functionality and, therefore, additional expenditures for an institution of higher education connected with the creation and introduction of such systems.

The fragmentation of the means of solution to different problems, their isolation in time and place of their creation require setting up a certain “system of the information management in IS”, the concept of the creation of which for higher educational institutions is suggested. Such information management systems can and must be created in other spheres as well, not only in higher educational institutions. Nevertheless, considering the disadvantage cited below, it is clear that it is rational to implement them only if we deal with an enterprise that has a complex organization, where different information systems function. For example, if enterprise resources planning systems, ERP, which initially integrate the functional of different subdivisions, are implemented at an enterprise, the EIP introduction may not be necessary. The disadvantage of ERP is its high cost, which is often a decisive factor for the Ukrainian enterprises.

The proposed concept gives a general idea about EIP, but it is not an instruction to its creation. Conducted research make it possible to concentrate the attention of developers not simply on the solution of the functional problems of users, but on the creation of a uniform managing unit of the IS in higher educational institutions. The fundamentals of setting up such systems are formulated in this article.

Based on the conducted studies, it is planned in future to create a commercial version of EIP system, which will be adjusted to different IS families and used not only at higher educational institutions, but also at enterprises of different spheres of activity.

8. Conclusions

1. Special features of creating a digital ecosystem at higher educational institutions are revealed. Based on the example of the USA, Poland and Great Britain, the tendencies of informatization of higher educational institutions are shown. It was revealed that the main trends of educational sphere in the USA and Great Britain are the integration of higher education into a common digital ecosystem with the common curricula, teaching staff and students, as well

as transition from training students on campuses to the instruction through on-line services of universities.

2. Classification of the information systems of institutes of higher education was carried out and a three-component model of the digital ecosystem was proposed. Digital ecosystem contains the following components: IT entity (information systems for educational process, administrative information systems, information systems for scientific studies and external information systems), organizational entity (Rector’s office, the bodies of an institute of higher education, students and teaching staff) and environment (IS of Ministry, IS of other higher educational institutions, etc).

3. The informatization medium of higher educational institution was described based on a digital ecosystem. It was noted that for the effective digital ecosystem functioning, the timely and coordinated interaction of all its elements is necessary. Therefore, for all its entities to be integrated into a digital ecosystem of a higher educational institution, it was proposed to create the information management system (EIP) of an institute of higher education, which provides planning, collection, storage, working and control of electronic information. EIP manages any information, produced by the information systems of an institute of higher education and used beyond the borders of these systems. The functions were developed and the capabilities of EIP in information management at an institute of higher education were defined. They are connected with the information interaction organization and control, planning information processes, maintaining the use of information representations in a united information technology of an institute of higher education, control of fulfillment of assignments initiated through EIP, disseminating general information and the system upgrades. The method of reducing the time of processing requests to obtain the information based on planning actors’ interactions in EIP was suggested. Its main idea lies in addressing the problems of actors’ actions control in the algorithms of the EIP operation. This makes it possible to solve the task of eliminating parallels and introducing the addressed information interaction in the process of working with the information resources at an institute of higher education. We attach an example of fulfilling a request to obtain documents, which illustrates the advantage of the approach to an institute of higher education informatization based on the EIP usage.

4. A practical result of the conducted research based on the example of the EIP system realization at the Kiev National University named after Taras Shevchenko was shown. The algorithms, the functions, the architecture and the interface of such a system were developed. The description of the EIP advantages and disadvantages at a higher educational institution was given. The disadvantage of EIP is additional expenditures of an institution of higher education for its creation. Their advantage is the fact that they make it possible to localize the information management functions of IS in EIP, to maintain functional and informational IS independence, to manage the process of fulfilling requests to obtain information in the united functional EIP medium. The cited EIP advantages make it possible to solve the problems of the information management in other branches as well. First of all, at the enterprises, the work of which is connected with the need to manage considerable information resources, for example, aircraft construction, instrument manufacture, development and others. Taking into account the increasing role of

information in today's world, understanding and assuming that a dramatic increase in the amount of information will continue, the creation of information management systems will be increasingly in demand in the sphere of information

technologies. Therefore, this work will create prerequisites for developing a new class of systems – Enterprise Information Planning, which will always be needed in modern information world.

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