# Innovative Architectural Development of Corporate Enterprise Administration Systems

Volodymyr Opanasenko [1,*,†], Serhii Matvieishyn [1,†] and Vladislav Kaverinskiy[2,†]

[1] Glushkov Institute of Cybernetics of the National Academy of Sciences of Ukraine, 40 Glushkov ave., Kyiv, 03187, Ukraine
[2] I.M. Frantsevich Institute for Problems of Material Sciences of the National Academy of Sciences of Ukraine, 3 Krzhizhanovsky str., Kyiv, 03142, Ukraine

## Abstract

The problems and peculiarities of administrative and management activities in institutions and enterprises of Ukraine were considered and analyzed. The necessary list of divisions that are part of the administration has been selected: management (directorate), accounting, personnel, planning-production and scientific-organizational services. The proposed formalization and unification of the necessary set of functions for them, as well as structuring of the sequence of introduction and mutual exchange of generalized information between them. In order to confirm the conducted research, as well as the existing need to automate such processes, the design, development, testing and practical implementation of a single software complex for automating the main functionality of these services was carried out. The peculiarities of the structural and modular organization of the specified complex are highlighted.

## Keywords

Automation management, Administrative Services, Management Functions, Object-oriented Database, Cloud Environment

## 1. Introduction

Due to the intensive development of computer technology and constantly arising problems related to the efficiency and reliability of solving tasks of administrative and management activities in the institutions of Ukraine, there was an urgent need to automate these processes. Preliminary studies and analysis of the problems and features of such activities have been carried out. The proposed unification and formalization of the functions of scientific and organizational, planning and production, personnel and accounting services, as well as the structuring of the sequence of input and mutual exchange of generalized information between them. The design, development, testing and practical implementation of the software complex for the automation of the main functionality of these services was carried out. Some features of the structural and modular organization of the specified complex are considered and presented.

The article summarizes the research results of the project on the automation of administrative and management activities of Ukrainian institutions. The possibility of its practical implementation has been confirmed and an effective complex structure of building and functioning of such a software complex has been proposed. Prospective areas of further development of the system are considered.

## 2. Formalization and Unification of Management Functions

In order to be able to effectively manage the activities of each enterprise, there are urgent needs to provide maximum information support for its individual divisions and services. Every manager wants to see the results of the enterprise as a whole, as well as in the section of different departments, branches or different areas of activity. The information necessary for operational management of

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the enterprise is contained in the management accounting system, which is considered one of the new and promising directions.

**Management accounting** is a process of identifying, measuring, accumulating, analyzing, preparing, interpreting and transmitting information used by management for planning, evaluation and control within the enterprise [1]. Management accounting, in contrast to financial accounting, is aimed at obtaining information not about the actual value of property, expenses and income, the state of calculations and obligations, but at determining and studying factors, circumstances and conditions that affect the economic activity of the enterprise. Its purpose is to provide information for making management decisions and check the effectiveness of their implementation [2]. Management accounting can be defined as an independent direction of enterprise accounting, which provides the management apparatus with information used for planning, management, control, and evaluation of the enterprise as a whole, as well as its structural subdivisions.

The development of management accounting at the current stage consists in the combination of such functions as planning, accounting, control and analysis. The result of such a combination should be a system of information support for making management decisions, which should be served by management accounting [3].

The article presents the results of research into the problems and features of administrative and managerial activity in enterprises and institutions of Ukraine and the possibilities of its automation. The necessary functionality for the work of such administrative services has been formed and formalized. The practical result of the conducted research was the design, development, approval and implementation of a single software complex for the automation of the main functionality of these services. The necessity of using some features of the structural-modular organization of the specified complex was investigated and its practical implementation was presented.

Research and analysis of the availability of software developments in the field of complex automation of administrative and management activities for organizations in accordance with the state legislation of Ukraine showed that such developments exist in a very small number and are limited to only some fields of activity and small functionality (A5 Systems, IT-Enterprise, Bookkeeper, Debit Plus, Clerk, MASTER:Accounting, SAP Business One, Microsoft Dynamics 365).

Conventionally, such software developments can be classified into the following groups according to the list of automation functions: Enterprise Resource Planning – integrates various aspects of management for commercial enterprises; Customer Relationship Management – allow you to automate the processes of interaction with customers, sales and marketing management; Business Process Management – used for modeling, automation, monitoring and optimization of business processes; Project Management Systems – allow you to organize and automate the processes of project planning, implementation and monitoring; Human Resource Management – help to automate human resources management, including personnel recruitment, training, performance evaluation, payroll management, etc.; Document Management Systems – automate document management, ensure their preservation, version control, access and sharing. Basically, these developments are limited to the automation of simplified functionality for accounting work, personnel accounting, payroll, accounting for material values and management for commercial enterprises.

The specifics of the construction of the proposed development envisage the automation of the complex functionality of administrative and management activities for non-commercial institutions and enterprises in which the main source is state budget funding. This development allows automating all the necessary basic functionality in a single software complex for budget institutions and enterprises in accordance with the legislation of Ukraine, but currently limits some functionality of commercial activity. In this regard, there was a need to research, analyze and form a list of functions for the automation of these services, as well as their interrelationships.

For the effectiveness of complex automation, it is necessary to cover the activities of the following basic services of enterprises: scientific and organizational; planning and production; personnel; accounting; salary; office management; directorate.

Scientific and organizational activities are aimed at methodical, organizational support and coordination of scientific, scientific-technical and scientific-pedagogical activities [4]. In its activities,

the scientific and organizational service is guided by the requirements of the Laws of Ukraine "On scientific and scientific and technical activities", "On higher education", resolutions and orders of the Presidium of the National Academy of Sciences of Ukraine, orders of the Ministry of Education and Culture of Ukraine on the organization of educational activities, other regulatory and instructional documents, the Statute institution, orders of the director, decisions of the directorate.

The planning and production service forms the planned indicators of the enterprise's activity and is responsible for the development and establishment by the enterprise's management of a system of qualitative and quantitative indicators of its development, which determine the rates, proportions and trends of the development of this enterprise both in the current period and in the future. It also monitors the compliance of the planned and actual indicators of this activity, as well as, if necessary, promptly makes the necessary changes. The automation of such activities consists in the possibility of forming these indicators in electronic form, as well as taking into account the introduction of primary data and current changes, obtaining the dynamics and results of these indicators.

The personnel service of the organization is a set of specialized structural divisions in the field of organization management, together with the officials employed in them (managers, specialists, executives), who are called to manage personnel within the framework of the selected personnel policy. The main purpose of the personnel service is not only to be guided by the company's interests in the implementation of the personnel policy, but also to act taking into account the labor legislation, the implementation of social programs adopted at both the state and territorial levels. The functions, structure, and tasks of the personnel service are closely related to the nature of economic development, the organization's management's understanding of the role of personnel in fulfilling the goals and tasks facing the production (organization). Accounting is a structural division of a business entity, which is designed for accounting. Accounting provides relevant users, first of all management, with complete and unbiased information about the financial situation, results of operations and funds of the enterprise [5].

Salary - a structural unit, which is designed for calculating and paying salaries to employees of the institution. Salary (employee's salary) - remuneration for work or participation in work. Depending on the employee's qualifications, the complexity, quantity, quality and conditions of the work performed, as well as compensation and incentive payments; monetary compensation that the employee receives for his work.

Clerkship is an activity that provides documentation, document circulation, prompt storage and use of documents. One of the main directions, which represents the greatest attention for us, is document management. Document circulation is the movement of documents in the institution from the moment of creation or receipt from a party to the moment of transfer to the archive for storage. Ukrainian legislation provides the following definition of the term: document circulation in an institution — the movement of official documents from the moment of their creation or receipt to the completion of execution or dispatch [6]. With the help of this direction, for the automation of administrative and management activities, the possibility of forming a set of electronic "chains" from the list and sequence of the necessary operations for the full-fledged operation of the complex function can be provided.

The directorate is the management unit of the institution, which directly organizes all management of activities and is responsible for the results of its work before the superior organization or the owners of the enterprise. The direct head of the directorate is the director. The automation of the directorate's activities mainly consists in the possibility of providing generalized reports on planned and actual indicators of various areas of activity and analyzing their results, as well as operational management of the institution's work (for example, with the help of document management).

Based on the results of the analysis of the conducted studies, the necessary basic functionality for their full-fledged work was formed and grouped with reference to the corresponding service. Below is a list of such functions.

The scientific and organizational service mainly consists in the need to prepare and fill in primary documents related to scientific activity and the formation of reports based on the results of this work:

- filling out the "Request" document;
- filling out the document "Agreement" for the performance of scientific research and documents upon its completion ("Deed of submission-acceptance", "Scientific report");
- filling out the "Contract document" of economic activity and the document upon its completion ("Deed of delivery-acceptance");
- filling in information on registration of conferences, seminars, congresses;
- filling in information for intellectual property objects (patent activity);
- filling in information for accounting of exhibitions;
- filling in data on publications;
- formation of reports on the institution's scientific work;
- formation of separate sections and parts for the institution's annual report;
- generation of necessary reports in paper or electronic form.

Planning and production service:

- work with the operations of forming and making changes to the estimate of the institution and estimates of scientific topics, scientific and economic contracts;
- work with operations of forming and making changes to the staff list and staff arrangement of the institution's employees;
- simulation of work with a virtual staff list and staff arrangement of the institution's employees;
- formation of distribution of actual costs by funds and topics;
- formation of reporting for comparison of conformity and deviation of planned and actual expenses of the institution;
- generation of necessary reports in paper or electronic form.

Human Resources service:

- filling in information about employees and individuals who have relations with the organization;
- filling in information about the regulated calendar, forming and filling in work schedules and making changes;
- filling in information on the movement of personnel, employment and personnel administration;
- filling in information about the time sheet;
- filling in information about personnel movement of employees in the institution (recruitment, personnel transfer, change of status, dismissal);
- generation of necessary reports in paper or electronic form.

Salary:

- filling in regulatory and directory information on employees for the possibility of salary calculation;
- filling in current information on employees (time sheet, sick leave, vacation, etc.);
- calculation of salaries for employees of the institution;
- payment of salaries to employees of the institution;
- formation of the necessary certificates for the social insurance fund, the pension fund and the tax office;
- generation of necessary reports in paper or electronic form.

Accounting:

- forming and keeping records of material values;
- formation and maintenance of financial records;
- carrying out operations of actual costs with control of compliance with planned costs;
- management and control of operations for the provision of additional services (rental of premises, communal services);
- generation of necessary reports in paper or electronic form.

Clerkship – building a set of electronic "chains" of functions for the full operation of a complex operation:

- recruitment to the organization;
- personnel transfer of an employee;
- dismissal of an employee;
- calculation of salaries for employees;
- group adjustment of position forks and charges to employees by coefficient.

The Directorate has a constant need to receive information about the state of affairs of the institution in a generalized form or according to the necessary indicators and, accordingly, the possibility of making operational decisions to stabilize the institution's activities: receiving reports of planned or actual financial activities for the required period, as well as their comparative analysis; receiving reports of planned or actual activities for the required period, as well as their comparative analysis; based on the results of the analysis of such activities, the possibility of making management decisions.

The peculiarity of such functions, if it is necessary to perform some of them, is the need to engage the work of two or more administrative and management services. For example: the "Employee Hiring" function in HR requires the necessary functions to be performed by several other services. Before the personnel forms an order for hiring a future employee, the planning and production service must check the availability of a vacancy for the required position, if it is not available, it is necessary to make changes to the staff and add such a vacancy, the scientific-organizational or other necessary service must check the candidate's compliance with professional requirements for the required position. Thus, if it is necessary to perform some functions by one service, a chain of additional performance of several other functions by other services is formed.

In order to structure all operations, there was a need to organize and group functions for these services. This allows for the automation of all operations to create a user-friendly interface that visually separates and groups these functions.

## 3. Design and Development of the Control Automation System

During the design of the system of automation of administrative and management activities of Ukrainian institutions, some features arose:

- the set of functions for each service may change over time (new functions are added, the form and informational content of existing one's changes, or outdated ones are removed);
- the need for information communication and data exchange between different services;
- if it is necessary to perform some functions, automated construction of chains is required for additional performance of the necessary set of functions by other services.

For the efficiency of the development of such a system, there was a need to use software platforms of object-oriented programming (OOP) and database management systems (DBMS).

**Object-oriented programming** is a programming method based on the presentation of a program in the form of a collection of interacting objects, each of which is an instance of a certain class, and the classes are members of a certain inheritance hierarchy [7]. Typical modern representatives of OOP are the following platforms: C++, Object Pascal, Java, C#.

**A database management system** is a set of interrelated data (database) and programs for accessing these data [8]. Provides opportunities to create, save, update and search for information in databases with data access control. Typical modern representatives of DBMS are the following platforms: Microsoft Access, Paradox, dBase, FoxPro, Visual FoxPro, Oracle Database, MS SQL Server.

If you choose separate platforms, it is imperative that they are compatible with each other. Also, for the convenience and speed of development of the software system, it is necessary to pay attention to the complete set of their functionality.

The most attractive option is the use of one combined platform with full functionality of OOP and DBMS - object-oriented database (OBDB). Their selection is based on 2 criteria: the system must be object-oriented and represent a database. The result of combining the capabilities (features) of databases and the capabilities of object-oriented programming languages are object-oriented database management systems (OODBMS). OODBMS allows you to work with database objects in the same way as with objects in programming in object-oriented programming languages (OOPL). OODBMS extends programming languages by transparently adding long-term data, parallelism management, data updates, associated queries and other capabilities (Visual FoxPro, Java, Microsoft Access) [9].

Taking into account the peculiarities and needs of the object of automation, the design and development of the system was built according to the following principles:

- a single information base for working with all administrative services of the institution;
- modularity of software construction in accordance with the service of the institution;
- authorized separation of rights and authorities of users' access to information and objects of its processing (forms for entering and changing information, directories, reports, etc.) for the corresponding service;
- openness of the software code for developers and administrators with the possibility of prompt changes to the system;
- absence of duplication of the same information by different services, and the organization of their common use of this data;
- the need to develop an intelligent interface for various services, which allows the user to choose and perform the necessary operations from one place without the need to search and fill in all the necessary additional information, and the system itself automatically guides him through the steps of execution and, if possible, selects and provides this data to the user;
- the possibility of organizing communication and electronic exchange of system data in the appropriate format with other external systems.

Based on the results of the research, a single software complex of the automated information system (AIS) was designed and developed. In the future, we will call it AIS ENTERPRISE. In accordance with the services of the administrative and management activities of the AIS ENTERPRISE, it is also built according to the modular principle and consists of subsystems for each service. Below is the following correspondence: scientific and organizational service - "SOA" subsystem; planning and production service - "FINANCES" subsystem; personnel service - "STAFF" subsystem; salary - "SALARY" subsystem; accounting department - "ACCOUNTING" subsystem; office management - subsystem "DOCUMENT"; directorate - subsystem "DIRECTORATE". The generalized model of the program complex of administrative and management activities of a scientific institution is presented in Figure 1. Each of these subsystems is designed to automate the activity of the corresponding service.

The "DOCUMENT" subsystem in the AIS ENTERPRISE is a guide for the performance of complex functions, which independently, according to a previously formed algorithm, forms the necessary set and sequence of operations performed by various services. Control over the actual execution of operations and compliance with the planned deadlines is carried out. The optimal option for this is the presence of this subsystem in the software platform itself. This allows you to directly use the algorithm to perform the functions from other subsystems, and the relevant users only need to perform them, and the control over the sequence and actual execution is carried out by the software module itself. The "DIRECTORATE" subsystem allows you to automate the receipt of the necessary reporting on the institution's activities, promptly respond to deviations or changes, analyze possible decision-making options and make the most optimal one.
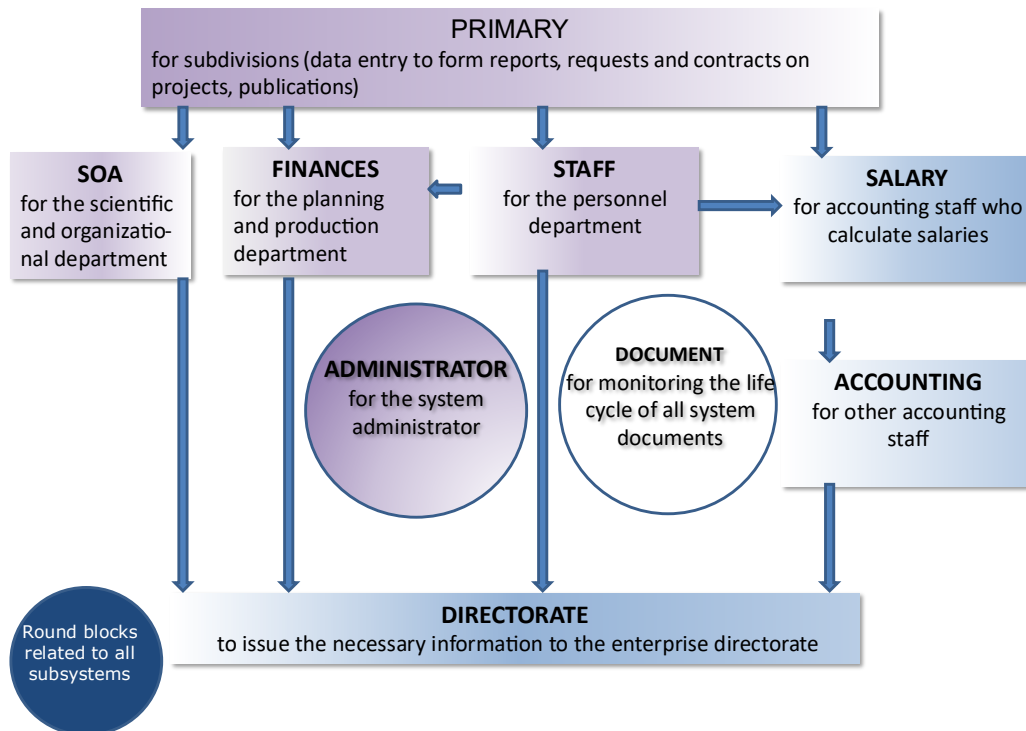


**Figure 1**: The model of the construction of the software complex AIS ENTERPRISE

In addition, for the organization of the full and correct functioning of the AIS ENTERPRISE itself, protection against unauthorized intervention, authorized access rights, distribution of powers, and the possibility of using the necessary data by users, an internal subsystem "ADMINISTRATOR" has been developed for the administrator of the software complex.

In accordance with the set of necessary operations for the full-fledged operation of administrative services, an appropriate list of basic functions was analyzed and formed, which are necessary for inclusion in the list for automation for each subsystem of the AIS ENTERPRISE software complex.

Preliminary research on user needs in the field of administrative and management work automation, as well as an analysis of existing developments in this area, have shown that an important factor in designing and developing the AIS ENTERPRISE software complex is the need to implement some artificial intelligence (AI) tools. These tools will allow automating many routine tasks that were previously performed manually and will significantly simplify the user's interaction with the complex. For example, the system allows for the formation of a set and sequence of individual functions into a single comprehensive operation, with the selection and provision of necessary information and control over the results of its execution; the ability to model, analyze, and select the optimal option for changes to the institution's staffing table based on chosen criteria; authorized user access to the system, as well as control and prevention of unauthorized access; and, for HR operations, the ability to analyze and select candidates for a position according to the necessary selection criteria.

Another example of the use of AI tools in the system is the creation of a "friendly" interface for the user. The essence of creating such an interface is the maximum simplification of the user's work with the minimum number of necessary operations to perform the necessary functions, as well as visual clarity of working with the system. In addition, there was a need to develop such a toolkit that allows you to direct the user's actions in the right direction and, if possible, provide the maximum set of necessary data. It also makes it easier to train users to work with the complex.

The main idea of this interface is that the user can perform any desired function through it from start to finish. The interface is built in a structured way and has several tabs. Each tab combines the necessary group of functions, which is responsible for a separate line of activity. By name, the user chooses the necessary tab and works there with the desired function. This simplifies his work and saves time for preparation for execution.

In addition, for the efficiency of the institution's work, there was a need to build an additional software module for the possibility of modeling staffing and staffing. This allows you to virtually simulate several state options, analyze and evaluate them, choose the optimal one, and immediately change the necessary parameters from virtual to actual ones and transfer it to the real one. For example, this operation is effective when recalculating position forks and employee accruals according to the inflation index.

## 4. Prospects for Further Development of the AIS ENTERPRISE Software Complex

At the moment, one of the main problems when using the AIS ENTERPRISE is the sufficiently high financial cost for the purchase of technical and software tools, as well as the necessary work at the preparatory stage of implementation and its immediate operation.

This software complex allows several users to work with the system at the same time. The structure of the complex's functioning currently assumes its location on one powerful computer, the server, and users get remote access to the system through a local network or the Internet to work with it. The general list of necessary technical and software includes:

- availability of a server;
- availability of a local computer network for user access to the server;
- licensed operating system (OS) for the server and a license for remote access to it;
- licensed version of the OODBMS software platform;
- a license for simultaneous access to the software platform.

Considering the fact that these needs are worth significant financial costs, there was a need for alternative options for its use. One of the options for solving this problem is the use of cloud environment tools.

**Cloud data storage** is a model of online storage in which data is stored on numerous servers distributed in the network, provided for use by clients, mainly by a third party [10]. Unlike the model of data storage on own dedicated servers, which were purchased or leased specifically for similar purposes, the number or any internal structure of servers is generally not visible to the client. Data is stored and processed in the so-called "cloud", which is, from the client's point of view, one large virtual server. Physically, such servers can be located geographically far from each other. For the placement and operation of the AIS ENTERPRISE complex in the cloud environment, a list of the following basic organizational issues is provided: preliminary measures to analyze the need for implementation, choosing a cloud environment model and agreeing and formalizing relations with a provider that provides services for use in a cloud environment; selection of the list and sequence of placing the necessary system applications in the cloud environment, which will allow placing and operating the AIS ENTERPRISE complex; selection of the list and sequence of placement of all necessary modules directly in the AIS ENTERPRISE complex itself in the cloud environment;

adjustment of user access rights to individual functional modules and information resources of the AIS ENTERPRISE complex in the cloud environment; approbation and testing of complex operation of AIS ENTERPRISE in the cloud environment.

Preliminary measures before the start of work on the placement and operation of the AIS ENTERPRISE complex in the cloud environment include the following measures: analysis and assessment of the necessity of placing or transferring the AIS ENTERPRISE complex to the cloud environment and its implementation for operation; selection of possible options and components of the cloud environment; selection of the minimum and maximum configuration of the AIS ENTERPRISE complex and the necessary applications for it when placed in a cloud environment; according to the selected criteria, evaluate the effectiveness of various options and choose the most optimal one; coordination and formalization of relations with the provider that provides services for use in the cloud environment.

When analyzing the need to place the AIS ENTERPRISE complex in a cloud environment, the following problems should be considered and evaluated:

- for the implementation and operation of the AIS ENTERPRISE complex in offline mode (without use in a cloud environment), it is necessary to have or purchase the necessary minimum set of technical means and licensed software and estimate the cost of such additional purchases;
- in the offline mode, additional costs for connecting and configuring these technical means, installing and configuring licensed software and estimating the cost of such additional works are also required;
- in the offline mode, additional costs for maintenance, updating and repair of these technical and licensed software tools and an estimate of the cost of such additional work are also required;
- for the placement and operation of the AIS ENTERPRISE complex in the cloud environment, all these additional costs are not necessary, with the exception of a minimum set of personal computers for users with Internet access, but it is necessary to agree with the provider and estimate the cost of such services.

The initial stage of the transfer, placement and operation of the AIS ENTERPRISE complex in the cloud environment should be carried out with the optimization of the infrastructure for the features of the cloud environment.

After the move, all the infrastructure and all the problems and shortcomings will remain. But in the cloud, you pay for the resources you use. Therefore, it is important to optimize for cloud requirements.

Providers provide recommendations on these issues. Additionally, performance issues and security issues need to be addressed. There are services in the cloud that will help solve these issues. Administration infrastructure, data protection, anti-virus protection must be provided. There are also monitoring services that will help monitor the status of applications.

Relocation requires upgrade costs. Many services can be replaced by cloud services. Their use is cheaper and more productive, and their support will no longer be your concern. But migration will be necessary, not copies of the project. Depending on the specifics of the project, this moment alone can be a reason to abandon the cloud. And the project must be rebuilt for the use of cloud services.

Using the cloud effectively is possible through the understanding of optimized services. The more services will be built in, the cheaper and more productive the application itself will be. Cloud services offer many advantages. This is fault tolerance, scalability and high performance. The maintenance and support of this functionality is no longer the concern of users. Another advantage is the ability to develop and optimize your infrastructure. New services can be quickly tried in the cloud, and the number of these services is growing quite dynamically.

It is possible to check the application of the software complex in the cloud. This is one of the advantages. No need to wait for equipment. There are ready-made templates and ready-made virtual machines. You can immediately take and try. Understand what does not fit and what needs to be added. Evaluate performance and cost. Try the infrastructure. Understand what needs to be done and

completed for migration. All this makes it relatively easy to decide whether you need to use the cloud or not. But on the other hand, the application must be cloud-ready to realize all the benefits.

**Consider the cost**. The cloud will not be a cheap solution. Since costs depend on the resources used, it is important to optimize performance. This is the essence of elastic scaling. The application should work when it is used. And this setting changes during the day. But even then, the service will not become super-cheap. It will work "as it should". It also needs to be serviced, the administrator cannot be fired.

**Take into account the requirements of the legislation**. One of the main issues: the ban on the export of personal data. It is important to consider the moment of storage and processing of user data.

**Result.** Of course, cloud services have many advantages. But these solutions are not universal both in terms of quality and cost. Perhaps, over time, any project can be placed in the cloud and it will be profitable. If, taking into account these requirements, the user decides to abandon the cloud, there is no need to rush. In addition to full migration, the cloud offers many other possibilities. You can consider the option of a hybrid infrastructure, when part of the services is placed in the cloud. In addition, cloud tools can be implemented in your applications without migrating to the cloud. Therefore, it is important to know about cloud services and understand them. After all, the day may come when the cloud will become profitable for any business.

After placing, testing for operability and compliance and commissioning of these system applications, the next step should be placing and testing for operability in the cloud application of the appropriate version of the OODBMS software platform for managing the operation of the AIS ENTERPRISE software complex. The peculiarity is that the complex will not be able to work independently without such a platform, therefore the presence of this platform is mandatory.

As a final step, it is necessary to carry out the task of transferring, placing and testing the operability and compliance of the AIS ENTERPRISE software complex itself in the cloud environment. The generalized model of placing all necessary applications and AIS ENTERPRISE in the cloud environment is presented in Figure 2.
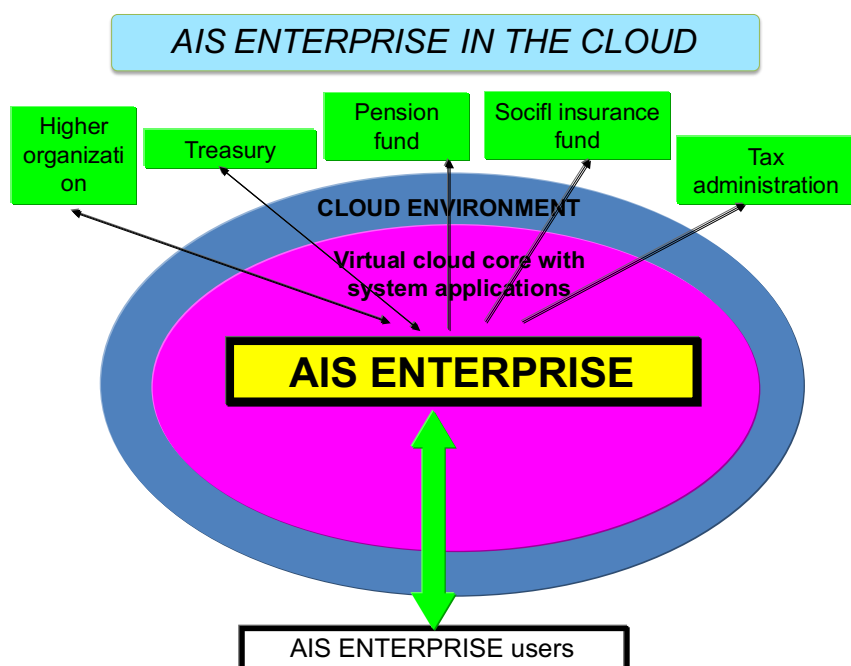


**Figure 2**: A model of the construction of the AIS ENTERPRISE software complex in a cloud environment

Summarizing all of the above, it can be concluded that the transfer of the operation of the USTANOVA AIS software complex to the cloud environment has prospects for further use, will allow

it to be used effectively without significant financial costs and does not require significant modifications compared to its autonomous use. Given the tendency to reduce the cost of using cloud technologies, this method may become the most effective in the future.

## 5. Conclusions

The problem of complex automation of administrative and management activities of Ukrainian institutions has been studied and this possibility has been confirmed. A basic set of functionalities for each service has been developed and offered [11 – 14]. Options for building complex operations that require the joint performance of several services, as well as virtual modeling of staffing, are additionally considered.

The design, development, testing and practical implementation of the software complex for the automation of this activity was carried out. Its practical effectiveness has been proven thanks to a comprehensive approach that allows joint use of a single information database, joint interdepartmental operations, an intelligent interface service, and additional modeling tools.

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