

Information System "Workload Assignment at a University Department"

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Abstract

Information technology is an indispensable element of the modernization of education in all countries. The quality of education directly depends on the satisfaction of the university teaching staff with its academic (educational, methodological, scientific, and organizational) workloads. The paper presents an approach to the creation of an information system for the department's workflow focused on storing information in one place, and on obtaining reporting documentation in the required format. The authors propose the modeling of the department's document management information system as a finite state machine. Also, the article presents the models of assignment of educational, methodological, scientific, and organizational workload of the department teaching staff. The practical implementation of the proposed approach is presented on the example of the Department of Management and Public Administration of the State University of Infrastructure and Technologies (Kyiv, Ukraine). The authors have developed recommendations for integrating the information system of the department into the corporate system of the university.

Keywords

Department's workflow, department's document management information system, academic workload, modelling of information system, department teaching staff.

1. Introduction

Modern education is characterized by increasing complexity associated with all aspects of management, both from the perspective of students and the university [1, 2 and others]. This necessitates the introduction of information technology for more efficient management of university resources.

The activities of a university require constant paperwork (search and creation of many documents), which, in turn, leads to a significant amount of time processing information of the same type and performing routine processes. A lot of resources, both human and time, are always spent for searching and obtaining the necessary information, developing training, and working training programs, counting the necessary elements (the number of hours of individual work of students and classes, etc.). At the same time, fast and high-quality management of all business processes is one of the conditions for the development of a modern university. This necessitates the introduction of an information system that would cover all structural units, including departments.


Consider the implementation of the department's electronic document management using the example of the Department of Management and Public Administration of the State University of Infrastructure and Technology. The main purpose of creating a system should be not only the storage of information in one place, but also the receipt of reporting documentation in the required format. The system must contain a database, its population system, and a system of formation reports and

Information Technology and Implementation (IT&I-2023), November 20-21, 2023, Kyiv, Ukraine

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 CEUR Workshop Proceedings (CEUR-WS.org)

curricular documents. According to the content, such a system should implement the following functions.

1. Reflect all the tasks through which the main and supporting scientific, educational and management processes are fully implemented.
2. Create a documentation system and ensure its transparency and accessibility for employees.
3. Create convenient and full-scale channels for the delivery, storage, and safety of information.

This will significantly reduce the time spent on the preparation of documents and reduce the possibility of errors. Thus, the introduction of electronic document management systems allows us to solve three problems: (i) improve the efficiency of the department; (ii) optimize business processes; (iii) ensure compliance with the requirements of legislation in the field of circulation.

The information system is based on the department's document management system as an integral part of the university's corporate management system. The document management system includes methodological documentation, reporting documentation for lecturers, scientific reports, curricula, work plans, and other documentation related to the educational process, as well as assignment of the workload between lecturers. Assigning the workload and forming an individual lecturer's plans are some of the most important tasks. On the one hand, both the quality of teaching students and the moral climate at the department depend on their decision. On the other hand, interaction with other departments and structural units of the university is carried out.

Since the departments that academic disciplines and provide the information necessary for the formation of the academic workload can be assigned among the autonomous structural units of the university, it is convenient to use network technologies and Internet resources to simplify and accelerate the process of data exchange between the departments and the directorate [3]. The system provides for the formation of academic workload assignment between teaching staff in the form of standardized document templates – academic workload. The automated system includes two modes of operation (user mode and administrator mode) and performs the mutually coordinated management of system processes.

2. Related Work

Publications by researchers were devoted to various aspects of the organization of electronic control systems, including those at universities. So, in [4] the authors noted that institutions need information systems to facilitate document management during business processes. At the same time, based on empirical research, it is shown that when implementing an electronic document management system, it is necessary to consider the factors influencing the implementation and use of EDMS in a particular university, namely the expected productivity and social impact.

One of the characteristic features of the functioning of both academia and business in modern conditions is the generation of large volumes of information, which for effective use must be structured, analyzed and presented [5]. At the same time, the strategic value of information technology, information management capabilities, the effectiveness of decisions made, and the productivity of business processes in institutions are determined by available resources, primarily infrastructure, human resources and administrative functions [6].

The research presented in [7] is devoted to the development of the mathematical apparatus for structural-parametric synthesis of the optimal electronic document management system for educational and scientific institutions. When developing information systems, the emphasis is on the peculiarities of document flow in universities, as well as meeting the needs of various categories of users.

In [8], the authors emphasize the need for digital transformation of modern universities. Structural characteristics of universities and used information management systems were investigated based on samples of small and large universities. The authors proposed a roadmap for implementing the process of digital transformation of universities.

The authors in [9] have shown that information systems are one of the main resources for the development of a progressive university, playing a significant role for all stakeholders (administration, heads of departments, teaching staff, students). The authors focus on the specifics of developing information systems for universities.

In [10], the authors considered various aspects of the use of document management systems in higher educational institutions (regulatory, organizational, technical, financial, cultural, and psychological). The article substantiates that the introduction of an electronic document management system will improve not only the efficiency of university management, but also the level of its competitiveness in the markets of educational, scientific, and technical services.

Analysis of publications allows us to conclude that the information management system of the department as a structural unit of the university should consider the peculiarities of the organization of educational, methodological, scientific, organizational, and educational activities at the university.

3. Results of the Research

3.1. Modelling of Information System

The formalization of the department's document management should include the allocation of sets of key objects and subjects, as well as the relationships between them. Then the document management process (D_k) can be described as follows:

$$D_k = \{L, A, S\}, \quad (1)$$

where L – the set of the department employees who taking part in the document management (department head, teaching staff, laboratory head, engineer, laboratory assistant);

A – the set of actions on documents, the implementation of which is permissible in the department's document management system (formatting curriculum, adjusting them, assigning the academic workload, creating reports for the department and lecturers, monitoring the implementation of curriculum, etc.);

$S = \{S_k: k = \overline{1, K}\}$ – the set of document states that they can accept after actions from the set A by the participant from the set L (the original version, the final version).

The relationship between the sets L, A, S can be represented as follows: a document can change its state depending on the action that was performed on it by a certain employee of the department at time t , i.e.

$$S(t) = \{s_i(t): L(t) \times A(t)\}, \quad (2)$$

where s_i – the state of document i at t ;

$I (i = \overline{1, I})$ – the set of documents generated at the department.

This study is based on the presentation of the department's document management as a finite state machine. Then work with an individual document can be represented by a tuple of the following form:

$$D_{k,i}(t) = \{S_{k,i}, \Sigma_{k,i}, \delta, s_{i0}, S'_{k,i}, t\}, \quad (3)$$

where $S_{k,i}$ – the set of states in which document i can be at t ;

$\Sigma_{k,i}$ – the finite set of input characters for document i , that is, the set of data that is entered into the document;

δ – the transition function, the arguments of which are the current state of the document and the set of input parameters, and the value is the new state, i.e.

$$S_{k,i}(t) \times \Sigma_{k,i}(t) \rightarrow S_{k,i}(t+1); \quad (4)$$

where s_{i0} – the initial state of document i such that $s_{i0} \in S_{k,i}$;

$S'_{k,i}$ – the set of final states of document i such that $S'_{k,i} \subseteq S_{k,i}$; t is the time parameter.

The finite state machine $D_{k,i}$ as a system will possess the internal logic of the process of creating and updating a document, i.e.

$$\begin{aligned} \langle Creation \rangle &\rightarrow \langle Adjustment 1 \rangle \rightarrow \dots \rightarrow \langle Adjustment n \rangle \rightarrow \\ &\rightarrow \langle Approval \rangle \rightarrow \langle Using \rangle. \end{aligned} \quad (5)$$

The diagram of department's document management assigning the workload is shown in Fig. 1.

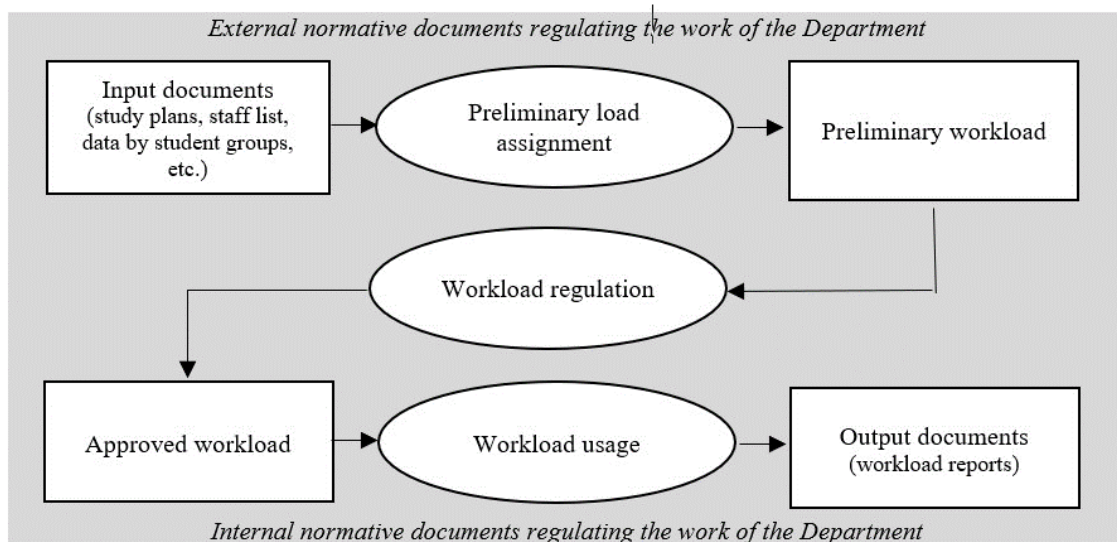


Figure 1: Diagram of department's document management assigning the workload

The automated assignment of the academic workload is based on the implementation of the model of the automated system (1)–(5) to meet the requirements of the Bologna process concerning compulsory considering of the student's free choice of academic disciplines.

The workload of the teaching staff at the State University of Infrastructure and Technology includes three components (scientific work, methodological work, and organizational work) and depends on the amount of teaching workload determined by the head of the department.

The problem of assigning the workload by components is an important task, in solving which the head of the department should consider both the qualifications of each lecturer, as well as his desire and ability to engage in various activities. Then the lecturer's workload should correspond to this formula:

$$\Sigma_{m,i} + \Sigma_{s,i} + \Sigma_{o,i} \leq 1540, \quad (6)$$

where $\Sigma_{m,i}, \Sigma_{s,i}, \Sigma_{o,i}$ are the methodological, scientific, and organizational workloads of the lecturer.

3.2. Modelling the methodological workload of teaching staff

The automated assignment of the academic workload is based on the implementation of the model of the automated system (1)–(5) to meet the requirements of the Bologna process concerning compulsory considering of the student's free choice of academic disciplines [11].

The user mode support module implements the method of automated generation of the department's academic workload, providing compliance with the requirements put forward to the creation the final form of academic workload. The workload assignment between the teaching staff is engaged the head of the department's laboratory. He, as a participant in the department activities (L_1), has the right to work with 4 sets of documents:

$$L_1(t) = \{D_{k,1}, D_{k,2}, D_{k,3}, D_{k,4}, t\}, \quad (7)$$

where $D_{k,1}, D_{k,2}, D_{k,3}, D_{k,4}$ – "General information", "Lecturers", "Filling the academic workload" and "Academic workload assignment", respectively.

These sets of documents are presented in the main menu of the department's document management system. Consider the formation of the teaching staff's academic workload. It will include such data sets:

$$\Sigma_{k,i} = [\text{Sub}, \text{Lect}, \text{Gr}, \text{Res}], \quad (8)$$

where Sub – the set of academic disciplines related to the department;

Lect – the number of lecturers; Gr is the set of student groups;

Res – the set of restrictions formed for each lecturer.

These sets have different dimensions. So, the Department of Management and Public Administration of the State University of Infrastructure and Technologies has 10 lecturers, who teach 75 academic disciplines for 34 student groups.

The set of restrictions should include 2 groups of indicators.

1. General, which characterize the "possibilities" of the lecturer to teach, namely his qualifications, scientific interests, work experience.

2. Specific, which characterize the quality of teaching in terms of students. They can be formed according to the results of anonymous questioning of students. It should also consider how often students chose the lecturer's academic discipline in previous years.

These indicators in total will determine the maximum allowable academic workload for each lecturer, considering the standards of the Ministry of Education and Science of Ukraine, the university's limitations, and the desires of the lecturer himself. Then the data set of basic information (input characters) in accordance with (8) will be formed in accordance with the following formula:

$$\text{Sub} \times \text{Lect} \times \text{Gr} \times \text{Res} \rightarrow \Sigma_{k,i}. \quad (9)$$

Planning the academic workload is, on the one hand, the basis for the formation of the methodological workload of teaching staff, and, on the other hand, it is included in the methodological workload, i.e.

$$\Sigma_{m,i} = f(\Sigma_{k,i}). \quad (10)$$

3.3. Modelling the scientific workload of teaching staff

Research work is one of the priority directions of the formation of a single educational space of a modern university, based on ensuring a close relationship between fundamental science, education, and the professional environment of future specialists. At the State University of Infrastructure and Technology, the research work of lecturers includes: the implementation of department research work, scientific publishing activities, scientific and representative activities, competition and grant activities, leadership of the research work of students, etc. At the Department of Management and Public Administration, the planning of the scientific workload is carried out by teaching staff independently, considering their scientific interests, inclination to engage in scientific activities, as well as whether he is preparing for the defense of a candidate's or doctoral dissertation. Then the planning of the lecturer's scientific activity will include the following data sets:

$$\Sigma_{s,i} = [Lect, RES_s, RES_L, M_L, M_s], \quad (11)$$

where RES_s – the set of scientific interests of the teaching staff;

RES_L – the set of scientific achievements of the department teaching staff, which, among others, should contain information about the level of its scientific qualifications;

M_L – the binary matrix of size $1 \times Lect$, which reflects the lecturer's inclination to engage in scientific activities (1 – if the lecturer is inclined to engage in scientific activities, 0 – if the lecturer does not have such a propensity);

M_s – the matrix of size $3 \times Lect$, which reflects information about whether the lecturer is preparing to defend a dissertation (2 – the lecturer is preparing to defend a dissertation for the degree of Doctor of Science; 1 – the lecturer is preparing to defend a thesis for the degree of Doctor of Philosophy; 0 – the lecturer is not preparing to defend his thesis).

These datasets will have the same size, which will be equal to 10 (the number of lecturers in the department). Formula (11) must be supplemented with the following restriction: the head of the department, based on the development strategy of the university and the department, can also put forward requirements for the volume and quality of scientific work of lecturers, the place of their presentation, etc. Then the formation of the teaching staff's scientific workload in accordance with (11) will be carried out in accordance with the following formula:

$$Lect \times RES_s \times RES_L \times M_L \times M_s \times REG_H \rightarrow \Sigma_{s,i}, \quad (12)$$

where REG_H – the set of requirements of the head of the department to the scientific work of lecturers.

At the State University of Infrastructure and Technology, the research work of teaching staff includes the implementation of department research work, research and publishing activities,

was developed. Login is carried out by opening a browser and entering the address of the web application "http://masters" in the address bar – the main page of the system will be displayed on the screen. The main functions are in the main menu, which consists of four items presented in the form of buttons: "Main", "Scientific work", "Methodical", "Organizational" and "Output forms". Opening the corresponding menu, the lecturer is planning the workload (Fig. 3–5).

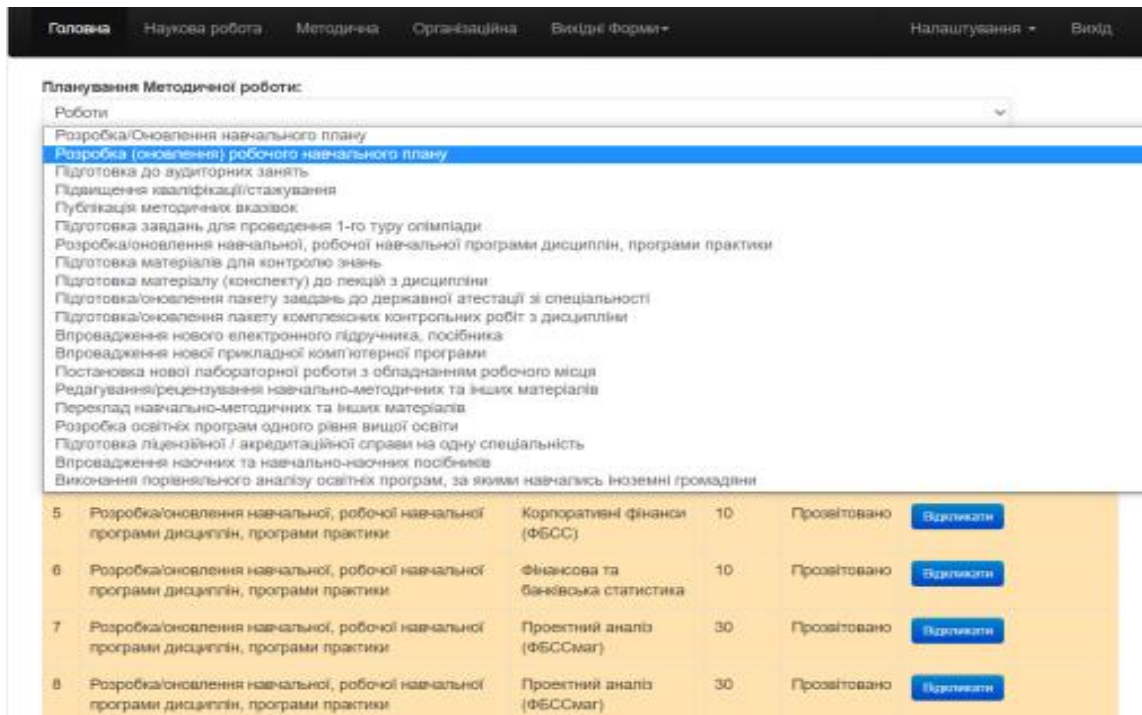


Figure 3: The interface of the methodological workload of teaching staff of the Department of Management and Public Administration

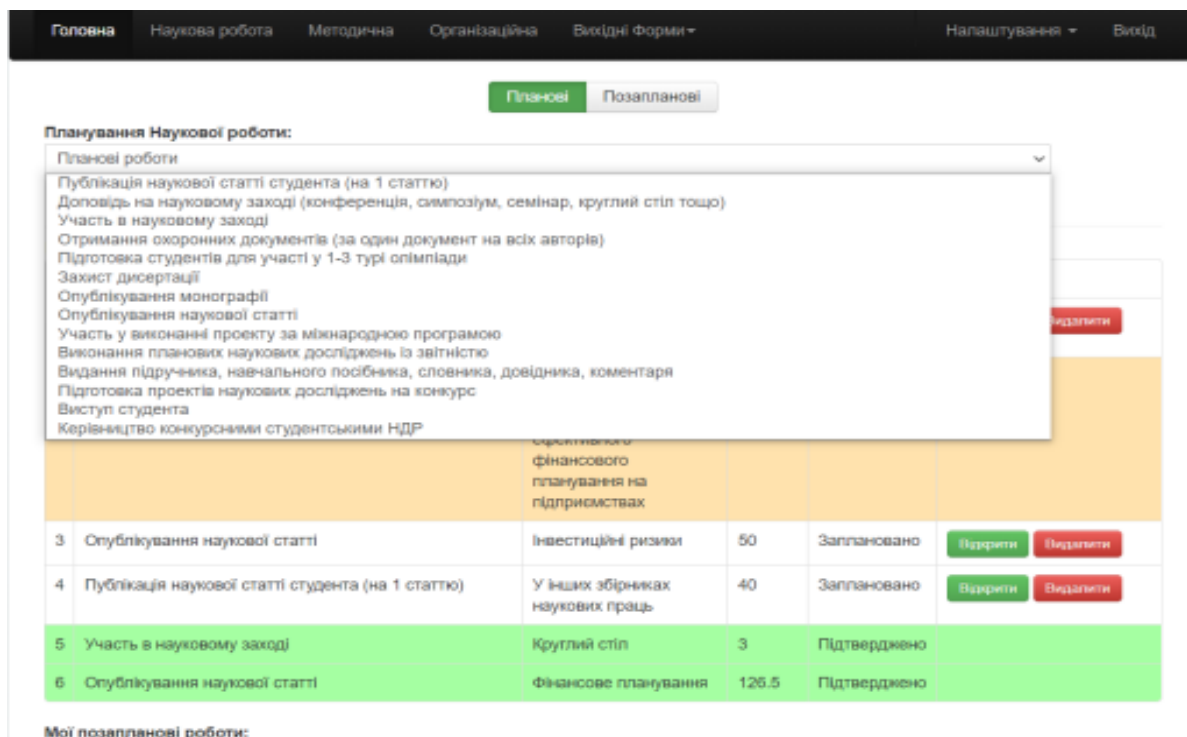


Figure 4: The interface of the scientific workload of teaching staff of the Department of Management and Public Administration

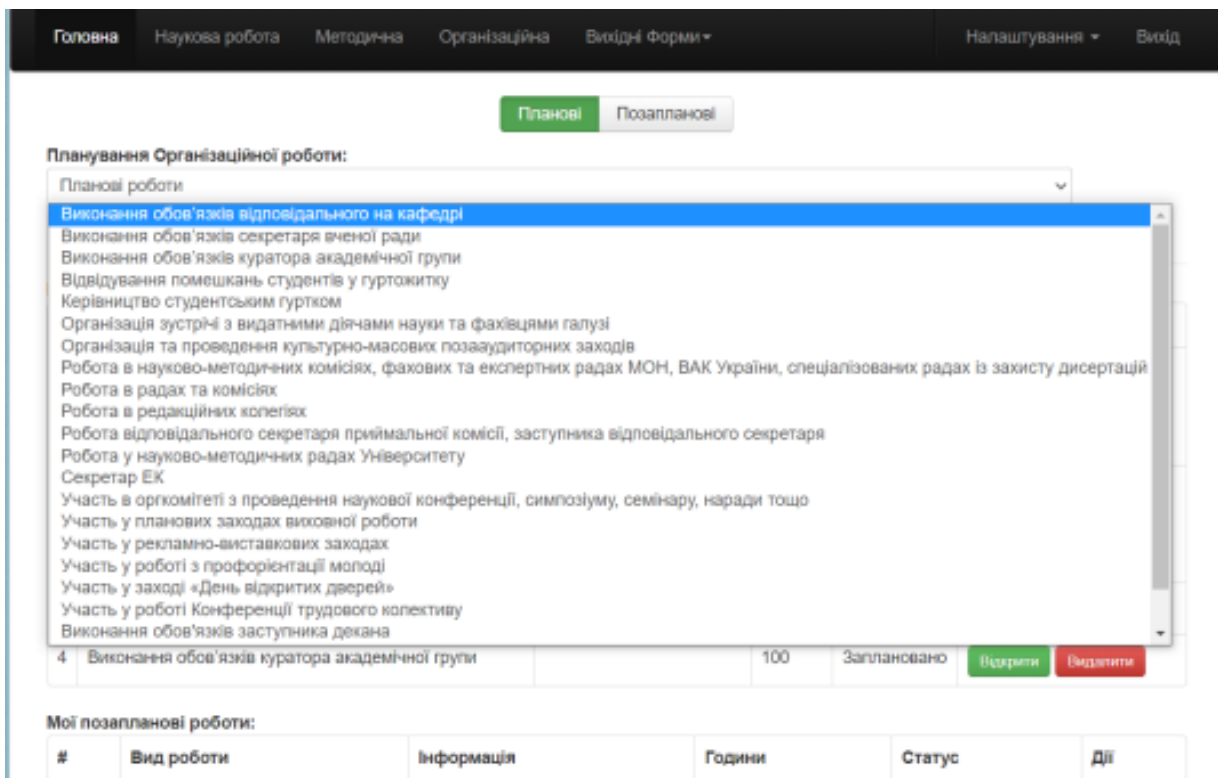


Figure 5: The interface of the organizational work of teaching staff of the Department of Management and Public Administration

As a result of the workload planning, a lecturer's work plan for the academic year is formed (Fig. 6). The head of the Department of Management and Public Administration forms a general plan of work for the department (Fig. 7). This allows to monitor the implementation of individual plans and generate a report for the department in pdf format (Fig. 8).

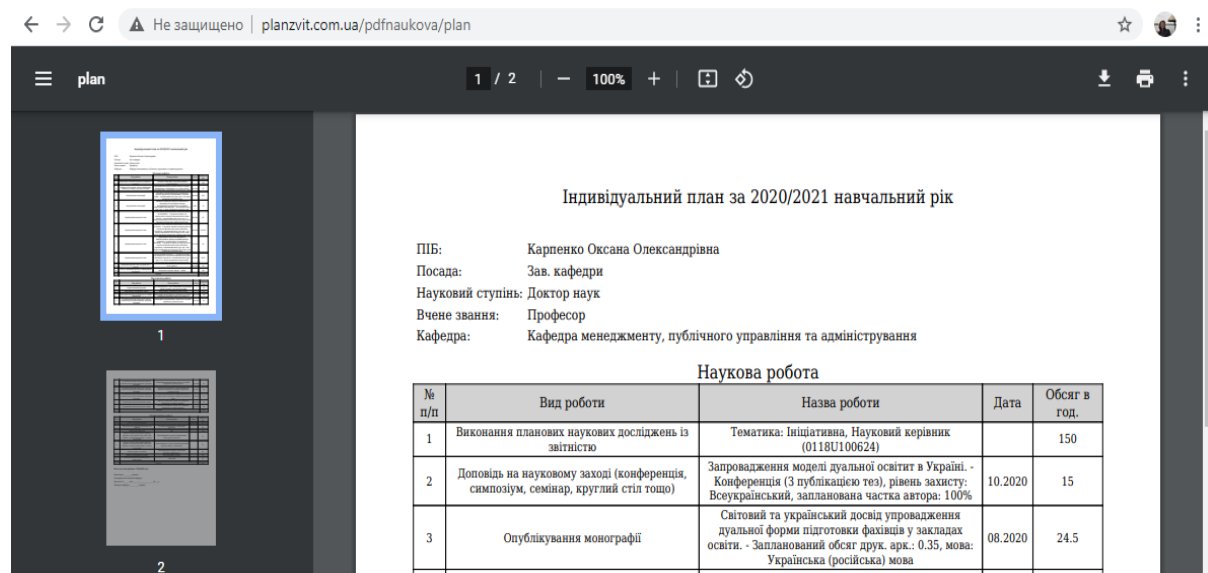


Figure 6: Individual plan of a lecturer

Practical testing of the software module "Plans" on the example of the Department of Management and Public Administration of the State University of Infrastructure and Technologies made it possible to determine the main consequences of its application.

1. Significant simplification of the work of the teaching staff responsible for the assignment of academic workload.
2. Save time when performing repetitive operations,

3. Reduce the possibility of errors in automated document generation,
4. The ability to access data and create reports quickly and conveniently.
5. Provide remote access to the system and the simultaneous operation of several users,
6. Prevention of a subjective approach in the assignment of academic workload.

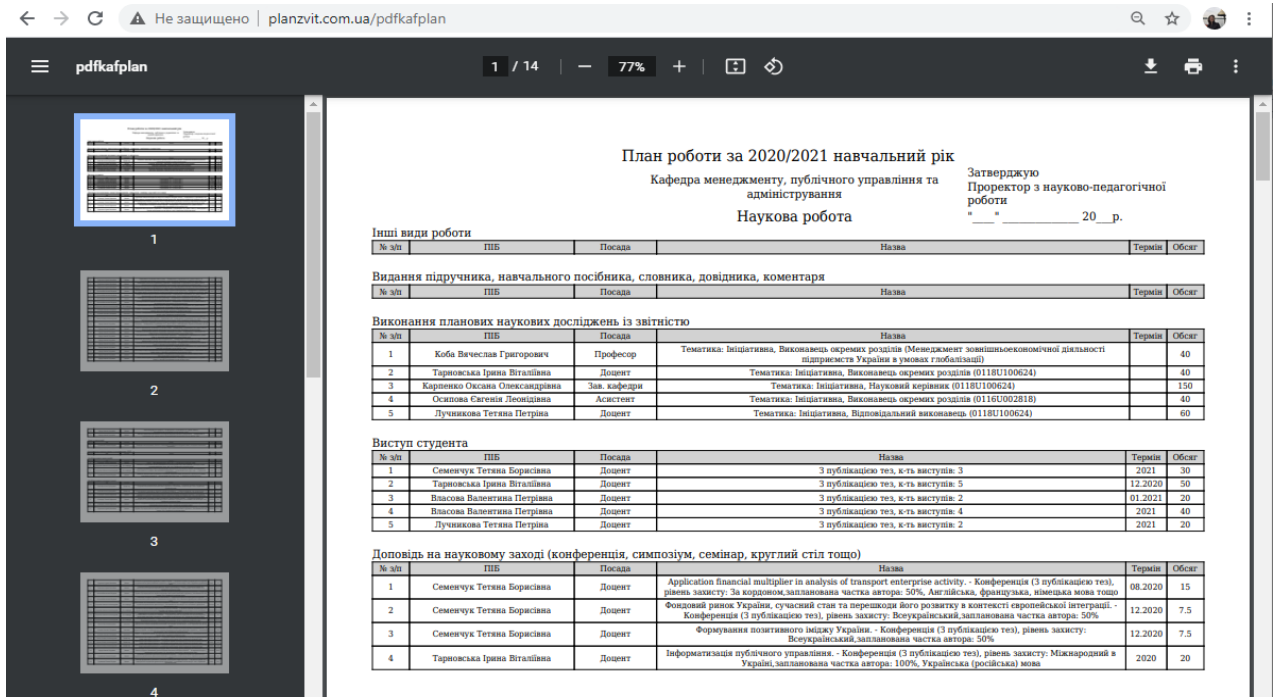


Figure 7: General plan of the Department of Management and Public Administration

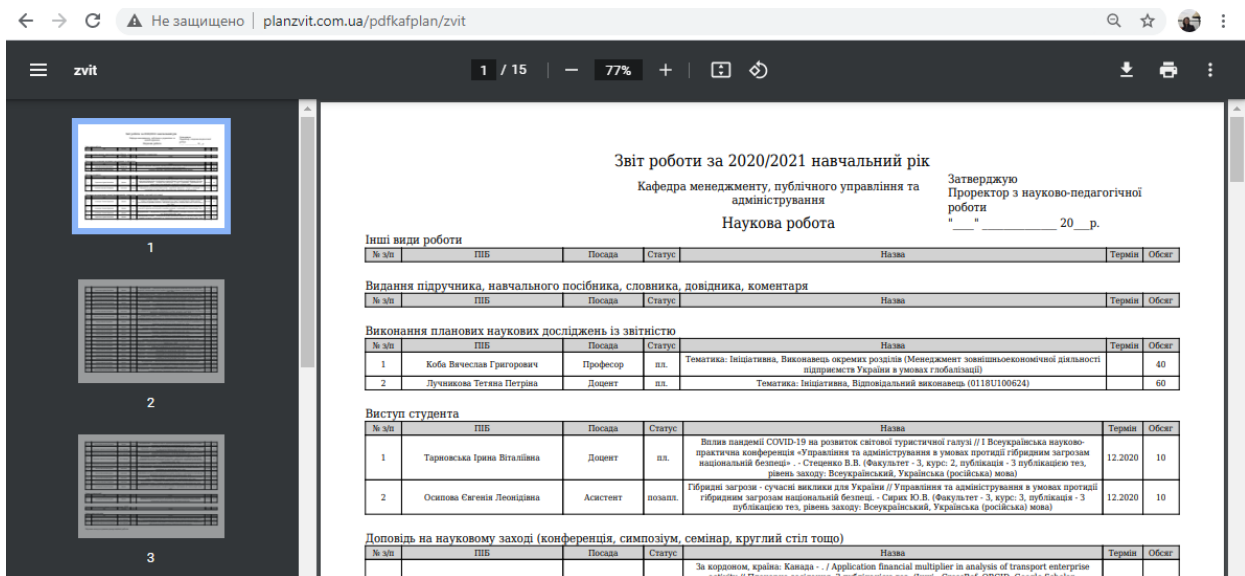


Figure 8: Report of the Department of Management and Public Administration

5. Conclusions

The role of information systems in the management of modern universities has changed dramatically in recent years. Now information systems should include modules responsible for almost all activities of university departments, including the assignment of academic load. To automate the process of assigning the academic load, a model of the department's document management information system was developed as a finite automaton. This model considers the relationship between teaching staff, the status of individual documents and possible actions with them. Models

have also been developed for the assignment of educational, methodological, scientific, and organizational workload of the department teaching staff, based on the specifics of the organization of the educational process in Ukrainian universities. The introduction of such an information system makes it possible to increase not only the degree of lecturers' satisfaction with their workload, but also to ensure the required quality of teaching. This is achieved by considering both the wishes of each lecturer and his capabilities. In addition, the automation of the assignment of the teaching staff workload significantly speeds up this process, reduces both the workload on employees and the likelihood of errors. Increasing the efficiency of the department's information system will result from its further integration into the university's corporate information system. This should be done in the following directions.

1. Communication with the dean's office and the schedule department to obtain operational information about changes in the educational process, to monitor the conduct of classes by lecturers, as well as student attendance. In addition, this will allow the head of the department to quickly receive the results of student questionnaires.

2. Communication with the scientific and methodological departments to control the timeliness of the lecturers' fulfillment of their load. This will also allow you to receive timely information about conferences, seminars, student competitions, etc.

3. Communication with other departments to timely change in training programs, and working training programs, etc.

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