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Quantitative Structuring of Academic Staff in HEIs: Analytics Tool for Data-Driven Decision-Making

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***Abstract*:** *Decision-making for human resource management is among the important processes determining the Higher Educational Institution's* (*HEI*) *future stability and development. The article presents the process for the design and development of an analytics tool to assist the HEI governing bodies in monitoring the academic personnel provision from a quantitative point of view and making decisions about the need to announce appointment and career growth competitions of academic staff members. The tool generates comparative staffing analyses at different HEI levels according to a predefined set of criteria. It allows the governing bodies to track which academic units there is a need for appointments, so that at the same time, the educational process is ensured and the relevant regulatory requirements are met. This enables the optimization and promotion of the efficiency of human resource management processes. The results of the conducted experiments prove the tool's effectiveness and applicability.*

***Keywords*:** *Decision-making, Analytics, Academic staff, Career growth, Monitoring.*

1. Introduction

Human resources are a significant factor in the success of any organization and the achievement of its development goals, including for Higher Education Institutions (HEIs). The teaching staff of HEIs has a vital role in providing high-quality education to students and achieving significant results in scientific research [1-3]. Therefore, the HEIs' leadership must effectively manage human resources by integrating policies, procedures, and management practices for recruiting, using, retaining, and developing employees, following the HEI's vision and goals, and continuously monitoring the university's staffing.

Decision-making for the selection and development of human resources is a key organizational process that determines the HEI's future stability and development [4]. When making such decisions, personal judgments and preferences can have an impact [5], which often leads to doubts about the transparency of the process and reduces the motivation of academic staff [6]. Effectively functioning transparent staff selection systems can help HEIs develop a set of policies, systems, and practices that

provide an environment for developing skills and increasing staff motivation to achieve the highest possible level of performance over time [4].

Traditional ways of managing human resources and methods of acquiring information limit the development of human resource management in HEIs [3]. Therefore, the HEI leadership is looking for ways to improve the processes related to human resource management (better planning, strategic decision-making, and more targeted change in human resource management), recognize the importance of strategic human resource management [6], and formalize the processes for making personnel decisions [7]. The implementation of strategic human resource management practices (such as training, reward and appraisal, compensation, retention plans, etc.) increases the effectiveness of universities [8], improves the intangible assets of the university [9] and ensures that the human capital of the institution contributes to the achievement of its goals. There is growing interest in knowledge management to improve organizational effectiveness [10] and the use of statistical tools, measures, and procedures for human resource analysis [11], helping those in leadership positions to make predictive decisions based on statistical evidence and analytical data.

Effective human resource management requires constant monitoring of key performance indicators, assessing their implementation, and making informed and data-based decisions. The values of these indicators can provide practical insights that can be used in decision-making, whether related to human resources or other organizational activities. The results of such monitoring allow organizations to verify the effectiveness of their human resources programs and management strategies. On the other hand, the digitalization of processes in HEIs during the last decade has led to large data sets that HEI leadership can analyze and use to make informed decisions. This motivates the interest of researchers in implementing intelligent Decision Support Systems (DSS) to help executives make accurate and timely informed decisions by extracting and analyzing accumulated data and applying problem-solving models [3, 5, 11-15]. These systems [13] facilitate the decision-making process for promotion, transfer, nomination, preparation of employee savings funds, retirement, bonuses, leave for travel privileges, and compensation for earned leave, helping in collecting relevant data and transforming it into information and knowledge to improve the timeliness and quality of decision-making.

Implementing tools for monitoring the need for teaching staff is particularly important for HEIs, teachers, and institutions at the national level. HEIs' governing bodies are responsible for hired human resources effective use and need tools to help identify staff shortages and needs. The tools ensure transparency of staff selection procedures and can help academic staff members better understand the current staffing needs of the university. Finally, the tools can support HEIs' accountability for staffing to national institutions.

The article presents the work on the design and development of an analytics tool to assist the governing bodies in higher education institutions in monitoring the university's staffing and making decisions on the need to announce competitions for appointments and career growth of the academic staff. The tool generates comparative analyses with quantitative data on the distribution and qualification of

the academic staff at different university levels according to a predefined set of criteria. It allows the governing bodies to track which departments there is a need for new appointments to ensure the educational process and meet legal requirements. In this way, the tool allows for optimization and increases the efficiency of human resource management processes, encourages systematic planning of the HEI's mission and goals, and supports the development of human resource management plans to achieve full university staffing over the next decade.

2. Literature review

In recent years, there has been an increasing interest in implementing intelligent human resource management systems and artificial intelligence tools to support human resource management processes.

Prokushev [7] studies parameters describing employees (work results, education and qualifications, social and psychological characteristics, and personal data) and proposes a mathematical apparatus based on the methods of decision theory and expert assessments, which formalizes the processes of making personnel decisions based on calculated values of quantitative and qualitative indicators.

Czarnowski and Pszczółkowski [5] design an intelligent decision support system for human resources. The system has an analytical module for the quality assessment process, quantitative and qualitative data correlation studies, a data collection module, and a forecasting module for data analysis and decision-making recommendations based on an artificial intelligence engine. The system collects values of various human resource indicators, monitors them, and gives warnings when these indicators reach or exceed critical levels. It also predicts actions (decisions) using machine learning tools that management can apply to mitigate the negative effects of value fluctuations.

Bai proposes a decision-making model for human resource management based on intelligent big data analysis [3]. The designed system uses data mining technology to analyze and process existing data for selected indicators (knowledge level, teaching skills, teaching quality), predict future situations, and provide decision-making support. According to simulation results, the decision-making accuracy of this model can reach 95.68%.

Mohammed and Anad [16] propose a data warehouse architecture for human resource systems of public and private organizations that provide authorized access to information for students and support staff selection based on annual payment data.

Tadić, Marasović and Jerković [4] proposes a fuzzy multi-criteria model based on the Order Preference for Similarity to Ideal Solution (TOPSIS) technique for decision support for HEIs' teaching and research staff selection. The model is based on hierarchically structured quantitative and qualitative selection criteria and required competencies of experts.

Ridwan et al. [1] examines issues related to quality assurance in education and the benefits of developing a quality assurance information system in the field of human resources, which can monitor the provision of human resources in university

units and facilitate the accreditation process carried out by independent organizations by providing data and evidence. Such a system would allow the university to carry out consistent and sustainable quality assurance of human resources, improve management effectiveness, create a favorable process of training and development of scientific activity, management effectiveness, and lead to the university's rise in the rating rankings and increase the competitiveness of the university.

The mentioned research presents a compelling rationale for adopting decision-making support tools within HEIs' human resource management, facilitating the attainment of enhanced organizational efficacy. To be implemented in HEI, the systems must comply with the legislation of the respective country and the institutional regulatory documents that regulate the processes of selection, performance evaluation, promotion, and dismissal of employees.

3. Software tool

The design and development of an analytics tool to assist the HEIs' governing bodies in monitoring the university's staffing and making decisions on the need to announce competitions for appointments and career advancement of members of the academic staff proceeds in five steps.

- **Step 1.** Identification of stakeholders in the university and their needs.
- **Step 2.** Analysis of regulatory documents and definition of a set of monitoring indicators.
- **Step 3.** Selection of technologies for implementation.
- **Step 4.** Design and development of dashboards for monitoring the values of the indicators.
- **Step 5.** Development of a software module for visualizing the developed dashboards and integration into the existing university infrastructure.

The following subsections describe the process of designing and developing an analytics tool for monitoring the need for recruitment in higher education institutions. Due to the specifics of the organizational structure of higher education institutions and the differences in regulatory requirements at the national and institutional levels, the proposal of a universal tool is impossible. Therefore, some steps in the following subsections will be specified for a typical Bulgarian university.

3.1. Stakeholders in HEIs and basic needs

The university's governing bodies are the main stakeholders as they must monitor the need to announce competitions for academic positions in HEI and make decisions regarding the development of the academic staff. Faculty management (middle management) must make informed decisions to announce competitions for academic positions to provide the necessary human resources to ensure the educational process in the study programs offered by the faculty. Therefore, they are interested in continuously monitoring the faculty's staffing and using the data to motivate the need for new appointments and competition for the Rector's management. In turn, the Rector's management (top management) is interested in monitoring faculty staffing according to various indicators. This continuous monitoring would allow the top

management to make informed and data-based decisions on announcing competitions for a specific faculty when, due to regulatory requirements and limited financial resources, more than one faculty is "competing" for a certain number of places for relevant academic positions. Heads of basic teaching units (departments) benefit from tracking data on the staffing of the unit they manage, which they can use to motivate the need to announce competitions to the faculty management.

Another stakeholder is the members of the HEI human resources departments. They are interested in tracking the number of tenured faculty members in each academic position across all faculties and how many of them are approaching retirement age.

The analysis revealed the following key user roles: Top Management, Middle Management, Department Management, and Human Resources (HR) Department. Administrator and dashboard developer roles are also required to ensure the tool provides all necessary functionalities for the identified stakeholders. The main activities that need to be performed by these actors are:

- User Management. The administrator can manage user accounts and give access rights to dashboards.
- Dashboard Development. The dashboard developer designs and develops dashboards to visualize values of a specific set of indicators, selecting appropriate elements to visualize the values.
- Dashboard Viewing. Identified stakeholders access the developed dashboards according to their user role and view the calculated values of the indicators.
- Document generation. Stakeholders generate comparative reports with calculated values of key indicators at a specific time, with faculty deans and department heads generating motivated reports with data on students enrolled, faculty/department staffing status, and provided teaching workload.

Fig. 1 illustrates the user roles and access to functionalities of the tool.

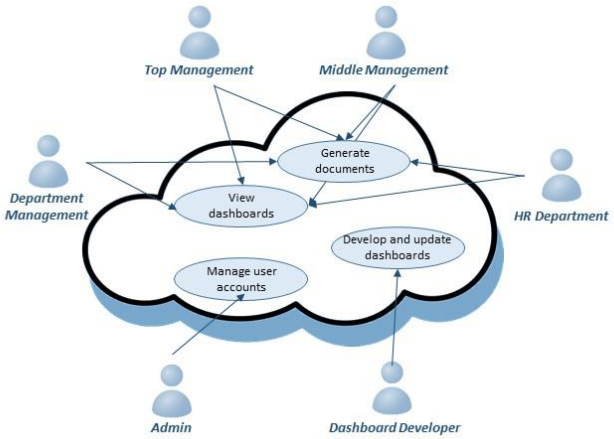


Fig. 1. User roles and access

3.2. Analysis of regulatory documents and definition of a set of monitoring indicators

Determining a set of indicators for effective monitoring of the HEI's staffing, the calculated values of which would support decision-making on the need to announce competitions for appointments and career advancement of the academic staff, requires an in-depth analysis of regulatory documents at different levels. Due to the specificity of regulatory documents, this subsection will present an exemplary analysis for a typical Bulgarian university.

The need to announce competitions for academic positions in Bulgaria must comply with the provisions of the Higher Education Act, Act on Development of the Academic Staff in the Republic of Bulgaria, the National Evaluation and Accreditation Agency (NEAA) criteria for accreditation and post-accreditation monitoring of professional fields, as well as the HEI internal regulations. These requirements dictate which regulatory acts and documents must be analyzed to determine the key indicators for monitoring staffing in a typical Bulgarian university.

Bulgarian HEI has primary units, service units, and branches in its structure. The primary units are the faculties, departments, institutes, and colleges. Service units are relatively separate structures (such as centers, libraries, administrative departments, publishing complexes, etc.) that provide administrative services. Branches are territorially outsourced structures of a HEI. Each main unit/branch unites no less than three departments to provide training for students, PhD students, and postgraduates in one or several professional fields in which the HEI has accreditation to provide training. The department conducts educational and scientific research activities in one or a group of related disciplines. It includes at least seven academic staff members on a basic employment contract in a higher education institution. According to the current Higher Education Act [17], decisions to announce competitions for filling positions in HEIs are made by the academic council upon proposals from the primary units and/or branches and must comply with legal requirements. Art. 26. Habilitations from the academic staff (holding academic positions of associate professor and professor) of the faculty/branches on a basic employment contract must conduct for each specialty no less than 70% of the lecture hours in no less than 50% of the lecture courses, and only if necessary and after a decision of the academic council for individual specialties may habilitations conduct no less than 50% of the lecture hours. The NEAA Criteria System for Program Accreditation of Professional Fields [18] has a quantitative indicator that measures the relative share of lecture courses (in percentages) in the current academic year led by habilitated persons on basic employment contracts.

The Act on the Development of Academic Staff in the Republic of Bulgaria and the regulations established by individual HEIs define the process for filling academic positions (Assistant, Chief Assistant, Associate Professor, and Professor). According to the Act [19], HEI can announce a competition for filling an academic position if it can ensure the teaching or research workload per the relevant regulations of the higher education institution or scientific organization.

The internal regulations define the terms and conditions for holding academic positions in a specific HEI. In the majority of HEIs, the appointment of an academic position of Assistant is carried out by the Rector upon a proposal from the head of

the department, approved by the Academic Council, ratified by a decision of the Faculty Council, when the department can provide an annual quota for an academic year (300 teaching hours) The remaining academic positions (Chief Assistant, Associate Professor and Professor) are filled based on competition and selection, as the department can announce a competition when can provide a corresponding annual quota for an academic year. The department must ensure that the newly hired person teaches a lecture course in a mandatory discipline that meets the specifics of the professional field of the competition to announce free academic positions of Associate Professor and Professor. The Dean submits a report to the Rector with a request from the relevant faculty to announce a competition for an academic position. Most regulations specify the ratio between the academic positions of Professor, Associate Professor, Chief Assistant, and Assistant. Within these regulations, Assistants and Chief Assistants are commonly counted as a combined group. At the University of Plovdiv "Paisii Hilendarski", for example, this ratio is 1:2:3 [20].

Based on the analysis of regulatory documents, the following key indicators for monitoring staffing can be defined:

- Number of lecturers holding the academic position of Assistant;
- Number of lecturers holding the academic position of Chief Assistant;
- Number of lecturers holding the academic position of Associate Professor;
- Number of lecturers holding the academic position of Professor;
- Average number of teaching hours per lecturer;
- Average number of lecture hours per habilitated lecturer;
- Number of habilitated lecturers over the age of 65;
- Number of non-habilitated lecturers over the age of 65;
- Number of lecture hours led by full-time lecturers
- Number of laboratory and seminar hours led by full-time lecturers
- Number of lecture hours led by lecturers on a civil contract
- Number of laboratory and seminar hours led by lecturers on a civil contract
- Number of lecture hours;
- Number of laboratory and seminar hours;
- Ratio of lecture hours led by habilitated lecturers;
- Ratio of lecture hours led by full-time lecturers;
- Ratio of laboratory and seminar hours led by full-time lecturers;
- Number of students in a professional field;
- Number of students in a faculty;
- Ratio of lecturers in individual academic positions.

3.3. Selection of technologies for implementation

The development of analytics tools requires selecting appropriate data to extract values for the formed criteria and software tools to extract, analyze, and visualize data from university systems. For developing a tool for monitoring values of the formed set of indicators, many data analysis platforms on the market could be used, such as Power BI, Tableau, JasperSoft, Qlik, Plotly, Oracle Analytics, Grafana, QuickSight, Looker, Mode, ThoughtSpot, and Zoho Analytics. Software tool

selection should involve experimental testing and comparison against defined criteria, such as price and proposed delivery methods, supported programming language, data integration and management capabilities, supported data sources, capabilities for generating comparative analyses, data visualization elements, data and document export formats, business intelligence functions, compatibility and integration with other tools, automatic monitoring and sending notifications, provided customization capabilities, provided collaboration capabilities, functionalities for creating dashboards, intuitive user interface, customer support and user community, access control for different categories of users. The selection of a dashboard development platform requires particular attention to the range of supported data sources and the platform's ability to integrate with the university's current infrastructure.

The technologies used to develop the tool presented in this article are the JasperSoft business intelligence platform (the JasperSoft Studio and JasperReport Server tools) and the PHP programming language.

The tools from the Jaspersoft BI platform help developers design, embed, manage, and deploy reports, self-service ad hoc reports, and dashboards. Jaspersoft Studio allows the development of customized report templates with rich design and data visualization capabilities that meet user requirements and can extract data from the widest range of data sources, such as relational databases, big data sources, unstructured data, etc. The designed reports/dashboard can contain a variety of basic (text fields, tables, images, crosstabs, subreports, etc.) and additional elements (HTML5 charts and maps, Google Maps, TIBCO GeoAnalytics Maps, etc.). Each report has three groups of objects that can store values (fields, parameters, and variables) used in data source queries. Parameters pass values to the report from the application that launches it and to component elements of the report (such as tables, subreports, charts, etc.). Variables store intermediate results and perform complex calculations with the data extracted from a data source. Their values are formed after evaluating JavaScript, Groovy, and Java expressions. The tool's extensible architecture allows developers to implement generic elements and custom components and use libraries and functionality from third-party software.

JasperReport Server allows organizing a repository for storing projects developed with JasperSoft Studio, generating documents according to designed reports/dashboards and exporting generated documents in a format preferred by the user. A repository allows the creation of personalized dashboards that display several reports in a single, integrated view. Users can create appealing, data-rich dashboards that quickly convey trends by combining different content types. JasperReport Server allows the set of alerts to monitor the data and notify users of any significant change in the data. The built-in ad hoc Editor is the interactive designer for creating and editing an ad hoc view, where users can explore and analyze data from Topic, Domain, or OLAP data sources. Users can also use ad hoc views to create content for reports. In addition, the server can launch report/dashboard templates on a predefined schedule and then store the generated results in a specific location. The other benefit of JasperServer is its ability to integrate with external applications, including through web services.

The JasperReports Server REST API is an Application Programming Interface that allows client applications to interact with the server through the HTTP protocol [21]. The REST API allows clients to interact with all features of the server, such as running, exporting, and scheduling reports, reading and writing resources in the repository, and managing organisations, roles, and users. It requires credentials for every operation and enforces the same permissions and administrator restrictions as the server's user interface. Client applications send requests to named URLs that are called services. A service provides several operations on a feature. To describe resources and objects in the server, the REST API sends and receives data structures called descriptors specific to each service. Most services support descriptors in XML and JSON. Descriptors are usually sent and received in HTTP requests and responses, so the client application relies on further APIs to handle the HTTP communications.

The JasperReports Server PHP Client [22] is a wrapper for the JasperReports Server REST API, which provides easy integration with external applications written in PHP. This client abstracts the details behind communications with the server into simple-to-use functions. It allows developers to deal with objects that represent resources within the server without parsing and creating JSON data. The client provides the ability to access JasperReports Server for organizing the repository (searching for resources in the repository, creating resources, working with composite resources, visualizing binary resources, deleting, moving and copying a resource), managing permissions (searching, changing, creating and deleting permissions), importing and exporting resources, working with reports (starting a report execution with and without specified input control values, downloading the result in a selected file format, managing input control values), task management, executing queries, administrative services (role and user-managed).

3.4. Dashboards design and development

Based on the defined key indicators for which values will be calculated, seven dashboard templates have been designed. Each template (see Dashboard template column in Table 1) allows the visualization of aggregated values of a certain set of indicators (see Indicators column in Table 1) and other data (see Other visualized data column in Table 1). The assigned role determines the set of templates by which users can generate reports (see User column in Table 1). Thus, a user with the Middle Management role can generate a *Detailed report on the academic staff by department,* a *Summary report on the academic staff by department*, a *Summary report on classroom hours and staffing by study programmes* and a *Detailed report on the faculty academic staff by professional fields*. The values of the indicators in some of the designed templates will be calculated based on the submitted value of the parameter (see Parameter column in Table 1). To eliminate the risk of entering incorrect parameter values and generating reports for other departments/faculties other than those managed by the respective user, it is planned that the value of the parameter for users with the roles Middle Management/Department Management to be automatically submitted by the application from which the reports will be generated. For example, if the head of department X generates a report using the template Detailed report on the department's academic staff, when calculating the

Number of lecturers holding the academic position of Professor, only the professors in department X will be counted.

Table 1. Dashboards and indicators

Dashboard template	User	Parameter	Indicators	Other visualised data
Detailed report on the department's academic staff	Department Management and Middle Management	Department	Number of lecturers holding the academic position of Assistant Number of lecturers holding the academic position of Chief Assistant Number of lecturers holding the academic position of Associate Professor Number of lecturers holding the academic position of Professor Number of lecturers Average number of teaching hours per lecturer Number of habilitated lecturers over the age of 65 Number of non-habilitated lecturers over the age of 65 Number of lecture hours led by full-time lecturers Number of laboratory and seminar hours led by full-time lecturers Number of lecture hours led by lecturers on a civil contract Number of laboratory and seminar hours led by lecturers on a civil contract	Department name
Detailed report on the academic staff by department	Middle Management and Top Management	Faculty	Number of lecturers holding the academic position of Assistant Number of lecturers holding the academic position of Chief Assistant Number of lecturers holding the academic position of Associate Professor Number of lecturers holding the academic position of Professor Number of lecturers Average number of teaching hours per lecturer Number of habilitated lecturers over the age of 65 Number of non-habilitated lecturers over the age of 65 Number of lecture hours led by full-time lecturers Number of laboratory and seminar hours led by full-time lecturers Number of lecture hours led by lecturers on a civil contract Number of laboratory and seminar hours led by lecturers on a civil contract	Department name
Summary report on the academic staff by department	Middle Management and Top Management	Faculty	Number of lecturers holding the academic position of Assistant Number of lecturers holding the academic position of Chief Assistant Number of lecturers holding the academic position of Associate Professor Number of lecturers holding the academic position of Professor Number of lecturers Average number of teaching hours per lecturer Number of habilitated lecturers over the age of 65 Number of non-habilitated lecturers over the age of 65 Number of lecture hours Number of laboratory and seminar hours Total number of hours	Department name

Table 1 (c o n t i n u e d)

Summary report on classroom hours and staffing by study programmes	Middle Management and Top Management	Faculty	Number of lecture hours Number of laboratory and seminar hours Ratio of lecture hours led by full-time lecturers Ratio of laboratory and seminar hours led by full-time lecturers	Faculty Study programme Professional field
Detailed report on the faculty academic staff by professional fields	Middle Management and Top Management	Faculty	Number of students in the Professional Field Number of lecturers holding the academic position of Assistant in Professional Field Number of lecturers holding the academic position of Chief Assistant in the Professional Field Number of lecturers holding the academic position of Associate Professor in the Professional Field Number of lecturers holding the academic position of Professor in the Professional Field Ratio of lecturers in individual academic positions	Faculty Professional field
Summary report on the academic staff by faculty	Top Management and HR Department	Without parameter	Number of students in a faculty Number of lecturers holding the academic position of Assistant Number of lecturers holding the academic position of Chief Assistant Number of lecturers holding the academic position of Associate Professor Number of lecturers holding the academic position of Professor Ratio of lecturers in individual academic positions	Faculty
Detailed report on the academic staff by faculty	Top Management and HR Department	Without parameter	Number of students in a faculty Number of lecturers holding the academic position of Assistant Number of lecturers holding the academic position of Chief Assistant Number of lecturers holding the academic position of Associate Professor Number of lecturers holding the academic position of Professor Ratio of lecturers in individual academic positions Number of habilitated lecturers over the age of 65 Number of non-habilitated lecturers over the age of 65 Number of lecture hours Number of laboratory and seminar hours Average number of lecture hours per habilitated lecturer Average number of teaching hours per lecturer	Faculty

Calculating the values of the proposed set of indicators requires familiarization with the capabilities of the software systems used in the university and potential data sources. This analysis aims to identify the data stored in potential sources and determine how it can be used to calculate key indicators. In general, the following should be analyzed:

- systems for storing academic staff data to extract data on academic position held, professional field of the position, and age;
- systems for reporting teaching employment to extract data on the workload of academic staff;
- systems for storing curricula to extract data on the number of lecture hours and hours for seminar and laboratory exercises;

- systems for storing student data to extract data on students per study programmes and professional fields.

The process of calculating indicator values involves summarizing data using aggregation functions, specifically those that sum and average numeric columns. The designed templates were developed using JasperSoft Studio. The templates contain three types of elements (labels, text fields, tables) that visualize the values of indicators, which are formed based on queries for extracting data from the selected data source and subsequent processing of the obtained results. Calculating the values of some of the elements requires calculating the values of expressions that combine various SQL operators, functions, and values. Aggregation functions are used in all queries to group values to generate summarized data, such as the number of values in a given column. Fig. 2 presents a developed template of a *Detailed report on the academic staff by faculties* for the needs of the Top management and HR management. All developed templates are stored in the JasperReports Server.

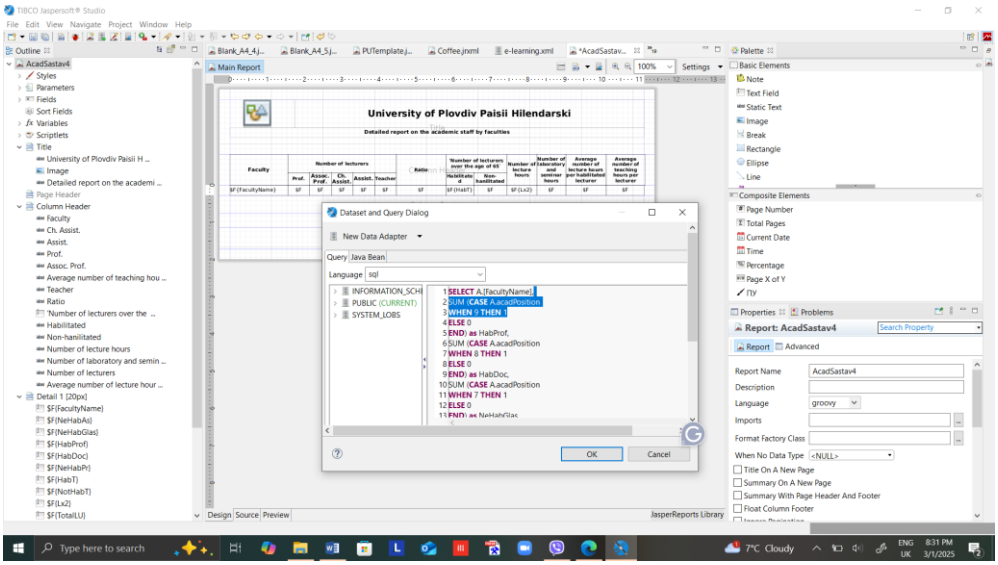


Fig. 2. Dashboard template

3.5. Development of a software module for visualizing the developed dashboards and integration into the existing university infrastructure

In the last step, a software module was designed and developed that can be integrated into the software system used by the governing bodies. The main goal of the module is to allow those in management positions to view calculated values of key indicators at the department, faculty, and university level in the visualized dashboards and to download documents containing up-to-date reports with summarized data from their familiar interface without knowledge of working with JasperReport Server. Fig. 3 presents a UML Sequence Diagram with the main steps for visualizing values of key indicators and generating documents on the visualized dashboards.

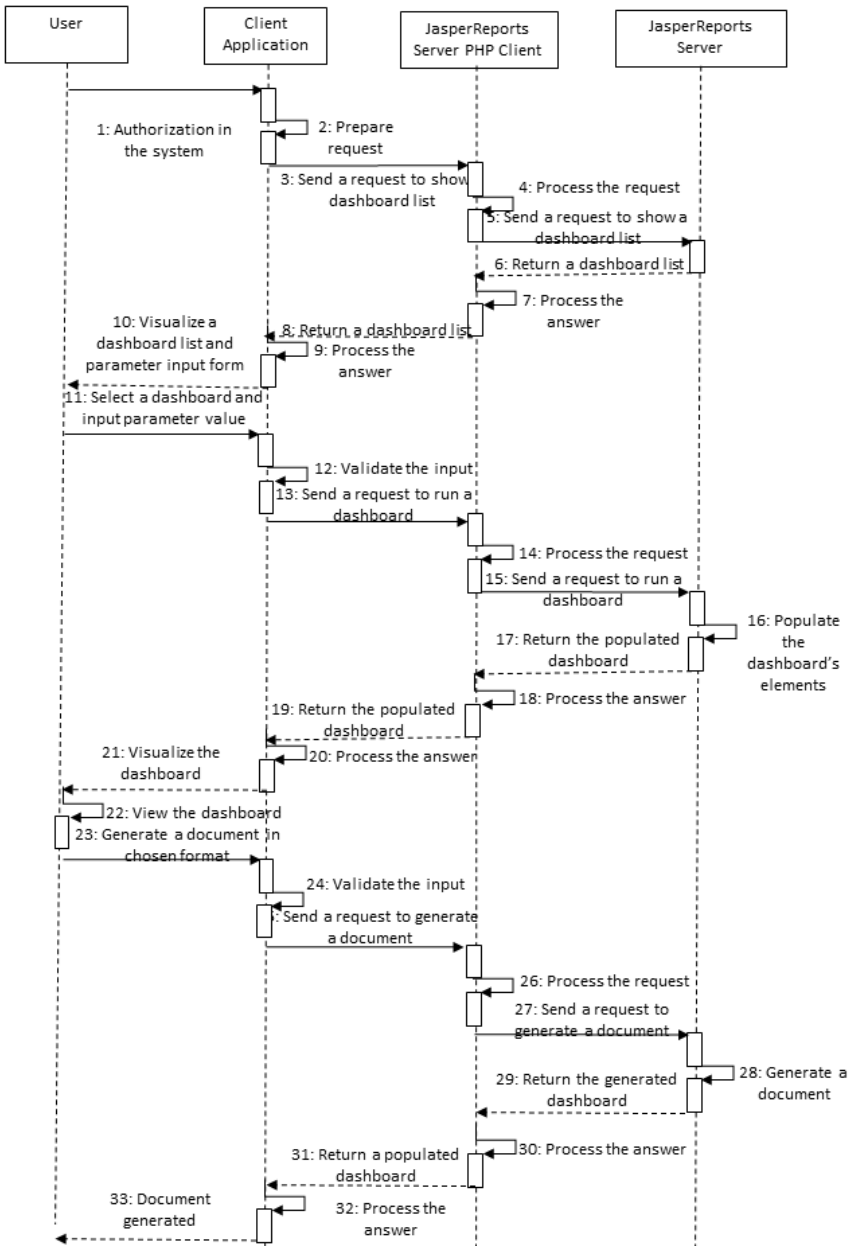


Fig. 3. Steps for dashboard visualisation and document generation

The user logs in to the system through a username and password. The client application (the developed software module) requests the JasperReports Server PHP Client to visualize a list of dashboards a user can view based on their role. JasperReports Server PHP Client forwards the request to the JasperReports Server REST API, which returns as a result to the JasperReports Server PHP Client a list of all dashboards that are available to stakeholders from the logged-in user's group and their corresponding parameters. JasperReports Server PHP Client returns the

response to the client application. The client application processes the received response and visualizes a list of dashboards. The user views and selects which of the available dashboards to visualize. In cases where the dashboard has parameters, to prevent attempts to visualize dashboards with data of a department/faculty other than those managed by the logged-in user, the client application visualizes a form for selecting the parameter value only when the user is a member of the Top Management or the HR Department. In this case, the user selects a value for the parameter (Department, Faculty). The parameter values for all other users are automatically supplied by the client application and extracted from the user data stored in the client application database. The client application validates the parameter format (if any). Then, it sends a request to the JasperReports Server PHP Client to launch a dashboard visualization request, creating a client instance with the dashboard address, the specified parameter values, and an HTML format for dashboard visualization.

The JasperReports Server PHP Client launches a REST service on the Jasper Server to populate the dashboard based on the parameter values provided. The web service interface responds to the HTTP request from the client application, JasperReport Server addresses the data source and extracts the data required for populating the dashboard elements, performs the necessary calculations, populates the dashboard elements with current data, and returns the populated dashboard as a response to the request made to the JasperReports Server PHP Client. JasperReports Server PHP Client returns the response to the client application. The client application processes the received response and visualizes a filled-in dashboard and buttons for generating a document with the data visualized in the dashboard in PDF or XLS format. The user views the visualized dashboard. The client application sends a request to the JasperReports Server PHP Client to start a request to generate a document, creating a client instance with the address of the dashboard, the specified parameter values, and the selected document format. JasperReports Server PHP Client starts a REST service on Jasper Server to populate the dashboard based on the specified parameter values and return the result in a document in the selected format. The web service interface responds to the HTTP request from the client application. Then, the JasperReport Server addresses the data source and extracts the data necessary for populating the dashboard elements, performs the calculations, populates the dashboard elements with current data, generates a file in the selected format, and returns the file as a response to the request made to the JasperReports Server PHP Client. JasperReports Server PHP Client returns the response to the client application. The client application processes the response and allows the user to save the file to a location of their choice.

The developed module can work independently or be integrated into software tools written in PHP that support the assigned user roles. Fig. … presents an example of the architecture of a software system suitable for integrating with the developed module. The system includes a system client, three levels (User Interface, System Components, Access to External Services), databases, database management systems, and other external services. Users access the system functionalities through an interface provided by a web or mobile application. Key functions for various user roles (administrators, academic and administrative staff) at the presentation level,

provided by different modules of the system, are the management of user profile data and user rights, visualization of a control panel, generation of documents for educational and administrative activities in the university, etc. At the second level are the system components that perform their main business logic, such as the System Authentication Module, the Visualization Module for Control Panels with Numerical Data for the Academic Staff, etc. The system modules communicate with the database management system and other external systems and services through the components located at the Access to External Services level. The system database provides reliable storage of all necessary data for the system to operate. JasperSoft Studio and JasperReport Server are used as external services. JasperReport Server communicates with the software system through REST services. JasperReport Server communicates with external databases and data sources from which it extracts data for filling in the values of control panel elements, such as data on academic staff, reporting on teaching employment, data on curricula, and data on students. In the case of an integrated system of the type `digital university`, one database can store this data. The system architecture is flexible, enabling the integration of various databases, services, and data analysis tools.

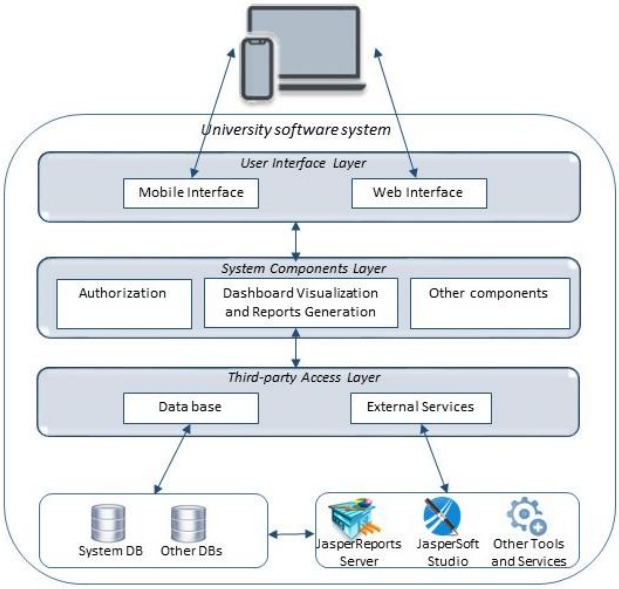


Fig. 4. System architecture

The module is suitable for implementation in any HEI. This process requires HEI to perform the following steps:

- **Step 1.** Modification of the requests in the designed dashboards to extract data from the used software systems;
- **Step 2.** Installation of JasperReport Server for storing the designed dashboards should;
- **Step 3.** Update the address of the JasperReport Server in the developed module.

- **Step 4.** Setting the way for extracting necessary values for the parameters when users who are heads of departments and members of the dean's boards request visualization of a dashboard.

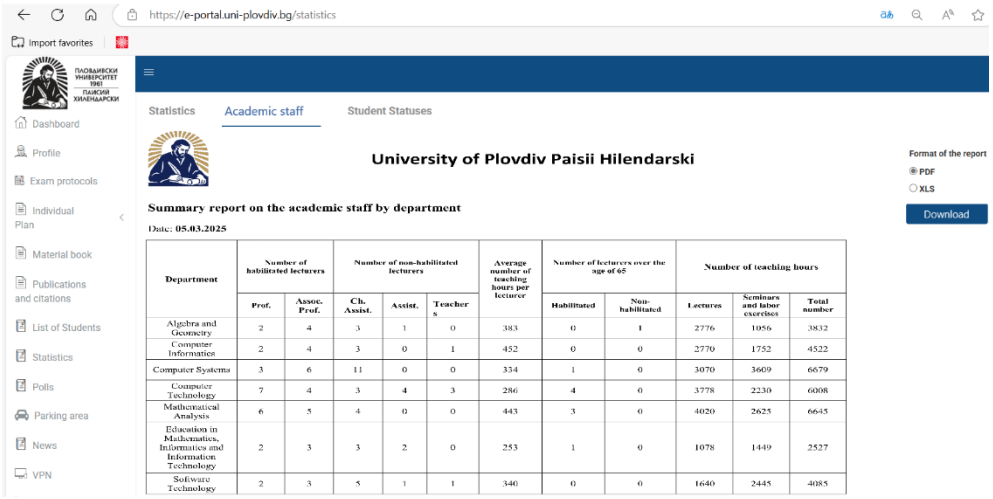
4. Experiment

The developed module has been tested at the University of Plovdiv "Paisii Hilendarski". The module has been integrated into the University's electronic portal, through which HEI offers administrative services to students, lecturers, and administrative staff. The tool is accessible from the university Intranet and thus it is well secured from viruses and hacker attacks, as all other university digital assets, by applying a robust security policy, firewalls, strong user access control, use of encryption security technology, etc. The system administrator sets the rights of users to use certain functionalities. Upon successful login to the portal, the session variable stores data on the functionalities for which the user has authorised rights. The integrated module will enable the Rector's Office, Dean's Offices, Heads of Departments, and employees in the HR Department to track the values of key indicators in visualized dashboards and to export data from these dashboards in PDF and XLS formats. Access to this functionality is allowed only to users who hold the relevant positions. The developed dashboards have been modified to extract data from the electronic portal database (Step 1), which stores all the data necessary to fill in the values of the elements in the dashboards. The dashboards are located in the JasperReport Server installed (Step 2), and the address of the JasperReport Server has been updated in the module (Step 3). In the last step of the integration, the module code has been modified to allow the value of the faculty and department parameters for users with the role of Middle Management and Department Management to be retrieved from the portal database (the value of the field that stores the faculty/department that manages the logged-in user).

The following figures present dashboards visualized by users with Middle Management and Top Management roles.

Fig. 5 presents an interactive dashboard that visualizes summarized data on the academic staff in the Faculty of Mathematics and Informatics. The visualized dashboard presents in tabular form summarized data on the distribution of teaching workload and the demographic characteristics of the academic staff, which allows the faculty management to assess the staffing situation of the faculty and make informed decisions for its development. The faculty management can review the distribution of teachers by departments and positions, which departments have the minimum/maximum teaching load, the average workload of teachers in each department, and how many of the teachers in each department are of retirement age. The visualization shows that teachers in the "Computer Informatics" and "Mathematical Analysis" departments have the highest workload. The data shows that they teach an average of 452 and 443 hours, which is significantly above the average for the faculty, and that they have the greatest need for new teachers' appointments. The lecturers in the "Education in Mathematics, Informatics and Information Technologies" department have the least workload, which will not

require new appointments in the coming years. Information on the number of lecturers of retirement age is crucial for planning succession and preventing a possible shortage of lecturers. The dashboard shows that the Department of Mathematical Analysis has three habilitated lecturers over 65 years old, which signals a need to attract young lecturers. Based on this information, the dean of the faculty can make informed decisions about appointing new lecturers to priority departments if the financial situation allows and encourages the attraction of young lecturers. Thus, the interactive dashboard provides the dean with a powerful tool for making data-based decisions, allowing for more effective management of the academic staff.

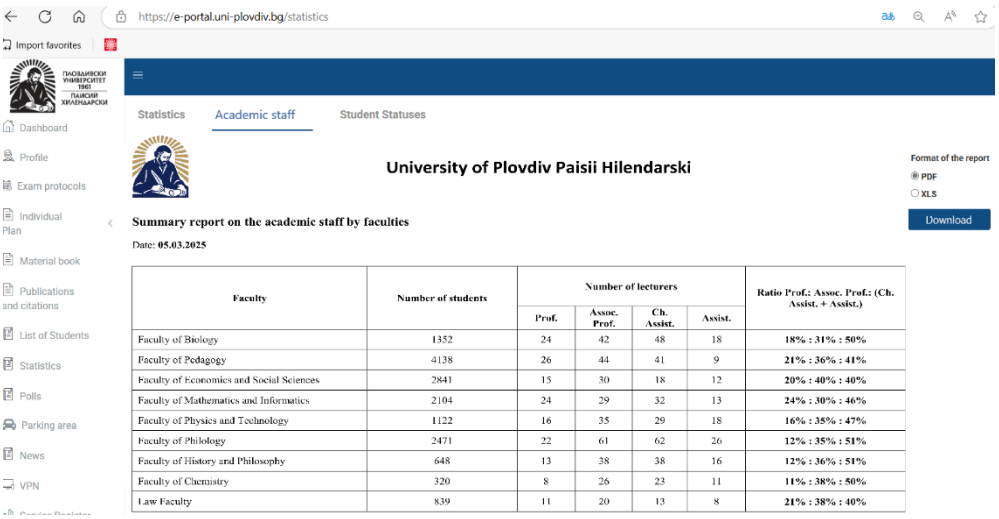


Department	Number of habilitated lecturers		Number of non-habilitated lecturers			Average number of teaching hours per lecturer	Number of lecturers over the age of 65		Number of teaching hours		
	Prof.	Assoc. Prof.	Ch. Assist.	Assist.	Teachers		Habilitated	Non-habilitated	Lectures	Seminars and labor exercises	Total number
Algebra and Geometry	2	4	3	1	0	383	0	1	2776	1056	3832
Computer Information	2	4	3	0	1	452	0	0	2770	1752	4522
Computer Systems	3	6	11	0	0	334	1	0	3070	3609	6679
Computer Technology	7	4	3	4	3	286	4	0	3778	2230	6008
Mathematical Analysis	6	5	4	0	0	443	3	0	4020	2625	6645
Education in Mathematics, Informatics and Information Technology	2	3	3	2	0	253	1	0	1078	1449	2527
Software Technology	2	3	5	1	1	340	0	0	1640	2445	4085

Fig. 5. Summary report on the academic staff by department

Fig. 6 illustrates a summary report on the staffing situation by faculty, presented by faculty. This report aims to provide university management with an overview of the distribution of academic staff by positions and faculties and allow it to identify potential areas for attention. The data presented shows that as of the 5 May 2025, the distribution of academic staff by positions – is as follows: 17% of the university's lecturers hold the position of professor, 35% – associatee professor, and 48% – chief assistant or assistant. The report shows that the highest percentage of habilitated lecturers is in the Faculty of Economic and Social Sciences (60%) and the Faculty of Law (59%). The lowest percentages have the Faculty of Philology (47%), the Faculty of Philosophy and History (48%), the Faculty of Biology (49%), and the Faculty of Chemistry (49%). This difference in percentages may be due to various factors, such as the specificity of the scientific fields, traditions in career growth, or current needs of the faculty. The large number of students studying at the Faculty of Philology, combined with the low percentage of habilitated lecturers, signals a potential need to strengthen the academic staff. This can be achieved by stimulating the chief assistants and assistants working in this faculty and announcing competitions for their professional development. For more detailed information and more informed decision-making, it is advisable to use the generated detailed report. Using these boards, university management can identify the needs of individual faculties, plan

effective personnel development, make informed decisions on resource allocation, and optimize the academic staff.



Faculty	Number of students	Number of lecturers				Ratio Prof.: Assoc. Prof.: (Ch. Assist. + Assist.)
		Prof.	Assoc. Prof.	Ch. Assist.	Assist.	
Faculty of Biology	1352	24	42	48	18	18% : 31% : 50%
Faculty of Pedagogy	4138	26	44	41	9	21% : 36% : 41%
Faculty of Economics and Social Sciences	2841	15	30	18	12	20% : 40% : 40%
Faculty of Mathematics and Informatics	2104	24	29	32	13	24% : 30% : 46%
Faculty of Physics and Technology	1122	16	35	29	18	16% : 35% : 47%
Faculty of Philology	2471	22	61	62	26	12% : 35% : 51%
Faculty of History and Philosophy	648	13	38	38	16	12% : 36% : 51%
Faculty of Chemistry	320	8	26	23	11	11% : 38% : 50%
Law Faculty	839	11	20	13	8	21% : 38% : 40%

Fig. 6. Summary report on the academic staff by faculty

5. Conclusion

The conducted experiments proved that the developed tool supports governing bodies in making decisions regarding academic staff based on their management experience and the calculated indicator values.

Based on feedback from the experimental testing of the tool from representatives of different stakeholder groups, the tool's functionalities will be expanded. The next version of the tool will implement machine learning methods to predict future faculty workload and the need for faculty appointments at HEIs based on analysis of historical data on faculty workload (number of hours, number of students per faculty member, etc.), faculty demographic data (age, experience, specialization), and number of students.

The tool is part of a package of tools to guide governing bodies in making informed decisions for increasing the student success rate, career development, and faculty staff scientific activity, ensuring a higher quality of training and services offered.

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References

1. Ridwan, M., S. Mulyani, R. Putra, H. Pratiwi, V. Kumbara. Assessment of Human Resource Management Performance in Higher Education with Information Systems – Journal IPTEKS Terapan, Vol. **17**, 2023, No 2, pp. 217-223.

2. Irawan, A., R. Erdiansyah, P. Anggarina, K. Patrick. Factors Affecting the Improvement of Human Resource Competence in Adapting and Facilitating Learning Changes in Higher Education – In: Proc. of International Conference on Economics, Business, Social, and Humanities (ICEBSH'2021), Atlantis Press, 2021, pp. 1421-1425.
3. Bai, Y. Innovative Mode of Human Resource Management of University Teachers Based on Intelligent Big Data Analysis. – Computational Intelligence and Neuroscience, 2022.
4. Tadić, I., B. Marasović, I. Jerković. Fuzzy Multicriteria Model to Support Decision Making during the Selection Process of Teaching and Research Staff in Higher Education – Systems Research and Behavioral Science, Vol. **39**, 2022, No 4, pp. 867-885.
5. Czarnowski, I., P. Pszczółkowski. A Novel Framework for Decision Support System in Human Resource Management. – Procedia Computer Science, Vol. **176**, 2020, pp. 1548-1556.
6. Allui, A., J. Sahni. Strategic Human Resource Management in Higher Education Institutions: Empirical Evidence from Saudi Arabia. – Procedia-Social and Behavioral Sciences, Vol. **235**, 2016, pp. 361-371.
7. Prokushev, Y. The Features of the Development of HR Decision-Making Support Systems. – In: CEUR Workshop Proceedings, 2021, pp. 71-80.
8. Sahni, J., T. Jain. A Study of Modelling Strategic Human Resource Management Practices – International Journal of Engineering, Management &Medical Research, Vol. **1**, 2015, No 1, (1).
9. Bahrami, S. Simple and Multiple Relations between Strategic Human Resource Management and Intellectual Capital in Iranian Higher Education. – African Journal of Business Management, Vol. **7**, 2013, No 35, pp. 3451-3460.
10. Govender, L., R. Perumal, S. Perumal. Knowledge Management as a Strategic Tool for Human Resource Management at Higher Education Institutions. – South African Journal of Information Management, Vol. **20**, 2018, No 1, pp. 1-10.
11. Mohammed, D. HR Analytics: A Modern Tool in HR for Predictive Decision Making – Journal of Management, Vol. **6**, 2019, No 3.
12. Nguyen, D., L. Phan, H. Ho, A. Le. Human Resource Management Practices in Higher Education: A Literature Review Using Co-Word Analysis. – International Journal of Management in Education, Vol. **16**, 2022, No 1, pp. 40-61.
13. Samy, N., R. Abd El Aziz, M. Tarek, M. Ismail. HRIS Mediating Role in the Relationship between TOE and Decision Making. – Technology and Investment, Vol. **14**, 2023, No 1, pp. 1-21.
14. Gaftandzhieva, S., R. Doneva, M. Bliznakov. Quality of Blended Learning Implementation in HEIs: Tool for Monitoring the Use of e-Learning Management Systems. – Cybernetics and Information Technologies, Vol. **24**, 2024, No 2, pp. 86-104.
15. Rijati, N., D. Purwitasar, S. Sumpeno, M. Purnomo. A Rule-Generation Model for Class Imbalances to Detect Student Entrepreneurship Based on the Theory of Planned Behavior. – Cybernetics and Information Technologies, Vol. **22**, 2022, No 2, pp. 160-178.
16. Mohammed, M., M. Anad. Data Warehouse for Human Resource by Ministry of Higher Education and Scientific Research. – In: Proc. of International Conference on Computer, Communications, and Control Technology (I4CT'14), IEEE, 2014, pp. 176-181.
17. Ministry of Education and Science, Higher Education Act. 2024.
https://lex.bg/laws/ldoc/2133647361
18. NEAA, Criteria System for Program Accreditation of Professional Fields. 2023.
https://www.neaa.government.bg/images/OA-PA-PN/Kriterii_za_programna_akreditacija_na_PN-SRP-2023.pdf
19. Ministry of Education and Science, Act on the Development of Academic Staff in the Republic of Bulgaria. 2022.
https://www.mon.bg/nfs/2023/02/act_on_development_acadstaff_022023.pdf
20. University of Plovdiv Paisii Hilendarski, Regulations on the Development of Academic Staff in the University of Plovdiv Paisii Hilendarski, 2024.
https://procedures.uni-plovdiv.bg/docs/praspu2024_3.pdf

21. JasperSoft Community, JasperReports Server REST API.
https://community.jaspersoft.com/documentation/jasperreports-server/tibco-jasperreports-server-rest-api-reference/vv900/jasperreports-server-rest-api-reference-overview/
22. JasperSoft Community, JasperReports Server PHP Client.
https://community.jaspersoft.com/wiki/php-client-sample-code

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