IRSTI 14.35.07

10.51889/2959-5894.2026.93.1.025

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POWER BI AS A DATA VISUALIZATION AND ANALYSIS TOOL IN THE DEPARTMENT'S EDUCATIONAL MANAGEMENT

Abstract

The article is devoted to the problem of increasing the efficiency of management of the university department through the introduction of business intelligence (BI) tools. Traditional methods of data analysis are time-consuming and do not allow for prompt management decisions in a modern educational environment characterized by a large amount of data. The purpose of this study is to substantiate the feasibility of using MS Power BI, one of the most popular business intelligence tools, to optimize the management of the university's department, develop interactive dashboards for monitoring and visualizing key performance indicators of the department (faculty publication activity, student academic performance, etc.) in real time and assess their impact on improving management efficiency. activities of the department. The methodological basis of the research is a systematic approach, which uses a set of theoretical and experimental methods. To assess the impact of using Power BI on improving the effectiveness of department management, an experimental method of single-group preliminary and subsequent questionnaires was chosen. The sample consisted of 47 teachers of the Department of Informatics and Informatization of Education of the Kazakh National Pedagogical University named after Abai, 40% of whom have permanent general departmental duties. The survey was conducted in an online format using the GoogleForms service. The developed questionnaire included 21 questions on a 5-point Likert scale. The reliability of the results was confirmed using the Cronbach's alpha coefficient. The results of the study. The proposed innovative method of department management based on Power BI has proven to be highly effective. It allows you to automate the generation of reports, quickly identify problem areas and trends, which, in turn, contributes to making informed management decisions. The results of the research have practical significance and will serve as a basis for implementation in the practice of department management in other educational institutions, contributing to the development of the educational management system.

Keywords: business intelligence system, dashboard, Microsoft Power BI, data visualization, management reporting, digitalization.

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POWER BI КАФЕДРАНЫҢ БІЛІМ БЕРУ ҚЫЗМЕТІН БАСҚАРУДАҒЫ ДЕРЕКТЕРДІ ВИЗУАЛИЗАЦИЯЛАУ ЖӘНЕ ТАЛДАУ ҚҰРАЛЫ РЕТІНДЕ

Аңдатпа

Мақала жоғары оқу орны кафедрасының қызметін басқару тиімділігін бизнес-аналитика (BI) құралдарын енгізу арқылы арттыру мәселесіне арналған. Дәстүрлі деректерді талдау әдістері еңбек сыйымдылығы жоғары және қазіргі білім беру ортасында, үлкен көлемдегі деректермен сипатталатын жағдайда, басқарушылық шешімдерді жедел қабылдауға мүмкіндік бермейді. Зерттеудің мақсаты жоғары оқу орны кафедрасының қызметін басқаруды оңтайландыру үшін бизнес-аналитиканың кең таралған құралдарының бірі болып табылатын MS Power BI қолданудың орындылығын негіздеу, кафедра қызметінің негізгі көрсеткіштерін (профессор-оқытушылар құрамының жарияланымдық белсенділігі, студенттердің үлгерімі және т.б.) нақты уақыт режимінде мониторингтеу мен визуализациялауға арналған интерактивті дашбордтарды әзірлеу және олардың басқару тиімділігін арттыруға ықпалын бағалау болып табылады. Зерттеудің әдіснамалық негізін жүйелік тәсіл құрайды, оның аясында теориялық және эксперименттік әдістер кешені қолданылды. Power BI қолданудың

кафедра қызметін басқару тиімділігіне әсерін бағалау үшін бір топқа жүргізілген алдын ала және кейінгі сауалнамаға негізделген эксперименттік әдіс таңдалды. Зерттеу іріктемесін Абай атындағы Қазақ ұлттық педагогикалық университеті Информатика және білім беруді информатизациялау кафедрасының 47 оқытушысы құрады, олардың 40%-ы кафедра деңгейінде тұрақты міндеттер атқарады. Сауалнама Google Forms сервисін пайдалану арқылы онлайн форматта жүргізілді. Әзірленген сауалнама 5 балдық Лайкерт шкаласы бойынша 21 сұрақтан тұрды. Нәтижелердің сенімділігі Кронбах альфа коэффициенті арқылы расталды. Зерттеу нәтижелері. Power BI негізінде ұсынылған кафедраны басқарудың инновациялық тәсілі өзінің жоғары тиімділігін көрсетті. Ол есептерді қалыптастыруды автоматтандыруға, проблемалық аймақтар мен үрдістерді жедел анықтауға мүмкіндік береді, бұл өз кезегінде негізделген басқарушылық шешімдерді қабылдауға ықпал етеді. Зерттеу нәтижелері практикалық маңызға ие және жоғары оқу орындары кафедраларын басқару тәжірибесіне енгізу үшін негіз бола алады, білім беруді басқару жүйесінің дамуына үлес қосады.

Түйін сөздер: бизнес-аналитика жүйесі, дашборд, Microsoft Power BI, деректерді визуализациялау, басқарушылық есептілік, цифрландыру.

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POWER BI КАК ИНСТРУМЕНТ ВИЗУАЛИЗАЦИИ И АНАЛИЗА ДАННЫХ В УПРАВЛЕНИИ ОБРАЗОВАТЕЛЬНОЙ ДЕЯТЕЛЬНОСТЬЮ КАФЕДРЫ

Аннотация

Статья посвящена проблеме повышения эффективности управления деятельностью кафедры вуза через внедрение инструментов бизнес-аналитики (BI). Традиционные методы анализа данных трудоемки и не позволяют оперативно принимать управленческие решения в условиях современной образовательной среды, характеризующейся большим объемом данных. Целью данного исследования является обоснование целесообразности использования MS Power BI – одного из наиболее популярных инструментов бизнес-аналитики, для оптимизации управления деятельностью кафедры вуза, разработка интерактивных дашбордов для мониторинга и визуализации ключевых показателей деятельности кафедры (публикационной активности ППС, успеваемости студентов и др.) в режиме реального времени и оценка их влияния на повышение эффективности управления деятельностью кафедры. Методологической основой исследования является системный подход, в рамках которого использован комплекс теоретических и экспериментальных методов. Для оценки влияния использования Power BI на повышение эффективности управления деятельностью кафедры выбран экспериментальный метод одногруппового предварительного и последующего анкетирования. Выборка составила 47 преподавателей кафедры информатики и информатизации образования Казахского национального педагогического университета имени Абая, 40% из которых имеют постоянные общекафедральные обязанности. Опрос проводился в онлайн-формате с использованием сервиса GoogleForms. Разработанная анкета включала в себя 21 вопрос по 5-балльной шкале Лайкерта. Надежность результатов подтверждена с помощью коэффициента альфа Кронбаха. Результаты исследования. Предложенный инновационный метод управления кафедрой на основе Power BI доказал свою высокую эффективность. Он позволяет автоматизировать формирование отчетов, оперативно обнаруживать проблемные зоны и тенденции, что, в свою очередь, способствует принятию обоснованных управленческих решений. Результаты исследования имеют практическую значимость и послужат основой для внедрения в практику управления кафедрами и в других учебных заведениях, внося вклад в развитие системы управления образованием.

Ключевые слова: система бизнес-аналитики, дашборд, Microsoft Power BI, визуализация данных, управленческая отчетность, цифровизация.

Introduction

In today's rapidly changing world, educational institutions are faced with the need for operational analysis of large amounts of data to make informed management decisions. Departments, as structural divisions of universities, are no exception. They use diverse information about educational, scientific and educational activities. The analysis of these data plays a key role in making the right decisions to optimize the educational process, improve the quality of education and the effectiveness of the department's resource management.

Current data on the department's activities is also important when passing accreditation, which is one of the key tools for improving the quality of educational services in the higher education system of Kazakhstan. It is conducted in accordance with established standards by independent national and international accreditation agencies. The standards include measurable indicators (KPIs) for an objective assessment of the quality of educational services [1].

Traditional methods of data processing and analysis (spreadsheets) often do not ensure proper objectivity and efficiency of monitoring. At the same time, the experience of the corporate sector demonstrates the effectiveness of business intelligence systems (BI system), which not only consolidate data from various sources, but also provide opportunities for their visualization in a convenient format, which helps to make informed management decisions, as well as provide opportunities for in-depth analysis in order to identify trends, patterns, and problem areas [2-4].

Among the available BI platforms, Microsoft Power BI stands out for its extensive integration capabilities with Excel, SharePoint, Azure and other Microsoft services, as well as with interactive dashboard creation tools [5-7]. Due to its accessibility and ease of operation, the application can be used not only by professional data analysts, but also in management activities in educational institutions.

Various architectural approaches to implementing BI platforms in education are actively discussed in the scientific literature: from service-oriented (SoBI) to integrate disparate systems to the concept of Self-Service Business Intelligence (SSBI), which allows end users to work with data independently. Research confirms the effectiveness of Power BI in predicting academic performance [8-10], analyzing the causes of student dropout [11], monitoring attendance [12], and automating the work of admissions committees [13].

MS Power BI software has an extensive set of tools for data analysis and visualization, allowing you to create visual and informative reports and dashboards for operational and informed management decision-making in educational institutions. Despite the huge opportunities and growing popularity in educational management, the issues of its application for comprehensive monitoring and analysis of the activities of university departments remain insufficiently studied.

The purpose of this study is to substantiate the feasibility of using MS Power BI to optimize the management of the Department of higher education, to develop interactive dashboards for monitoring and visualizing key performance indicators of the department in real time and to assess their impact on improving the effectiveness of department management.

Research methodology

The methodological basis of the research is a systematic approach, which uses a set of theoretical and empirical methods: studying and analyzing scientific literature on the research topic; collecting data on the department's activities, comparative analysis of modern business intelligence tools; exploring the functionality and experience of using MS Power BI in other organizations; developing a data model and creating interactive dashboards in Power BI; conducting testing of developed dashboards.

To assess their impact on improving the effectiveness of the department's management, a quantitative approach was chosen using the experimental method of single-group preliminary and subsequent questionnaires. The study sample consisted of 47 teachers of the Department of Informatics and Informatization of Education of the Kazakh National Pedagogical University named after Abai, 40% of whom have general departmental duties. The survey was conducted to identify their data visualization and analysis needs, as well as to test the effectiveness of using Power BI in managing the department's activities. The survey to form the empirical basis of the study was conducted in an online format using the GoogleForms service. The developed questionnaire included 21 questions.

An analysis of the survey results using the Cronbach's alpha coefficient showed a high degree of reliability and reliability of the results both before and after the implementation of dashboards

developed on the basis of MS Power BI. The values of this coefficient were 0.962 and 0.98, respectively, which confirms the excellent internal consistency of the data.

Results of the study

To monitor the key performance indicators of the university department in the Power BI environment, a semantic model based on a subject-oriented approach has been developed. The model is a structured system of interconnected tables that provide a holistic and consistent presentation of information about the activities of the university department, and integrates data from heterogeneous sources [14]. The relationships between the tables are implemented according to the Star Schema principle, where the central fact tables are combined with measurements through key fields. This approach is a widely accepted standard in data warehouse design and is recommended for Power BI, as it provides high performance of DAX (Data Analysis Expressions) calculation measures, scalability and fast integration of data from diverse sources: LMS, Excel reports, sensors installed in smart classrooms, MySQL databases [14]. This semantic model ensures the logical integrity of the data and serves as the foundation for building interactive dashboards.

The Power BI Desktop application is sufficient to create informative reports with data visualization and subsequent analysis and forecasting. This tool combines all the necessary steps: from data acquisition and processing to modeling and visualization. The created dashboard can be published in the Power BI Service to provide multi-user web access and rights sharing. As part of this research, a system has been developed that implements two levels of analytics through interactive dashboards:

1. A management dashboard for the department's management, which provides comprehensive monitoring of KPIs in the main areas of the department's activities: academic performance dynamics, research and development (publication activity, Hirsch index through Tree Maps), contingent forecasting. The drill-down functions allow you to move from aggregated department indicators to detailing individual achievements.

2. The pedagogical dashboard for teachers is focused on the personalization of the educational process and operational intervention: the use of scatter plots to analyze the correlation between attendance and academic results, as well as built-in Power BI machine learning tools to predict final grades based on current dynamics to identify students at risk and personalize learning.

With the help of Power BI, it can be useful to predict exam results based on the results of current student academic performance and attendance, the level of activity in mastering the topic on learning platforms, and the digital footprint in the LMS in order to provide timely support to the underachievers, provide personalized training, and adjust teaching methods. This is especially true for groups with a large number of students. At the same time, taking into account various internal and external factors that affect student academic performance gives high accuracy in predicting students' final academic performance [15]. Thus, Microsoft Power BI is not just a visualization tool, but also a methodological base for continuous improvement of the quality of education, confirming its status as an innovative tool in the field of Learning Analytics. In the field of academic management, Power BI provides scientifically based forecasting of the department's performance indicators - the number of students, the need for human, logistical and other resources. This creates a solid foundation for effective strategic planning. In addition, the use of the Power BI platform in the management of the department's educational activities contributes to improving the effectiveness of management decisions, ensures the efficiency of data analysis and increases the transparency of educational processes. The effectiveness of using the Power BI platform in managing the department's activities has been experimentally proven by comparative analysis of key performance indicators (KPIs) before and after its implementation. The experimental study was conducted during two academic years 2023-2024 and 2024-2025 on the basis of the Department of Informatics and Informatization of Education of the Kazakh National Pedagogical University named after Abai with the participation of 47 teachers of the department. Two time intervals are allocated:

– The control period before the introduction of Power BI is one academic year of the department's work with traditional reporting methods (using Excel tools, generating paper reports). During this

period, the analysis of the traditional management system of the department was carried out, its key drawbacks were identified – the high complexity of generating reports using traditional methods, fragmentation and fragmentation of data, as well as low visual visibility of the results of activities. The initial indicators are fixed.

In parallel, during this period, active work was carried out on the development and implementation of interactive reports and dashboards in the Power BI environment. The platform was integrated with the department's key data sources (LMS, Excel files on Google Disk and a web server) in order to clearly and visually visualize the selected key performance indicators (KPIs). The developed Power BI panel, structured according to the main areas of activity, has been implemented in management practice. The target aspects of the department's activities that require improvement have been identified, and scenarios for management decisions based on panel data have been worked out. The head and staff of the department began to use the panel as a tool for planning, analyzing, monitoring and forecasting management indicators;

– and the pilot period after the introduction of Power BI, also lasting one academic year, began after the introduction of the Power BI analytical platform. During this period, all key management decisions of the department, in particular those related to the analysis of academic performance and attendance, were made solely on the basis of data and visualizations presented in Power BI dashboards. A comprehensive assessment of the dynamics of key performance indicators of the department and an analysis of the level of satisfaction of the head and staff of the department with the results and process of the experiment was carried out. Both quantitative and qualitative assessment criteria were used for a comprehensive analysis. Empirical data was collected using the built-in Power BI tools, the analysis of the official accounting documentation of the department, the survey of employees, as well as the analysis of data from the learning management system (LMS).

To ensure comparability of the results, the collection of factual data in the control and experimental periods was carried out according to identical criteria of key performance indicators. The summary results of the experimental study are shown in Table 1.

Table 1. Dynamics of key performance indicators of the department in the control and experimental stages

Criteria	*Before the introduction of Power BI*	*After implementation*	*Change*
Average report preparation time	*5 days*	*2 days*	*decreased by 60%*
Frequency of using analytical tools (Power BI, Excel, text reports) in decision-making (%)	*25%*	*85%*	*increased by 60%*
The level of implementation of the planned indicators of the department (%)	*87%*	*99%*	*increase by 12%*
The level of employee satisfaction with data visualization, which contributes to a more accurate and faster interpretation of information (on a 5-point scale)	*3.2 points out of 5 possible*	*4.8 out of 5 points*	*increased by 50%*
Student academic performance (average score in the disciplines of the department)	*2.7*	*3.2*	*0.5*
Student attendance (%)	*84%*	*96%*	*12%*
Teachers' publication activity (%)	*46%*	*71%*	*25%*
The number of identified and eliminated problem areas based on the results of the analysis	*9*	*36*	*27*
The speed of obtaining analytical information (the time from the request to the finished report)	*2*	*0.5*	*The time was reduced by 75%*
Employee involvement in management processes (%)	*32%*	*84%*	*52%*

To check the statistical significance of the differences between the initial and final results, the Student's t-test was applied. The empirical value of t_{emp} =2.62 exceeds the critical value of t_{crit} =2.262 with a significance level of $p < 0.05$. This indicates that there are statistically significant differences between the results at the level of 5%, which confirms the effectiveness of using Power BI in managing the department's activities.

At the end of the experiment, a comparison of the KPI values in both the control and experimental periods showed the impact of the introduction of Power BI on the quality and speed of decision-making:

– Several specific management situations were recorded in the experimental period, demonstrating how the rapid receipt of data from Power BI led to a better and more timely decision compared to how it would have happened in the control period. The number of academic debts decreased by 15% after the introduction of Power BI, which made it possible to quickly identify "problem" groups and make timely decisions. This is proof of the increased effectiveness of data-based management decision-making.

– The introduction of the new tool has significantly increased the speed of decision-making and the overall efficiency of the department. A direct proof of the efficiency improvement was the reduction in the average time for preparing semester and annual reports from 5 days to 2 days, which is 60% time savings. In addition, the system allows you to instantly create lists of teachers who meet the specified criteria, which is very important for the prompt nomination of recommendations for prizes and awards, and the rapid identification of a list of teachers who meet the requirements for managing master's theses.

In order to subjectively assess the impact of the introduction of Power BI on improving management efficiency, an additional questionnaire survey of the head and staff of the department (47 respondents) was conducted. The questionnaire has a clear structure of three thematic blocks that ensure the completeness and reliability of the assessment:

– data visualization and analysis needs. The questions in this section are aimed at assessing the current needs of employees in data visualization and analysis, regardless of the tools used;

– experience and skills of working with Power BI. This unit evaluates the actual proficiency of the tool and its use among the department staff, including skills in creating dashboards, interpreting reports, and working with data sources;

– perception of the influence of Power BI on improving the effectiveness of department management and the organization of the educational process. These questions are aimed at assessing the staff's subjective perception of the contribution of Power BI to improving the effectiveness of the organizational and managerial activities of the department and the organization of the educational process.

As a result of the survey, it was revealed that the staff of the department are aware of the high importance of prompt, objective and centralized access to data. The vast majority of the department's staff (93.6% of respondents) consider it important to have a single, centralized platform for viewing key indicators. Power BI, as a centralized BI analytics tool, is a direct answer to this question. It provides consolidation of data on all types of department activities in a single space, which was previously impossible when using disparate tables and reports. The high assessment of the importance of using up-to-date data to improve work efficiency confirms the willingness of staff to use BI-tools to visualize and analyze data, and make informed decisions based on them.

The responses from employees with experience working with Power BI (section 2) demonstrate a generally positive attitude towards the tool and its main characteristics. The majority of respondents (66%) agree that data visualization in Power BI reports is clear and informative, and they also consider the Power BI interface intuitive. Satisfaction with one's own skills in working with Power BI and the degree of agreement with the intuitiveness of the interface showed the lowest levels among the positive responses. A moderate level of satisfaction with current qualifications, with an overall positive attitude towards the tool, indicates the need for further development of training and resources, rather than rejection of the platform itself.

Discussion

The survey results in section 3 directly confirm that Power BI is an effective tool for managing the department's activities. The vast majority of employees (87.2%) agree that Power BI speeds up the reporting process and helps to objectively evaluate the department's performance. The high percentage of agreement that Power BI reports contribute to the timely identification of problems demonstrates the transition from reactive to proactive management. The final question showed a high consensus that the introduction of Power BI is justified in terms of improving management efficiency.

The survey confirmed that the head and staff of the department not only feel an urgent need for modern data analysis and visualization tools, but also positively assess the existing experience in using Power BI. The reliability of the data obtained is confirmed by high internal consistency: the Cronbach's alpha coefficient (α) was 0.962. This indicates a high internal consistency of the data.

Thus, Power BI has proven its effectiveness as a tool for:

– improving the objectivity and speed of management decisions,

– improving transparency and coordination of the department's activities,

– providing employees with access to critical data.

Moreover, the positive impact of the platform on management processes is confirmed by the results obtained during a questionnaire survey of the staff and the head of the department. Their satisfaction with access to data and the quality of reporting has increased significantly.

Conclusion

The conducted research confirms that the implementation of the Power BI platform in the department's management transforms disparate data sets into a strategic asset for making informed decisions. The transition from static reports to the Data-Driven Management model has made it possible to overcome data fragmentation and automate monitoring of key performance indicators.

The main results of the study are as follows:

– centralized collection of information from LMS, DBMS, and IoT sensors was implemented, which ensured high accuracy and efficiency of analytics,

– The developed interactive dashboards allow not only to visualize the current state of educational and scientific activities, but also to identify latent trends and "risk zones" at early stages,

– The use of predictive analytics tools has created a methodological basis for the transition to proactive resource planning and personalization of educational trajectories.

Thus, the proposed approach to the digitalization of academic management contributes to the formation of a culture of analytical thinking at the university. The developed semantic model and the Power BI toolkit are an effective basis for continuous improvement of the quality of education and optimization of administrative processes in the context of digital transformation of higher education.

Acknowledgements

This research is funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan within the project «IoT Transformation of an Educational Institution: Design, Implementation of Smart Classrooms and Training of Specialists in the Field of IoT for Education» (IRN AP23490844).

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