ІНФОРМАТИКА, ОБЧИСЛЮВАЛЬНА ТЕХНІКА ТА АВТОМАТИЗАЦІЯ

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Alakbar A.N.
https://orcid.org/0009-0006-4579-6681
Nakhchivan State University (Azerbaijan)

ETHICAL, ORGANIZATIONAL, AND TECHNOLOGICAL CHALLENGES OF BIG DATA ADOPTION IN HIGHER EDUCATION

The increasing adoption of big data technologies in higher education has become a defining feature of the digital transformation of universities. Educational institutions collect and process large volumes of data generated through learning management systems, administrative platforms, research infrastructures, and digital communication tools. These data are increasingly used to support decision-making processes, improve educational quality, enhance student success, and optimize institutional performance. Despite these potential benefits, the practical adoption of big data in higher education remains accompanied by a wide range of challenges that extend beyond purely technical considerations. This article examines the ethical, organizational, and technological challenges associated with big data adoption in higher education institutions. Ethical challenges arise from issues related to data privacy, informed consent, transparency, surveillance, and algorithmic bias. As universities intensify data collection and analytics practices, concerns regarding the protection of personal data and the responsible use of analytics become central to maintaining trust among students, academic staff, and other stakeholders. These concerns are further complicated by regulatory requirements and differing institutional interpretations of ethical responsibility. Organizational challenges are closely linked to institutional readiness for data-driven transformation. The adoption of big data technologies often requires changes in governance structures, decision-making cultures, and professional competencies. Many higher education institutions face limitations related to fragmented data governance, insufficient analytical expertise, and resistance to data-driven management approaches. Without clear organizational strategies and defined responsibilities, big data initiatives risk remaining isolated or underutilized. Technological challenges include issues of data integration, infrastructure scalability, system interoperability, and cybersecurity. Legacy information systems, heterogeneous data sources, and limited financial resources frequently constrain the effective implementation of big data solutions in higher education. These technological limitations interact with ethical and organizational factors, creating complex adoption barriers that cannot be addressed in isolation. By analyzing these interconnected challenges, the article contributes to a deeper understanding of the conditions necessary for sustainable and responsible big data adoption in higher education. The findings emphasize the importance of integrated strategies that balance technological innovation with ethical considerations and organizational capacity, supporting the development of data-driven universities aligned with the values and missions of higher education.

Keywords: *big data, higher education, education management, data ethics, digital transformation, data governance.*

Formulation of the problem. The rapid expansion of digital technologies in higher education has led to the large-scale collection and processing of data related to students, academic staff, and institutional operations. Learning management systems, student information systems, research platforms, and administrative databases continuously generate vast volumes of data that can be analyzed to support decision-making, improve educational quality, and enhance institutional efficiency. Within this context, big data has become a central component of the digital transformation of higher education institutions.

While the potential benefits of big data adoption in higher education are widely acknowledged, the practical implementation of data-driven approaches remains complex and uneven. Universities increasingly rely on data analytics to support activities such as performance monitoring, student retention strategies, quality assurance, and strategic planning. However, the growing dependence on data-intensive technologies has also exposed higher education institutions to a range of ethical, organizational, and technological challenges that cannot be addressed through technical solutions alone. [1] Ethical concerns related to data privacy, informed consent, transparency, and fairness have become particularly prominent as universities collect detailed information about student behavior, learning patterns, and personal characteristics. The use of big data analytics in educational contexts raises questions about the boundaries between support and surveillance, as well as the potential for bias and unintended discrimination in data-driven decision-making. These issues directly affect trust in institutional governance and influence the acceptance of analytics-based systems by students and staff.

Analysis of recent research and publications. At the organizational level, the adoption of big data technologies often requires substantial changes in institutional structures, workflows, and decision-making cultures. Many higher education institutions face challenges related to limited analytical expertise, fragmented data governance frameworks, and resistance to data-driven management practices. The absence of clear policies and responsibilities for data use can undermine the effectiveness of analytics initiatives and lead to inconsistent or inefficient implementation across organizational units. [2] Technological challenges further complicate the adoption of big data in higher education. Universities must integrate heterogeneous data sources, ensure data quality, maintain secure and scalable infrastructures, and support continuous system evolution. Legacy information systems, budget constraints, and cybersecurity risks frequently limit the ability of institutions to fully exploit the potential of big data technologies. As a result, technological limitations often interact with ethical and organizational issues, creating complex barriers to successful adoption. These challenges highlight the need for a comprehensive analytical perspective on big data adoption in higher education that goes beyond technical performance considerations. Understanding how ethical, organizational, and technological factors interact is essential for developing sustainable data-driven strategies that align with the core values and missions of higher education institutions. [2] This study addresses this need by systematically examining the key challenges associated with big data adoption in higher education and by discussing their implications for education management and institutional governance. The growing interest in big data adoption within higher education has generated a substantial body of research spanning multiple disciplines, including education studies, information systems, data science, and organizational management. Existing studies approach the topic from different perspectives, reflecting the multifaceted nature of big data and its implications for higher education institutions. A review of recent literature indicates that research in this area can be broadly grouped into three overlapping streams: analytical and technological studies, ethical and social analyses, and organizational and governance-oriented investigations. A significant portion of the literature focuses on the technological and analytical potential of big data in higher education. These studies emphasize the use of data analytics to improve learning outcomes, monitor student engagement, support quality assurance processes, and enhance institutional efficiency. Researchers highlight the capacity of big data technologies to process large and heterogeneous datasets generated by learning management systems, administrative platforms, and digital learning environments. While these works demonstrate the value of analytics-driven approaches, they often prioritize performance improvement and system capabilities, devoting limited attention to the broader consequences of data-intensive practices. [3] Ethical issues associated with big data adoption have received increasing attention in recent years. Scholars address concerns related to student privacy, data ownership, informed consent, and transparency of analytical processes. [5] Several studies argue that the extensive collection of behavioral and personal data in educational contexts may lead to forms of surveillance that conflict with academic values and individual autonomy. Algorithmic bias and fairness have also emerged as critical topics, particularly in relation to predictive models used for student assessment, risk identification, and decision support. [3] Although ethical challenges are widely acknowledged, the literature often treats them as isolated issues rather than as elements embedded within institutional and technological structures. Organizational aspects of big data adoption represent another important research direction. Studies in this stream examine institutional readiness, data governance frameworks, and the role of leadership in promoting data-driven decision-making. Researchers note that many higher education institutions lack coherent

strategies for integrating big data analytics into management practices. Fragmented data infrastructures, limited analytical expertise, and resistance to organizational change are frequently identified as barriers to effective adoption. Some authors emphasize the need for interdisciplinary collaboration and professional development to support the sustainable use of analytics in higher education. [4] Despite the growing number of publications, several gaps can be identified in the existing literature. First, many studies focus on individual dimensions of big data adoption–technological, ethical, or organizational–without sufficiently examining their interdependence. Second, empirical research often concentrates on specific applications, such as learning analytics, while broader management and governance implications remain underexplored. Finally, there is limited integrative analysis that connects ethical concerns with organizational practices and technological constraints within a unified framework. [6] [8] These gaps suggest the need for a comprehensive analytical approach that considers ethical, organizational, and technological challenges as interconnected components of big data adoption in higher education. Addressing this need provides the foundation for the subsequent analysis presented in this study and supports a more holistic understanding of data-driven transformation in higher education institutions. An overview of representative studies and their focus on ethical, organizational, and technological challenges is presented in Table 1.

The increasing integration of big data technologies into higher education has created a need for systematic analysis that goes beyond isolated technical or pedagogical perspectives. While existing studies often emphasize the benefits of data-driven approaches, fewer works focus on the complex challenges that accompany big data adoption at the institutional level. This creates a gap between technological potential and practical implementation, particularly in the context of education management and governance. [12] The purpose of this study is to analyze the ethical, organizational, and technological challenges associated with big data adoption in higher education institutions. Rather than evaluating specific analytical tools or algorithms, the article adopts a management-oriented perspective that considers how these challenges influence institutional decision-making, system sustainability, and stakeholder trust. By examining these dimensions collectively, the study seeks to provide a structured understanding of the barriers that may limit the effective and responsible use of big data in higher education. [7] The scope of the research is focused on higher education institutions that employ big data technologies for management, governance, quality assurance, and learning-related analytics. The analysis covers data generated through digital learning environments, administrative systems, and institutional platforms that support strategic and operational decision-making. The study does not aim to assess individual learning analytics models or technical performance metrics but instead concentrates on the broader conditions that shape big data adoption at the organizational level.

Ethical challenges are examined in relation to data privacy, transparency, consent, and fairness, with particular attention to their implications for trust and

Table 1

Key Categories of Challenges in Big Data Adoption in Higher Education

Challenge Dimension	Core Issues	Affected Stakeholders	Potential Consequences for Higher Education
Ethical	Data privacy, informed consent, transparency of analytics, algorithmic bias, surveillance risks	Students, academic staff, administrators	Loss of trust, ethical violations, reduced acceptance of analytics systems
Organizational	Lack of data governance frameworks, limited analytical expertise, resistance to data-driven culture, unclear responsibilities	University leadership, administrative units, IT departments	Inefficient decision-making, fragmented implementation, underutilization of data
Technological	Data integration difficulties, legacy systems, infrastructure scalability, cybersecurity threats, data quality issues	IT services, system developers, end users	System instability, security breaches, unreliable analytical outcomes
Legal and Regulatory	Compliance with data protection regulations, cross-border data issues, policy uncertainty	Institutions, legal units, policymakers	Legal risks, restricted data usage, increased administrative burden
Cultural and Social	Perceptions of data misuse, fear of monitoring, limited data literacy	Students, faculty, institutional community	Resistance to adoption, misinterpretation of analytics results

accountability in higher education. Organizational challenges are analyzed through the lens of institutional readiness, governance structures, professional competencies, and cultural attitudes toward data-driven management. Technological challenges are considered in terms of infrastructure, data integration, system interoperability, and security, emphasizing their interaction with ethical and organizational factors. By defining this scope, the study positions itself as a conceptual and analytical contribution to the discussion on big data adoption in higher education. The findings are intended to support education managers, policymakers, and institutional leaders in identifying critical challenges and in developing balanced strategies that align technological innovation with ethical responsibility and organizational capacity. [8] Big data adoption in higher education refers to the systematic integration of data-intensive technologies and analytical practices into institutional processes related to teaching, learning, administration, and governance. Unlike isolated uses of data for reporting or evaluation, big data adoption implies a strategic shift toward continuous data collection, integration, analysis, and use in decision-making across multiple levels of the institution. This shift is closely linked to the broader digital transformation of universities and to changing expectations regarding accountability, efficiency, and educational quality. [14] In higher education contexts, big data is generated from a wide range of sources that differ in structure, frequency, and purpose. Learning management systems produce detailed logs of student activity, including content access, participation patterns, and assessment outcomes. Administrative systems store data related to enrollment, finance, human resources, and infrastructure usage. Additional data sources include digital libraries, research information systems, campus services, and communication platforms. The combination of these heterogeneous data streams creates opportunities for holistic analysis but also introduces significant complexity in terms of data management and interpretation.

The adoption of big data technologies is often motivated by the promise of improved decision support and evidence-based management. Universities seek to use analytics to identify students at risk, monitor academic performance, optimize resource allocation, and support strategic planning. At the governance level, data-driven insights are increasingly expected to inform policy development, quality assurance processes, and institutional benchmarking. These expectations position big data as a strategic asset rather than a purely technical resource. [9] However, big data adoption is not a uniform or linear process. Institutions differ significantly in their technological capacity, organizational culture, regulatory environment, and strategic priorities. In some cases, adoption is driven by top-down initiatives aimed at modernization and competitiveness, while in others it emerges incrementally through localized projects led by individual departments or units. This diversity of adoption pathways influences how challenges are experienced and addressed within different institutional contexts. It is also important to distinguish between the availability of data and the effective use of data. The presence of large datasets and analytical tools does not automatically translate into meaningful insights or improved outcomes. Effective big data adoption requires alignment between technological infrastructure, organizational processes, and ethical principles. Without such alignment, data-driven initiatives may remain fragmented, underutilized, or contested by institutional stakeholders. [12] Understanding big data adoption in higher education therefore requires a conceptual perspective that recognizes its multidimensional nature. Ethical, organizational, and technological challenges do not arise independently but are interconnected aspects of the same transformation process. This perspective provides the foundation for the detailed examination of ethical challenges presented in the following section. The ethical dimension of big data adoption represents one of the most sensitive and complex areas of data-driven transformation in higher education. As universities increasingly rely on large-scale data collection and analytics to support management and educational processes, questions arise regarding the appropriate limits of data use and the responsibilities of institutions toward students, academic staff, and other stakeholders. Ethical challenges are particularly pronounced in educational environments due to the asymmetry of power between institutions and individuals whose data are collected and analyzed. One of the central ethical concerns relates to data privacy and the protection of personal information. Higher education institutions collect extensive data on student behavior, academic performance, communication patterns, and, in some cases, emotional or psychological indicators. While such data may be used to provide academic support or improve institutional services, their collection and processing raise concerns about the extent to which individuals are aware of, and have control over, how their data are used. Inadequate safeguards or unclear data handling practices can undermine trust and expose institutions to ethical and legal risks. Closely related to privacy is the issue of informed consent. In

many higher education settings, participation in digital learning environments and administrative systems is mandatory, leaving individuals with limited ability to opt out of data collection. Consent mechanisms are often embedded in complex institutional policies that are difficult for non-specialists to interpret. This creates a tension between institutional objectives and individual autonomy, particularly when data are repurposed for analytics beyond their original intent. [13] Transparency and accountability constitute another major ethical challenge. Data-driven decision-making processes may rely on analytical models or algorithms that are not easily understandable by affected stakeholders. When decisions related to academic progression, resource allocation, or risk identification are informed by opaque analytical processes, individuals may find it difficult to question or contest outcomes. This lack of transparency can lead to perceptions of unfairness and weaken the legitimacy of data-driven governance. Algorithmic bias and fairness are increasingly recognized as ethical risks in big data applications. Analytical models trained on historical data may reproduce existing inequalities or introduce new forms of discrimination, particularly when demographic, socioeconomic, or behavioral variables are involved. In higher education, biased analytics can influence decisions related to student support, assessment, or intervention strategies, potentially disadvantaging certain groups and contradicting institutional commitments to equity and inclusion. [8]

The ethical challenges associated with big data adoption are not limited to individual issues but interact with organizational practices and technological design choices. Addressing these challenges requires more than compliance with formal regulations; it necessitates the development of ethical frameworks, transparent governance mechanisms, and institutional cultures that prioritize responsible data use. A structured overview of key ethical challenges, their implications, and affected stakeholders is provided in Table 2.

Organizational factors play a decisive role in determining whether big data initiatives in higher education move beyond isolated technical projects to become integrated components of institutional management and governance. Even when ethical frameworks and technological infrastructures are in place, organizational limitations may significantly constrain the effective use of data-driven approaches. These challenges are often less visible than technical problems but tend to have a long-term impact on sustainability and institutional acceptance. [10]

One of the most significant organizational challenges relates to data governance. Many higher education institutions lack clearly defined structures that specify responsibility for data ownership, quality assurance, access rights, and decision-making authority. In the absence of coherent governance frameworks, data initiatives are frequently fragmented across departments, leading to inconsistent practices and duplicated efforts. This fragmentation reduces the strategic value of data and complicates efforts to ensure ethical and secure data use. [16] Institutional culture also strongly influences big data adoption. Traditional decision-making processes in higher education have often relied on professional judgment, academic autonomy, and qualitative evaluation. The introduction of data-driven management may be perceived as a threat to these established practices, generating resistance among academic and administrative staff. When data analytics are viewed as instruments of control rather than support, institutional actors may disengage from or actively oppose analytics initiatives.

A further organizational challenge concerns human capital and competencies. Effective big data adoption requires not only technical specialists but also managers and academic leaders who are capable of interpreting analytical results and integrating them into decision-making processes. Many institutions face a shortage of data literacy skills among

Table 2

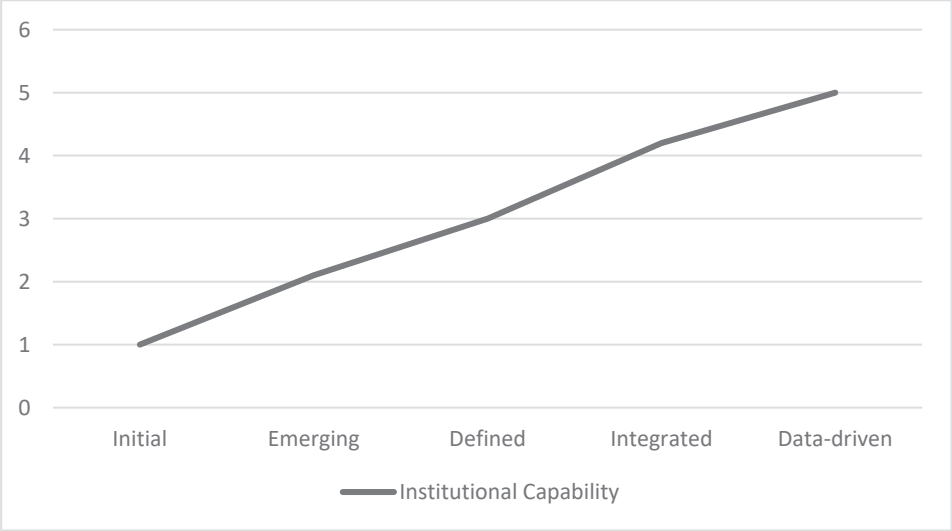
Ethical Challenges of Big Data Adoption in Higher Education

Ethical Issue	Description	Affected Stakeholders	Potential Ethical Risks
Data privacy	Collection and processing of sensitive personal and behavioral data	Students, academic staff	Loss of trust, data misuse, privacy violations
Informed consent	Limited awareness or choice regarding data use	Students, staff	Reduced autonomy, ethical non-compliance
Transparency	Opaque analytics and decision-support processes	Students, administrators	Perceived unfairness, lack of accountability
Algorithmic bias	Reproduction of social or institutional inequalities	Vulnerable student groups	Discrimination, inequitable outcomes
Surveillance concerns	Continuous monitoring of learning and behavior	Students, faculty	Chilling effects, resistance to adoption

staff, limiting the practical impact of analytics. Professional development initiatives are often unevenly implemented, reinforcing disparities between units with differing levels of expertise. Leadership and strategic alignment are equally important. Big data initiatives that are not embedded within broader institutional strategies may lack continuity and long-term support. Changes in leadership, shifting priorities, or budgetary constraints can interrupt analytics projects before they reach maturity. Conversely, strong leadership commitment can facilitate cross-departmental coordination and promote a shared understanding of the role of data in institutional development. [11]

These organizational challenges are often interconnected and cumulative. Institutions with weak governance structures may also struggle with cultural resistance and skills gaps, creating reinforcing barriers to adoption. To illustrate typical patterns of organizational readiness for big data adoption in higher education, a conceptual representation of maturity levels is presented in Graph 1.

The graph illustrates a gradual progression from fragmented and ad hoc data use toward fully integrated, data-driven management practices. Most institutions are positioned in the intermediate stages, where technological tools exist but organizational alignment and cultural acceptance remain incomplete. [15] Technological challenges represent a critical dimension of big data adoption in higher education, as they directly influence the feasibility, reliability, and sustainability of data-driven initiatives. Even when ethical principles and organizational strategies are clearly articulated, technological limitations can significantly restrict the effective use of big data technologies. These challenges are often rooted in the complexity of existing information environments within universities and the rapid pace of technological change. One of the most persistent technological challenges is data integration. Higher education institutions typically operate multiple information systems developed at different times and for different purposes, including learning management systems, student information systems, research databases, and administrative platforms. These systems often use incompatible data formats and standards, making it difficult to combine data into unified analytical datasets. As a result, analytics initiatives may rely on incomplete or inconsistent data, reducing the reliability of insights used for decision-making. [13] Infrastructure scalability is another major concern. Big data applications require computing resources capable of handling large data volumes, high processing speeds, and continuous data flows. Many universities rely on legacy infrastructures that were not designed for intensive analytics workloads. Limited server capacity, insufficient storage, and outdated network architectures can constrain system performance and increase operational risks, particularly during peak usage periods. Data quality and reliability also pose significant technological challenges. Educational data are frequently affected by missing values, inconsistencies, and errors resulting from manual data entry or fragmented data collection processes. Poor data quality undermines the effectiveness of analytics and may lead to inaccurate or misleading conclusions. Addressing data quality issues requires not only technical solutions but also coordinated data management practices across organizational units. [6] Cybersecurity and data protection have become increasingly important as higher education institutions expand their data collection and analytics capabilities. Big data sys-



Graph 1. Organizational Readiness Levels for Big Data Adoption in Higher Education

tems often aggregate sensitive personal and institutional information, making them attractive targets for cyberattacks. Ensuring secure data storage, controlled access, and protection against breaches is a continuous challenge that requires both technical safeguards and institutional commitment. Failures in this area can result in serious reputational damage and legal consequences. Interoperability and system evolution further complicate technological adoption. As new analytics tools and platforms emerge, institutions must ensure that existing systems can adapt without extensive reconfiguration or disruption. Dependence on proprietary solutions may limit flexibility and increase long-term costs, while insufficient technical support can hinder system maintenance and upgrades. These technological challenges are closely intertwined with ethical and organizational factors. For example, inadequate security measures may exacerbate ethical concerns related to privacy, while poor system integration can reinforce organizational resistance to data-driven practices. A structured overview of key technological challenges and potential mitigation strategies is presented in Table 3.

The analysis of ethical, organizational, and technological challenges demonstrates that big data adoption in higher education is not a purely technical process but a complex institutional transformation. These challenges do not arise independently; rather, they interact and reinforce one another in ways that shape the outcomes of data-driven initiatives. Addressing one dimension in isolation is therefore unlikely to produce sustainable or widely accepted solutions. Ethical concerns such as privacy, transparency, and fairness are closely linked to organizational practices and technological design choices. For example, advanced analytics systems may technically enable detailed monitoring of student behavior, but without transparent governance frameworks and clear consent mechanisms, such capabilities can generate resistance and undermine trust. Similarly, algorithmic bias cannot be understood solely as a technical flaw; it often reflects institutional priorities, historical data practices, and organizational decision-making cultures. [10] Organizational readiness emerges as a critical mediating factor in big data adoption. Institutions with well-defined data governance structures, leadership commitment, and data literacy among staff are better positioned to integrate ethical considerations into technological systems and to use analytics meaningfully in management processes. In contrast, weak governance and fragmented responsibilities can amplify both ethical risks and technological inefficiencies, limiting the strategic value of big data initiatives. Technological challenges further illustrate the need for integrated approaches. Infrastructure limitations, data integration problems, and security risks frequently constrain the scope of analytics projects and affect institutional confidence in data-driven decision-making. When technological systems are unreliable or difficult to maintain, organizational actors may question the legitimacy of analytics-based insights, reinforcing cultural resistance and ethical concerns. Conversely, robust and transparent technological solutions can support ethical accountability and organizational acceptance. From a management perspective, these findings suggest that big data adoption should be approached as a long-term institutional strategy rather than a series of isolated projects. Education managers and policymakers must balance innovation with responsibility, ensuring that technological development is aligned with ethical values and organizational capacity. This requires

Table 3

Technological Challenges and Mitigation Strategies in Big Data Adoption

Technological Challenge	Description	Potential Impact on Institutions	Mitigation Strategies
Data integration	Incompatibility between heterogeneous information systems	Fragmented analytics, unreliable insights	Standardization, middleware solutions, data integration platforms
Infrastructure scalability	Limited computing and storage capacity	Performance bottlenecks, system instability	Cloud-based infrastructure, scalable architectures
Data quality	Incomplete, inconsistent, or erroneous data	Misleading analytics, poor decision-making	Data governance policies, validation and cleaning procedures
Cybersecurity	Vulnerability to data breaches and unauthorized access	Legal risks, reputational damage	Encryption, access control, continuous security monitoring
Interoperability	Difficulty adapting systems to new technologies	High maintenance costs, limited flexibility	Modular system design, open standards

cross-functional collaboration between academic leadership, administrative units, IT services, and legal or ethics committees. The analysis also highlights the importance of context in shaping big data adoption. Higher education institutions differ in size, mission, regulatory environment, and resource availability, which influences how challenges are experienced and addressed. Flexible frameworks that can be adapted to institutional contexts are therefore more likely to support sustainable adoption than uniform, technology-centered solutions.

Conclusions. The growing reliance on big data in higher education reflects a fundamental transformation in how universities organize their activities, exercise governance, and evaluate institutional performance. As digital platforms increasingly mediate teaching, learning, and administration, data-driven approaches have become central to education management. However, the analysis presented in this article demonstrates that the adoption of big data in higher education is accompanied by a set of complex challenges that extend well beyond technological considerations. Ethical challenges related to privacy, consent, transparency, and fairness emerge as critical issues in data-intensive educational environments. The collection and analysis of detailed personal and behavioral data raise concerns about surveillance, algorithmic bias, and the erosion of trust between institutions and their stakeholders. These ethical risks cannot be adequately addressed through technical safeguards alone; they require institutional commitments to responsible data use, clear governance frameworks, and ongoing ethical oversight. Organizational challenges further shape the outcomes of big data adoption. Fragmented governance structures, limited data literacy, and resistance to data-driven decision-making often constrain the effective use of analytics in higher education institutions. The analysis highlights the importance of leadership, institutional culture, and professional capacity in determining whether big data initiatives support meaningful management improvements or remain isolated technological projects. Without organizational alignment and strategic vision, the potential benefits of big data are unlikely to be realized. Technological challenges, including data integration, infrastructure scalability, system interoperability, and cybersecurity, reinforce the need for coordinated approaches to big data adoption. Universities frequently operate within complex and heterogeneous information environments, where legacy systems and resource constraints limit analytical capabilities. These technological limitations interact with ethical and organizational factors, creating reinforcing barriers that complicate implementation and sustainability. By examining ethical, organizational, and technological challenges as interconnected dimensions of big data adoption, this study contributes to a more comprehensive understanding of data-driven transformation in higher education. The findings underscore that responsible and effective big data adoption requires integrated strategies that balance innovation with institutional values and capacities. Education managers and policymakers are encouraged to approach big data not merely as a technological resource, but as an institutional capability that must be carefully governed and continuously developed. Future research may extend this work by investigating empirical cases of big data implementation across diverse higher education contexts, exploring stakeholder perceptions of data-driven governance, and assessing the long-term implications of analytics-based management for educational quality and equity. Such efforts would further support the development of higher education systems that are not only data-informed, but also ethically grounded and organizationally resilient.

Bibliography:

1. Williamson B. *Big Data in Education: The Digital Future of Learning, Policy and Practice*. London: SAGE Publications, 2017.

2. Selwyn N. *Education and Technology: Key Issues and Debates*. 2nd ed. London: Bloomsbury Academic, 2016.

3. Daniel B. Big data and analytics in higher education: Opportunities and challenges. *British Journal of Educational Technology*. 2019. Vol. 50, No. 1. Pp. 43–58.

4. Romero C., Ventura S. Educational data mining and learning analytics: An updated survey. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*. 2020. Vol. 10, No. 3. Article e1355.

5. Lin L., Zhou D., Wang J., Wang Y. A systematic review of big data-driven education evaluation. *SAGE Open*. 2024. Vol. 14.

6. Ghavifekr S., Wong S. Y. Role of big data in education. *Advances in Business Strategy and Competitive Advantage*. 2022.

7. Elam K. M. Exploring the challenges and future directions of big data and artificial intelligence in education. *Journal of Artificial Intelligence General Science (JAIGS)*. 2024. ISSN 3006-4023.

8. Ovdiyenko Y. Big data, education, and social responsibility. *International Forum Journal*. 2018.

9. Vaitsis C., Hervatis V., Zary N. Introduction to big data in education and its contribution to quality improvement processes. 2016.

10. Bajpai S., Mani S. Big data in education and learning analytics. *Journal on Educational Technology*. 2017. Vol. 7. Pp. 45–55.

11. Gazawy Q., Buyrukoğlu S., Akbas A. Deep learning for enhanced education quality: Assessing student engagement and emotional states. *Proceedings of the 2023 Innovations in Intelligent Systems and Applications Conference (ASYU)*. 2023. Pp. 1–8.

12. Alzubaidi L., Zhang J., Humaidi A. J., Al-Dujaili A., Duan Y., Al-Shamma O., Santamaría J. I., Fadhel M. A., Al-Amidie M., Farhan L. Review of deep learning: Concepts, CNN architectures, challenges, applications, future directions. *Journal of Big Data*. 2021. Vol. 8.

13. Berndtsson M., Hansson J., Olsson B., Lundell B. Big data challenges in higher education institutions. *Procedia Computer Science*. 2019. Vol. 164. Pp. 173–180.

14. Zuboff S. The age of surveillance capitalism and the challenge for education institutions. *Organization Studies*. 2020. Vol. 41, No. 7. Pp. 963–985.

15. Floridi L., Taddeo M. What is data ethics? *Philosophical Transactions of the Royal Society A*. 2016. Vol. 374. Article 20160360.

16. Mittelstadt B. D., Allo P., Taddeo M., Wachter S., Floridi L. The ethics of algorithms: Mapping the debate. *Big Data & Society*. 2016. Vol. 3, No. 2.

Алакбар А.Н. ЕТИЧНІ, ОРГАНІЗАЦІЙНІ ТА ТЕХНОЛОГІЧНІ ВИКЛИКИ ВПРОВАДЖЕННЯ ВЕЛИКИХ ДАНИХ У ВИЩІЙ ОСВІТІ

Зростаюче впровадження технологій великих даних у вищій освіті стало визначальною рисою цифрової трансформації університетів. Освітні заклади збирають та обробляють великі обсяги даних, що генеруються за допомогою систем управління навчанням, адміністративних платформ, дослідницьких інфраструктур та інструментів цифрового зв'язку. Ці дані все частіше використовуються для підтримки процесів прийняття рішень, покращення якості освіти, підвищення успішності студентів та оптимізації роботи закладів. Незважаючи на ці потенційні переваги, практичне впровадження великих даних у вищій освіті залишається супроводжуваним широким спектром проблем, які виходять за рамки суто технічних міркувань. У цій статті розглядаються етичні, організаційні та технологічні проблеми, пов'язані з впровадженням великих даних у вищих навчальних закладах. Етичні виклики виникають через питання, пов'язані з конфіденційністю даних, інформованою згодою, прозорістю, спостереженням та алгоритмічним упередженням. Оскільки університети посилюють практику збору та аналізу даних, занепокоєння щодо захисту персональних даних та відповідального використання аналітики стають центральними для підтримки довіри між студентами, викладачами та іншими зацікавленими сторонами. Ці проблеми ще більше ускладнюються нормативними вимогами та різними інституційними інтерпретаціями етичної відповідальності. Організаційні виклики тісно пов'язані з інституційною готовністю до трансформації, керованої даними. Впровадження технологій великих даних часто вимагає змін у структурах управління, культурі прийняття рішень та професійних компетенціях. Багато вищих навчальних закладів стикаються з обмеженнями, пов'язаними з фрагментованим управлінням даними, недостатньою аналітичною експертизою та опором підходам до управління, керованими даними. Без чітких організаційних стратегій та визначених обов'язків ініціативи щодо великих даних ризикують залишитися ізольованими або недостатньо використаними. Технологічні виклики включають питання інтеграції даних, масштабованості інфраструктури, сумісності систем та кібербезпеки. Застарілі інформаційні системи, неоднорідні джерела даних та обмежені фінансові ресурси часто обмежують ефективне впровадження рішень для великих даних у вищій освіті. Ці технологічні обмеження взаємодіють з етичними та організаційними факторами, створюючи складні бар'єри для впровадження, які неможливо вирішити окремо. Аналізуючи ці взаємопов'язані виклики, стаття сприяє глибшому розумінню умов, необхідних для сталого та відповідального впровадження великих даних у вищій освіті. Результати дослідження підкреслюють важливість інтегрованих стратегій, які балансують технологічні інновації з етичними міркуваннями та організаційним потенціалом, підтримуючи розвиток університетів, орієнтованих на дані, відповідно до цінностей та місій вищої освіти.

Ключові слова: *великі дані, вища освіта, управління освітою, етика даних, цифрова трансформація, управління даними.*

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