Original Research Article

Big-data-driven approaches to enhancing the precision of student management in higher education

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Abstract: This study explores how big-data technologies can enhance the precision, efficiency, and scientific rigor of student management in higher education. Traditional management approaches often rely on fragmented information and static processes, leading to limited predictive capability and insufficient personalized support. By introducing big-data-driven frameworks, universities can integrate multisource data, build dynamic student profiles, improve early-warning systems, and optimize decision-making processes. This paper adopts a conceptual and analytical research method, drawing on existing big-data practices in education, and constructs a multi-dimensional precision-management model. The results indicate that big-data-enhanced student management can refine service delivery, strengthen risk control, and boost institutional governance capacity. The study concludes with recommendations for data infrastructure construction, management workflow redesign, privacy-protection mechanisms, and future development directions in higher education.
Keywords: big data; student management; higher education; data-driven decision-making; precision governance

1. Introduction

The rapid development of digital technologies has transformed organizational management across diverse sectors, and universities are no exception. As higher education faces increasing complexity—Ranging from diversified student needs to intensified academic pressures and rising expectations for personalized support—Traditional management models have shown their limitations. Big data provides new opportunities for universities to understand students more comprehensively, detect risks more promptly, and design services more effectively. Existing research demonstrates that data-driven approaches can optimize resource allocation and improve educational outcomes, yet the question of how to systematically apply big data to enhance the precision of student management remains insufficiently explored. This study aims to analyze the structural issues in conventional university management, discuss the functional advantages of big-data technologies, and build a theoretical pathway for precision management in higher education driven by data integration, intelligent analytics, and dynamic decision-making.

2. Transformations in the student management paradigm under big data

The shift toward big-data-enabled governance represents a fundamental transformation in how universities conceptualize and execute student management. Traditional practices often rely on static records, periodic reporting, and manual interventions, resulting in delayed responses and limited predictive capability. Big data introduces real-time, high-volume, and high-variety information flows that allow management to transition from reactive to proactive. Administrative decisions can be grounded in empirical evidence rather than intuition, and student support can move from generalized services to targeted interventions. Universities gain the ability to observe behavioral patterns, monitor learning trajectories, and interpret campus engagement trends, offering deeper insights into student development. Such changes not only enhance the accuracy of managerial decisions but also strengthen institutional accountability and transparency. Furthermore, big data expands the management paradigm by enabling multi-departmental collaboration, as shared data platforms break information silos and support coordinated governance across academic and administrative units.

3. Construction of a big-data-integrated student information system

A comprehensive data architecture is foundational to the precision management of students. Universities

must establish a unified platform capable of aggregating academic records, attendance logs, learning-management-system activities, counseling data, dormitory access records, and campus service usage. These multisource datasets enable the construction of multidimensional student profiles that reflect not only academic performance but also behavioral patterns and well-being indicators. The integration process requires standardized data formats, reliable data-cleaning mechanisms, and interoperable interfaces to ensure smooth information exchange. The platform should support real-time synchronization, enabling management staff to access updated data whenever necessary. When designed effectively, such a system becomes a central intelligence hub, supporting continuous monitoring and facilitating precise interventions. Importantly, system construction must follow technical principles of scalability, security, and modularity, allowing universities to gradually expand data functionalities while maintaining system robustness.

4. Precision services and decision-making enabled by data analytics

The application of analytical models is essential for transforming raw data into actionable insights. Through machine-learning algorithms, predictive analytics, and visual dashboards, universities can identify hidden patterns related to student performance, engagement, and potential risks. For example, learning-behavior analytics can help detect declining academic motivation, while absenteeism patterns may reveal psychological stress or adjustment difficulties. Data-driven decision-making enables the personalization of educational services, including tailored academic guidance, differentiated advising, and customized extracurricular recommendations. Management staff can make informed judgments regarding resource allocation, policy formulation, and student-support planning. Additionally, big data facilitates continuous evaluation of institutional initiatives, allowing universities to monitor the effectiveness of new policies and make dynamic adjustments. Over time, such data-supported feedback loops help build a comprehensive precision-management ecosystem in which both students and institutions benefit from enhanced responsiveness and adaptability.

5. Data-driven early-warning and risk-management mechanisms

Risk prediction is a core advantage of big-data-driven student management. Universities can construct early-warning systems that continuously monitor key indicators related to academic performance, attendance stability, emotional well-being, and campus-life engagement. When abnormal patterns emerge—Such as sudden grade decline, repeated absences, or decreased dormitory access frequency—The system can automatically issue alerts to counselors or relevant departments. Early interventions can then be implemented before problems escalate, supporting student retention and well-being. These mechanisms help institutions address challenges such as dropout risks, mental-health crises, or behavioral concerns with greater precision and timeliness. To ensure reliability, early-warning models should be continuously optimized through historical-data analysis and machine-learning model recalibration. Human oversight remains essential, as counselors must interpret data ethically and contextualize patterns. A balanced model that integrates data intelligence with professional judgment can significantly enhance the sophistication of campus risk governance.

6. Ethical, organizational, and practical considerations in implementing big-data management

Despite its advantages, big-data-driven management presents challenges in ethics, privacy, and organizational practices. The collection and analysis of student data must strictly adhere to legal frameworks and institutional data-governance policies. Transparency in data usage, informed consent, data-minimization principles, and secure storage are essential components of responsible data governance. Additionally, universities must cultivate a data-literate workforce, including training administrators, counselors, and faculty members to interpret data effectively. Organizational restructuring may be required to support cross-departmental collaboration, as data-driven governance thrives in environments with shared responsibilities and coordinated communication. Practical challenges—Such as financial investment, system maintenance, and cultural resistance—Must also be addressed through long-term planning and stakeholder engagement. When implemented conscientiously, big-data-enabled management can create a balanced ecosystem that respects student rights while advancing institutional

development.

7. Conclusion

This study identifies the transformative potential of big-data technologies in enhancing the precision of student management within higher education. Through integrated data systems, predictive analytics, and early-warning mechanisms, universities can shift from fragmented, reactive practices to holistic, proactive strategies. Big-data-driven management not only improves administrative efficiency but also fosters personalized student services, strengthens risk-control capabilities, and supports evidence-based decision-making. Ethical governance, organizational preparation, and sustainable infrastructure development remain critical to successful implementation. Future research may examine cross-institutional data collaboration, intelligent-adaptive learning environments, and long-term impacts of data-driven governance on student development. As higher education enters an era of digital transformation, big-data-supported precision management will continue to shape innovative governance models and promote student success.

About the author

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