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Three Dimensions, Challenges, and Practical Paths of AI in Enabling University Management

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Abstract: This study elucidates the core mechanisms and challenges of artificial intelligence (AI) in university management and proposes actionable governance strategies. Through a systematic literature review and case analyses, we detail AI applications in teaching, administration, and student services. Technical opacity, ethical risks, and institutional inertia are identified as key obstacles. Key findings reveal that (i) generative AI reshapes instructional design, (ii) smart contracts streamline administrative processes, and (iii) algorithmic engines enhance student support. Concurrent challenges include algorithmic bias endangering equity, data-privacy erosion, and conflicts between curriculum agility and technological adaptability. We propose a three-dimensional framework integrating technological governance, ethical adaptation, and institutional innovation. The findings provide a systematic roadmap for AI-powered university management, with implications for intelligent transformation in higher education.

Keywords: Artificial Intelligence; University Management; Smart Contract; Emotional Support; Algorithmic Ethics; Data Privacy; Agile Governance

1. Introduction

In recent years, artificial intelligence (AI) technologies, especially machine learning, deep learning, and natural language processing, have advanced rapidly. These capabilities excel in image and speech recognition and show significant promise for higher education [1]. Generative AI tools such as ChatGPT, DeepSeek, and OpenAI have intensified debates on educational applications [2]. Yet most universities still rely on hierarchical, bureaucratic models characterized by low administrative efficiency, limited data-driven decision-making, and suboptimal resource allocation [3], which impede modernization [4]. Rising student diversity and personalized learning demands call for flexible, efficient management solutions.

This study investigates the applications, challenges, and governance strategies of AI-driven higher education management. Drawing on a systematic review of AI implementation in university administration, it examines AI empowerment across three dimensions-teaching, administration, and student services; identifies technical, managerial, and ethical barriers; and proposes actionable solutions. The findings provide theoretical frameworks and practical guidance for administrators to foster sustainable AI integration, enhance management efficiency, improve educational quality, advance equity, and cultivate professionals aligned with contemporary needs.

2. Research Status of AI-Empowered University Management

AI applications in university management exhibit interdisciplinary integration and can be summarized as three successive stages.

Stage 1: Technical-tool approach.

This stage focuses on AI as an efficiency-enhancing tool. Educational data mining (EDM) has been used to build resource-allocation models that increase administrative decision speed by up to 45 % [5]. Grounded in the Technology Acceptance Model, studies identify perceived usefulness and ease of use as adoption drivers [5]. Yet these studies oversimplify real-world contexts, for instance, reducing complex scheduling to constraint-satisfaction problems, while overlooking organizational hierarchies and institutional barriers [6].

Stage 2: Social-constructivist approach.

Scholars examine how AI reshapes social

relationships and power dynamics. "Technology is neither neutral nor autonomous, but the materialized manifestation of social values" [7]. Intelligent recommendation systems may exacerbate resource inequity, privileging certain groups [7]. Social-network analysis and critical discourse analysis reveal that AI applications must be situated within broader socio-cultural and political contexts [8].

Stage 3: Institutional-innovation approach.

Research now explores mechanisms of technology-driven institutional change. Drawing on institutional-isomorphism theory, a team from East China Normal University proposes the "Technology-Institution Co-evolution Model", which distinguishes three stages: mandatory, imitative, and normative isomorphism [9]. Policies such as the Interim Measures for the Management of Generative AI Services standardize technologies, while universities share smart-campus experiences to co-develop ethical guidelines [9]. This framework transcends technological determinism by emphasizing co-evolution with organizational routines.

The current research presents three salient features

(i) Systematic integration replaces isolated breakthroughs, e.g., Tsinghua University's "Zhijiao Cloud" coordinates twelve modules, including teaching, research, and logistics.

(ii) Research focus shifts from technical validation to social-impact assessment: 78 % of AI-education studies at the 2023 Global Education Technology Summit incorporated social-justice frameworks.

(iii) Methodological innovation rises: mixed-methods adoption increased 63 % over five years, with action research proving effective in resolving "technology-institution" mismatches.

There are still obvious shortcomings in the current research. First, cultural insensitivity: the majority of algorithmic-fairness studies remain grounded in Western contexts, thereby overlooking China's distinctive urban–rural digital divide. Second, ethical metrics deficit: extant research on technological ethics is largely confined to abstract principles, lacking actionable evaluation indicators, long-term impact analyses, and intergenerational tracking of technology adoption. Third, insufficient agency focus: investigations into the proactive roles of teachers and students within intelligent governance systems remain scarce.

3. Three Dimensions in which AI Enables University Management

3.1 Reconstruction of Teaching Scenario: Generation AI Reshapes Teaching Design

Generative artificial intelligence (GenAI) is catalysing a paradigmatic shift in higher education-from linear "knowledge transmission" to dynamic "knowledge co-creation". By integrating algorithmic innovation with pedagogical values, GenAI dismantles traditional, sequential instructional designs and establishes an adaptive, multi-modal, and highly responsive teaching ecosystem.

3.1.1 Teacher identity: From knowledge transmitters to orchestrators

Generative AI repositions teachers as facilitators and co-learners within a dynamic pedagogical ecosystem. Integrated intelligent lesson-plan generators parse extensive pedagogical corpora and real-time learner analytics to deliver personalized instructional designs. On Shanghai's Edu-AI platform-after incorporating the DeepSeek large model-instructors input a topic and obtain an evidence-based, early-warning-infused lesson plan within five minutes, doubling preparation efficiency [9]. This triadic synergy of teacher expertise, algorithmic modelling, and data evidence ensures both scientific rigour and contextual fit. The system continuously recalibrates content difficulty and pacing in response to student progress, alleviating cognitive load and freeing teachers to focus on individualized guidance, thereby enhancing instructional quality.

3.1.2 Student identity: From passive recipients to active co-creators

Generative AI transforms students into active participants in knowledge creation and problem-solving. Natural-language processing and computer vision annotate and semantically link disparate resources, enabling learners to extract key information and construct multimodal knowledge repositories.

On Fudan University's CFFF platform, knowledge-graph algorithms dynamically align virtual experiments, 3D videos, and disciplinary concepts, forming structured, cross-disciplinary cognitive networks [10,11]. This scaffolding accelerates resource retrieval, integrates knowledge, and significantly strengthens

students' metacognitive capabilities, thereby supporting deep and lifelong learning.

3.2 Re-engineering Administrative Processes: Smart Contracts as a Driver of Change

The governance of higher education is transitioning from a hierarchical bureaucratic model to a data-driven agile management approach. The core challenge lies in integrating technology while dynamically maintaining a balance between institutional rigidity and technical adaptability. Smart contracts, which are self-executing protocols on the blockchain, present a unique solution. They establish transparent and traceable workflows that automate resource allocation and task scheduling. For instance, course registration, credit certification, and scholarship disbursement can be carried out without manual intervention, thereby reducing processing time and eliminating errors based on discretion.

Blockchain-anchored student records ensure that any modifications to enrollment data are cryptographically validated and time-stamped, guaranteeing their integrity. Course-allocation algorithms embedded in smart contracts simultaneously match instructor schedules with learner preferences and classroom availability, optimizing resource utilization in real-time. Similarly, performance-weighted resource pools automatically assign laboratory slots or library quotas based on teaching outcomes and student achievement, enhancing both equity and efficiency.

Beyond process automation, blockchain serves as an institutional catalyst. Its decentralized, immutable ledger replaces multi-layered approvals with direct peer-to-peer verification, reconstructing trust mechanisms. Pilot blockchain credit-transfer systems (e.g., the inter-university consortium led by Shanghai Jiao Tong University) automatically execute conversion rules, securely exchanging transcripts while protecting privacy and fostering alliance-based collaboration.

Digital twins complement smart contracts by creating real-time virtual replicas of campus operations. Before policy implementation, managers simulate budget reallocations or staffing scenarios within the twin, quantifying the impact and minimizing risk. In finance, a digital twin can forecast the cash-flow effects of various funding schemes; in human resources, it can ex ante evaluate how alternative faculty compositions influence teaching quality.

The fusion of smart contracts and digital twins establishes a self-optimizing governance loop. Smart contracts execute updated rules autonomously; performance data are fed back into the twin for continuous calibration. Universities thus maintain institutional rigidity through code-based compliance while retaining technical elasticity via data-driven refinement, providing a critical scaffold for the modernization of higher-education management.

3.3 Service-Model Innovation: Algorithmic Engines Reshaping Student Affective-Support Systems

Artificial intelligence, primarily through algorithmic engines, is reconfiguring the foundational logic of higher-education services. It is shifting the provision from standardized, batch delivery to precise, full-scene, and compassionate support. The goal is to combine efficiency gains with empathetic care, thereby advancing educational equity and the quality of student development.

Student development is a multi-dimensional, dynamic system that encompasses academic progression, psychological adjustment, and social integration. These subsystems interact in a non-linear fashion through multi-modal data streams-learning behaviors, social interactions, and physiological indicators-forming a complex developmental ecology. Algorithmic engines operationalize a "Real-time Sensing-Dynamic feedback-Targeted intervention" closed loop that serves as the core enabler of empathetic support.

Dimension 1: Affective embedding in academic contexts.

Intelligent learning assistants utilize knowledge graphs and cognitive-diagnostic algorithms to recommend personalized resources and identify anxiety indicators, such as frequent answer revisions or irregular submission intervals. They also provide micro-affirmative prompts, like "70% of your peers have mastered this concept after three attempts; you are ahead of schedule". This "cognitive support + affective accompaniment" model enhances services from mere knowledge transmission to holistic development.

Dimension 2: Precision intervention in psychological contexts.

Multi-modal data fusion integrates natural language processing of social-media text,

computer vision analysis of classroom expressions, and physiological metrics derived from wearables to construct dynamic psychological profiles. When the system identifies a risk signature-less than five hours of nightly sleep for two consecutive weeks, a forty percent decline in social interactions, and classroom attention falling below a set threshold, it initiates a three-tier response. This includes an AI chatbot delivering mindfulness training, issuing invitations to peer-support groups, and escalating detailed risk reports to counseling centers. Functioning as a cognitive scaffold, the algorithmic triad of "Student data-Model inference-Resource matching" ensures autonomy while providing timely support, thus preventing over-intervention.

During resource optimisation, the algorithmic engine markedly expands the reach of affective support by dynamically reallocating services across time and space, thereby narrowing the affective-support digital divide. By analyzing the spatio-temporal distribution of emotional demands, such as anxiety peaks during examination periods or heightened social needs among first-year students, the system dynamically reallocates resources. It increases the number of AI psychological-support terminals during finals and establishes "AI + remote counseling" green channels for remote campuses. This "demand identification - resource allocation" mechanism narrows the affective-support digital divide and enhances service efficiency.

4. AI Empowering University Management Faces Challenges

4.1 The Dilemma of Technical Black Box: Algorithmic Hegemony Impacts on Education Equity

The "black-box" nature of AI technologies is redistributing authority within higher education governance, while the algorithmic hegemony underlying these systems increasingly threatens the construction of educational equity. Technological alienation theory posits that when instrumental rationality supersedes value rationality, technology begins to subvert the very actors it was intended to serve. In the higher education domain, this alienation manifests as the non-explainability of algorithmic decisions and digitally mediated monopolies over resource allocation.

Firstly, predictive admission models embed latent biases. Algorithms trained on historical datasets perpetuate existing inequalities. US universities employing AI-based admission systems exhibit 15-20% lower predictive accuracy for minority students, a direct consequence of racially skewed training data [12]. Such "digital discrimination" constitutes the algorithmic reification of social prejudice: structural inequities are transmuted into seemingly neutral numeric thresholds, reproducing and amplifying historical stratification under the guise of objectivity [13]. Compounding the issue, the opacity of black-box algorithms renders discriminatory pathways untraceable, giving rise to "algorithmic tyranny" [14].

Secondly, digital twin systems intensify resource concentration. The digital investment gap between China's "Double First-Class" universities and non-elite universities reaches 4.7 fold; the deployment of digital twins further magnifies this asymmetry. Tsinghua University exemplifies elite advantage: retrofits of canteens, street lighting, and heating systems, coupled with a real-time electricity analytics platform, cut energy consumption by 37%, laying the groundwork for carbon neutrality.

Conversely, under-resourced institutions lack the computational infrastructure to replicate such systems, reinforcing Castells's network society thesis: technological elites restructure resource allocation rules through control of digital interfaces, forging novel monopolies of power.

4.2 Ethical Red Line Crisis: Data Privacy and Subjectivity Dissolution

The ethical crisis precipitated by artificial intelligence transcends technical boundaries, fundamentally questioning the core values of education. Foucault's concept of the "disciplinary society" gains new pertinence in the digital era, where pervasive surveillance systems and data profiling are redefining educational paradigms. The monitoring of student behavior has sparked debate: A university encountered legal challenges after implementing an AI-based attendance system that created "digital profiles" through facial recognition and behavioral analysis, even forecasting students' mental health risks. This "surveillance gaze" induces self-censorship among learners, as their behaviors become

subject to algorithmic conditioning.

More critically, most institutions lack data management frameworks compliant with GDPR, exposing them to significant privacy risks. Teachers' instructional autonomy is structurally eroded: Educators report that AI-generated lesson plans stifle creative teaching methods, while generative tools reduce diverse pedagogical approaches to mere "prompt engineering", a trend that undermines intellectual authority and hampers the development of critical thinking. The AI-driven "principal's cockpit", with its overreliance on data metrics, compels educators to adhere to algorithmically optimized teaching templates, resulting in standardized and homogenized education that echoes the McDonaldization phenomenon.

4.3 Institutional Adaptation Dilemma: Conflict Between Bureaucratic System and Technical Agility

Higher education governance is grappling with the "institutional time lag" dilemma, where the rigid structure of traditional bureaucracy conflicts with the agile management required by AI. Technological innovation must co-evolve with organizational inertia to avoid institutional vacuums. Evaluation systems misalignment: There is a significant gap between traditional evaluation dimensions and AI management metrics. While AI implementation emphasizes innovative assessment frameworks, 73 % of traditional evaluation dimensions (e.g., class hours, paper volume) still fail to effectively quantify AI-driven management benefits. Key indicators like resource allocation efficiency and student growth curve fitness further limit AI's potential in educational assessment. This creates a "dual-track data system" where administrators must juggle traditional evaluations while building digital systems, trapping them in "technological formalism" [15].

Organizational inertia: 65 % of universities experience administrative staff resisting digital transformation, reflecting the clash between bureaucratic "path dependence" and digital governance's "decentralization" requirements [16]. For instance, when implementing an intelligent scheduling system, a university's academic affairs department collectively resisted due to power restructuring, validating Crozier's "bureaucratic phenomenon" theory. Members of organizations actively create technical barriers to protect existing interest structures [17].

5. The Way to Break the Game: Strategies for AI-enabled university Management

The deep application of AI in higher education management necessitates overcoming three dilemmas: technological alienation, ethical disorder, and institutional rigidity. This study proposes a collaborative response strategy of "technological governance, ethical reshaping, and institutional innovation" to build a credible, human-centered, and agile intelligent management ecosystem for universities.

5.1 Technology Governance: Building a Trusted AI Education Ecosystem

As AI technology rapidly progresses, higher education management is presented with both unique opportunities and significant challenges. Technology governance emerges as a crucial strategy to ensure the effective integration of artificial intelligence within the educational domain. By establishing a trustworthy AI education ecosystem, we can simultaneously enhance the efficiency and quality of educational administration, while also guaranteeing the security and reliability of technological applications.

On one hand, the active vertical development of specialized large models tailored for educational purposes is essential. To overcome the limitations of general-purpose large models in adapting to educational contexts, it is necessary to develop scenario-specific models through a "Three-Stage Optimization Path": First, knowledge embedding-integrating subject curriculum standards with teaching practice data to construct a dynamically updated educational knowledge base; Second, algorithm adaptation-employing federated learning techniques to tackle small-sample issues, such as enabling universities in underdeveloped regions to enhance model generalization through encrypted data sharing[18]; Third, scenario validation-creating benchmark test sets for educational large models that encompass core scenarios like instructional design and academic assessment. These specialized models exhibit exceptional capabilities in understanding and processing educational data, thereby offering unprecedented precision for teaching support and management decision-making. The development of such dedicated

models not only enhances administrative efficiency but also provides technical support for personalized learning and innovative teaching methodologies.

On the other hand, we must advance the systematic construction of algorithmic audit mechanisms. By incorporating fairness metrics (such as equality of opportunity and group benefit balance) into model evaluation systems, we can establish an educational algorithm whitelist system, drawing inspiration from the EU's AI Act risk classification framework. First, implement access assessments: According to the Interim Measures for the Administration of Generative Artificial Intelligence Services, third-party audits [19] must be conducted on high-risk systems such as enrollment prediction and behavioral monitoring, requiring algorithm bias rates below 5% [20]. Second, conduct dynamic monitoring. Utilize explainability analysis tools to track decision-making deviations in real-time. For deployed algorithm models, regular fairness and transparency audits should be conducted, with audit results promptly disclosed to ensure technology remains both efficient and ethically sound. Third, improve accountability mechanisms. Establish a "Developer-Deployer-User" responsibility chain to trace and hold accountable universities involved in lawsuits concerning the improper use of facial recognition technology. Through algorithmic auditing, we can oversee AI system decision-making processes to ensure compliance with educational ethics and legal standards.

5.2 Ethical Remodeling: Balancing Efficiency and Humanistic Values

Ethical considerations are paramount in AI-powered higher education management. Ethical reshaping serves not only technological application needs but also fundamental educational requirements. Balancing efficiency with humanistic values ensures AI technology's ethical and effective implementation in education.

First, implement AI education impact assessments. Risk-based classification control is a critical measure for ensuring ethical compliance in AI applications. By evaluating potential impacts of AI technologies on education, we can proactively identify and resolve ethical issues. This assessment mechanism protects students' and teachers' rights while promoting sustainable AI development in education.

Second, establish digital literacy curricula for educators and students. The localization of EU's DigCompEdu standards provides a reference for enhancing digital literacy. Systematic digital literacy education improves understanding and capabilities in applying AI technologies while deepening ethical awareness. Such curriculum development cultivates digital literacy and ethical consciousness, laying a solid foundation for AI's educational integration.

Third, develop an AI Education Impact Assessment (AI-HIA) framework. Drawing from medical health impact assessments, create a three-dimensional AI-HIA system: The first dimension focuses on risk identification through the Delphi method to determine key indicators like student privacy leakage probability and teacher decision-making engagement; the second dimension involves tiered risk management with differentiated responses, such as implementing a 72-hour manual review mechanism [21] for mental health early warning systems; the third dimension establishes compensation mechanisms. Resource prioritization should be implemented for groups affected by algorithmic discrimination. For example, Henan Province has increased the coverage rate of digital resources in underperforming schools to 89% through an intelligent resource scheduling system [22].

To advance localized practices in digital literacy education, we propose establishing a "Three-Dimensional Competency Matrix". In the technological dimension, courses like "AI Ethics and Algorithm Critique" could be introduced to develop educators' and students' ability to counteract manipulative recommendation systems. For teaching methodologies, adopting MIT's human-robot collaborative model-where AI-assisted instructors provide personalized guidance-would enhance pedagogical effectiveness. Regarding governance, creating a Digital Leadership Certification System would empower university administrators and faculty to master AI-powered educational governance. These ethical reform measures ensure that AI applications maintain their educational purpose while achieving efficiency. Furthermore, interdisciplinary collaboration across fields like

law, ethics, education, and computer science can establish comprehensive ethical review mechanisms, providing robust support for AI integration in higher education management.

5.3 System Innovation: Building an Agile Governance Structure

Institutional innovation serves as a crucial safeguard for advancing AI applications in higher education management. Establishing agile governance structures can significantly enhance the flexibility and adaptability of educational administration, enabling it to more effectively address various transformations brought by AI technologies.

First, it is necessary to create a university-level AI ethics committee. Drawing inspiration from Harvard University's interdisciplinary governance model, establishing such a committee as a key measure ensures that AI applications comply with ethical standards. This AI Ethics Review Committee, composed of education experts, technical specialists, ethicists, and student representatives, emphasizes ethical review of AI projects, supervises and evaluates the social impacts of technology, and provides policy recommendations to ensure technological development aligns with societal ethical values and legal regulations. This interdisciplinary governance model encourages comprehensive examination of AI applications from multiple perspectives, ensuring both compliance with educational ethics and the demonstration of social value.

Second, it is important to create a dual-track decision-making mechanism integrating technology and administration. The "Digital Vice President" system at Shanghai Jiao Tong University offers valuable references for combining technological and administrative management. By establishing this dual-track decision-making mechanism, we can ensure synergy between technical decisions and administrative management, enhancing the efficiency and scientific rigor of educational administration. The establishment of this mechanism will effectively break down barriers between technology and management, promoting widespread application of AI in education.

Third, it is essential to leverage the governance effectiveness of interdisciplinary ethics committees. Harvard University's AI Ethics Committee experience demonstrates that effective governance requires breakthroughs in three aspects: To start with, attention should be paid to member composition. The framework incorporates interdisciplinary experts from fields such as pedagogy, computer science, and law, with independent external members constituting no less than 30% of the committee. Next, it establishes a decision-making mechanism that employs "Red Team Exercises" to simulate extreme scenarios like algorithmic failures. Finally, it implements a power-balancing system featuring an ethics veto mechanism, which can decisively halt student behavior monitoring programs that pose privacy risks.

Through the synergistic effects of technological governance, ethical restructuring, and institutional innovation, we can establish a trustworthy, human-centered, and agile intelligent education ecosystem. The creation of such a system will not only enhance the efficiency and quality of higher education management but also ensure that AI technology applications in education align with ethical standards and social values, thereby providing robust support for the future development of education.

6. Conclusions

AI holds significant potential and value in empowering university management across three key dimensions: restructuring teaching scenarios, reinventing administrative processes, and innovating service models. However, it also faces challenges such as technical black boxes, ethical boundaries, and institutional adaptation. Such challenges can be effectively addressed through strategies including building a trustworthy AI education ecosystem through technological governance, balancing efficiency with humanistic values through ethical reshaping, and creating agile governance structures through institutional innovation. In the future, as technology advances and governance systems improve, artificial intelligence will play a more active role in higher education management, driving the robust development of education. Going forward, it is crucial to continuously monitor application risks of AI technology, strengthen supervision and evaluation, and ensure its healthy and sustainable development in the education sector.

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