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ASSESSING DIGITAL GOVERNANCE EFFECTIVENESS IN HIGHER EDUCATION INSTITUTIONS: EVIDENCE FROM UZBEKISTAN

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Abstract. The rapid advancement of digital technologies has significantly transformed management processes in higher education institutions. However, the absence of a comprehensive and scientifically grounded framework for assessing the effectiveness of digital governance remains a major challenge. This study aims to develop and validate an Integrated Digital Management Index (IDMI) for evaluating the level of digital governance effectiveness in higher education institutions. The proposed index is constructed based on five key dimensions: Administrative Efficiency, Resource Management, Decision-Making, Transparency and Reporting, and Innovation and Development.

Keywords: digital governance, higher education institutions, digital transformation, Integrated Digital Management Index (IDMI), management effectiveness, digital maturity, econometric analysis, Uzbekistan.

Аннотация. Стремительное развитие цифровых технологий существенно трансформировало процессы управления в высших образовательных учреждениях. Однако отсутствие комплексного и научно обоснованного инструментария для оценки эффективности цифрового управления по-прежнему остается одной из актуальных проблем. Цель данного исследования заключается в разработке и апробации Интегрального индекса цифрового управления (IDMI) для оценки уровня эффективности цифрового управления в высших образовательных учреждениях. Предлагаемый индекс основан на пяти ключевых компонентах: административная эффективность, управление ресурсами, принятие решений, прозрачность и отчетность, а также инновации и развитие.

Ключевые слова: цифровое управление, высшие образовательные учреждения, цифровая трансформация, Интегральный индекс цифрового управления (IDMI), эффективность управления, цифровая зрелость, эконометрический анализ, Узбекистан.

INTRODUCTION

At present, although the implementation of digital technologies in higher education institutions is progressing rapidly, there is still no single scientifically grounded indicator capable of comprehensively, objectively, and comparatively assessing their actual impact on management efficiency. Most existing approaches are limited to evaluating technological infrastructure, such as the number of computers, internet speed, or the operation of individual digital platforms, including HEMIS and edo.ijro.uz. However, these approaches do not fully reflect the extent to which digital technologies are integrated into management processes, nor do they adequately measure their influence on decision-making quality, transparency, accountability, and resource optimization. Therefore, the Integrated Digital Management Index (IDMI) has been developed as a novel methodological tool designed to provide a holistic assessment of the digital management level of higher education institutions.

The IDMI is constructed on the basis of five interrelated dimensions that collectively enable a comprehensive and multidimensional evaluation of digital management processes in higher education institutions. These dimensions include Administrative Efficiency (ADM), Resource Management (RES), Decision-Making (DEC), Transparency and Reporting (TRA), and Innovation and Development (INN). Each dimension comprises a set of specific indicators that complement one another and collectively cover the entire management cycle, ranging from technological infrastructure and operational processes to strategic planning and institutional development. The performance of each dimension is assessed on a scale ranging from 0 to 100 points.

LITERATURE REVIEW

The issue of digital governance effectiveness in higher education has received increasing attention in recent academic and policy literature. Studies on digital transformation emphasize that universities are no longer limited to traditional administrative systems; instead, they increasingly rely on integrated digital platforms, data-driven decision-making, artificial intelligence, and automated reporting mechanisms to improve institutional performance.

International research highlights that digital governance in higher education should be assessed not only through technological infrastructure, but also through broader managerial dimensions such as administrative efficiency, resource management, transparency, innovation, and strategic decision-making. In this regard, econometric and multivariate assessment methods are widely used to identify the impact of different digital factors on institutional effectiveness. Works by Hair et al., Gujarati and Porter, and Wooldridge provide a methodological basis for applying regression analysis, diagnostic testing, and quantitative model validation in institutional performance studies.

Existing literature also shows that digital maturity is closely linked to the effective use of information systems, staff digital competence, financial capacity, and institutional readiness for innovation. However, many current approaches focus mainly on separate indicators, such as internet access or the availability of digital platforms, without offering a comprehensive index-based assessment. Therefore, the development of an Integrated Digital Management Index (IDMI) represents an important methodological contribution, as it allows higher education institutions to evaluate digital governance effectiveness in a systematic, comparative, and evidence-based manner.

RESEARCH METHODOLOGY

This study employs a quantitative and analytical research approach to assess the effectiveness of digital governance in higher education institutions. The proposed Integrated Digital Management Index (IDMI) was developed based on five key dimensions: Administrative Efficiency (ADM), Resource Management (RES), Decision-Making (DEC), Transparency and Reporting (TRA), and Innovation and Development (INN).

The empirical analysis was conducted using data collected from 20 leading higher education institutions in Uzbekistan, including public, private, and international universities. Each dimension was evaluated on a scale ranging from 0 to 100 points. Multiple regression analysis was applied to determine the relative impact of each dimension on overall management effectiveness and to calculate the corresponding weight coefficients of the IDMI.

To ensure the reliability and validity of the model, several diagnostic tests were employed, including the Variance Inflation Factor (VIF) test for multicollinearity, the Breusch–Pagan test for heteroskedasticity, and the Jarque–Bera test for normality. In addition, the bootstrap method was used to verify the stability of the estimated coefficients. The results provide a comprehensive framework for measuring digital governance effectiveness and evaluating the level of digital transformation in higher education institutions.

ANALYSIS AND RESULTS

The first dimension, Administrative Efficiency (ADM), evaluates the effectiveness of daily administrative operations supported by digital systems. This dimension measures the extent to which operational processes are automated and streamlined, thereby determining the institution's potential to save time and resources. Key indicators include the level of automation of academic processes, such as the management of curricula, class schedules, student records, and enrollment procedures through digital platforms. Additional components include the speed of electronic document circulation, AI-based optimization of staff workload, and the effectiveness of digital archiving systems, including cloud storage and rapid information retrieval capabilities. Together, these elements contribute to improving the transparency, accuracy, and efficiency of administrative operations (Table 1).

Table 1
Components and Content of the IDMI Based on Five Main Factors¹

No.	Factors	Abbreviation	Description	Components
1	Administrative Efficiency	ADM	Assessment of the efficiency of administrative processes through digital systems	• Level of automation of academic processes • Speed of document circulation • Optimization of staff workload • Effectiveness of digital archiving
2	Resource Management	RES	Degree of managing financial, human, and infrastructural resources through digital tools	• Digital budget monitoring • Human resource management through ERP systems • Infrastructure optimization through IoT technologies • Resource consumption forecasting
3	Decision-Making	DEC	Degree of utilization of artificial intelligence and big data in decision-making processes	• Data-driven strategic decision-making • Risk forecasting • Real-time monitoring • Share of automated decisions
4	Transparency and Reporting	TRA	Digital provision of transparency and accountability in management processes	• Open data portals • Automated reporting • Efficiency of auditing and control mechanisms • Integration of stakeholder feedback
5	Innovation and Development	INN	Assessment of innovation implementation and institutional development through digital technologies	• Speed of adopting new technologies • Staff professional development programs • Effectiveness of collaboration platforms • Dynamics of development indicators

As a factor that directly complements Administrative Efficiency (ADM), Resource Management (RES) is considered an essential dimension of the Integrated Digital Management Index. This factor evaluates the degree to which financial, human, and infrastructural resources are effectively allocated, monitored, and controlled through digital technologies. Components such as real-time budget monitoring, human resource management through Enterprise Resource Planning (ERP) systems, infrastructure optimization using Internet of Things (IoT) technologies—for example, automated energy consumption management—and forecasting resource utilization through big data analytics contribute significantly to improving institutional resource efficiency. As a result, unnecessary resource expenditures can be minimized, while financial sustainability and operational effectiveness are enhanced.

Effective resource management, in turn, serves as the foundation for the Decision-Making (DEC) dimension. This factor assesses the extent to which artificial intelligence (AI) and big data analytics are utilized in managerial decision-making processes, with the objective of improving the quality of both strategic and operational decisions. Key components include strategic planning based on data analytics, risk forecasting through AI-driven models, real-time monitoring through digital dashboards, and increasing the proportion of automated decisions. Collectively, these elements strengthen institutional adaptability, responsiveness, and long-term sustainability. Furthermore, this dimension enhances the effectiveness of the preceding factors and elevates the overall management system to a more intelligent and data-driven level.

The effective implementation of decision-making processes requires a high degree of Transparency and Reporting (TRA). This factor evaluates the openness of management processes and the extent to which reporting mechanisms are digitally supported. Components such as the establishment of open data portals, automated report generation, implementation of digital auditing systems, and integration of stakeholder feedback contribute to increasing institutional transparency, accountability, and reliability. A higher level of transparency strengthens trust both within and outside the institution, thereby improving governance quality and stakeholder confidence.

Finally, Innovation and Development (INN) is evaluated as the outcome of the successful implementation of all preceding dimensions. This factor measures the institution's capacity to introduce innovations through digital technologies and its potential for long-term development. Components such as the rapid adoption of emerging technologies, the effectiveness of staff professional development programs, the activity of digital collaboration platforms, and the dynamics of institutional development indicators determine the institution's adaptability to

¹ Developed by the author

digital transformation and its future competitiveness. The interrelationship and logical consistency among these five dimensions transform the IDMI from a static assessment instrument into a powerful mechanism for dynamic monitoring and strategic planning. Consequently, the index serves not only as a tool for evaluating digital management performance but also as a comprehensive framework for guiding the continuous improvement and sustainable development of higher education institutions.

This integrated framework establishes a robust methodological foundation for the comprehensive assessment and continuous improvement of digital management in higher education institutions.

Considering the five factors discussed above, the Integrated Digital Management Index (IDMI) is calculated using the following formula:

$$IDMI = w_1 \cdot ADM + w_2 \cdot RES + w_3 \cdot DEC + w_4 \cdot TRA + w_5 \cdot INN$$

Here, w_1 , w_2 , w_3 , w_4 , and w_5 represent the weight coefficients assigned to each factor. These coefficients are determined through multiple regression analysis and satisfy the condition. As a key scientific contribution of this study, the proposed index introduces a novel methodological approach for assessing the digital management level of higher education institutions. Through this approach, it becomes possible to empirically demonstrate the impact of digital transformation on management effectiveness.

Several methods can be employed to determine weight coefficients, including expert evaluation (Delphi method), the Analytic Hierarchy Process (AHP), Principal Component Analysis (PCA), and Multiple Regression Analysis. In the present study, multiple regression analysis was selected because it identifies the actual statistical relationships between the explanatory factors and overall management effectiveness based on empirical evidence. Unlike alternative approaches, the regression-based method is less dependent on subjective judgments and provides more objective, quantitative, and reliable results.

The main advantages of the regression approach are as follows:

It directly measures empirical relationships between variables;

It enables the testing of statistical significance through p-values;

It determines the explanatory power of the model through the coefficient of determination (R^2);

It allows for the detection and control of multicollinearity using the Variance Inflation Factor (VIF).

As the primary stage of the empirical analysis, digital management indicators of the 20 leading higher education institutions in Uzbekistan were collected and analyzed for the year 2025. The sample consisted of 15 public universities and 5 private and international universities. The selection included leading universities located in the capital city, major regional public universities, as well as the most actively digitalizing private and international institutions.

For each institution, performance scores ranging from 0 to 100 points were generated based on the following five key dimensions: Administrative Efficiency (ADM), Resource Management (RES), Decision-Making (DEC), Transparency and Reporting (TRA), and Innovation and Development (INN), as presented in (Table 2).

Table 2

Digital Management Indicators of 20 Leading Higher Education Institutions in Uzbekistan (2025, 0–100 Points)²

No.	Higher Education Institution	ADM	RES	DEC	TRA	INN	Overall Efficiency (y)
Public Universities							
1	National University of Uzbekistan named after Mirzo Ulugbek	88	85	91	87	89	88.1
2	Tashkent State University of Economics	86	84	89	86	88	86.7
3	Tashkent University of Information Technologies	94	92	95	90	93	93.2
4	Tashkent State Technical University	82	80	85	83	84	82.9
5	Samarkand State University	74	76	71	75	73	73.8
6	Bukhara State University	77	78	80	76	79	78.1
7	Fergana State University	71	73	74	72	75	72.9
8	Andijan State University	79	77	82	80	81	79.8
9	Namangan State University	83	81	86	84	85	83.7
10	Karshi State University	68	70	65	69	67	67.9

² Developed by the author

11	Navoi State University	76	75	78	74	77	76.2
12	Urgench State University	73	74	72	73	76	73.5
13	Jizzakh State University	70	71	69	70	72	70.4
14	Gulistan State University	72	73	70	71	74	71.9
15	Termez State University	75	76	77	74	78	76.0
Private and International Universities							
16	Inha University in Tashkent	96	95	97	94	96	95.8
17	Webster University Tashkent	93	91	94	92	93	92.7
18	Tashkent International University	89	88	92	90	91	90.1
19	Amity University Tashkent	91	90	93	89	92	91.2
20	Alfraganus University	88	87	90	88	89	88.4

The data presented in Table 2 provide the basis for a cross-sectional analysis of the digital management level of Uzbekistan's higher education system as of 2025. As can be observed, private and international universities demonstrate significantly higher performance indicators than public universities across all dimensions of digital management. This advantage can largely be attributed to their greater exposure to international best practices, stronger financial capacities, and enhanced ability to rapidly adopt and integrate modern digital technologies into institutional management processes.

Among public universities, the Tashkent University of Information Technologies and the National University of Uzbekistan occupy leading positions in terms of digital management performance. In contrast, several regional institutions, including Karshi State University, Jizzakh State University, and Gulistan State University, exhibit comparatively lower levels of digital maturity. These findings highlight substantial disparities in digital infrastructure, managerial capabilities, and institutional readiness for digital transformation across higher education institutions in Uzbekistan.

Based on these empirical data, the following logical sequence of scientific and practical analyses is undertaken.

First, a multiple regression analysis is conducted to determine the extent to which each factor influences overall management effectiveness. The regression model is specified as follows:

$$y = \beta_0 + \beta_1 \cdot \text{ADM} + \beta_2 \cdot \text{RES} + \beta_3 \cdot \text{DEC} + \beta_4 \cdot \text{TRA} + \beta_5 \cdot \text{INN} + \varepsilon$$

Here, y represents the overall management effectiveness score, which is calculated as a composite performance indicator. β_0 denotes the constant term (intercept), β_1 – β_5 represent the coefficients measuring the impact of each explanatory factor, and ε refers to the error term. Through regression analysis, the extent to which each factor influences overall management effectiveness (y) can be identified and quantified. The results of the regression analysis are presented in (Table 3).

Table 3
Regression Results³

Y	Coef,	St,Err,	t-value	p-value	[95% Conf	Interval]	Sig
ADM	,27	,024	11,39	0	,219	,321	***
RES	,208	,017	12,29	0	,171	,244	***
DEC	,235	,014	17,09	0	,205	,264	***
TRA	,155	,013	12,29	0	,128	,182	***
INN	,132	,018	7,36	0	,093	,17	***
Constant	,195	,269	0,72	,48	-,382	,772	
Mean dependent var	81,665		SD dependent var		8,675		
R-squared	0,95		Number of obs		20		
F-test	67572,735		Prob > F		0,000		
Akaike crit, (AIC)	-47,680		Bayesian crit, (BIC)		-41,706		

*** p<,01, ** p<,05, * p<,1

All independent variables—Administrative Efficiency (ADM), Resource Management (RES), Decision-Making (DEC), Transparency and Reporting (TRA), and Innovation and Development (INN)—were found to be statistically significant at the p -value = 0.000 level ($p < 0.01$), indicating a strong and statistically significant relationship with overall management effectiveness. Furthermore, the model produced an R-squared value of 0.95, suggesting that the selected explanatory variables account for approximately 95% of the variation in overall management effectiveness. This result demonstrates the strong explanatory power and robustness of the proposed model.

To examine the potential presence of multicollinearity among the explanatory variables, the Variance Inflation Factor (VIF) test was conducted. The VIF values ranged from 1.8 to 3.4, which are considerably below the commonly accepted threshold value of 5.0. Therefore, the results indicate that there is no serious multicollinearity problem among the independent variables included in the model. In addition, the Breusch–Pagan⁴ test was employed to assess the presence of heteroskedasticity, that is, the possibility of non-constant error variance. To evaluate the normality of the residuals, the Jarque–Bera⁵ test was conducted. The test results confirmed that the residuals were normally distributed⁶, thereby satisfying one of the key assumptions of multiple regression analysis.

Finally, to provide additional verification of the stability and reliability of the estimated weight coefficients, the bootstrap method was applied. To derive the final weight coefficients, the absolute values of the regression coefficients were first calculated and subsequently normalized by dividing each coefficient by the sum of all coefficients. The normalization procedure can be expressed as follows:

$$w_i = \frac{|\beta_i|}{\sum |\beta_i|}$$

As a result, the weight coefficient (w_i) for each factor of the Integrated Digital Management Index (IDMI) is derived, and the sum of all weight coefficients is equal to one.

ADM =0,270; RES =0,208; DEC = 0,235; TRA =0,155; INN = 0,132

If these values are extracted and converted into percentages, they can be presented as shown in Figure 1.

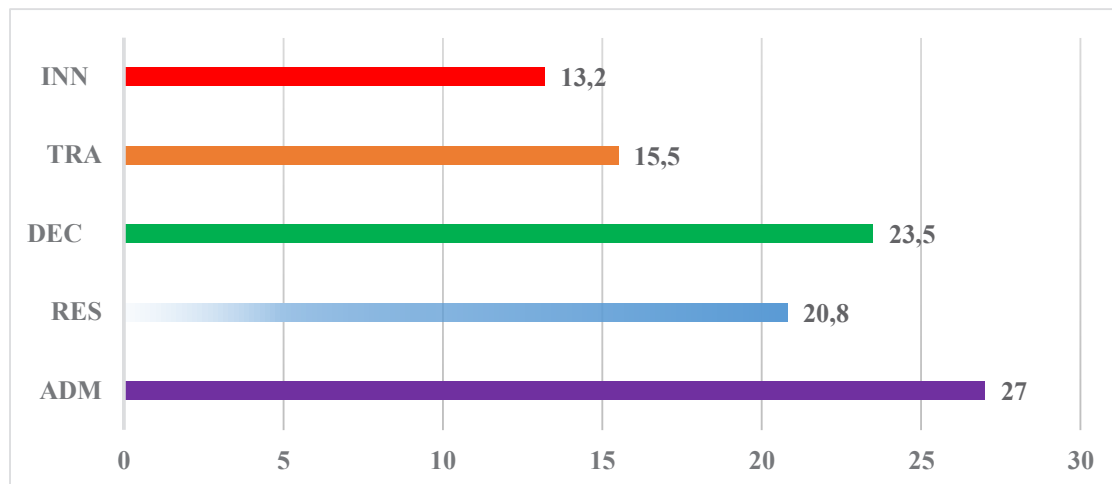


Figure. Weight Coefficients of the IDMI Factors⁷.

4 Abdul-Hameed, A. B., & Matanmi, O. G. (2021). A modified Breusch–Pagan test for detecting heteroskedasticity in the presence of outliers. Retrieved online from the website: <http://article.pamathj.net/pdf/10.11648.j.pamj.20211006>

5 Thadewald, Thorsten, and Herbert Büning. "Jarque–Bera test and its competitors for testing normality—a power comparison." *Journal of applied statistics* 34.1 (2007): 87-105.

6 DiCiccio, T. J., & Efron, B. (1996). Bootstrap confidence intervals. *Statistical science*, 11(3), 189-228.

7 Prepared by the author based on the results obtained through econometric analysis.

To further explore these institutional and regional disparities, the relationships between the Integrated Digital Management Index (IDMI) and a set of additional explanatory factors were examined through correlation and regression analyses. The results revealed that the IDMI score is positively and statistically significantly associated with the number of students, the volume of financial resources, the level of staff digital competence, and the extent of international cooperation. In particular, staff digital competency and the degree of data integration emerged as the strongest determinants of the IDMI. These findings further confirm that the IDMI serves not only as a diagnostic tool but also as a comprehensive indicator reflecting the overall digital maturity of a higher education institution.

Based on these findings, a set of targeted and practical recommendations was developed for institutions exhibiting relatively low IDMI scores. Specifically, for institutions such as Karshi State University, Jizzakh State University, Gulistan State University, and several other regional universities, priority should be given to modernizing digital infrastructure, ensuring the full integration of the HEMIS and edo.ijro.uz systems, implementing continuous digital skills development programs for staff, and establishing data-driven decision-making mechanisms. These recommendations were designed not only to address technological challenges but also to promote organizational and cultural transformation within higher education institutions.

At the final stage of the analysis, all empirical findings—including graphical analyses, regression results, institutional differences, and policy recommendations—were synthesized to provide a practical foundation for educational policymaking, financing digital transformation initiatives, improving monitoring mechanisms, and supporting strategic planning processes. These findings possess significant scientific and practical value for enhancing the digital sustainability of Uzbekistan's higher education system, improving resource allocation efficiency, and strengthening international competitiveness. Furthermore, they establish a methodological foundation for future research in the field of digital governance in higher education.

Based on the empirical findings and graphical analyses, a comprehensive set of practical recommendations aimed at enhancing the digital management capacity of higher education institutions was developed. These recommendations were formulated as an integrated framework consisting of mutually reinforcing measures that can be implemented in a gradual and systematic manner.

First, the high IDMI scores achieved by private and international universities indicate that their success is largely attributable to integrated digital platforms, data-driven decision-making systems, and a highly skilled digital workforce. Therefore, public higher education institutions should actively study and adapt the best practices of the private sector through pilot projects and institutional innovation initiatives. This process can be facilitated through knowledge-sharing programs between public and private universities, joint training activities, and the establishment of a Digital Leadership Center dedicated to promoting digital transformation across the higher education sector.

The transfer of such experience is particularly important for regional universities, as the relatively low IDMI scores of institutions such as Karshi, Jizzakh, and Gulistan State Universities are associated with limited infrastructure, insufficient digital competencies, and regional inequalities in resource allocation. For these institutions, the implementation of centralized digital infrastructure projects is essential. Such initiatives may include subsidized access to cloud-based servers and broadband internet services, as well as the introduction of free or preferential digital capacity-building programs for academic and administrative staff.

CONCLUSION AND RECOMMENDATIONS

The rapid development of digital technologies has fundamentally transformed management processes within higher education institutions, creating new opportunities for improving efficiency, transparency, and strategic decision-making. However, the lack of a comprehensive methodological framework for evaluating the effectiveness of digital governance has limited the ability of institutions to objectively assess the outcomes of digital transformation initiatives.

From a practical perspective, the study provides a set of evidence-based recommendations for policymakers and university administrators. These recommendations include the modernization of digital infrastructure, the integration of HEMIS and edo.ijro.uz platforms, the implementation of continuous digital capacity-building programs, and the promotion of data-driven governance practices. The adoption of these measures can contribute to improving institutional effectiveness, strengthening digital sustainability, and enhancing the international competitiveness of higher education institutions.

The scientific contribution of this research lies in the development of a novel methodological approach for assessing digital governance effectiveness through the IDMI framework. Beyond serving as a diagnostic instrument, the index can be applied as a strategic management tool for monitoring digital transformation progress, supporting policy formulation, and guiding resource allocation decisions. Furthermore, the proposed framework establishes a methodological foundation for future research on digital governance, institutional

performance, and higher education transformation in Uzbekistan and beyond.

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