ENHANCING UNIVERSITY PERFORMANCE THROUGH INTEGRATED SMART AND GREEN SYSTEMS: AN EMPIRICAL MODEL OF INSTITUTIONAL TRANSFORMATION

Hadi Setiawan[1]*[2], Dewa Ketut Sudarsana[1], Wahyu Susihono[2], Anak Agung Istri Agung Sri Komala[1]
[1] Department of The Engineering Science Doctoral Programme, Faculty of Engineering, Universitas Udayana, Badung, Bali 80361, Indonesia.
[2] Department of Industrial Engineering, Faculty of Engineering, Universitas Sultan Ageng Tirtayasa, Serang City, Banten 42163, Indonesia
*Email: hadi@untirta.ac.id

Abstract

This study investigates the role of *Integrated Smart and Green* (ISG) in enhancing university performance through a structural model approach. ISG is conceptualized as a multidimensional construct consisting of *smart governance and smart academic systems*, *green campus management*, and *smart–green innovation culture*. The study employs a quantitative method using Structural Equation Modelling–Partial Least Squares (SEM-PLS), with data collected from universities in Banten Province, Indonesia, categorized as "excellent" and "very good" accreditation levels.

The results indicate that Integrated Smart and Green has a positive and significant effect on university performance, with an R-square value of 0.523, demonstrating moderate explanatory power. Among the dimensions, *green campus management* shows the strongest influence (T-statistic = 9.358; $f^2 = 1.022$), followed by *smart–green innovation culture* (T-statistic = 5.965; $f^2 = 0.369$), and *smart governance and smart academic systems* (T-statistic = 6.773; $f^2 = 0.105$). These findings suggest that integrating digital governance, sustainable campus practices, and an innovation-driven culture contributes to improved institutional efficiency, academic service quality, and overall university reputation.

This study offers a theoretical contribution by integrating smart and green paradigms into a unified framework for higher education performance. Practically, it provides insights for university stakeholders to strengthen performance through the strategic implementation of ISG.

Keywords: Integrated Smart and Green, University Performance, Smart Governance, Green Campus, Innovation Culture, SEM-PLS

INTRODUCTION

Higher education institutions are currently facing increasing pressure to improve university performance amid globalization, digital disruption, and sustainability challenges. Universities are no longer evaluated solely based on academic achievement, but also on their institutional adaptability, technological readiness, innovation capacity, and environmental responsibility. In the era of digital transformation and sustainable development, universities are expected to create integrated systems capable of supporting academic excellence, operational efficiency, and long-term institutional competitiveness. Therefore, the issue of university performance has become a strategic concern in higher education management worldwide.

One of the key determinants of university performance is human capital. Human capital reflects the collective knowledge, competencies, motivation, leadership capacity, organizational climate, and teamwork effectiveness within an institution. Previous studies have emphasized that universities with strong human capital tend to achieve better academic quality, organizational productivity, and institutional reputation. However, the effectiveness of human capital in improving university performance depends not only on individual competencies but also on the institutional ecosystem that supports innovation and sustainable transformation.

In recent years, the concept of smart universities has gained considerable attention in higher education research. Smart universities integrate digital technologies into governance, academic systems, and institutional decision-making processes to improve efficiency and service quality.

Simultaneously, the green campus movement has emerged as a global response to environmental sustainability challenges by promoting energy efficiency, waste reduction, and environmentally responsible campus management. Although both concepts have developed rapidly, most previous studies examine smart campus and green campus initiatives separately, resulting in fragmented institutional transformation models.

This study introduces the concept of *Integrated Smart and Green* (ISG) as a comprehensive framework that combines smart governance and smart academic systems, green campus management, and smart–green innovation culture into a unified institutional model. The integration between technological intelligence and environmental sustainability is expected to strengthen university performance more effectively than partial implementation approaches. In this context, universities require not only advanced technology but also a sustainable innovation culture capable of supporting institutional transformation.

Several previous studies have confirmed the positive relationship between smart systems, sustainability practices, and organizational performance. However, empirical studies examining the integrated relationship between these dimensions and university performance remain limited, particularly in developing countries. Furthermore, limited research has investigated the strategic role of Integrated Smart and Green as a multidimensional institutional construct in higher education. This gap indicates the need for a more comprehensive model capable of explaining how integrated smart and green systems contribute to university performance improvement.

Indonesia, particularly universities in Banten Province, provides an important context for this study due to the increasing demand for digital transformation and sustainable campus development. Universities with excellent and very good accreditation are expected to become pioneers in implementing smart and green institutional systems. Therefore, examining the influence of Integrated Smart and Green on university performance provides both theoretical and practical contributions to higher education management.

This study aims to analyze the effect of Integrated Smart and Green on university performance using the Structural Equation Modelling–Partial Least Squares (SEM-PLS) approach. The findings are expected to contribute to the development of higher education management literature by offering an integrated institutional transformation model that combines technology-driven governance and environmental sustainability. In addition, this study provides strategic recommendations for university stakeholders to strengthen institutional performance through smart and sustainable practices.

LITERATURE REVIEW

University Performance

University performance refers to the achievement level of higher education institutions in carrying out their academic and managerial functions effectively and efficiently. University performance is commonly measured through indicators such as academic quality, research productivity, community service, institutional reputation, governance quality, and stakeholder satisfaction. In the context of global competition, university performance has become a strategic issue because it reflects institutional competitiveness and sustainability.

Integrated Smart and Green

Integrated Smart and Green (ISG) is a conceptual framework that integrates digital transformation and environmental sustainability into higher education management systems. ISG consists of three main dimensions: smart governance and smart academic systems, green campus management, and smart–green innovation culture.

Smart governance and smart academic systems refer to the use of information technology in academic administration, decision-making processes, digital learning systems, and institutional

governance. Green campus management emphasizes sustainable resource management, including energy efficiency, waste management, and environmentally friendly campus policies. Meanwhile, smart–green innovation culture reflects the institution's ability to foster innovation, collaboration, and sustainability-oriented behavior among academic communities.

Relationship between Integrated Smart and Green and University Performance

Previous studies indicate that digital governance systems improve institutional efficiency and service quality in higher education. Likewise, sustainable campus management contributes to institutional image, operational efficiency, and environmental responsibility. Innovation culture also plays a significant role in improving institutional adaptability and competitiveness. Therefore, integrating smart and green approaches is expected to strengthen university performance comprehensively.



Figure 1. Integrated Smart and Green Model Framework.

RESULTS AND DISCUSSION

Measurement Model Evaluation

The measurement model evaluation indicated that all indicators met convergent validity and discriminant validity requirements. Composite Reliability and Cronbach's Alpha values exceeded the recommended threshold of 0.70, indicating acceptable reliability.

Structural Model Evaluation

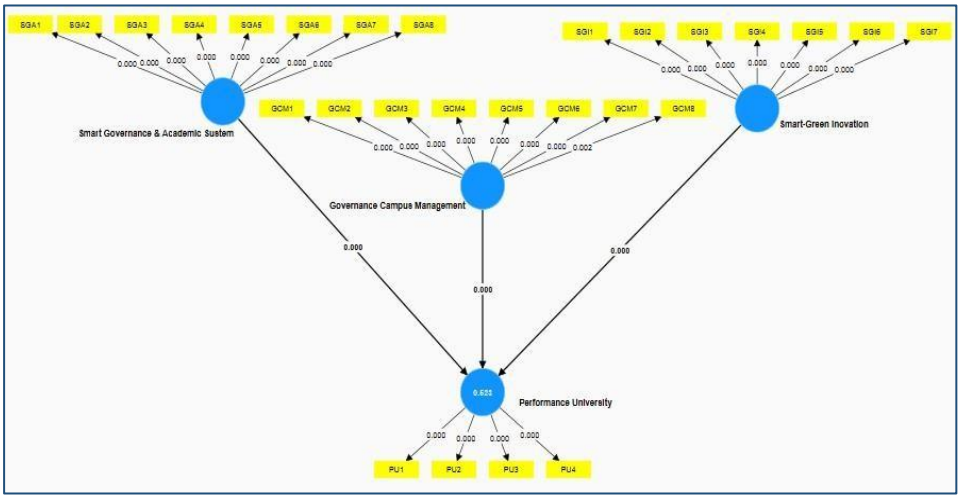

Figure 2. Structural Model of Integrated Smart and Green

The structural model illustrates the relationships between the dimensions of Integrated Smart and Green and university performance. The model consists of Smart Governance and Smart Academic Systems, Green Campus Management, and Smart–Green Innovation Culture as exogenous variables influencing university performance.

Table 1. Hypothesis Testing Results

Hipotesis	***Path Coefficient***	***T Statistics***	***P Values***	***95% Confidence Interval Path Coefficient***	
				Lower limit	**Uper limit**
H_1(+): X1 → Y	0.394	6.773	0.000	0.200	0.361
H_2(+): X2 → Y	0.281	9.358	0.000	0.312	0.479
H_3(+): X3 → Y	0.233	5.965	0.000	0.160	0.311

The hypothesis testing results indicate that all dimensions of Integrated Smart and Green have positive and significant effects on university performance.

The results revealed that Integrated Smart and Green had a positive and significant effect on university performance with an R-square value of 0.523. This indicates that 52.3% of university performance variance can be explained by Integrated Smart and Green.

The structural model results showed that:

- Smart Governance and Smart Academic Systems had a T-statistic value of 6.773 with an f^2 value of 0.105.
- Green Campus Management had a T-statistic value of 9.358 with an f^2 value of 1.022.
- Smart–Green Innovation Culture had a T-statistic value of 5.965 with an f^2 value of 0.369.

Among these dimensions, Green Campus Management demonstrated the strongest effect on university performance.

Table 2. *R-Square Model*

Variabel	***R-Square***	***R Square Adjusted***
University Performance	0.523	0.519

This model directly indicates that the university performance variable is positively and significantly influenced by the integrated smart and green variable, which consists of the dimensions of smart governance and smart academic system, green campus management, and smart-green innovation culture, with an R-square value of 0.523. These findings suggest that the implementation of an integrated smart and green university system contributes substantially to improving institutional performance. The proposed research model is consistent with the growing body of literature on the smart university concept, which emphasizes the importance of information technology utilization and data-driven systems in enhancing the effectiveness and efficiency of higher education management. Previous studies have demonstrated that the implementation of smart governance and smart academic systems can improve the quality of academic services, accelerate decision-making processes, and encourage innovation in teaching and learning activities. Therefore, digital transformation has become one of the primary drivers of institutional performance improvement in the era of disruption.

This model is developed based on the assumption that the performance of modern universities is no longer determined solely by conventional academic excellence. Instead, higher education institutions are required to systematically and sustainably integrate digital transformation (smart) and environmental sustainability (green) into institutional management. The structural model testing results reveal that integrated smart and green has a positive and significant effect on university performance, indicating that a higher level of smart and green implementation in university management leads to more optimal institutional performance.

In this study, the smart dimension is represented by smart governance and smart academic system. These dimensions reflect the university's capability to manage institutional processes transparently, accountably, adaptively, and data-driven through the utilization of information technology. The structural model testing results indicate that the smart governance and smart academic system dimensions of the integrated smart and green variable positively and significantly affect university performance, as evidenced by a T-statistics value of 6.773 and a P-value of 0.000. These results indicate that the implementation of smart governance promotes more effective decision-making processes, enhances bureaucratic efficiency, and improves the quality of academic and non-academic services.

Meanwhile, the smart academic system plays a crucial role in supporting the academic performance of higher education institutions. The path coefficient value of the smart governance and smart academic system dimensions on university performance is 0.394, indicating that the implementation of intelligent governance and technology-based academic systems contributes 39.4% to improving university performance. Digital-based smart academic systems, such as learning management systems, research and community service information systems, and the digitalization of student services, can enhance learning quality, lecturer productivity, and students' learning experiences. Furthermore, the implementation of smart governance supports more effective institutional decision-making, greater bureaucratic efficiency, and higher-quality academic and administrative services.

Accordingly, the smart governance and smart academic system dimensions substantially contribute to achieving university performance indicators, particularly in terms of academic performance, innovation, and institutional competitiveness. Digital academic systems enable universities to create more adaptive, responsive, and sustainable educational environments, thereby strengthening institutional capacity to compete in the increasingly dynamic global higher education landscape.

CONCLUSION

This study confirms that Integrated Smart and Green (ISG) plays a significant role in enhancing university performance. The findings demonstrate that the integration of smart governance and smart academic systems, green campus management, and smart–green innovation culture positively contributes to institutional effectiveness, academic service quality, and university competitiveness. The SEM-PLS analysis indicates that Integrated Smart and Green explains 52.3% of the variance in university performance, highlighting its substantial contribution to institutional transformation in higher education.

Among the ISG dimensions, green campus management emerged as the strongest predictor of university performance, followed by smart–green innovation culture and smart governance and smart academic systems. These results suggest that sustainability-oriented campus management, supported by digital transformation and innovation culture, strengthens institutional reputation and operational efficiency. Universities implementing integrated smart and green strategies are more capable of adapting to technological change, sustainability demands, and global competition.

The study contributes theoretically by proposing an integrated framework that combines digital governance and environmental sustainability within higher education management. Practically,

the findings provide strategic insights for university leaders and policymakers to strengthen institutional performance through smart and sustainable transformation initiatives. Future research is recommended to expand the study scope by involving broader geographical contexts and additional variables related to innovation capability and digital readiness.

REFERENCES

Alcaide-Pulido, P., Gutiérrez-Villar, B., Ordóñez-Olmedo, E., & Pérez-Escolar, M. (2025b). Analysis of faculty readiness for online teaching: assessing impact and adaptability in diverse educational contexts. *Smart Learning Environments, 12*(1). https://doi.org/10.1186/s40561-02400353-2

Akpen, C. N., Asaolu, S., Atobatele, S., Okagbue, H., & Sampson, S. (2024). Impact of online learning on student's performance and engagement: a systematic review. *Discover Education, 3*(1). https://doi.org/10.1007/s44217-024-00253-0

Aydin, M. K., Yildirim, T., & Kus, M. (2024). Teachers' digital competences: a scale construction and validation study. *Frontiers in Psychology, 15*, 1356573.

De Los Ángeles Domínguez-González, M., De La Rosa, A. L., Hervás-Gómez, C., & RománGraván, P. (2025). Teacher digital competence: Keys for an educational future through a systematic review.

Kim, S. Y., & Martin, F. (2023). Validation of the Faculty Readiness to Teaching Online (FRTO) scale. *Journal of Applied Research in Higher Education, 16*(5), 1781–1798. https://doi.org/10.1108/jarhe- 03-2023-0108

Tekcan, Z. Ş., Geçer, A., & Topal, A. D. (2025). An investigation of the factors affecting faculty members' readiness for online teaching using chi-squared automatic interaction detection (CHAID) analysis. *International Review of Education, 71*(4), 655–683. https://doi.org/10.1007/s11159-02510139-4

Yan, M., & Pourdavood, R. G. (2024). Faculty and student perspectives on online learning in higher education. *Education Sciences, 14*(8), 801. https://doi.org/10.3390/educsci14080801

Howard, S. K., & Tondeur, J. (2023). Higher education teachers' digital competencies for a blended future. *Educational Technology Research and Development, 71*(1), 1–6. https://doi.org/10.1007/s11423-023-10211-6

Ormilla, R. C. G., & Ongan, M. G. O. (2024, January 30). *Navigating the shift: Faculty preparedness for online teaching in the evolving global higher education landscape*. https://www.ijlter.net/index.php/ijlter/article/view/1830

Karimi, H., & Khawaja, S. (2025, February 5). *Exploring Digital Competence among Higher Education Teachers: A Systematic Review*. Karimi | International Journal of Learning, Teaching and Educational Research. https://www.ijlter.org/index.php/ijlter/article/view/12168

He, J., Wang, Q., & Lee, H. (2025). Enhancing online learning engagement: teacher support, psychological needs satisfaction and interaction. *BMC Psychology, 13*(1), 696. https://doi.org/10.1186/s40359-025-03016-0

Ahmed, V., Anane, C., Alzaatreh, A., & Saboor, S. (2023). Faculty perception of online education: considerations for the post-pandemic world. *Frontiers in Education, 8*. https://doi.org/10.3389/feduc.2023.1258980

Du, W., Liang, R., Zhang, J., & Wang, L. (2023). Factors influencing teachers' satisfaction and performance with online teaching in universities during the COVID-19. *Frontiers in Psychology, 14*, 1120662. https://doi.org/10.3389/fpsyg.2023.1120662

Najjar, N., Rouphael, M., Bitar, T., & Hleihel, W. (2025). The rise and drop of online learning: adaptability and future prospects. *Frontiers in Education, 10*. https://doi.org/10.3389/feduc.2025.1522905

Rueda, M. M., Cerero, J. F., Cerero, D. F., & Meneses, E. L. (2024). Perspectives on online learning: Advantages and challenges in higher education. *Contemporary Educational Technology*, *16*(4), ep525. https://doi.org/10.30935/cedtech/15011

Martin, F., Budhrani, K., Wang, C., & University of North Carolina Charlotte. (2019). Examining faculty perception of their readiness to teach online. *Online Learning Journal*, *23*(3), 97–119. https://doi.org/10.24059/olj.v23i3.1555

Moraes, R., Santos, C., & Pedro, N. (2025). Teacher Digital Competences in Online Higher Education: A Systematic Literature review. *Ubiquity Proceedings*, 53. https://doi.org/10.5334/uproc.221

Des Armier Jr, D., & Xu, D. Z. (2025). Experienced faculty's online teaching readiness PostPandemic. *Journal of Open, Flexible and Distance Learning*, *29*(i), 64–91. https://files.eric.ed.gov/fulltext/EJ1480671.pdf

Dang, T. D., Phan, T. T., Vu, T. N. Q., La, T. D., & Pham, V. K. (2024). Digital competence of lecturers and its impact on student learning value in higher education. *Heliyon*, *10*(17), e37318. https://doi.org/10.1016/j.heliyon.2024.e37318

Bharti, N., Sharma, A., & Pandey, A. (2024). Modern Communication Methods in Higher Education: A Post-COVID-19 Analysis. *Engineering Proceedings*, 161. https://doi.org/10.3390/engproc2023059161

Zhang, O. X. (2024, September 26). *Attitudes and perceived effectiveness among first-time online instructors during Covid-19*. arXiv.org. https://arxiv.org/abs/2409.17600

Molavi, M., Moein, M., Tavakoli, M., Faraji, A., Mol, S. T., & Kismihók, G. (2025, December 15). *Embedding-Based Rankings of Educational Resources based on Learning Outcome Alignment: Benchmarking, Expert Validation, and Learner Performance*. arXiv.org. https://arxiv.org/abs/2512.13658

Yulin, N., & Danso, S. D. (2025, February 17). *Assessing Pedagogical Readiness for Digital Innovation: A Mixed-Methods Study*. arXiv.org. https://arxiv.org/abs/2502.15781

Tettey, N. (2025). Navigating Online Teaching Challenges: best practices and institutional recommendations for faculty support. *Journal of Education and Learning*, *14*(6), 48. https://doi.org/10.5539/jel.v14n6p48

Ahmed, V., Anane, C., Alzaatreh, A., & Saboor, S. (2023b). Faculty perception of online education: considerations for the post-pandemic world. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1258980

Du, W., Liang, R., Zhang, J., & Wang, L. (2023b). Factors influencing teachers' satisfaction and performance with online teaching in universities during the COVID-19. *Frontiers in Psychology*, *14*, 1120662. https://doi.org/10.3389/fpsyg.2023.1120662

Alcaide-Pulido, P., Gutiérrez-Villar, B., Ordóñez-Olmedo, E., & Pérez-Escolar, M. (2025c). Analysis of faculty readiness for online teaching: assessing impact and adaptability in diverse educational contexts. *Smart Learning Environments*, *12*(1). https://doi.org/10.1186/s40561-02400353-2

Pedro, N. S., & Kumar, S. (2020). Institutional support for online teaching in quality assurance frameworks. *Online Learning*, *24*(3). https://doi.org/10.24059/olj.v24i3.2309

Verstraeten, J., Van Dongen-Leunis, A., Scheepers, R., Nederhand, M. L., De Koning, B. B., & Van Deen,

W. K. (2025). Teachers' perceptions about online teaching: Analysis of their experiences and opportunities for knowledge sharing. *International Journal of Educational Research Open*, *9*, 100450. https://doi.org/10.1016/j.ijedro.2025.100450

Zhang, J., Huang, Y., Wu, F., Kan, W., & Zhu, X. (2024). Scaling up online professional development through institution-initiated blended learning programs in higher education. *The Internet and Higher Education*, *65*, 100988. https://doi.org/10.1016/j.iheduc.2024.100988