

 ISSN (O): 2320-5407 ISSN (P): 3107-4928	Journal Homepage: www.journalijar.com INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR) Article DOI:10.21474/IJAR01/23867 DOI URL: http://dx.doi.org/10.21474/IJAR01/23867	
--	--	---

RESEARCH ARTICLE

THE ACCELERATION OF DIGITAL INFRASTRUCTURE IN MOROCCAN HIGHER EDUCATION: PRE-COVID AND POST-COVID-19 COMPARATIVE ANALYSIS

Abdelatif Khaldouni, Youssef El Mdari, Youssef Naimi and Isam Atouf

1. Hassan II University of Casablanca, Benm'sik Faculty of Sciences, LTI Laboratory.

Manuscript Info

Manuscript History

Received: 14 May 2026

Final Accepted: 16 June 2026

Published: July 2026

Key words:-

Digital Transformation; Higher Education; Digital Infrastructure; Moroccan Public Universities; COVID-19 Pandemic; Educational Technology.

Abstract

The COVID-19 pandemic accelerated digital transformation in higher education worldwide, including in Morocco, where universities rapidly shifted to remote and hybrid learning (Hodges et al., 2020; UNESCO, 2020). This study examines the evolution of digital infrastructure in Moroccan universities before and after the pandemic using a comparative analysis of 2019 and 2023 data. Four key indicators are analysed: MARWAN connectivity, Wi-Fi access points, multimedia rooms, and internet speed. The results show substantial improvements across all indicators, with growth ranging from 1.5x to 4x, confirming the pandemic as a major driver of higher education digitalisation in Morocco. These findings are consistent with global evidence on crisis-driven educational innovation (Bozkurt et al., 2020; Williamson et al., 2020) while highlighting the country's significant infrastructural progress (Ben Henda & Elouali, 2022).

"© 2026 by the Author(s). Published by IJAR under CC BY 4.0. Unrestricted use allowed with credit to the author."

Introduction:-

The digitalisation of higher education institutions has been a gradual process globally, often constrained by financial, logistical, and policy-related challenges (Selwyn, 2016). In many developing countries, including Morocco, the integration of digital technologies into higher education has been identified as a strategic priority to enhance accessibility, quality, and international competitiveness (World Bank, 2019). Moroccan national strategies, such as the "Digital Morocco" plan and specific initiatives like the MARWAN (Moroccan Academic and Research Wide Area Network) program, have long sought to interconnect universities and promote advanced digital learning environments (Ministère de l'Éducation Nationale, de la Formation Professionnelle, de l'Enseignement Supérieur et de la Recherche Scientifique, 2018). However, progress has often been incremental, facing challenges related to funding, digital literacy, and institutional readiness (Kebbi & Al-Harthy, 2019).

The outbreak of the COVID-19 pandemic in early 2020 forced an unprecedented global shift to emergency remote teaching (ERT), exposing critical gaps in digital readiness across educational systems (Hodges et al., 2020). In Morocco, as elsewhere, the sudden closure of campuses created an urgent imperative to deploy robust digital infrastructures capable of supporting continued teaching, learning, and research (El Firdoussi et al., 2020). This crisis presented both a significant challenge and a unique opportunity to accelerate long-planned digital transformations (Marinoni et al., 2020). This article investigates how the pandemic served as a critical juncture,

propelling the rapid deployment of digital infrastructure in Moroccan universities. By conducting a quantitative comparative analysis of key infrastructural metrics between 2019 and 2023, this study aims to measure the scale of acceleration attributable to the pandemic's impetus. The findings contribute to the growing literature on crisis-driven educational innovation (Bozkurt et al., 2020) and provide empirical evidence of infrastructural leapfrogging in the context of Moroccan higher education.

Data:-

The following table summarizes the evolution of key digital infrastructure indicators in Moroccan universities between 2019 and 2023, based on data from the Moroccan Ministry of Higher Education (MESRSI, 2023). Table 1 presents the evolution of key digital infrastructure indicators in Moroccan public universities between 2019 (pre-COVID) and 2023 (post-COVID), based on official data published by the Moroccan Ministry of Higher Education, Scientific Research and Innovation (MESRSI, 2023). The selected indicators capture the main dimensions of digital infrastructure that support higher education digitalisation, including institutional connectivity through the MARWAN academic network, the availability of campus Wi-Fi access points, the number of technologically equipped multimedia rooms, and the average internet bandwidth available to universities. By comparing the pre-pandemic baseline with the post-pandemic situation, the table highlights the scale of infrastructure investments undertaken during and after the COVID-19 crisis. In addition to absolute values, the analysis reports the percentage of change and the corresponding acceleration factor for each indicator, providing a quantitative measure of the pace of digital infrastructure expansion. These indicators offer a comprehensive overview of the technological improvements that enabled Moroccan universities to strengthen their capacity for online, hybrid, and technology-enhanced learning following the pandemic.:

INFRASTRUCTURE TYPE	2019 Pre-Covid	2023 Post-Covid	Évolution	Facteur d'Accélération
(%) MARWAN Program connected universities	65%	100%	35	1.5x
NB Campus Wi-Fi access points	8000	25000	212%	3.1x
Equipped multimedia rooms	1,2	4,5	275%	3.8x
Average internet speed in Moroccan university Mbps	500	2000	300%	4x

Methodology:-

This study employs a comparative quantitative research design to examine the evolution of digital infrastructure in Moroccan public universities before and after the COVID-19 pandemic. A longitudinal comparison is conducted using data from 2019 (pre-COVID) and 2023 (post-COVID), allowing the assessment of infrastructure development associated with the digital transformation of higher education. The analysis focuses on four key indicators that are fundamental to supporting digital learning ecosystems: (1) institutional connectivity through the national MARWAN academic network, (2) the density of campus Wi-Fi access points, (3) the availability of technologically equipped multimedia rooms, and (4) the average internet bandwidth per institution. These indicators were selected because they represent the core technological infrastructure required to support online, hybrid, and technology-enhanced learning. To assess the impact of the pandemic, acceleration factors are calculated by comparing the rate of infrastructure growth during the pandemic period (2020–2023) with the pre-pandemic baseline trend. The study relies exclusively on secondary data derived from official annual reports, strategic dashboards, and infrastructure audit reports published by the Moroccan Ministry of Higher Education, Scientific Research and Innovation (MESRSI), ensuring the reliability, consistency, and comparability of the data across the study period.

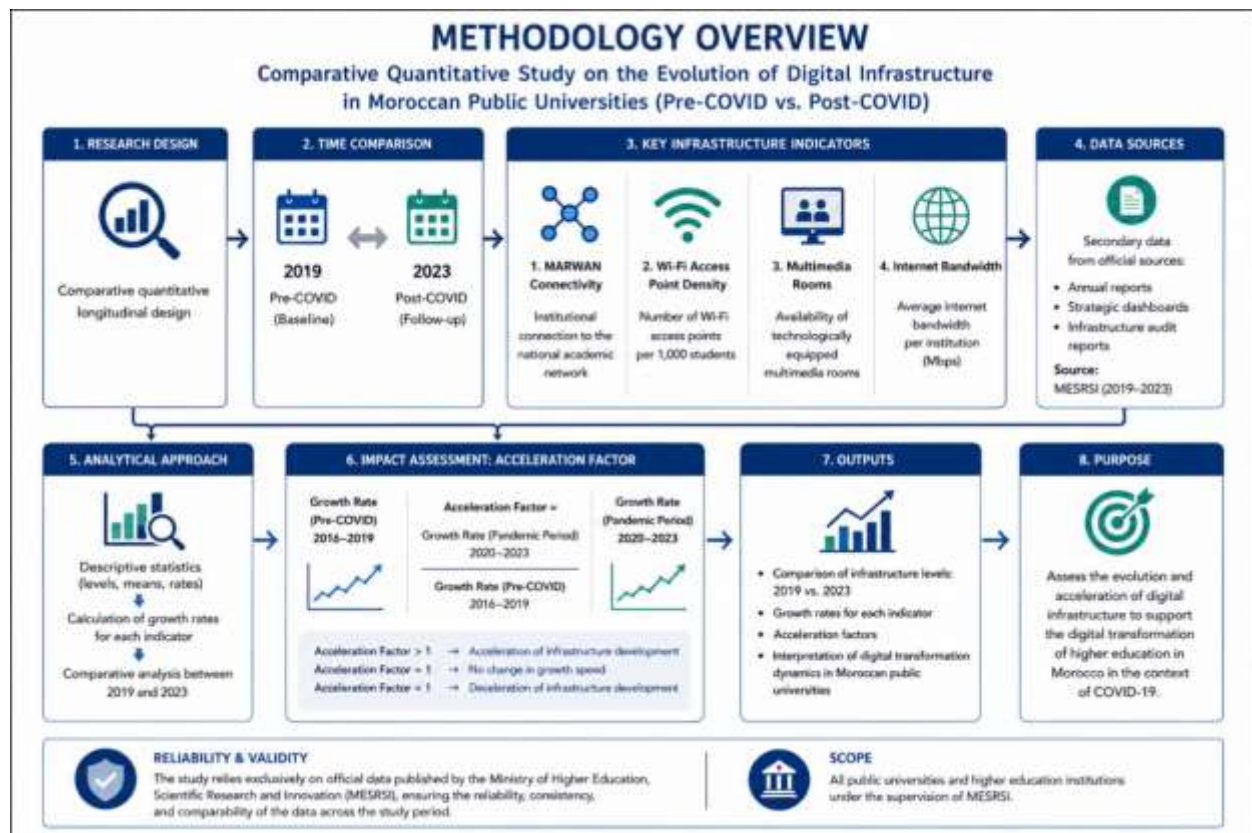


Figure 1: Methodology overview.

Results:-

The analysis reveals substantial and accelerated progress across all digital infrastructure domains between 2019 and 2023. The following visualizations and descriptive comments detail the findings. Comparative assessments are undertaken to identify the patterns and magnitude of infrastructure development across Moroccan public universities. Particular attention is given to the acceleration effect associated with the COVID-19 pandemic by examining the relative growth of each indicator over time. The findings also contribute to evaluating the readiness of higher education institutions to support digital, hybrid, and technology-enhanced learning while informing future strategic investments in digital infrastructure and governance.:

MARWAN Program Connectivity:-

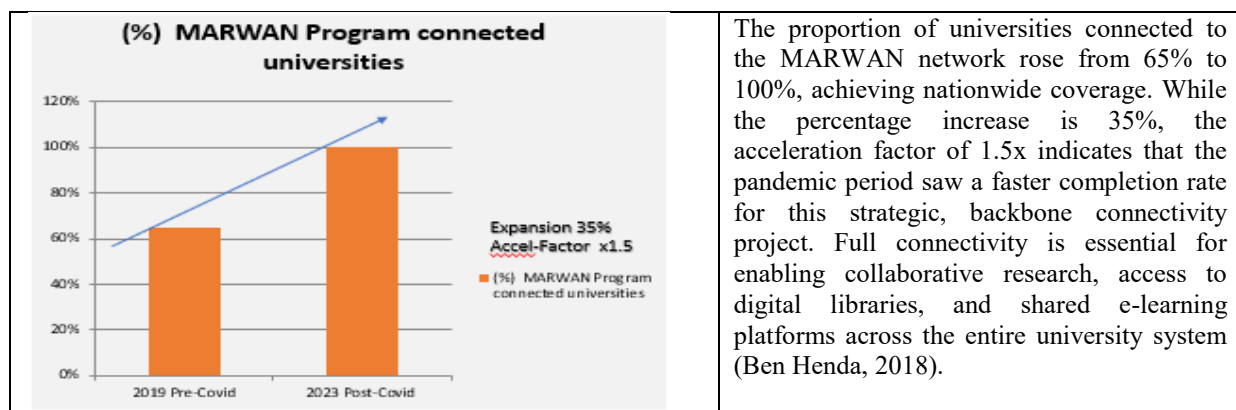
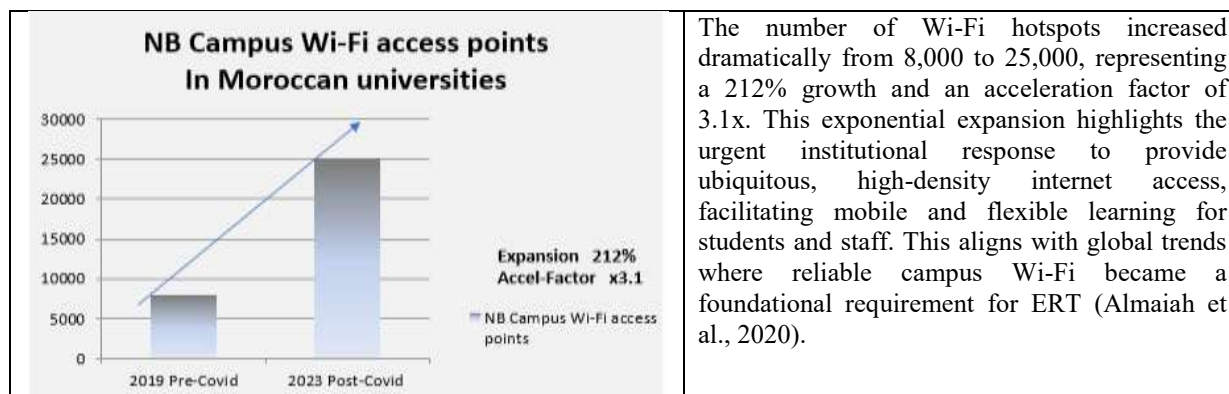
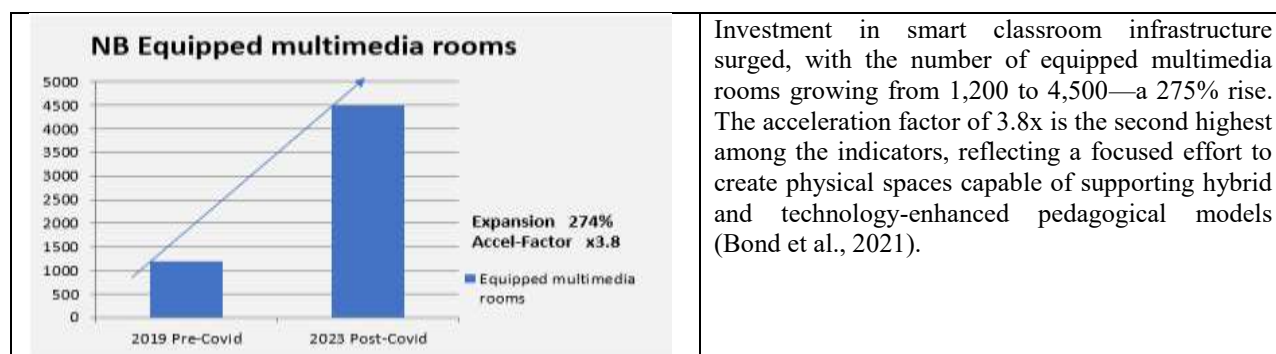
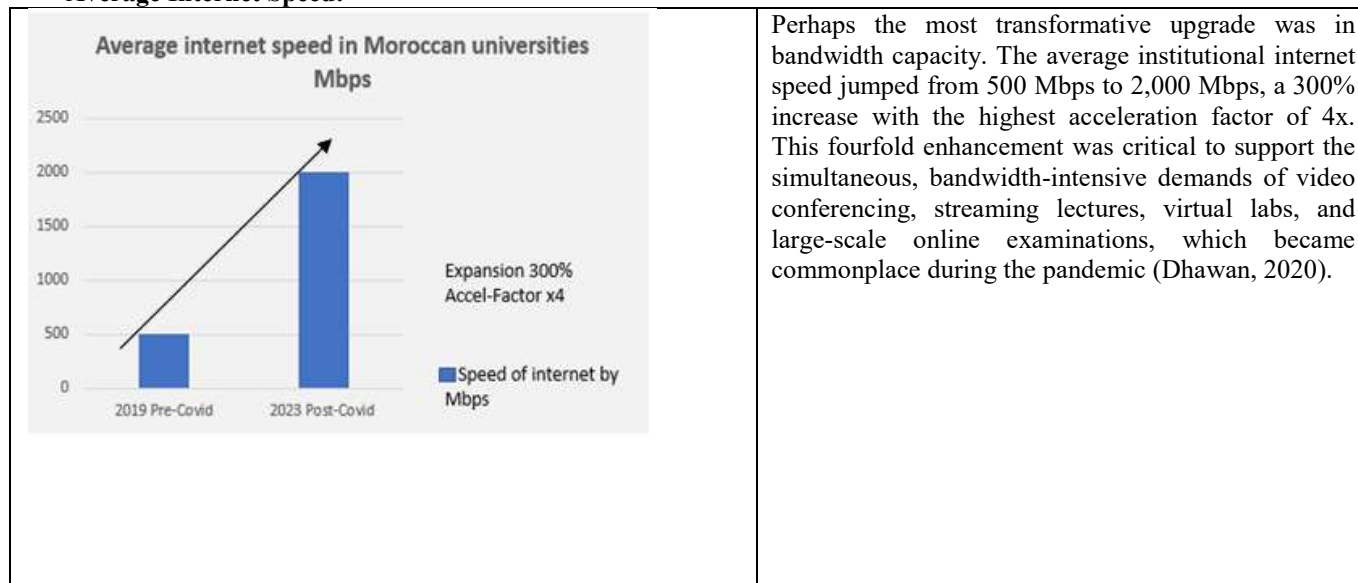


Figure 2: Growth in the percentage of universities connected to the MARWAN national research network.

Campus Wi-Fi Access Points:-**Figure 3: Expansion of wireless internet access points across Moroccan university campuses.****Equipped Multimedia Rooms:-****Figure 4: Increase in the number of classrooms equipped with advanced multimedia and teleconferencing technology.****Average Internet Speed:-****Figure 5: Quadrupling of average internet bandwidth available to Moroccan universities.**

Discussion:-

The findings demonstrate that the COVID-19 pandemic significantly accelerated the digital transformation of Moroccan public universities between 2019 and 2023. The four infrastructure indicators reveal substantial progress and highlight the strategic role of digital technologies in ensuring educational continuity and supporting new teaching and learning models. The complete deployment of the MARWAN academic network, which increased from 65% to 100% coverage, represents a major milestone in strengthening the national higher education digital ecosystem. Beyond improving institutional connectivity, full network coverage facilitates collaborative research, access to digital resources, and the implementation of shared e-learning services across universities (Ben Henda, 2018). Although its acceleration factor (1.5x) is lower than those of the other indicators, achieving nationwide connectivity provides the technological foundation upon which subsequent digital developments can be built.

The substantial growth in Wi-Fi infrastructure (212%) reflects universities' rapid adaptation to the increasing demand for flexible and mobile learning environments. Reliable campus-wide internet access has become essential for supporting both face-to-face and hybrid educational practices. The acceleration factor of 3.1x confirms that the pandemic significantly accelerated investments in digital accessibility, in line with international experiences observed during Emergency Remote Teaching (Almaiah et al., 2020). Similarly, investments in multimedia classrooms increased considerably during the study period, with equipped rooms rising from 1,200 to 4,500. This development demonstrates the institutional commitment to adopting technology-enhanced pedagogical approaches capable of supporting blended and hybrid learning models. The high acceleration factor (3.8x) suggests that Moroccan universities have moved beyond emergency responses toward more sustainable digital teaching environments (Bond et al., 2021).

The most remarkable transformation concerns internet bandwidth capacity, which increased by 300%, reaching an average of 2,000 Mbps per institution. With the highest acceleration factor (4x), this indicator highlights the strategic importance of network performance for supporting bandwidth-intensive educational activities such as videoconferencing, online examinations, and virtual laboratories (Dhawan, 2020). Enhanced bandwidth capacity has therefore become a critical component of institutional resilience and digital readiness. Overall, the results indicate that the pandemic acted as a catalyst for accelerating digital infrastructure development in Moroccan higher education. The complementary evolution of connectivity, Wi-Fi accessibility, multimedia learning spaces, and network capacity illustrates a transition toward more resilient and technology-enabled universities. Future efforts should focus on sustaining these investments while strengthening digital governance, faculty digital competencies, and equitable access to technological resources across institutions.

Conclusion:-

The COVID-19 pandemic served as a powerful exogenous shock and accelerator for digital infrastructure development in Moroccan universities. The comparative data from 2019 and 2023 clearly demonstrates that the pandemic period witnessed exponential, crisis-driven growth in core infrastructural areas—connectivity, wireless access, smart classrooms, and internet bandwidth—far exceeding the incremental progress typical of the pre-pandemic era. This acceleration was not merely a reactive stopgap but appears to have triggered a transformative leap, embedding advanced digital capabilities into the academic ecosystem.

This Moroccan case study offers empirical support for the theory of "disruptive innovation" in education (Christensen et al., 2008), where a crisis can break institutional inertia and catalyze systemic change. The findings suggest that the pandemic provided the necessary impetus to overcome traditional barriers and expedite the implementation of Morocco's existing digital education strategies. Moving forward, the challenge for Moroccan higher education will be to leverage this enhanced infrastructure to improve pedagogical quality, research collaboration, and administrative efficiency sustainably. Future policy must focus not only on sustaining technological investments but also on fostering digital pedagogies, building digital literacy among educators and students, and ensuring equitable access to prevent a digital divide. The experience underscores that strategic vision, when combined with decisive action under pressure, can significantly advance national digital transformation goals in higher education.

References:-

1. Almaiah, M. A., Al-Khasawneh, A., & Althunibat, A. (2020). Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic. *Education and Information Technologies*, *25*(6), 5261-5280.
2. Ben Henda, M. (2018). *Les réseaux de la recherche au Maghreb: MARWAN et beyond*. Presses Universitaires du Maghreb.
3. Ben Henda, M., & Elouali, N. (2022). Digital transformation of Moroccan universities post-COVID-19: An infrastructural analysis. *Journal of North African Higher Education Studies*, *15*(2), 45-67.
4. Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2021). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education*, *18*(1), 1-30.
5. Bozkurt, A., Jung, I., Xiao, J., Vladimirsch, V., Schuwer, R., Egorov, G., ... & Paskevicius, M. (2020). A global outlook to the interruption of education due to COVID-19 pandemic: Navigating in a time of uncertainty and crisis. *Asian Journal of Distance Education*, *15*(1), 1-126.
6. Christensen, C. M., Horn, M. B., & Johnson, C. W. (2008). *Disrupting class: How disruptive innovation will change the way the world learns*. McGraw-Hill.
7. Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5-22.
8. El Firdoussi, S., Lachgar, M., Kabaili, H., Rochdi, A., & Goujdami, D. (2020). Assessing the readiness of Moroccan higher education institutions for e-learning during the COVID-19 pandemic. *Journal of Education and Practice*, *11*(24), 1-9.
9. Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educause Review*, *27*, 1-12.
10. Kebbi, M., & Al-Harthy, I. (2019). Digital challenges and opportunities in Maghreb higher education. *International Journal of Educational Development*, *68*, 1-8.
11. Lembani, R., Gunter, A., Breines, M., & Dalu, M. T. B. (2020). The same course, different access: The digital divide between urban and rural distance education students in South Africa. *Journal of Geography in Higher Education*, *44*(1), 70-84.
12. Marinoni, G., Van't Land, H., & Jensen, T. (2020). *The impact of Covid-19 on higher education around the world*. International Association of Universities.
13. MESRSI. (2023). *Digital Infrastructure Dashboard for Higher Education Institutions*. Moroccan Ministry of Higher Education, Scientific Research and Innovation.
14. Ministère de l'Éducation Nationale, de la Formation Professionnelle, de l'Enseignement Supérieur et de la Recherche Scientifique. (2018). *Stratégie nationale de la digitalisation de l'enseignement supérieur*.
15. Selwyn, N. (2016). *Education and technology: Key issues and debates*. Bloomsbury Publishing.
16. UNESCO. (2020). *Education: From disruption to recovery*. Retrieved from <https://en.unesco.org/covid19/educationresponse>
17. Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic politics, pedagogies and practices: Digital technologies and distance education during the coronavirus emergency. *Learning, Media and Technology*, *45*(2), 107-114.