

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

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).

Keywords:- COVID-19, Digital transformation, Moroccan higher, education, Distance/hybrid learning, Digital infrastructure, Connectivity (MARWAN), University Wi-Fi, High-speed internet.

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.:

Categorie INFRASTRUCTURE dans	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

UNDER PEER REVIEW IN 13

A. Methodology

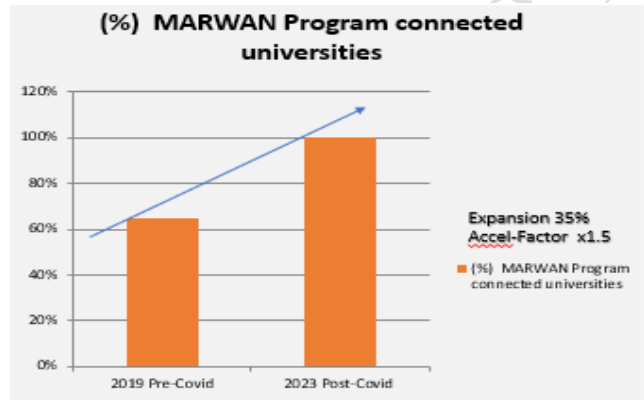
This study employs a comparative quantitative research design to examine the evolution of digital infrastructure in Moroccan public universities before and after the COVID-19 pandemic. A longitudinal comparison is conducted using data from 2019 (pre-COVID) and 2023 (post-COVID), allowing the assessment 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.

B. 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:

1. MARWAN Program Connectivity

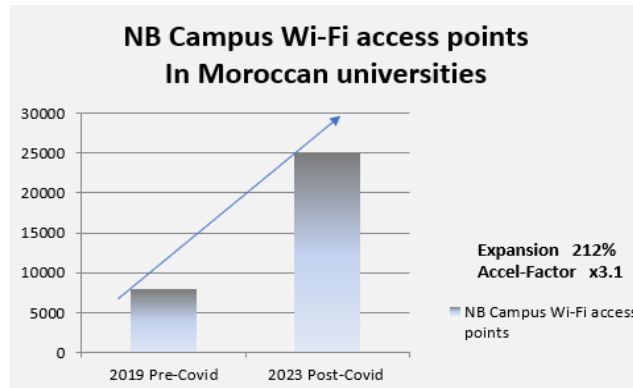
Figure 1: Growth in the percentage of universities connected to the MARWAN national research network.



The proportion of universities connected to the MARWAN network rose from 65% to 100%, achieving nationwide coverage. While the percentage increase is 35%, the acceleration factor of 1.5x indicates that the pandemic period saw a faster completion rate for this strategic, backbone connectivity project. Full connectivity is essential for enabling collaborative research, access to digital libraries, and shared e-learning platforms across the entire university system (Ben Henda, 2018).

1) 2. Campus Wi-Fi Access Points

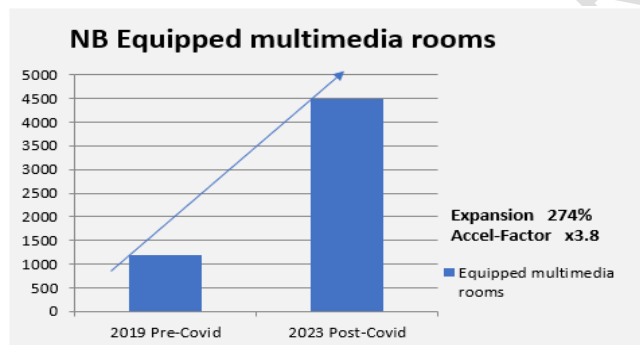
Figure 2: Expansion of wireless internet access points across Moroccan university campuses.



The number of Wi-Fi hotspots increased dramatically from 8,000 to 25,000, representing a 212% growth and an acceleration factor of 3.1x. This exponential expansion highlights the urgent institutional response to provide ubiquitous, high-density internet access, facilitating mobile and flexible learning for students and staff. This aligns with global trends where reliable campus Wi-Fi became a foundational requirement for ERT (Almaiah et al., 2020).

2) 3. Equipped Multimedia Rooms

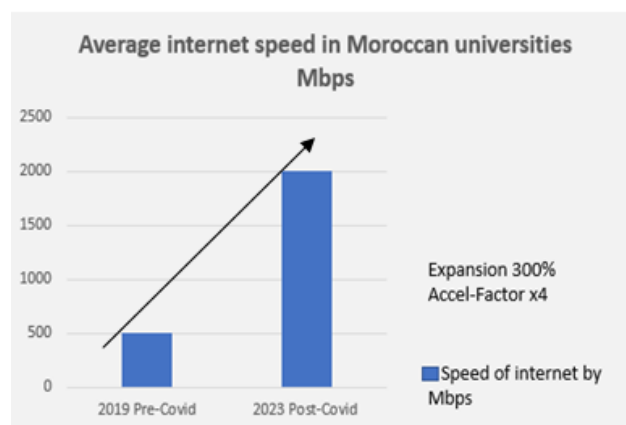
Figure 3: Increase in the number of classrooms equipped with advanced multimedia and teleconferencing technology.



Investment in smart classroom infrastructure surged, with the number of equipped multimedia rooms growing from 1,200 to 4,500—a 275% rise. The acceleration factor of 3.8x is the second highest among the indicators, reflecting a focused effort to create physical spaces capable of supporting hybrid and technology-enhanced pedagogical models (Bond et al., 2021).

3) 4. Average Internet Speed

Figure 4: Quadrupling of average internet bandwidth available to Moroccan universities.



Perhaps the most transformative upgrade was in bandwidth capacity. The average institutional internet speed jumped from 500 Mbps to 2,000 Mbps, a 300% increase with the highest acceleration factor of 4x. This fourfold enhancement was critical to support the simultaneous, bandwidth-intensive demands of video conferencing, streaming lectures, virtual labs, and large-scale online examinations, which became commonplace during the pandemic (Dhawan, 2020).

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.

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