Aligning Campus Infrastructure and Institutional Practice with SDG 11 in an Open and Distance Learning Institution

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DOI: https://dx.doi.org/10.47772/IJRISS.2025.91100279

Received: 10 November 2025; Accepted: 20 November 2025; Published: 06 December 2025

ABSTRACT

This conceptual paper examines how an open and distance learning (ODL) institution aligns its physical and digital infrastructure with Sustainable Development Goal (SDG) 11, focusing on accessible mobility (11.2), inclusive planning (11.3), protection of institutional assets (11.4), environmental performance (11.6), universal accessibility (11.7) and resilience planning (11.b). The paper highlights that despite firm institutional commitments to sustainability, many universities face uneven progress in translating these goals into practice, particularly in infrastructure management and organisational routines. For an ODL institution, the centrality of digital platforms introduces added challenges in ensuring equitable access, usability and continuity of services. Drawing on literature from campus sustainability, digital transformation, accessibility and SDG governance, the paper proposes a conceptual framework that links infrastructure conditions with institutional factors to explain how SDG 11 outcomes emerge. The framework emphasises the importance of coordinated planning across physical facilities, digital systems, leadership direction, policy clarity, and operational processes. It provides a foundation for future empirical work, utilising approaches such as accessibility audits, user experience studies, and sustainability dashboards. It provides a structured framework for fostering sustainable, inclusive, and resilient campus development in alignment with SDG 11.

Keywords: SDG 11, Digital accessibility, Physical infrastructure, Institutional factors, Open and distance learning

INTRODUCTION

Universities are described as vital actors in shaping sustainable futures, with many scholars highlighting their duty to support the Sustainable Development Goals (SDGs) through teaching, governance, campus planning and community engagement (Arsenault, 2021; Blasco, Brusca and Labrador, 2020). Across the higher education sector, there is growing discussion on how institutions should integrate sustainability into their physical spaces, digital systems and organisational decisions, as seen in global reviews of SDG implementation and campus governance (Leal Filho et al., 2023; Serafini et al., 2022). This shift places pressure on institutions to move beyond symbolic commitments and demonstrate a clear alignment between their operations and the SDG principles.

Recent studies show that sustainability efforts in higher education are uneven, with many campuses adopting partial or fragmented practices. Several reviews have found that, despite widespread awareness, gaps persist in infrastructure planning, resource management, accessibility, and leadership coordination (Abo-Khalil, 2024; Mansor et al., 2023). Evidence from smart and sustainable campus research suggests the need for integrated systems that connect physical environments, digital technologies, and user experiences, rather than isolated technical upgrades (Martins et al., 2021; Zou et al., 2024). These patterns indicate that institutions may struggle to translate sustainability goals into operational outcomes that benefit staff, students and surrounding communities.

Malaysia's higher education sector has begun to introduce sustainability-related guidelines and campus initiatives; however, national reports indicate that implementation varies across institutions (MOHE, 2023). An ODL institution faces additional responsibilities due to its strong dependence on digital platforms, online services, and blended campus models. Research has drawn attention to digital accessibility issues in such settings, including gaps in platform design, content delivery and support systems, which risk excluding learners with diverse needs (Hadj and Chong, 2021). When combined with ageing facilities, varying departmental practices, and differing interpretations of sustainability across units, these challenges may hinder an ODL institution's ability to make meaningful progress toward SDG 11.

Although global and regional studies highlight workable frameworks and indicators for sustainable campuses, there is limited analysis focusing on the alignment between physical and digital infrastructure within a Malaysian ODL institution. Very few studies examine how leadership actions, internal policies and departmental routines influence the pace and quality of campus sustainability work. The absence of evidence on these institutional dynamics leaves a gap in understanding how an ODL institution meets the expectations of SDG 11 related to accessibility, inclusivity, and sustainable development. Without a structured assessment of its infrastructure and organisational practices, such an institution may face difficulties in planning improvements, addressing user concerns or reporting progress to national and global stakeholders (UNESCO, 2023; Leal Filho, Salvia and Eustachio, 2023).

This study addresses these gaps by evaluating the alignment of the physical and digital infrastructure of an ODL institution with SDG 11 targets, while examining the internal challenges and enabling factors that shape its sustainability and accessibility practices. Through this focus, the study aims to provide evidence-based insight that can guide institutional planning and strengthen progress toward sustainable and inclusive campus development.

LITERATURE REVIEW

Universities, SDGs and the role of campus infrastructure

Universities are increasingly viewed as key agents for advancing the SDGs in policy, operations and outreach (Arsenault, 2021; Blasco, Brusca and Labrador, 2020). Global reviews indicate that higher education institutions make clear commitments to the 2030 Agenda; however, their level of engagement and depth of implementation vary significantly across regions and institutional types (Leal Filho, Salvia, and Eustachio, 2023; Serafini et al., 2022). Much of this work emphasises that campus infrastructure and digital systems are not neutral backdrops; they shape access, inclusion, and the lived experience of sustainability on campus (Aoun, Elhusseini, and Mohtar, 2023; Mansor et al., 2023).

Fia, Ghasemzadeh and Paletta (2022) describe how many universities "walk their talk" unevenly, with more substantial progress in teaching and research than in campus operations and built environment. Abo-Khalil (2024) reports similar patterns at the global level, highlighting persistent gaps in funding, coordination and organisational capacity. In the Southeast Asian context, Mansor et al. (2023) find that sustainability is often framed as a strategic priority; however, the operational translation into building management, mobility, digital systems, and inclusive design remains partial. These findings highlight the need for studies that investigate how specific campuses integrate their physical and digital infrastructure with SDG-linked goals, such as accessibility, inclusivity, and environmental performance, which are central to SDG 11 (UNESCO, 2023).

Campus sustainability assessment and indicators

Campus sustainability assessment has evolved into a distinct area of research, featuring a range of indicators and frameworks tailored explicitly for higher education settings. Dawodu et al. (2022) propose a structured set of dimensions for campus sustainability, encompassing energy, mobility, waste, water, the built environment, and governance. Alshuwaikhat and Abubakar (2022) outline principles and practices for sustainability assessment in universities, emphasising the need for comprehensive frameworks that integrate environmental, social, and economic dimensions, in line with the triple bottom line approach (Elkington, 1997). Oliveira and

Proença (2025) review operational practices across institutions and emphasise the role of systematic monitoring and reporting for continuous improvement.

Several studies focus on tools and dashboards that support evidence-based decision making. Gonzalez et al. (2025) describe a spatial dashboard that maps sustainability indicators across a campus, enabling engaged action by managers and users. Adenle, Abdul-Rahman, and Soyinka (2022) investigate how social media data can inform campus sustainability assessment frameworks, highlighting new feedback channels that complement surveys and audits. Collectively, these works suggest that the assessment of campus alignment with SDG-related goals benefits from clear metrics, spatial and digital visualisation, and the integration of user perspectives (Dawodu et al., 2022; Gonzalez et al., 2025; Oliveira and Proença, 2025).

Smart, digital and sustainable campuses

Research on smart and sustainable campuses links digitalisation, data-driven management and sustainability outcomes. Martins et al. (2021) propose an application-oriented architecture for a smart and sustainable campus, aiming to streamline digitisation and support sustainability in academic settings. Mahariya et al. (2023) extend this with the notion of Smart Campus 4.0, where Industry 4.0 technologies, sensors and analytics are embedded into campus operations to support innovation and sustainability. Magalhães et al. (2025) introduce the Campus 5.0 concept, which combines digital services, user-centred mobile applications and sustainability functions to support an intelligent campus experience.

Case studies reveal how specific digital solutions contribute to campus sustainability. Zaballos et al. (2020) develop a smart campus digital twin for monitoring comfort and the environment. Ceccarini et al. (2021) illustrate how data visualisation and IoT devices can increase sustainability and safety, for example in lighting and space usage. Yasuoka et al. (2023) present an IoT-based energy management system on a Brazilian campus, demonstrating measurable gains in energy efficiency. Research on mobility demonstrates how campus design and transportation planning impact sustainable travel behaviours; Zadeh and Thompson (2025) investigate active transportation at a Canadian campus, linking path networks, infrastructure quality, and student choices. These studies suggest an integrated view of physical and digital infrastructure, where the campus functions as a living laboratory for sustainability (Mazutti et al., 2020; Ravesteyn, Plessius, and Mens, 2014).

Digital transformation aligns closely with SDG implementation in universities. Zou et al. (2024) discuss a Chinese green university initiative that utilises digital technologies to support sustainability goals, arguing that digitalisation can bridge the gap between policy and practice when coupled with clear governance structures. Buhr et al. (2025) examine how digital education practices in a Latin American institution incorporate the SDGs in teaching and learning. Together, these works support the idea that evaluation of campus alignment with SDG 11 should address both physical facilities and digital infrastructures, including learning platforms, monitoring systems and smart services (Martins et al., 2021; Zou et al., 2024).

Accessibility, inclusivity and digital design in an ODL institution

Accessibility and inclusivity form core components of SDG 11, particularly for institutions serving diverse and geographically dispersed learners. The Universal Design for Learning Guidelines provide a key conceptual basis for inclusive digital environments, emphasising multiple means of engagement, representation and action (CAST, 2018). In an ODL institution, these principles gain practical relevance, since many learners interact with the university primarily through digital channels.

Hadj and Chong (2021) explore digital accessibility in an ODL institution, documenting challenges related to platform usability, content formats, assistive technology compatibility and organisational support. Their study highlights the fragmentation of responsibility for accessibility, with departments interpreting obligations in varying ways. Pretorius et al. (2019) analyse sustainability in an ODL institution, noting that teaching, learning, and student support functions can act as anchors for a campus sustainability culture; yet, physical and digital infrastructure need to work together for equitable access. These studies suggest that the assessment of

an ODL institution's alignment with SDG 11 should encompass both the physical campus and digital learning ecosystem, with a focus on accessibility and inclusivity standards (CAST, 2018; Hadj and Chong, 2021).

Governance, leadership and institutional drivers

Governance and leadership strongly shape how sustainability and SDGs are integrated in higher education institutions. Leal Filho et al. (2023) identify global trends in SDG governance within universities, highlighting the importance of clear responsibilities, coordination, and reporting structures. Harris (2020) discusses how leadership and governance practices influence sustainability culture, showing that policies alone are insufficient without everyday routines and organisational support. Serafini et al. (2022) and Fia, Ghasemzadeh, and Paletta (2022) both find that institutional drivers, such as incentives, accountability mechanisms, and stakeholder engagement, influence whether SDG efforts move beyond symbolic declarations.

Regional and national studies highlight contextual drivers. Mansor et al. (2023) demonstrate that universities in Southeast Asia frequently frame sustainability through strategic plans and flagship projects, yet they face constraints related to resource limitations, governance complexity, and policy coherence. MOHE (2023) outlines sustainable campus initiatives in Malaysian higher education, calling for stronger alignment between national policy, institutional strategies and campus-level practice. Arsenault (2021) and Abo-Khalil (2024) argue that future work should focus more on institutional pathways, internal barriers and enablers, as well as the ways leadership translates global goals into campus realities.

In this body of work, a gap appears around ODL institutions with blended physical and digital campus models, particularly in relation to SDG 11 targets on inclusive, safe, resilient and sustainable settlements. Research seldom examines how leadership decisions, departmental practices and infrastructure planning intersect in institutions that rely heavily on digital provision. The present study addresses this gap by focusing on an ODL institution, drawing on this literature to frame the evaluation of physical and digital infrastructure alignment with SDG 11 and to interpret institutional challenges and enabling factors identified through conceptual analysis.

METHODOLOGY

This conceptual paper employs an integrative review and analytical synthesis approach to investigate how physical and digital infrastructure, in conjunction with institutional conditions, impact alignment with SDG 11. The methodology draws on established practices for conceptual research in higher education and sustainability studies, where theoretical perspectives and empirical evidence from existing work are combined to generate a structured model for analysis (Fia et al., 2022; Serafini et al., 2022).

The first stage involved identifying relevant literature on sustainable campuses, digital transformation, accessibility frameworks and SDG governance within higher education. Peer-reviewed journal articles, book chapters, and policy documents from recognised international bodies formed the primary sources. Studies were selected based on their relevance to campus infrastructure, institutional drivers and SDG 11 outcomes, following guidance from previous reviews of sustainability in higher education (Oliveira and Proença, 2025; Abo-Khalil, 2024). This process produced a consolidated evidence base that informs the components of the proposed framework.

The second stage focused on comparing themes across the selected studies. Attention was given to how researchers conceptualised sustainable and inclusive campus environments, the role of leadership and governance in SDG implementation and the integration of digital and physical infrastructure into campus planning. Patterns identified across the literature were then aligned with SDG 11 targets on accessibility, inclusivity, safety, sustainability and resilience, drawing from global reports that frame these dimensions within higher education contexts (UNESCO, 2023).

The third stage involved developing the conceptual framework that links infrastructure conditions and institutional factors to SDG 11 outcome dimensions. The structure of the framework was shaped by indicators

for campus sustainability (Dawodu et al., 2022), models of smart and sustainable campuses (Martins et al., 2021), accessibility standards such as the Universal Design for Learning guidelines (CAST, 2018) and studies on SDG governance in universities (Leal Filho et al., 2023). By synthesising these bodies of work, the framework positions SDG 11 alignment as an outcome of interacting environmental and organisational attributes.

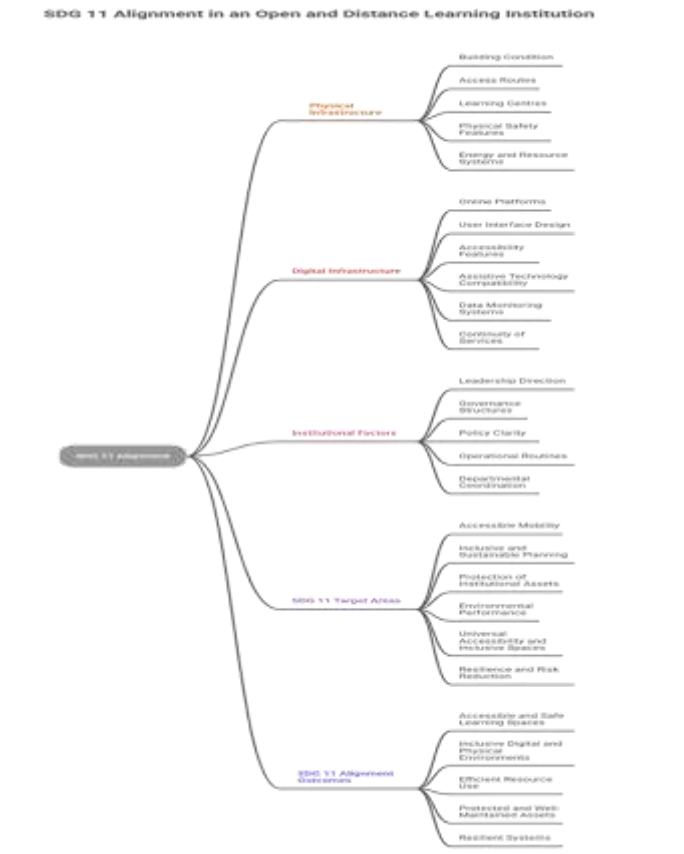
Overall, the methodology ensures that the conceptual model is grounded in current scholarship and supported by multiple strands of evidence. This approach allows the paper to highlight theoretical linkages, identify gaps in existing knowledge and propose areas for future empirical investigation.

DISCUSSION

The conceptual framework (Figure 1) integrates findings from sustainability, digital transformation and SDG governance research to explain how its infrastructure conditions and institutional arrangements shape alignment with SDG 11 in an ODL institution. Studies on campus sustainability consistently demonstrate that physical and digital environments significantly influence inclusion, access, and user experience, particularly when campuses rely on blended learning models and technology-based service delivery (Dawodu et al., 2022; Martins et al., 2021). This supports the framework's placement of physical and digital infrastructure as a primary set of influences on SDG 11 outcomes.

Research further shows that infrastructure alone cannot drive sustainable or accessible campus development. Leadership direction, governance clarity, organisational culture and day-to-day departmental routines strongly affect sustainability progress across higher education institutions (Harris, 2020; Leal Filho et al., 2023). Studies also highlight common challenges, such as limited coordination, inconsistent implementation of policies and varied departmental interpretations of sustainability (Abo-Khalil, 2024; Serafini et al., 2022). These findings underscore the significance of institutional factors in influencing the pace and depth of SDG-related work within an ODL institution.

Figure 1: Conceptual Framework for SDG11 Alignment Study



The role of digital accessibility is particularly significant for institutions that rely heavily on online systems for communication, learning and support. Research on accessibility in ODL settings identifies recurring issues in platform design, content formats and assistive technology compatibility, which can limit the inclusiveness of the learning environment (Hadj and Chong, 2021). The Universal Design for Learning guidelines provide a structured basis for assessing and improving digital access, linking directly with SDG 11's emphasis on inclusivity and equitable environments (CAST, 2018). These insights validate the framework's inclusion of digital infrastructure as a core component.

Anchoring the framework in SDG 11 outcome dimensions creates a direct connection between campus-level factors and global sustainability goals. International reports emphasise that accessibility, safety, inclusivity and resilience form the foundation of sustainable learning spaces (UNESCO, 2023). By aligning these dimensions with infrastructure and institutional influences, the framework provides a structured approach to examining the current state of an ODL institution and identifying areas that may require improvement.

Overall, this discussion demonstrates that the framework offers a coherent approach to understanding how environmental and organisational conditions interact to influence progress toward SDG 11 in an ODL institution. It lays the groundwork for future empirical studies that can test, refine and extend the model.

CONCLUSION

This conceptual paper synthesised evidence from campus sustainability, digital transformation and SDG governance studies to develop a framework for assessing how an ODL institution aligns with SDG 11. The framework highlights the combined influence of physical and digital infrastructure, leadership direction, governance clarity and everyday organisational routines. By linking these elements to specific SDG 11 targets—accessible mobility (11.2), inclusive planning (11.3), protection of institutional assets (11.4), environmental performance (11.6), universal accessibility (11.7) and resilience planning (11.b)—the paper provides clearer insight into the areas that shape sustainability outcomes.

For an ODL institution, digital accessibility and inclusive technological design carry added importance, as learners depend heavily on online platforms and digital support services. The framework provides a structured approach to analysing how far existing systems and practices support safe, inclusive, and sustainable learning environments.

Future research may apply the framework through empirical methods. Accessibility audits can provide evidence on compliance with Target 11.7. User experience studies can shed light on mobility, platform use and planning processes linked to Targets 11.2 and 11.3. Dashboards and environmental monitoring tools support assessment of Target 11.6, while organisational reviews can examine resilience and continuity planning related to Target 11.b. Longitudinal studies may reveal how shifts in infrastructure or governance influence the alignment of SDG 11 over time.

Through these avenues, the framework can evolve into a practical instrument for institutional planning, policy refinement and continuous improvement, strengthening the ability of an ODL institution to progress toward sustainable and inclusive development in line with SDG 11.

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