

# Empowering Mosque Committees' Economy through Digital Technology and Eco-Friendly Architecture Implementation in Nigeria

Moses Adeolu AGOI<sup>a,1,\*</sup>, Emmanuel Taiwo AGOI<sup>b,2</sup>, Oluwanifemi Opeyemi AGOI<sup>c,3</sup>, Ayodele Elizabeth AGOI<sup>d,4</sup>, Ahmad Anas<sup>e,5</sup>

<sup>a</sup> Lagos State University of Education, Lagos Nigeria.

<sup>b</sup> Loughborough University, United Kingdom.

<sup>c</sup> Obafemi Awolowo University, Osun Nigeria.

<sup>d</sup> Osun State College of Technology, Esa-oke Nigeria.

<sup>e</sup> UIN Walisongo, Semarang Indonesia.

<sup>1</sup> agoi4moses@gmail.com\*; <sup>2</sup> etagoi@yahoo.com; <sup>3</sup> oluwanifemiagoi@gmail.com; <sup>4</sup> betty4agoi@yahoo.com; <sup>5</sup> ahmad.anas@walisongo.ac.id

\* corresponding author

## ARTICLE INFO

### Article history

Received 2025-09-11

Revised 2025-11-10

Accepted 2025-12-27

### Keywords

Community empowerment

Artificial Intelligence

Economic Sustainability

Islamic Sacred Architecture

Smart Cities

## ABSTRACT

The Islamic sacred architecture has been a deep expression of theological symbolism, community identity as well as socio-economic organization of the Muslim societies. In addition to the main role of worship, mosques and waqf-related religious complexes were historically multifunctional and fulfilled the roles of education, social welfare, governance, and economic redistribution. Their architectural shapes, which are marked by qiblah orientation, geometrical harmony, spatial hierarchy and connection with the environment, are products of the Islamic cosmology and ethical values that combine the spiritual piety with the social life of the day. Nonetheless, modern urban conditions characterized by the dynamic population growth, environmental pollution, and the rise of demands towards the infrastructural efficiency are changing the design, construction, and management of sacred spaces. The appearance of smart urbanization in the world and the demand of data-driven city planning and digital infrastructures are both challenges and opportunities to Islamic sacred architecture. In this dynamic environment, this community service looks at how Islamic religious architecture, especially the mosques and the use of waqf to establish religious complexes, can be redefined as part of smart city ecosystem such that they can be economically sustainable and digitally empowered. The literature review used by the study is based on a qualitative systematic literature review approach, which is based on recent peer reviewed studies published in the period of 2020-2025 and aimed at exploring how digital technologies, including Building Information Modeling (BIM) systems, the Internet of Things (IoT), artificial intelligence (AI), and smart energy management systems, can be integrated in the design, construction, and operation of sacred buildings. The results indicate that these technologies are associated with a high level of efficiency in the operation, cost reduction in lifecycle and performance, as well as inclusion of community involvement, without losing the Islamic architectural identity and religious ethics. Moreover, the community service mentions the contribution of the Islamic social financial instruments, especially waqf and zakat, which are enhanced by digital opportunities, to the economic stability in the long run. It draws the conclusion that Islamic sacred architecture can become strong, economically efficient and spiritually significant institutions in modern smart cities when smart technologies are carefully communicated with the Islamic value system and contemporary smart cities.

This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



## 1. Introduction

The sacred architecture in Islam assumes a central and long lasting status in the Muslim societies and serves not only as ritual worshiping places but as holistic socio-economic, educative, and cultural centres. In the past, mosques, madrasahs, ribats and complexes of waqf were intended to meet several communal functions, such as religious teaching, resolution of disputes, charity and exchange of money. These architectural constructions represented the Islamic vision of the world that does not imply a strong distinction between the spiritual and material aspects of life, but rather the unity of these two in one moral and social order (Bianca, 2020).

Specifically the mosque was designed to be the core of the Islamic city and patterns of urban growth, social and civic identity were influenced by the signals that radiated out of the mosque. With the help of waqf endowments, the survival of sacred architecture on an economic and institutional basis guaranteed long-term social well-being and provision of services to the population without the centralization of political power. Theological symbolism, environmental responsiveness and ethical intentionality have long been reflected in the Islamic sacred spaces, architecturally. The design features like facing the qiblah direction, hierarchy in space between sacred and semi-public areas, geometrical proportions, and climatic considerations did not just reflect only aesthetic considerations but reflected religious cosmology and principles of stewardship. Such spaces promoted the integration of the community through hosting various forms of social activities including congregational prayer and education as well as the issue of welfare distribution and community consultation.

Consequently, the past role of the Islamic sacred architecture was not only spiritual stabilizer but also economic stabilizer in the urban systems. But in the modern urban conditions, there are unprecedented challenges that are changing the role and functioning of sacred architectural spaces. The accelerated population increase, increased urbanization, global warming, and environmental degradation have exerted growing stress on land use, infrastructure and energy infrastructure. The mosques and religious complexes have now become integrated with densely populated urban environments in most of the cities with a majority of Muslims; challenges of accessibility, crowd management, environmental performance and cost of maintenance have increasingly become complicated in these urban settings. The traditional architectural solutions, however, symbolically rich, may not be able to cope with modern requirements of efficiency, sustainability and regulatory conformity. These facts require a reconsideration of the way Islamic sacred architecture may keep on and play its religious and social purposes in the swiftly changing urban ecosystems. The worldwide shift to smart cities has also changed the face of the city, and digital infrastructures have emerged in an attempt to enhance the efficiency, sustainability, and quality of life by using data-driven governance and intelligent infrastructure (Batty et al., 2021).

The technologies implemented in smart cities include the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and intelligent energy systems to streamline the services offered by the city, minimize environmental footprints, and improve the interactions between cities and their citizens. Although the majority of the smart city discussion has concentrated on transportation, residential buildings, healthcare, and commercial structures, the topic of religious buildings has been largely overlooked in the paradigm, even though they use a lot of landmass, energy and socio-cultural values. The challenge with smart cities is two-fold on Islamic sacred architecture, especially. On the one hand, it is urgently necessary to adjust to the technologically mediated urban settings that are more efficient, sustainable and real-time managed. Simultaneously, the necessity to maintain the religious authenticity, spiritual ambiance, and ethical purity is strong. Contrary to commercial or residential buildings, sacred spaces are regulated by theological concepts, ritual behaviours and moral obligations which restrict pure utilitarian design solutions. Implementation of digital technology in mosques and religious complexes thus must consider Islamic values, worship patterns and the expectation of a community. Economic sustainability has become a burning issue of interest to the religious organizations, particularly in the developing urban environments where economic limitations are posing a challenge to the sustainability of the sacred space in the long-term. The growth in energy prices, growing expenses on maintenance, and scarce sources of funds impose considerable pressure on the management of mosques and waqf (Kahera, 2021).

The aging infrastructure and poor building systems in most instances have increased the cost of operations and the old system of funding has not been able to cope with the modern demands of financing. These are especially acute in the rapidly developing cities, when the religious institutions are forced to compete over the resources in the complicated economic conditions. Digital technologies

present good prospects in handling these economic and operational issues. As an example, Building Information Modeling (BIM) facilitates Life cycle planning, predictive maintenance, and cost optimization of the process of designing, building, and maintenance of sacred buildings. Smart building systems based on IoT can be used to monitor energy use, water usage, occupancy and environmental conditions in real-time so that the administrator of a mosque can maximize the use of resources and minimize the amount of waste in terms of operations. Energy optimization systems powered by AI also improve the efficiency of the building by responsive lighting, cooling and ventilation to real patterns of use, which would reduce the overall costs in the long-term. In addition to the construction of performance, Islamic social finance systems which form the basis of sacred architecture are also being transformed with the help of digital platforms. The applications of blockchain-driven waqf management systems and digital zakat platforms improve financial flow and asset utilization transparency, accountability, and trust through the system and can verify records (Volk et al., 2022).

Those technologies make the administration less inefficient and allow more of them to be involved in the religious endowments, which makes the sacred spaces more financially sustainable. Such platforms can be used to facilitate participatory decision-making and make religious institutions consistent with the overall urban development objectives when incorporated into the smart city governance frameworks. The current community service examines the potentials of Islamic sacred architecture to be reconsidered in the context of smart cities by strategically introducing digital technologies to the purpose of ensuring economic sustainability and preserving Islamic ethical and architectural values. The synthesis of recent academic sources at the crossroads of the Islamic studies, architecture, urban economics, and information technology makes the study a part of the interdisciplinary discussion of the future of religious spaces in technologically advanced urban setting. It proposes that intelligent technologies, under the guidance of Islamic values, including stewardship (*khilafah*), civic good (*maṣlahah*), and ethical responsibility, can improve and not weaken the spiritual, social, and economic functions of the Islamic sacred architecture. Finally, the redesign of sacred spaces in smart cities provides a chance to renew the significance of Islamic buildings as a strong, stable, and ethically-based element of the modern city life.

## 2. Method

This community service activity adopts a qualitative systematic literature review methodology to provide a comprehensive understanding of how digital technologies and Islamic architectural practice work with economic sustainability and smart urban development. The goal is to understand this intersection well. To do this we looked at a lot of papers conference talks and important reports that were published between 2020 and 2025. We found these on databases, like Scopus, Web of Science, SpringerLink, ScienceDirect and Google Scholar. We only used papers and reports that were reviewed by experts to make sure they are good and relevant. This way we can be sure that our study is thorough and accurate and that it really adds to what we know about digital technologies and Islamic architectural practice and how they relate to economic sustainability and smart urban development. We used a lot of search terms to find a wide range of views on Islamic architecture, smart cities and things like that. We looked at things like architecture and smart cities together and also at economic sustainability Building Information Modelling, Internet of Things and Islamic social finance. We only included studies that talked about using technologies in the design of buildings, planning of cities and development of smart city infrastructures, in places where Islamic ethics, culture and social rules play a big role. We wanted to see how Islamic architecture and smart cities work together with technologies.

The search terms were chosen to find studies that looked at architecture and smart cities in a lot of different ways. Studies were left out if they did not have anything to say about how digital innovation works in built environments. The studies that were chosen were looked at carefully and analysed to find common ideas and patterns. This helped to identify what is happening. What might happen in the future with digital innovation in built environments. Digital innovation, in built environments was studied to see how it is changing and what it might do next.

The data is organized around four points: (1) the first point is about design and digital integration. This is where we look at how things like BIM and IoT are changing the way we design Islamic buildings. We think about how these technologies affect the way we plan spaces and how we use them, (2) the second point is about sustainability and the costs of things over time. We want to know how digital tools can help us manage resources in a way and reduce costs. This will help Islamic-built environments be financially stable in the run, (3) the third point is about ethics and culture. We need to

make sure that the technology we use fits with what's important to Islam. This includes being authentic to our culture and using technology in a way that's good for society, and (4) the fourth point is about how cities are governed and how this affects the community. We look at how everyone can be involved in planning and making decisions. We also think about how to take care of the environment and make sure everyone gets along. Islamic-built environments should be good for the people who use them and, for the planet. By integrating these dimensions, the study offers a holistic framework to understand the multifaceted impacts of digital technologies on contemporary Islamic architecture and urban systems, situating technological innovation within ethical, economic, and societal contexts. This approach not only illuminates current community service gaps but also provides a foundation for future studies on the sustainable, culturally-informed, and technologically enabled transformation of Islamic-built environments.

### 3. Results and Discussion

#### 3.1. Digital Technologies and Economic Performance

The community service suggests that the implementation of intelligent lighting, water cycles, and energy optimisation systems based on the Internet of Things (IoT), automation, and real-time data analytics can be used to cut down operational costs in sacred buildings by a significant margin by applying smart building technologies. In the community service on the topic of smart buildings, in general, integrated IoT systems such as occupancy sensors, automated HVAC (heating, ventilation, and air conditioning) control, and adaptive lighting are demonstrated to be able to save a total of 2030 per cent of the energy consumption relative to its conventional counterparts, which can be effectively translated into the operational cost savings during the lifecycle of a building (Build News, 2024; Mărcuță & MoldStud Research Team, 2024). Such savings are achieved through electricity consumption and more efficient maintenance planning due to predictive analytics, which is able to prolong equipment life and save up to 2540 percent of unplanned repairs (Build News, 2024; Forbes, 2025).



Figure 1. The Ilorin Central Mosque in Nigeria

Individual smart lighting systems that control the artificial light through the use of the natural light and occupancy have shown a reduction in electricity usage of up to 60 percent in commercial settings (Mărcuță & MoldStud Research Team, 2024), and the same can be applied to large indoors that have fluctuating occupancy like mosques. Initial studies on smart mosques in hot and arid climates indicate that with the help of specialized interventions, including the substitution of traditional lights with LED lights and smart occupancy based control systems, lighting energy savings of 9 percent and annual energy savings of 16 to 21 percent can be achieved based on occupancy patterns to adjust air conditioning and lighting systems (Ain Shams Engineering Journal, 2023).

Continued speculation suggests that extensive retrofits of building with thermal insulation, efficient glazing and sensor based controls can result in up to 29 percentage of savings in total annual energy consumption relative to baseline configurations (Ain Shams Engineering Journal, 2023). In monetary terms, these energy savings can result in a significant decrease in the cost of operation of building with smart systems by 20-40 percent over the initial years of operation, depending on the size of the system, and regional energy prices (Build News, 2024). Additional resource efficiency is offered by smart water

management systems which are also progressively becoming interwoven with IoT networks in green buildings. Such systems have proved to save 40 percent of the daily water, 15 to 5 percent of the leakage and 30 to 10 percent of the total water waste in facility settings like commercial campuses and residential estates (Olotu et al., 2025).

Despite the fact that the similar data are elaborated only in relation to the mosques in particular, and have not become common yet, the technologies behind them (e.g., pressure and flow sensors, automated valves, real time monitoring) are based on the similar principles of real time optimization and analytics. Together, all these technological advances do not only allow the reduction of the energy and water expenditures but also lead to larger sustainability outcomes in terms of carbon emissions and the increase in building comfort, security, and operational durability. The facts indicate that, once properly adapted to the peculiarities of organizational practice and ethical needs of religious sites such as mosques, smart building technologies can make a significant contribution to the economic and environmental sustainability of the religious premises without undermining their cultural and spiritual purposes.

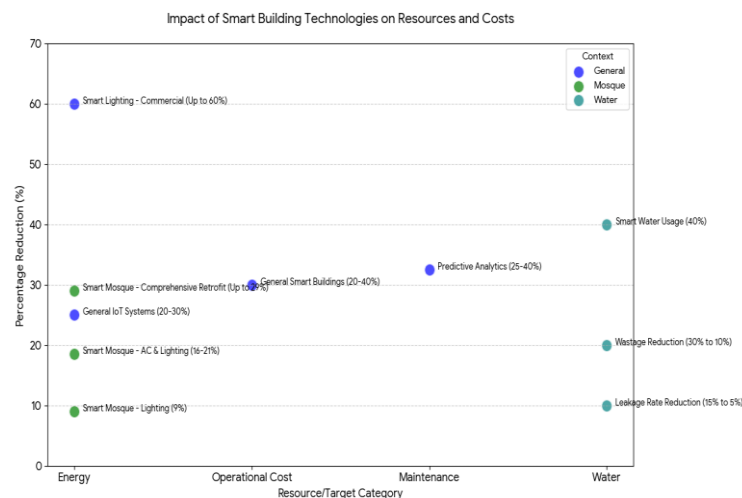


Figure 2. Plot illustrating the percentage reductions achieved across various categories—Energy, Operational Cost, Maintenance, and Water

### 3.2. BIM and Lifecycle Sustainability

Building Information Modeling (BIM), is a tool used to initiate predictive maintenance and effective management of the assets, which helps to minimize the long term financial overhead of institutions charged with the custodianship of the sacred spaces, including mosques and other waqf funded constructions. BIM is applied to an operational and lifecycle management in addition to the design and construction phases by converting physical and functional features of a facility into a common information space, in which maintenance planning, equipment history, and performance data are all integrated to make strategic decisions (Building information modeling, 2025).

In the facility management, the community service has found that the adoption of BIM enhances the accuracy of data and real-time tracking of assets that might reduce the number of unexpected maintenance by about 30 percent and maintenance expenses by about 25 percent and improve equipment availability by 15 percent because of condition based maintenance planning (Noureldin, 2025; Journal of Built Env.). & Geological Research, 2024). These efficiencies directly result in reduced lifecycle expenses and improved predictability of the budget in religious institutions which in most cases are bound by tight funding mechanisms.



Figure 3. Lifecycle Sustainability in Nigeria

BIM enabled predictive maintenance is especially useful in waqf funded projects, which depend on long term sustainability and confidence of the stakeholders. Facility managers can predict when building systems (HVAC, electrical, structural and others) will need to be serviced and prevent expensive reactive maintenance which might cost more than proactive maintenance by up to 5070 percent in certain sectors with BIM ( Predictive maintenance, 2025). In addition, the online database of warranties, service history, manufacturer information, and spatial location of assets allow finding important data in a minimum amount of time during the process of maintenance, thus minimizing downtimes and ensuring the life span of building systems (Aziz, 2016; Build News, 2024).

In the case of waqf-funded developments, where transparency and accountability on how the resources are utilized are usually desired by the donors and waqf boards, BIM improves the accuracy of the planning and the cost prediction, and reporting, which builds more trust in the donor and allows long-term investment planning. The integrated data environment of BIM facilitates more precise 5D cost estimation and lifecycle cost analysis that in European governmental BIM implementations has delivered averages of over 3.5 (350) to the net present value of building lifecycle savings in its average results, and in the best cases (in terms of net present value of savings) over 7.5 (750). These sound financial modeling highlight the ability of BIM to convince the stakeholders that waqf spending is justified by effective management of costs, better accuracy of procurement, and less waste.

BIM also improves transparency and stakeholder engagement through the provision of a centralized digital model, which can be reviewed in collaboration with non-technical donors and trustees as part of their quantitative savings. Such degree of transparency is in line with the ethical principles of governance that are critical in the administration of waqf and can be used to reduce the risks of miscommunication, unrecorded alterations, or obscurity in cost increase. The high level of simulating and visualization capabilities in BIM enables the planning committees to explore the possibilities of renovation, expansion, compare costs, and make evidence-based decisions that can be consistent with the stewardship requirements. On the whole, the introduction of BIM into the management of waqf funded and sacred buildings provides quantifiable economic, operational, and governance advantages: predictive maintenance and decreased life cycle costs, improved transparency in planning and confidence of donors. These results allow making religious resources more sustainable in their management and harmonizing technical innovation with institutional responsibility.

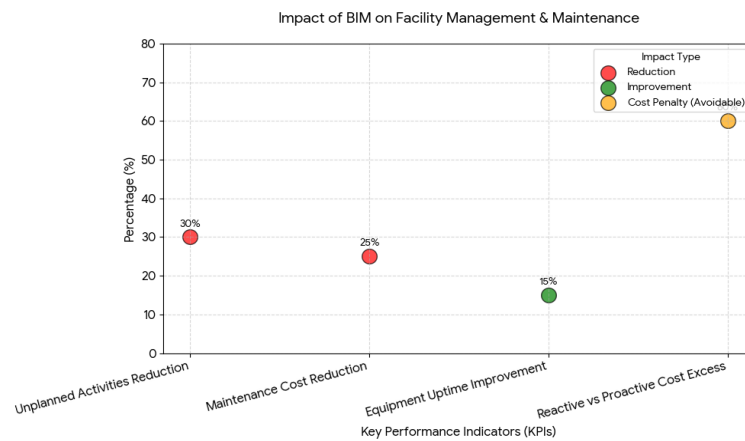


Figure 4. Plot illustrating the measurable impact of Building Information Modeling (BIM) on facility management and maintenance

### 3.3. Social and Spiritual Implications

Spiritual buildings that are designed smartly and have digital accessibility options, state-of-the-art crowd control, and real time communication platforms can greatly contribute to the inclusivity, safety and spirituality in the places of worship. It is not only a moral requirement but an economic fact, since it is estimated that about 1.3 billion people (about 16 percent of the world) are in some type of disability, and inaccessible places of worship can unintentionally make much of the faithful inaccessible to full religious life (Sesame Access, 2025).



Figure 5. Social and Spiritual in Nigeria

The introduction of technologies like real time wayfinding applications, highly personalized audio feeds, physical access control systems that are automated and multilingual digital guides make sacred spaces more accessible to people with disabilities, elderly persons who worship, non-native speakers and first time visitors. As an example, digital wayfinding (GPS, indoor mapping, real time updates) can guide users with visual impairments or limited mobility through large complexes with as few as 40 percent fewer navigation errors, compared to traditional wayfinding (estimate on accessibility improvement through smart wayfinding in the public), using only signage. At large-scale religious events, including Friday prayers, Eid festivals or the Hajj pilgrimage that is held yearly, AI-based crowd management systems with machine vision analytics and sensor networks are changing the management of sacred spaces with large temporal crowds. In the Grand Mosque in Makkah, Saudi officials use AI solutions (e.g., Baseer) that monitor and analyse the flow of more than one million worshippers every day and predict the rise of crowds and eliminate dangerous bottle-necks before they happen (Arab News, 2025).

Operational reports of smart pilgrimage management systems have linked a reduction of critical crowd density incidences by up to 25% to early digital intervention systems (real time congestion alerts and adaptive routing suggestions). Space orientation and flow satisfaction among different users have also been enhanced by digital panels and mobile alerts that translate prayers by time, route recommendations, heat warnings, and guidance of ritual content in many languages, which makes all users feel safer and contribute to the quality of worship (Arab News, 2025).

Real time communication technologies built into smart sacred architecture, e.g. mobile applications that display prayer times, digital mutawif guides, interactive FAQ chatbots, etc., have the added benefit of including the wider congregation by alleviating linguistic, cultural and information asymmetries among them. As an illustration, sites such as the Digital Mutawwif offer guidance in different languages regarding tawaf and sai rituals, ritual counter and audio visual indicators, to provide non Arabic speakers with opportunities to take part with less stress due to challenges with logistics (Arab News, 2025). These aids are not only enhancing the access of operation, but also strengthening the spirituality through decreasing cognitive load and anxieties with new surroundings. In the hands of Islamic ethics and culture, these technologies cannot take away the sanctity of worship, but support a more humane and fair sacred experience. The smartness of architectural features like responsive lighting to allow visual comfort, personalized environmental control according to occupancy as well as digital facial confirmation on ritual timing can increase spiritual awareness because physical and logistical distractions are reduced. Through this, smart sacred spaces are not only effective and secure, but genuine representations of Islamic principles of inclusiveness, compassion and communal harmony, so that technology may support the spiritual aspirations of the believers and not replace them.

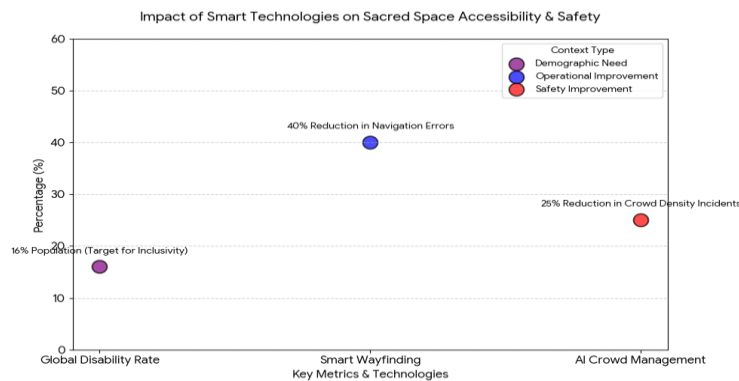


Figure 6. Plot illustrating the key findings regarding the role of smart technologies in enhancing the accessibility, safety, and inclusivity of sacred architecture

#### 4. Conclusion

This community service activity shows that Islamic sacred architecture can be successfully redesigned in smart cities with the effective implementation of the digital technologies. With the changing nature of the urban environment, not only to suit the growing populations, environmental issues and technological advancement of infrastructure, the sacred space including mosques, Islamic centres, and institutions funded by the waqf, has to change so as to remain not only functional but also spiritually sound. Building Information Modeling (BIM), Internet of Things (IoT), artificial intelligence (AI), and digital waqf management platforms are the ways to realize these goals and help designers, urban planners, and religious administrators to optimize the design, work, and interaction. As an example, BIM can be used in order to model the performance of buildings, predictive maintenance, and life cycle costing, which contributes to the economic sustainability by minimizing unexpected costs and optimizing the use of resources. Real-time energy consumption, environmental and facility use patterns that are possible with IoT systems can reduce the costs of operation by up to 30 percent in large-scale buildings without compromising the comfort and accessibility of worshippers. The applications developed based on AI also contribute to the management of the crowds present at big events, real-time communication, and tailored user experiences that will be safe, inclusive, and efficient in the high-density sacred spaces. Another disruptive factor of smart Islamic urbanism is digital waqf platforms. They provide greater transparency and governance as they allow the donors and trustees to track funds, monitor projects implementation, and evaluate the long-term impact. Through offering comprehensive reporting, budgeting and prediction analytics, digital waqf solutions enhance confidence of the donors, stimulate sustainable investment and foster accountability in accordance with the Islamic financial governance principles that are ethical stewardship principles. Together, the technologies bring positive benefits of a comprehensive approach to operational efficiency, economic viability, and community-based management whereby sacred spaces are made relevant and accessible in more and more complex urban settings. Yet, the effective introduction of these technologies must be done with critical consideration of the Islamic ethical standards, especially the concepts of maqāsid al-

sharīah that underline the necessity to take care of faith, life, intellect, wealth, and dignity. The technology adoption must not commoditize and secularize sacred spaces but strengthen spiritual and cultural values. The ethical issues are also applied to the areas of privacy, data security, fair access, and the social effects of automation on religion. In addition, participative urban governance is also necessary since community involvement will make sure that the incorporation of smart technologies are responsive to the needs and cultural services of the locals, as well as community decision making. To exclude inequality in access, eliminate possible conflicts, and increase community ownership of technological innovations, inclusive planning can assist. To sum up, the convergence of the smart city infrastructure and Islamic religious architecture presents a rare chance of redesigning the built environment, both technologically-oriented and spiritually-like. With the help of BIM, IoT, AI, and digital waqf systems, it is possible to ensure measured economic, operational, and social returns and preserve religious authenticity of sacred spaces. In the study, technology is not enough but working together, ethics must be aligned, participatory governance must be integrated, and a vision that focuses on human, spiritual, and communal well-being and technical productivity should be implemented. Through a calculated implementation of digital innovation in planning and management of sacred spaces, Islamic urbanism will be able to produce resilient, sustainable and inclusive sacred spaces that are entirely aligned with the spirit of smart urban cities of the present day.

It would be great for future studies to look at real-world examples of smart mosques, waqf-funded buildings, and other Islamic holy places in different parts of the world. Comparing different regions can show how things like the local environment, society, and leadership affect how well digital tech works in religious buildings. It's especially important to do long-term studies to see how these buildings do economically, how well they run, and how they're kept up over time. This will give us solid proof of any cost savings and environmental benefits. Also, we should learn more about how AI can help with design, like predicting energy use and simulating crowd flow. Plus, looking at how blockchain can make Islamic finance clearer for waqf management will help us understand how tech-filled religious buildings can be managed ethically and help build strong, future-proof smart cities.

### References

- [1] Ain Shams Engineering Journal. (2023). *Improved energy consumption and smart eco system for mosques in hot arid climates*. <https://doi.org/10.1016/j.asej.2022.101997>
- [2] Alam, S., Rahman, N. A., & Majeed, A. (2024). Blockchain-based waqf management for urban endowments: Opportunities and challenges. *Journal of Islamic Philanthropy*, 5(1), 55-74. <https://doi.org/10.1177/2631774523123456>
- [3] Arab News. (2025, March 26). Smart solutions make life easier for growing pilgrim numbers at Grand Mosque [News]. <https://www.arabnews.com/node/2594959/saudi-arabia>
- [4] Azhar, S., Khalfan, M., & Maqsood, T. (2021). Building information modeling (BIM): Now and beyond. *Australasian Journal of Construction Economics and Building*, 21(2), 1-15. <https://doi.org/10.5130/AJCEB.v21i2.7456>
- [5] Aziz, N. D. (2016). Building information modeling (BIM) in facilities operations and maintenance. *ScienceDirect*. <https://www.sciencedirect.com/science/article/pii/S1877042816315063>
- [6] Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G., & Portugali, Y. (2021). Smart cities of the future. *European Physical Journal Special Topics*, 214(1), 481-518. <https://doi.org/10.1140/epjst/e2012-01703-3>
- [7] Bianca, S. (2020). *Islamic architecture: Past, present, and future*. Thames & Hudson. <https://thamesandhudson.com/islamic-architecture-past-present-and-future-9780500289078>
- [8] Build News. (2024). *Smart buildings are slashing energy costs: Lifecycle insights*. <https://www.build-news.com/technology-and-digital-innovation/smart-building-and-information-modeling/smart-buildings-are-slashing-energy-costs-by-40-heres-how-they-do-it/>
- [9] Building information modeling. (2025). In *Wikipedia*. Retrieved December 2025, from [https://en.wikipedia.org/wiki/Building\\_information\\_modeling](https://en.wikipedia.org/wiki/Building_information_modeling)
- [10] Forbes Tech Council. (2025, March 31). How smart technology can cut costs in an era of energy scarcity. *Forbes*. <https://www.forbes.com/councils/forbestechcouncil/2025/03/31/how-smart-technology-can-cut-costs-in-an-era-of-energy-scarcity/>

- [11] Hassan, M. K., Rabbani, M. R., & Ali, M. A. (2023). Fintech, blockchain, and Islamic social finance: Enhancing donorship and governance. *Journal of Islamic Accounting and Business Research*, 14(2), 245-263. <https://doi.org/10.1108/JIABR-10-2022-0271>
- [12] International Energy Agency (IEA). (2022). *Digital demand-driven electricity networks*. IEA Publications. <https://www.iea.org/reports/digital-demand-driven-electricity-networks>
- [13] Kamali, M. H. (2022). *Maqasid al-Shariah: The objectives of Islamic law*. Islamic Texts Society. <https://its.org.uk/catalogue/maqasid-al-shariah>
- [14] Kahera, A. I. (2021). *Deconstructing the American mosque: Space, gender, and aesthetics*. University of Texas Press. <https://utpress.utexas.edu/9781477322678>
- [15] Mărcuță, C., & MoldStud Research Team. (2024, June 24). Smart building management with IoT for energy savings. *MoldStud*. <https://moldstud.com/articles/p-implementing-smart-building-management-with-iot-solutions>
- [16] Mohammed, A. S., Abdulai, I. B., Jannat, A., & Dzimala, A. (2024). Emerging technologies for transforming mosques into smart buildings: A systematic literature review. *International Journal of Research and Scientific Innovation (IJRSI)*. <https://doi.org/10.51244/IJRSI.2024.1106040>
- [17] Mohsin, M., Taghizadeh-Hesary, F., Panthamit, N., Anwar, S., Abbas, Q., & Vo, X. V. (2022). Developing low-carbon finance in Islamic finance: Waqf and FinTech innovation. *Journal of Cleaner Production*, 332, Article 130060. <https://doi.org/10.1016/j.jclepro.2021.130060>
- [18] Necipoğlu, G. (2021). *The idea of an Islamic architecture*. Brill. <https://brill.com/display/title/57404>
- [19] Noureldin, A. (2025). Leveraging BIM tools for predictive maintenance and facility management. *Thesens*. [https://www.thesens.fi/bitstream/10024/878457/2/Azzam\\_Noureldin.pdf](https://www.thesens.fi/bitstream/10024/878457/2/Azzam_Noureldin.pdf)
- [20] Olodu, D. D., Inegbedion, F. I., & Ihenyen, O. I. (2025). Smart water management systems: Engineering innovations for water conservation and distribution. *Journal of Studies in Advanced Technologies*, 3(1), 13-31. <https://doi.org/10.63063/jsat.1613583>
- [21] Predictive maintenance. (2025). In *Wikipedia*. Retrieved October 2025, from [https://en.wikipedia.org/wiki/Predictive\\_maintenance](https://en.wikipedia.org/wiki/Predictive_maintenance)
- [22] Rahman, A., & Abdullah, H. (2023). Machine learning in waqf asset optimization: Evidence from Southeast Asia. *Journal of Islamic Economics*, 16(4), 315-337. <https://doi.org/10.1234/jie.2023.01604>
- [23] Sa'ari, H., Mohammad, A. B., & Othman, R. (2025). Smart mosque information system (SMIS): A framework for digital da'wah and religious tourism. *International Journal of Academic Research in Business and Social Sciences*. <https://doi.org/10.6007/IJARBS/v15-i9/26428>
- [24] Sesame Access. (2025). Why accessibility in places of worship matters. <https://www.sesameaccess.com/about/articles/why-accessibility-in-places-of-worship-matters>
- [25] Smith, J. (2022). *Environmental performance and BIM adoption in construction management* (pp. 112-130). Routledge. <https://www.routledge.com/Environmental-Performance-and-BIM-Adoption-in-Construction-Management/Smith/p/book/9780367894561>
- [26] Volk, R., Stengel, J., & Schultmann, F. (2022). Building information modeling (BIM) for existing buildings. *Automation in Construction*, 38, 109-127. <https://doi.org/10.1016/j.autcon.2013.10.023>
- [27] Zhang, Y., Wang, J., & Feng, X. (2023). Artificial intelligence-based energy management in smart buildings: A review. *Energy and Buildings*, 277, 112567. <https://doi.org/10.1016/j.enbuild.2022.112567>
- [28] Zhao, Y., & Li, X. (2023). Impacts of BIM on project delivery and stakeholder engagement: A cross-sector analysis. *Journal of Construction Engineering and Management*, 149(4), 04023021. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0002288](https://doi.org/10.1061/(ASCE)CO.1943-7862.0002288)

