PROSPECTIVE ARTIFICIAL INTELLIGENCE (AI) IN ENHANCED MASJID ACCESSIBILITY FOR PERSONS WITH DISABILITIES (PWDS)

IBRAHIM, A.[1*] – TUMIRAN, M. A.[1] – ZARMANI, N. F.[1]

[1] *Academy of Contemporary Islamic Studies (ACIS), UiTM Shah Alam Branch, Selangor, Malaysia.*

**Corresponding author*
e-mail: b2024334823[at]student.uitm.edu.my

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Abstract. The integration of Artificial Intelligence (AI) in enhancing masjid accessibility for Muslim persons with disabilities is a critical aspect of inclusivity in religious spaces. However, implementing such technology solutions presents several obstacles that must be carefully considered and strategically planned. This study aims to review the prospective AI in enhancing the accessibility of PWDs in Masjid. This study utilized content analysis as a methodological approach to investigate and evaluate the challenges and existing trends related to AI applications aimed at improving mosque accessibility for PWDs. This study has identified several prospective AI technologies that can be applied and practical in enhancing Masjid accessibility for PWDs. Some of them include: (a) a vibrotactile stimuli device; (b) audio-visual speech recognition technology; (c) a sign language translator; and (d) QR code scanning for location information. In conclusion, this holistic approach to future research would allow for the ongoing growth of accessible religious places while maintaining the delicate balance of technical innovation and religious authenticity. Such projects would benefit not only the immediate stakeholders but would also contribute to the larger discussion on inclusive religious settings in the modern period.
Keywords: *artificial intelligence, accessibility, person with disabilities, masjid, future technology*

Introduction

The concept of Masjid accessibility for Muslim persons with disabilities is a critical aspect of inclusivity in religious spaces. Masjid is not meant for places of worship only, but its function extends to various community activities for every Muslims. These areas must be accessible to all, including Person with Disabilities (PWDs), because Islam embraces the concept of equality and inclusivity that will contribute to the overall growth and unity of the Muslim community. To achieve that concept, Artificial Intelligence (AI) technology integration is demanding and important in today's modernization. This technology is not deviating from Islamic teachings and is consistent with modern technical solutions to increase accessibility among PWDs in the Masjid. However, the implementation of such technology creates several obstacles that must be carefully observed and strategically planned. Masjids frequently face financial constraints that prevent them from investing in advanced AI systems and accessibility infrastructure, especially in smaller communities or underdeveloped countries. Furthermore, religious institutions substantially lack technological expertise to effectively manage and operate these systems. While informed about Islamic values, many Masjid administrators and religious leaders may lack the technology literacy required to adopt and implement AI technologies fully. In addition, the application procedure poses important considerations on how Masjids might keep their traditional architectural aesthetics and spiritual ambience while incorporating contemporary

technologies. This delicate balance between technology and tradition necessitates careful examination of cultural sensibilities and religious requirements while attempting to develop more inclusive prayer spaces.

This study aims to review the prospective AI in enhancing the accessibility of PWDs in Masjid. There are multifaceted benefits to improved Masjid accessibility for PWDs. Firstly, this technological breakthrough enables PWDs to become autonomous and dignified by allowing them to participate in religious activities through individualized support systems and smart help. Besides that, implementing AI promotes greater engagement in congregational or communal events at the Masjid. As a result, PWDs feel more accepted, which improves their mental health. Furthermore, this technology improves their safety at the Masjid by employing complicated algorithms to monitor ambient variables, detect potential threats, and coordinate necessary actions during emergencies. This complete improvement not only meets the urgent needs of PWDs but also ensures future readiness by preparing Masjids for an evolving technological landscape.

Literature review

AI is the intellectual underpinning that is closely linked to various religious and metaphysical traditions throughout nations, as evidenced by ancient Jewish mythology about the golem, an anthropomorphic being created by theurgic rites. This theological precedent had a significant impact on early AI theorists, who perceived connections between supernatural animating of inanimate matter and computational intelligence. Similarly, in the Japanese context, the ontological frameworks of Buddhism and Shintoism, which postulate the existence of spiritual essence within material objects, have shaped distinct cultural approaches to robotics development, though this religious determinism only partially explains their technological trajectory. This religious-technological synthesis extends to Islamic traditions as well. AI applications are in sync with Islamic values and have improved different areas of Islamic knowledge. Indeed, the incorporation of AI technologies has advanced the analysis of sacred texts such as the Qur'an and Hadith, Islamic jurisprudence, and related disciplines. Besides that, the benefits of AI extend to accessibility issues too through the incorporation of this technology into religious institutions, notably mosques, which is a game-changing approach that combines traditional accessibility solutions with cutting-edge technical advances (Barnawi and Aksoy, 2023). While traditional mosque accessibility has mostly focused on physical adaptations such as ramps, larger doorways, and adaptable restrooms, the advent of AI-powered technologies opens new avenues for overall accessibility improvement (Kubullek and Doğangün, 2023). These smart solutions not only meet the different demands of PWDs through intelligent mobility systems but also provide advanced building management capabilities (Obracht-Prondzyńska et al., 2022). Mosques may improve accessibility, energy efficiency, and occupant comfort all at the same time by using AI-powered building control systems (Merabet et al., 2021).

Building on AI deployments in mosques for accessibility improvements, religious institutions must build a thorough knowledge of AI's cognitive awareness, which includes perception, prediction, and generative skills, to enable future breakthroughs (Birkstedt et al., 2023). From leadership to operational staff, including those related to building management systems driven by artificial intelligence, must be well-versed about the information processing mechanisms and decision-making frameworks of AI (Jöhnk et al., 2021). This underlying data helps to develop reasonable performance

criteria and possible uses in religious environments, especially in optimizing mosque accessibility using AI-enabled systems that can adapt to various user needs, monitor facility use patterns, and react actively to accessibility requirements (Kubullek and Doğangün, 2023). In summary, AI in religious institutions demonstrates a blend of ancient religious traditions and contemporary technological capabilities. AI technology in Masjids has enhanced accessibility through intelligent building management and adaptable settings, while simultaneously maintaining religious sanctity. This integration demonstrates how religious institutions can effectively integrate technical innovation and spiritual values to address today's accessibility concerns.

Materials and Methods

This study utilized content analysis as a methodological approach to investigate and evaluate the challenges and existing trends related to AI applications to improve Masjid accessibility for PWDs. To gain insights into academic publications, books and reports, the research will employ the terms “Artificial Intelligence”, “accessibility”, “person with disabilities” and “Masjid”. The database used for references in this study encompasses JSTOR, PubMed, ProQuest, and Google Scholar. The content analysis will scrutinise the material to ascertain prevalent themes, deficiencies, and inconsistencies and generate novel perspectives on inventive potential strategies for enhancing Masjid accessibility among PWDs. The research aims to offer pragmatic suggestions, derived from the analysis, for enhancing the accessibility of PWDs through AI technology applications. The goal is to equip Masjid authorities with the necessary knowledge to incorporate Islamic architectural principles and universal design standards to ensure a comprehensive evaluation of accessibility solutions.

Results and Discussion

This study has identified several prospective AI technologies that can be applied and practical in enhancing Masjid accessibility for PWDs. Some of them include: (a) a vibrotactile stimuli device; (b) an audio-visual speech recognition technology; (c) a sign language translator; and (d) a QR code scanning for location information.

Vibrotactile stimuli device

Supporting blind and visually impaired people in navigating independently necessitates providing several forms of information, including geographical, directional, and status data (Li et al., 2019). However, giving numerous forms of information simultaneously can make perceiving and understanding the information difficult. Therefore, Lee and In (2023) proposed a unique wrist-worn tactile display with eight vibrators capable of delivering clear and identifiable vibrotactile information via both stationary and moving tactons. This method improves information recognition rates by categorizing vibration patterns based on spatial properties, resulting in greater transfer when compared to using them separately. User testing with blind and visually impaired individuals revealed that the categorized vibrotactile information was quickly recognized, allowing users to travel autonomously without prior knowledge of the route (Jicol et al., 2020). This technology has great potential for improving accessibility within Masjid by providing discreet and non-intrusive navigation assistance. It allows

visually impaired worshippers to move securely and autonomously in the sacred space, fostering inclusivity and dignity in real time.

Similarly, people with physical disabilities frequently rely on power wheelchairs for mobility but decreased driving abilities can make operating these wheelchairs dangerous. Devigne et al. (2020) proposed using wearable vibrotactile haptics for wheelchair navigation assistance, employing one or two haptic armbands each equipped with four equally spaced vibrotactile actuators to provide various navigation cues. This method may be adjusted to fit different limbs, therefore enabling individuals unable to utilize conventional kinesthetic interfaces, and provides thorough navigation information while preserving user control over wheelchair mobility. In addition, Jicol et al. (2020) discovered that studies with human participants demonstrated a 49% reduction in collisions and a preference for haptic feedback. The participants found the armbands to be comfortable to wear and use, thus confirming the practicality and effectiveness of this technique in enhancing navigation safety for wheelchair users. The adoption of such technology in Masjid improves accessibility, safety and movement independence for wheelchair users within religious settings. Furthermore, adopting such accessible solutions aligns with the universal design objective by making religious environments more pleasant and accommodating to all users. Masjid can make significant progress in increasing accessibility and inclusivity for all worshippers by leveraging these advanced technologies.

Audio-visual speech recognition technology

Growing availability of audio-visual voice recognition technology enables PWDs, especially those who are deaf or mute, to actively participate in daily events, including Masjid activities. Following Berner and Alves (2021) research, it shows that this technology's dual-input system improves the independence and participation of PWDs. The system interprets both auditory inputs, such as speech and lecture recordings, even in noisy surroundings and visual inputs such as lip movements, facial expressions, and hand gestures, making it one of the most dependable speech recognition solutions. This technological advancement has benefited religious institutions by allowing PWDs to participate more inclusively in a wide range of religious activities, from daily prayers to educational sessions, as the Masjid environment fosters a more accessible and welcoming environment for all community members. Moreover, Norkhalid et al. (2020) found that, depending on past research results, this technology can be implemented in normal mobile device capabilities, replacing accessibility services such TalkBack for Android and VoiceOver for iOS, as these accessibility services offer fewer functions on navigation. Ryumin et al. (2023) indicated that merging the auditory and visual information for speech recognition through two big datasets namely Lip Reading in the Wild (LRW) dataset for voice recognition and Anadolu University Turkish Sign Language (AUTSL) dataset for gestures can obtain more than 98% accuracy in both tasks making it simpler for deaf and mute individuals to engage in daily activities including religious practices. These technological advancements provide comprehensive and accurate solutions than traditional accessibility tools while maintaining user-friendly interfaces that can be easily integrated into existing mobile devices.

Advances in audio-visual voice recognition technology have transformed basic accessibility features, becoming more accessible, particularly in building inclusive religious settings. The successful integration of dual-input systems with high-accuracy recognition capabilities in practice marks a fundamental paradigm where assistive

technology can be used in everyday situations. Moving forward, these advancements lead to a future in which technology barriers can be cushioned to benefit PWDs in increasing their participation and interaction within religious communities while also establishing new norms for inclusive design in digitally accessible solutions.

Sign language translator

Currently, there has been significant development of assistive technology in reducing communication obstacles between deaf and hearing people by developing sign language translator technology (Obi et al., 2023). This innovative technology that utilizes visual recognition has emerged as an important solution for facilitating continuous communication across diverse communities (Kemkar et al., 2023). It incorporates AI algorithms and computer vision techniques to capture, process, and interpret hand gestures in real-time, and then convert them into comprehensible text or speech output for non-signing individuals. Furthermore, the effectiveness of this technology is evidenced particularly in Arabic Sign Language translation. The introduction of complex machine learning approaches, specifically through the utilization of Random Forest classifiers and advanced feature extraction systems, has shown significant efficacy in gesture identification, with accuracy rates exceeding 92.15 %. Contemporary developments have expanded the functionality of these systems to include bidirectional communication capabilities, enabling not only the translation of signs to speech but also the conversion of spoken language into visual sign representations through avatar-based interfaces (Kanvinde et al., 2021). As this technological progression can be integrated into mobile platforms, it yields enhanced accessibility and practicality of sign language translation systems in daily communications, marking a significant stride toward inclusive technological solutions for the deaf and hard-of-hearing community.

Sign language translator technology has served as a communication breakthrough between deaf and hearing individuals in a wide range of places, including Masjid, by combining visual recognition systems, artificial intelligence, and computer vision techniques. The evolution of these systems, which now include bidirectional communication via avatar-based interfaces and mobile integration, has significantly improved accessibility for religious spaces, resulting in more inclusive solutions for the deaf and hard-of-hearing community in everyday life.

QR code scanning for location information

Previous study address the essential issue of accessibility for visually impaired people in public places by developing an innovative technology solution called a dual-application system. The first part of this system applies to a QR code scanner with audio output capabilities to assist visually impaired users in understanding their surroundings. Whereas, for the second part, it applies a planning interface that allows setting up and managing the QR code guides in different locations. This integration system will be placed in strategic public areas through a planning interface, and when the users scan the QR code, they will receive real-time audio instructions and information. According to Moyà-Köhler and Doménech (2022), this system is a simple through single-touch activation and promises widespread adoption across varied public contexts, solving the ongoing challenge of accessibility infrastructure development.

Meanwhile according to Wahyuni et al. (2023), they focused on the application of QR code-based informational systems at Universitas Pembangunan Panca Budi by using

an Android-based application, which is Java programming in Android Studio and combining it with Firebase Realtime Database for data management. The system includes an administrative interface for data management and delivers detailed building-specific information such as spatial orientation data, facilities, and emergency protocols. Arif and Hussain (2022) revealed that the system's ability to provide fast access to relevant information indicates that it can be used in both indoor and outdoor environments for place identification and navigation. These studies show the versatility and efficacy of QR code technology in improving accessibility. This technology is useful for enhancing accessibility in Masjid, as visually impaired people could utilize such devices to obtain real-time navigational signals and detailed geographical information. All these advantages create a more inclusive setting for all worshippers, regardless of visual abilities.

Conclusion

In conclusion, this study highlighted the massive potential of AI technology in improving Masjid accessibility for PWDs. Several novel AI-driven solutions were identified and evaluated through systematic analysis, including vibrotactile stimulation devices, audio-visual speech recognition systems, sign language interpreters, and QR code-based location information systems. The findings indicate that these technological interventions can significantly increase PWDs' autonomy, dignity, and religious involvement while preserving the holiness and historic spirit of Islamic places of worship. The adoption of these AI solutions exemplifies the perfect combination of modern technical advances with core Islamic principles of equality and accessibility. Future research efforts should concentrate on a few essential domains. Investigations into the development of the integration of multiple AI accessibility solutions deserve special attention for various Masjid settings. Furthermore, empirical research into cost-effectiveness and sustainability models is critical, especially for resource-constrained religious institutions. The cultural and theological consequences of AI deployment must be thoroughly investigated, particularly the preservation of traditional Masjid aesthetics and atmospheric aspects. Another important topic for future research is technological upgrade prospects. This includes the creation of complex algorithms specifically tailored for religious space navigation, improving sign language translation accuracy for religious terms, and increasing the dependability of audio-visual recognition systems in a variety of Masjid situations. Longitudinal studies examining user experiences and adaptation patterns would provide useful information about the efficacy of these technology solutions. This holistic approach to future research would allow for the ongoing growth of accessible religious places while maintaining the delicate balance of technical innovation and religious authenticity. Such approaches would benefit not only the immediate stakeholders but would also contribute to the larger discussion on inclusive religious settings in the modern period.

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Conflict of interest

We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research has not been submitted for publication nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to Quantum Journal of Social Sciences and Humanities.

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