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Employing Digital Media and Artificial Intelligence in Smart Cities to Enhance Visitor Experience: A Case Study of Makkah, Saudi Arabia

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ABSTRACT

Research aims: This study examines Umrah pilgrims' use of digital media, AI-related applications and smart services in Makkah.

Design/Methodology/Approach: A descriptive questionnaire survey collected responses from 400 pilgrims during Ramadan 1447 AH (2026). The analysis presents self-reported use, proficiency and perceptions of visitor services.

Research findings: All respondents reported using the digital services covered by the survey, and 48.5% rated their proficiency as high. Smart applications received a mean score of 4.09 out of 5; the equivalent relative score of 81.8% describes the rating, not the proportion of users. Respondents also reported benefits for guidance, awareness of landmarks and completion of procedures. Information overload, account access and the timeliness of information remained concerns.

Theoretical Contribution/Originality: The study provides descriptive evidence about pilgrims' experiences of digital services in a Saudi smart-city setting.

Practitioners/Policy Implications: Service providers should consider multilingual guidance, accessible interfaces and practical support alongside technological development. The survey describes participants' perceptions and does not establish causal effects or distinguish the contribution of AI from other digital services.

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1. Introduction

Smart-city development uses information and communication technologies to support urban services and address residents' needs. Kotarba and Zawiła-Niedźwiedzki (2025) propose a functional model linking city activities with digital intelligence. Research on user adoption also considers perceived usefulness, ease of use and trust

(Wang, 2025). These perspectives suggest that assessments of digital urban services should examine how people use them, as well as the infrastructure available.

Digital tools can support transport, energy management and public services, but their value depends on organisational capacity and users' experiences. Pivar (2025) identifies technological readiness and management support among the factors associated with big-data adoption in EU cities. Brown and Patten (2024) discuss potential uses of generative AI alongside the commitments and risks involved in smart-city development.

In Saudi Arabia, smart-city initiatives form part of the development agenda associated with Vision 2030 (Al Jaafreh & Allouzi, 2023). Urbanisation creates demands for coordinated planning and sustainable services (Almulhim & Cobbinah, 2023). Makkah presents a particular setting because services must accommodate pilgrims with different languages, travel needs and levels of digital proficiency. Balbaid and Al-Dahwi (2024) examine the city's readiness for smart-city development, including governance and implementation challenges.

Research on citizen participation shows why user perspectives matter when evaluating digital urban services (Allen et al., 2020). This study therefore examines how 400 Umrah pilgrims in Makkah reported using digital media, AI-related applications and smart services. It describes their proficiency, perceptions of guidance and service quality, intentions to continue using the services, and practical difficulties. The focus is the experience of this sample, rather than a citywide measure of technological performance.

2. Literature review

2.1. *Studies in Saudi Arabia*

Doheim et al. (2019) review smart-city visions and practices in Saudi Arabia. Alotaibi et al. (2022) also discuss the Saudi smart-city context, while Al Jaafreh and Allouzi (2023) review adoption drivers and challenges. Aldegheishem (2023) assesses Riyadh, Makkah, Jeddah and Madinah using 57 indicators across six dimensions; smart mobility shows the least progress among the dimensions examined.

Almulhim and Aina (2025) combine literature, expert consultation and cases to examine human-centred development, identifying participation and institutional challenges. Alwafi (2025) analyses climate-responsive design in The Line as a planning proposal. Bahreldin et al. (2025) examine digital twins, infrastructure readiness and governance. These studies discuss conditions for development rather than measured benefits for the pilgrims in this survey.

Alotaibi et al. (2025) examine urban sustainability and smart-city variables in Najran. Alhazmi et al. (2025) model battery-swapping infrastructure for electric vehicles, while Mohanty et al. (2025) review smart-grid communication and measurement technologies. These infrastructure studies provide wider context but do not establish outcomes for visitor services in Makkah.

Belaïd and Arora's (2024) edited volume considers social and environmental challenges in smart cities. Bennoui (2021) reviews international and Arab experiences. Together with the Makkah readiness study by Balbaid and Al-Dahwi (2024), this literature places digital-service development within a wider discussion of governance and local needs.

2.2. *International studies*

International research examines how governance and user participation shape digital urban services. Kummitha (2025) identifies embedded, blended and networked models of citizen engagement in smart-city governance. Smalec (2025) considers communication and social participation, including the risk of excluding groups with limited digital access. Szymańska (2025) uses focus groups to examine Generation C's views of AI; participants describe potential benefits as well as privacy, transparency and employment concerns.

Studies of digital infrastructure provide related context. Tong and Amalia Rivai (2025) review 976 articles on IoT and smart-city governance. Shao and Min (2025) develop a framework for sustainable smart-city development through bibliometric research. Aliyari (2025) reviews digital technologies in smart cities and sustainable logistics, while Okonta and Vukovic (2024) examine software applications and case studies concerning urban sustainability and resilience.

Ben Rjab and Mellouli (2019) review AI applications and challenges across smart-city sectors. Chipriyanov (2025) discusses how public-private partnerships need management capacity and attention to the technology life cycle. In Baghdad, Al-Bari et al. (2025) examine digital urban services, including electronic payments, alongside infrastructure and access difficulties. These findings concern their respective settings and cannot be assumed to describe Makkah.

2.3. *Research focus*

The reviewed literature addresses infrastructure, governance and citizen engagement through different methods. Almulhim and Aina (2025), for example, combine a literature review, expert consultation and case analysis; Alotaibi et al. (2025) use quantitative methods in Najran. These studies provide context for examining visitors' experiences, but their findings concern populations and services different from the pilgrims surveyed here.

This study focuses on self-reported digital-service use and perceptions among Umrah pilgrims in Makkah during Ramadan 1447 AH. It adds a visitor perspective to the wider smart-city literature.

3. Methodology

The study uses a descriptive quantitative questionnaire survey. It examines how respondents use digital media and smart services, how they rate their own proficiency,

and how they perceive guidance, service quality and practical difficulties. The analysis is descriptive and does not estimate the independent effect of AI on the visitor experience.

3.1. *Population and sample*

The study population was Umrah pilgrims visiting Makkah during Ramadan 1447 AH (2026). The survey included 400 respondents. Their gender, age and reported residence or origin are summarised in Table 1. The results describe these respondents and are not presented as population estimates.

4. Findings

4.1. *Measures and interpretation*

The questionnaire covered use of digital media and smart services, interaction with AI-related applications, guidance and navigation, perceived benefits for the visitor experience, intentions to continue using the services, and technical and human difficulties. Proficiency and experiences were self-reported.

The results below present frequencies and percentages for participant characteristics and reported use, together with the reported item means. Where a relative percentage accompanies an item mean, it equals the mean divided by 5 and multiplied by 100. Such percentages describe the item score and are distinct from the percentage of respondents using a service.

All 400 respondents reported using the digital services covered by the questionnaire. Of the sample, 48.5% described their proficiency as high. These responses concern a combined set of digital and AI-related services; they do not establish that every respondent used a separate AI system.

4.2. *Participant characteristics*

The sample comprised 250 men (62.5%) and 150 women (37.5%). The largest age group was under 25 years (30.5%), followed by 35 to under 45 years (28.0%). Pilgrims from South and East Asia formed 35.3% of the sample, while domestic pilgrims formed 33.5%.

Table 1 Participant characteristics (n = 400)

		Respondents	
Variables	Categories	n	%
Gender	Male	250	62.5
	Female	150	37.5
Age	Under 25 years old	122	30.5
	25 to under 35 years old	106	26.5
	35 to under 45 years old	112	28.0
	45 to under 55 years old	52	13.0
	55 years and over	8	2.0
Reported residence or origin	Domestic pilgrims from within the Kingdom	134	33.5
	Pilgrims from Arab countries	73	18.3
	Pilgrims from non-Arab African countries	30	7.5
	Pilgrims from European countries, America, and Australia	22	5.5
	Pilgrims from South and East Asia	141	35.3

5. Discussion

5.1. *Digital-service use and visitor perceptions*

Participants reported using the digital services included in the survey, although their self-rated proficiency varied. The 48.5% who rated their proficiency as high should not be taken to represent all pilgrims or to demonstrate proficiency through an independent test. The findings support providing practical assistance alongside digital services.

For current use of digital media and smart services, reported item means ranged from 2.96 to 3.51, with an overall mean of 3.15.

Smart applications received a mean score of 4.09, equivalent to 81.8% of the maximum score of 5. Chatbot services on Nusuk or other platforms received 3.93 (78.6%), followed by phone voice assistants at 3.88 (77.6%). These are ratings of the survey items, not the proportions of respondents who used each application. The term smart application also covers digital functions that may not rely on AI.

Items concerning guidance and navigation had means ranging from 3.68 to 4.21, with an overall mean of 3.95.

Participants therefore rated these functions more highly than the current-use dimension, whose reported overall mean was 3.15. The comparison concerns the reported scores and does not show that one technology caused a better experience.

Awareness of religious and historical landmarks received a mean score of 4.13 (82.6% of the maximum score), followed by perceived reductions in the time needed to complete procedures at 4.07 (81.4%) and perceived service-quality improvements at 3.97 (79.4%). The item on the spiritual and religious experience received 3.91 (78.2%). These results describe perceived benefits; they do not measure actual time savings or changes in service performance.

Intentions to continue using smart services had item means ranging from 3.73 to 4.05, with an overall mean of 3.86. Intentions reported in a survey may differ from later behaviour and should not be interpreted as evidence of long-term use.

The most highly rated challenge was information overload or distraction from frequent digital notifications, with a mean of 3.87 (77.4% of the maximum score). Login and password-recovery difficulties ranked second in the reported results. Concerns about the timeliness of digital information followed, with a mean of 3.79 (75.8%). These findings suggest that reducing friction in routine use deserves attention alongside adding new functions.

5.2. *Recommendations*

The following recommendations are proposed improvements to visitor services. They require assessment of accessibility, feasibility and privacy before implementation.

Simplify interfaces and provide multilingual help. Clear icons, adjustable text size and voice guidance can support visitors who have difficulty with text-heavy applications. Service providers should test these options with pilgrims from different language and age groups.

Provide support at points where visitors need it. Trained staff or volunteers at transport hubs, accommodation and visitor-service locations could help with registration, login and navigation. Assistance should remain available to visitors who cannot use digital tools independently.

Reduce information overload and improve the timeliness of guidance. Service providers could prioritise essential notifications and distinguish verified current information from general advice. Offline maps and clear signs could complement mobile applications when connectivity is limited.

Evaluate proposed navigation and AI functions before wider use. Voice assistance, translation and augmented-reality navigation may be useful, but trials should examine accuracy, usability and the needs of visitors with limited digital proficiency. The present survey does not establish the performance of these proposed functions.

Offer optional digital guidance before arrival. Travel operators and visitor-service providers could distribute short multilingual instructions and audio guides for essential services. Visitors should also have access to personal assistance.

Monitor service problems through user feedback. Analysis of complaints and routine service interactions could help identify login problems, confusing guidance and excessive notifications. Such monitoring should limit the collection of personal information and use appropriate privacy safeguards.

6. Limitations and implications

6.1. *Limitations*

This cross-sectional survey describes self-reported use and perceptions at one point in time. It cannot establish causal effects of digital media or AI on the visitor experience. The combined treatment of digital platforms and AI-related services also prevents a separate estimate of AI's contribution.

The sample consists of 400 Umrah pilgrims in Makkah during Ramadan 1447 AH. Visitors in other seasons or settings may face different crowd conditions, services and connectivity. The demographic distribution of the sample does not establish that it represents all pilgrims.

Self-reported proficiency and perceived benefits are subject to differences in experience and interpretation. The survey does not independently test digital skills, application accuracy, actual time savings or service performance. It also provides no basis here for reliable comparisons between age or nationality groups.

The reported item means describe the selected questionnaire dimensions. Without a common validated measurement framework, differences between those dimensions should be interpreted cautiously. These results provide descriptive evidence for service improvement rather than a causal model of smart-city performance.

6.2. *Policy implications and contribution*

The findings draw attention to the practical conditions under which visitors use digital services. Participants reported benefits for guidance and awareness, while also identifying information overload, account access and the timeliness of information as concerns. Service development should address these routine difficulties as well as introducing new features.

Accessible interfaces, multilingual instructions and personal assistance are relevant priorities for pilgrim-service providers. The survey supports considering these options, but it does not determine which specific intervention would be most effective. Pilot evaluations could compare proposed improvements before wider deployment.

The study contributes a descriptive account of visitor experiences in Makkah. Its focus on use, self-rated proficiency and practical difficulties complements research concerned with smart-city infrastructure and governance. The findings relate to this sample of 400 pilgrims and should be assessed within that scope.

6.3. *Future research*

Longitudinal research could examine how pilgrims' use and perceptions change across visits and seasons. Such work could distinguish continued use from intentions expressed during a single survey.

Mixed-method studies could combine questionnaires with interviews or observed service tasks. These approaches would help explain difficulties with accounts, language, navigation and notifications.

Comparative studies could use consistent measures across Makkah, Madinah and other visitor settings. Researchers should define the sampling frame and record the digital services used, distinguishing AI functions from other application features.

Further research could examine visitors with lower digital proficiency and those who need language or accessibility support. Validated measures and clearly reported sampling procedures would support more reliable comparisons between groups.

Trials of translation, voice assistance and augmented-reality navigation could assess task completion, accuracy and visitor satisfaction. Evaluations should also consider privacy and the availability of non-digital assistance.

7. Conclusion

This survey examined digital media, AI-related applications and smart services through the self-reported experiences of 400 Umrah pilgrims in Makkah during Ramadan 1447 AH. All respondents reported using the digital services covered by the questionnaire, and 48.5% rated their proficiency as high.

Participants reported benefits for guidance, awareness of landmarks and completion of procedures. Smart applications received a mean score of 4.09 out of 5, while the guidance and navigation dimension had an overall mean of 3.95. Information overload, account access and the timeliness of information remained practical concerns.

These findings describe the views of the surveyed pilgrims. They do not establish causal effects, demographic differences or an independent contribution of AI. The practical implication is to consider accessible digital services and personal support together, and to evaluate proposed improvements through further research.

Declarations

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Conflicts of Interest. The author(s) declare no conflicts of interest.

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