STAKEHOLDER PERCEPTIONS OF BARRIERS AND OPPORTUNITIES IN AI-POWERED CROWD MANAGEMENT: A CASE STUDY OF KATARA CULTURAL VILLAGE, QATAR

Ilyas P A

Research Scholar, Desh Bhagat University, Mandi Gobindgarh, Punjab, India

Navdeep Kaur

Professor, Department of Management & Commerce, Desh Bhagat University, Mandi Gobindgarh, Punjab, India

ABSTRACT

Artificial Intelligence (AI) has emerged as a promising solution for improving crowd control, safety, and service efficiency in high-density cultural destinations. However, successful implementation of AI-powered crowd management requires strong stakeholder readiness and supportive organizational conditions. This study examines stakeholder perceptions of the barriers and opportunities associated with implementing AI for crowd management at Katara Cultural Village, Qatar. A quantitative approach was employed using a structured questionnaire distributed to key stakeholder groups, including management, security personnel, event coordinators, technical staff, and technology vendors. The findings reveal that stakeholders strongly recognize opportunities such as improved real-time monitoring, predictive congestion forecasting, faster emergency responsiveness, intelligent resource allocation, and enhanced destination image through smart tourism innovation. At the same time, significant barriers were identified, including high implementation and maintenance costs, system integration challenges, limited workforce skills, privacy and ethical concerns, cybersecurity risks, and resistance to organizational change. The study concludes that AI crowd management should be approached as a strategic institutional transformation rather than only a technological upgrade, requiring capacity building, governance frameworks, and ethical readiness to ensure sustainable adoption. The study contributes to literature by providing stakeholder-based evidence from a real cultural destination environment and offers practical implications for policymakers and destination managers aiming for responsible and scalable AI deployment.

Keywords: Artificial Intelligence; Crowd Management; Stakeholder Perception; Barriers and Opportunities; Katara Cultural Village

1.INTRODUCTION

Large-scale cultural destinations have become increasingly complex environments due to rising visitor volumes, high-density festivals, and the need to maintain safety, service quality, and smooth mobility during mass cultural events. In such settings, crowd congestion, bottlenecks, delays, and crowd-related safety incidents can negatively affect institutional reputation and operational outcomes, making crowd management a strategic necessity rather than a routine operational function (Sharma et al., 2018). Traditional crowd control approaches that depend heavily on manual supervision and reactive decision-making are often inadequate in high-footfall cultural destinations, where crowd movement patterns change rapidly across zones and time periods (Narayanan et al., 2025). Consequently, Artificial Intelligence (AI) has emerged as a critical enabler of intelligent crowd management by integrating real-time data streams from sensors, smart cameras, Wi-Fi/GSM tracking systems, and

predictive models to forecast crowd surges, detect anomalies, and support proactive interventions (Al-Nabhan et al., 2025; Bilade et al., 2024).

AI-driven crowd management has been reported to enhance operational preparedness by enabling predictive analytics, real-time monitoring dashboards, automated alerts, and intelligent allocation of resources, allowing organizations to respond quickly to crowd density fluctuations (Bandewar & Khandelwal, 2025; Almutairi et al., 2024). Empirical and review-based studies across mass gatherings and event venues demonstrate that AI approaches can improve crowd density estimation accuracy, reduce response time, and strengthen decision-making through data-driven coordination among operational teams (Narayanan et al., 2025; Bandewar & Khandelwal, 2025). However, successful implementation depends not only on technological capability but also on organizational readiness, staff competence, infrastructure integration, ethical governance, and stakeholder acceptance (Chhatre & Singh, 2024; Oyekunle & Boohene, 2024). In public cultural settings, stakeholders such as managers, technical teams, event coordinators, security personnel, and vendors play central roles in evaluating AI's feasibility and sustainability because they directly experience cost-related constraints, integration challenges, training requirements, and regulatory pressures (Venkatesh et al., 2003; Tornatzky & Fleischer, 1990).

Katara Cultural Village in Doha, Qatar provides a suitable case context for examining these issues because it functions as a major cultural tourism hub, hosting large-scale festivals, exhibitions, and national celebrations that produce high-intensity crowd patterns and operational complexity (Elhajjar et al., 2025). While AI has shown strong potential in improving crowd flow and safety management, cultural destinations in the Gulf region face unique implementation challenges such as multilingual visitor diversity, strict data governance expectations, high-cost technology adoption, and the need for inter-agency coordination in public-event security (Chafiol & Brenot, 2024; Shah, 2024). Moreover, current research has largely examined AI crowd management through technical effectiveness metrics or visitor satisfaction outcomes, whereas fewer studies have systematically explored stakeholder perspectives regarding barriers and opportunities during implementation in real cultural destinations (Elhajjar et al., 2025; Narayanan et al., 2025). Therefore, this study aims to identify and evaluate the key barriers (e.g., cost, integration complexity, staff training, resistance to change, privacy governance) and opportunities (e.g., smart tourism development, sustainability, improved coordination, data-driven strategy) associated with AI-powered crowd management at Katara Cultural Village from stakeholders' viewpoints. This approach contributes to both theory and practice by strengthening understanding of organizational adoption conditions and supporting scalable AI deployment in cultural tourism environments aligned with national smart destination visions.

2. LITERATURE REVIEW

Artificial intelligence (AI)–powered crowd management has emerged as a critical strategic solution for managing congestion, ensuring safety, and improving operational decision-making in high-density event environments. The literature highlights that AI-based crowd systems integrate computer vision, IoT sensor networks, Wi-Fi/GSM tracking, and machine learning to provide real-time monitoring, anomaly detection, and proactive congestion forecasting (Al-Nabhan et al., 2025; Bilade et al., 2024; Narayanan et al., 2025). Empirical evidence from mass gathering and event settings suggests that AI crowd density estimation can achieve high prediction accuracy and significantly reduce response delays by generating automated alerts and optimizing emergency interventions (Almutairi et al., 2024; Bandewar & Khandelwal, 2025). In cultural destinations, such systems also strengthen operational efficiency through intelligent resource allocation and real-time crowd flow redirection, thereby improving overall organizational performance and service continuity during peak cultural events (Sharma et al., 2018; Elhajjar et al., 2025).

A second thematic stream of literature focuses on stakeholder readiness and implementation conditions, emphasizing that AI adoption success depends not only on technical capability but also on organizational and environmental factors. Studies based on frameworks such as the Technology–Organization–Environment (TOE) model indicate that cost burden, infrastructure maturity, system interoperability, training needs, leadership support, and regulatory compliance strongly shape implementation outcomes (Tornatzky & Fleischer, 1990; Oyekunle & Boohene, 2024). Similarly, technology acceptance research suggests that stakeholders' perceptions of usefulness, ease of use, and facilitating conditions affect willingness to rely on AI dashboards and automated decision-support tools (Venkatesh et al., 2003). At the same time, ethical governance concerns such as transparency, privacy, cybersecurity, and legitimacy of surveillance practices remain important barriers, particularly in public cultural environments where stakeholder accountability and visitor trust are essential (Chafiol & Brenot, 2024; Floridi et al., 2018). Thus, the literature suggests that AI crowd management should be examined not only as a safety technology but also as an institutional innovation that requires stakeholder alignment, capability building, and responsible governance.

3. RESEARCH GAP & AIM OF THE STUDY

Despite the growing body of research on AI-enabled crowd monitoring, major gaps persist regarding stakeholder-centered empirical evidence in cultural tourism destinations. Most existing studies prioritize technical outcomes (accuracy, prediction, detection speed) or focus on visitor satisfaction, while limited research systematically explores how diverse stakeholders (managers, security staff, technical teams, event coordinators, and AI vendors) perceive implementation barriers and opportunities in real cultural venues (Bilade et al., 2024; Narayanan et al., 2025; Elhajjar et al., 2025). Moreover, Middle Eastern cultural destinations such as Katara operate under distinct governance expectations and data privacy sensitivity, yet contextual research remains limited in this region (Chafiol & Brenot, 2024). Therefore, there is a clear need for a case-based study that identifies stakeholder-perceived barriers (cost, integration complexity, resistance, training and regulation) and opportunities (smart tourism growth, sustainability, data-driven governance) to guide scalable and ethical implementation of AI-powered crowd management in cultural destinations.

The main aim of this study is to identify and analyse the key barriers and opportunities in implementing Artificial Intelligence (AI) for crowd management from stakeholders' perspectives, using Katara Cultural Village, Qatar, as the case setting. Specifically, the study seeks to understand how different stakeholders, such as management, technical staff, event coordinators, security personnel, and AI technology vendors, perceive the implementation of AI-powered crowd management tools and systems (e.g., real-time monitoring, predictive analytics, smart surveillance, and automated alerts). The study also aims to evaluate how stakeholder perceptions influence the feasibility, readiness, and long-term sustainability of AI adoption in cultural event environments, and to generate practical recommendations for improving AI deployment through better governance, training, system integration, and policy support.

4. METHODOLOGY USED

The study adopted a mixed-methods research design with a descriptive-explanatory approach to examine stakeholders' perceptions of barriers and opportunities to implementing AI-powered crowd management at Katara Cultural Village, Qatar. A convergent mixed-methods design was applied, in which quantitative and qualitative data were collected simultaneously and later integrated through triangulation to enhance validity and credibility (Creswell & Plano Clark, 2018; Denzin, 2012). Quantitative data were gathered using a structured questionnaire (5-point Likert scale) administered to 65 stakeholders, including management, technical staff, event coordinators, security personnel, and AI

technology vendors. The stakeholder sample was selected using purposive and stratified sampling to ensure representation of all key stakeholder categories. In addition to closed-ended items, the instrument included open-ended qualitative questions to capture deeper insights on operational challenges, system integration issues, cost constraints, training needs, ethical governance, and future implementation opportunities. Quantitative analysis involved descriptive statistics (mean, standard deviation, frequency, percentage) and inferential techniques such as t-tests, ANOVA, correlation, and regression to examine relationships among AI implementation variables and perceived organizational outcomes. Qualitative responses were analyzed using thematic analysis, identifying recurring patterns related to barriers and opportunity themes, and the final interpretation was strengthened through triangulation of findings across both data strands.

5. ANALYSIS AND DISCUSSION

5.1 Stakeholder Profile

The demographic and professional profile of respondents was analyzed to ensure that perceptions were obtained from diverse stakeholder groups involved in crowd management planning and implementation at Katara Cultural Village. Stakeholders included management authorities, security personnel, event coordinators, technical staff, and technology vendors. The profile indicates balanced representation across key functional roles, strengthening the generalizability of findings within the case setting.

Table 1: Stakeholder Profile

Stakeholder Category	Frequency (n)	Percentage (%)
Management/Administration	14	21.5
Security & Safety Team	16	24.6
Event Coordination Team	13	20.0
Technical/IT Team	12	18.5
AI/Technology Vendor/Consultant	10	15.4
Total	65	100

The highest participation was from security and safety teams, reflecting their direct operational responsibility during peak events. Management and technical teams were also strongly represented, which is critical because AI implementation requires both strategic approval and technical integration.

5.2 Descriptive Analysis of Barriers to AI Implementation

Stakeholders were asked to rate perceived barriers in implementing AI-powered crowd management. The analysis shows that barriers were mostly associated with financial constraints, integration complexity, limited technical skills, and ethical/regulatory concerns.

Table 2: Descriptive Statistics: Barriers to AI Implementation

Barrier Dimension	Mean	Std. Dev.	Level
High initial cost and maintenance	4.41	0.61	Very High
Integration with existing systems	4.22	0.69	High
Lack of trained manpower/skills	4.14	0.72	High
Data privacy and surveillance concerns	4.06	0.73	High
Cybersecurity risks	4.03	0.71	High

Resistance to change (staff)	3.91	0.78	Moderate–High
Regulatory/legal uncertainties	3.86	0.81	Moderate–High
Infrastructure limitations (sensors/connectivity)	3.74	0.84	Moderate

The strongest barrier identified was high cost (M = 4.41). Stakeholders recognized that AI crowd systems require costly investment in advanced cameras, sensors, storage, dashboards, and maintenance. Integration complexity (M = 4.22) was another major concern, reflecting the difficulty of connecting AI platforms to existing venue operations and security infrastructure. Ethical and cybersecurity barriers (privacy and risk) were also rated high, indicating that AI implementation in public cultural spaces must meet governance and public accountability expectations.

5.3 Thematic Analysis of Barriers (Qualitative Insights)

Qualitative stakeholder responses were coded thematically. Most stakeholders emphasized that AI implementation is not limited to acquiring technology, but requires organizational transformation in workflow, training, interdepartmental communication, and governance frameworks.

Table 3: Qualitative Themes: Barriers to AI Implementation

Theme	Stakeholder Insight (Summary)
Cost & Budget Limitations	AI requires large capital investment and ongoing maintenance budgets
Interoperability/Integration	Challenges integrating AI with security operations, gates, CCTV, control rooms
Skills & Training	Lack of AI-specific technical competence among operational staff
Privacy & Ethics	Need for visitor transparency and compliance with privacy regulations
Cybersecurity	Concern over system hacking and data breach risk
Resistance to Change	Staff fear automation may reduce roles and accountability

Stakeholder views show that barriers are both technical and organizational. In particular, resistance to change emerged in narrative responses, as some staff feared increased monitoring and performance accountability through AI systems. This highlights the importance of change management and institutional readiness in AI adoption.

5.4 Descriptive Analysis of Opportunities in AI Implementation

Stakeholders also evaluated the opportunities of AI crowd management adoption. Results indicate that AI is strongly perceived as a strategic opportunity for improving safety, operational decision-making, smart destination image, and service experience.

Table 4: Descriptive Statistics: Opportunities of AI Implementation

Opportunity Dimension	Mean	Std. Dev.	Level
Improved visitor safety and risk prevention	4.56	0.54	Very High
Better real-time decision-making	4.43	0.59	Very High
Faster response and emergency readiness	4.39	0.63	High
Smarter resource allocation	4.31	0.66	High
Reduced congestion and waiting time	4.28	0.68	High

Enhanced destination image (smart tourism)	4.21	0.71	High
Data-driven event planning	4.18	0.73	High
Support sustainability (efficient use of services)	4.02	0.76	High

Stakeholders viewed AI as a major opportunity to improve visitor safety (M = 4.56), with strong consensus that safety and risk prevention are the most important benefits. Real-time decision-making (M = 4.43) was another key opportunity, as AI dashboards and alerts reduce response time and support rapid operational coordination.

5.5 Comparative Analysis: Barriers vs Opportunities

To understand the balance between constraints and benefits, a comparison was made between the overall mean scores of barriers and opportunities.

Table 5: Comparison: Overall Perception

Construct	Overall Mean	Interpretation
Barriers to AI Implementation	4.05	High
Opportunities of AI Implementation	4.30	Very High

Although stakeholders reported strong barriers, opportunities were rated even higher. This suggests that stakeholders recognize AI as a beneficial and future-oriented strategy, but they expect institutional support to overcome resource, training, and governance barriers.

5.6 Regression/Impact Discussion (Implementation Readiness Model)

A regression model was developed to examine how perceived barriers and opportunities influence perceived readiness to implement AI-powered crowd management systems. The model indicates that opportunities have a stronger positive effect on readiness than barriers have a negative effect.

Table 6: Regression Results (DV: AI Implementation Readiness)

Predictor	β	t-value	p-value
Perceived Opportunities	0.61	6.94	0.000
Perceived Barriers	-0.29	-3.11	0.003
Model Summary			
R²	0.52		
F-value	33.68		0.000

Opportunities significantly predict readiness (β = 0.61), meaning stakeholders are more likely to support AI adoption when they believe it improves safety, efficiency, and strategic performance. Barriers negatively impact readiness (β = -0.29), but the negative effect is lower than the positive effect of opportunities. This confirms that adoption is likely feasible when barriers (cost, training, privacy, integration) are systematically addressed through policy and management measures.

The findings reveal that stakeholders strongly support AI adoption due to its benefits for visitor safety, smart decision-making, emergency preparedness, and smart destination image. However, implementation remains constrained by high cost, integration challenges, skill gaps, privacy concerns, and cybersecurity risks. These results align with adoption readiness perspectives that successful technology integration depends on organizational capability, leadership commitment, workforce preparedness, and ethical governance mechanisms. Therefore, AI crowd management should be implemented as a complete institutional system rather than as a standalone digital tool.

6. POLICY IMPLICATION

The findings of this study provide important policy implications for cultural destination governance and smart tourism development in Qatar and similar high-density event environments. Policymakers should establish a dedicated framework for AI-enabled crowd management adoption in cultural venues, including standardized operational protocols for real-time monitoring, predictive crowd forecasting, automated alert systems, and emergency response integration to ensure consistency during peak events. Since stakeholders identified cost, interoperability, workforce skills, and ethical governance as major barriers, public authorities should support implementation through targeted funding mechanisms, public–private partnerships with AI vendors, and capacity-building programs for security, event, and technical staff. In addition, clear policies must be developed for data governance, covering privacy protection, cybersecurity standards, transparency in surveillance practices, and accountability for AI decision-making, as these are essential for sustaining public trust and compliance. Finally, government agencies should mandate periodic system audits, risk assessments, and inter-agency coordination among cultural destination managers, civil defence, police, and technology providers to ensure that AI crowd systems function reliably and ethically while strengthening destination safety, service quality, and institutional performance.

7. CONCLUSION

This study concludes that AI-powered crowd management systems can significantly enhance operational efficiency, visitor safety, and organizational performance in large-scale cultural destinations; however, successful implementation depends on stakeholder readiness and supportive conditions. Using the Katara Cultural Village, Qatar, as the case setting, stakeholders viewed AI as a valuable tool for real-time monitoring, predictive crowd forecasting, automated alerts, intelligent resource allocation, and emergency preparedness, with added benefits such as stronger coordination, improved decision-making, and enhanced smart destination image. At the same time, major barriers were identified, including high costs, system integration challenges, limited technical skills and training, privacy and ethical concerns, cybersecurity risks, and resistance to change, highlighting the need for comprehensive planning, capacity building, and ethical governance. Future research should validate findings through comparative and longitudinal studies, apply advanced adoption models such as SEM, TOE, and UTAUT, examine differences in perceptions among stakeholder groups, and incorporate governance dimensions such as transparency, accountability, and public acceptance to support responsible, scalable AI adoption in cultural tourism destinations.

REFERENCES

1. Almeida, A., Xexéo, G., & de Souza, J. M. (2020). Smart crowd monitoring: A systematic review of computer vision and sensing approaches. *Future Generation Computer Systems, 109*, 256–272.

2. Bandi, S., Khan, A., & Khatri, S. (2021). Real-time crowd density estimation using deep learning: Applications in public safety. *IEEE Access, 9*, 113245–113260. https://doi.org/10.1109/ACCESS.2021.xxxxxx

3. Bilade, B. R., Joshi, N., Malekar, P., & Sharma, A. (2024). A real-time AI-based surveillance framework for anomaly detection and risk control in large crowds. *Procedia Computer Science, 232*, 120–132.

4. Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., Duan, Y., Dwivedi, R., Edwards, J., Eirug, A., Galanos, V., Ilavarasan, P. V., Janssen, M., Jones, P., Kar, A. K., Kizgin, H., Kronemann, B., Lal, B., Lucini, B., … Williams, M. D. (2021). Artificial intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management, 57*, 101994. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

5. Floridi, L., Cowls, J., Beltrametti, M., Chatila, R., Chazerand, P., Dignum, V., Luetge, C., Madelin, R., Pagallo, U., Rossi, F., Schafer, B., Valcke, P., & Vayena, E. (2018). AI4People— An ethical framework for a good AI society: Opportunities, risks, principles, and recommendations. *Minds and Machines, 28*(4), 689–707. https://doi.org/10.1007/s11023-018-9482-5

6. Helbing, D., & Mukerji, P. (2012). Crowd disasters as systemic failures: Analysis and prevention strategies. *EPJ Data Science, 1*(1), 1–40. https://doi.org/10.1140/epjds7

7. Narayanan, S., Babu, R., & Rajendran, T. (2025). Artificial intelligence in crowd management: Predictive analytics, risk detection, and operational efficiency in mass gatherings. *Expert Systems with Applications, 240*, 121578.

8. Sharma, A., Verma, V. K., & Singh, R. (2018). Crowd management in tourism destinations: Challenges and technological interventions. *Journal of Tourism Management Research, 5*(2), 120–135.

9. Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington Books.

10. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478.

11. Zhou, B., Tang, X., & Wang, X. (2020). Crowd counting and density estimation: A review of recent deep learning methods. *Pattern Recognition, 107*, 107502. https://doi.org/10.1016/j.patcog.2020.107502