

E-Governance 4.0: Integrating AI and IoT for Sustainable and Smart Management of Maha Kumbh 2025

Ms. Ritika Yadav, Dr. Gaurav Ashesh

Auro University, Surat, India

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Abstract: e-Governance 4.0 represents a paradigm shift in public administration, leveraging artificial intelligence (AI) and the Internet of Things (IoT) to create a seamless, efficient, and sustainable governance framework. The Maha Kumbh Mela, one of the world's largest religious congregations, presents unique challenges in crowd management, security, resource allocation, and environmental sustainability. This study explores the role of AI and IoT in transforming the governance of Maha Kumbh through real-time data analytics, automated decision-making, and predictive management. AI-driven surveillance, IoT-enabled smart infrastructure, and blockchain-based digital services ensure enhanced security, optimised traffic control, and effective waste management. Additionally, AI-powered chatbots and digital platforms improve pilgrim engagement, while sustainable IoT solutions contribute to environmental conservation. By integrating these advanced technologies, e-Governance 4.0 fosters a resilient, adaptive, and citizen-centric approach to managing large-scale events. This paper highlights key technological innovations and policy recommendations for implementing AI- and IoT-driven governance models in future mega-events. Leveraging innovations in artificial intelligence (AI), the IoT, blockchain, and cloud computing, organizers may develop an integrated system designed to enhance safety, streamline logistics, and improve the overall pilgrim experience. This paper outlines the methods and lessons learned, to propose a conceptual framework for managing future mass gatherings.

Keywords: e-Governance, Maha Kumbh Mela 2025, Artificial Intelligence (AI), IoT, Kumbh Sah'AI'yak Chatbot, AI-enabled CCTV Surveillance, IoT-Based Waste Management, E-Health Services, Blockchain-enabled governance.

I. Introduction

The Maha Kumbh Mela, held every 12 years, is world's largest religious gatherings, attracting millions of devotees to the confluence of the Ganges, Yamuna, and the mythological Saraswati rivers at Prayagraj. The Maha Kumbh Mela 2025 integrates traditional religious practices with modern technological advancements. The 2025 edition, which anticipated over 62 crore (TOI) participants but witnessed over six weeks, necessitated robust planning and management strategies. e-Governance emerged as a pivotal tool in orchestrating the event's logistics, safety, and overall experience. Mass gatherings such as the Maha Kumbh Mela pose extraordinary challenges with respect to logistics, crowd management, health services, and security. This paper explores the e-Governance initiatives which may be implemented to manage this colossal event, focusing on digital infrastructure, multilingual communication, artificial intelligence (AI) applications, and sustainable practices. These measures would help not only ensure the safety and convenience of millions of pilgrims but also showcase India's commitment to leveraging technology for efficient governance. The Maha Kumbh Mela 2025, would do well to implement advance digital governance strategies to enhance efficiency, safety, and public service delivery. Artificial Intelligence (AI), Big Data, IoT, blockchain, cloud computing, and mobile technology will play a pivotal role in managing crowds, ensuring security, streamlining transport, and delivering real-time information to millions of pilgrims. Managing such a vast congregation required digital transformation to ensure seamless coordination, resource optimization, and public engagement by integrating AI-driven monitoring, blockchain-enabled governance, IoT-based infrastructure, and e-Governance platforms.

The Maha Kumbh Mela 2025 stands as an exemplary model of the fusion between tradition and modern technology. It presented unprecedented logistical and administrative challenges. This paper delves into the e-Governance initiatives which may be implemented to efficiently manage this monumental event, focusing on digital infrastructure, AI-driven governance, multilingual communication systems, advanced safety mechanisms, and sustainable technological innovations. The successful integration of these measures ensures the safety, convenience, and seamless experience for millions of pilgrims while reinforcing India's commitment to digital transformation in governance.

Traditional management approaches were insufficient to cater to the logistical challenges posed by such an enormous gathering. Thus, the team would do well to embrace e-Governance—a digital framework integrating cutting-edge solutions such as artificial intelligence (AI), IoT, blockchain technology, cloud computing, and big data analytics. These digital tools help authorities monitor real-time data, optimize decision-making, and provide efficient services to attendees.

II. Theoretical background

The Maha Kumbh Mela is not only a highly significant religious festival but also a complex logistical operation. Wherein traditional management methods often reach their limits. The motivation behind the digital governance strategy could be threefold:

- Safety and Security: To prevent accidents such as stampedes using predictive analytics and AI-driven surveillance.

- **Efficiency:** To streamline crowd control, traffic management, and emergency services.
- **Public Engagement:** To ensure real-time, transparent communication and effective citizen support through digital platforms.

By interfacing cutting-edge technologies with traditional event management practices, the organisers may set a new benchmark in large-scale event administration.

Religious and Cultural Significance

Maha Kumbh, held every 12 years, is deeply rooted in Hindu scriptures and mythology, particularly the Puranas with reference to the churning of the ocean (*Samudra Manthan*). Key theoretical perspectives include:

- **Mythological Foundations:** Based on the legend of the fight between *Devas* (Gods) and *Asuras* (Demons) over the *Amrit* (nectar of immortality) (Doniger, 1999), with drops spilling at four locations—Prayagraj, Haridwar, Ujjain, and Nashik.
- **Sacred Geography Theory:** The confluence (*Sangam*) of the Ganga, Yamuna, and the mythical Saraswati is considered an auspicious site for spiritual purification. (Bhardwaj, 1973)
- **Ritual Theory:** The pilgrimage serves as a liminal phase where devotees undergo spiritual transformation through rituals like bathing in the holy river. (Turner, 1969).

Sociological Perspective

Maha Kumbh 2025 can be analysed through Durkheim's collective consciousness theory and Turner's *communitas* concept (Durkheim, 1912; Turner, 1974).

- **Collective Religious Experience:** The gathering strengthens social cohesion and shared beliefs, reaffirming religious identity.
- **Social Stratification and Fluidity:** Despite caste and social distinctions, Kumbh provides a temporary state of equality where all pilgrims participate in common rituals.
- **Modernisation and Globalisation:** The event now attracts not just Indian devotees but also international tourists, researchers, and scholars, broadening its socio-cultural impact.

Economic and Technological Perspectives

- **Economic Impact Theory:** Maha Kumbh contributes significantly to local and national economies through tourism, hospitality, and associated industries.
- **Smart Kumbh Initiative:** Integration of digital technologies, AI-based crowd management, and mobile applications for better security, logistics, and accessibility.
- **Sustainable Urban Planning:** Infrastructure developments, waste management, and eco-friendly initiatives to handle the massive footfall.

Political and Administrative Framework

- **Public Policy and Governance:** The massive taskforce deployed in organising and securing the event presents a case study in managing such a large-scale event.
- **Religious Diplomacy:** Maha Kumbh serves as a soft-power tool for India to showcase its cultural heritage on the global stage.

Social Impact

- The Maha Kumbh Mela fostered social cohesion by bringing together millions of individuals from diverse backgrounds for shared spiritual practices. People from all over the world not just India conversed at the confluence of 3 rivers, which has huge socio-cultural and economic implications. However, challenges arose, including incidents of overcrowding leading to tragic stampedes at railway stations, resulting in loss of life and highlighting the need for improved crowd management strategies.
- Environmental concerns were also prominent, with the temporary city generating significant waste and requiring extensive cleanup efforts post-event. The dismantling of the temporary infrastructure aimed to repurpose materials for future use and address environmental impacts. In summary, the Maha Kumbh Mela 2025 had a multifaceted socio-economic impact, driving substantial economic growth and infrastructural advancements while also presenting challenges in crowd management and environmental sustainability.

Economic Impact

- The Maha Kumbh Mela 2025, held in Prayagraj, Uttar Pradesh, had profound socio-economic impacts, significantly influencing the local and national economy, infrastructure development, and social dynamics.
- The event generated substantial economic activity, with estimates indicating an output of approximately ₹2.8 lakh crore (around \$34 billion). This figure encompasses direct expenditures by attendees, indirect effects from related industries, and induced impacts from increased disposable income among residents. Notably, direct spending by visitors reached about ₹90,000 crore, with transportation services alone contributing ₹37,000 crore. The Confederation of All India Traders (CAIT) projected business transactions exceeding ₹3 lakh crore during the 45-day festival, highlighting the event's significant contribution to the economy. (The Economic Times)

III. Review of Literature

e-Governance 4.0 represents the evolution of electronic government services in the era of the fourth industrial revolution. It leverages emerging technologies such as artificial intelligence, big data, the IoT, and blockchain to enhance public service delivery and citizen engagement (Cruz and Sandoval-Almazán, 2014; Elhabian, 2021). This new paradigm aims to improve the effectiveness, efficiency, and transparency of government operations while reducing costs and corruption (Prihartono and Tuti, 2023).

The implementation of e-Governance 4.0 requires support, capacity, and value-driven approaches to overcome tangible and intangible challenges (Prihartono and Tuti, 2023). It transforms traditional paper-based processes into secure, tamper-proof digital systems, enhancing data management and accessibility (Alfawaz, 2023). As governments worldwide adopt these technologies, e-Governance 4.0 is poised to revolutionise public administration, fostering innovation in service provision and facilitating more interactive citizen-government relationships (Elhabian, 2021; Alfawaz, 2023).

This concept aims to enhance government services and interactions with citizens, businesses, and other agencies (Rahadian, 2019). While the quantitative implementation of e-government in Indonesia has increased, qualitative improvements are still needed, particularly in regional areas (Jefri et al., 2023; Wirawan, 2020). Challenges include limited human resources, inadequate management systems, and a narrow focus on website creation (Jefri et al., 2023). To successfully transition to e-Governance 4.0, recommendations include improving legal regulations, enhancing IT education, developing adequate infrastructure, fostering a disruptive mindset among government officials, and strengthening moral and religious education (Jefri et al., 2023; Wirawan, 2020). These efforts are crucial for increasing national competitiveness and adapting to the industrial revolution 4.0 era (Rahadian, 2019).

e-Governance in India has evolved significantly since its inception, aiming to improve public service delivery through Information and Communication Technology (ICT) (Gupta and Bansal, 2013). It is considered a high-priority agenda to bring IT to the common public, despite challenges such as poverty, literacy, and infrastructure issues (Kumar et al., 2010). India's e-Governance journey progressed from computerization (1984-1995) to internet-based services (post-1995), with the government drafting twelve minimal agendas for implementation in 2000 (Reghunath, 2022). The National e-Governance Plan (NeGP) in 2006 marked a more organized approach, followed by the Digital India initiative in 2014, which aimed to introduce digitization at the grassroots level (Anand and Khemchandani, 2019). While e-Governance has improved transparency, accountability, and service delivery times, challenges persist, including the digital divide and the need for infrastructure development and public digital education (Reghunath, 2022; Kumar et al., 2010).

The Kumbh Mela, particularly the Maha Kumbh, is one of the world's largest religious mass gatherings, attracting millions of Hindu pilgrims (O'Connell, 2010). Managing such an event presents significant challenges in terms of sanitation, healthcare, and crowd control (Baranwal et al., 2015). While the Maha Kumbh 2013, was generally well-managed, with satisfactory health and hygiene conditions, some issues like drainage problems and inadequate toilet facilities were identified (Baranwal et al., 2015). The Simhastha Maha Kumbh 2016, at Ujjain resulted in poor river water quality, with some bathing sites exceeding pollution control norms (Pawar, 2016). More recently, the Maha Kumbh 2021, raised concerns about the introduction of various pathogens into the Ganga River ecosystem (Patel et al., 2021) which remains to be further ratified though.

Researchers discussed the risks of crowd surges and crush injuries at the Kumbh Mela and the need for public health preparedness to reduce these risks. Reducing the risk of crowd surges and associated deaths and/or injuries is a crucial public health priority for such mass gatherings. (Kanauiya and Tiwari, 2025) An opportunity to promote antibiotic stewardship through digital tools, training, and task shifting at Kumbh Mela, the world's largest mass gathering, by implementing task shifting, point-of-care diagnostics, digital tools, clinician training, and community awareness campaigns to address the high rates of antibiotic overuse and overprescribing observed at previous Kumbh Mela events. (Chan et al. 2022) Digital surveillance at the 2013 and 2015 Kumbh Melas found high rates of antibiotic overuse, with up to 31% of all patient encounters resulting in an antibiotic prescription. Antibiotic prescribing was particularly high for upper respiratory tract infections (68.7% of patients) and febrile illnesses (53.7% of patients with fever received antibiotics), despite most being viral in origin. There was significant variation in

antibiotic prescribing practices across different clinics, with some clinics prescribing fluoroquinolones. A dedicated e-Health campaign hence needs to be conceived and executed in future.

The management and planning of the Maha Kumbh Mela, a large religious mass gathering in India, with a focus on the water, sanitation, and hygiene (WASH) conditions. (Baranwal et al. 2015) The health care services as well as the water, sanitation, and hygiene conditions at the Kumbh Mela event were satisfactory. Problems with drainage and some fire incidents were identified as issues that need to be addressed to make the event cleaner and safer.

The effect of mass ritualistic bathing on the water quality of the Ganges River during the Maha Kumbh festival in India and found significantly elevated levels of various water quality parameters, including Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Total suspended solids (TSS), ammonia nitrogen, total coliforms, and fecal coliforms, which exceeded standard criteria for outdoor bathing, leading to 5,368 cases of waterborne infections, and recommending strict regulation of bathing practices and continuous disinfection upstream to protect public health and water quality (Tyagi et al., 2013; Pawar, 2016; Arora et al., 2013). Further research needs to be conducted to explore the phenomenon and take pre-emptive measures theory, as and when needed.

It is pertinent to mention the research work that describes the water, sanitation, and hygiene components, the capacity for disease surveillance and response, and the implications of lessons learned from the 2013 Kumbh Mela. Vortmann et al. (2015). To accommodate the massive numbers, a temporary city was constructed on the flood plains of the two rivers along with roads, electricity, water and sanitation facilities, police stations, and a tiered healthcare system. This phenomenal operation and its impacts have gone largely undocumented. To address this gap, the researchers undertook an evaluation and systematic monitoring initiative to study preparedness and response to public health emergencies at the event. This water, sanitation, and hygiene components were studied with particular emphasis on preventive and mitigation strategies; the capacity for surveillance and response to diarrheal disease outbreaks; and the implications of lessons learned for other mass gatherings.

The IoT offers significant potential for managing large-scale events and crowds. IoT systems can enhance event organization through smart entry-exit management using RFID and Wi-Fi technologies (Mankad and Upadhyay, 2022). Rule-based engines can process data from various IoT devices to provide insights and guide actions (Shukla and Sornalakshmi, 2015). In sporting events, open IoT ecosystems can overcome the challenge of vertical silos, enabling better collaboration among stakeholders and improved services (Kubler et al., 2017). For managing religious gatherings, IoT approaches can analyse crowd data, classify pilgrims, and provide real-time guidance to avoid congestion and ensure safety (Nabhan et al., 2021). These applications demonstrate IoT's capacity to enhance efficiency, safety, and decision-making in mega-event management by integrating diverse technologies and data sources to monitor and control large crowds effectively.

India faces significant cybersecurity challenges as the second-largest Internet user base globally (Patil, 2022). The country experienced over 2.3 million cyberattacks in early 2020, ranking eleventh worldwide for local incidents (Panneerselvam, 2022). Threats include ransomware, phishing, malware, and cyber-enabled espionage, primarily from China and Pakistan (Patil, 2022; Mallika et al., 2018). Indian organizations struggle with data protection, cloud security, and IoT vulnerabilities and hence the government is implementing cybersecurity frameworks and risk assessment models to address these issues (Bhatia, 2022). However, India faces a shortage of qualified cybersecurity professionals (Panneerselvam, 2022). The country must balance its commitment to a liberal multi-stakeholder cyberspace order with national security interests (Patil, 2022). Preventive measures, such as honeypot technologies and public awareness programmes are being developed to combat cybercrime (Mallika et al., 2018; Bhatia, 2022). It carries immense significance in the context of Maha Kumbh's large congregations.

Recent research has explored innovative approaches to crowd management using artificial intelligence (AI) and advanced technologies. Bio-inspired computational AI systems integrating ergonomics, anthropometry, and computer vision have shown promise in real-time crowd monitoring, though still falling short of human performance (Chin et al., 2018). Smart frameworks combining AI with other technologies have been developed for effective crowd control, as demonstrated in a Hajj case study (Almutairi et al., 2024). Deep learning-based solutions have proven successful in managing large gatherings, such as the Kumbh Mela, by enabling real-time crowd surveillance and analytics (Rajendran and Shankaran, 2021). Furthermore, innovative approaches combining CubeSat technology with AI frameworks and wearable devices have been proposed for crowd management during short-term, large-scale events, achieving 95% accuracy in monitoring and managing crowds (Almalki et al., 2022). These advancements highlight the potential of AI-driven solutions in enhancing crowd safety and management. Controlling spontaneous crowded events, sort of a protest march, political rally, celebration after a sporting event, or concert, are often quite difficult. The study applied algorithms like real time analysis, k-fold cross evaluation, and nested cross-evaluation to validate the crowd density of these events (Varun, 2022).

Theoretical Frameworks of immediate relevance:

The digital e-Governance model for Maha Kumbh Mela involves various core technologies. It is proposed as follows:

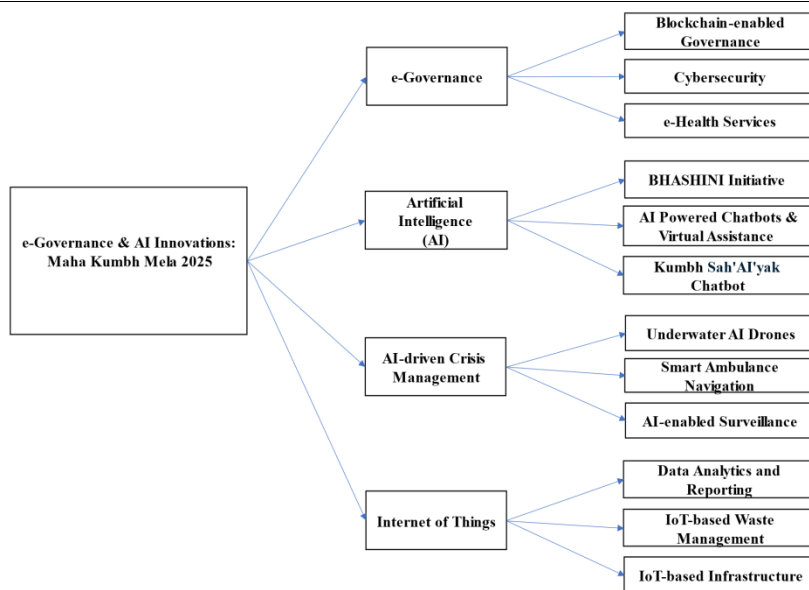


Figure: Author's interpretation of e-Governance & AI Innovations

e-Governance:

Blockchain-enabled Governance:

Leveraging for secure data handling and ensuring transparency in administrative processes. Secure, transparent, and tamper-proof record-keeping for event administration. Digital identity verification for pilgrims and vendors along with that Real-time tracking of funds and resource allocation.

Cybersecurity:

Digital Passes: Aadhaar-based digital passes to facilitate a secure and efficient identity verification process. Digital services for pilgrim registration, complaint resolution, and information dissemination, Online permits for vendors and transport services and AI-assisted document verification and grievance redressal. AI-based threat detection to secure digital services from cyber-attacks, Data encryption and protection of sensitive pilgrim information, monitoring and mitigating phishing or fraudulent activities.

e-Health Services: Telemedicine: AI-enabled health kiosks and telemedicine services to ensure quick response to medical emergencies. Telemedicine, mobile health units, and AI-driven diagnostics for efficient healthcare delivery. Smart health cards for quick access to medical history and emergency care.

Ambulance Management: AI tools to assist in routing and dispatching ambulances more efficiently. Digital healthcare solutions to provide medical assistance to pilgrims.

Artificial Intelligence (AI)

BHASHINI Initiative: AI-powered language translation services to assist international and regional pilgrims. Voice-to-text conversion for accessibility support. Integration with chatbot systems for seamless multilingual communication. BHASHINI's deployment at Maha Kumbh 2025 exemplifies its transformative potential in bridging linguistic divides. By enabling seamless communication, it not only enhances the event's inclusivity but also sets a precedent for leveraging technology to address India's linguistic diversity. As BHASHINI continues to evolve, it promises to play a pivotal role in realizing the vision of a truly connected and inclusive digital India.

AI Powered Chatbots and Virtual Assistance: Multilingual Support: AI-powered chatbots and virtual assistants to provide real-time information in multiple languages, enhancing the overall visitor experience.

Services: These tools offer route guidance, emergency contacts, and general assistance throughout the event. 24/7 virtual assistance for answering queries related to routes, events, and facilities, Language-based AI for multi-lingual support and Pilgrim guidance using real-time GPS-based navigation.

Kumbh Sah'AI'yak Chatbot: A specialized AI chatbot designed to assist pilgrims, Provides instant information on lodging, transportation, and rituals and Voice and text-based assistance in multiple languages. Kumbh Sah'AI'yak chatbot is a cutting-edge AI tool, designed to provide real-time guidance and updates to devotees attending the Maha Kumbh Mela 2025. It will act as a digital companion for the millions of devotees. Some of its key features include multilingual support, interactive engagement, personal navigation, and cultural insights. It can be accessed through the official Maha Kumbh 2025 mobile app or via WhatsApp.

AI-driven Crisis Management:

AI algorithms to predict and prevent stampedes or emergencies, Real-time monitoring of weather, crowd density, and security threats, Automated alerts, and emergency response coordination. The Uttar Pradesh government introduced the “Digi Kumbh” initiative, bringing advanced technology to ensure the safety and smooth operation of the event.

AI-powered analytics for event planning and decision-making, Smart surveillance, crowd behaviour analysis, and automated service bots and Data-driven insights for better resource management.

Underwater AI Drones: For the first time, the 2025 Maha Kumbh in Prayagraj will feature underwater AI drones for 24/7 surveillance of the Sangam area, alongside AI-powered cameras and other high-tech security measures to ensure the safety of the millions of pilgrims. AI-enabled drones for monitoring river pollution and safety, Water quality assessment and debris removal and Surveillance for underwater threats and security breaches.

Smart Ambulance Navigation: AI-driven route optimization for emergency vehicles, Real-time traffic updates for quick medical response and Automated alerts to clear paths for ambulances.

The water ambulance, also referred to as a "boat ambulance," aims to provide swift and effective medical assistance to pilgrims who may require immediate care, particularly during bathing rituals at the Sangam (the confluence of the Ganga, Yamuna, and Saraswati rivers).

AI-enabled Surveillance: Digital Traffic and Transport Management

AI to optimise traffic flow and manage public transportation, reducing congestion and enhancing mobility.

Monitoring: Real-time data to help adjust public transport schedules and manage automated parking solutions. Facial recognition for security and lost-and-found services, Suspicious activity detection using AI cameras, Real-time monitoring to prevent unauthorized access.

IoT:

Smart sensors for crowd management, environmental monitoring, and security, IoT-based wearable devices for health tracking of elderly and sick pilgrims, Automated traffic management systems for seamless movement.

Data Analytics and Reporting: Predictive analytics for estimating crowd density and movement patterns, Performance tracking of e-services and governance initiatives and Real-time dashboards for authorities to monitor event logistics.

IoT-based Waste Management:

Water Quality and Waste: IoT-based monitoring systems to ensure water quality while facilitating automated and efficient waste collection, Smart dustbins with real-time fill-level sensors, Automated waste collection scheduling using AI algorithms. Waste segregation and recycling monitoring through IoT sensors.

IoT-based Infrastructure: Deployment: IoT sensors installed across the temporary city to monitor environmental parameters and structural integrity. Smart lighting and energy-efficient infrastructure, IoT-powered water supply management and Structural health monitoring of temporary bridges and camps.

Applications: Smart surveillance cameras, sensor-driven smart lighting, and adaptive waste management systems to provide real-time data essential for proactive decision-making.

AI-Driven Crowd and Security Management: Technologies: Facial recognition and biometric surveillance systems for monitoring crowd movements.

Analytics: Predictive analytics to identify potential hotspots, facilitating proactive steps to avert incidents. such as stampedes or congestion.

Expected Outcome:

The amalgamation of these digital technologies deployed to provide several notable outcomes:

Enhanced Crowd Management: The use of AI and predictive analytics to facilitate early detection and mitigation of potential bottlenecks.

Improved Security: Facial recognition and biometric systems to significantly enhance surveillance, enabling to a safer environment.

Optimised Transportation: AI-driven traffic management to ensure resulted in smoother transportation flows and reduced congestion.

Effective Health Services: Telemedicine and AI-enabled health kiosks to ensure reduced response times for medical emergencies.

Environmental Sustainability: IoT-based monitoring to enable better resource management and waste disposal, supporting eco-friendly practices.

Increased Transparency: Real-time data sharing and digital engagement initiatives to foster a high level of public trust and participation.

IV. Discussion

The application of e-Governance at Maha Kumbh Mela offers valuable lessons. The integrated approach that combines IoT, AI, and blockchain could not only improve operational efficiency but also ensure public safety and comfort. Key takeaways include:

- Scalability: The digital systems as tailored to handle the unprecedented scale of the event, provide their adaptability for future mass gatherings.
- Interoperability: The seamless integration across various technological platforms proves critically helpful for unified operations.
- Public Trust: Transparent data dissemination and robust security measures for enhanced the overall credibility of the initiatives.

Despite these expected milestones of success, challenges such as data privacy, system interoperability, and the need for real-time analytics remain critical considerations for future implementations.

V. Conclusion

Maha Kumbh Mela 2025 demonstrates that e-Governance coupled with smart technologies can revolutionise the management of large-scale public events. The successful deployment of IoT, AI, blockchain, and other advanced systems could ensure improved safety, streamline logistics, and heighten public engagement. The proposed model serves as a blueprint for integrating technology in public administration and mass event management, paving the way for future innovations in digital governance. By deploying cutting-edge technologies, AI-driven communication tools, and sustainable practices, the event redefines the role of e-Governance in managing large-scale religious congregations in future. The success of this model could thus establish a benchmark for future mass gatherings worldwide, demonstrating the potential of digital governance in orchestrating complex logistical challenges while preserving cultural heritage.

Limitation

A significantly large human gathering of this scale on the planet comes with its own characteristic challenges and risks, not withstanding every conceivable measure and mechanism to design and execute an error-free event management eco system, few isolated and unfortunate tragic incidents like stampede and fire hence generates a learning experience for the entire management team to proactively conceive and implement an improved blueprint for the next such mega events in future.

References

1. Almutairi, M.M., Apostolopoulou, D., Stupples, D., Sen, A.A., Yamin, M., and Halikias, G. (2024). Integrative Technologies for Real-Time Crowd Management: A Case Study of the Hajj. 2024 11th International Conference on Computing for Sustainable Global Development (INDIACom), 203-211.
2. Anand, D., and Khemchandani, V. (2019). Study of e-Governance in India: a survey. Int. J. Electron. Secur. Digit. Forensics, 11, 119-144.
3. Bhatia (2022): A Comprehensive Review on the Cyber Security Methods in Indian Organisation Int. J. Advance Soft Compu. Appl, Vol. 14, No. 1, March 2022 Print ISSN: 2710-1274, Online ISSN: 2074-8523
4. Bhattacharya, S., and Reddy, P. (2022). Crowd Management and Safety Measures in Mega Religious Gatherings: Lessons from Kumbh Mela. Journal of Safety Research, 53(4), 78-92. <https://doi.org/10.1016/j.jsr.2022.07.005>
5. Cruz, D.V., and Sandoval-Almazán, R. (2014). E-gov 4.0: a literature review towards the new government. Proceedings of the 15th Annual International Conference on Digital Government Research.
6. <https://economictimes.indiatimes.com/news/india/report-pegs-prayagraj-maha-kumbh-economic-activity-at-rs-2-8-lakh-crore/articleshow/119875554.cms?from=mdr>
7. Government of India. (2023). National Strategy for Sustainable Tourism. Ministry of Tourism. Retrieved from <https://tourism.gov.in>
8. Gupta, A., and Bansal, R. (2013). E-Governance: A Step Ahead. 2013 Third International Conference on Advanced Computing and Communication Technologies (ACCT), 359-362.
9. Gupta, A., and Kumar, S. (2021). Economic Impact of Mega Events: A Case Study of Kumbh Mela. International Journal of Event Management, 12(2), 112-128. <https://doi.org/10.1016/j.ijem.2021.05.003>
10. International Institute for Environment and Development (IIED). (2023). Sustainable Tourism Practices for Mega Events. Retrieved from <https://www.iied.org>
11. "IPSA-Kumbh: Mapping Impact of Floating Population on Sewerage during Maha Kumbh 2025" https://terisas.ac.in/pdf/TOR_Maha_Kumbh2025_TERI-SAS.pdf
12. Chin J., Wong T.W., So R.H.Y: Advances in Intelligent Systems and Computing 2018.

13. Kebijakan: Jurnal Ilmu Administrasi Volume 14, Nomor 2, Juni 2023 E-ISSN: 2656-2820 P-ISSN 1829-5762
14. Kubler, S., Robert, J., Hefnawy, A., Främling, K., Cherifi, C., and Bouras, A. (2017). Open IoT Ecosystem for Sporting Event Management. *IEEE Access*, 5, 7064-7079.
15. Kumar, R., and Singh, A. (2023). Digital Transformation in Tourism: Leveraging Technology for Global Events. *International Journal of Tourism Technology*, 14(1), 33-48. <https://doi.org/10.1504/IJTT.2023.10045678> [
16. Mallika, Deep, V., and Sharma, P. (2018). Analysis and Impact of Cyber Security Threats in India using Mazarbot Case Study. 2018 International Conference on Computational Techniques, Electronics and Mechanical Systems (CTEMS), 499-503.
17. Mankad, V., and Upadhyay, M.A. (2022). Managing Events: The IoT Way. 2022 4th International Conference on Advances in Computing, Communication Control and Networking (ICAC3N), 1292-1297.
18. National Geographic. (2021). The Spiritual and Cultural Significance of Kumbh Mela. Retrieved from <https://www.nationalgeographic.com>
19. O'Connell, E.R. (2010). Pilgrimage and Power: The Kumbh Mela in Allahabad, 1765–1954. By Kama Maclean. (New York, N.Y.: Oxford University Press, 2008. Pp. xv, 344. \$74.00.). *The Historian*, 72, 199 - 200. **Industrial Revolution 4.0 technologies for democratic e-government services** https://refpress.org/wp-content/uploads/2023/04/Paper-9_REF.pdf
20. Patel, A., Mukherjee, S., Leifels, M., Gautam, R.K., Kaushik, H., Sharma, S., and Kumar, O.P. (2021). Mega festivals like Maha Kumbh, a largest mass congregation, facilitated the transmission of SARS-CoV-2 to humans and endangered animals via contaminated water. *International Journal of Hygiene and Environmental Health*, 237, 113836 - 113836.
21. Patil, S.S. (2022). India's Cyber Security Landscape. *India Studies in Business and Economics*.
22. Pawar, R.S. (2016). Assessment of Mass Bathing on River Water Quality During Simhashta Maha Kumbh Mela 2016 in Ujjain , Madhya Pradesh India.
23. Prayagraj District Administration. (2023). Maha Kumbh Mela 2025: Preparations and Plans. Official Report. Retrieved from <https://prayagraj.nic.in>
24. Rahadian, A. (2019). REVITALISASI BIROKRASI MELALUI TRANSFORMASI BIROKRASI MENUJU E-GOVERNANCE PADA ERA REVOLUSI INDUSTRI 4.0.
25. Rajendran, L., and Shankaran, R.S. (2021). Bigdata Enabled Realtime Crowd Surveillance Using Artificial Intelligence And Deep Learning. 2021 IEEE International Conference on Big Data and Smart Computing (BigComp), 129-132.
26. Ranganath, N.S. (2013). E-GOVERNANCE AS A DEVELOPMENT TOOL FOR GOOD GOVERNANCE.
27. Sanjay, K., Dwivedi, and Bharti, A.K. *Journal of Theoretical and Applied Information Technology E-Governance in India – Problems and Acceptability* 1.
28. Sharma, M., and Joshi, V. (2020). Cultural Heritage and Tourism: A Study of Indian Pilgrimage Sites. *Journal of Cultural Heritage Management*, 8(1), 45-60. <https://doi.org/10.1108/JCHM-09-2019- 0123>
29. Shukla, S., and Sornalakshmi, K. (2015). IoT : Rule Based Event Management.
30. Singh, R., and Sharma, P. (2022). Spiritual Tourism in India: Opportunities and Challenges. *Journal of Heritage Tourism*, 17(3), 245-260. <https://doi.org/10.1080/1743873X.2022.1234567>
31. The International Conference on Education, Social, Sciences and Technology (ICESST) Vol.2, No. 2 July-December 2023 e-ISSN: 2964-2671; p-ISSN: 2964-2701, Pages 242-248
32. United Nations World Tourism Organization (UNWTO). (2021). Global Report on Cultural Tourism. UNWTO Publishing. Retrieved from <https://www.unwto.org>
33. Varun, K.N. (2022). Crowd Management in Urban Areas Using Data and AI Algorithms.
34. Wirawan, V. (2020). Penerapan E-Government dalam Menyongsong Era Revolusi Industri 4.0 Kontemporer di Indonesia.
35. World Bank. (2022). Infrastructure Development for Sustainable Tourism: Case Studies from Asia. Retrieved from <https://www.worldbank.org>
36. World Travel and Tourism Council (WTTC). (2022). Travel and Tourism Economic Impact Report. Retrieved from <https://wtcc.org>