Enhancing Risk Management in Events by Providing AI-Risk Assessment Framework

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Abstract:

The Kingdom of Saudi Arabia has emerged as a global hub for large-scale events, driven by Vision 2030's strategic goals to diversify the economy and position the nation as a leading destination for tourism, culture, and business. These events showcase Saudi Arabia's rich cultural heritage and progressive identity and also play a pivotal role in fostering economic growth and international recognition. Nevertheless, the increasing complexity and scope of these events have exposed substantial deficiencies in conventional risk management strategies, which frequently lack the predictive capabilities, scalability, and agility necessary to confront contemporary challenges. This study suggests a conceptual framework that optimizes risk management in the events sector by utilizing cutting-edge technologies, including artificial intelligence (AI), the Internet of Things (IoT), and real-time analytics. The study identifies user requirements and preferences by utilizing a User-centered Design (UCD) approach and Action Research Methodology to gain insights from key stakeholders, such as risk managers, event organizers, and technology professionals. The results underscore the significance of collaborative tools, AI-powered decision-making, customizable features, and dual-format accessibility in the promotion of proactive risk management. While this research does not offer a fully operational framework, it offers practical suggestions for the creation of innovative solutions that enhance safety, efficiency, and inclusivity in the planning and execution of events. The suggested framework establishes a basis for future advancements, tackling practical issues while conforming to Saudi Arabia's aspiration to emerge as a global leader in the events industry.

Keywords: Risk Management, Event Management, Design, Artificial Intelligence (AI) Internet of Things (IoT), Farmwork.

1. Introduction:

The event management sector in Saudi Arabia has experienced exponential development as a result of Vision 2030, which encourages the promotion of tourism, culture, and entertainment through large-scale events. These events not only boost economic development but also enhance Saudi Arabia's global reputation as a progressive and vibrant nation, drawing millions of visitors annually. The success of such large-scale events and the safety of visitors is contingent upon the implementation of effective risk management strategies to decrease potential obstacles and guarantee a seamless execution. In addition, risk management is about protecting the reputation of event organisers and sponsors; it ensures the safety of attendants by addressing potential hazards such as overcrowding, logistical failures, and health emergencies. Furthermore, it safeguards financial investments by reducing the likelihood of losses that could result from factors such as cancellations or accidents. The effect on visitors is significant, as effective risk management not only prioritises their safety but also promotes trust and encourages repeat attendance. Currently, as technology advances continue to evolve, it is probable that advancements in technology are being employed in risk management within event management, aiding in risk mitigation such as AI or IoT and other tools. Artificial intelligence has significantly transformed numerous sectors by tackling complex challenges and reduce event management risks and enhance efficiency. Moreover, AI assists the event planners in anticipating hazards, speeding up operations, and making smarter decisions using advanced algorithms, machine learning, and predictive analytics. The aim of research is that suggest a framework that incorporates AI-powered tools and collaborative features to enhance risk management in the context of event planning and execution. By emphasizing user-cantered design principles, this investigation endeavours to offer actionable insights and suggestions for optimizing risk management strategies in the swiftly expanding events sector of Saudi Arabia. The framework that has been proposed will serve as a foundation for future advancements, guaranteeing that risk-management procedures are proactive, inclusive, and adaptable to the distinctive challenges of large-scale events.

1.1. Research Problem:

The research problem is that the events sector has exposed deficiencies in conventional risk management strategies. Inefficiencies, reactive responses, and potential safety breaches are frequently the result of existing systems' failure to deal with the complexity and scope of risks

Volume 6 – Issue 71

Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

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associated with large-scale events (Arnott, 2020) (Leopkey &Parent, 2009). Furthermore, there is a dearth of research on the integration of sophisticated technologies such as AI and IoT into risk management frameworks to improve real-time monitoring, decision-making, as well as predictive capabilities (Tircovnicu & Hategan, 2023). This research will address the necessity of a conceptual framework that effectively mitigates risks and promotes collaboration and awareness among stakeholders by the employing technology. Shared knowledge, tools, and communication platforms play a critical role in enabling proactive risk identification and mitigation. As Saluja (2011) notes, "Collaborative risk management fosters a culture of shared responsibility, enabling stakeholders to pool resources, share insights, and collectively address challenges. By leveraging collaborative tools and platforms, organizations can enhance their ability to identify, assess, and mitigate risks in dynamic environments."

1.2. Objectives of the study:

- To present a conceptual framework that amalgamates AI-driven tools, IoT sensors, and collaborative functionalities to improve risk management procedures.

- To assess user preferences and needs for a comprehensive, adaptable, and scalable risk management solution.

- To illustrate the significance of sophisticated technologies in facilitating proactive risk identification, real-time surveillance, and data-informed decision-making.

- To underscore the significance of education, collaboration, as well as awareness in the cultivation of a culture of safety and preparedness among stakeholders.

1.3. The Important of Research:

- **Theoretical Importance:** This research enhances academic understanding of risk management in large-scale events by integrating AI, IoT, and collaborative tools. It explores the intersection of risk management theories and emerging technologies, offering a conceptual model that reconciles traditional approaches with technological advancements, paving the way for future research and innovation.

- **Practical Importance:** The study proposes a framework for event organizers, risk administrators, and policymakers in Saudi Arabia and globally, focusing on user-centered design, inclusion, and technological integration. It offers recommendations for future tools and systems to enhance safety, efficiency, and success of large-scale events.

Volume 6 – Issue 71

Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

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1.4. Terms of study:

- **Risk Management:** "Risk management is a systematic approach to identifying, assessing, and mitigating potential threats or uncertainties within an organization, involving risk analysis, strategy development, and effective monitoring." (Gibson, 2023)**.**

- **Artificial Intelligence:** **"**Artificial intelligence refers to the development of computer-controlled robots capable of performing tasks associated with human intelligence, such as reasoning, meaning discovery, generalization, and learning from past experiences." (Britannica, 2025).

1.5. Study Determinants:

- **Human Determinant:** The research concentrates on the perspectives and requirements of critical stakeholders in the event management industry, such as regulatory authorities, event organizers, technology professionals, and risk managers. Their input guarantees that the proposed framework is user-centered and effectively addresses real-world challenges.

- **Geographical Determinant:** The study is contextualized within the Kingdom of Saudi Arabia, taking into account the distinctive attributes of its events sector, including the regulatory environment, cultural diversity, and scope of events.

- **Temporal Determinant:** The study is undertaken within the period of Vision 2030, which reflects the Kingdom's ongoing endeavors to diversify its economy and establish itself as a global lead in tourism, business, and culture. The results are pertinent to the present and future developments in risk mitigation and event management.

2. Literature Review:

The rapid evolution of technology, particularly in artificial intelligence (AI), the Internet of Things (IoT), and machine learning, has revolutionized the way risks are managed in various industries, including event management, Mehrotra, A., & Lopo, J. (2020, June). This literature review examines the use of AI and IoT-driven risk management systems in event planning. It highlights their transformative impact on risk identification, monitoring, and mitigation. The review examines early risk detection, real-time monitoring, regulatory compliance, and user engagement. It highlights gaps in research and emphasizes the need for transparency, human oversight, and system interoperability to integrate AI and IoT effectively into risk management frameworks.

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Issued on: 20 September 2025

International Journal of Research and Studies Publishing

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ISSN: 2709-7064

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2.1. Developments in Risk Management in Events:

The use of artificial intelligence (AI) has significantly impacted risk management in events. Traditional methods were manual, inefficient, and time-consuming, leading to delayed responses and increased errors. Kapil (2024) highlighted the challenges faced by financial institutions before adopting AI in risk management. Traditional methods were prone to errors and inaccuracies, resulting in poor decision-making and delayed responses. The study found that machine learning models improved risk prediction accuracy by 35% and enhanced decision-making efficiency. AI has enabled better risk identification, monitoring, and mitigation compared to traditional methods, making it a game-changer for event safety management. The authors suggested increasing security personnel and improving the accuracy of AI-based surveillance systems to address health-related risks more effectively.

2.2. AI Can Improve Risk Management:

AI is revolutionizing risk management in dynamic environments like sports events, enhancing early risk detection and emergency response. By analyzing crowd flow data and monitoring potential risks through IoT sensors, AI can help organizers address challenges like overcrowding and security threats. However, AI needs improved integration with human decision-making for effective situational awareness. Jibraili et al. (2024) demonstrated how AI can identify overcrowded areas and suggest alternative routes to ease congestion, improving attendees' safety. AI-powered emergency response uses real-time monitoring through IoT sensors, providing instant alerts about potential incidents. The study calls for better integration of AI-based systems with human decision-making to improve situational awareness during events. While AI has significantly enhanced safety by detecting risks early, providing real-time emergency responses, and identifying overcrowded areas, its full potential lies in integrating with human decision-making processes.

2.3. Evaluating the Risk of Events with the Aid of AI and IoT:

The integration of AI and IoT has significantly improved risk management in large-scale outdoor events by providing real-time data on crowd movement and health-related risks. This has led to the need for portable surveillance solutions to address the complexities of open environments. Sari et. al. (2024) assessed AI- and IoT-based systems for monitoring hazard during large-scale outdoor events, providing real-time data on population movements and alerting

Volume 6 – Issue 71

Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

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organizers to health-related risks. The study underscored the necessity of portable AI-based surveillance systems to secure open environments effectively. The potential of AI and IoT-based systems in enhancing risk management for large-scale outdoor events is significant, enhancing attendee safety and the role of portable AI-based surveillance systems.

2.4. Collaboration Between Event Organizers and Regulatory Authorities:

Artificial intelligence is revolutionizing event management by enabling real-time violation identification, highlighting the need for robust risk management frameworks. However, gaps must be addressed for transparency and effective human-AI integration. According to Mgbachi, T.V. (2023), AI-based systems can improve regulatory compliance by identifying violations and recommending remedial actions, achieving 90% accuracy using machine learning algorithms on IoT sensor data. AI and government oversight are crucial for event managers to develop robust AI-centric risk management frameworks.

This ensures that AI systems align with existing regulations and can adapt to evolving legal requirements. Governments set standards for AI adoption, ensuring responsible and effective use in event management. However, there are identified gaps in AI decision-making processes, such as greater transparency and clear principles for integrating AI with human judgment in compliance monitoring. Mgbachi (2023) emphasizes that the lack of interpretability in AI models can hinder trust among stakeholders, making it essential to establish guidelines for accountability and fairness.

2.5. Effect of Risk Management Technologies on Financial and Operational Aspects:

The study by Kapil et al. (2024) found that Artificial intelligence (AI) has significantly impacted event management, reducing operational costs by 20% and improving risk detection accuracy by 35%. This has implications for financial planning and decision-making in events. AI-powered models are also reshaping insurance practices by improving coverage precision and reducing premiums. However, challenges remain in interoperability with traditional financial systems. AI-based systems reduce operational costs by 20% and improve risk detection accuracy by 35%. AI-based insurance models can also improve insurance coverage precision, enabling reduced premiums and better financial planning. The study highlights the need for improved interoperability between AI systems and traditional financial models to maximize cost savings.

2.6. Enhancing the Framework and User Engagement:

The performance and usability of mobile applications are important aspect for user engagement, particularly in event management. Native and web-based apps face hardware compatibility and server communication limitations, respectively. AI-enhanced apps, like health apps, improve user retention rates through personalized feedback and better performance monitoring, enhancing the framework's usability. Kakkar et. al. (2013) compared native and web-based apps, finding that native apps faced hardware compatibility issues, while web-based apps struggled with server communication. AI-powered mobile apps enhance user engagement by providing personalized, real-time feedback, which is critical for framework usability in event management. However, the study identified gaps in AI-powered performance monitoring, which could improve responsiveness and user adoption in dynamic environments like event management.

2.7. Machine Learning Techniques for Real-Time Risk Identification:

Machine learning techniques are revolutionizing real-time risk identification and event management. The Dynamic Verifier Core model, developed by Khatavakhotan et al. (2015), has improved risk detection accuracy by 15% and reduced response times by 20%. AI-powered predictive analytics enhance system resilience, minimizing downtime and ensuring smoother operations during events. However, a critical gap exists for AI systems to adapt to unforeseen risks and incorporate human oversight for better decision-making. Addressing these challenges can enhance machine learning's effectiveness in managing risks in complex event environments. The study emphasizes the need for AI systems to adapt to unexpected risks and incorporate human oversight for better decision-making.

At the end, the reviewed literature underscores the significant potential of AI, IoT, and machine learning in transforming risk management for events. These technologies have demonstrated remarkable capabilities in areas such as early risk detection, emergency response, crowd flow management, and compliance monitoring, offering event organizers tools to proactively address challenges and ensure attendee safety. However, despite these advancements, several gaps remain, including the need for improved interpretability of AI predictions, better integration of AI with human decision-making, and enhanced accuracy of IoT-based surveillance systems. Rane, N., Mallick, S., Kaya, O., & Rane, J. (2024, October). Addressing these gaps is crucial to building trust, ensuring regulatory compliance, and maximizing operational efficiency.

As the field continues to evolve, collaboration between event managers, regulatory authorities, and technology developers will be essential to creating robust, transparent, and adaptable risk management systems. By leveraging the insights from these studies, the proposed framework aims to bridge existing gaps and set additional features for safety and innovation in the event management industry.

3. Proposed Framework:

The proposed framework aims to revolutionize event risk management by leveraging Artificial Intelligence (AI) and advanced technologies like IoT, predictive analytics, and collaborative framework. "Artificial intelligence has the potential to revolutionize risk management by enabling predictive analytics, real-time monitoring, and data-driven decision-making. However, the integration of AI must be accompanied by measures to ensure transparency and maintain human oversight, fostering trust among stakeholders." Mohtashami, M., Marlowe, T. J., Kirova, V. D., & Deek, F. P. (2011). Traditional risk management practices often rely on manual processes, fragmented tools, and reactive measures, leaving event managers unprepared for unforeseen challenges. Recent advancements in technology have highlighted the need for proactive and data-driven solutions in event management. Research from organizations like the World Health Organization (WHO) and the International Organization for Standardization (ISO) 11.ISO 31000:2018 Risk management, emphasize the importance of integrating AI, IoT, and real-time monitoring systems to enhance predictive capabilities and mitigate risks before they escalate. The framework introduces a comprehensive, AI-powered framework designed to address these gaps by providing predictive insights, real-time monitoring, interactive training, and collaborative tools. Each feature is carefully designed to address specific pain points identified through interviews with event managers, literature reviews, and case studies of past events. AI-powered risk assessment leverages predictive analytics to analyze historical data and real-time inputs, enabling proactive decision-making. IoT integration allows for continuous monitoring of environmental factors, ensuring potential risks are detected early and addressed promptly. Collaborative frameworks and digital awareness campaigns further enhance knowledge sharing and promote best practices among stakeholders. By integrating these elements, the framework not only addresses current challenges but also lays the groundwork for future advancements in event risk management.

Volume 6 – Issue 71

Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

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Below are a detailed explanation of the core features and their advantages:

3.1. AI-Powered Risk Assessment:

The feature utilizes predictive analytics and machine learning to analyze historical data and environmental factors, identifying potential risks before they escalate into critical incidents. It generates real-time alerts for proactive mitigation, relying on user input quality and accuracy.

3.1.1. How It Works?

The AI-powered risk assessment process uses historical data, real-time inputs, environmental factors, and user inputs to analyze past events, predict risks, and develop mitigation plans. It uses sensors, IoT devices, and live feeds to analyze crowd movement, temperature changes, and other dynamic factors. Environmental factors include weather forecasts, noise levels, and air quality to predict risks like extreme heat, unsafe sound, or poor ventilation. User inputs from event plans evaluate potential risks and develop mitigation plans. The system uses advanced machine learning models to predict potential risks, such as overcrowding prediction, weather-related risks, and security threats. Overcrowding prediction suggests alternative routes, staffing, or temporary closures, while weather-related risks alert managers to implement contingency plans. Security threats detect crowd behavior anomalies and suspicious activity through video analytics, triggering further investigation.

3.1.2. The Most Important Inputs for Event Managers:

The AI-powered risk assessment system for events requires key inputs from event managers. These include event details such as venue layout, capacity limits, entry/exit points, and emergency exits, as well as the event type, such as outdoor or indoor. Attendee data, such as real-time ticket sales data, demographics, and environmental factors, can help predict crowd density and recommend alternative routes. Historical data, such as past incident reports and venue-specific insights, can identify recurring risks and trends from past events. Real-time sensor data, such as IoT devices, can provide real-time updates on crowd movement, environmental conditions, and anomalies. Wearable devices can also provide real-time health data, enabling system detection of individual medical risks. Compliance and regulatory requirements are ensured by notifying managers of non-compliance issues, such as exceeding the venue's capacity or number of exit doors. Custom risk parameters can be defined using user-defined scenarios, such as VIP security,

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Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

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restricted zones, or logistical challenges. This system can help event managers prioritize safety measures and ensure a safe and enjoyable event for all attendees.

3.1.3. Real-Time Alerts and Mitigation:

The feature provides real-time alerts for event managers, enabling swift action through push notifications, dashboard visualizations, and automated workflows. These alerts are sent to event staff's mobile devices, highlight high-risk areas, and trigger predefined actions like notifying emergency services or deploying resources. The system also uses GPS-enabled maps to locate incidents and guide first responders in medical emergencies.

3.1.4. Advantages of AI-Powered Risk Assessment:

AI integration in risk assessment offers numerous benefits, including proactive risk mitigation, data-driven decision-making, scalability, improved resource allocation, enhanced safety compliance, cost efficiency, and customizable risk models. Early identification of risks helps prevent major incidents, while AI provides actionable insights for managers. The framework adapts to events of all sizes, ensuring seamless management. Predicting risks in advance optimizes resource allocation, and the system triggers immediate alerts for non-compliance. Additionally, AI models can be customized to focus on specific risk types.

3.1.5. Examples of AI-Powered Risk Assessment in Action:

To illustrate the practical applications of this feature, consider the following scenarios:

- **Scenario 1: Overcrowding at Entry Points**: During a large concert, the system predicts overcrowding at Gate A based on ticket scanning rates and real-time crowd density data. It recommends opening Gate B and deploying additional staff to manage the flow, preventing bottlenecks and ensuring attendee safety.

- **Scenario 2: Medical Emergencies**: If a sudden increase in temperature is detected in a crowded indoor venue, the system alerts managers to activate cooling systems and provide hydration stations to prevent heat exhaustion.

3.1.6. Future Potential:

Looking ahead, AI-powered risk assessment has the potential to evolve further with AI-powered risk assessment is set to evolve with advancements in technology, including integration with wearable devices, real-time monitoring of social media and attendee feedback, and the ability

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Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

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to simulate risk scenarios for contingency planning and staff training. These advancements will help identify emerging risks and improve risk management.

3.2. Interactive Safety Guidelines:

The framework provides customizable safety protocols for various events, including fire evacuations, medical emergencies, power outages, and crowd control. It offers checklists, automated workflows, real-time updates, and compliance checks, making it an essential tool for event safety management.

3.2.1. How It Works?

The Interactive Safety Guidelines feature is a user-friendly tool designed to manage safety during events. It offers customizable protocols based on event type and specific risks, such as weather hazards or security threats. The system provides scenario-based guidance for high-pressure situations, such as fire evacuations and fire department contact details. It also allows automated incident reporting, workflows, task assignment, and escalated issues. Compliance monitoring ensures safety protocols align with local regulations and industry standards, reducing legal and reputational risks. For example, in Saudi Arabia, event managers must follow guidelines set by GEA and SCEGA. Overall, the Interactive Safety Guidelines is a comprehensive solution for event safety management.

3.2.2. Key Components of the Feature:

The framework includes step-by-step checklists for emergencies and high-risk situations, such as managing extreme heat. It also features an incident reporting system for tracking progress and ensuring follow-up actions. Real-time updates on protocol changes or new risks are provided, allowing users to update evacuation plans and send alerts. The framework adheres to regional regulations and best practices, such as those used in Saudi Arabia, where guidelines from the General Authority of Entertainment, National Events Center, and SCEGA are used.

3.2.3. Advantages of Interactive Safety Guidelines:

The integration of interactive safety guidelines into risk management frameworks offers several benefits. These include customization for specific event types, efficient incident resolution through automated workflows, compliance with local and international safety standards, reduced legal and reputational risks, enhanced staff preparedness through checklists and step-by-step

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International Journal of Research and Studies Publishing

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instructions, and a centralized knowledge base for staff to access safety-related information. The framework allows event managers to tailor safety protocols to their specific needs, ensuring relevance and effectiveness. It also minimizes non-compliance risks and penalties, such as fines or shutdowns, by incorporating local and international safety standards. The framework also enhances staff preparedness through regular drills and provides a centralized knowledge base for staff to access safety-related information.

3.2.4. Examples of Interactive Safety Guidelines in Action:

Here are practical examples of how this feature enhances event safety:

- **Scenario 1: Fire Evacuation:** Input: A fire alarm is triggered during a conference. Output: The system provides a step-by-step evacuation plan, assigns roles to staff such as (guiding attendees, checking rooms), and notifies local fire departments.

- **Scenario 2: Power Outage:** Input: A sudden power outage occurs during an outdoor event. Output: The system activates backup generators, notifies attendees via announcements, and updates evacuation plans if necessary.

3.2.5. Alignment with Saudi Arabian Guidelines:

The framework in Saudi Arabia is based on guidelines from the General Authority of Entertainment (GEA), National Events Center, and Saudi Conventions & Exhibitions General Authority (SCEGA). These authorities provide safety standards for entertainment events, oversee national events, and set guidelines for conventions and exhibitions. This ensures compliance with local regulations and expectations, ensuring the safety and quality of events.

3.2.6. Future Potential:

The Interactive Safety Guidelines feature is set to evolve with gamification, AI-powered recommendations, and multilingual support to improve staff engagement, analyze past incidents, and ensure inclusivity for international attendees and staff.

3.3. Training and Knowledge Hub:

The Training and Knowledge Hub are a comprehensive solution for safety-related education, offering a range of tools and resources to equip event managers and staff with the knowledge and skills needed to handle risks effectively. Key components include interactive modules, gamification elements, downloadable resources, certifications and badges, localized

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Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

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content, and multilingual support. Interactive modules provide foundational knowledge, gamification elements enhance engagement, downloadable resources offer practical tools, certifications validate expertise, and localized content ensures compliance with regional regulations. The framework also offers interactive courses on critical topics like risk assessment, emergency protocols, crowd management, and regulatory compliance. Gamification elements motivate users to complete courses and earn rewards like "Fire Safety Expert" badges. Downloadable resources provide practical tools like evacuation plans and crowd density monitoring templates for staff to implement safety measures during events. Certifications and badges validate users' skills and knowledge, enhancing professional credibility and demonstrating compliance with safety standards. The hub uses region-specific regulations and best practices to ensure event managers comply with local guidelines. Multilingual support ensures inclusivity and accessibility for international attendees and staff.

3.3.1. Advantages of the Training and Knowledge Hub:

The integration of a centralized training hub into a risk management framework offers several benefits. It provides event managers and staff with the necessary knowledge and skills to handle risks effectively, such as emergency response training. Gamification enhances learning by making it enjoyable and rewarding, encouraging users to complete training programs and earn badges. The framework offers flexible access, allowing users to complete modules at their own pace. It ensures compliance with regulatory requirements, including Saudi Arabian regulations, by incorporating local and international safety standards. Regular updates to training content, such as AI-powered risk assessment tools, keep users updated on the latest safety practices and technologies. Certifications and badges also enhance professional profiles, making them more competitive in the job market.

3.3.2. Examples of Training and Knowledge Hub in Action:

Here are practical examples of how this feature enhances event safety:

- **Scenario 1: Crowd Management Training:** Input: A user completes a course on crowd management, earning a certification. Output: During an event, the user applies their knowledge to design an efficient layout, preventing overcrowding and ensuring smooth attendee flow.

- **Scenario 2: Emergency Response Certification:** Input: A staff member earns a certification in emergency response after completing a series of quizzes and simulations. Output: During a

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Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

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medical emergency, the staff member confidently takes charge, coordinating with first responders and ensuring a swift resolution.

3.3.3. Future Potential:

The Training and Knowledge Hub feature has potential for future evolution, including AI-powered personalization, VR simulations for immersive emergency handling experiences, and global collaboration among event professionals. AI can analyze learning patterns and recommend courses, while VR simulations offer immersive experiences. This could foster a global community of safety experts. The Training and Knowledge Hub is an important risk management tool for event managers, combining interactive courses, gamification, and localized content to enhance skill development, engagement, and compliance.

3.4. Community and Partnership:

The Event Safety Forum is a framework that promotes collaboration and knowledge sharing among event managers, safety professionals, and stakeholders. It facilitates partnerships with regulatory bodies, industry associations, and experts to ensure safety standards compliance and promote industry-wide improvements, building trust, innovation, and strengthening risk management capacity.

3.4.1. How It Works and Key Components?

The Community and Partnership feature in the Event Safety Forum is a dynamic platform that connects stakeholders in the event management ecosystem, promoting collaboration, knowledge sharing, and compliance with safety standards. It includes a centralized forum for discussions on critical topics like crowd management, emergency response, and risk mitigation. The forum partners with regulatory authorities like GEA to align discussions with local regulations and international best practices. Expert contributions from safety professionals, industry leaders, and academic experts are invited to contribute to discussions. The framework also offers a shared resources repository for effective safety measures implementation and risk analysis. Industry-wide initiatives drive industry-wide improvements, raising awareness about safety measures and encouraging widespread adoption. The Community and Partnership feature fosters collaboration, trust, and innovation, allowing open dialogue, compliance with safety standards, expert guidance, and shared resources.

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Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

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This supportive environment encourages event managers, safety professionals, and stakeholders to work together to address risks and continuously improve safety practices.

3.4.2. Benefits of Community and Partnership:

The integration of a collaborative framework into risk management offers several benefits. It encourages knowledge sharing, compliance assurance, trust building, innovation, access to expert knowledge, and scalability. The forum encourages learning from each other's experiences, reducing the risk of repeating mistakes and promoting continuous improvement. Regulatory bodies like Saudi's National Event Center maintain partnerships to keep users informed about safety standards and regulations. Open dialogue fosters trust and community, enhancing confidence in event managers to implement safety measures. The framework also promotes industry-wide improvements through the sharing of innovative ideas and best practices. It also provides access to expert case studies and caters to all experience levels, offering guided discussions for beginners and advanced insights for experienced professionals.

3.4.3. Examples of Community and Partnership in Action:

Here are practical examples of how this feature enhances event safety:

- **Scenario 1: Handling Medical Emergencies:** Input: A user posts a question on the forum about managing medical emergencies during outdoor events. Output: Certified safety professionals and experienced event managers respond with actionable advice, such as setting up medical stations and training staff on first aid.

- **Scenario 2: Resource Sharing:** Input: A user uploads a downloadable checklist for fire safety protocols. Output: Other users download and adapt the checklist for their own events, improving their preparedness for fire-related risks.

3.4.4. Future Potential:

The proposed risk management framework includes a Community and Partnership feature, which could evolve further with AI-powered moderation, global collaboration, and gamified contributions. AI can analyze forum discussions to identify trending topics and recommend resources, while the framework could include international stakeholders and encourage active participation by earning points or badges for valuable insights. This feature promotes collaboration, knowledge sharing, and safety compliance among event managers, safety professionals, and regulatory bodies.

3.5. Technology and Innovation:

The IoT-based framework uses sensors and mobile applications to provide real-time risk tracking and monitoring for event managers. It monitors factors like crowd density, temperature, noise levels, and movement patterns, providing a centralized dashboard for accessibility. The framework uses advanced technologies like AI, machine learning, and deep learning to enhance risk management in large-scale events, enabling predictive analytics, real-time monitoring, and automated decision-making. As noted by Soori et al. (2023), "AI, machine learning, and deep learning have revolutionized industries with predictive analytics, real-time decision-making, and automation. However, scalability, bias addressing, and ethical standards remain crucial for sustainable and trustworthy outcomes".

3.5.1. How It Works and Key Components?

The Technology and Innovation feature of the event management system combines IoT sensors and mobile apps to create a real-time monitoring system for event managers. The system uses IoT devices to monitor environmental factors, providing real-time data to detect risks like overcrowding and poor ventilation. The mobile app interface offers a centralized dashboard for event managers, displaying live updates, heat-maps, and notifications. The system also provides automated alerts and notifications, alerting users to anomalies or risks, providing actionable recommendations. The technology integrates with AI-Powered Risk Assessment and Interactive Safety Guidelines, utilizing IoT sensor data for predictive analytics and proactive mitigation strategies. The framework uses IoT sensor data to provide insights, identify trends, and improve future events, enabling managers to redesign layouts and optimize resource allocation. The mobile app enhances operational efficiency and facilitates coordinated responses, especially in remote locations. This holistic approach to risk management ensures safety, compliance, and operational efficiency across events of all sizes.

3.5.2. Benefits of Technology and Innovation:

The integration of IoT sensors and mobile apps into risk management offers numerous benefits, including real-time monitoring, enhanced accuracy, proactive risk mitigation, mobility and convenience, scalability, data-driven insights, and compliance assurance. IoT sensors provide precise, objective data, reducing reliance on manual observations and subjective assessments.

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Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

IJRSP

They enable immediate responses to risks, such as adjusting cooling systems or redirecting attendees when unsafe temperatures arise. Real-time alerts and predictive analytics enable early risk management, such as identifying overcrowding early to implement crowd control measures. The mobile app enhances operational efficiency by providing access to critical information anytime, anywhere, allowing event managers and staff to monitor risks and coordinate responses. The technology is versatile, enabling deployment across various venues for events of all sizes. Post-event sensor data analysis helps identify trends and areas for improvement, driving continuous safety practices. The framework ensures safety standards by integrating local regulations and international best practices, avoiding penalties.

3.5.3. Examples of Technology and Innovation in Action:

Here are practical examples of how this feature enhances event safety:

- **Scenario 1: Overcrowding Detection:** Input: IoT sensors detect overcrowding at Gate A based on real-time crowd density data. Output: The mobile app sends an alert recommending opening Gate B and deploying additional staff to manage the flow, preventing bottlenecks.

- **Scenario 2: Noise Level Monitoring:** Input: Noise sensors detect unsafe sound levels near a stage area. Output: The app alerts staff to adjust sound systems or relocate attendees to safer zones, ensuring compliance with health and safety standards.

3.5.4. Future Potential:

The Technology and Innovation feature of an event could include wearable devices, AI-powered predictive analytics, and Augmented Reality (AR) overlays. Smart wristbands could provide real-time health data, enabling the system to detect individual medical risks. Advanced AI models could analyze sensor data to predict risks before they occur, enhancing proactive mitigation. The integration of IoT sensors and mobile apps ensures safety, compliance, and operational efficiency, enhancing event risk management.

3.6. Awareness and Marketing:

The framework highlights risk management through digital campaigns, success stories, and certified event safety badges. It showcases AI-powered tools and high safety standards, promoting innovative practices. Events with high standards are recognized with badges, enhancing their reputation and encouraging others to adopt best practices, positioning the framework as a leader in safety and innovation.

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3.6.1. How It Works and Key Components?

The Awareness and Marketing feature in event management uses a digital framework, storytelling, and partnerships to promote safety and innovation. It showcases AI-powered tools and compliant events, raising awareness and fostering adoption. Key components include digital awareness campaigns, success stories, certified event safety badges, partnerships with regulatory bodies, recognition programs, and gamified challenges. Digital campaigns educate event managers and stakeholders about AI-powered risk management tools, showcasing real-world examples of how advanced technologies have improved safety and prevented incidents. Success stories and case studies from event managers showcase the effectiveness of AI-powered risk management tools, inspiring others to adopt similar practices. Certified event safety badges are awarded to events that meet or exceed safety standards, enhancing their credibility and marketability. Partnerships with regulatory authorities, industry associations, and international organizations align campaigns, guidelines, and tools with local regulations and global best practices. These partnerships ensure compliance, drive innovation, and amplify the framework's impact across the event management industry. Event managers are rewarded with awards, certifications, and public recognition for their innovative AI-powered risk management practices. The Awareness and Marketing feature combines digital campaigns, success stories, certified badges, and recognition programs to promote safety, innovation, and compliance in the event management industry. It aligns with local and global standards, fosters trust, and encourages widespread adoption of best practices through partnerships with regulatory bodies and gamified challenges.

3.6.2. Benefits of Awareness and Marketing:

The integration of awareness and marketing strategies into the risk management framework offers numerous benefits. It encourages the adoption of AI-powered tools, enhances credibility for compliant events, establishes industry leadership and trust building, motivates event managers through recognition, and promotes global adoption of best practices. Digital campaigns and success stories, such as a venue fire outbreak campaign, inspire others to invest in similar technologies. Compliant events with certified badges gain a competitive edge, attracting attendees, sponsors, and stakeholders. The framework also establishes itself as a trusted authority in event safety by promoting best practices and collaborating with regulatory bodies like GEA and ESA. Recognition motivates event managers to prioritize safety and innovation, driving continuous

improvement. The framework aligns campaigns with local and international regulations, promoting compliance requirements to encourage event managers to adhere to safety standards.

3.6.3. Examples of Awareness and Marketing in Action:

Here are practical examples of how this feature enhances event safety:

- **Scenario 1: Preventing a Stampede**: Input: A social media campaign highlights how AI-powered tools predicted overcrowding and prevented a stampede during a large concert. Output: Event managers are inspired to adopt similar technologies to enhance safety at their own events.

- **Scenario 2: Success Story Publication:** Input: A case study details how a corporate conference used AI-powered tools to manage cybersecurity risks. Output: Other event managers read the case study and implement similar measures to protect attendee data.

3.6.4. Future Potential:

The Awareness and Marketing feature of the framework has the potential to evolve further, including virtual reality campaigns to showcase the benefits of AI-powered risk management tools. Expanding recognition programs to international events could foster a safety-focused community. AI-powered campaign optimization could identify trends and optimize future initiatives. The framework promotes AI-powered risk management tools through digital campaigns, certified badges, and regulatory partnerships, positioning itself as a leader in safety and innovation.

3.7. Performance Evaluation & Continuous Improvement:

The feature evaluates risk management strategies by analyzing post-event feedback from attendees, staff, and stakeholders. It provides actionable recommendations for future improvements, fostering accountability and learning. This iterative process enhances event safety, creating safer, more efficient events over time.

3.7.1. How It Works and Key Components?

The Performance Evaluation & Continuous Improvement feature is a system that uses feedback, analytics, and benchmarking to improve event safety and efficiency. It uses post-event feedback collection to identify strengths, pain points, and areas for improvement. Advanced analytics tools generate detailed reports based on feedback and performance metrics, identifying recurring issues like overcrowding and noise levels.

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The system offers personalized recommendations for safety practices, resource allocation, and attendee experiences, shared with event managers via a centralized dashboard. The learnings from one event guide future planning and execution, fostering a cycle of continuous improvement across various events. The framework compares event performance against industry benchmarks, ensuring expectations are met or exceeded and identifying opportunities for innovation. Performance evaluation insights inform AI-Powered Risk Assessment and Interactive Safety Guidelines, fostering continuous improvement and enabling better temperature monitoring in future events. This iterative process enhances safety, compliance, and attendee satisfaction, making it an essential tool for modern event professionals.

3.7.2. Benefits of Performance Evaluation & Continuous Improvement

Performance evaluation and continuous improvement are crucial in risk management, offering numerous benefits. They ensure accountability, continuous learning, data-driven improvements, and measurable safety performance. Feedback and analysis help event managers hold themselves accountable for safety outcomes, fostering a culture of responsibility. Event insights enhance knowledge, allowing managers to learn from past experiences and refine practices. Data-driven improvements reduce subjective opinions and result in more effective solutions. AI-powered crowd monitoring tools have shown a 20% reduction in reported incidents, providing quantifiable safety performance insights. Feedback addresses attendee experiences by resolving pain points and improving event quality. Lessons learned from large-scale events can be applied to smaller corporate meetings, ensuring consistent improvements across all types of events. Regular evaluations ensure events adhere to local and international regulations, reducing legal and reputational risks.

3.7.3. Examples of Performance Evaluation & Continuous Improvement in Action:

Here are practical examples of how this feature enhances event safety:

- **Scenario 1: Bottleneck Identification**: Input: Attendee surveys reveal long queues at Gate A due to insufficient staffing. Output: The framework recommends redesigning the entry layout and deploying additional staff for future events.

- **Scenario 2: Temperature Monitoring**: Input: Feedback indicates that unsafe temperatures in a venue caused discomfort for attendees. Output: The system suggests installing cooling systems and increasing ventilation in high-risk areas.

3.7.4. Future Potential:

Looking ahead, The Performance Evaluation & Continuous Improvement feature has potential for future evolution, including AI-powered sentiment analysis, predictive benchmarking, and global knowledge sharing. AI can analyze qualitative feedback to identify trends and emerging risks, while advanced models can predict future risks based on historical feedback and industry benchmarks. This enables proactive mitigation and fosters cross-industry learning and innovation.

In conclusion, The AI-powered Risk Management Framework is a groundbreaking tool designed to enhance safety, security, and operational efficiency in large-scale events. It addresses key risks such as overcrowding, health emergencies (e.g., heatstroke or fainting), security threats (e.g., unauthorized access), and the continuity of critical services (e.g., electricity, communications). The framework facilitates rapid evacuations and ensures smooth operations during emergencies. Applicable to high-stakes events like Hajj and Umrah, sports tournaments, concerts, festivals, and conferences, it integrates AI-driven insights with real-time data to empower quick decision-making. For instance, it predicts crowd density, suggests optimal pathways, and enables partial automation for tasks like activating emergency systems or rerouting crowds. The framework leverages advanced technologies, including surveillance cameras, IoT sensors, drones, and smart applications, to monitor crowd movement, environmental conditions, and security threats. Data is collected in real-time for immediate action and securely stored for future analysis, ensuring compliance with privacy regulations through mechanisms like encryption, anonymization, and restricted access.

By supporting multi-level decision-making—providing predictive alerts, instructions, and autonomous actions—it ensures accountability while maintaining human oversight. Its modular design allows customization for different event types, ensuring scalability and adaptability across diverse scenarios. Ultimately, this framework sets a new standard for risk management in complex environments, improving safety and operational resilience.

4. Methodology:

This study aims to design a framework for AI-powered risk management in event management, utilizing User-Centered Design (UCD) and Action Research Methodology. These methodologies prioritize user needs, preferences, and iterative feedback to ensure the framework is functional, adaptable, and aligned with the safety management requirements of events.

The research employs qualitative methods to gather insights through targeted interviews with key stakeholders, including technology professionals, risk managers, and event organizers. This approach ensures the framework is technologically advanced, user-friendly, and inclusive.

4.1. Study Population and Sample

The study focuses on professionals from event management, risk management, technology, and quality assurance sectors in Saudi Arabia. The participants were chosen from three cities: Medina, Riyadh, and Jeddah. The sample includes sports club directors, public relations managers, technical infrastructure engineers, event managers, tour guides, risk management specialists, and quality management specialists. The selection was based on relevance to the research topic, gender, and geographic diversity, and included representatives from multiple sectors.

4.2. Study Tool

The study used semi-structured interviews in three formats: face-to-face, phone/video calls, and asynchronously through text-based platforms. Participants were recruited based on their expertise and relevance to the research topic. Over 20 professionals were invited, but only 11 responded and completed the interviews. All interviews were recorded, transcribed, and coded for analysis. Responses were manually analyzed to extract meaningful themes and patterns. Notes were taken during live interviews to capture key insights. Interviews were conducted in Arabic or English, depending on the participant's preference. Data collection occurred over a defined timeframe to ensure consistency and reliability. Probing questions were used to clarify responses and explore deeper insights, ensuring comprehensive data collection.

4.3. Data Analysis

The data collected from 11 interviews was analyzed using Latent Content Analysis, a qualitative method that goes beyond surface-level descriptions to identify underlying meanings and themes in participants' responses. This approach allowed for the extraction of meaningful trends and prioritized actionable recommendations based on user feedback. The analysis process followed these structured steps:

1. **Initial Review:**

The transcripts of all interviews were read multiple times to gain a comprehensive understanding of the content and context. This step ensured familiarity with participants' perspectives and highlighted recurring ideas.

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2. Coding:

Key segments of text were identified and labeled with codes representing specific concepts or themes. For example, mentions of "offline functionality" or "real-time alerts" were tagged accordingly to capture their significance.

3. Categorization:

Similar codes were grouped into broader categories that reflected common topics or patterns. For instance, codes related to platform preferences (e.g., mobile app vs. website) were grouped under the category "Framework Format."

4. Theme Extraction:

Overarching themes were derived from the categories to address the research objectives. For example, themes such as "cross-device compatibility," "importance of educational tools," and "trust in AI-powered decision-making" emerged from the categorized data.

5. Validation:

The extracted themes were reviewed periodically to ensure they aligned with the raw data and research goals. Participant responses were revisited to confirm the accuracy and relevance of the themes.

This process was conducted manually to allow for nuanced interpretation and deeper engagement with the data. The findings were grounded in participant responses and provided actionable insights for refining the AI-powered Risk Management Framework. The analysis revealed meaningful trends and prioritized recommendations that addressed user preferences, challenges, and expectations effectively.

5. The Results and Recommendations:

The analysis of user feedback across the five categories—Framework Format, Features and Tools, Target Audience, Advanced Technologies, and Collaboration and Awareness —has yielded critical insights into user preferences, challenges, and expectations for the AI-powered Risk Management Framework. Below is a consolidated summary of key findings, actionable insights, and recommendations to refine the framework's design and functionality.

5.1. Category 1: Framework Format

The study identifies three main themes in the Framework Format category: Offline Functionality, Cross-Device Compatibility, and Preferred Framework Format.

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The preferred framework format is dual-format availability, focusing on flexibility and risk management applicability. It should be designed as both a mobile app and a website, ensuring accessibility and catering to diverse user needs. Cross-device compatibility is crucial, with respondents emphasizing responsive design and Progressive Web Apps (PWAs) for consistency. Usability testing is recommended to identify compatibility issues. Offline functionality is essential in environments with poor internet connectivity, with 9 out of 11 respondents agreeing. The framework should include features like risk checklists, incident reporting, and emergency protocols, and automatically synchronize cached data once an internet connection is restored. Recommendations include developing the framework as both a mobile app and a website, implementing a responsive design framework, conducting extensive usability testing, and including robust offline functionality to address real-world connectivity challenges.

5.2. Category 2: Features and Tools

The study explores the functionality and usability of an AI-powered Risk Management Framework, focusing on key features for event management, the importance of an educational section, and expected reports and data outputs. Key features include real-time alerts, live data analysis, incident logging, communication tools, integration with IoT devices, and user-friendly design. The framework should prioritize these features for efficient response and seamless teamwork during events. An educational section should be included, offering interactive modules, short video tutorials, case studies, and expert insights for engaging training. Customized content is also critical. The framework should include real-time alerts, post-event analysis, and compliance reports. Real-time notifications are vital for immediate risk identification, while post-event analysis provides comprehensive analysis of incidents, lessons learned, and improvement areas. Compliance reports ensure safety regulations adherence, while crowd and environmental data are valuable for proactive risk management. The study recommends developing a robust framework with essential features to enhance user skills and confidence, and generating actionable reports and data outputs to support proactive risk management and regulatory adherence.

5.3. Category 3: Target Audience

The third category of questions focuses on User Accessibility, examining the design of a framework for risk management professionals and a broader audience, including general event organizers and other stakeholders. The framework should be designed with an inclusive approach,

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offering basic functionalities for non-professionals and advanced tools for experts. The study aims to determine if the interface can be customized to suit different user types, with suggestions including role-based dashboards, personalization options, and event-specific customization based on event size, location, and audience type. Challenges for new users include thematic coding, onboarding and training, support systems, and simplified navigation. The framework should provide interactive tutorials, hands-on training, demo sessions, AI-powered chat assistance, help sections, and user forums to ease the learning curve. Recommendations include designing a tiered interface, implementing a customizable interface with role-based dashboards, providing comprehensive onboarding, interactive training, and robust support systems to ensure a smooth user experience.

5.4. Category 4: Advanced Technologies

The study examines user acceptance of advanced technologies like IoT sensors, real-time analytics, and AI-powered decision-making in risk management. It highlights the benefits of these technologies, trust in AI-powered decision-making, and challenges in adopting AI-based frameworks. IoT sensors detect risks early and provide instant alerts, but they also have potential drawbacks like dependency on technology. The recommendation is to integrate these technologies to improve operational efficiency and prevent dependency, while allowing human oversight and manual overrides. Trust in AI-powered decision-making is decisive for enhancing risk management accuracy and effectiveness. Challenges in adopting AI-based frameworks include data privacy, accuracy, reliability, resistance to change, and human oversight. To overcome these issues, the framework should implement robust security measures, training programs, user-friendly design, manual override options, and human oversight. Regular updates and refinements to AI models can also improve accuracy and reliability. The study concludes that integrating IoT sensors and real-time analytics, leveraging AI-powered decision-making for accuracy and efficiency, and addressing adoption challenges through robust security measures, training programs, user-friendly interface design, and manual override options can build trust and confidence among users.

5.5. Category 5: Collaboration and Awareness

The study emphasizes the importance of collaboration and awareness in enhancing the effectiveness of an AI-powered Risk Management Framework. It suggests that interactive forums,

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educational content, gamification, real-life examples, and success stories can foster knowledge-sharing and collaboration. Social media integration is also suggested to amplify awareness efforts. The study highlights the role of social media monitoring in identifying risks early and providing potential benefits. It can detect early warning signs, track public sentiment, and identify potential threats. AI-powered sentiment analysis can identify potential threats and protect event reputation. The recommendation is to incorporate social media monitoring as a proactive tool, enabling timely interventions to detect negative feedback, complaints, or security concerns, enhancing reputation management and prompt responses to emerging risks. The AI-powered Risk Management Framework is a comprehensive solution designed to address evolving challenges of event safety management. It is user-centered, inclusive, innovative, and impactful, addressing user preferences, challenges, and expectations across five categories: Framework Format, Features and Tools, Target Audience, Advanced Technologies, and Collaboration and Awareness. Key takeaways include dual-format accessibility, essential features and tools, inclusivity and customization, advanced technologies, and collaboration and awareness. The framework's targeted recommendations will enhance accuracy, efficiency, and responsiveness of risk management practices while promoting inclusivity, education, and collaboration among users. The methodology has demonstrated the value of iterative feedback loops, cross-disciplinary input, and data-driven decision-making in developing an innovative and grounded solution.

6. Feasibility:

The proposed AI-powered risk management framework for events is evaluated using five key dimensions: technical feasibility, operational feasibility, resource availability, economic feasibility, and legal feasibility. These dimensions evaluate the integration of advanced technologies like AI and IoT, the effectiveness of the framework in existing event management workflows, the cost-effectiveness of the framework, and compliance with regulatory standards and data protection laws. The framework incorporates ethical guidelines, transparency measures, and human oversight to ensure fairness and build trust among stakeholders. Technical feasibility involves the integration of AI algorithms with IoT sensors, allowing machine learning models to process real-time data from devices like temperature sensors and environmental trackers. Industry collaboration with event organizers, safety experts, and technology partners enhances the framework's applicability across various event types. Open-source tools like Tensor Flow and

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Python-based frameworks simplify AI model development, making it a practical and innovative solution for modern risk management challenges. Operational feasibility addresses safety concerns in crowd management, emergency response coordination, and compliance monitoring using AI-driven predictions and real-time IoT data. The framework is developed through close collaboration with key stakeholders, including event managers, regulatory authorities, and AI/ML experts, to ensure it meets operational requirements and industry standards. Resource availability ensures robust performance in diverse scenarios using publicly available datasets, advanced tools, academic resources, and industry networks. Economic feasibility is assessed through its cost-effective implementation, significant ROI, and scalability across industries. Legal feasibility is ensured by the framework's compliance with strict data protection regulations, ensuring user data privacy and security. It also establishes clear legal frameworks for AI errors and system failures, using contracts, disclaimers, and liability agreements to mitigate risks and clarify stakeholder accountability. Advanced security measures like strong encryption, anonymization, and ethical AI guidelines protect sensitive information and foster trust among users and regulatory bodies.

6.1. Challenges and Mitigation:

The development and implementation of an AI-powered risk management framework for events presents challenges in technical, operational, financial, and legal domains. These include the complexity of AI integration, user unfamiliarity, limited access to real-world event data, high initial investment costs, and compliance with data privacy regulations. To address these challenges, comprehensive training programs will be developed, focusing on user-friendly interfaces and clear demonstrations of the framework's value. Alternatives include simulated datasets and anonymized case studies, using tools like MATLAB and crowd simulation frameworks. High initial investment costs can be managed through a phased implementation strategy, starting with core functionalities and gradually expanding. External funding can offset initial costs, and leveraging scalable cloud solutions and open-source tools can further reduce expenses. Compliance with data privacy laws like GDPR and CCPA is crucial to avoid legal penalties, reputational damage, and loss of user trust. Strong encryption protocols and anonymization techniques will be implemented to protect sensitive data, while user consent mechanisms will be integrated. Regular compliance audits will identify vulnerabilities, and adherence to ethical AI guidelines will promote transparency, accountability, and trust between

users and regulatory bodies. The proposed AI-powered risk management framework has been assessed for its potential to address safety and operational challenges in the events industry by integrating advanced technologies like AI and IoT, ensuring technical feasibility while maintaining cost efficiency. It aligns with event organizers' needs, supports resource availability through publicly accessible datasets, and ensures legal compliance through data protection regulations.

7. Recommendation:

The research proposes two sets of recommendations for an AI-powered risk management framework for events. The first set focuses on real-world deployment and scaling, while the second explores academic research opportunities to address gaps and advance theoretical foundations. These recommendations aim to ensure the framework remains innovative, sustainable, and impactful in enhancing event safety and operational efficiency.

7.1. Recommendations for Future Implementation of the Framework:

- Category 1: Framework Format
  - Develop the framework in both mobile app and website formats to cater to diverse user preferences.
  - Implement responsive design using Progressive Web App (PWA) technology for seamless cross-device compatibility.
  - Include robust offline functionality to ensure accessibility in areas with poor internet connectivity, focusing on essential features like risk checklists and incident reporting.

- Category 2: Features and Tools
  - Integrate real-time alerts, IoT devices, and collaboration tools to enhance operational efficiency during events.
  - Incorporate an educational section with interactive modules, video tutorials, and scenario simulations to empower users with risk management knowledge.
  - Generate actionable reports such as post-event analysis and compliance reports to support regulatory adherence and proactive risk management.

- Category 3: Target Audience
  - Design a tiered interface with role-based dashboards to cater to both professionals and general users.

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- Provide customizable layouts based on event type, size, or location to enhance usability and relevance.

- Offer comprehensive onboarding programs, including interactive training, demo sessions, and AI-powered chat assistance, to address adoption challenges.

- Category 4: Advanced Technologies

- Test and refine IoT sensor performance in diverse event scenarios to ensure robust data collection and real-time monitoring.

- Explore advanced analytics such as predictive analytics, anomaly detection, and natural language processing to proactively identify risks.

- Ensure transparency in AI-powered decision-making by explaining recommendations and maintaining human oversight for critical decisions.

- Category 5: Collaboration and Awareness

- Incorporate interactive forums and communities to foster knowledge-sharing and collaboration among users.

- Use gamification and real-life examples in educational content to increase user engagement and awareness.

- Integrate social media monitoring with AI-powered sentiment analysis to detect risks early and manage event reputation effectively.

7.2. Recommendations for Future Academic Research

- Investigate methods to enhance real-time risk prediction models for improved accuracy and responsiveness in event management.

- Develop standardized datasets derived from real-world scenarios and simulations to train, validate, and benchmark AI models for event risk analysis.

- Study the optimization of real-time data processing and visualization techniques to enable swift interpretation of risk alerts.

- Explore lightweight, scalable, and cost-effective solutions such as edge computing and decentralized AI architectures for large-scale events.

- Examine barriers to AI adoption in event risk management and propose strategies to address these, such as intuitive interfaces and robust training programs.

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- Assess the impact of modular features on customization and scalability of AI-powered frameworks across different event types.

- Advance research on data anonymization techniques and mitigation of algorithmic biases to ensure ethical AI deployment in event management.

- Establish ethical guidelines for AI use in events, focusing on transparency, fairness, and accountability in automated decision-making.

- Evaluate the long-term effectiveness of AI-IoT integration in improving crowd movement forecasting and anomaly detection during events.

- Align future research with national goals, such as Saudi Arabia's Vision 2030, to promote innovation, enhance tourism, and support economic diversification through AI-driven solutions.

8. Research Ethics:

This research adhered to ethical principles throughout the data collection, analysis, and reporting processes to protect the rights, privacy, and well-being of participants. Participants were informed about the study's goals, methods, and data usage before conducting interviews, and they were given the option to leave at any time without penalty. Confidentiality and privacy were strictly protected, with anonymization of personal data and secure access to password-protected files or encrypted systems. Transparency and honesty were maintained throughout the study, with no manipulation or misrepresentation of data, and any limitations or potential biases were clearly acknowledged.

The research team ensured that all claims and recommendations were supported by evidence gathered during the study. Participants were treated with respect and dignity at all stages of the research, with their opinions and contributions valued and their views expressed freely without fear of judgment or bias. The research team avoided any language or behavior that could be perceived as discriminatory, coercive, or disrespectful.

This research upholds academic integrity by prioritizing ethical principles like informed consent, confidentiality, transparency, and participant respect, which protect participant rights and enhance the credibility of the study's findings, ensuring responsible and ethical development of a framework for risk management in the events industry.

9. Conclusion:

The events industry in Saudi Arabia is experiencing significant growth due to Vision 2030's ambitious objectives, but it faces challenges such as population management, cybersecurity threats, health and safety concerns, and logistical inefficiencies. This study proposes a conceptual framework to improve risk management practices in the events industry by incorporating advanced technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and real-time analytics. The User-centered Design (UCD) approach and the Action Research Methodology were used to gather insights from stakeholders such as risk managers, event organizers, technology professionals, and regulatory authorities. The proposed framework is informed by critical themes such as dual-format accessibility, essential features and tools, inclusivity and customization, advanced technologies, and collaboration and awareness. The interface is designed to accommodate both professionals and general users, with customizable dashboards and a hierarchical structure. AI-powered decision-making, IoT sensors, and real-time analytics improve proactive risk detection, operational efficiency, and predictive capabilities. Key recommendations include integrating social media monitoring with AI-powered sentiment analysis, robust offline functionality, dual-format framework with seamless cross-device compatibility, and embedding educational content. The framework prioritizes user-friendly design, customization, and inclusivity to ensure widespread adoption and usability. This study establishes a fundamental framework for future AI-powered risk management tools, proposing innovative approaches to reduce hazards and improve safety during large-scale events. It contributes to the academic understanding of AI and IoT in risk mitigation, providing practical insights for developing scalable, inclusive, and adaptable risk management solutions.

10. Authors' Contributions

All authors equally contributed to the study design, data collection, analysis, and manuscript preparation. All authors reviewed and approved the final version.

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Volume 6 – Issue 71

Issued on: 20 September 2025

International Journal of Research and Studies Publishing

المجلة الدولية لنشر البحوث والدراسات

ISSN: 2709-7064

IJRSP

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12. Appendices:

Interview Questions for Research Project

1. Platform Format   **Category**: General Preferences
1.1 Would you prefer the Risk Management Platform to be a mobile app, a website, or both? Why?
1.2 How can we ensure the platform works seamlessly across different devices like smartphones, tablets, and computers?
1.3 Do you think the platform should include offline functionality in case of poor internet connectivity during events? Why?
2. Features and Tools   **Category:** Functionality and Usability
2.1 What features or tools do you think would make the Risk Management Platform more effective and user-friendly for event management?
2.2 Would you find value in an educational section or knowledge center within the platform that offers interactive training on risk management? If so, what type of training would you prefer?"
2.3 What types of reports or data do you expect the AI-powered Risk Management Platform to provide? For example, real-time alerts, post-event analysis, or compliance reports?
3. Target Audience   **Category:** User Accessibility
3.1 Should the platform be designed for risk management professionals only, or should it be simple enough for anyone to use? Why?
3.2 Do you think the platform's interface should be customizable to meet the needs of different types of users? How could this be achieved?

3.3 What challenges do you think new users might face when adopting the platform, and how can we address them?

4. Advanced Technologies

Category: Innovation and Trust

4.1 What is your opinion on using technologies like IoT sensors or real-time analytics to detect risks during events? Do you think these technologies would be beneficial? Why?

4.2 Do you believe AI-powered decision-making for risks can improve the accuracy and effectiveness of actions? Why or why not?

4.3 What challenges do you think you might encounter when using an AI-based platform for risk management? How can these challenges be addressed?

5. Collaboration and Awareness

Category: Community and Education

5.1 Would you find value in a feature that allows users to share experiences and insights through forums or interactive communities? Why?

5.2 What methods can we use to increase awareness about the importance of risk management in events through the platform? Would having awareness content within the platform be helpful?

5.3 Do you think integrating social media monitoring (e.g., tracking mentions of your event) into the platform would help identify risks early? Why or why not?