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Artificial Intelligence for Food Safety in Africa's Hospitality Sector: Opportunities and Challenges

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Abstract

The hospitality sector nowadays takes an important place in Africa's economy, driven by rapid urbanisation, increasing domestic and international tourism, and expanding hospitality services. Unfortunately, foodborne illnesses, cross-contamination, and unsanitary handling practices remain challenges for that business across the continent. Artificial Intelligence (AI) solutions have been developed worldwide to address the food safety concerns in the hospitality industry. This narrative mini-review explores the potential of AI in enhancing food safety in the hospitality sector. Innovations such as smart sensors for temperature control, AI-driven hygiene monitoring systems, and AI-based staff training solutions are highlighted. Factors that might limit their use and adoption in Africa are also discussed. AI systems could help reduce foodborne risks if adapted to low-resource environments and supported by training and policy frameworks. Governments' investments in ICT and public-private partnerships to foster sustainable food safety in Africa's hospitality sector form the basis.

Keywords: Hospitality Industry; Africa; Food safety; Artificial Intelligence; Challenges

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Introduction

Hospitality represents the warm, friendly, and generous welcoming of guests, with services such as food, beverages, and accommodation. In a business context, it refers to establishments that offer these services, among which are hotels, restaurants, cafés or bars (Kunwar, 2017). Motels, resorts and spas, theme parks, conference centres and tour companies are also integrated. The hospitality sector is helpful for people who travel away from home, either for a short visit or an extended stay. It goes beyond the travel and tourism industries by targeting not only vacationers and travellers but also locals seeking its services. In Africa, like in many other parts of the world, this sector plays an important role in the economy and has been growing swiftly, by attracting important funding from domestic and international stakeholders (Skobkin et al., 2020; Sampaio et al., 2024). For restaurants, hotels, catering services, and food outlets, food safety is a critical aspect to be considered. Indeed, effective food safety practices are directly linked to guest satisfaction, which influences whether customers will return or recommend a facility (Moise et al., 2018; Han et al., 2018). This makes food safety a health imperative and a competitive factor for hospitality businesses, as it can affect travel destination choices (Yeung & Yee, 2020). As food away from home (FAFH) consumption rises, hospitality businesses are often required to adopt food safety systems like Hazard Analysis Critical Control Point (HACCP) to prevent foodborne illnesses (Da Cunha, 2021; Vukotić et al., 2024). These diseases account for approximately 135 million cases and 180,000 related deaths each year (International Food Policy Research Institute-IFPRI, 2020). Food safety should therefore be considered as a priority in the continent's hospitality industry.

As reported by Vukotić et al. (2024), challenges in food safety management are particularly evident in hotels and catering facilities, which handle high-risk raw materials and often have limited storage space. The complexity of this management also varies depending on the accommodation type (Sun & Ockerman, 2005). Successful implementation of food safety systems like HACCP requires employee education and motivation and addressing financial and human resource constraints (Borovčanin & Kilibarda, 2020; Ibrahim et al., 2021). Many hospitality workers lack proper food hygiene and safety training, leading to poor practices like improper handwashing and unsafe ingredient handling. Even with training, inconsistent implementation across shifts and locations persists. This food safety monitoring and enforcement has been described as challenging, especially in resource-limited or understaffed establishments (Ale et al., 2023). Food safety remains a major public health concern in Africa, this being associated to various infrastructural and socio-economic challenges (Kareem & Tadesse, 2024; Tohonon et al., 2025). Its hospitality sector is also highly concerned. With rapid urbanisation, increasing domestic and international tourism, and the expansion of hospitality services, the need to strengthen food safety systems across African nations has become both urgent and essential. This pressing need has prompted the exploration of innovative solutions, among which Artificial Intelligence (AI). The latter has emerged as an invaluable tool to support food safety (Qian et al., 2023; Dhal & Kar, 2025). Many AI-driven solutions have recently been developed to monitor, predict, and manage food safety risks (Figure 1), which might be a great opportunity for Africa. Focusing on the hospitality sector (from kitchen to service), this article explores practical applications opportunities that has have been developed, and presents possible challenges which might be associated with their implementation.

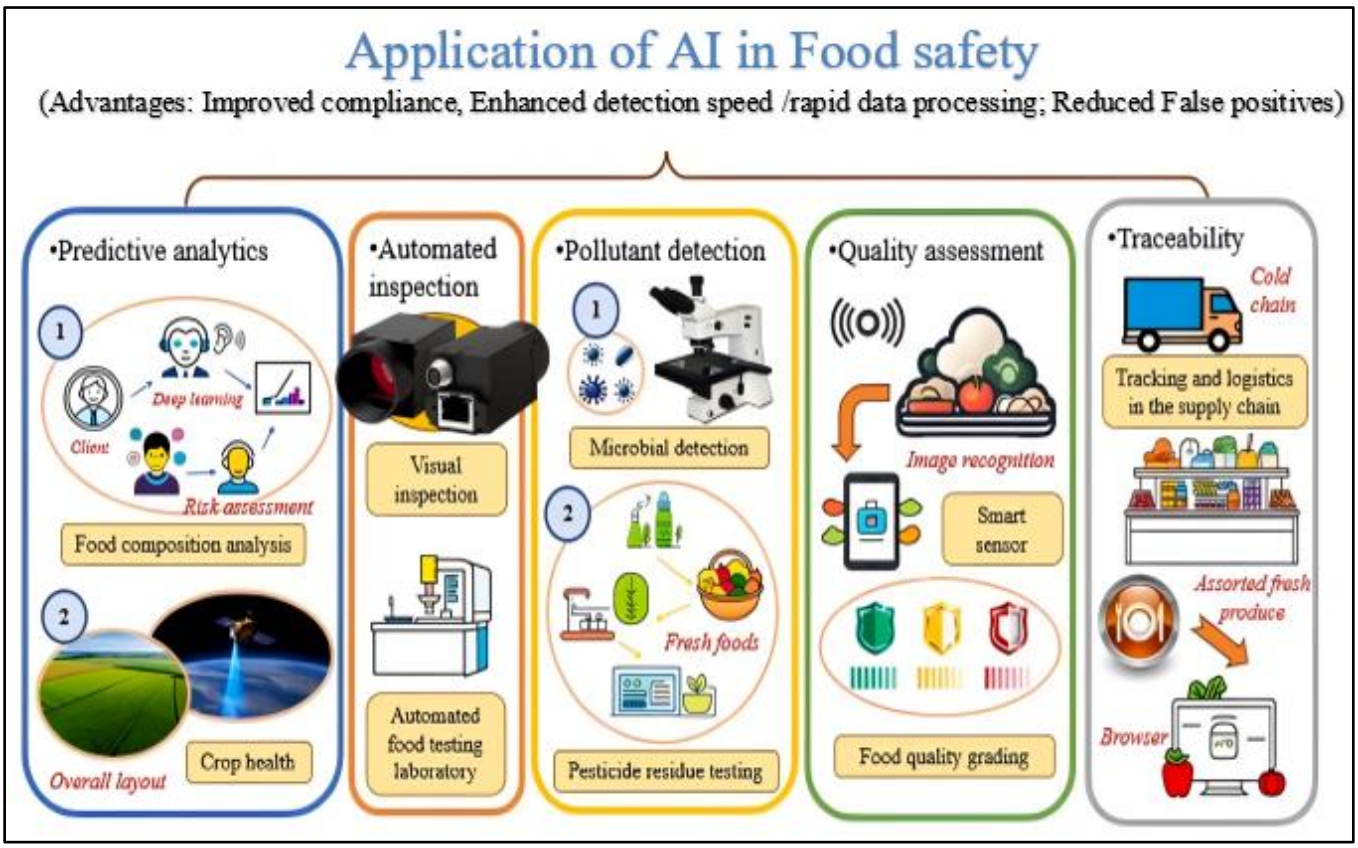

Figure 1. Application cases of AI in food safety testing (Yu et al., 2025)

Smart sensors for temperature control

Refrigeration, freezing, cooking, and drying are conventional methods used to extend shelf life and maintain food safety. Limitations as inconsistent temperature control, reliance on manual monitoring, human error, and difficulties in managing large volumes of diverse food items, are common. The U.S. Food Safety and Inspection Service (FSIS) recommend refrigerated food to be kept at or below 5°C and hot food at or above 60°C to avoid microorganisms' growth (Singh et al., 2019). Many outbreaks have been associated worldwide with a variety of foods, including those generally proposed to customers in hospitality settings. They include red and white meat products, dairy, fresh produce, bakery items, and ready-to-eat foods (WHO, 2008; Todd, 2014). Inadequate cooking and improper storage highly contribute to foodborne diseases (Augustin et al., 2020). Considering the complexity of food storage, preparation, and service, as well as the large quantities of food handled daily in hospitality businesses (hotels, restaurants, and catering services as examples), it is essential to maintain the right temperature for compliance with food safety regulations, preserving customer trust and minimising food spoilage.

Smart AI-powered sensors have been developed for temperature monitoring. Installed in refrigerators, freezers, and storage units, they provide real-time temperature tracking, ensuring that food remains within a safe temperature range (Waldhans et al., 2024; Arabsheybani et al., 2024; Claassen et al., 2024; Eze et al., 2024). These systems are made to detect temperature fluctuations that may compromise food safety and immediately alert staff and managers. The objective is to enhance businesses' capacity for rapid intervention, thereby preventing contamination and reducing health risks. This new technology has also been designed to enable remote supervision and allow managers to oversee temperature conditions from any location. Different advantages are associated, including a reduction of the reliance on manual checks and enhancement of operational efficiency, assurance that food safety standards are consistently met, even when physical oversight is limited. A sensor-based device designed to monitor food spoilage, extend food lifespan, and provide alerts on spoilage timing was introduced by Sonwani et al. (2022), with 95% accuracy. They developed a prototype that tracks food quality and manages home storage systems by monitoring gas emissions, humidity, and temperature levels of fruits and vegetables using sensors and actuators to detect spoilage. The authors proposed further improvements, including the use of image processing and machine learning for early spoilage detection, and integration into refrigeration systems or food transport containers. While proper temperature control is critical in preventing microbial growth, maintaining hygienic conditions throughout food preparation and service is equally vital.

AI-driven hygiene monitoring

Respecting hygienic working conditions is a basic recommendation in the hospitality sector to ensure the well-being of guests and staff. It helps reduce the risk of cross-contamination. Augustin et al. (2020) reported that foodborne disease burden could

be reduced by 67–85% (CI90) with a strict implementation of good hygienic practices at the final food preparation step. Different AI solutions have been suggested for efficient hygiene monitoring, which are applicable to hospitality settings. As cleanliness and sanitation are imperative in kitchens, AI-based systems are able to follow compliance with food safety regulations proposed. They use computer vision and deep learning models to detect whether kitchen staff respect proper hygiene practices automatically. For instance, Tao et al. (2021) worked on a deep learning model which uses cameras to monitor staff behaviour, that aimed ensuring protocols like handwashing, glove-wearing, and surface cleaning are being followed. A similar model was developed by Radhakrishnan et al. (2024), who further advanced this concept by developing an AI-powered system that integrates machine learning, computer vision, and cloud technologies for hygiene monitoring in restaurant kitchens. Strategically placed cameras instantly detect hygiene violations such as improper attire (apron, gloves, hairnet), presence of pests (lizard, rat, cockroach), and adherence to hygiene protocols. Immediate corrective actions could therefore be taken. Detailed violation histories of food safety compliance could be obtained through an associated mobile app. Nayar et al. (2023) had also developed a deep learning model for pest detection in food preparation areas. Such AI solutions that focus on pests are quite useful as these latter are an important source of food contamination. On the other hand, Galkin et al. (2019) are rather interested in an AI-based system for real-time handwashing processes (hand hygiene), which is particularly important in preventing the spread of foodborne pathogens in restaurants and hotels. The system ensures that staff consistently follow proper handwashing protocols. Another one proposed by Sathyamurthy et al. (2021) appeared adequate to ensure that staff members and guests comply with mask-wearing policies during the COVID-19 pandemic. Such a system is also able to monitor social distancing and crowd management. Technology alone is insufficient without well-informed staff who consistently practice proper hygiene and comply with safety protocols.

AI for staff training and education

Ensuring employees are well-trained in food safety practices is a significant challenge in food safety management. Studies have shown that while effective in increasing employee knowledge, traditional food safety training programs often fail to change employees' observed behaviours, leaving the risk of foodborne illness unchanged (Beck et al., 2016). Online food safety education has gained popularity, especially in shifting technological and cultural landscapes. Berglund et al. (2024) found that online programs were moderately effective, but challenges remain, such as social isolation among students and difficulty for food workers in understanding training material. Future programs were recommended to incorporate shorter, more frequent sessions, use simple language, and focus on shifting attitudes toward food safety. The study highlighted the importance of using technology to educate different populations, though it acknowledged the need for improved engagement and risk perception among participants. AI-driven training programs offer a scalable solution by leveraging machine learning, virtual reality (VR), and augmented reality (AR) simulations to create interactive, controlled training environments (Truong et al., 2022; Tian, 2023). AR has been proposed as an innovative tool for enhancing compliance by providing real-time guidance and feedback during food handling tasks, bridging the gap between knowledge acquisition and practical application. AR overlays digital information onto the physical world, offering interactive training experiences that help employees better adhere to safety standards (Beck et al., 2016). By engaging employees with up-to-date content, AI helps foster a strong safety culture and minimise human error. Research for hospitality management education has shown that immersive technologies improve learning outcomes by providing interactive environments where employees can practice food safety protocols in realistic scenarios, enhancing both understanding and retention (Traynor et al., 2024). VR has shown great promise in industrial and food safety training. Research by Holusa et al. (2023) emphasised VR's potential to offer immersive learning experiences that improve practical skills and teamwork, while also being more time-efficient than traditional methods. VR training is safe, controlled, and resource-efficient, although it can be costly due to the need for specialised hardware. The use of VR for spotting risks in kitchen workplaces has also been validated, showing its effectiveness in the hospitality sector (Saad et al., 2022). AI continuously evaluates staff, keeping them informed about the latest food safety regulations and industry standards. This ongoing improvement is vital for maintaining high safety standards. AI-driven programs might also be valuable for training inspectors through virtual simulations and adaptive learning experiences.

Challenges and considerations

Despite the previously enumerated benefits of AI in promoting food safety, several challenges persist, particularly within the African context. The main one might be the high cost of implementing AI-driven systems, which can be prohibitive for small and medium-sized enterprises (SMEs) in the hospitality sector. This is especially true in regions with limited financial and technological resources (Ade-Ibijola & Okonkwo, 2023). The effectiveness of systems like the Haar Cascade Classifier used by Bernabe et al. (2023) may be influenced by lighting or obstructions in a busy kitchen environment as they employed a DHT22 sensor for kitchen temperature monitoring, IR Flame sensors for stove activity, and an ESP32-CAM for live surveillance. Poor infrastructure (including limited access to stable electricity) significantly constrains the broader use of technology in countries like Zambia and across Africa (Kala, 2023). Reliable internet connections, sufficient data storage, and robust hardware are not yet available in many parts of Sub-Saharan Africa (World Bank Group, 2024). These gaps are more pronounced in rural and underserved areas, making the implementation of AI solutions for food safety uneven and challenging. Although investments in ICT infrastructure have shown a positive impact on inclusive growth (Nchake & Shuaibu, 2022), the pace of development remains insufficient to fully support widespread AI adoption. The absence of a structured data ecosystem and limited technical skills, as noted by Ade-Ibijola & Okonkwo (2023), further impedes innovation and the maintenance of

AI systems, while cultural resistance and a lack of trust in technology in rural communities can also slow down the acceptance of AI solutions (Kala, 2023). The informal nature of businesses in Africa also represents a challenge. The informal economy in Sub-Saharan Africa was already pointed out by Medina et al. (2017) one of the world's largest, though gradually declining. They reported informality varying from 20–25% in Mauritius, South Africa, and Namibia to 50–65% in Benin, Tanzania, and Nigeria. In such context, it might therefore be also difficult to promote the use of these AI-driven food safety solutions in the hospitality settings. Policies that encourage formalization (such as access to micro-loans or business development services in exchange for registration) could encourage informal businesses to transition into the formal sector, making them eligible for AI-related support and programmes.

Conclusion

In the hospitality sector, food safety determines customer satisfaction and business reputation. Despite existing regulations like HACCP, challenges such as inadequate training and resource limitations persist, especially in Africa. AI solutions, such as smart sensors, hygiene monitoring, and training programmes, offer significant benefits for improving food safety. However, their widespread adoption might be limited by their high costs, limited infrastructure, and the cultural resistance hinder in Africa. Governmental investments in ICT and training, along with collaboration between businesses might be key approaches that can help unlock AI's potential to enhance food safety in the sector across the continent. Public-private partnerships are also necessary. Research and development efforts should focus on tailoring AI technologies to low-resource environments and involving local stakeholders in design and rollout.

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