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Research Article

ARTIFICIAL INTELLIGENCE ETHICS AND DIGITALIZATION IN TOURISM: THE RISE OF SERVICE ROBOTS AND POSSIBLE CONSEQUENCES**,***

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Abstract

The tourism and hospitality industry is one of the most rapidly transforming sectors, with artificial intelligence (AI) and service robots at its core. The increasing use of AI-powered service robots in hotels, restaurants, airports, and travel agencies offers various benefits, including enhanced operational efficiency, reduced costs, and improved guest experiences. However, it raises significant ethical concerns, including data security and privacy, job displacement, human-robot interaction, algorithmic biases, and the ethical responsibility of the stakeholders involved. This study aims to examine the ethical challenges of adopting AI-driven service robots in the tourism and hospitality industry and to discuss potential solutions to these challenges. The research is a qualitative review based on a comprehensive analysis of relevant academic literature. This study examines the ethical implications of AI and robotics in the T&H industry by critically evaluating the existing body of knowledge. Findings indicate that integrating AI and service robots in tourism businesses generates major ethical concerns, particularly regarding data security and privacy, employment and workforce dynamics, the boundaries of human-robot interaction, the lack of emotional connection and human touch, and algorithmic fairness. In response to these concerns, the study proposes various strategic solutions. Strengthening data protection policies, adopting transparent data governance processes, implementing privacy-focused design principles, and increasing the transparency of algorithmic processes are among the recommended measures. Additionally, fostering human-robot collaboration models and promoting reskilling programs are suggested to mitigate workforce displacement. Ensuring fairness and transparency in AI algorithms, as well as designing service robots with a human-centered and inclusive approach, are also identified as critical strategies for achieving these goals. The findings contribute to the academic literature while providing practical insights for industry professionals, guiding the responsible and sustainable adoption of innovative technologies in the tourism and hospitality industry.

Keywords: Artificial Intelligence, Service Robots, Tourism, Ethical Concerns, Workforce Restructuring

Introduction

The tourism and hospitality (T&H) industry is among the sectors that rapidly embrace and heavily utilize technological advancements. Artificial intelligence (AI) and robotic technologies are increasingly accepted in this sector, significantly transforming service delivery methods. These advanced technologies are widely adopted in various operational tasks, including guest welcoming, guidance, luggage handling, room service, housekeeping, reception, concierge services, restaurant order-taking, food preparation, airport information services, and security. This technological transformation enhances operational efficiency, reduces costs, and improves guest experiences (Germak, Giuliano, and Lupetti, 2015; Skubis, Mesjasz-Lech, and Nowakowska-Grunt, 2024). Thus, it can be argued that AI and robotics hold substantial potential for the industry. In the near future, innovative technologies such as AI, machine learning, autonomous devices, and the Internet of Things (IoT) are expected to become increasingly prevalent within T&H. Businesses aware of these advantages have already begun integrating AI and service robots into their operations to gain a competitive edge.

However, the integration of AI and service robots not only brings numerous benefits but also raises significant ethical concerns, especially in an industry characterized by human-centered service delivery. Key ethical issues

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include data privacy, ethical design, impacts on human labor, and the nature of human-robot interactions (Dogru et al., 2024; Y. Liu et al., 2023). For instance, service robots that collect and process personal guest data can result in privacy breaches and data security risks. Additionally, integrating these technologies into operational processes can alter employment dynamics and threaten job security by potentially replacing human workers. Furthermore, robots' inability to adequately provide human interactions, empathy, and emotional bonding—which guests often seek—can negatively affect guest satisfaction and constitute a critical ethical concern.

A thorough examination, understanding, and management of the ethical dimensions of AI and robotics in T&H are essential for all stakeholders. It is argued that sustainable success in this guest-focused industry, which relies heavily on human interaction, can only be achieved when advanced technologies are balanced with ethical responsibilities (Cascio and Montealegre, 2016; Nosratabadi et al., 2022). Otherwise, negative consequences such as privacy violations and loss of trust in the business may occur, making technological adoption more challenging. Therefore, the ethical dimensions of AI and service robots should be addressed within the framework of corporate digital responsibility and proactively managed by businesses (Lu et al., 2020). Compliance with legal regulations and adherence to ethical principles in corporate reputation management will enhance guest trust and satisfaction in the long term.

Existing literature suggests that research on AI and service robots in T&H is still in its early stages (Ivanov, Webster, and Garenko, 2018; Murphy, Hofacker, and Gretzel, 2017). Past studies have primarily focused on technology adoption at the organizational level (Nam et al., 2021; Pizam et al., 2022), guest acceptance (Li and Wang, 2022; Ozturk et al., 2023), and online guest reviews (Molinillo, Rejón-Guardia, and Anaya-Sánchez, 2023; Seyitoğlu and Ivanov, 2022), whereas the ethical dimensions of technology remain relatively underexplored (Ivanov and Umbrello, 2021). For example, the widely used Technology Acceptance Model prioritizes individual acceptance while insufficiently addressing organizational strategies and ethical concerns (El Hajal and Yeoman, 2024). Literature highlights significant gaps in the ethical implications of AI and robotics, calling for deeper investigations and comprehensive strategic development (Belanche et al., 2024; Gursoy and Cai, 2025).

This study aims to systematically analyze ethical issues arising from the growing use of AI and service robots' usage in T&H, contribute to ongoing debates, and develop practical recommendations. The suggested solutions draw from existing literature and the authors' expertise to propose innovative strategies. As previously noted, although the existing literature contains numerous studies evaluating these technologies in terms of operational efficiency, customer experience, and cost-effectiveness, relatively few studies address their ethical implications in depth. Therefore, this study aims to fill a significant gap in the literature by focusing on the ethical dimensions associated with integrating AI and service robotics into T&H contexts. In addition to identifying and examining key ethical concerns, this study also proposes solutions to mitigate these concerns in practical applications within the sector. By doing so, the study helps bridge the gap between theoretical discourse and sectoral needs. The proposed solutions are grounded in a thorough review of the current literature and enriched with the authors' original insights and domain expertise, allowing for the development of novel and context-sensitive strategies. Accordingly, the study contributes to rethinking and reshaping the ethical landscape of AI and robotic technologies in T&H by offering a framework for understanding how ethical principles can be translated into actionable practices. In this regard, it is expected that the study will both address theoretical gaps in the literature and serve as a guiding reference for industry practitioners involved in policy development and technological implementation.

Initially, the study evaluates the utilization of AI and robotics in T&H, comprehensively highlighting their benefits and ethical challenges. Subsequently, critical ethical concerns, including data privacy and security, workforce transformation, human-robot interaction outcomes, algorithmic decision-making, algorithmic bias, and discrimination, are analyzed in detail, assessing how T&H businesses can ethically adopt AI and service robots. Finally, practical recommendations and strategies are discussed to minimize these ethical concerns.

Artificial Intelligence and Robotic Technologies

Concept of Artificial Intelligence

Industry 4.0, also known as the Fourth Industrial Revolution, was first introduced at a trade fair in Hanover, Germany, in 2011. Subsequently, it became part of Germany's national policy (Schwab, 2017). Unlike previous industrial revolutions, which were primarily focused on raw materials and energy utilization, Industry 4.0 represents a novel approach to production and service delivery, integrating machines digitally and enabling

technology to interact seamlessly with society (Roblek, Meško, and Podbregar, 2021). The fundamental resource of Industry 4.0 is information, emphasizing that accumulated knowledge is critically significant for technological advancements (Roblek, Meško, and Krapež, 2016). While these technologies were predominantly considered science fiction and unrealistic until the late 20th century, the early 21st century marked a turning point. With the widespread adoption of the fourth industrial revolution, both practically and academically, these advanced technologies have become increasingly integral to daily life (Kılıçhan and Yılmaz, 2020).

Robots are undoubtedly among the most significant advanced technologies today. They possess varying degrees of autonomous movement capability. Autonomous robots are defined as robots capable of performing intended tasks without human intervention, relying on the conditions of their environment and data collected from sensors (International Federation of Robotics, 2024b). The autonomous capability of robots is enabled primarily through artificial intelligence (AI) technologies. Hence, it is crucial to examine the conceptual foundations of artificial intelligence and robotic technologies in detail.

In the literature, artificial intelligence is generally recognized as a subfield of computer engineering (Shubhendu and Vijay, 2013; Tussyadiah, 2020). Fundamentally, artificial intelligence involves simulating human-specific cognitive processes through various machines, particularly computer systems (Russell and Norvig, 2016). McCarthy (2007) succinctly defines artificial intelligence as "the science and engineering of creating intelligent machines." Gil et al. (2020: 4) further characterize AI as a computer science field investigating methods that enable machines to exhibit intelligent behaviors.

Concept of Robotic Technology

Robots have become increasingly prevalent in contemporary technology, impacting various fields in diverse ways. The term "robot" was first introduced by Karel Čapek in his 1921 play *R.U.R. (Rossum's Universal Robots)*. The term "robotics" was first used by Isaac Asimov in his short stories, published in 1941 (Hegel et al., 2009: 169). Robots are generally defined as machines capable of being programmed to perform specific tasks and operate autonomously or semi-autonomously (Mukherjee et al., 2021). The concept of robotic technology varies among researchers; some broadly define it as any self-propelled mechanism, while others limit it specifically to machines capable of independent movement from one point to another (Cicolani, 2018: 1). The American Robot Institute, in 1979, defined robots as "*reprogrammable, multifunctional, remotely operable machines designed to manipulate parts, tools, or specialized devices through programmed movements for performing various tasks*" (Hegel et al., 2009: 169). As these definitions illustrate, early conceptualizations of robots primarily emphasized their industrial applications.

Robots are not limited to a single field of application but are widely evaluated within diverse contexts, including both industrial and service-oriented applications. In this regard, the International Federation of Robotics (IFR) categorizes robots into two main groups: industrial and service robots (International Federation of Robotics, 2024b). Furthermore, service robots are subdivided into professional and personal service robots, depending on their specific fields of application.

Service Robots: Concept and Classification

Service robots stand out prominently among contemporary technological innovations, becoming increasingly prevalent in both commercial and everyday settings due to their ability to perform specific tasks autonomously. The International Federation of Robotics (IFR) describes a service robot as "*an actuated mechanism programmable in two or more axes, designed to perform beneficial tasks for humans or equipment by moving within its operational environment, excluding industrial automation applications*" (International Federation of Robotics, 2024a). As these definitions indicate, service robots transcend simple mechanical operations and possess capabilities enabling direct interaction and cooperation with humans, thus facilitating easy integration into daily life.

Service robots are categorized into two primary groups: professional service robots and personal service robots. Professional service robots operate outside industrial environments, supporting individuals in specific occupational tasks (Thrun, 2004: 12). The IFR (2024b) defines professional service robots as "operated by trained personnel, primarily intended for commercial tasks." Although the adoption rate of professional service robots is relatively lower than that of industrial robots, their growth rate is considerably higher (Thrun, 2004). These robots play a crucial role in reducing human involvement in hazardous or challenging tasks in non-industrial settings, consequently enhancing workplace safety.

Personal service robots are classified into subcategories: social robots, household cleaning robots, research/educational/competitive robots, assistant robots, and therapeutic robots (Garcia-Haro et al., 2021: 4)**.** Distinguished by their high levels of social interaction capability and autonomy, personal service robots possess the highest growth potential among robot types (Murphy et al., 2017: 107). Thus, the significant social interaction capacities of personal service robots enrich the human-robot interaction domain, positioning them as influential factors in technological advancements and societal adaptation processes.

The Role of Artificial Intelligence and Robotics in the T&H Industry

With the rapid advancement of technology today, artificial intelligence (AI) and robotic technologies have emerged as primary drivers of transformation within the T&H industry. Although various studies have explored the application of AI and robotic technologies in this industry (Doborjeh et al., 2021), a significant need remains for comprehensive research in this domain (Kong et al., 2023). It is particularly noteworthy that research on service robots and automation systems is still in its early stages (Ivanov et al., 2018; Murphy et al., 2017), although these technologies are projected to achieve widespread acceptance and applicability in the coming years. Practically, T&H businesses have already begun integrating service robots—whether humanoid, zoomorphic, or machine-like—into various operations, including guiding guests, luggage handling, cooking, cleaning, serving, and bellboy services (Drexler and Lapré, 2019; Ivanov, Webster, and Berezina, 2017).

Many leading T&H businesses have already begun investing in AI and robotic technologies, accelerating the industry's transformation process. Companies that closely follow technological innovations and rapidly adopt them are expected to gain significant competitive advantages. Therefore, businesses aiming to solidify their market positions will inevitably accelerate their efforts to integrate these technologies into their operational frameworks. Given that AI and robotic systems have become central components of smart tourism and smart business concepts, it is increasingly likely that enterprises adopting these technologies will be classified as "smart enterprises," thereby strengthening their positions within the sector (Nam et al., 2021: 554).

In the hospitality industry, service robots have a broad range of applications. They are utilized by guests, staff, and managers for various purposes, leading to increased scholarly attention in this field (Chen et al., 2023). It is frequently noted that hotel managers prefer to deploy robots for tasks that are repetitive, dirty, or hazardous. In contrast, they continue to rely on human workers for roles that require interpersonal skills and emotional intelligence (Ivanov, Seyitoğlu, and Markova, 2020).

Several illustrative examples of service robots commonly used in the T&H industry are presented below. However, the scope of service robots is not limited to the categories listed, as many other robot types serve various additional functions within this industry.

Robot Receptionists: Robot receptionists are service robots and AI-powered systems capable of performing various front-desk tasks traditionally managed by human receptionists, such as guest check-in and check-out processes. These robots possess basic communication skills for interacting with guests. A prominent example of robotic receptionist technology is the Henn-na Hotel, widely recognized as the world's first robotic hotel (Rajesh, 2015). The Henn-na Hotel Group emphasizes the proactive use of advanced technologies and the substantial delegation of reception services to robots (Henn na Hotel, 2024). In these hotels, all systems are automated, significantly minimizing direct human contact (Ivanov et al., 2017). Guests interact predominantly with humanoid or zoomorphic receptionist robots (Tung and Au, 2018).

Robot Bellboys: In the T&H sector, robot bellboys are employed primarily for tasks such as carrying, delivering, and storing luggage. These robots may also function as cloakroom assistants, welcoming and escorting guests to reception areas (Orea-Giner et al., 2022). For example, the service robot Sacarino serves as a robotic bellboy (Zalama et al., 2014). At Yotel New York, a robot named Yobot operates as a luggage assistant, capable of securely storing luggage, delivering newspapers to guests, moving freely within the hotel premises, and engaging in fundamental conversational interactions with guests (Yotel, 2024).

Robot Concierges: Robot concierges are AI-powered service robots designed to provide guests with hotel services and information about local tourist destinations, addressing specific requests through personalized assistance (Liu et al., 2024: 138). Inspired by traditional concierge roles, these robots facilitate tasks such as assisting check-ins, explaining hotel amenities, recommending local tourist attractions, making restaurant reservations, and providing weather forecasts (Tussyadiah and Park, 2018). A notable example is Connie, utilized by Hilton Hotels, which interacts directly with guests, offering information and guidance (Shin and Jeong, 2020). Developed in collaboration with IBM, Connie can answer queries about hotel services, suggest local sightseeing destinations, and manage restaurant reservations. Notably, Connie continually enhances its

capabilities through ongoing interactions with guests (Ivanov et al., 2017; Lee, 2024; Lukanova and Ilieva, 2019; Trejos, 2016; Tussyadiah and Park, 2018). Additional examples of robotic concierges include Mario in Ghent, Pepper at the Mandarin Oriental Hotel in Las Vegas, Botlr at Starwood's Aloft, Nao at Tokyo Airport, and Toshiba's Chihira Kanae (Chestler, 2016; Dobrosovestnova, Hannibal, and Reinboth, 2022; Logan, 2016).

Robot Waiters: Robot waiters used in restaurants and hotels can greet guests, take orders, serve food and beverages, and clear dishes from tables. Their popularity notably increased during the COVID-19 pandemic due to their role in maintaining social distancing and enhancing health safety protocols (Kim et al., 2021; Romero and Lado, 2021). For instance, Pizza Hut utilizes "Pepper," a robot waiter equipped with voice recognition and artificial intelligence technology for customer interactions. Additionally, Istanbul's Touch Restaurant—the first restaurant in Turkey to employ robots—features Rozzy and Robby robot waiters (Güner and Aydoğdu, 2022; Hazarhun and Yılmaz, 2020). Similarly, Rong Heng restaurant in Singapore uses robots, Lucy and Mary, to greet guests and take orders (Ang, 2016).

Robot Bartenders: Robot bartenders are autonomous systems capable of preparing and serving beverages without human intervention, often designed as robotic arms or humanoid robots (Tussyadiah, Zach, and Wang, 2020). In China, a restaurant within an Alibaba-owned hotel employs robotic bartenders that can create up to 20 different cocktails, including coffee-based beverages (Devitt, 2019). Similarly, the Tipsy Robot uses two robotic arms to mix and garnish drinks in Las Vegas, delivering an innovative bar experience (Rigie, 2018; The Tipsy Robot, 2024).

Robot Chefs: Robot chefs in restaurant and hotel kitchens represent innovative technologies with significant potential to accelerate food preparation processes and reduce food costs (Sochacki et al., 2024). AUSCA, the world's first robotic chef, began service at the M Social Singapore Hotel in 2017 and can prepare fried eggs and omelets within approximately 2.5 minutes (HospitalityNet, 2018). "Flippy," another robot chef, can autonomously cook hamburgers and fries (Berezina, Ciftci, and Cobanoglu, 2019). Furthermore, "Moley," a robot developed in the UK, can download recipes online and prepare various meals accordingly (Zhu and Chang, 2020: 1367).

Housekeeping robots: Housekeeping robots are designed to autonomously clean hotel rooms, corridors, and swimming pools. These robots, equipped with artificial intelligence and sensor-based systems, utilize advanced navigation and obstacle-avoidance algorithms to optimize cleaning efficiency (Lee et al., 2019). WINBOT, specifically designed for cleaning hotel windows, uses intelligent path-planning algorithms to perform multi-directional cleaning tasks (ECOVACS, 2024). Rosie, developed by Tailos, is recognized as the world's first hotel housekeeping robot, designed to optimize cleaning processes and reduce physical workloads for human staff (Tailos, 2024). Additionally, the Robot Cleaner Store manufactures automated pool cleaners that streamline pool maintenance processes within hotel facilities (Robot Cleaner Store, 2024).

Methodology

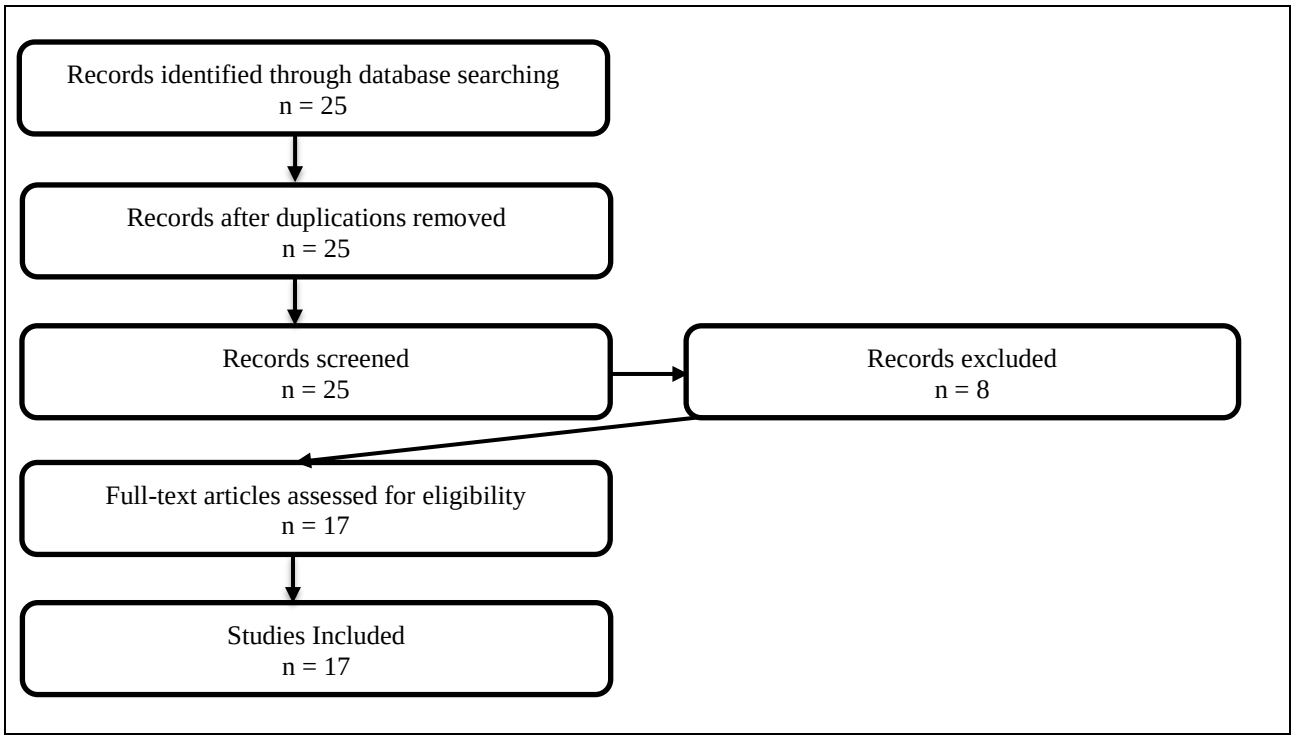
The research was designed as a qualitative study. Qualitative research enables the researcher to acquire knowledge about and make sense of phenomena occurring in the world and in their surroundings. It typically involves the use of data collection methods such as case studies, personal experiences, observations, interviews, analysis of audio recordings, and document analysis (Kozak, 2014; Sekaran and Bougie, 2016: 332; Denzin and Lincoln, 2018: 43). In this study, through document analysis, the ethical issues related to integrating artificial intelligence and robotic technologies into the T&H industry were identified based on a comprehensive review of the literature. The study aims to systematically identify and categorize the ethical issues discussed in the literature, highlight existing gaps in the literature, and develop solutions and policy recommendations for the sector. In this respect, the research not only deepens theoretical debates but also offers a practice-oriented, guiding framework. *Therefore, the study does not fall within the scope of research requiring ethics committee approval, and ethics committee approval is not required.*

The relevant literature review was conducted on January 25, 2025, via the Web of Science (WoS) database. The keywords were constructed to reflect an integrated perspective on artificial intelligence, service robots, and ethical issues within the context of the T&H industry. In this regard, the search terms were structured as follows:

TITLE: “"robot*" OR "chatbot" OR "service robot*" OR "conversational agent" OR "virtual concierge" OR "virtual assistant" OR "artificial intelligence"”; **TOPIC:** “"ethical considerations" OR "ethics" OR "ethical issues"”; **TOPIC:** “"tourism" OR "hospitality" OR "travel" OR "travel agenc*" OR "hotel*" OR "restaurant" OR "museum*" OR "airline*" OR "aircraft" OR "airplane"”

As a result of the search, 25 publications were identified. These records were initially examined based on their titles and abstracts, and studies that were not consistent with the research aim or did not prioritize ethical issues in their inquiry were excluded from the scope. Following this preliminary screening, eight studies were excluded, and the analysis proceeded with a total of 17 studies. Since all remaining studies were aligned with the research purpose and addressed ethical issues, no additional exclusion criteria were applied.

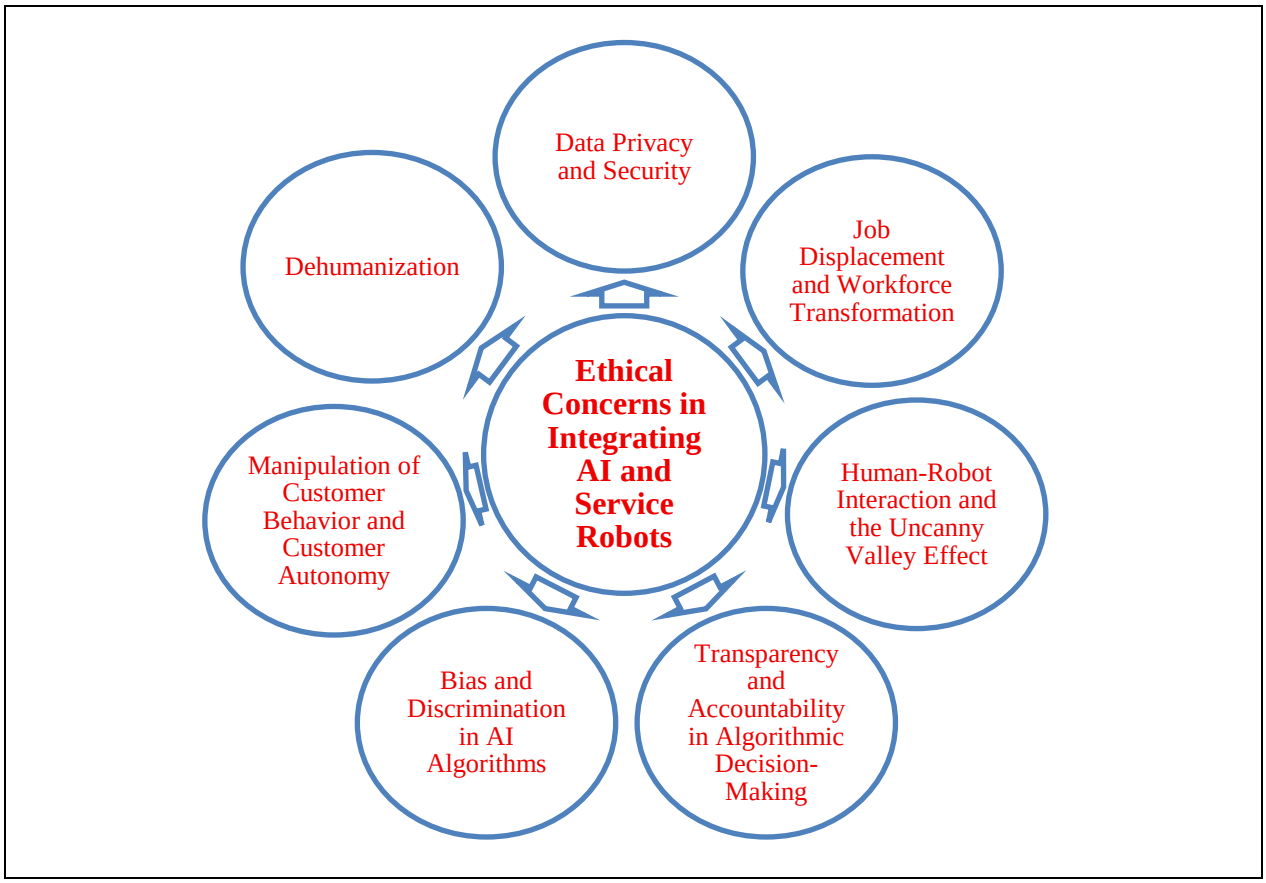
Figure 1. Flow Diagram for the Study



The studies included in the analysis were examined using a qualitative thematic analysis approach. Each study was systematically evaluated in terms of the type of technology it addressed (e.g. service robots, chatbots, virtual assistants, virtual concierges), the tourism context in which it was situated (hotel, restaurant, museum, airline, travel agency, etc.), the types of ethical issues it foregrounded (privacy and data security, job displacement, human–robot interaction and the uncanny valley effect, algorithmic bias and transparency, customer autonomy and behavioral manipulation, dehumanization, etc.), and the solution or policy recommendations it proposed.

Based on this examination, the prominent ethical concerns identified in the studies were reclassified under thematic categories, which are discussed in detail in the findings and discussion section. In this way, ethical concerns were analyzed within a framework that is directly relevant to sectoral practices. Following this classification, the most frequently highlighted ethical concerns in the literature are presented in Figure 2.

Figure 2. Ethical Concerns in Integrating AI and Service Robots into the T&H Industry



Ethical Concerns in Integrating AI and Service Robots

The T&H industry encompasses a wide range of entities, including hotels, restaurants, airlines, and entertainment businesses. Service robots are becoming increasingly widespread within this industry, performing tasks such as room service, food and beverage delivery, housekeeping, front desk operations, and concierge services. Integrating these robots offers significant advantages, including enhanced operational efficiency, reduced costs, and improved guest experiences. However, alongside these benefits, integrating artificial intelligence (AI)-driven service robots raises substantial ethical concerns and managerial challenges. These ethical issues are considered within the broader framework of corporate digital responsibility, encompassing the norms and standards guiding the adoption of digital technologies in business processes (Lu et al., 2020). Thus, before implementing service robots into operational procedures, tourism businesses must carefully evaluate the ethical implications, considering both the associated norms and principles of corporate digital responsibility (Lu et al., 2020).

Ethics is broadly defined as "the perception of something being good or right" (Saltz and Dewar, 2019: 198) or, more formally, "the science of morals or moral evaluation of choices" (Ulrich, 2008). The Oxford Learner's Dictionaries (2025) describe ethics as "moral principles that control or influence a person's behaviour." With specific reference to AI, the European Commission (2019) characterizes AI ethics as a discipline exploring moral issues linked to the development, application, and proliferation of AI Technologies.

As service robots become more prevalent in T&H, various theoretical models have emerged to understand technology acceptance. However, the widely used Technology Acceptance Model emphasizes technological convenience and economic benefits while overlooking ethical responsibilities and potential risks (El Hajal and Yeoman, 2024). Therefore, integrating AI-driven technologies into operational processes should be evaluated not only in terms of technological compatibility and economic criteria, but also in consideration of ethical considerations and potential risks (Cascio and Montealegre, 2016; Nosratabadi et al., 2022).

The widespread adoption of AI-driven service robots in T&H generates several ethical concerns from the guests' perspective, including data privacy and security, potential job displacement, socioeconomic impacts, limitations of human-robot interaction, and the emotional aspects of human-robot connections. Scholars

emphasize the necessity for hospitality businesses to thoroughly assess these ethical issues and develop comprehensive strategies to address them effectively (Belanche et al., 2024; Gursoy and Cai, 2025).

Data Privacy and Security

The integration of service robots into T&H businesses raises significant concerns regarding data privacy and security (Buhalis et al., 2024; Knani, Echchakoui, and Ladhari, 2022; Skubis et al., 2024; Vlačić et al., 2021; Wirtz et al., 2018). In today's information age, data privacy is a central consideration in ethical decision-making (Mason, 2017). Protecting guests' personal data and addressing concerns related to unauthorized use have become critical issues within the hospitality industry.

AI-powered service robots are increasingly collecting and processing personal data to optimize services provided to guests. These robots' utilization of cameras, sensors, and various data collection technologies enables them to access sensitive information, raising substantial ethical concerns such as potential misuse and unauthorized access (Dogru et al., 2024; Fosch-Villaronga, Lutz, and Tamò-Larrieux, 2020; Lin et al., 2024; Y. Liu et al., 2023; Skubis et al., 2024). Although these systems require large datasets to analyze guest behavior, a lack of transparency regarding how data is collected, processed, and utilized presents significant ethical issues (Bulchand-Gidumal et al., 2024).

Furthermore, service robots are notably vulnerable to cyber-attacks. Should they be hacked, not only guests' personal data but also their physical safety could be compromised (Manthiou et al., 2021). For example, robots could be remotely controlled and pose a physical threat within hospitality establishments, or financial data, such as credit card information, could be stolen. This emphasizes that not only individual privacy but also the physical security of guests must be safeguarded (Wirtz et al., 2018). In this context, meticulous attention to data protection measures and the establishment of transparent data-use policies are essential to maintaining guest trust and upholding ethical standards within the hospitality industry (Fosch-Villaronga et al., 2020; Lin et al., 2024; Liu and Chen, 2023).

Ubiquitous surveillance poses significant ethical risks regarding data privacy. This concept refers to service robots monitoring and recording guests' behaviors and conversations without their explicit consent (Lin et al., 2024: 968). AI-driven systems track guests' movements comprehensively within hotel premises, narrowing the scope of privacy (Belk, 2021). For instance, security robots equipped with integrated cameras and sensors utilize facial recognition technologies to authenticate identities, continuously recording guest activities (Hospitality Technology, 2019). The recording of images or audio by such robots without the consent of hotel guests and human staff constitutes a clear privacy violation. Guests who experience constant, unauthorized surveillance may feel discomfort, which can adversely affect their overall hotel experience. Additionally, intelligent assistants recording conversations without guest consent provoke substantial ethical debates, diminishing trust in data privacy due to ambiguity regarding which interactions are being recorded.

Job Displacement and Workforce Transformation

Integrating autonomous service robots into the T&H industry enhances operational efficiency and has a substantial socioeconomic impact on the human workforce. These impacts fundamentally alter the nature of jobs within the industry, raising ethical and economic concerns related to job displacement (Germak, Giuliano, et al., 2015; Ivanov and Umbrello, 2021; Law, Ye, and Lei, 2025; Tuomi, Tussyadiah, and Stienmetz, 2021). Central to these concerns is the ongoing debate about whether robots serve primarily as complementary tools or replacements for human labor (Germak, Giuliano, et al., 2015). The widespread adoption of service robots, particularly in low-skilled positions, heightens job security anxieties among employees and significantly transforms employment dynamics over time (Skubis et al., 2024). Consequently, robot deployment can lead to workforce transformation and potentially increased unemployment rates (Ivanov and Umbrello, 2021).

Routine and repetitive tasks, such as housekeeping, food service, and concierge services, are increasingly being undertaken by robots, thereby reducing employment opportunities for low-wage workers (Ivanov et al., 2017). This automation trend aligns with the concept of "botsourcing," as discussed in the literature (Waytz and Norton, 2014). Within this model, robots assume roles traditionally performed by human employees—such as waiting tables, reception duties, and concierge services—thereby accelerating operational processes but simultaneously creating heightened socioeconomic pressures on workers.

The socioeconomic consequences of workforce automation in tourism extend beyond individual job losses, creating broader economic and societal impacts. Low-income workers are especially vulnerable to these changes, and extensive automation within tourism businesses can exacerbate socioeconomic inequalities

(Ivanov and Umbrello, 2021; Licardo, Domjan, and Orehovački, 2024). Without proper redirection and retraining of displaced workers toward alternative employment opportunities, social and economic inequality becomes inevitable. Therefore, retraining and reskilling initiatives are essential to mitigate these adverse outcomes. Consequently, striking a balance between technological advancement and ethical responsibility has become a prominent topic of discussion in the industry.

Finally, the necessity of contactless services triggered by the COVID-19 pandemic has accelerated the adoption of service robots within T&H establishments (Romero and Lado, 2021). This shift underscores a transformation in employment dynamics and a significant reconfiguration of service delivery models (Ye, Sun, and Law, 2022). Therefore, workforce transformation driven by automation has a profound impact on employment patterns and reshapes the very nature of service delivery.

Human-Robot Interaction and the Uncanny Valley Effect

Integrating service robots in T&H raises significant ethical concerns, especially regarding human-robot interaction (HRI) and the "uncanny valley" effect. Initially proposed by Masahiro Mori, the uncanny valley hypothesis suggests that as robots increasingly resemble humans, they evoke positive emotional responses up to a certain threshold. Beyond this point, the resemblance becomes unsettling or disturbing, triggering adverse emotional reactions (Mara, Appel, and Gnambs, 2021; Thepsoonthorn, Ogawa, and Miyake, 2021; Wang, Lilienfeld, and Rochat, 2015). This phenomenon is particularly relevant to T&H, where service robots designed for personalized interactions and close engagements significantly influence guest satisfaction and overall experience.

When robots exhibit anthropomorphic (human-like) characteristics but fail to replicate human realism fully, discomfort and unease among guests may occur. Anthropomorphic designs significantly shape guest perceptions and emotional reactions. Guests tend to prefer robots exhibiting human-like facial features and emotional expressions, which can enhance perceived service quality (Akdim, Belanche, and Flavián, 2023; Christou, Simillidou, and Stylianou, 2020). However, highly anthropomorphic robots may also provoke negative emotions such as disgust, fear, and anxiety (Diel, Weigelt, and Macdorman, 2022; Laue, 2017). Similarly, the uncanny valley effect may occur if robots with advanced anthropomorphic attributes fail to convincingly emulate human behaviors, leading to negative guest experiences and reluctance to engage with the technology (Sun, Ye, and Law, 2025; Tussyadiah et al., 2020). For instance, studies conducted at Japan's Henn-na Hotel revealed that guests were uneasy with robotic staff exhibiting mechanical movements, despite their human-like appearance (Leung, 2024; Sadangharn, 2022).

While service robots enhance operational efficiency and hygiene, they cannot entirely replicate the warmth and empathy of humans. This limitation results in emotional distance and reduced willingness among guests to engage in interactions traditionally characterized by human-to-human contact (Mukherjee et al., 2021). Elderly guests, in particular, may be reluctant to interact with robots due to discomfort associated with the uncanny valley effect (Huang, 2022). Moreover, the lack of emotional intelligence in robots, especially in interactions requiring subtlety and empathy, exacerbates ethical concerns among guests (Ivanov et al., 2020; D. Liu et al., 2023; Skubis et al., 2024). In other words, the absence of empathy or misinterpreted robot behaviors amplifies ethical apprehensions during guest interactions (Skavronskaya, Hadinejad, and Cotterell, 2023). The central challenge here is the inability of service robots to fully substitute human interactions and adequately address guests' emotional needs.

Some research also highlights the limitations of robots in establishing emotional connections and trust with guests. Recognizing that interactions with robots are based solely on pre-programmed responses can negatively affect guests' perceptions of service quality and overall experiences (Khoa et al., 2023). Similarly, robotic museum guides that provide only predetermined answers can hinder dynamic and personalized experiences, leading to visitor dissatisfaction (Germak, Lupetti, et al., 2015). Consequently, using robots in services requiring emotional connection could adversely affect guest satisfaction.

Transparency and Accountability in Algorithmic Decision-Making

AI-based service robots typically operate using algorithms described as "black boxes," whose internal workings are not fully understood or transparent (Roestamy et al., 2023; Zhu and Zhang, 2024). Algorithmic decision-making, a process wherein artificial intelligence (AI) and machine learning (ML) systems automatically generate decisions based on specific datasets, directly affects service quality and ethical boundaries within the T&H industry (Y. Liu et al., 2023). For example, AI-driven dynamic pricing algorithms can adjust hotel room prices based on guest profiles (Roestamy et al., 2023). However, this may lead to unfair

pricing mechanisms, significantly impacting lower-income guests and thus exacerbating social inequalities (Bulchand-Gidumal et al., 2024).

Insufficient transparency in the decision-making processes of service robots can significantly undermine guest trust. When AI-powered robots employ complex algorithms without clear explanations of their operational logic, guests may feel uncertain and skeptical about engaging with these services (Ivanov and Umbrello, 2021). Hotel establishments' failure to adequately inform guests about the decision-making processes and purposes of robots' data usage further damages guest confidence and negatively shapes perceptions of robotic services (Bulchand-Gidumal et al., 2024; Lin et al., 2024). Ambiguities and a lack of upfront disclosure about robotic functions, as well as the late identification of robots' true nature, heighten ethical concerns, adversely affecting customer loyalty (Y. Liu et al., 2023; Zhu and Zhang, 2024).

Lack of transparency in algorithmic decision-making presents concerns not only for guests but also for hotel employees. For instance, an AI-driven concierge robot may recommend restaurants to guests; however, if these recommendations are based on commercial agreements with specific establishments, their impartiality and reliability are called into question. Likewise, the rationale behind AI-based dynamic pricing systems, which offer varying prices to different guests, often remains unclear, fostering mistrust and raising ethical concerns.

Accountability emerges as a significant ethical concern associated with the integration of service robots. Detecting and rectifying errors in AI-based systems is a complex task, posing challenges to accountability (Ivanov and Umbrello, 2021). As robots assume more autonomous roles, responsibility for service failures or negative guest experiences becomes increasingly ambiguous. For instance, if a service robot provides incorrect information or an airport security robot directs passengers inaccurately, the accountability may be unclear—whether it lies with the hospitality business, the robot manufacturer, or the software developer. Similarly, ethical concerns are raised regarding the impartiality and fairness of autonomous service robots when handling guest complaints or evaluating service quality (Bulchand-Gidumal et al., 2024).

The absence of clear guidelines regarding responsibility for decisions made by service robots creates considerable uncertainty for businesses and customers. This ambiguity—whether responsibility rests with the robot itself, the business owner, the operational manager, or IT/front-desk staff—poses significant ethical and legal dilemmas. The unresolved issues regarding robots' legal personality and ability to assume responsibility for their decisions are central ethical and legal challenges awaiting resolution (Manthiou et al., 2021). Therefore, deploying AI-based service robots in tourism necessitates comprehensive regulations and oversight to ensure transparency, accountability, and ethically sound decision-making processes. Making algorithmic decisions more transparent and traceable is crucial for ensuring that service robots operate within ethically acceptable boundaries.

Bias and Discrimination in AI Algorithms

The increasing adoption of AI-enabled service robots within the T&H sectors brings significant ethical concerns, notably the biases embedded and reinforced by AI algorithms during the learning process (Lin et al., 2024). Algorithms can inadvertently reflect biases in training datasets, potentially advantaging or disadvantaging certain customer groups (Ivanov and Umbrello, 2021). Ethical concerns arise, mainly when AI-based systems unintentionally or deliberately utilize customer profiling factors such as race, ethnicity, gender, or socioeconomic status, thereby perpetuating discrimination (Chouldechova, 2017; Ivanov and Umbrello, 2021; Law et al., 2025).

Programming service robots to preferentially serve particular customer profiles (e.g., VIP status, income level, nationality, age) can result in algorithmic discrimination. For instance, a robotic receptionist prioritizing frequent guests during check-in could inadvertently create longer waiting times for new guests, generating inequality in perceived service quality. Similarly, autonomous service robots that support only specific languages or struggle to recognize diverse accents and dialects may restrict access to services for particular tourist groups (Bulchand-Gidumal et al., 2024). Additionally, older adults encountering difficulties interacting with AI-driven systems can experience an exacerbated digital divide (Lin et al., 2024). Similarly, hotel reservation systems that are not fully compatible with visually impaired users can lead to discrimination (Bulchand-Gidumal et al., 2024).

Societal biases related to gender and race have also been observed in the design of AI-driven service robots (Ivanov and Umbrello, 2021). Anthropomorphic robots predominantly designed with Asian or Caucasian facial features may marginalize the representation of other ethnicities, contributing to perceptions of discrimination. Furthermore, programming AI-based assistants and service robots predominantly with

feminine voice tones and stereotypically gendered roles perpetuates gender biases (Milwood, Hartman-Caverly, and Roehl, 2023). This reinforcement of gender stereotypes can reproduce discriminatory practices in hospitality and tourism services (Manthiou et al., 2021).

Similar biases have been noted in AI-driven security systems. Facial recognition technologies often exhibit lower accuracy rates for specific ethnic groups, leading to unfair targeting or misidentification (Milwood et al., 2023). Such systemic errors can institutionalize discrimination within security frameworks, adversely affecting inclusive principles in the T&H sectors.

Finally, using service robots also raises ethical issues related to customer autonomy. When artificial intelligence algorithms are not designed with principles of fairness and inclusivity in mind, they can reinforce existing biases or give rise to new forms of discrimination (Law et al., 2025). For instance, AI-supported customer service bots often exhibit lower responsiveness to guests with specific accents or recommend inferior quality services to lower-income customers, while prioritizing high-spending guests, creating ethically problematic scenarios. Ensuring fairness in service provision and equitable access for all guests is crucial. Thus, proactively addressing biases and ensuring equitable tourism experiences through transparent and inclusive AI-driven customer service practices are imperative for the industry's ethical development.

Manipulation of Customer Behavior and Customer Autonomy

The rapid development and widespread adoption of service robots in the T&H industry have increasingly raised ethical concerns, particularly regarding the manipulation of customer behavior and consumer autonomy. At the core of these ethical issues lies the capability of service robots to influence customers' decision-making processes, establish direct interactions, and collect and process personal data. Consequently, as tourism enterprises adopt these technologies, understanding their effects on guest experiences and decision-making mechanisms becomes critically important.

Although service robots are fundamentally designed to serve guests and enhance their experiences, their algorithms can also be strategically utilized to encourage additional spending, influence preferences, and shape decision-making processes (Belk, 2021). This practice sparks significant ethical debate.

The first method for service robots to manipulate customer behavior involves personalized marketing and behavioral nudging. AI-driven service robots analyze customer behavior to offer personalized suggestions, effectively guiding guests toward specific actions or purchase decisions (Bulchand-Gidumal et al., 2024). Known as behavioral nudging, this raises important ethical questions (Ivanov and Umbrello, 2021; Law et al., 2025). A central issue here revolves around the transparency of these interactions and the degree to which guests are informed about such manipulative influences. The concept of informed consent becomes particularly relevant; guests must be clearly informed about how their data is used and to what extent their decision-making processes might be influenced (Lin et al., 2024). For instance, an AI-powered robot serving in a hotel may analyze a guest's consumption habits and recommend the most expensive menu items or luxurious rooms. While the guest may perceive these recommendations as impartial suggestions, they might actually be strategically driven by algorithms intended to maximize the hotel's revenue. Similarly, AI-supported travel planning systems could highlight popular hotels and destinations, overshadowing alternative choices and thus limiting consumer autonomy.

Another manipulation technique involves recognizing emotions and employing persuasive strategies. Certain service robots can assess guests' emotions through facial recognition and emotional analysis, adjusting their responses accordingly (Dogan, Mistry, and Nanu, 2024). This capability may be leveraged to steer guests toward specific choices, sparking further ethical concerns. Evaluating and using emotions in this manner raises concerns about infringing on personal data privacy and threatens guests' rights to privacy.

Social pressure and trust constitute additional manipulation techniques. Due to neutrality bias, guests may inherently trust robots and accept recommendations without critical reflection. However, these recommendations might actually be driven by algorithms designed to serve commercial interests, intensifying ethical concerns (Lin et al., 2024). Misleading or excessively personalized marketing techniques could thus foster widespread manipulative and unethical practices (Bulchand-Gidumal et al., 2024).

Customer autonomy refers to individuals' capacity to make free and informed decisions. Excessive reliance on service robots may weaken customers' own decision-making mechanisms (Belanche, Casaló, and Flavián, 2021). Automated check-ins, robotic concierges, and voice assistants may reduce guests' active participation in decision-making processes.

Particularly in the T&H sectors, the COVID-19 pandemic accelerated the adoption of contactless services, with the employment of service robots emerging prominently. Guests using services provided by robots face reduced human interaction. Robot replacement of human employees creates environments that minimize human interaction, consequently limiting customer autonomy. The robotic constraints in performing specific tasks or providing predetermined responses, coupled with the lack of human touch, may cause guests to feel restricted in making independent choices, leading to discomfort (Fusté-Forné and Jamal, 2021; Germak, Giuliano, et al., 2015). This scenario can negatively affect guest satisfaction and loyalty. Additionally, interactions with robots may weaken emotional connections between people and reduce social interactions. Therefore, businesses must remain cautious regarding the deployment of robots, ensuring that human interactions are not entirely eliminated but rather preserved.

Dehumanization

Dehumanization emerges as human interactions diminish and services increasingly transition to robot-operated platforms. The growing reliance on service robots to perform tasks traditionally performed by humans carries significant implications for guest experiences and interactions. Guests often perceive the use of service robots as a departure from human-centered hospitality, which raises concerns, particularly in the T&H industry, where human interaction is crucial for guest satisfaction (Akdim et al., 2023).

Historically, the hospitality sector has distinguished itself by emphasizing human interactions, which foster emotional connections and enhance the overall guest experience. Shifting service delivery from humans to robots may diminish the perceived "human touch," alienating guests who value the warmth and empathy of human staff (Hu, Min, and Su, 2021). Particularly in sectors where emotional labor is essential, encounters with mechanical, impersonal, and emotionless services can weaken guests' emotional attachment to businesses (Ivanov and Umbrello, 2021; Law et al., 2025; Lin et al., 2024). Consequently, such transformations may negatively impact guest experiences, resulting in reduced emotional satisfaction within the industry.

Furthermore, dehumanization presents ethical implications not only for guests but also for employees. The increased deployment of service robots fosters job insecurity among human workers and amplifies anxieties described as "robot-phobia" (Chen and Cai, 2025). Employees fear that their roles may diminish or become obsolete, heightening their sense of vulnerability. This fear may intensify workplace stress, anxiety, and emotional exhaustion (Milwood et al., 2023). Such conditions negatively affect employee well-being and can also diminish the quality of services provided to guests.

Additionally, other ethically problematic scenarios arise from dehumanization. For instance, guests often feel less moral responsibility towards robots, making them more prone to unethical behaviors, such as fraudulent returns or exploitation of additional services without proper payment (Y. Liu et al., 2023). Moreover, restaurants that do not transparently disclose the use of robot chefs engage in deceptive and unethical practices, as guests remain unaware that their meals are robot-prepared (Zhu and Zhang, 2024). Furthermore, despite the rapid expansion of AI-driven technologies in T&H, the lack of global or local regulations to oversee their ethical use represents a critical ethical concern (Roestamy et al., 2023).

Proposed Solutions for Ethical Concerns

The T&H industry is characterized by its rapid adoption and integration of technological advancements into operational processes. While the extensive use of artificial intelligence and robotic technologies enhances the industry's efficiency, it simultaneously introduces several ethical concerns, as previously discussed in detail. Developing and implementing various policies and strategies is crucial to addressing these ethical issues and mitigating their impacts effectively. This section explores potential solutions aimed at alleviating or mitigating guests' ethical concerns.

Data Privacy and Security

Privacy and data security are among the primary ethical concerns regarding artificial intelligence and robotic systems in the hospitality and tourism industries. Growing concerns about how personal data is collected, processed, and stored necessitate that hospitality businesses adopt transparent and trustworthy policies. Firstly, transparency in data collection and usage must be ensured. Explicit consent should be obtained from guests before collecting their personal data, clearly informing them about which data are gathered and for what purposes they will be utilized (Licardo et al., 2024; Manthiou et al., 2021). User-friendly interfaces should enable guests to manage their personal information and preferences regarding data sharing and control their own data.

Guests should have clear options about which robots can access their personal data, the type of data they can share, and the duration of data storage. Accordingly, guests should only be required to share basic identification details for reservation and authentication purposes. Sharing data about personal preferences should remain optional and intended solely for enhancing service quality. Explicit consent should be obtained for marketing and promotional uses of data. Additionally, when robots perform audio or video recordings, guests must be notified beforehand via audible alerts, LED indicators, or on-screen notifications.

Another critical principle is data minimization and anonymization. To protect personal information, hospitality businesses should adopt data minimization practices, gathering only the data necessary for operational needs and avoiding the storage of unnecessary personal data. Furthermore, collected data must be anonymized and encrypted to prevent any disclosure of guests' identity information.

Cybersecurity measures represent another essential principle in maintaining privacy and data security. Robust cybersecurity policies should be adopted, ensuring guests' identity and credit card information are encrypted securely. Multi-factor authentication methods (e.g., passwords combined with biometric verification) should be employed to prevent unauthorized access to robotic systems. Local servers should be preferred over cloud-based storage, but stringent security protocols must be enforced if cloud solutions are necessary.

Preventing ubiquitous surveillance through privacy-friendly design is another vital consideration. Robots should activate audio and video recordings only with the explicit consent of the guest. Security robots must operate exclusively in public spaces and parking areas without access to guest rooms or private areas. Facial recognition technology should be deployed only with the guest's approval, and guests should be allowed to request the deletion of their biometric data.

Transparency in crisis management, particularly in the event of data breaches, constitutes an additional ethical principle. Hospitality establishments must adopt swift and transparent crisis management procedures to ensure an effective response to emergencies. In the event of a data breach, guests must be informed within 24 hours, measures taken should be communicated, and cybersecurity insurance and compensation mechanisms should be activated in cases involving the theft of sensitive information, such as credit card or identification data.

Compliance with legal regulations and ethical standards represents one of the most crucial principles. T&H businesses should fully comply with legal frameworks such as the European Union's General Data Protection Regulation (GDPR) and the Law on the Protection of Personal Data (KVKK). Additionally, industry-specific ethical guidelines and standards for AI and robotics should be developed and consistently implemented (Doğan and Çakıcı, 2022; Khoa et al., 2023).

Job Displacement and Workforce Transformation

The increasing utilization of autonomous service robots in the T&H sectors has led to significant transformations in employment dynamics. This shift raises ethical concerns, particularly regarding the displacement of human workers and the reshaping of occupations. Various strategies should be implemented to address these concerns effectively and facilitate workforce adaptation to technological changes.

Firstly, developing reskilling (Licardo et al., 2024) and upskilling programs is crucial (Ivanov et al., 2019; Manthiou et al., 2021). Specifically, targeted programs should be designed for lower-skilled employees, emphasizing human-robot collaboration, robotic system management, and digital technologies. Adopting a lifelong learning approach is crucial for workforce adaptation, as it provides employees with continuous educational opportunities. Additionally, promoting participation in training programs that focus on emotional intelligence skills can help employees overcome the challenges associated with human-robot collaboration (Khoa et al., 2023).

Moreover, fostering innovation and developing new business models constitute important strategies to mitigate job losses. Emerging fields such as robotic technicians, data analysts, and digital guest relations specialists can be created, and employees should be encouraged to establish new micro-enterprises through technological innovation and R&D initiatives. Collaborations between tourism enterprises and robotic technology companies can significantly enhance employee competencies. Employees should be provided with training programs that focus on working effectively with robots, understanding the operations of robotic systems, and performing maintenance and management tasks (Khoa et al., 2023).

Lastly, regulatory frameworks and policy development are vital in addressing employment-related ethical concerns. Gradual automation policies should be developed to manage the transition of operational processes within tourism enterprises, allowing human workers to adapt progressively. Furthermore, defining ethical

standards and guidelines for the use of service robots is a crucial step toward safeguarding employee rights and ensuring fair labor practices.

Human-Robot Interaction and the Uncanny Valley Effect

Integrating artificial intelligence systems and service robots into operational processes within tourism enterprises raises various ethical concerns, notably the "uncanny valley" effect. Minimizing this effect is critical for successfully positioning robots in the tourism industry in an acceptable and effective manner.

A primary strategy to mitigate the uncanny valley effect involves designing anthropomorphic robots with a carefully balanced approach. Although service robots may possess human-like characteristics, these features must remain moderate, avoiding overly realistic human appearances and indicating their artificial nature. Minimalistic facial expressions, mechanical or stylized designs, gentle voice tones, and subtle gestures can significantly reduce discomfort associated with the uncanny valley (Epley et al., 2008; Manthiou et al., 2021; Tinwell, Grimshaw, and Williams, 2011). Robots prioritizing functionality over hyper-realistic facial features, incorporating user-friendly and stylized aesthetics, can also decrease perceived discomfort. The Pepper robot, widely used in Japan, exemplifies this approach. Despite its humanoid design, Pepper's exaggerated eyes and simplified expressions effectively circumvent the uncanny valley effect.

Improving human-robot interaction further involves developing and implementing models for human-robot collaboration. Tasks assigned to service robots should be carefully defined in accordance with ethical principles, positioning robots not as replacements but as supportive tools that complement human workers by reducing their workload (Germak, Giuliano, et al., 2015). For example, while service robots manage repetitive and physically demanding tasks such as order-taking, human employees can engage in more personalized interactions, responding directly to guest inquiries. Additionally, emphasizing human competencies—such as empathy, creativity, and complex problem-solving skills—ensures the preservation of human interaction within service processes (Lin et al., 2024; Manthiou et al., 2021; Skubis et al., 2024).

Enhancing the emotional intelligence and interaction algorithms of service robots represents another critical step. Currently, many robots interact through pre-programmed responses, limiting their effectiveness. However, improvements in natural language processing and contextual awareness capabilities can foster more personalized and effective interactions. Robots capable of analyzing guests' emotional states, recognizing frustration or confusion, and responding appropriately can significantly enhance user experience. For instance, displaying gestures and expressions that match the user's emotional state can foster empathetic interactions. Furthermore, programming robots to be culturally sensitive will allow more inclusive and effective service delivery within the global tourism market (Germak, Giuliano, et al., 2015).

Offering guests the ability to customize their interaction levels with service robots can also effectively address these ethical concerns. Allowing guests to specify their preferred interaction levels during check-in or via mobile applications can optimize their service experiences (Dogru et al., 2024; Germak, Giuliano, et al., 2015). For example, elderly guests or individuals who are uncomfortable with technology should retain the option to receive service from human staff, thereby reducing potential discomfort. Similarly, enabling guests to request human assistance instead of robotic services at any point enhances ethical flexibility and personalization in service delivery.

In conclusion, acknowledging the ethical dimensions of human-robot interactions is crucial for achieving sustainable and widely accepted integration of service robots within the tourism sector. Consciously designed robots, ethically grounded human-robot collaboration models, enhanced emotional intelligence capabilities, and providing guests with interaction preferences are essential to minimizing the uncanny valley effect and effectively addressing related ethical concerns.

Transparency and Accountability in Algorithmic Decision-Making

Transparency is critical in T&H services, significantly influencing guest trust and service reliability. A lack of transparency can erode guest confidence, leading to serious concerns about service quality. Several solutions are suggested to ensure transparency and increase guest trust.

Firstly, integrating Explainable AI systems is essential (Germak, Giuliano, et al., 2015; Y. Liu et al., 2023). AI-supported service robots in T&H should clearly explain how decisions are made, addressing the "black box" issue and clarifying the criteria used for specific outcomes (Khoa et al., 2023). For example, a concierge robot recommending a restaurant should transparently disclose criteria such as proximity, popularity, and customer ratings.

Another critical measure is increasing transparency in data policies. T&H enterprises should provide informative materials regarding the operation of AI systems and explicitly communicate how guests' personal data is utilized. User-friendly privacy policies can foster a stronger sense of security and trust among guests.

Identifying service robots as artificial intelligence entities is another approach to enhancing transparency (Zhu and Zhang, 2024). Guests must clearly understand whether their service provider is a human or an AI-driven robot. Service robots can explicitly identify themselves through verbal or visual notifications, such as "I am an AI-supported service robot" or "My decisions are algorithmically generated."

A lack of accountability in AI systems can cause uncertainty about who is responsible for errors in robotic decisions. Regular monitoring and auditing of AI systems are fundamental solutions to this problem (Khoa et al., 2023). Independent audit firms should monitor robot performance and decision-making processes, proactively detect errors, and intervene appropriately to maintain system reliability.

Clearly defining accountability mechanisms is another significant strategy (Doğan and Çakıcı, 2022; Germak, Giuliano, et al., 2015). Responsibilities related to service errors or incorrect decisions made by AI-supported service robots must be clearly defined and explicitly identified. Depending on the nature of the error (e.g., software faults, algorithm updates, data entry mistakes), relevant parties such as robot manufacturers, business managers, front office supervisors, or IT administrators should have clearly defined accountability frameworks. Furthermore, establishing robust complaint and feedback mechanisms can strengthen accountability. User-friendly digital platforms or mobile apps should enable guests to easily report unethical practices or incorrect robot decisions, allowing businesses to address these concerns quickly.

Ensuring algorithmic decision-making processes are ethical and fair is critical for all stakeholders. Algorithms should be regularly audited to confirm impartiality and prevent discrimination based on demographic or socioeconomic factors. For instance, dynamic pricing algorithms must be checked regularly to ensure they do not systematically disadvantage lower-income guests. Implementing human oversight for algorithmic decisions is also recommended. AI systems should primarily serve as advisory tools, with final decisions reserved for human employees. Human oversight, particularly in customer service, pricing, and reservation processes, can effectively reduce errors and ethical issues. Moreover, clearly defining error detection and compensation mechanisms is necessary. Pre-established compensation strategies should be in place for instances where incorrect robot decisions occur. For example, mechanisms should be defined that offer complementary services in response to guest inconveniences caused by robot errors. Lastly, developing AI ethics codes explicitly tailored to the tourism sector can guide responsible and ethical management of AI applications (Khoa et al., 2023). Tourism-specific ethical standards will facilitate the responsible governance and ethical use of artificial intelligence within the industry.

Bias and Discrimination in AI Algorithms

The presence of biases or discriminatory tendencies within artificial intelligence (AI) algorithms and service robots poses significant ethical challenges for the T&H industry. Ensuring these technologies deliver services fairly and impartially is critically important for promoting ethical AI practices in the sector. Primarily, it is essential to ensure diversity in the datasets used during the training processes of AI algorithms. Data sets should represent different ethnic backgrounds, age groups, genders, and socioeconomic classes equally. This approach prevents systematic biases against particular guest groups. During the algorithm training phase, biased data should be identified, removed, and replaced with fair and balanced datasets. Additionally, developing AI systems based on principles of fairness and inclusivity can significantly mitigate ethical concerns. The operational logic of algorithms should be regularly audited, and potential risks of discrimination should be proactively minimized. Furthermore, AI-based services should be structured transparently, ensuring their learning processes do not disadvantage specific guest groups (Dogru et al., 2024). Decision-making processes within algorithms must be transparent and auditable, enabling all stakeholders to assess how decisions are formulated. Embracing explainable AI methodologies can enhance transparency in algorithms' decision-making processes, thereby bolstering user trust (Germak, Giuliano, et al., 2015; Y. Liu et al., 2023).

Supporting multilingualism in service robots is another vital strategy for preventing bias and discrimination within AI systems (Skubis et al., 2024). Training robots to comprehend multiple languages, accents, and dialects can effectively counteract cultural biases. Consequently, guests from diverse cultural backgrounds would enjoy more inclusive and high-quality service experiences. Eliminating language barriers promotes equitable access to services, thereby reinforcing the tourism industry's commitment to fairness and inclusivity. Additionally, enhancing accessibility features for elderly guests or individuals with disabilities (such as visual,

auditory, or mobility impairments) can prevent the deepening of the digital divide and increase the inclusivity of service robots. Such measures significantly reduce the risk of AI-driven discrimination against specific groups.

Another source of bias emerges from the characterizations AI algorithms apply to specific guest demographics, notably regarding gender coding. For instance, AI systems exclusively designed with female voice tones or specific feminine facial characteristics may unintentionally perpetuate gender-based biases (Manthiou et al., 2021). Culturally neutral and gender-independent designs should be prioritized to mitigate these biases. Moreover, employing diverse voice tones and cultural representations in virtual customer assistants and voice-enabled robots can enhance guest satisfaction. Encouraging a neutral approach toward ethnicity and gender in the development of AI-driven services facilitates a more inclusive digital transformation in the T&H industry.

Manipulation of Customer Behavior and Customer Autonomy

The T&H industry is fundamentally service-oriented, making customer attitudes and behaviors toward services critically important. However, the increasing deployment of AI systems and service robots has heightened ethical concerns regarding the manipulation of customer behavior and autonomy. Addressing these concerns requires implementing proactive measures at both managerial and technological levels.

Firstly, embracing principles of transparency and informed consent is essential. It must be explicitly communicated to customers how service robots generate recommendations, detailing the data and rationale behind these suggestions clearly and understandably (Licardo et al., 2024). For example, when recommending hotels or restaurants, robots should explicitly state if suggestions are based on past reservation preferences or the most popular choices. Furthermore, AI-supported service robots should inform guests about the intended use of their personal data—such as purchase histories or emotional analyses—and obtain explicit consent (Licardo et al., 2024; Manthiou et al., 2021). Such transparency significantly mitigates the risk of manipulating customer behavior.

Offering alternative options to customers is another critical strategy for preserving customer autonomy. Service robots should not only provide recommendations but also facilitate access to a variety of choices, thereby supporting the decision-making process. Additionally, retaining human interaction as an available option is crucial, allowing guests the freedom to choose between robot-assisted and human-delivered services. For instance, during the hotel check-in process, guests should be able to complete procedures either through robots or human staff. Furthermore, AI algorithms must be designed to support, rather than restrict, customer decision-making processes. Adopting hybrid service models, where robots and human staff coexist in a balanced way, can reduce dependency on fully automated systems and minimize manipulation risks.

Another significant step towards safeguarding customer autonomy involves limiting the use of behavioral nudging techniques. Tourism businesses should prioritize recommendations based on genuine customer preferences rather than manipulative practices aimed at profit maximization. Service robots should, therefore, adopt strategies that prioritize guest needs and expectations, rather than exclusively pursuing revenue increases. Additionally, robots performing emotional analysis must operate within ethical boundaries. For instance, a robot should avoid exploiting situations where a guest appears stressed or upset by recommending expensive products, as such practices are ethically questionable and potentially detrimental to customer satisfaction.

Dehumanization

Integrating service robots into the T&H industry raises critical ethical concerns regarding guest experiences and employee welfare. With the growing prevalence of AI and robotics technologies, it has become increasingly essential to integrate these technologies ethically into operational processes while maintaining a human-centered approach to service delivery. Maintaining the human touch is a priority strategy in this context (Lin et al., 2024; Manthiou et al., 2021; Skubis et al., 2024).

The increased use of robots may reduce human interaction, potentially weakening the emotional connection guests establish with hospitality businesses. To counteract this, it is essential to distribute tasks effectively between human staff and robotic systems. Specifically, operational tasks should be allocated to robots—particularly those involving routine and repetitive functions—while humans should handle areas that require emotional engagement, empathy, and personalized interaction. For example, robots can manage repetitive tasks like check-in, basic inquiries, room service delivery, and straightforward guidance. In contrast, roles requiring empathy, such as welcoming guests, personalizing services, or handling sensitive customer

interactions, should remain with human employees. This balanced approach ensures that while robots handle routine tasks, human employees can preserve their essential role in emotionally nuanced services (Manthiou et al., 2021).

Additionally, it is crucial to adopt measures aimed at workforce development to mitigate potential negative impacts on employee well-being. Adopting AI and robotic systems could create significant psychological and professional pressures among staff. Therefore, offering reskilling and upskilling programs for employees becomes critical (Ivanov et al., 2019; Manthiou et al., 2021). Through these programs, employees can transition into more creative and guest-oriented roles, thereby enhancing their job satisfaction and sense of purpose. Such initiatives would also facilitate smoother adaptation to new technology-driven work environments. Furthermore, offering counseling and psychological support services is recommended to manage potential psychological stress or anxiety arising from increased robotic integration.

Another essential measure for mitigating the dehumanization effect is to design robots with human-centered attributes. Features that emphasize empathy, natural interaction patterns, and emotional responsiveness should be incorporated into robotic designs, thereby reducing the perception of robotic interactions as cold or impersonal. Empathy-driven robot designs facilitate warmer and more natural interactions with guests, preserving a meaningful human touch in the in-service experience.

In conclusion, adopting AI and robotic technologies within the T&H sectors can be made more ethical and sustainable by carefully considering the human factor. Strategies such as balanced human-robot collaboration, comprehensive employee training programs, psychological support for staff, and empathetic robotic design can significantly mitigate potential negative impacts associated with dehumanization. These approaches are summarized in Table 1.

Table 1. Ethical Concerns, Proposed Solutions, and Recommended Actions for Integrating AI and Service Robots into the T&H Industry

Ethical Concerns	Proposed Solutions	Recommended Actions
Data Privacy and Security	Transparency in Data Collection and Usage	✓ Explicit informed consent ✓ Privacy preference options ✓ Clear notifications regarding data collection
	Data Minimization and Anonymization	✓ Avoid unnecessary data collection ✓ Data anonymization and encryption
	Cybersecurity Measures	✓ Application of encryption standards ✓ Multi-factor authentication ✓ Usage of local servers
	Prevention of Ubiquitous Surveillance and Privacy-friendly Design	✓ Prevention of unauthorized recordings ✓ Limiting surveillance zones ✓ Restrictions on facial recognition technology
	Transparency in Crisis Management During Data Breaches	✓ Clearly outlined incident response plans ✓ Cyber insurance coverage
	Compliance with Laws and Ethical Standards	✓ Adherence to regulations like GDPR and KVKK ✓ Sector-specific ethical guidelines
Job Displacement and Workforce Transformation	Reskilling and Upskilling Programs	✓ Industry-specific training programs ✓ Lifelong learning approach
	Encouraging Innovation and New Business Models	✓ Creation of new occupational fields ✓ Investments in R&D ✓ Support for digital entrepreneurship
	Joint Programs between Tourism Businesses and Robotics Firms	✓ Training in robot interaction skills ✓ Advanced technology skill development
	Development of Regulatory Frameworks and Policies	✓ Gradual automation policies ✓ Ethical automation guidelines
Human-Robot Interaction and the "Uncanny Valley" Effect	Balanced Anthropomorphism in Robot Design	✓ Limiting overly human-like designs ✓ Prioritizing functional aesthetics
	Adoption and Development of Human-Robot Collaboration Models	✓ Complementary and supportive roles for service robots ✓ Highlighting the value of human interaction
	Enhancement of Robots' Emotional Intelligence and Interaction Algorithms	✓ Advanced AI and conversational algorithms ✓ Enhanced empathy and emotional responsiveness ✓ Recognition of cultural and social differences

	Providing Guests with Options for Robot Interaction	✓ Customizable interaction preferences ✓ Opt-out choice
Transparency and Accountability in Algorithmic Decision-Making	***Transparency***	
	Implementation of Explainable AI Systems	✓ Explainable decision-making processes
	Transparency of Data Policies	✓ Informative materials regarding robot operations and decision-making ✓ Clear communication of personal data usage ✓ User-friendly language in policy statements ✓ Explicit communication of policies to guests
	Clear Identification of Service Robots	✓ Explicit distinction between human and robotic interactions ✓ Audible and visual alerts by robots to inform guests
	Accountability	
	Monitoring and Auditing AI Systems	✓ Independent audits and reviews
	Establishment of Responsibility Mechanisms	✓ Clearly defined responsibilities based on the nature of service errors
	Complaint and Feedback Systems	✓ User-friendly feedback channels for reporting service issues
	Algorithmic Decision-making	
	Neutrality and Prevention of Discrimination in Algorithms	✓ Ensuring algorithms do not result in demographic or socioeconomic discrimination ✓ Upholding equality principles for all guests
	Human Oversight in Algorithmic Decisions	✓ AI provides recommendations, but final decisions remain under human supervision
	Clarification of Error Detection and Remediation Mechanisms	
	Development of Sector-specific AI Ethics Codes	
Bias and Discrimination in AI Algorithms	Data Diversity and Cleanliness	✓ Equal representation across ethnicities, age, gender, and socioeconomic classes ✓ Removal of biased data
	Fairness and Inclusivity	✓ Algorithms designed to minimize discrimination ✓ Application of supervised learning processes
	Transparency in Algorithm Design	✓ Understandable and transparent AI systems ✓ Implementing Explainable AI methodologies
	Multilingual and Inclusive Capabilities of Service Robots	✓ Support for multiple languages, accents, and dialects ✓ Accessibility for all guests, including elderly and disabled individuals
	Prevention of Gender and Racial Coding	✓ Adoption of gender-neutral and culturally neutral designs ✓ Inclusion of diverse voice tones and cultural representation ✓ Neutrality in gender and ethnic identity design
Manipulation of Customer Behavior and Customer Autonomy	Transparency and Informed Consent	✓ Clear disclosure of data usage ✓ Informed consent for the use of personal data
	Alternatives Supporting Customer Autonomy	✓ Providing alternative options besides robot suggestions ✓ Allowing guests to choose between human or robot services ✓ Algorithms designed to reinforce customer autonomy ✓ Adoption of hybrid service models
	Limitations of Behavioral Nudging Techniques	✓ User preference-based guidance ✓ Prevention of emotional manipulation
Dehumanization	Preservation of Human Touch	✓ Robots for routine and repetitive tasks ✓ Humans for tasks requiring empathy
	Adoption of Human-centric Transition Strategies	✓ Reskilling and upskilling programs ✓ Technology adaptation training ✓ Psychological support and counseling services
	Human-centered Technology Design	✓ Designs enriched with uniquely human sensory capabilities

Discussion

This study demonstrates that ethical concerns related to the use of artificial intelligence and service robots in the T&H industry have been addressed in the literature to date in a largely fragmented and dispersed manner, and that there is a clear need for a more integrated and comprehensive analytical framework. The findings

indicate that seven core ethical concern areas emerge: data privacy and security, job displacement and workforce transformation, human–robot interaction and the uncanny valley effect, transparency and accountability in algorithmic decision-making, bias and discrimination in AI algorithms, manipulation of customer behavior and customer autonomy, and dehumanization. Although these themes have been partially examined in prior studies (Ivanov and Umbrello, 2021; Lin et al., 2024; Skubis et al., 2024), the present study consolidates these discussions within a systematic structure and contributes to the literature by elaborating concrete solution strategies for each ethical concern.

The results related to data privacy and security are consistent with previous work highlighting that privacy breaches constitute one of the primary ethical concerns in tourism contexts where guest data are extensively collected and processed (Germak, Giuliano et al., 2015; Lin et al., 2024; Roestamy et al., 2023). However, this study advances the debate by proposing a set of differentiated solutions, including informed consent mechanisms, data minimization, anonymization practices, robust cybersecurity measures, limitations on continuous surveillance, and transparent crisis management in the event of data breaches. In this regard, the study expands existing discussions on privacy and develops actionable policy and governance recommendations for T&H businesses.

The findings concerning job displacement and workforce transformation also substantially align with the literature (Bulchand-Gidumal, 2024; Law et al., 2025; Manthiou et al., 2020; Skubis et al., 2024), which suggests that low-skilled workers are disproportionately affected by automation. In the present study, however, workforce transformation in the T&H context is re-examined through an ethical perspective, with particular emphasis placed on employee training and development. Recommendations such as reskilling, upskilling, and promoting new job models are proposed as mechanisms to support the professional development of low-skilled employees, while simultaneously foregrounding principles of fairness and equity among staff.

The findings on human–robot interaction and the uncanny valley effect corroborate the dual impact of anthropomorphic robots on guest experience. While Christou et al. (2020) and Akdim et al. (2023) argue that robots endowed with social and emotional interaction capabilities can enhance perceived service quality, studies such as Mara et al. (2021), Diel et al. (2022), Laue (2017), Leung (2024), and Sadangharn (2022) demonstrate that highly human-like robots that nonetheless fail to emulate human behavior fully may trigger an uncanny valley effect, generating discomfort, distrust, and unease. This study interprets these findings from an ethical standpoint. It contributes to the existing body of knowledge by proposing solutions such as balanced anthropomorphism in robot design, the adoption of human–robot collaboration models, the development of interaction algorithms grounded in emotional intelligence and empathy, and the provision of user choice regarding the level of interaction with robots.

Algorithmic transparency, accountability, and bias constitute another critical dimension of the findings. Prior research has shown that errors arising from algorithms are often difficult to detect and correct, thereby giving rise to accountability challenges (Ivanov and Umbrello, 2021), eroding customer trust (Zhu and Zhang, 2024), and, when coupled with data-driven biases, potentially placing certain demographic groups at a structural disadvantage and generating serious ethical concerns (Chouldechova, 2017; Ivanov and Umbrello, 2021; Law et al., 2025). Expanding this debate in the context of T&H, the present study proposes a series of solutions, including the adoption of explainable AI systems, greater transparency in data policies and robot usage, the regular monitoring and auditing of algorithms in line with principles of fairness and inclusivity, and the design of systems that support multilingualism and accessibility to remove language barriers and ensure service provision to all guests. These recommendations underscore the need to position algorithmic transparency and justice at the core of ethical deliberations in tourism.

The findings related to customer autonomy and behavioral manipulation indicate that the boundary between personalization and manipulation is becoming increasingly blurred. Behavioral nudging and persuasive technologies can be employed to influence guests' preferences and shape their decision-making processes (Belk, 2021; Ivanov and Umbrello, 2021; Lin et al., 2024), which may, in turn, weaken individuals' freedom of choice. In the tourism context, this study highlights the ethical risks associated with subtly steering guests toward more expensive products and services without their full awareness, as well as with increasing dependence on automation. It argues that mechanisms such as informed consent, transparent recommendation practices, the provision of alternative options that support customer autonomy, and the possibility for guests to choose between robot-delivered and human-delivered services can strengthen autonomy and mitigate these risks. In this respect, the study conceptualizes the limitation of behavioral manipulation and the protection of customer autonomy as key ethical design imperatives for technological products and services in this sector.

Finally, the findings highlight the risk of dehumanization. In the T&H industry, where human interaction is by its very nature a central component of service delivery, excessive automation can lead to the neglect of guests' emotional needs, the amplification of stress and anxiety, and heightened perceptions of threat among employees regarding the future of their roles (Hu et al., 2021; Milwood et al., 2023; Chen and Cai, 2025). To mitigate this risk, the study recommends preserving the "human touch" by deploying robots primarily for routine and repetitive tasks, while maintaining human employees in positions that require empathy and emotional labor. Additionally, it suggests offering psychological support and training programs for staff. Together, these measures aim to strike a balance between technological innovation and human-centered service, thereby mitigating the dehumanizing potential of automation in tourism and hospitality.

Conclusion and Recommendations

This study, grounded in a literature-based foundation, examines the ethical issues associated with the use of artificial intelligence and service robots in the T&H industry, aiming to contribute to a more systematic understanding of these issues. Drawing on an analysis of studies identified through a Web of Science search conducted in January 25, 2025, the findings show that the integration of these technologies generates a range of technical outcomes—such as operational efficiency gains, cost advantages, and faster service delivery—while simultaneously giving rise to ethical concerns related to privacy and data security, job loss and workforce transformation, human–robot interaction and the uncanny valley effect, algorithmic transparency and bias, customer autonomy and behavioral manipulation, and dehumanization. Within this framework, the study identifies seven core ethical themes and develops 35 concrete recommendations to address these concerns.

From a theoretical standpoint, the study contributes to the literature by consolidating ethical debates that have thus far been treated in a fragmented manner within tourism technologies research into a holistic, theme-based framework, thereby helping to make existing conceptual gaps more visible. In particular, the systematic classification of the ethical dimensions of artificial intelligence and service robots in the tourism context, and the explicit linkage of normative discussions to concrete governance and policy recommendations, can be regarded as key original contributions of this research.

From a practical perspective, the study offers a set of recommendations that may guide T&H businesses in several critical domains, including strengthening data protection and privacy policies, enhancing the transparency and auditability of algorithmic decision-making processes, adopting egalitarian and inclusive approaches to service design, preserving the human touch through hybrid service models, and supporting employees via reskilling and upskilling programmes. Collectively, these recommendations underline the importance of ensuring that guest rights, employee well-being, and principles of justice are not overlooked in the process of integrating innovative technologies into the sector.

Overall, this study has addressed the ethical challenges surrounding the use of service robots and AI systems in T&H. It has discussed in detail ethical issues emerging from the growing prevalence of automation and digitalisation in the tourism sector, including workforce transformation, data privacy, customer autonomy, human–robot interaction, and transparency in algorithmic decision-making. While service robots undoubtedly offer significant benefits in terms of operational efficiency and cost reduction, their impact on the human-centred nature of hospitality requires scrutiny. Accordingly, sectoral stakeholders must exercise particular caution to ensure that the deployment of AI-powered service robots to enhance the guest experience does not overstep ethical boundaries.

Limitations of the study: Although this study addresses ethical concerns regarding the integration of service robots and AI systems within the T&H industry from a broad perspective, several limitations exist. Firstly, analyses are based solely on a literature review, and primary data derived from field studies or real-world applications have not been included. Secondly, although ethical issues have been examined within specific conceptual frameworks, the influence of regional and cultural differences on ethical concerns has not been analyzed comprehensively. Additionally, a thorough analysis of legal regulations across different countries has not been carried out, which limits the ability to propose specific policy recommendations. Lastly, given the rapid evolution of technologies such as artificial intelligence and service robots, ethical considerations are likely to transform over time. Thus, while the ethical issues discussed reflect current conditions, it is probable that future technological advancements, regulations, and changes in societal perceptions will introduce new ethical debates.

Recommendations for future research: Future research may delve deeper into guests' and employees' attitudes, ethical concerns, and experiences regarding AI-supported service robots. Conducting qualitative and

quantitative field studies could facilitate a more comprehensive evaluation of individual and societal perceptions. Moreover, comparative studies should be conducted more thoroughly better to understand the impact of cultural differences on ethical concerns. For example, analyses of ethical regulations and practices in regions such as the United States, Asia, and Europe could provide a more holistic perspective on the ethical acceptance of service robots. Additionally, the effects of anthropomorphic robots on guest experiences and the implications of the "Uncanny Valley" phenomenon in service processes warrant detailed investigation. Applied research focusing on algorithmic transparency, human-robot collaboration models, and employee reskilling initiatives can further contribute to the development of an industry that is ethically sound. More empirical studies are needed to examine the long-term effects of service robots on the labor market and strategies for managing potential employment losses. Finally, research addressing biases and discriminatory practices in AI-driven decision-making processes can support the development of fair and accountable algorithms.

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