

Innovative Risk Control Measures for Future Health Threats Among Tourism Destinations in the Province of Rizal

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Abstract

This study examined the use of innovative risk control measures for future health threats among tourism destinations in the Province of Rizal. Anchored on Innovation Diffusion Theory, the study used a descriptive quantitative research design through a survey technique and a researcher-made questionnaire-checklist. The respondents were 384 domestic tourists who stayed overnight in Rizal tourism destinations from January 2023 to December 2024, selected through purposive sampling. Findings showed that most respondents were female, aged 26 to 35, single, college graduates, residents of Rizal, and visitors of Antipolo City. The respondents perceived innovative risk control measures as effective, particularly the use of social media for health-risk awareness, air purifiers, electrostatic sprayers, and ultraviolet light. They were generally knowledgeable about virtual reality experiences, QR codes, and mobile applications, but had lower knowledge of robots, digital key systems, and cleaning robot systems. Tourism destinations in Rizal were perceived to often implement risk control measures, mainly cleanliness practices, health-risk information, air purifiers, and sanitation technologies, while advanced systems such as face recognition and service robots were least implemented. Significant differences in perceived effectiveness and perceived knowledge were found according to age, civil status, and educational attainment, while sex showed no significant difference. Perceived implementation did not significantly differ by destination location. The study concluded that Rizal tourism destinations should invest in technology-based risk control measures, strengthen staff training, and promote accessible digital tools for tourists, especially older visitors. The study supports SDG 3, SDG 8, SDG 9, SDG 11, SDG 12, and SDG 16 by promoting health protection, resilient tourism, technological innovation, safer communities, responsible practices, and policy-based tourism management. Its sustainability impact lies in strengthening public health, institutional preparedness, socio-economic resilience, and community safety in tourism destinations.

Keywords: Artificial Intelligence, Domestic Tourists, Future Health Threats, Innovative Risk Control Measures, Sustainable Tourism, Technology-Based Risk Management, Tourism Destinations, Tourism Risk Management, Virtual Reality

1. Introduction

This study examines the use of innovative risk control measures to address future health threats among tourism destinations in the Province of Rizal. Tourism relies heavily on human mobility and face-to-face service encounters, making the sector vulnerable to infectious disease risks, as demonstrated during the COVID-19 pandemic. The study focuses on how technology-based and innovation-driven measures—such as contactless systems, health applications, QR codes, thermal scanners, air purification, electrostatic sprayers, ultraviolet-light technology, artificial intelligence, robotics, virtual reality, and social media-based information systems—can reduce health risks, strengthen tourist confidence, and support resilient tourism operations.

The tourism industry is one of the most dynamic economic sectors because it depends on the movement of people across destinations, accommodations, and service environments. This mobility increases exposure to health risks, especially during global epidemics such as COVID-19. As tourism continues to recover and transform, innovative technologies have become necessary tools for protecting tourists, tourism workers, local communities, and destination economies. Contactless services and real-time health monitoring have become central to tourism safety. Digital health passports, mobile health applications, automated thermal scanners, contactless payments, online check-ins, and digital boarding systems reduce physical interaction and support early detection of possible health risks. The use of Artificial Intelligence, big data analytics, predictive models, and real-time monitoring also strengthens risk assessment and emergency response by helping destinations identify possible outbreaks and implement timely interventions. The development of tourism through innovation is aligned with the United Nation (UN) Sustainable Development Goals (SDG) 9, which emphasizes resilient infrastructure, sustainable industrialization, and technological innovation. In the Philippine context, tourism remains economically significant, with the industry generating almost P760 billion in 2024 and surpassing pre-pandemic levels by 26.75%, reflecting a recovery rate of 126.75% (Department of Tourism, 2025). Rizal Province is particularly relevant

because of its proximity to Metro Manila, scenic attractions, nature-based destinations, and growing hospitality establishments, making it a major destination for domestic tourists. Health-risk management in tourism is also supported by Republic Act No. 9593, or “The Tourism Act of 2009,” which promotes tourism development that protects the well-being of Filipinos, and by Republic Act No. 11058, or the Occupational Safety and Health Standards Law. Effective risk and crisis management helps tourism and hospitality firms protect guests and staff, preserve operations, and maintain public trust (Findlay, 2023). Technological innovation, defined as the improvement or creation of products and services through technology, is especially relevant because prior research has linked innovation, information adoption, and perceived risk in online environments (Sustacha, Pina, & Del Valle, 2023).

Related literature shows that tourist characteristics influence travel behavior, technology acceptance, and safety perceptions. The Philippine Statistics Authority's (PSA) 2024 report indicates that female domestic passengers composed 52.9% of domestic passengers in 2022. Domestic passengers were mostly below 45 years old, representing 68.7% of domestic travelers, while Rizal was identified as one of the leading domestic destinations (Mapa, 2024). Domestic tourists aged 25 to 34 also formed a large travel segment (Balita, 2024), and Antipolo City was recognized as the most visited municipality in Rizal Province in 2021 (Garcia, 2022). Age affects travel decisions because younger tourists are generally more receptive to new experiences, while older tourists tend to rely more on public information, expert recommendations, and interpersonal sources (Li & Cao., 2022). Studies on domestic leisure travel also show that women and college graduates make up a large proportion of leisure tourists, with travel motivations centered on experiencing new places, cultures, rest, and relaxation (Castaneda et al. (2024). Social media is another important factor because tourists who are highly involved in destination decisions also pay greater attention to online information, including health and sanitation safety content (Acharjee and Ahmed, 2023). Technology has transformed tourism, health tourism, and wellness experiences by giving travelers access to information, services, and tools that support safety and well-being. Virtual reality, wearable devices, mobile applications, websites, and social media help tourists access health information, monitor wellness behavior, and make informed decisions (Sustacha et al., 2023). Technological integration in hospitality is supported by the internet of things, the internet of service, and human–cyber–physical systems, which can improve service delivery and reduce COVID-19-related health risks (Roussakou & Carayanni, 2025). The literature also emphasizes the role of robotics, artificial intelligence, and contactless service systems. Robots and AI can reduce direct human contact, although age, culture, communication, empathy, and the need for human service remain important considerations (Nozawa et al., 2022). Contactless services became more acceptable during health emergencies, but the hospitality and catering sectors still require human interaction (Guan et al., 2022). Robots may assist with guest services and infection control, while ultraviolet-light disinfection robots can help eliminate pathogens in tourism and hospitality facilities (Alotaibi & Khan, 2022). Hospitality establishments have also adopted artificial intelligence, service robots, ventilation systems, and self-service technologies to strengthen cleanliness, safety, and customer confidence (Roussakou & Carayanni, 2024). Wellness tourism benefits from technology because travelers can remain informed, connected, and guided toward healthier choices while away from home (Kumar & Singh, 2023). Virtual simulations, wearable devices, fitness trackers, smartwatches, and mobile health reminders support activity monitoring, hydration, meditation, and exercise during travel (Adams & White, 2022). However, technology use in tourism must consider culture, community participation, privacy, data security, and digital inclusion. Wellness technologies should respect local beliefs, traditions, and community-based practices (Smith & Johnson, 2023). Local communities should be involved in designing wellness experiences to ensure authenticity, inclusivity, and cultural sustainability (Lijun et al., 2024). Health and wellness tourism also raises privacy concerns because wearable devices, mobile applications, and online platforms collect sensitive health data, requiring secure communication, access controls, and compliance with privacy standards (Benitez, 2024). Data breaches in digital health platforms show the risks of inadequate security (Yallop et al., 2023), making encryption, authentication, privacy compliance, security audits, and data protection essential (Fernandez & Costa, 2023). Digital literacy and access are also critical because technology-based tourism safety systems may exclude older adults, people with limited education, persons with disabilities, low-income travelers, and communities with poor internet access. Health literacy has been shown to vary according to age, education, and family status (Šulinskaitė et al. (2022). Smart tourism technology further supports destination competitiveness through tourism applications, decision-support systems, ambient intelligence, virtual reality, augmented reality, mobile devices, intelligent cards, integrated payment systems, and cloud computing (Kovačić, 2022). Artificial intelligence and robotics can improve customer interaction, operational efficiency, and service delivery, but excessive reliance on technology may cause service failures and dissatisfaction (Guo et al., 2024). Automation can reduce waiting time and staff workload, but it must be balanced with personalized human service (Mandić et al., 2023). AI, robotics, and service automation can improve service processes and strengthen word-of-mouth, but overreliance on technology may reduce human communication and create discomfort among customers (Basiouny, 2023; Goel et al., 2022). Smart tourism infrastructure includes hardware, software, networks, travel agencies, wearable technologies, chatbots, QR codes, near field communication, radio frequency identification, social networks, beacons, cloud computing, artificial intelligence, big data, Wi-Fi, virtual reality, and augmented reality. These technologies can improve tourist experiences and support health-risk mitigation, including the use of service robots, virtual hotel tours, digital keys, facial recognition, cleaning robots, self-check-in, self-check-out, ultraviolet light, germicidal robots, and electrostatic sprayers (Koerten & Abbink, 2022). Informative travel experiences are important because tourists value access to destination information, local attractions, cultural institutions, and dining

choices (Guo et al. (2024). Smart tourism applications can also personalize itineraries and improve engagement (Armutcu et al. (2023); Leung et al., 2022). However, privacy and security concerns may reduce trust in smart tourism systems, requiring digital solutions that improve traveler experiences without misusing personal data (Elshaer & Marzouk, 2022; Batat & Hammedi, 2023; Yang & Zhang (2022); Benitez, 2024; Ionescu and Sârbu, 2024).

Globally, the COVID-19 pandemic accelerated the adoption of health-focused tourism technologies. Branded hotels have adopted mobile check-in systems, kiosk check-ins, robot cleaning systems, electrostatic sprayers, and ultraviolet-light technology to reduce staff–guest interaction and improve disinfection (Marques et al. (2022). Technological advancements can improve hygiene and reduce contact between guests and staff, making them useful strategies for lowering hotel-related health risks (Schwarz, 2025). Nationally, the Philippine tourism sector has shown strong recovery after the pandemic, but health threats remain a continuing challenge. Tourism policies emphasize safety, quality, competitiveness, and the general well-being of the Filipino people. Republic Act No. 9593 supports the promotion of the Philippines as a safe and wholesome destination, while Republic Act No. 11058 reinforces occupational safety and health standards across workplaces, including tourism settings. Locally, Rizal Province is an important research context because it attracts domestic tourists from Metro Manila and nearby provinces. Its scenic destinations, accessibility, nature-based sites, and hospitality establishments make it suitable for examining how innovative risk control measures are perceived, understood, and implemented in post-pandemic tourism. Despite the growth of technology in tourism, limited local studies have examined how these measures are used in Rizal tourism destinations, particularly from the perspective of domestic tourists.

The study is anchored on Innovation Diffusion Theory (Rogers, 1962), which explains how innovations are communicated through channels over time among members of a social system. The theory describes adoption as a process involving awareness, interest, persuasion, decision, adoption, and confirmation (Guo & Huang, 2023). It is appropriate for this study because innovative risk control measures in tourism require awareness, acceptance, and actual use by tourists, tourism workers, and destination managers. Rogers (2003) identifies five attributes that influence innovation adoption: relative advantage, compatibility, complexity, trialability, and observability. In tourism risk management, relative advantage refers to whether tools such as AI-driven predictive analytics are seen as better than traditional risk assessment. Compatibility refers to how well mobile risk alerts, QR codes, and health applications fit tourists' existing smartphone habits. Complexity refers to how easy or difficult the innovation is to understand and use. Trialability refers to whether technologies such as AI monitoring can be tested before full implementation. Observability refers to whether the benefits of technologies, such as real-time tracking or emergency response systems, are visible to other destinations and stakeholders. Conceptually, the study links respondent demographics, perceived effectiveness, perceived knowledge, and perceived implementation and use of innovative risk control measures. These inputs are assessed through a researcher-made and validated questionnaire, followed by data collection, analysis, and interpretation. The expected output is the development of Tourism Management Guidelines for future health threats in Rizal Province.

Although technology is increasingly used in tourism and hospitality, there remains limited research in the local setting on the implementation and use of innovative risk control measures for future health threats. Existing studies discuss smart tourism, robotics, artificial intelligence, contactless services, wellness technologies, and health-risk mitigation, but few focus on domestic tourists' perceived knowledge, the perceived effectiveness of these measures, and their implementation in specific Philippine destinations. There are also no current studies identified in the manuscript that examine how tourist destinations in Rizal Province use technological innovations for tourism risk management. The study therefore addresses this gap by analyzing domestic tourists' socio-demographic profile; their perception of the effectiveness of innovative risk control measures; their knowledge of such measures; and their perception of implementation and use across tourism destinations in Rizal. It also examines whether perceptions differ by sex, age, civil status, educational attainment, and destination location, and whether demographic factors significantly contribute to tourists' perceived knowledge.

This study aligns most directly with SDG 3 – Good Health and Well-Being because it focuses on reducing health risks, preventing disease transmission, and improving tourist and community safety in tourism destinations. It also supports SDG 8 – Decent Work and Economic Growth because safer destinations help sustain tourism businesses, protect livelihoods, and maintain the economic role of tourism in Rizal and the Philippines. The study is also strongly linked to SDG 9 – Industry, Innovation and Infrastructure because it examines technological innovation, digital systems, and risk-control infrastructure in tourism. It supports SDG 11 – Sustainable Cities and Communities by promoting safer, more resilient tourist destinations that protect visitors and host communities. It contributes to SDG 12 – Responsible Consumption and Production through the discussion of eco-friendly sanitation practices, resource-use efficiency, and clean technologies. It is also related to SDG 16 – Peace, Justice, and Strong Institutions because tourism safety is connected to policy compliance, regulatory standards, institutional preparedness, and governance mechanisms under Republic Act No. 9593 and Republic Act No. 11058.

The study contributes to public health sustainability by identifying risk control measures that can reduce exposure to infectious diseases in tourism environments. It contributes to technological and innovation sustainability by examining

how tourism destinations can adopt, implement, and improve digital and smart technologies for health-risk management. It supports socio-economic sustainability by helping tourism destinations maintain tourist confidence, business continuity, and local livelihoods during and after health emergencies. The study also contributes to institutional and governance sustainability by supporting evidence-based tourism management guidelines aligned with tourism and occupational safety laws. It contributes to community sustainability because safer tourism destinations protect both visitors and local residents. Environmental sustainability is reflected in the attention to eco-friendly sanitation, ventilation, clean technologies, and sustainable destination management. Educational and digital sustainability are also relevant because tourists' knowledge, health literacy, digital access, and awareness affect their ability to use innovative risk control measures effectively.

The study focuses on domestic tourists who stayed overnight in Rizal tourism destinations from January 2023 to December 2024, during the post-pandemic period. It is limited to respondents' perceptions and does not include an actual physical audit of existing risk control strategies in tourism establishments. The major variables include socio-demographic profile, perceived effectiveness, perceived knowledge, perceived implementation and use, and the influence of demographic factors on perceived knowledge. The findings are intended to benefit tourists by improving awareness of health-risk control measures, tourism destination owners by guiding adoption of relevant technologies, tourism offices by providing assessment data on current practices, and future researchers by offering a basis for related studies. The expected output is a set of Tourism Risk Management Guidelines for future health threats in Rizal Province.

2. Material and methods

2.1 Research Design

The study used a descriptive quantitative research design through a survey technique and a researcher-made questionnaire-checklist. According to Cresswell & Cresswell (2023), a survey design provides a quantitative description of trends, attitudes, and opinions of a population, or tests associations among variables by studying a sample of that population. This design was used to assess the perceived effectiveness, perceived knowledge, and perceived implementation and use of innovative risk control measures for future health threats among tourism destinations in Rizal Province.

2.2 Locale of the Study

The study was conducted in the Province of Rizal, a tourism area with both same-day visitors and overnight tourists. The province recorded 7,199,596 same-day visitor arrivals and 395,364 overnight tourists. Same-day visitor arrivals were distributed across municipalities and cities such as Antipolo, Angono, Baras, Binangonan, Cainta, Jalajala, Morong, Pililla, Montalban, San Mateo, Tanay, Taytay, and Teresa. For overnight stays, Antipolo recorded 77,902 visitors, while Angono, Baras, and Binangonan recorded no overnight visitors in the cited data.

2.3 Respondents of the Study

The respondents were domestic tourists or guests who visited tourism destinations in Rizal Province. They were required to have stayed in tourist spots offering accommodation or facilities using equipment or strategies intended to mitigate health risks, particularly risks associated with exposure to bacterial and viral infections.

2.4 Sample and Sampling Procedure

The study considered the overnight tourist population of Rizal Province, reported at 395,364. Using Cochran's formula for sample size computation with $p = .5$, $q = .5$, a 5% margin of error, and $z = \pm 1.96$, the computed sample size was 384 respondents. Purposive sampling was used because the study required respondents who were domestic tourists with overnight visits to tourism destinations in Rizal.

2.5 Research Instrument

Data were collected using a researcher-made survey questionnaire checklist. The instrument was developed from related studies and researcher-formulated questions aligned with the study's objectives. It covered the respondents' socio-demographic profile, perceived effectiveness of innovative risk control measures, perceived knowledge of tourists regarding these measures, and perceived implementation and use of such measures in Rizal tourism destinations. The questionnaire was validated by tourism officers and tourism professors. It was also pilot-tested for reliability using Cronbach's Alpha. The reliability result was 0.961, indicating excellent internal consistency and confirming that the instrument was acceptable for use in the study. The instrument used Likert-scale responses to measure perceived effectiveness, perceived knowledge, and perceived implementation and use. The interpretation of average percentages for perceived knowledge was adopted from Meidiastuti and Safitri (2021).

2.6 Data Gathering Procedure

The researcher used an online survey through Google Forms to collect the needed data. Data collection lasted three months until the required number of respondents was reached. The completed responses were reviewed, consolidated, and

submitted for statistical treatment. The researcher assured the confidentiality of responses and allowed respondents to remain anonymous to encourage honesty in answering the questionnaire.

2.7 Data Analysis Techniques

The study used frequency and percentage distribution to describe the respondents' socio-demographic profile, including sex, age, highest educational attainment, civil status, place of residence, and location visited. Weighted mean was used to analyze responses on perceived effectiveness, perceived knowledge, and perceived implementation and use of innovative risk control measures. Analysis of Variance was used to test significant differences across respondent categories, while multinomial logistic regression analysis was used to determine whether sex, age, civil status, and highest educational attainment significantly contributed to the respondents' perceived knowledge of innovative risk control measures.

3. Results and Discussion

3.1 Socio-Demographic Profile of the Respondents

3.1.1 Sex

The respondents were mostly female, with 257 respondents or 66.9%, while 127 respondents or 31.1% were male. This indicates that most tourists in Rizal Province were female. This finding is consistent with the report of Mapa (2024) of the Philippine Statistics Authority (PSA), which stated that female domestic travelers in the Philippines accounted for 52.9% in 2022.

3.1.2 Age

Most respondents were 26 to 35 years old, comprising 107 respondents or 27.9%. This was followed by those aged 36 to 45 years old with 103 respondents or 26.8%, those aged 18 to 25 years old with 91 respondents or 23.7%, and those aged 45 years old and above with 83 respondents or 21.6%. The findings show that most tourists in Rizal Province belonged to the 26 to 35 age group. This is congruent to the report of Mapa (2024) that most domestic travelers in the Philippines were under 45 years old in 2021 and 2022, comprising 68.7% of domestic travelers in 2022. This is also supported by the report of Balita (2024), which stated that in 2021 and 2022, about a quarter of domestic travelers were between 25 and 34 years old, followed by those between 15 and 24 years old.

3.1.3 Civil Status

Most respondents were single, with 270 respondents or 70.3%. Married respondents numbered 86 or 22.4%, while widows or widowers accounted for 28 respondents or 7.3%. This shows that most tourists in Rizal Province were single. This is in line with the findings of Castaneda et al. (2024) on travel motivation among domestic leisure tourists in the Philippines, where most respondents were also female, comprising 74.6% of the respondents.

3.1.4 Highest Educational Attainment

Most respondents were college graduates, with 209 respondents or 54.4%. College undergraduates accounted for 134 respondents or 34.9%, respondents with master's units numbered 26 or 6.8%, and postgraduates accounted for 15 respondents or 3.9%. The findings reveal that more than half of the tourists in Rizal Province were college graduates. This is in line with the findings of Castaneda et al., (2024), who found that most respondents in a study on domestic leisure tourists in the Philippines were also college graduates, comprising 77.2%.

3.1.5 Place of Residence

Most respondents were residents of Rizal Province, with 347 respondents or 90.4%, while 37 respondents or 9.6% lived outside Rizal. This suggests that most tourists in Rizal Province were local residents who preferred to visit nearby towns within the province. Rizal's position as a domestic tourism destination is supported by Mapa (2024), who reported that in 2001, Rizal Province was among the top eight main destinations of domestic travelers, with pleasure or vacation as the main purpose of trips in 2021 and 2022.

3.1.6 Location of Tourist Destination Visited

Antipolo City was the most visited location, with 148 respondents or 38.5%. It was followed by Tanay with 76 respondents or 19.8%, Angono with 47 respondents or 12.2%, Rodriguez with 45 respondents or 11.7%, Cainta with 36 respondents or 9.4%, and Binangonan with 32 respondents or 8.3%. The findings indicate that Antipolo City was the most preferred destination among the respondents. This is supported by the report of Garcia (2022), which recognized Antipolo City as the most visited town in Rizal Province in 2021, accounting for 75% of total tourist arrivals in the province.

3.2 Perceived Effectiveness of Innovative Risk Control Measures

The respondents perceived the overall effectiveness of innovative risk control measures as effective, with an average mean of 4.17. The highest-rated measures were the use of social media channels for health risk awareness, air purifiers in common areas, and electrostatic sprayers, ultraviolet light, or germ-zapping robots for sanitation, with mean scores of 4.84, 4.72,

and 4.64, respectively. The lowest-rated measures were digital key systems and face recognition systems, with mean scores of 3.20 and 3.12, both interpreted as moderately effective. These findings suggest that tourists perceived commonly visible technologies, such as air purifiers and electrostatic sprayers, as more effective in reducing health risks. This indicates tourists' awareness of human–cyber–physical systems. As explained by Roussakou & Carayanni (2025), technological integration in the new hospitality age includes the internet of things, the internet of service, and the human–cyber–physical system, which combines human and machine intelligence to improve customer satisfaction and service standards. However, the lower ratings for digital key systems and face recognition differ from Schwarz (2025), who emphasized the importance of mobile check-in and digital room key technologies in providing contactless and safer hotel experiences.

3.3 Perceived Knowledge of Innovative Risk Control Measures

The respondents were generally aware and knowledgeable about innovative risk control measures, with an average mean of 3.72. The highest-rated areas of knowledge were virtual reality experiences for immersive simulations and educational modules, QR codes for contactless check-ins and check-outs, and social media channels for health awareness information, with mean scores of 4.46, 4.41, and 4.21, respectively. The lowest-rated areas were digital key systems, cleaning robot systems, and robots used as waiters, bartenders, or front desk personnel, with mean scores of 2.84, 3.18, and 1.96, respectively. These findings indicate that tourists were more knowledgeable about communication-based and mobile-based technologies than equipment-based technologies. This may be due to their greater exposure to commonly used digital platforms and limited exposure to service robots and advanced facility-based technologies in Rizal. Roussakou, & Carayanni (2024) discussed that the hospitality and catering sector has adopted artificial intelligence, service robots, ventilation systems, and self-service technologies to improve cleanliness and meet safety standards. The findings also align with Sustacha et al. (2023), who stated that technology can teach and raise awareness about health and wellness concerns, and with Kumar & Singh (2023), who emphasized that technology helps travelers stay informed and connected to services that support healthy lifestyles.

3.4 Perceived Implementation and Use of Innovative Risk Control Measures

The respondents perceived the overall implementation and use of innovative risk control measures as often implemented and used, with an average mean of 3.94. The most implemented measures were cleanliness of rooms, high-touch areas, and surfaces; provision of appropriate information on risk-reduction strategies; availability of air purifiers; and use of electrostatic sprayers, ultraviolet light, or germ-zapping robots, with mean scores of 4.78, 4.76, 4.72, and 4.71, respectively. The least implemented measures were face recognition systems and robots used as waiters, bartenders, or front desk personnel, with mean scores of 2.02 and 1.29. The results show that tourism destinations in Rizal Province prioritize cleanliness, health information, and commonly available sanitation technologies but have not fully adopted high-technology measures such as robots and facial recognition systems. As cited by Alotaibi & Khan, (2022), robots can provide important guest services and help control viral infections in tourism and restaurant businesses. The findings suggest that Rizal tourism destinations are not yet fully technologically advanced in health-risk control, possibly because of the cost of acquisition, implementation, and staff training. This is also supported by Abou Kamar (2022), who stated that as local suppliers and hotel businesses collaborate (Abou Kamar, 2022), technological investments and adaptation can provide security against emerging crises. Human resource training is also needed for businesses (Diker et al., 2022), while technology supports risk management by reducing infection risks and limiting human interaction (Diker et al., 2022).

3.5 Differences in Perceived Effectiveness by Respondent Profile

There was no significant difference in perceived effectiveness when respondents were grouped by sex, with an F-value of 1.04 and p-value of .308. However, significant differences were found when respondents were grouped by age, civil status, and highest educational attainment, with F-values of 42.2, 9.79, and 3.13 and p-values of <.001, <.001, and .026, respectively. Post hoc results showed significant differences between younger age groups and those aged 46 years old and above, between single and widowed respondents, between married and widowed respondents, and between college graduates and college undergraduates. These findings indicate that age, civil status, and education influenced perceptions of the effectiveness of innovative risk control measures. Older tourists, widowed respondents, and respondents with different educational backgrounds had varying perceptions, which may be linked to differences in exposure to technology. This supports Elshaer & Marzouk (2022), who explained that technology can improve access to health and wellness services but may also worsen existing inequalities in digital literacy and technology access. Jones et al. (2021) also noted that travelers without access to cellphones, laptops, or high-speed internet may have limited participation in technology-driven wellness experiences.

3.6 Differences in Perceived Knowledge by Respondent Profile

There was no significant difference in perceived knowledge when respondents were grouped by sex, with an F-value of 2.96 and p-value of .086. Significant differences were found when respondents were grouped by age, civil status, and highest educational attainment, with F-values of 72.5, 16.6, and 13.4, all with p-values of <.001. Post hoc results showed significant differences between respondents aged 18 to 25, 26 to 35, and 36 to 45 years old compared with those aged 46 years old and above; between single and widowed respondents; between married and widowed respondents; between

college graduates and college undergraduates; and between college undergraduates and those with master's units. These results show that older tourists, widowed respondents, and respondents with lower educational attainment differed in perceived knowledge of innovative risk control measures. This may be attributed to differences in exposure to modern technologies, particularly internet-based and computer-based tools. The age of tourists significantly affects consumer behavior, assessments, and decisions, as younger individuals are more likely to accept new ideas while older individuals tend to be more cautious and reliant on information from others or public sources (Li & Cao., 2022).

3.7 Differences in Perceived Implementation and Use by Tourist Destination Location

There was no significant difference in perceived implementation and use of innovative risk control measures when respondents were grouped according to the location of the tourist destination. The computed F-value was 1.03, with a p-value of .398. This indicates that respondents had similar perceptions of implementation and use across the tourist destinations in Rizal Province. The result suggests that the level of implementation of innovative risk control measures was generally comparable across the locations included in the study.

3.8 Factors Contributing to Perceived Knowledge of Innovative Risk Control Measures

The regression model explained 50.1% of the variance in perceived knowledge, with an R-square value of .501. The model was significant, with an F-value of 41.7 and p-value of <.001. Sex, being 26 to 35 years old, being 36 to 45 years old, being married, having a postgraduate degree, and having master's units were not significant predictors. However, being 46 years old and above, being widowed, and being a college undergraduate were significant factors. The beta coefficients showed that being 46 years old and above decreased perceived knowledge by .35858 units, being widowed decreased it by .10449 units, and being a college undergraduate decreased it by .20048 units. These findings indicate that higher age and lower educational attainment were associated with lower perceived knowledge of innovative risk control measures. This suggests that tourists' exposure to and acceptance of technology may affect their knowledge of health-related tourism technologies. This is supported by the findings of Nozawa et al. (2022), who stated that the use of technology in the tourism industry, including robots and artificial intelligence, appears to be influenced by factors such as age and culture. Guan et al. (2022) also emphasized that contactless services are more widely accepted during health emergencies, although the human element remains essential in hospitality and catering services.

4. Conclusion & Recommendations

The study concluded that most tourist respondents were female, aged 26 to 35, single, college graduates, Rizal residents, and visitors of Antipolo City. Social media, air purifiers, electrostatic sprayers, and ultraviolet light were perceived as very effective innovative risk control measures for reducing health risks. Tourists were highly knowledgeable about virtual reality experiences, QR codes, and mobile applications, but tourism destinations in Rizal were not yet fully implementing technology-based risk control strategies, with current practices focused mainly on cleanliness and health-risk information. Perceptions of effectiveness and knowledge differed by age, civil status, and educational attainment, while perceived implementation did not differ by tourist destination location. Age 46 and above, widowhood, and being a college undergraduate were identified as factors contributing to perceived knowledge of innovative risk control measures.

Tourism industries in Rizal should invest in technology-based innovative risk control measures to address future health threats, while employees should receive training to guide domestic tourists, especially older visitors, in using these technologies. Local tourism departments should set standards for basic cleanliness-related facilities such as electrostatic sprayers and air purifiers, encourage the use of mobile check-in, digital room keys, and robots for reduced human contact, and promote virtual reality and mobile applications for communicating health and safety guidelines. Seminars and training should also be provided to tourism destination owners so they can adopt suitable risk control measures for future health threats affecting the tourism industry.

The study was limited to domestic tourist respondents who stayed overnight in Rizal tourism destinations from January 2023 to December 2024 during the post-pandemic period. It was also limited to respondents' perceptions of knowledge, effectiveness, and implementation of innovative risk control measures and did not include an actual inspection or survey of the existing risk control strategies used by tourism destinations in Rizal Province.

Compliance with ethical standards

The study was conducted in accordance with the institutional research standards of the Polytechnic University of the Philippines, with the necessary permissions, approvals, and data privacy endorsements secured before data collection; participation of the domestic tourist respondents was voluntary, and informed consent was obtained through their willingness to answer the online questionnaire. Respondents were allowed to remain anonymous, all information gathered was treated with strict confidentiality, and the data were used solely for research purposes. The researcher acknowledges the contributions of the adviser, panel members, validators, institutional offices, respondents, and other individuals who

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