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Exploring the Role of Innovation and Perceived Security in Contactless Technology Adoption: Evidence from Contactless Travel Services

Mary Grace Burkett
Universidad Complutense de Madrid, Spain
Recuero Virto, Nuria
Universidad Complutense de Madrid, Spain

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Abstract
This study offers new empirical insights into how contactless technologies and customer experience shape technology adoption in post-pandemic tourism. By integrating TAM and TPB, the research aims to understand consumer behavioural intentions toward contactless technologies in the tourism sector. A quantitative research approach was adopted, utilising PLS-SEM to analyse survey data from 851 respondents in Spain who have previously used contactless hotel and airline services, using SmartPLS software. This approach was used to examine the relationships between constructs and their corresponding indicators, making it especially appropriate for exploratory research. The results reveal that contactless services significantly enhance perceived security, perceived value, and the customer experience, fostering a positive attitude towards their use. Attitude toward adoption strongly predicts behavioural intentions. By applying TAM and TPB, this study offers new insights into how technological advancements influence perceived security, value, and travel intentions. Expanding on Neuberger and Egger (2021), it shows how innovation helps mitigate pandemic-related risks and enhance tourist confidence, offering guidance for providers of digital and contactless tourism services. The added value of this research lies in integrating TAM and TPB into a framework to analyse the adoption of contactless airline and hotel services, particularly in response to the pandemic. The framework also includes behavioural intentions and willingness to pay for additional security measures.

Key Words: TAM, perceived risks, perceived security, Tourism, Innovation, TPB, contactless services

JEL Classification: M3, O3, O4

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1. Introduction

Tourism's direct contribution to the global gross domestic product reached approximately USD 3.3 trillion in 2023, accounting for 3% of global GDP (UNWTO, 2024). Tourism is a highly labour-intensive industry and ranks among the world's leading job creators (Draskovic et al., 2022). However, the growth of the tourism sector has been significantly disrupted by global crises, including the COVID-19 pandemic and geopolitical conflicts, which have severely restricted individual mobility. The pandemic, in particular, dealt a severe blow to the global travel and tourism industry, resulting in the loss of an estimated 63 million jobs in 2020 (Sharma et al., 2024). This situation highlights the urgent need for innovative solutions to address these dynamic challenges and build resilience in the face of uncertainty (Lupton & Samy, 2022). Through sustainable tourism practices, technological advancements, and

adoption of digital transformation (Gavurova et al., 2024), the travel and hospitality industries have been transformed, fostering more secure, efficient, and customer-friendly experiences (Dias et al., 2022).

One of the most significant advancements in recent years has been the rise of contactless services, which aim to minimize in-person interactions while leveraging digital and automated solutions (Li et al., 2021). Prior to the COVID-19 pandemic, the adoption of contactless technologies was already emerging as a key trend in retail and service industries (Li & Huang, 2022). However, the pandemic accelerated their adoption, with industry professionals recognizing their critical role in mitigating risks and enhancing customer confidence. This shift has prompted a growing body of research examining customer responses to contactless service implementations (Chen et al., 2021; Kim et al., 2021, Liu & Yang, 2021).

The accelerated implementation and adoption of new technologies (Habánik et al., 2021), especially in consumer-oriented industries, depends on key psychological determinants that influence users´ acceptance decisions. According to Davis (1989), two primary factors - perceived usefulness and perceived ease of use - shape individuals´ willingness to embrace technological innovations. These constructs form the foundation of the widely applied Technology Acceptance Model (TAM), which has been extensively implemented and empirically validated by researchers as a robust model for explaining the key determinants of technology adoption and use (Alaeddin et al., 2018). Perceived usefulness is a key predictor of intention to use innovative technology (Herzallah et al., 2022), and it also refers to the extent to which consumers believe that a particular technology enhances their performance or experience (Belanche et al., 2024). In contrast, perceived ease of use pertains to the level of effort consumers expect to exert when using the technology (Davis, 1982; Ma et al., 2024). It's also defined to which a user finds a webpage or interface easy to access and use (Saoula et al., 2023).

This study applies Partial Least Squares Structural Equation Modelling (PLS-SEM) to examine the relationship between perceived risk and innovation in the tourism sector, with a specific focus on the adoption of contactless airline and hotel services in Spain. While perceived risk is acknowledged as a critical external factor influencing technology adoption, it primarily emphasizes potential negative outcomes. This risk-centric perspective tends to overlook the positive aspects—particularly perceived safety, that often drive consumers to adopt digital innovations. By reframing the discussion in terms of perceived security, this research offers a more balanced and insightful understanding of consumer behavior, particularly in the context of post-pandemic travel. The study specifically explores how perceived safety, contactless technology adoption, and the broader impact of the COVID-19 pandemic collectively shape tourists' behavioural intentions toward using contactless travel and hospitality services.

This study is further driven by the critical impact of the COVID-19 pandemic on the adoption of contactless airline and hotel services (Yepez & Leimgruber, 2024). As one of the leading global tourism destinations, Spain's ability to adapt to shifting consumer preferences for safety and convenience is paramount. This aligns with the broader objective of equipping Spanish tourism and hospitality companies with the tools to strengthen market orientation and response effectively to evolving consumer needs.

2. Literature review

This review aims to provide a solid theoretical foundation by examining existing academic work relevant to the adoption of technological innovations in the tourism sector. Specifically, it delves into the existing research on perceived risks and the role of innovation in shaping tourism practices, particularly in response to global health crises such as the COVID-19 pandemic. In this study, perceived risk is assessed in a positive light and reconceptualized as perceived safety, a proactive sense of security experienced by tourists. Tourism safety, in this context, is defined as an emerging discipline focused on the protection and smooth functioning of the tourism system, encompassing both domestic and international destinations (Korstanje, 2020). It emphasizes not only the mitigation of threats but also the

creation of conditions in which tourists feel secure and confident. By analysing how pandemics have influenced consumer behaviour and technological adoption, this section seeks to contextualize the evolving dynamics of the tourism industry and highlight critical gaps that this study intends to address.

2.1. Technology innovation influence on perceived security, perceived usefulness and ease of use

Technology innovation plays an important role in accelerating industry transformation and advancement. Wu and Liu (2021) highlighted that technological innovation enhances production efficiency, leading to reduced production costs, which in turn drives industry upgrades. Technological innovations harness advancements in fields such as big data, Internet of Things (IoT), and cloud technologies. Among these innovations, contactless technology has emerged as a critical driver of transformation (Manimuthu et al., 2021).

Contactless service refers to a technology-enabled, fully contactless, and disinfected service environment, which is achieved through an integrated package of self-service, robotic services, and Internet of Things (IoT) based implementations. The adoption of online channels surged during the Covid-19 pandemic (Civelek et al., 2021) as service providers accelerated the digitization of processes, such as online check-ins to reduce physical contact, minimize crowding, and maintain safe distances between tourists as well as facial recognition services, virtual assistants and robotic services (Teng et al., 2025).

Such innovations address the main concerns in hospitality service encounters, including touchless smart rooms, robotic services, auto-detection of body temperature, keyless access, and disinfection of public facilities and spaces. Collectively, these features focus around enhancing the customer journey and ensuring safety, efficiency, and convenience (Hao et al., 2023).

In recent years, understanding the risks perceived by tourists has become increasingly important for both tourism researchers and industry stakeholders. These perceived risks can significantly influence tourism decisions, behaviour, and overall satisfaction. Drawing from existing literature, the risks that tourist perceived are: (1) physical risk, the possibility of having a trip that will lead to physical danger or injury (Boksberger et al., 2007); (2) social risk, the possibility that a trip will not confirm to the standard of others (Aschauer, 2010); (3) performance risk, is the possibility that a trip will not provide satisfaction (An et al., 2010); (4) financial risk, is the possibility that the money invested in a trip will be lost (Boksberger et al., 2007); (5) privacy risk, is the potential loss of control over personal information (Featherman & Pavlou, 2003). And lastly, risk of traveling during pandemics (Sanchez-Cañizares et al., 2020).

With the perceived risks, this research intentionally reframes the concept of perceived risk as perceived security to better align with the evolving role of consumer perceptions in driving technological innovation—particularly in the context of contactless services within Spain's tourism industry. While perceived risk is recognized as a foundational external factor influencing the adoption of contactless technologies, this work emphasizes that it primarily highlights potential negative outcomes. However, this risk-oriented perspective falls short in capturing the positive aspect that more accurately reflect consumer motivations for embracing digital innovations within the tourism sector.

Risk is typically defined as the probability of certain adverse events occurring, multiplied by the magnitude of their potential consequences. In contrast, subjective or perceived risk refers to an individual's intuitive judgment of these probabilities and impacts, which may not align with objective assessments. (Larsen et al., 2008). A threat, on the other hand, Perceived threat refers to an individual's subjective assessment of the likelihood of experiencing personal or collective harm (Spiegel & Bodas, 2025).

Unlike perceived risk, which focuses on potential loss, perceived security highlights proactive trust and confidence in service design. Building on this understanding, the present research intentionally reframes perceived risk as perceived security to better align with the evolving role of consumer

perceptions in shaping technological innovation, particularly regarding the adoption of contactless services in Spain's tourism industry. While perceived risk is acknowledged as a key external factor influencing the uptake of these technologies, it tends to emphasize the possibility of negative outcomes. This risk-centric approach, however, fails to capture the positive side, namely, the perceived safety and trust, that often underlies consumer motivation to adopt digital innovations in tourism. By shifting the focus toward perceived security, this study offers a more balanced and accurate lens through which to understand consumer behaviour in a post-pandemic tourism context.

Security can be defined as a condition in which threats are absent (Dankiewicz 2022). Perceived security has increasingly been recognized as a pivotal variable in consumer decision-making processes within the context of B2C e-commerce. Accordingly, the long-term viability of B2C business models may depend significantly on a firm's capacity to effectively manage security risks and positively shape consumer perceptions of wireless technologies. This recognition has elevated perceived security to a prominent position in academia. A substantial body of this research is linked to the Technology Acceptance Model (TAM), an established framework in information systems that seeks to explain users' behavioural intentions toward adopting new technologies. Within this model, perceived security functions as an external variable that can substantially influence both the likelihood and the timing of user engagement with technological innovations. (Hartono et al., 2014).

The role of technological innovation in the post-pandemic tourism landscape, particularly in the hotel and airline sectors, contactless services are not merely adopted to reduce risk but are actively marketed and perceived as innovations that enhance safety, hygiene, and convenience (Zhang et al., 2023). Thus, focusing on perceived security allows for a more constructive and innovation-oriented analysis. Rather than viewing consumer behaviour through a lens of avoidance (risk), this approach views it through a lens of confidence and trust, which better reflects the proactive strategies of tourism firms aiming to differentiate themselves through technological enhancements.

In this study, while perceived risk is acknowledged as a foundational external factor influencing the adoption of contactless technologies, it primarily highlights potential negative outcomes. However, this focus does not sufficiently capture the positive aspects, that more accurately reflect consumer motivations for engaging with digital innovations in the tourism sector.

Building on this foundation, the present study explores how technological innovation can mitigate various dimensions of perceived security, particularly in the context of tourism during pandemics. Based on existing theoretical and empirical insights, the following hypothesis is proposed:

H1: Technology innovation significantly and positively influences *(a)* physical security, *(b)* financial security, *(c)* performance security, *(d)* social security, *(e)* privacy security, and *(e)* perceived security of traveling during pandemics.

2.2. Technology innovation significantly and positively influences (a) perceived usefulness, and (b) perceived ease of use.

The influence of technology innovation on TAM is an emerging area of study, examining its impact on perceived usefulness and perceived ease of use. For instance, Loh et al. (2019) explored the role of wearable technology in fostering a cashless society. Their research highlights how individuals with high mobile innovativeness actively seek opportunities to explore wearable payment solutions, engaging with these technologies through activities such as visiting mobile technology outlets and testing display units with the guidance of staff. This behaviour underscores their enthusiasm for adopting innovative payment methods, demonstrating the connection between technological innovation and perceived usefulness.

Perceived usefulness refers to the extent to which an individual believes that using a particular will enhance their job performance. This perception is shaped by how effectively the technology enables users to complete tasks more efficiently, boost productivity, and improve overall performance (Davis,

1989). Besides, perceived ease of use, in contrast, is the degree to which an individual believes that using a particular system would be free of effort (Alshurafat et al., 2021).

Furthermore, technological innovation also enhances perceived ease of use. Alalwan et al. (2018) found that the introduction of user-friendly interfaces and intuitive functionalities in mobile banking significantly reduced the cognitive effort required to use these technologies. Such advancements simplify interactions, making it easier for users to learn and adopt new systems. This reduction in perceived effort, driven by innovation, directly contributes to greater ease of use. In light of this evidence, it is proposed that:

H2: Technology innovation significantly and positively influences *(a)* perceived usefulness, and *(b)* perceived ease of use.

2.3. Customer experience influences on perceived value

Perceived experience refers to the way customers interpret and evaluate the experiential aspects of a service, encompassing their subjective feelings, thoughts, and impressions formed during their interactions with the service. This perception plays a crucial role in shaping their overall satisfaction and emotional connection. Ultimately, perceived experience serves as a fundamental prerequisite for fostering customer engagement, as it directly influences their willingness to interact, invest time, and build a lasting relationship with the brand (Konuk, 2019; Paulose & Shakeel, 2021).

The definition of customer perceived value has changed over time (El-Adly, 2019), However the meaning of "value" adopted for this study is "all factors, qualitative, and quantitative, subjective and objective, that make up the complete consumption experience". Based on this definition, customers' perceived value in the hotel and airline context as a multidimensional construct consisting of more dimensions than just price and quality. This also includes self-gratification, aesthetic pleasure, prestige, transaction, and hedonism (El-Adly, 2019).

Research highlights the strong relationship between perceived experience and perceived value. For example, Paulose and Shakeel (2021) explored the relationship between perceived experience, perceived value and customer satisfaction as antecedents to loyalty among hotel guests. Their findings revealed that both perceived experience and perceived value significantly influence customer satisfaction, which, in turn, has a strong impact on customer loyalty.

H3: Customer experience significantly and positively influences perceived value.

2.4. Perceived usefulness and perceived ease of use influences on attitude towards using contactless technology

According to Ajzen´s (1991) Theory of Planned Behaviour (TPB), behavioural beliefs play a critical role in shaping attitudes toward a behaviour, which can be either favorable or unfavorable. Behavioural intention defines as "the degree to which a person has formulated conscious plans regarding whether to perform a specified future behaviour" (Chai and Dibb, 2014, p3; Esawe 2022). Attitudes are influenced by two key dimensions: the affective dimension (e.g., feelings such as good vs. bad or pleasant vs. unpleasant) and the cognitive dimension, which reflects the utilitarian aspects linked to behavioural beliefs (Fu 2021). These dimensions together provide a holistic understanding of how individuals form attitudes toward specific behaviours.

The TAM extends the TPB by emphasizing the role of perceived usefulness and perceived ease of use in shaping attitudes toward technology adoption. Casalo et al. (2010) explored this relationship in the context of determinants of intention to participate in firm-hosted online tourism communities as well as Balakrishnan et al. (2021) in the context of AI-powered voice assistants (AIVA). Their study found that perceived usefulness, which reflects the degree to which users believe a technology improves their task efficiency, and perceived ease of use, which reflects how effortless users find the technology to use,

both significantly influence attitudes toward adopting AIVAs. The findings also highlighted how AI voice assistants simplify users' lives, thus fostering positive attitudes toward their use.

In the context of contactless services, perceived usefulness likely fosters favourable attitudes by emphasizing the convenience, efficiency, and timesaving benefits these services provide. Similarly, perceived ease of use reduces barriers to adoption by making interactions with the technology seamless and straightforward, encouraging a more positive attitude toward its usage (Duy & Giang 2022).

H4: Perceived usefulness significantly and positively influences attitudes toward using contactless services.

H5: Perceived ease of use significantly and positively influences attitudes toward using contactless services.

2.5. Attitude towards using contactless services influence on behavioural intentions

Behavioural intentions indicate the degree of a person´s commitment to carrying out a particular action. The stronger the intention, the higher the likelihood that the behaviour will be performed, (Ajzen, 1991). In the context of recommended products, key consumer behaviour intentions include the intention to follow advice, the intention to purchase, and intention to recommend. These intentions serve as strong predictors of future consumer behaviour (Flavian et al., 2022).

Law (2021) examined the intention to travel, highlighting that risk perception is a pivotal factor influencing tourists´ decisions to visit a specific destination. The study argues that heightened perceptions of risk can generate negative word-of-mouth, which may, in turn, harm the destination's image and ultimately deter travel intentions (Farrukh et al., 2020).

Intention to follow advice is conceptualized in the present study as the willingness to act on recommendations, comments, and suggestions from other members through digital media services (such as online tourism communities) when purchasing tourism services. In certain industries, the influence of eWOM plays a pivotal role in shaping consumer decision-making (Ruiz-Mafe et al., 2020)

Recommendation is an action closely linked to post-adoption behaviour, often serving as a significant driver for the successful diffusion of new products and services. In today's digital age, consumer recommendations are readily accessible on the Internet, including e-commerce platforms and social networks. These recommendations can facilitate the rapid spread of technologies and strongly influence the behaviour and attitude of other consumers (Ferreira et al., 2023)

Assessing willingness to pay (WTP) is a valid method for understanding consumers' attitudes and perceptions regarding sustainable features in food products. WTP estimates reflect the price premium or the maximum amount a current or prospective consumer is prepared to pay for a product or services (Li & Kallas, 2021). Recent study indicates that consumers who aim to support socially and environmentally responsible businesses are willing to pay a premium for their products (Farzin et al., 2022).

Attitudes toward using a product or service have been shown to significantly influence behavioural intentions. For example, Adu-Gyamfi et al. (2022) found that attitudes positively impacted adoption intentions for battery swap technology for electric vehicles. Similarly, Almajali et al. (2022) demonstrated that attitudes play a significant role in shaping intentions to use cryptocurrency, as supported by the extended Theory of Reasoned Action (TRA).

Tan et al. (2023) applied the extended TPB to predict willingness to pay for green and low-carbon energy transitions. They found that a positive attitude toward promoting Green and Low-Carbon Energy

Transition (GALCET) enhanced consumers' willingness to pay for retrofitting rooftops with solar photovoltaic tiles (SPVT).

H7: Attitudes toward using contactless services significantly and positively influences (a) intention to travel, (b) intention to follow advice, (c) intention to recommend, and (d) willingness to pay more.

3. Methodological approach

Data collection took place from November 22 to 25, 2024, via an online survey conducted in Spanish using the Qualtrics platform. Participants were recruited through Toluna, a well-established provider of online panels specializing in market research. The questionnaire included an introductory section that outlined the study's objectives and guaranteed anonymity to encourage truthful responses, following the recommendations of Podsakoff et al. (2003). To ensure relevance, all participants were required to have prior experience using QR codes.

As this research focuses on how tourists in Spain adopt airline and contactless technologies, it further examines the impact of this adoption on their consumer behavior. PLS-SEM is employed to evaluate the relationships between key constructs and their corresponding indicators, making it especially well-suited for this type of exploratory analysis (Amoah et al., 2021). This approach also enables the study to validate the role of contactless technologies in mitigating perceived risks and enhancing perceived security among users. The analysis was performed using SmartPLS version 4.1.1.4, suitable for analysing complex relationships in non-normal datasets and exploratory models, which was confirmed in this study.

The use of PLS-SEM was justified by the non-normal distribution of the data, consistent with Hair et al. (2011). The study analysed 851 valid responses, with statistical power ensured through G*Power 3.1 analysis, achieving a power level above 99% for the R^2 test, as recommended by Cohen (2013).

Table 1 shows that the respondents (n=851) exhibited a balanced gender distribution, with 53.8% male and 46.2% female. The majority fell within the 35–54 age range (59.6%), while very few were under 25 (0.2%) or over 65 (1.2%). Educational levels were generally high, with 39.4% holding a graduate degree and 11.3% a master's degree. Vocational training was common (27.5%), while fewer participants had secondary (17.4%) or primary education (0.9%). Employment status revealed that most respondents were employees (72.9%), followed by smaller proportions of self-employed individuals (8.9%), unemployed participants (8.8%), and homemakers (5.2%). Students (1.1%) and retirees (3.2%) represented the smallest categories. Income levels were varied, with 23.2% earning €1000–1500 per month and 20.6% earning over €3000. Regarding contactless technology usage, the majority had experience of 1–3 years (35%) or 4–7 years (31%), while smaller groups reported using it for less than 1 year (19%) or over 10 years (8%).

Table 1. **Profile of respondents. (n=851)**

Characteristics		**Frequency**	**Percentage**
Gender			
	Female	393	46.2
	Male	458	53.8
Age			
	Under 25	2	0.2
	24-34	153	18
	35-44	249	29.3
	45-54	258	30.3
	55-64	179	21

	Over 65	10	1.2
Education			
	Primary studies	8	0.9
	Secondary studies	148	17.4
	Vocational courses	234	27.5
	Graduate	335	39.4
	Master´s	96	11.3
	PhD	30	3.5
Current activity/employment			
	Housewife	44	5.2
	Self-employed	76	8.9
	Unemployed	75	8.8
	Employee	620	72.9
	Student	9	1.1
	Retired	27	3.2
Net monthly income			
	Less than 1000€	98	10.4
	1000€ - 1500€	218	23.2
	1501€ - 2000€	200	21.3
	2001€ - 2500€	143	15.2
	2501€ - 3000€	88	9.4
	Over 3000€	194	20.6
Contactless usage			
	Less than 1 year	158	19
	1-3 years	302	35
	4-7 years	266	31
	8-10 years	58	7
	Over 10 years	67	8

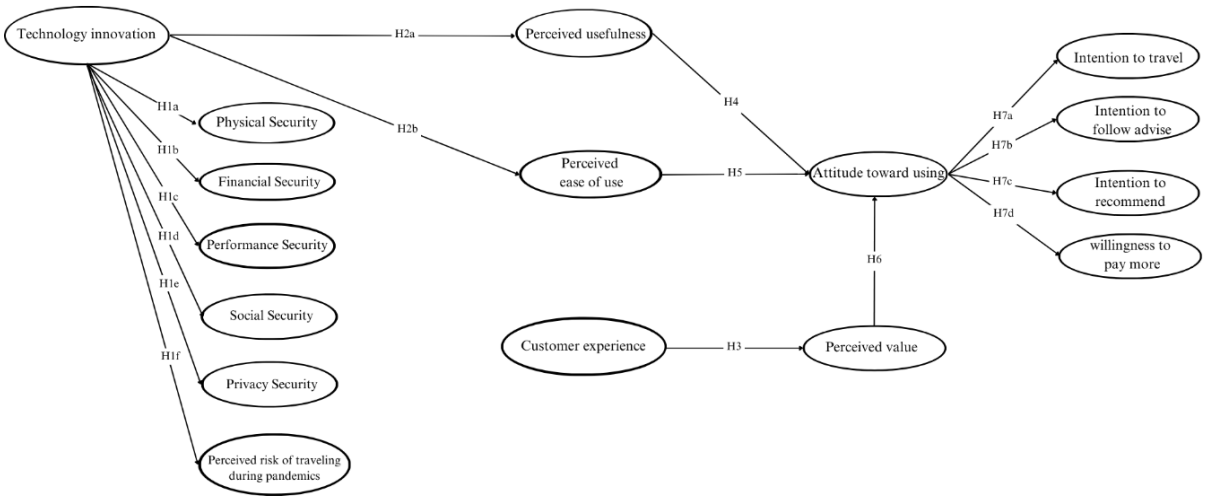
Source: Own research

3.1. Objectives and hypotheses

The primary objective of using PLS-SEM was to assess and validate the intricate relationships among multiple constructs (Hair, 2006), including perceived security, customer experience, perceived value, attitude, and behavioural intentions in the context of contactless airline and hotel services. Given the study's integration of the TAM and TPB. PLS-SEM enabled the researchers to evaluate both the measurement and structural models simultaneously, ensuring robust validation of hypotheses and the overall conceptual framework.

Figure 1 presents the tested model, incorporating scale items adapted from various prior studies. A seven-point Likert scale was utilized, ranging from 1 (strongly disagree) to 7 (strongly agree). Physical security, financial security, and technology innovation were derived from Ali and Ali (2021), while social security was adapted from Yuan et al. (2021). Performance and privacy risks were based on Yi et al. (2019). Items related to the privacy security of traveling during pandemics, intention to travel, and willingness to pay more were adapted from Sánchez-Cañizares et al. (2020). Customer experience was sourced from Hao and Chon (2021), perceived usefulness and perceived ease of use from Cho et al. (2020), perceived value from Han et al. (2016), attitude toward using from Sukendro et al. (2020), and intention to recommend from Casaló et al. (2018).

Figure 1. **Proposed model**



Source: Own research

Several constructs (physical security, social security, financial security, performance security, privacy security, and privacy security of touristsing during pandemics) were initially associated with perceived risks. However, as mentioned earlier, these constructs were modified to fit the context of this study. To ensure clarity and consistency across the scales, the items were reversed to align with the seven-point Likert scale, thereby enhancing comprehension and maintaining uniformity.

3.2. Metrics

Table 2 shows descriptive statistics revealing positive perceptions of contactless airline and hotel services, with high ratings for physical security, social security, financial security, and performance security, reflecting confidence in safety, cost-effectiveness, and functionality. Innovation constructs like technology innovation and customer experience scored well, emphasizing openness to advanced technologies. High scores for perceived usefulness and ease of use indicate satisfaction with practicality and accessibility. However, lower ratings for pandemic-related security reveal ongoing concerns about tourists safety. Overall, participants show strong acceptance of these services with some reservations.

Table 2. **Descriptive analysis**

Construct/Associated Items		**Mean**	**Standard Deviation**
Physical security			
PHS1	Contactless airline and hotel services lead to some comfortable physical effects due to their functionality and use.[R]	5.362	1.483
PHS2	Because contactless airline and hotel services are completely safe, I do not concern about potential physical risk.[R]	5.167	1.425
Social security (SOS)			
SOS1	Using contactless airline and hotel services does not affect my image in the eyes of other.[R, d]	5.240	1.478

SOS2	Choosing contactless airline and hotel services will fit in well with my self-image or self-concept.[R]	5.043	1.396
SOS3	Using contactless airline and hotel services may positively affect the way other think of me.[R, d]	4.622	1.527
Financial security (FIS)			
FIS1	I think that the conception of touristsing using contactless airline and hotel services would be less expensive than I expected. [R,d]	4.603	2.108
FIS2	I think that an additional fee must not be paid for contactless airline and hotel services. [R, d]	5.572	1.684
FIS3	I think that touristsing with contactless airline and hotel services would not involve unexpected extra expenses. [R]	5.362	1.457
Performance security (PES)			
PES1	I think that contactless airline and hotel services would provide me with the level of benefits that I expected it to. [R]	5.073	1.373
PES2	I think that the information on the contactless hotel will be credible with respect to the real accommodation. [R]	5.076	1.360
PES3	I think that the sanitation at the airline and hotel accommodation is beyond expectations when using contactless services. [R]	4.942	1.419
PES4	I think that my request or suggestion at the airline and hotel may be handled promptly when using contactless services. [R]	5.229	1.380
Privacy security (PRS)			
PRS1	Using contactless airline and hotel service may make privacy of payment information controlled. [R]	4.966	1.466
PRS2	If I use contactless airline and hotel service, there won't be a possibility that my personal information may be leaked without my knowledge. [R]	4.790	1.529
PRS3	If I use contactless airline and hotel services, I do not think hackers or criminals will be able to access my account. [R]	4.510	1.608
Perceived security of touristsing during pandemics (PST)			
PST1	Given the current situation, I prefer to avoid touristsing to large cities. [R]	3.898	1.913
PST2	Given the current situation, I prefer to shorten the duration of my potential trips. [R]	3.961	1.888
PST3	I feel more averse to touristsing because of the risk from pandemics. [R]	3.692	1.956
Technology innovation			
TEI1	If I heard about hotel and airline contactless technology, I would look for ways to experiment with it.	5.065	1.358
TEI2	Among my peers, I am usually the first to explore new technology i.e. contactless tourists.	4.420	1.661
TEI3	I like to experiment with new technology, i.e. contactless tourists.	4.831	1.477
TEI4	In general, I am not hesitant to try out new information technologies.	5.031	1.390
TEI5	Compared to my friends, I seek out a lot of information about contactless tourists services.	4.542	1.608

TEI6	I would try contactless airline and hotel services even if in my circle of friends nobody has trialed it before.	5.067	1.461
Customer experience (CUX)			
CUX1	Voice control (voice detection TV)	4.663	1.403
CUX2	Motion-sensing	4.933	1.268
CUX3	Mobile control	4.885	1.311
CUX4	Robotic services (i.e. robotic cleaning service)	4.610	1.358
CUX5	Thermal sensing (airport thermal screening)	4.722	1.330
CUX6	Facial recognition (contactless check-in)	4.973	1.389
CUX7	Auto temperature measurement	4.848	1.371
CUX8	Camera	5.039	1.312
CUX9	5G network and IoT	4.960	1.297
Perceived usefulness (PEU)			
PEU1	Using contactless airline and hotel services improves my tourists experience.	5.007	1.387
PEU2	Using contactless airline and hotel services enhances my effectiveness in touristsing.	5.100	1.348
PEU3	Using contactless airline and hotel services increases my productivity in touristsing.	4.937	1.351
PEU4	Using contactless airline and hotel services is useful for touristsing.	5.341	1.277
Perceived ease of use (PEE)			
PEE1	The contactless airline and hotel services is easy to use.	5.320	1.299
PEE2	Learning to use contactless airline and hotel services is easy.	5.296	1.301
PEE3	Instructions to navigate contactless airline and hotel services are clear and understandable.	5.153	1.342
Perceived value (PEV)			
PEV1	Contactless airline and hotel services offer good value for the money I spend.	4.873	1.369
PEV2	Contactless airline and hotel services provide a good deal compared to traditional booking (i.e. face-to-face counter).	4.939	1.391
Attitude towards using (ATU)			
ATU1	Using contactless airline and hotel services is a good idea for touristsing.	5.174	1.393
ATU2	I think the use of contactless airline and hotel services is a trend when touristsing.	5.255	1.266
ATU3	Contactless airline and hotel services will be compatible with smart devices I use when touristsing.	5.368	1.225
Intention to tourists (INT)			
INT1	I intend to tourists as soon as I can.	5.442	1.449
INT2	If I need to tourists for work in the short/medium term, I intend to do so.	4.981	1.726
INT3	If I need to tourists for leisure in the short/medium term, I intend to do so.	5.592	1.365
Intention to recommend (ITR)			
ITR1	I would likely recommend contactless airline and hotel services to friends and relatives interested in touristsing.	5.183	1.388
Intention to follow advice (ITF)			

ITF1	I would feel comfortable using contactless hotel and airline services as advised by peers and reviews.	5.239	1.356
ITF2	I would not hesitate to take into account the suggestions about the use of contactless airline and hotel services as advised by peers and reviews.	5.311	1.275
ITF3	I would feel secure in following suggestions about using contactless airline and hotel services.	5.280	1.330
ITF4	I would rely on the recommendations about using contactless airline and hotel services.	5.337	1.299
Willingness to pay (WTP)			
WTP1	I am willing to pay more for additional safety measures for the contactless airline and hotel services that serve me during my possible trips.	4.270	1.792
WTP2	I am willing to pay more for additional safety measures in the contactless airline and hotel I use, during my potential trips.	4.276	1.803
WTP3	I am willing to pay more for additional safety measures on the means of technology use during my potential trips.	4.333	1.830

Note: [R] Reversed item. [d] Dropped during the estimation of the measurement model

Source: Own research

3.3. Results: Reliability and validity evaluation

The evaluation of the measurement model focused on reliability and validity. Items SOS1, SOS3 (social security), and FIS1, FIS2 (financial security) were excluded for failing to meet the 0.7 loading threshold, as per Hair et al. (2011). Construct reliability was confirmed through Cronbach's alpha and composite reliability coefficients, all exceeding established thresholds, ensuring consistent measurement of constructs (Hair et al., 2006; Bagozzi & Yi, 1988; Fornell & Larcker, 1981).

Convergent validity was supported by AVE values surpassing the 0.50 benchmark (Fornell & Larcker, 1981). Discriminant validity was verified using AVE comparisons, confirming constructs' distinctiveness, and further supported by the HTMT ratio, with all values below 0.90 (Henseler et al., 2016; Teo et al., 2008). These evaluations underscore the robustness of the measurement model, as detailed in Tables 3 and 4.

Table 1. **Reliability and convergent validity of the final measurement model**

Factor	Indicator	Standardized loading	t-Value	CA	rho_A	CR	AVE
Attitude towards using	ATU1	0.885	41.824	0.862	0.862	0.915	0.783
	ATU2	0.884	44.145				
	ATU3	0.885	35.670				
Customer experience	CUX1	0.791	29.748	0.925	0.926	0.938	0.626
	CUX2	0.847	31.689				
	CUX3	0.803	25.567				
	CUX4	0.762	21.948				
	CUX5	0.819	25.962				
	CUX6	0.799	24.795				
	CUX7	0.802	24.363				
	CUX8	0.767	23.854				
	CUX9	0.728	17.850				

Financial security	FIS3	1.000	n/a				
Intention to tourists	INT1	0.886	21.074	0.784	0.796	0.876	0.703
	INT2	0.732	16.141				
	INT3	0.887	22.877				
Intention to follow advice	ITF1	0.874	40.440	0.915	0.915	0.940	0.796
	ITF2	0.892	41.462				
	ITF3	0.901	48.703				
	ITF4	0.901	44.155				
Intention to recommend	ITR1	1.000	n/a				
Perceived ease of use	PEE1	0.876	34.963	0.911	0.913	0.937	0.789
	PEE2	0.891	38.252				
	PEE3	0.902	61.917				
	PEE4	0.884	48.447				
Performance security	PES1	0.816	26.181	0.839	0.841	0.892	0.675
	PES2	0.867	31.742				
	PES3	0.808	26.163				
	PES4	0.792	22.273				
Perceived usefulness	PEU1	0.884	50.557	0.901	0.902	0.931	0.772
	PEU2	0.915	49.028				
	PEU3	0.856	46.892				
	PEU4	0.858	42.092				
Perceived value	PEV1	0.919	48.008	0.813	0.813	0.915	0.843
	PEV2	0.917	38.656				
Physical security	PHS1	0.890	22.706	0.748	0.748	0.888	0.799
	PHS2	0.897	34.994				
Privacy security	PRS1	0.856	29.990	0.823	0.838	0.894	0.738
	PRS2	0.911	18.481				
	PRS3	0.806	19.753				
Perceived security of touristsing during pandemics	PST1	0.923	18.626	0.903	0.910	0.939	0.837
	PST2	0.936	12.615				
	PST3	0.886	n/a				
Social security	SOS2	1.000	46.500				
Technology innovation	TEI1	0.799	23.188	0.901	0.906	0.924	0.669
	TEI2	0.806	42.290				
	TEI3	0.878	34.274				
	TEI4	0.814	23.020				
	TEI5	0.801	35.422				
	TEI6	0.808	43.582				
Willingness to pay	WTP1	0.943	48.512	0.949	0.950	0.967	0.907
	WTP2	0.960	46.758				
	WTP3	0.954	22.552				

Note: All loadings are significant at $p < .01$ level. CA = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted.

Source: Own research

Table 2**. Measurement Model Discriminant Validity (HTMT and Fornell-Larcker).**

Factor		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	ATU	0.885	0.639	0.504	0.494	0.771	0.679	0.781	0.702	0.788	0.718	0.592	0.541	0.085	0.539	0.670	0.349
2	CUX	0.715	0.791	0.385	0.464	0.669	0.575	0.637	0.623	0.701	0.670	0.502	0.556	0.326	0.506	0.709	0.516
3	FIS	0.543	0.401	1.000	0.334	0.487	0.406	0.512	0.587	0.513	0.418	0.479	0.470	0.095	0.403	0.439	0.180
4	INT	0.598	0.548	0.375	0.838	0.539	0.525	0.512	0.407	0.508	0.419	0.400	0.268	-0.085	0.392	0.500	0.238
5	ITF	0.869	0.726	0.510	0.634	0.892	0.775	0.749	0.662	0.764	0.697	0.580	0.569	0.109	0.568	0.689	0.405
6	ITR1	0.731	0.597	0.406	0.590	0.811	1.000	0.685	0.571	0.710	0.646	0.544	0.459	0.076	0.528	0.637	0.377
7	PEE	0.882	0.693	0.537	0.605	0.819	0.716	0.888	0.657	0.775	0.708	0.598	0.556	0.094	0.533	0.694	0.332
8	PES	0.825	0.705	0.641	0.504	0.755	0.624	0.751	0.821	0.732	0.678	0.635	0.662	0.262	0.604	0.660	0.429
9	PEU	0.892	0.767	0.540	0.605	0.841	0.748	0.854	0.842	0.879	0.749	0.629	0.591	0.123	0.625	0.731	0.408
10	PEV	0.857	0.772	0.464	0.529	0.808	0.716	0.821	0.820	0.875	0.918	0.530	0.617	0.233	0.532	0.688	0.512
11	PHS	0.737	0.603	0.553	0.521	0.701	0.630	0.726	0.803	0.766	0.679	0.894	0.527	0.102	0.610	0.551	0.274
12	PRS	0.628	0.632	0.509	0.320	0.643	0.493	0.627	0.789	0.673	0.748	0.655	0.859	0.351	0.482	0.593	0.443
13	PST	0.098	0.356	0.098	0.166	0.117	0.078	0.103	0.299	0.140	0.270	0.121	0.421	0.915	0.114	0.261	0.414
14	SOS	0.580	0.526	0.403	0.445	0.595	0.528	0.559	0.659	0.659	0.589	0.706	0.525	0.119	1.000	0.600	0.301
15	TEI	0.745	0.773	0.453	0.597	0.748	0.664	0.754	0.750	0.800	0.798	0.660	0.676	0.297	0.627	0.818	0.514
16	WTP	0.384	0.551	0.184	0.284	0.434	0.387	0.354	0.480	0.442	0.582	0.323	0.509	0.449	0.309	0.561	0.952

Note: Diagonal values are Fornell-Larcker square root.

Source: Own research

3.4. Results: Structural model

The model's explanatory power was assessed using R^2 values, with all dependent constructs exceeding the 0.10 threshold recommended by Falk and Miller (1992), indicating sufficient explanatory strength. Predictive relevance was confirmed through Stone-Geisser's Q^2 values, calculated using the blindfolding technique with an omission distance of 10. The positive Q^2 values validate the model's ability

to predict outcomes. A detailed breakdown of these indicators is presented in Table 5. Results for these indicators are detailed in Table 6.

Table 3. **Evaluation of the estimated models**

Concept	R^2	Q^2
ATU	0.658	0.479
FIS	0.193	0.190
INT	0.269	0.240
ITF	0.617	0.498
ITR1	0.520	0.406
PEE	0.482	0.480
PES	0.436	0.433
PEU	0.535	0.533
PEV	0.449	0.446
PHS	0.304	0.301
PRS	0.352	0.349
PST	0.068	0.065
SOS	0.360	0.359
WTP	0.264	0.221

Source: Own research

Bootstrapping, using individual sign changes across 5,000 samples, was conducted to determine the statistical significance of the hypothesized relationships. The results demonstrate that technology innovation significantly impacts various security dimensions, including physical security, financial security, performance security, social security, privacy security, and perceived security of touristsing during pandemics (H1a-H1f; β = 0.029, 0.032, 0.024, 0.025, 0.029, 0.037, respectively). Additionally, technology innovation positively influences perceived usefulness and perceived ease of use (H2a, H2b; β = 0.019, 0.022). Furthermore, customer experience was found to have a positive effect on perceived value (H3; β = 0.024). Perceived usefulness, perceived ease of use, and perceived value were also observed to have a significant positive effect on the attitude towards using contactless services (H4, H5, H6; β = 0.047, 0.053, 0.042). Finally, attitude towards using contactless services significantly influenced subsequent behavioural intentions, such as intention to tourists, intention to follow advice, intention to recommend, and willingness to pay more for additional safety measures (H7a-H7d; β = 0.034, 0.020, 0.024, 0.034). All relationships were found to be statistically significant, with p-values below the 0.01 threshold.

Table 4. **Hypotheses testing**

Hypothesis	Path	Standarized Path Coefficients	t-Value (Bootstrap)	P values
H1a	Technology innovation -> Physical security	0.029	19.223	0.000
H1b	Technology innovation -> Financial security	0.032	13.548	0.000
H1c	Technology innovation -> Performance security	0.024	27.090	0.000
H1d	Technology innovation -> Social security	0.025	23.860	0.000

H1e	Technology innovation -> Privacy security	0.029	20.322	0.000
H1f	Technology innovation -> Perceived security of touristsing during pandemics	0.037	7.083	0.000
H2a	Technology innovation -> Perceived usefulness	0.019	37.649	0.000
H2b	Technology innovation -> Perceived ease of use	0.022	32.201	0.000
H3	Customer experience -> Perceived value	0.024	27.776	0.000
H4	Perceived usefulness -> Attitude toward using	0.047	7.772	0.000
H5	Perceived ease of use -> Attitude toward using	0.053	6.980	0.000
H6	Perceived value -> Attitude toward using	0.042	4.338	0.000
H7a	Attitude toward using -> Intention to tourists	0.034	14.477	0.000
H7b	Attitude toward using -> Intention to follow advice	0.020	38.217	0.000
H7c	Attitude toward using -> Intention to recommend	0.024	27.857	0.000
H7d	Attitude toward using -> Willingness to pay more	0.034	10.419	0.000

Note: All loadings are significant at $p < .01$ level.

Source: Own research

4. Discussion

This study provides significant theoretical contributions, especially in the areas of technology innovation, perceived risks, and consumer behaviour in the context of contactless services. By incorporating theoretical frameworks from TAM and the TPB, it offers new insights into how technological advancements shape perceived security, perceived value, and behavioural intentions in the tourist's industry. A recent study reveal that the critical role of the TAM constructs (perceived usefulness and perceived ease of use) is identified having significant influence of perceived security and trust on users' attitudes and intentions (Shin, 2009; Alaeddin et al., 2018), making it appropriate to incorporate in this research.

The first contribution of this study is concerning the significant impact of technology innovation on various aspects of perceived security, including physical, financial, performance, social, and privacy security, and the perceived security of traveling during pandemics. While prior research has explored how innovation reduces uncertainty (Shin & Kang, 2020; Makki et al., 2016), this study advances the discussion by empirically validating the role of technology-driven security features in shaping consumer confidence in contactless services. The findings highlight that technological solutions, such as keyless entry, robotic sanitation, effectively reduce perceived risks and enhance user's trust, supporting hypotheses from H1a to H1f.

The second main contribution of this research is its regarding the positive impact of technology innovation on perceived usefulness and perceived ease of use, fundamental constructs of the TAM. While

this aligns with previous research (Loh et al., 2019; Alalwan et al., 2018), it specifically highlights the impact within the context of contactless travel services. The findings reinforce that technological advancements not only improve efficiency but also minimize cognitive effort, facilitating a smoother adoption process, supporting the hypothesis H2a and H2b.

The third major contribution of this study lies in the exploration of customer experience and its influence on perceived value (H3). While prior research emphasizes the role of perceived experience in service settings (Paulose & Shakeel, 2021), this study specifically situates it within the context of contactless airline and hotel services. The findings reveal that customer interactions with features such as mobile-controlled check-ins, robotic services, and biometric authentication enhance perceived value, further reinforcing the connection between experiential satisfaction and consumer decision-making.

The fourth theoretical contribution centres on the determinants of attitude of behavioural intention. In line with TPB and TAM, this study confirms that perceived usefulness, perceived ease of use, and perceived value play a crucial role in shaping attitudes toward using contactless services (H4-H6). These attitudes, in turn significantly influence behavioural intentions, including the intention to travel, follow advice, intention to recommend, and willingness to pay more for additional security services (H7a-H7d). These findings provide empirical validation for the integration of TAM and TPB, demonstrating how attitudes toward using technological service drive consumers' behaviour in the travel industry. This finding corroborates with the recent study at the time of this research by Khajehshahkoohi et al. (2022), regarding the factors affecting the behavioural intention of tourists on the use of bike sharing in tourism areas. The authors combined the TAM and the TPB, their research highlights that a well-designed bike sharing system with user-friendly technology and environmental benefits can enhance tourists´ willingness to adopt them, supporting sustainable tourism initiatives.

Finally, this study makes a significant contribution by connecting technology acceptance with pandemic-related security concerns. While previous research (Neuberger & Egger, 2021) highlights the influence of perceived risks on travel behaviour, this study expands on their findings by demonstrating how technology innovation helps mitigate these risks and encourages greater travel intentions. By establishing these connections, the research provides valuable insights for service providers seeking to enhance consumer confidence in digital and contactless tourism solutions.

5. Conclusion

Quantitative analysis using PLS-SEM to assess the relationships between constructs and their associated indicators, making it particularly suitable for exploratory research (Amoah et al., 2021), and validates the role of contactless technologies in addressing perceived risks and subsequently enhancing perceived security. It reinforces the relevance of TAM by demonstrating that innovations influence both perceived usefulness and perceived ease of use, facilitating adoption. This research highlights the importance of enhanced customer experience while using contactless technologies, in driving perceived value. By integrating TAM and TPB, the study shows that consumer attitude significantly shapes behavioural intentions, including travel intentions, intention to recommend contactless technologies, intention to follow advice, and willingness to pay for additional safety measures through contactless technologies.

5.1. Practical implications

The findings of this study offer practical implications for tourism and hospitality professionals managing contactless services. Prioritizing advanced security features can add value to the customer experience and facilitates loyalty of customers (Gupta et al., 2023).

Developers of these contactless services, such as mobile applications to carry out hotel and airline-check-ins should be meticulous in designing interface and the customer journey with the objective of making it more user-friendly (Medeiros et al., 2022), ensuring ease of use are crucial for improving customer experience and perceived value. Emphasizing the benefits of contactless services, such as convenience and efficiency, can encourage adoption. Hotel and airline mobile applications can also include real-time weather information, and airport e-maps available in airline applications to expedite the flight transfers of tourists; these features already exist in smart tourism as detailed by Tavitiyaman et al. (2021).

Managers should recognize that customers' past experiences with technology play a crucial role in shaping their willingness to adopt and use similar technologies in the future (Shin et al., 2021). A seamless and positive experience with travel apps (whether it would be hotel digital check-ins or airline flight management app) can increase confidence and encourage repeat usage. Subsequently, frustrations with complex interfaces or unreliable technology may lead to reluctance in adopting new travel-related innovations. By understanding how past experiences shape tourists' behavioural intentions, businesses can develop targeted marketing strategies that enhance engagement and adoption.

For example, airline companies can highlight their app's user-friendly features, offer personalized recommendations, provide easy access customer support, or showcase positive reviews to reassure hesitant tourists. Aligning marketing efforts with tourists' technological experiences can ultimately drive high adoption of digital travel solutions and improve customer satisfaction (Lai & Chen, 2011). Furthermore, based on this study, when tourists feel positive in using contactless technologies, this attitude depends on their past experience, and the functionality of the i.e. airline applications, whether it is easy to use and perceived as useful, the customer is willing to pay more for additional cost of innovation to improve their experience.

In the post-pandemic era, professionals should innovate and adapt services to meet evolving preferences. Collaborating with technology providers can help companies stay competitive. Hotels need to promote keyless entry, and their strict compliance with hygiene protocols to improve their guests´ perceived security to stay in their premises. Airlines should also emphasize on their data privacy as they deal with passengers' personal data in each transactions and when using contactless boarding.

By considering these implications, industry stakeholders can enhance customer satisfaction and drive business growth.

5.2. Limitations and future research areas

It is essential to recognize the limitations of this study as they provide a foundation for future research endeavours. Firstly, this research focuses on specific relationships within a proposed model, leaving several connections unexplored. Building on previous insights of studies such as contactless services by Hao (2022), Davis et al.'s Technology Acceptance Model (1989), and Ajzen's Theory of Planned Behaviour (1991). Future research could further examine the nuanced relationships within the TAM and TPB framework. Notably, this study did not explore certain aspects of TPB, such as subjective to norm and perceived behavioural control. Future studies could delve into unexplored links to provide a more comprehensive understanding of user behaviour in the context of contactless services, not limited to hotel and airline industries.

Additionally, other potential connections deserve further explorations. Hao (2022) examined the acceptance of contactless technology in the hospitality industry, using UTAUT and UTAUT2 linking to behavioural intentions. Future studies can use the same framework but involving contactless airline services.

Moreover, this study's sample was limited to Spain. Future research could explore different countries or conduct regional comparisons to assess how socio-demographic as mediating factors influence decision-making in adopting contactless technologies.

In conclusion, while this study provides valuable insights into contactless airline and hotel services, there remain uncharted territories and evolving behaviours that warrant further exploration. Acknowledging the importance of addressing these limitations and uncharted territories, future studies should aim to build on the behavioural intervention strategies presented in this research, extending their application to a broader range of tourist settings and behaviours, ultimately contributing to the innovation of the travel industry.

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Brief description of Author/Authors:

Mary Grace Burkett, PhD Candidate
ORCID ID: https://orcid.org/0009-0006-1503-6606
Affiliation: Marketing Department, Faculty of Commerce and Tourism, Complutense University of Madrid, Av. de Filipinas, 3, Chamberí, 28003 Madrid, www.ucm.es.
Email: mburkett@ucm.es
PhD candidate and experienced Marketing Consultant with a solid background in management consulting. Holds two Master's degrees in Innovation and Tourism Marketing and in EU Studies and Human Rights from UCAM, Spain. Her research focuses on immersive technologies and innovation. Awarded Best Paper (Senior Category) at AIRSI2025 for work on immersive technologies in marketing and tourism.

Nuria Recuero-Virto, Associate Professor
ORCID ID: https://orcid.org/0000-0002-5346-9502
Affiliation: Marketing Department, Faculty of Commerce and Tourism,Complutense University of Madrid, Av. de Filipinas, 3, Chamberí, 28003 Madrid, www.ucm.es.
Email: nrecuero@ucm.es
Associate Professor at Universidad Complutense de Madrid. She was awarded a Postdoctoral Scholarship (2014-2018) and a Predoctoral Scholarship (2010-2014). Given this background, her specific areas of interest are cultural tourism marketing, edtech, and neuromarketing. She has received multiple academic awards of excellence, including AIRSI2025 for Best Paper, Senior Category, in Immersive Technologies, AIRSI2021 for Best Extended Abstract, the ESIC AEDEM award for Best Marketing Research in 2017, and being a finalist for the Award Tribuna FITUR Jorge Vila Fradera for the best doctoral thesis.