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The role of technology in enhancing the tourism experience in smart destinations: A meta-analysis

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ABSTRACT

An increasing number of destinations are using smart technology to enrich the travel experience. The aim of this paper is to integrate the findings about how technology affects the tourism experience in smart destinations to provide an overview of its impact. Meta-analysis allows this question to be addressed in a transparent, objective and replicable way by providing unified conclusions based on previous studies that answer similar research questions. In this work, we used a random-effects meta-analysis model estimated with the restricted maximum likelihood method. The results confirm the positive relationship between smart technology and tourism experience, with informativeness and interactivity as the most influential attributes. In addition, there is a negative relationship between security and privacy concerns. This study will help destination managers understand the true scope of smart technology for creating value in the tourism experience and implementing measures to enhance it, thereby increasing visitor satisfaction and earning loyalty.

1. Introduction

In recent years, we have witnessed the widespread use of smart label (Gretzel, Sigala, Xiang, & Koo, 2015; Koo, Shin, Gretzel, Hunter, & Chung, 2016) applied to technology, buildings, cities (Albino, Berardi, & Dangelico, 2015; Vanolo, 2014) and tourism, where they have received a large amount of interest. Within the smart paradigm, smart destinations are understood as a new ecosystem (Boes, Buhalis, & Inversini, 2016; Gretzel, Werthner, Koo, & Lamsfus, 2015). Based on an innovative, accessible tourist space consolidated on a cutting-edge technological infrastructure that guarantees the sustainable development of the territory, smart destinations facilitate tourists' interaction and integration within the environment and improve visitors' experience with destinations as well as residents' quality of life (Segittur, 2015).

Smart destinations are underpinned by the implementation of advanced technological tools. This allows both demand and supply to co-create value and enrich tourists' experiences (Ballina, Valdés, & Del Valle, 2019) while generating benefits and competitive advantages for businesses and destinations (Boes, Buhalis, & Inversini, 2015). Smart tourism technologies (STTs) have changed the way visitors experience destinations (Ayeh, 2018). The internet, mobile devices and social media have enabled businesses and consumers to connect, interact, create and share experiences on an unprecedented scale (Neuhofer, Buhalis, & Ladkin, 2015). Moreover, consumed products are becoming increasingly personalised as tourists interact with the destination through portable and ubiquitous technological developments (Shoval & Birenboim, 2019).

Tourism research has emphasised the role of information and communication technologies (ICTs) in enhancing the tourism experience (Neuhofer, Buhalis, & Ladkin, 2012; Tussyadiah & Fesenmaier, 2009; Wang, Park, & Fesenmaier, 2012) and has largely focused on their positive effects (Egger, Lei, & Wassler, 2020). However, recent studies have highlighted potentially negative impacts, such as issues related to privacy and exclusion (Buhalis, 2019), the digital divide (Sigala, 2020), distraction (Ayeh, 2018) and even alienation and loss of authenticity (Tribe & Mkono, 2017). Therefore, there is a need to provide a unified conclusion that may reveal the true extent of STT in creating the tourism experience.

The main aim of this study is to integrate the findings about how technology affects the tourism experience in smart destinations to provide an overview of its impact. A meta-analysis was conducted to synthesise (Borenstein, Hedges, Higgins, & Rothstein, 2009) the

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quantitative results of the available scientific evidence on this topic in a transparent, objective and replicable way. Combining data from multiple previous studies increases the statistical power and generalisability of the findings (Higgins et al., 2019; Lipsey & Wilson, 2001), which leads to more precise estimates. As specific objectives, the role of STT attributes as well as security and privacy concerns on tourism experience are investigated. Furthermore, the study explores the existence of qualitative moderator variables, such as the year of previous studies, their geographical origin, and the country's level of ICT readiness, which could potentially affect the results.

To the best of our knowledge, this study is the first to provide a more comprehensive and precise estimate of the impact of smart technology on the tourism experience, thereby contributing to the existing body of knowledge. Additionally, it can inform evidence-based decision-making and guide future research.

2. Theoretical background and hypotheses development

The concept of a smart destination is closely linked to that of the smart city, a renewed approach to urban planning and management (Ivars-Baidal & Vera-Rebollo, 2019) whose strategy is based on the use of ICTs in key areas such as the economy, environment, mobility and governance to transform city infrastructures and services (Bakıcı, Almirall, & Wareham, 2013). As smart cities adopt technologies to increase the quality of life of residents, tourist destinations are also beginning to improve the travel experience of tourists and the competitiveness of the destination, thus becoming smart tourism destinations (Buhalis & Amaranggana, 2013). It is therefore essential to delimit the concepts of experience and technology in the context of smart destinations.

2.1. Smart tourism experience

The idea of creating an enriching and memorable experience for consumers is a recurring concept in the tourism industry (Neuhofer et al., 2012; Uriely, 2005). The tourism experience has been described as a set of sensations, experiences and emotions subjectively perceived by tourists (Tung & Ritchie, 2011). Pine and Gilmore (1998) operationalised experience into four dimensions: education, escapism, aesthetics and entertainment. Passive tourist participation in the destination's offerings characterises the entertainment and aesthetic dimensions, while the educational and escapist dimensions involve active participation (Oh, Fiore, & Jeoung, 2007). Moreover, the experience is not limited to staying at the destination but also occurs before, during and after the trip (Buhalis & Amaranggana, 2015; Wang et al., 2012; Xiang, Wang, O'Leary, & Fesenmaier, 2015). Tourists evaluate their own tourism experiences and selectively create memorable experiences (Tung & Ritchie, 2011), which are positively remembered and recalled after the event has occurred. Memorable experiences involve hedonism, refreshment, local culture, meaningfulness, knowledge, involvement, and novelty (Kim, Ritchie, & McCormick, 2012) while influencing tourists' behaviours, such as revisit intention, and shaping destination marketing (Hosseini, Cortes Macias, & Almeida Garcia, 2021).

According to Neuhofer et al. (2012), two major changes have drastically altered the nature of experiences: on the one hand, consumers have begun to play an active role in the co-creation of their own experiences; on the other hand, STT increasingly impacts experiences and is a key instrument in creating richer experiences and adding value for the consumer (Gretzel, Sigala, et al., 2015). In this context, the smart tourism experience refers to the use of advanced digital technologies to enhance the quality and personalisation of the travel experience. This includes tailoring tourism services based on individual tourists' needs and preferences, using real-time information to improve decision-making, and enabling interaction with the tourism environment through mobile devices and other digital means (Buhalis & Amaranggana, 2015). In essence, the use of technology seeks to create more attractive, efficient, and customised experiences for tourists. Thus, the main attributes of the smart tourism experience differ from those of the traditional experience (Lee & Jan 2022) with regard to: aesthetics, the virtual/augmented reality presence, usefulness, ease of use, hedonic experience, trust, and the learning experience.

In general, the literature largely neglects negative experiences (Hosany, Sthapit, & Björk, 2022) and uncritically assumes an automated technology-enhanced tourism experience (Neuhofer et al., 2015). However, works such as Neuhofer (2016) and Tanti and Buhalis (2016) suggest that the excessive use of technology may diminish the quality of the travel experience, creating barriers to escapism and a "momentary mental absence" when tourists interact online. Visitors' intention to preserve memories through mobile devices may prevent them from remembering the experience itself (Soares & Storm, 2018; Tamir, Templeton, Ward, & Zaki, 2018). Furthermore, hyperconnectivity and sharing the experience can be detrimental to tourists' enjoyment (Barasch, Zauberman, & Diehl, 2018). Smart tourists may risk alienation (Tribe & Mkono, 2017) and miss out on potentially enriching experiences. Gretzel, Reino, Kopera, and Koo (2015) point to several negative emotions, such as potential cognitive overload, and new terms have emerged, such as technostress or technological stress (Meuter, Ostrom, Bitner, & Roundtree, 2003) and the need for digital detox and disconnection (Dickinson, Hibbert, & Filimonau, 2016; Neuhofer & Ladkin, 2017).

2.2. Smart tourism technology

The rapid evolution of the internet and ICTs in the last decade has profoundly transformed travel, tourism (Xiang et al., 2015), and the way tourists live various types of experiences (Soliman, Cardoso, Almeida, Araújo, & Araújo Vila, 2021). According to Pai, Kang, Liu, and Zheng (2021), STTs are the basic infrastructure that integrates hardware, software and networks, travel services, and ICTs to provide real-time data to facilitate smarter decision-making by destination stakeholders. They include a variety of solutions, such as the internet of things (IoT), cloud computing, artificial intelligence, mobile devices and applications, big data, Wi-Fi, virtual reality, augmented reality, chatbots, wearable devices, QR codes, near field communication (NFC), radio frequency identification (RFID), social networks and beacons (Gajdošík & Orelová, 2020; Shen, Sotiriadis, & Zhang, 2020; Wang, Li, & Li, 2013). Overall, STTs encompass a broad range of applications that can enrich tourists' experiences while also generating additional value (Neuhofer et al., 2015). With their extended reach, useful information, increased flexibility, and decision support, STT can facilitate a more seamless and enjoyable travel experience (Gretzel, Werthner, et al., 2015). Therefore, the following hypothesis is proposed:

H1. STT has a positive effect on the tourism experience in smart destinations.

Several authors (Huang, Goo, Nam, & Yoo, 2017; Jeong & Shin, 2020; Lee, Lee, Chung, & Koo, 2018; No & Kim, 2015) consider STT to be a multidimensional constructs and evaluate its effectiveness for destinations based on four attributes: accessibility, informativeness, interactivity and personalisation. Accessibility is the degree to which tourists can obtain and use tourism information online (Um & Chung, 2021) and is a crucial element in the co-creation of tourist experiences (Buhalis & Amaranggana, 2013). Pai, Liu, Kang, and Dai (2020) demonstrated that accessibility was the most significant factor that influenced both the STT experience and tourist satisfaction. Lee et al. (2018) described informativeness as the volume, frequency, veracity, and accuracy of information. Informativeness reduces the time and energy spent searching for information and increases tourists' satisfaction with their experience (Pai et al., 2020). Interactivity is the degree to which smart technologies can actively provide real-time information to visitors (Huang et al., 2017). This attribute enhances two-way communication, connects all users, encourages visitors to explore, and improves their travel

experience (Gretzel, Sigala, et al., 2015). Personalisation makes it possible to provide tourists with proposals adequate for their needs (Buhalis & Amaranggana, 2015). Providing personalised services in smart destinations is an effective means of maximising the tourism experience as it enables destinations to tailor the information they provide (Jeong & Shin, 2020). This leads us to explore the following hypotheses:

H2. STT attributes have a positive effect on the tourism experience in smart destinations. Specifically, (**a**) accessibility, (**b**) informativeness, (**c**) interactivity and (**d**) personalisation are positively related to the tourism experience in smart destinations.

Tourists tend to use STT when they feel their personal information is safe (Pai et al., 2020). Security is defined as the safety of personal data while using STTs (Huang et al., 2017). González-Reverté, Díaz-Luque, Gomis-López, and Morales-Pérez (2018), Huang et al. (2017), and Xiang et al. (2015), among others, warn of potential privacy risks related to the sharing of personal data that may affect the use of smart technologies and even the destination's capacity to attract tourists (Jeong & Shin, 2020). Hence, the following hypothesis is suggested:

H3. Security/privacy concerns negatively impact the tourism experience in smart destinations.

Additionally, several moderating variables can help to explain the differences in effect sizes across studies (Borenstein et al., 2009): the year of publication, the study's geographical origin and the country's level of ICT readiness. Therefore, the research suggests the following:

H4. The year of the study has a moderating effect on the relationship between STT and tourism experience in smart destinations.

H5. The geographical origin of the study has a moderating effect on the relationship between STT and tourism experience in smart destinations.

H6. ICT readiness has a moderating effect on the relationship between STT and tourism experience in smart destinations (see Fig. 1).

3. Materials and methods

The existence of several studies that answer similar research questions and that sometimes present contradictory results in terms of the magnitudes or even the direction of the effects leads to the need for a unified conclusion. This is precisely the aim of meta-analysis (Glass, 1976): to provide a quantitative synthesis of the results across different studies to determine the overall effect size and its significance.

3.1. Study selection criteria

A systematic review was conducted in Scopus and the Web of Science following the guidelines of the PRISMA statement (Page et al., 2021) to identify the primary studies on the topic of smart destinations, STT, and tourist experience. The search strategy used the following query string: ("smart destination*" OR "smart touris*" OR "smart cit*") AND ("app*" OR "artificial intelligence" OR "augmented reality" OR "beacon*" OR "big data" OR "chatbot*" OR "cloud" OR "connectivity" OR "device" OR "digital*" OR "gamification" OR "ict" OR "information and communication technolog*" OR "intelligen*" OR "internet" OR "IoT" OR "mobile" OR "near field communication*" OR "NFC" OR "QR" OR "radio frequency identification" OR "RFID" OR "sensor*" OR "smart*" OR "social media" OR "social network*" OR "technolog*" OR "virtual reality" OR "wearable*" OR "Wi-Fi") AND ("touris* experience*" OR "travel* experience*" OR "visit* experience*" OR "trip experience*" OR "smart* experience*" OR "better experience*" OR "enhanc* experience*" OR "enrich* experience*" OR "quality experience*" OR "memorable experience*"). No time range was set, and publications indexed until April 24, 2023, the date of the search, were collected. Titles and abstracts were screened, and only records related to STT and the tourism experience in smart destinations were sought for retrieval. This search accounted for possible variations in the definition of a destination. In addition, studies had to meet several inclusion criteria to be eligible (Higgins et al., 2019): (1) journal articles, book chapters and conference proceedings were included; (2) only documents in English and Spanish were considered; (3) only selected empirical studies reporting correlation or regression coefficients as well as sample size were included. After the selection process, 37 papers were included in the meta-analysis (see Appendix B), providing data from a combined total of 14,276 surveys conducted in 14 different countries. The sample size of the publications studied ranged from 112 (Zadel, Honovic, & Badurina, 2020) to 1052 (Ranasinghe, Danthanarayana, Ranaweera, & Idroos, 2020), with an average of 386. Fig. 2 shows the entire process in detail.

3.2. Calculating the effect size and statistical analysis

One of the key issues is to define an effect size (and its corresponding standard error) capable of representing the quantitative results of the set of research studies in a standardised way to allow their comparison and analysis (Lipsey & Wilson, 2001). In our case, as we are dealing with studies that provide results on the association between two quantitative variables, the effect size index belongs to the *r* family, which is particularly suitable for correlational studies (Botella & Gambara, 2006). Thus, it was decided to use the *t*-value, *p*-value, Pearson's correlation coefficient, standardised regression coefficients and standardised structural estimates as metric variables to estimate the effect size.

The effect size values and their variances were calculated using David Wilson's[1] online calculator. In cases where there was more than one effect size for a construct within the same study, they were averaged (Lipsey & Wilson, 2001). Following the methodology of Borenstein et al. (2009), the *r*-value of each study was converted using Fisher's *z* transformation for the statistical analysis. To present and interpret the results, the transformed values were converted back to the original metric using the inverse *z* transformation (Hedges & Olkin, 1985; Lipsey & Wilson, 2001).

This study assumed that primary studies differ from each other due to two sources of variability: one is sampling error (within-study variance, σ_j^2) and the other is that each study estimates a parametric effect of its own (between-study variance, τ^2) (Field, 2003; Schmidt, Oh, & Hayes, 2009). Therefore, the random effects model was used because it accounts for these two components of variability (Borenstein et al., 2009). σ_j^2 were assumed to be known by design, while τ^2 was estimated from the sample of the effect sizes.

The mean effect size estimate was computed as the weighted average of the study-specific effect sizes, with larger weights given to more precise (larger) studies. There are several ways to estimate the weights w_j, although the most general approach assumes that in random effects models, the weights are inversely related to the total variance, $w_j = 1/(\sigma_j^2 + \tau^2)$. To estimate τ^2, this research used the restricted maximum likelihood method (REML) (Raudenbush, 2009), which assumes that the distribution of random effects is normal (see Appendix A) and produces an unbiased and nonnegative estimate of τ^2. Stata 16.1 was used for the analysis.

4. Results

The meta-analysis results are graphically represented by the forest plot (Lewis & Clarke, 2001) in Fig. 3. It reports the individual effect sizes, the mean effect size and confidence intervals, and various

[1] Practical Meta-Analysis Effect Size Calculator (https://www.campbellcollaboration.org/escalc/html/EffectSizeCalculator-R-main.php).

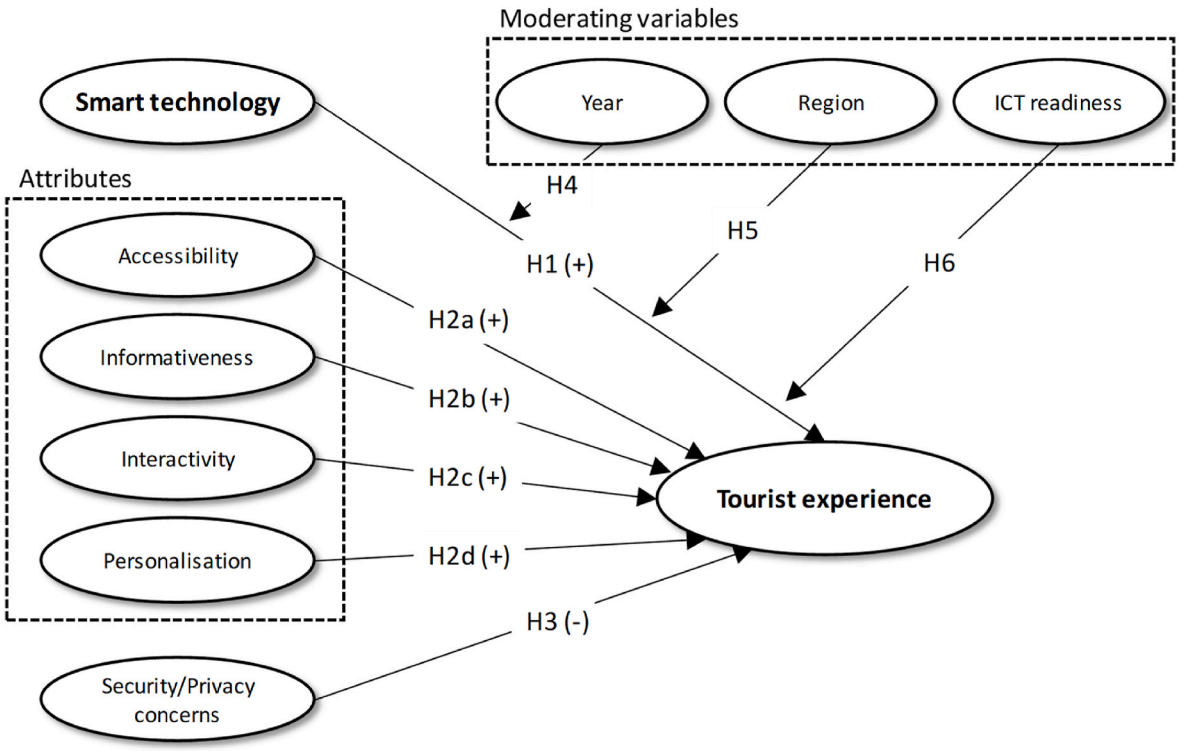

Fig. 1. Proposed research framework.

heterogeneity statistics. The chart also displays a vertical 'no effect' line starting from 0 along with a red vertical dashed line representing the 'mean effect size'.

As the value 0 (null effect) is not found within the confidence interval of the mean effect, we can determine that STTs have a positive influence on the tourism experience in smart destinations, validating Hypothesis 1. More formally, with the contrast statistic $z = 8.07$ ($p = 0.000$), we reject the null hypothesis that the parametric effect common to the studies is 0. How influential is STT? The mean effect size is $r = 0.482$ with a 95% confidence interval of 0.378–0.574. To assess the magnitude of the effect sizes, Cohen (1988) proposes considering 0.10, 0.30 and 0.50 as low, medium and high values, respectively, for the indices of the *r* family. Therefore, STT has a medium effect on the tourism experience.

The reported heterogeneity statistics confirm the high variability between the effect sizes of each study ($I^2 = 98.10\%$). The estimate of the between-study variance is $\tau^2 = 0.137$. The test for homogeneity of specific effect sizes, which evaluates whether the effect sizes are the same across the studies, is also rejected, with Cochran's *Q* statistic $Q(32) = 1938.07$ ($p = 0.000$).

In addition, a meta-analysis was performed on the effect sizes reported in the primary studies for STT attributes and security/privacy concerns. Furthermore, a subgroup meta-analysis was conducted based on the year of publication, region of origin, and ICT readiness (using country classifications provided by the World Economic Forum, 2022). The summary results are shown in Tables 1 and 2, ordered from largest to smallest effect size (the corresponding forest plot is provided in Appendix C). Table 3 shows the between-group heterogeneity statistics.

All of the attributes of STT have a positive impact on the creation of the tourism experience, validating Hypotheses 2a, 2b, 2c and 2d. Informativeness ($r = 0.214$) and interactivity ($r = 0.199$) seem to have a greater effect on the tourism experience at the destination than accessibility ($r = 0.182$) and personalisation ($r = 0.174$). Considered separately, the STT attributes have a low effect on the tourism experience. The results also confirm a negative relationship between security/privacy concerns and tourism experience, validating Hypothesis 3, although in this case, the effect is more moderate ($r = -0.127$).

Although there is no significant difference between the results by year (the *p*-value for the test of group differences is 0.411), rejecting Hypothesis 4, the correlation between STT and tourism experience is higher in studies published after 2020 ($r = 0.513$) than in those conducted before ($r = 0.431$). The results by region allow us to validate Hypothesis 5. The relationship between STT and tourism experience is greater in Europe and Eurasia ($r = 0.593$) and the Asia-Pacific region ($r = 0.468$) than in the Americas ($r = 0.214$), with significant differences between groups ($p = 0.001$). The Middle East and North Africa subgroup has only two countries and obtains an $r = 0.525$. Hypothesis 6 is rejected (*p*-value = 0.284 for the test of group differences). The correlation between STT and tourism experience appears to be stronger in studies published in countries with medium-high ICT readiness ($r = 0.550$) than in those with high readiness ($r = 0.428$).

In all the meta-analyses performed, Cochran's *Q* statistic was significant, except in the case of security and privacy concerns (Table 2), indicating that heterogeneity in effect sizes across studies was greater than would be expected from sampling error alone (Cooper, 2016). This result is supported by the values obtained for the I^2 and H^2 heterogeneity statistics. In the meta-analysis of subgroups, only the one that takes region into account was a significant predictor of heterogeneity between groups (Table 3).

5. Discussion and conclusions

This study shows that the use of technology positively affects the travel experience of tourists visiting smart destinations. The vast majority of the analysed papers report a positive relationship between these variables, which is in line with the most recognised literature (Neuhofer et al., 2012; Tussyadiah & Fesenmaier, 2009; Wang et al., 2012). Only two studies find no significant relationship (Lee et al., 2018; Salazar-Estrada, 2022). In addition, in eight other papers (Chang, 2022; Gao & Pan, 2022; Huang et al., 2017; Jeong & Shin, 2020; Kim, Koo, & Chung, 2021; Lee et al., 2018; Pai et al., 2021; Shin, Jeong, & Cho, 2021), there is at least one effect for which no significant relationship is found. However, research evidence from neurological studies points to adverse

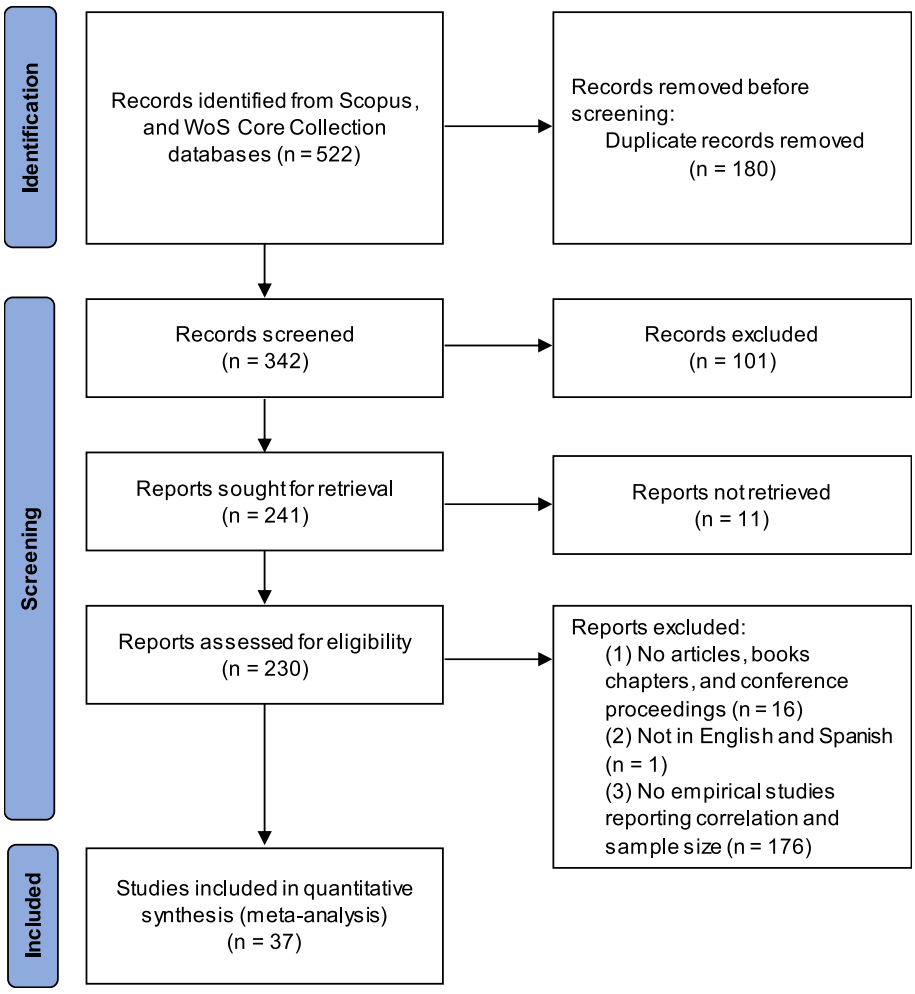

Fig. 2. Literature search flow diagram.

effects of STT on emotion processing, memory and experience storage (Coca-Stefaniak, 2019). In particular, mobile applications mediate the tourist experience and behaviour (Yetimoğlu, 2022) and can affect tourists' psychological wellbeing (Choi, Hickerson, Lee, Lee, & Choe, 2022).

The moderate effect size of STT on tourism experiences suggests that either the role of technology in creating experiences may have been overestimated or its potential to generate memorable tourism experiences has not been fully realised. This result is consistent with Molinillo, Anaya-Sánchez, Morrison, and Coca-Stefaniak (2019), who showed that smart cities are failing to capitalise on the possibilities offered by social media to visitors and residents.

The informativeness attribute contributed the most to tourists having a memorable travel experience, consistent with the findings of Azis, Amin, Chan, and Aprilia (2020) and Shin et al. (2021). According to Pai et al. (2020), the availability of information allows tourists to have more opportunities to participate in a wider range of activities and events. Interactivity is also an influential feature that enhances tourists' experience (Leung et al., 2022) as it allows smart destinations to accumulate dynamic tourism data and offer more attractive, tailor-made services (Jeong & Shin, 2020). The perceived lack of security or loss of privacy when using smart technologies is a concern for travellers and negatively affects the tourism experience. However, the extent of its impact appears to be relatively low, consistent with Huang et al. (2017), Krisna, Handayani, and Azzahro (2019) and Shin et al. (2021).

Although the year does not help to explain the heterogeneity observed between the studies, more recent works show a higher effect size. As technology becomes more present in our daily lives, it is becoming natural for tourists to stay connected even while on holiday (Pearce, 2011). However, there are statistically significant differences by region. Europe and Eurasia show a higher correlation, while STT has a medium effect on the tourism experience in the Asia-Pacific region and an effect that is even lower in the Americas. The greater academic interest in smart destinations in countries such as South Korea and Italy (Mehraliyev, Choi, & Koseoglu, 2019), as well as institutional support in Spain (Segittur, 2015) and China (Wang et al., 2013), could explain this result. The timing of implementing new technologies is crucial and is determined not only by the number of years that have passed but also by the technology's level of readiness. Nevertheless, the variability observed across studies cannot be attributed to differences in ICT readiness, and studies conducted in countries with a moderate to high level of technological readiness report higher effect sizes.

5.1. *Theoretical implications*

This study contributes to the existing body of knowledge in the following ways. First, to the best of our knowledge, this study is the first to provide a rigorous and systematic evaluation of the available empirical evidence on the impact of STT on the tourist experience. By including a variety of studies in the analysis that may have different sample characteristics, settings, and methodologies, our work helps to reduce bias and increase statistical power. Second, this work quantifies the mean effect of STT on the tourism experience. Third, it identifies key dimensions, such as informativeness and interactivity. In addition, it

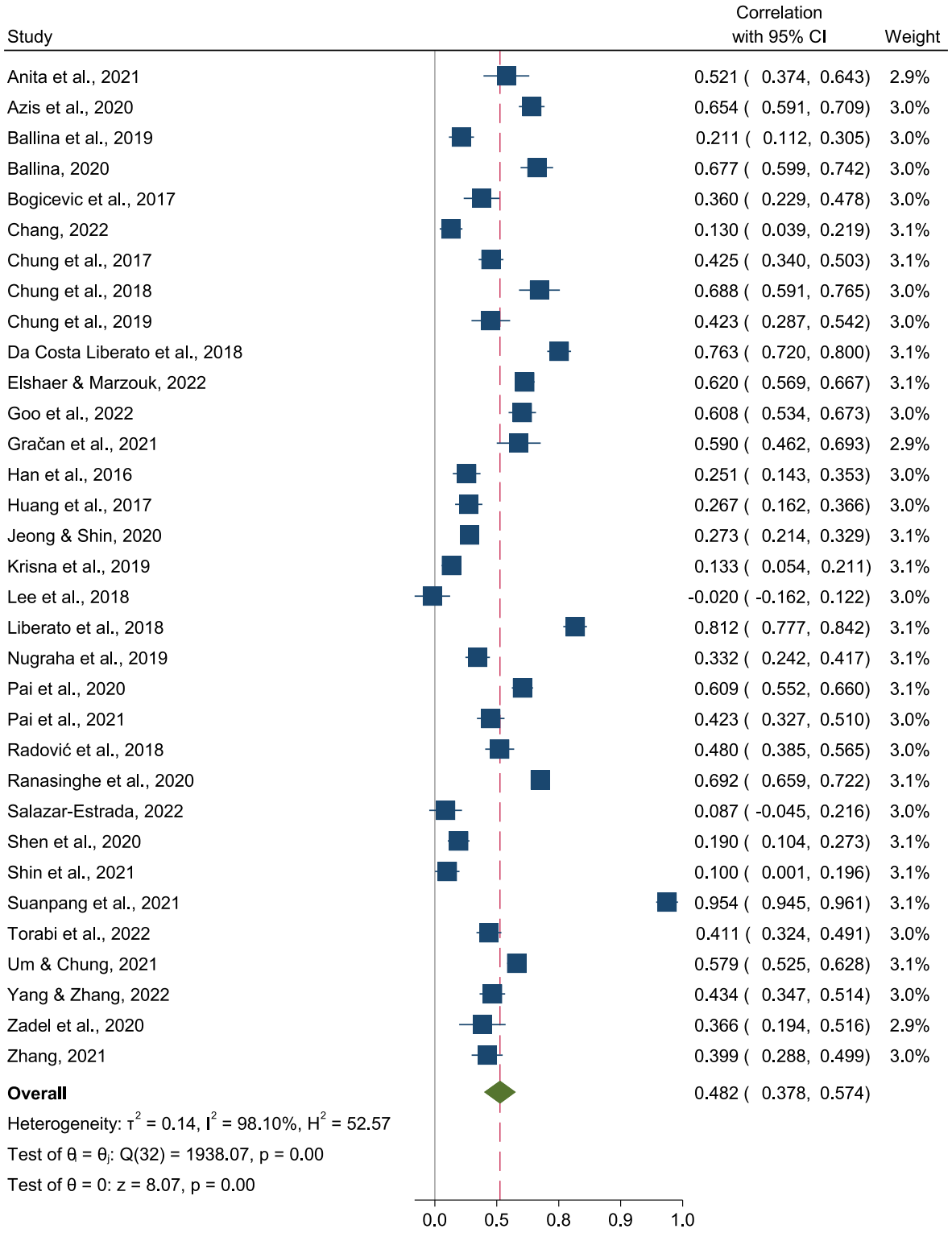

Fig. 3. Meta-analysis forest plot. Random-effects REML model.

shows what factors may moderate the relationship between STT and tourism experience; that is, it allows us to identify sources of variability across studies and examine how these differences affect the results.

5.2. Managerial implications

The results of this work provide several managerial implications. First, the improvement of the tourism experience, and therefore tourists' satisfaction with the destination and their intention to revisit it, depends largely on STT. Private entities, companies and marketing organisations in smart destinations should find technological solutions that add value to the tourism experience and that may ultimately provide a competitive advantage for the destination. Technology can be leveraged to create unique customer and service experiences (Batat & Hammedi, 2023) across various domains, including airports (Bogicevic, Bujisic, Bilgihan, Yang, & Cobanoglu, 2017), hotels (Elshaer & Marzouk, 2022) and

Table 1
Meta-analysis summary.

Group	Effect size and 95% interval					Test of null	
	k	N	*r*	CI_L	CI_U	*z*-value	*p*-value
Overall	33	12694	0.482	0.378	0.574	8.07	0.000
Attributes							
Informativeness	11	5430	0.214	0.085	0.336	3.22	0.001
Interactivity	13	5994	0.199	0.077	0.316	3.16	0.002
Accessibility	11	5430	0.182	0.073	0.286	3.25	0.001
Personalisation	11	5430	0.174	0.077	0.269	3.48	0.001
Security/privacy concerns	7	3180	−0.127	−0.161	−0.093	−7.19	0.000
Year							
≥ 2020	20	8480	0.513	0.374	0.630	6.40	0.000
<2020	13	4214	0.431	0.268	0.569	4.86	0.000
Region							
Europe and Eurasia	7	1970	0.593	0.409	0.731	5.39	0.000
Middle East and North Africa	2	992	0.525	0.292	0.699	4.04	0.000
Asia-Pacific	21	8084	0.468	0.322	0.593	5.73	0.000
The Americas	4	1648	0.214	0.090	0.332	3.35	0.001
ICT readiness							
Medium-high	12	4768	0.550	0.340	0.707	4.58	0.000
High	22	7926	0.428	0.316	0.528	6.90	0.000

Note: k = number of primary studies; N = total sample size; *r* = mean effect size (correlation); CI_L = lower confidence interval bound for mean effect size; CI_U = upper confidence interval bound for mean effect size; *z*-value = *z* statistic for test of significance of mean effect size; *p*-value = *p*-value for test of significance of mean effect size.

Table 2
Heterogeneity summary.

Group	df (Q)	Q-value	P > Q	τ^2	% I^2	H^2
Overall	32	1938.07	0.000	0.137	98.10	52.57
Attributes						
Informativeness	10	253.88	0.000	0.047	95.76	23.59
Interactivity	12	396.40	0.000	0.050	95.74	23.45
Accessibility	10	188.92	0.000	0.033	93.93	16.47
Personalisation	10	192.36	0.000	0.026	92.43	85.08
Security/privacy concerns	6	4.92	0.554	0.000	0.02	1.00
Year						
≥ 2020	19	1395.01	0.000	0.154	98.45	64.47
<2020	12	496.28	0.000	0.113	97.29	36.84
Region						
Europe and Eurasia	6	226.40	0.000	0.108	96.67	30.01
Middle East and North Africa	1	19.34	0.000	0.039	94.83	19.34
Asia-Pacific	20	1499.15	0.000	0.162	98.38	61.90
The Americas	3	13.46	0.004	0.013	80.53	5.14
ICT readiness						
Medium-high	11	1083.23	0.000	0.214	98.78	82.06
High	21	698.64	0.000	0.093	97.04	33.78

Note: df(Q) = degrees of freedom; Q-value = Cochran's *Q* heterogeneity test statistic; P > Q = *p*-value for heterogeneity test; τ^2 = between-study variance; % I^2—I^2 heterogeneity statistic. It estimates the proportion of variation between the effect sizes due to heterogeneity relative to the pure sampling variation. I^2 > 50 indicates substantial heterogeneity; H^2—H^2 heterogeneity statistic. A value of $H^2 = 1$ indicates perfect homogeneity among the studies.

Table 3
Tests of group differences.

Group	df	Q_b	P > Q_b
Year	1	0.67	0.411
Region	3	15.89	0.001
ICT readiness	1	1.15	0.284

Note: df = degrees of freedom; Q_b = Cochran's *Q* statistic for test of group differences; P > Q_b = *p*-value for test of group differences.

museums (Yang & Zhang, 2022). Second, not all STT attributes contribute to providing memorable experiences to the same extent. Therefore, the design of apps and websites, communication through social networks, and the use of STTs in their different manifestations should aim to improve the attributes of informativeness and interactivity above all else. Third, in an environment mediated by technology, failure to meet safety and privacy requirements in a destination can significantly impact the willingness of tourists (Jeong & Shin, 2020); thus, safeguarding and ensuring the privacy of personal data is an essential feature to maintain a positive reputation and attract visitors.

5.3. Limitations and directions for future studies

This study has some limitations. Despite a broad base of studies, very few report quantitative results that can be combined in a meta-analysis, according to Gretzel and Kennedy-Eden (2012). Furthermore, not all studies provide details on the attributes of STT or security/privacy concerns, which influences the capacity to generalise the results. Another important issue is publication bias. Studies that show negative results or are not statistically significant are less likely to be published (Borenstein et al., 2009; Lipsey & Wilson, 2001). In addition, the estimation of the mean effect size presents high heterogeneity that suggests the need for a cautious interpretation of the results. Therefore, there is a clear need for future empirical research with more uniform methodologies to consolidate (or not) the consensus on the positive role of technology in creating the tourist experience and to search for new moderating variables to explain heterogeneity.

Credit authors statement

Inés Sustacha: Conceptualisation, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing. José Francisco Baños-Pino: Conceptualisation, Funding acquisition, Writing - review & editing, Supervision. Eduardo Del Valle: Writing - review & editing, Supervision.

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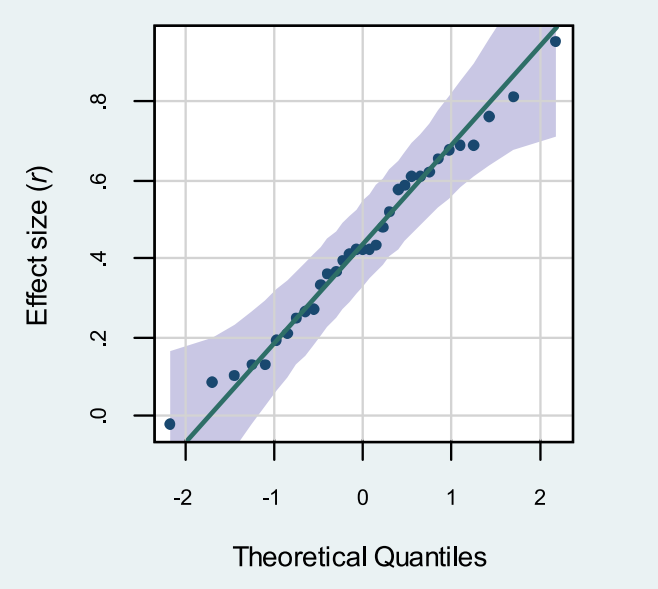
Appendix A. Normal Q-Q plot



Note: Normal quantile-quantile plot of the effect size sample against theoretical quantiles for the studies included in the meta-analysis. All but two points fall within the 95% confidence intervals. Applying the Shapiro-Wilk test resulted a *p*-value of 0.914, suggesting that the data follows a normal distribution.

Appendix B. Studies included in the meta-analysis

Authors (year)	Research objective	Variables						Sample Size	Country
		Ove	Acc	Inf	Int	Per	Sec		
Anita, Wijaya, Sarastiani, Kusumo, and Santi (2021)	Study the factors that influence public acceptance of virtual tour technology in museums and asses its influence on smart tourism and smart experience.	✓	×	×	×	×	×	115	Indonesia
Azis et al. (2020)	Investigate how STTs and memorable tourism experiences affect tourist satisfaction and destination loyalty.	✓	✓	✓	✓	✓	×	360	Indonesia
Ballina et al. (2019)	Study the gap between the paradigm of smart tourism destinations and the new phygital tourist experiences.	✓	×	×	×	×	×	377	Spain
Ballina (2020)	Study the perceptions and interests of rural tourists towards technological applications.	✓	×	×	×	×	×	226	Spain
Bogicevic et al. (2017)	Examine the relationship among airport technologies and travellers' confidence, enjoyment, and satisfaction.	✓	×	×	×	×	×	189	United States
Chang (2022)	Determine whether STT influences destination image by memorable tourism experiences.	✓	✓	✓	✓	✓	×	456	Taiwan
Chung, Tyan, and Chung (2017)	Fill the gap in understanding the relationship between social networking site use and satisfaction with tourism experience.	✓	×	×	×	×	×	387	South Korea
Chung, Lee, Kim, and Koo (2018)	Identify whether satisfaction with augmented reality influences the attitude towards and intention to visit tourism sites.	✓	×	×	×	×	×	145	South Korea
Chung, Tyan, and Lee (2019)	Examine the effects of technology-based eco-innovation on visitors' emotions and WOM intentions.	✓	×	×	×	×	×	161	South Korea
da Costa Liberato, Alén-González, and de Azevedo Liberato (2018)	Evaluate how technological components used in smart tourist destinations can improve tourists' experiences.	✓	×	×	×	×	×	423	Portugal
Elshaer and Marzouk (2022)	Investigate the role of STT in creating memorable tourist experiences through the mediating role of hotel innovations.	✓	×	×	×	×	×	612	Egypt
Gao and Pan (2022)	Explore what factors influence tourists' experiences with a smart tour guide system in four Chinese smart tourism destinations.	×	×	×	✓	×	×	248	China
González-Reverté et al. (2018)	Investigate the influence of privacy risk on satisfaction in the tourist experience involving the use of smartphones.	×	×	×	×	×	✓	532	Spain
Goo, Huang, Yoo, and Koo (2022)	Examine how tourists enhance their quality of trips with the use of STT.	✓	✓	✓	✓	✓	×	319	South Korea
Gračan, Zadel, and Pavlović (2021)	Investigate the importance and participation of mobile applications in improving the visitor experience.	✓	×	×	×	×	×	125	Croatia
Han, Park, Chung, and Lee (2016)	Examine the determinants of NFC reuse intention and Expo loyalty in relation to the utilisation of NFC.	✓	×	×	×	×	×	309	South Korea
Huang et al. (2017)	Examine the mechanism of how travellers use travel-related websites, social media, and smartphones to enhance travel satisfaction.	✓	✓	✓	✓	✓	✓	319	South Korea

(*continued on next page*)

(*continued*)

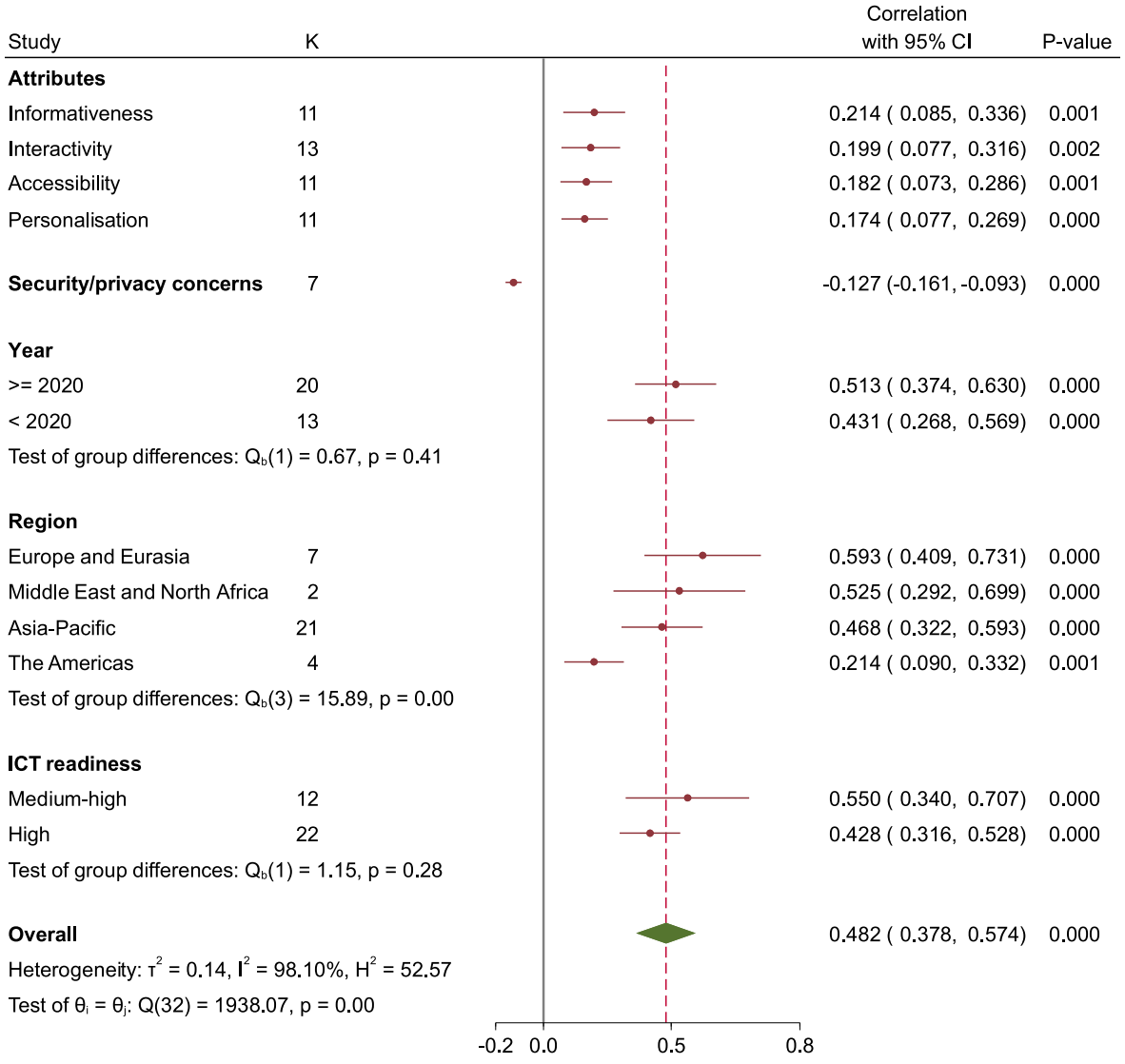
Authors (year)	Research objective	Variables						Sample Size	Country
		Ove	Acc	Inf	Int	Per	Sec		
Jeong and Shin (2020)	Measure the effects of STT usage on overall travel experience and future revisit intention.	✓	✓	✓	✓	✓	×	1010	United States

Note: Ove = overall, Acc = accessibility, Inf = informativeness, Int = interactivity, Per = personalisation, Sec = security/privacy concerns.

Authors (year)	Research objective	Variables						Sample Size	Country
		Ove	Acc	Inf	Int	Per	Sec		
Kim et al. (2021)	Examine the role of mobility apps in memorable tourism experiences by applying the stress-coping theory perspective.	×	×	×	✓	×	×	316	South Korea
Krisna et al. (2019)	Determine the relationship between using Instagram features, travelling experience, expectation, confirmation, and satisfaction on travelling journeys.	✓	×	×	×	×	✓	606	Indonesia
Lee et al. (2018)	Propose an integrated model with attributes of STT and destination values that contribute to tourists' life happiness.	✓	✓	✓	✓	✓	×	191	South Korea
Liberato et al. (2018)	Evaluate how the use of technology before, during and after the visit influences the tourist experience.	✓	×	×	×	×	×	423	Portugal
Nugraha, Wibowo, Disman, and Hurriyati (2019)	Find the correlation between smart tourism experience, perceived value, memorable tourism experience, and revisit intention.	✓	×	×	×	×	×	400	Indonesia
Pai et al. (2020)	Investigate the impact of STT experience on tourists' happiness and revisit intention.	✓	✓	✓	✓	✓	✓	527	Macao
Pai et al. (2021)	Examine the relationships between perceived STT experience, travel experience, and revisit intention.	✓	✓	✓	✓	✓	✓	312	Macao
Radović, Marković, and Varičak (2018)	Highlight the role and significance of information technology in creating the tourist experience.	✓	×	×	×	×	×	284	Croatia
Ranasinghe et al. (2020)	Identify the contribution of smart features on smart tourism exploration, smart tourism exploitation and travel experience satisfaction.	✓	✓	✓	✓	✓	×	1052	Sri Lanka
Salazar-Estrada (2022)	Comprehend the effect of the use of ICT by tourists on their travel experience.	✓	×	×	×	×	×	224	Mexico
Shen et al. (2020)	Explore how STT influences tourists' visit experience.	✓	×	×	×	×	×	503	China
Shin et al. (2021)	Examine the influence of STT and travellers' technology readiness on satisfaction and future behavioural intention.	✓	✓	✓	✓	✓	✓	398	United States & South Korea
Suanpang, Netwong, and Chunhapataragul (2021)	Study the impact of smart tourism destinations that affect revisit intentions during the COVID-19 pandemic.	✓	×	×	×	×	×	498	Thailand
Torabi et al. (2022)	Explore an integrated model describing the quality of memorable experiences and its impact on tourists' satisfaction and revisit intention via the use of STTs.	✓	×	×	×	×	×	380	Iran
Um and Chung (2021)	Examine how smart tourism satisfaction and service satisfaction affect the overall satisfaction of smart tourism cities.	✓	×	×	×	×	×	640	South Korea
Yang and Zhang (2022)	Investigate the perception of STT in creating museum tourism experiences.	✓	×	×	×	×	×	365	Macao
Zadel et al. (2020)	Determinate the correlation between museum visitors' experience and the way they use technology.	✓	×	×	×	×	×	112	Croatia
Zhang (2021)	Study tourists' experience and influencing factors in the context of smart tourism.	✓	×	×	×	×	×	246	China
Zhang, Sotiriadis, and Shen (2022)	Explore the influence of the attributes of STT on tourism experience in the context of visitor attractions.	×	✓	✓	✓	✓	✓	486	China

Note: Ove = overall, Acc = accessibility, Inf = informativeness, Int = interactivity, Per = personalisation, Sec = security/privacy concerns.

Appendix C. Attributes, security/privacy concerns and subgroup analysis forest plots. Random-effects REML model



Note: Plots show the effect of STT on tourist experience. The mean effect size, 95% confidence interval and the p-value for test of significance of mean effect size is shown for the overall result, attributes of technology (interactivity, informativeness, personalisation and accessibility), security/privacy concerns and each subgroup analysis (year, region, and ICT readiness).

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