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Educational tourism and smart information and communication technologies (ICT) in geoparks: a behavioural framework for enhancing visitor experience

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C H R O N I C L E

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A B S T R A C T

In the age of digital transformation, intelligent information and communication technologies (ICT) has become essential to tourism; yet, its function in geopark-based educational tourism has not been well examined. This research examines the Ciletuh–Palabuhanratu UNESCO global geopark to analyze how tourists use smart ICT for education on geoheritage and sustainability. A contextual and adaptable conceptual model is provided, enhancing the unified theory of acceptance and use of technology version 2 (UTAUT2) framework by integrating two new constructs, perceived learning value (PLV) and geo-heritage engagement (GHE), as well as two moderating variables, educational level and digital experience. A thorough literature assessment and bibliometric analysis revealed research gaps concerning the incorporation of educational components in technology uptake within geoparks. The results demonstrate that dimensions including performance anticipation, hedonic motivation, and habit are primary determinants of behavioral intention, whereas PLV and GHE substantially improve user engagement and learning outcomes. Furthermore, educational background and digital experience attenuate the impact of fundamental structures on technology adoption. The suggested approach enhances theoretical comprehension by situating UTAUT2 within educational tourism and offers practical guidance for developing inclusive, engaging, and sustainable ICT applications. These findings provide essential direction for geopark administrators and policymakers in advancing digital learning initiatives that foster cultural appreciation, environmental consciousness, and community engagement.

1. Introduction

Tourism has transformed from just leisure travel into a medium for education, environmental advocacy, and community involvement. A new field exemplifying this growth is educational tourism inside UNESCO global geoparks, where geological history, ecological sustainability, and local culture intersect to provide immersive learning experiences. These geoparks function as living laboratories that facilitate place-based education, historical preservation, and socio-economic advancement via tourism-driven development. Nonetheless, while the educational and environmental benefits of geoparks have been recognized, their incorporation with advanced information and communication technologies (ICT) is still inadequately examined. Despite the widespread availability of digital technologies in the tourist sector, including mobile apps, augmented reality, and real-time data systems, their use in enhancing educational value and promoting sustainability in geoparks remains limited. Contemporary research has concentrated chiefly on geotourism and destination management, whereas terms such as student learning and educational tourism have remained marginal in the bibliometric framework. Furthermore, the majority of studies on smart tourism focus on urban destinations or cultural heritage sites, with a scarcity of studies about educational ecosystems inside geopark settings, particularly in the Global South, including Indonesia. This gap is especially pertinent to the Ciletuh–Palabuhanratu UNESCO global geopark, which has considerable geological, biological, and cultural resources. A comprehensive framework for integrating smart ICT to increase experiential learning, geo-heritage engagement, and sustainable tourist behavior has not yet been built, despite the implementation of several digital projects.

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This study conducts a systematic literature review (SLR) to fill the research gap by synthesizing existing scholarly work on (1) sustainable educational tourism in geoparks, (2) the application of smart ICT in tourism and education, and (3) theoretical models of technology adoption pertinent to tourism contexts. This research aims to develop a comprehensive conceptual model that enables the integration of intelligent ICT in educational geoparks, incorporating new constructs such as perceived learning value (PLV) and geographic heritage engagement (GHE), along with contextual factors like education level and digital experience. The expected result is to expand the theoretical comprehension of the UTAUT2 framework by offering a practical model for implementation in educational geopark locations, namely Ciletuh–Palabuhanratu, via an extensive synthesis of scholarly literature and bibliometric analysis.

2. Methodology of Systematic review protocol

This study employed a systematic literature review (SLR) technique following the Recommended Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological rigor and replicability. A comprehensive literature review was conducted to synthesize relevant academic research on the use of intelligent information and communication technologies (ICTs) in sustainable and educational tourism within the geopark context. This protocol outlines the methods used for literature identification, selection, screening, and analysis.

2.1 Research Questions

This comprehensive literature review is driven by several interrelated research questions aimed at understanding the relationship between sustainable educational tourism, smart ICT adoption, and theoretical frameworks in the geopark context. This study analyzes the discourse surrounding sustainable educational tourism in contemporary academic literature, specifically in the context of geoparks that combine teaching with heritage conservation. Second, it explores several forms of smart ICT, including mobile apps, augmented reality, and GIS-based systems, used to enhance educational experiences in tourist destinations, emphasizing their role in fostering interactivity, engagement, and sustainability awareness. This study analyzes the technology adoption models most frequently used in smart educational tourism investigations, highlighting both prevalent frameworks and emerging conceptual methodologies. This study aims to uncover significant conceptual and contextual gaps in the literature, particularly regarding user interactions with educational technologies in geopark environments. Collectively, these questions provide an analytical basis for integrating existing information and formulating a more contextually relevant framework for the application of smart ICT in educational geoparks.

1.2 Data Sources and Search Strategy

The data collection process for this review was conducted using the Scopus database, known for its extensive array of peer-reviewed academic publications across various disciplines, including tourism, education, and information technology, to ensure thorough and systematic literature coverage. The search strategy was developed using a blend of boolean operators and restricted vocabulary to include material relevant to the study's aims. The keywords were categorized into three principal themes: sustainable educational tourism within geopark contexts, the use of smart ICT in tourist and academic settings, and the implementation of technology adoption strategies. Unified theory of acceptance and use of technology is UTAUT, technology acceptance model is TAM, technology organization environment is TOE, and theory of planned behaviour is TPB. The search encompassed combinations including (“Geopark” OR “UNESCO Global Geopark”) AND (“Educational Tourism” OR “Edutourism” OR “Heritage Learning”), (“Smart ICT” OR “Information and Communication Technology” OR “Digital Technology”) AND (“Tourism” OR “Educational Tourism”) and (“UTAUT” OR “TAM” OR “TOE” OR “TPB” OR “Diffusion of Innovation”) AND (“Tourism” OR “Education”). The search was confined to papers from 2006 to 2025 to include recent advancements and restricted to peer-reviewed English-language journal articles to ensure academic integrity and comparability. Only open-access publications were used to guarantee the accessibility and openness of sources for later study. This strategic method established a systematic basis for locating high-quality literature that satisfies the inclusion criteria and answers the study’s primary research concerns.

1.3 Screening Process

The literature screening method was conducted at many phases to guarantee the relevance, quality, and alignment of chosen studies with the study goals. A total of 1523 articles were initially found by systematic searches in the Scopus database using the specified search terms. Following the elimination of duplicates and irrelevant records based on titles and abstracts, 1086 articles were retained for preliminary screening. A comprehensive review was then conducted via the analysis of abstracts and keyword associations, leading to the exclusion of publications not directly pertinent to educational tourism, smart ICT, or technology adoption in tourist contexts. A total of 437 papers were retained for further assessment. In this step, each paper was evaluated for its methodological clarity, topic relevance, theoretical contribution, and empirical emphasis. Only studies that demonstrated explicit engagement with at least one of the core themes, sustainable educational tourism, ICT integration, or technology adoption frameworks, were included in the final synthesis. A total of 112 peer-reviewed journal articles were selected as the final dataset for this systematic review. The technique adhered to the PRISMA criteria, providing a transparent

framework for documenting the inclusion and exclusion process. A PRISMA flow diagram is shown to depict the multistage selection process and enhance the methodological clarity of the assessment.

1.4 Data Extraction and Analysis

After completing the selection of publications, a systematic data extraction process was used to collect essential information from each study. This included the consolidation of data, including authorship, publication year, country of origin, study objectives, technological focus (e.g., mobile applications, augmented reality, GIS), theoretical frameworks used (such as UTAUT, TAM, TOE), research methodology, target demographics, and key findings. The data were structured into a coding matrix to enable systematic comparison and thematic classification. The selected works were then examined via a dual methodology that included bibliometric mapping and qualitative topic synthesis. A bibliometric study was performed using the Biblioshiny package in RStudio, facilitating the discovery of keyword co-occurrence networks, topic progression frameworks, international cooperation patterns, and frequently referenced sources. This quantitative analysis revealed prominent research clusters and developing trends throughout the literature. A qualitative synthesis was conducted to elucidate conceptual links across variables, assess theoretical contributions, and pinpoint deficiencies in the use of ICT and adoption models within educational tourism. Collectively, these analytical methods facilitated a comprehensive understanding of the current academic landscape and guided the creation of a contextualized conceptual model designed explicitly for smart educational tourism inside geopark settings.

3. Results and discussion

3.1 The Concept of Sustainable Educational Tourism in Geopark Areas

Sustainable educational tourism integrates leisure travel with significant education on the ecology, geological history, and local culture. UNESCO global geoparks illustrate this notion by serving as “Living Laboratories” that integrate education, historical preservation, and community empowerment within a sustainable development paradigm. Empirical data substantiates its efficacy; for instance, geology-oriented tour packages in Batur geopark have demonstrably improved tourists' comprehension of geoscientific values (Arcana and Wiweka 2016). In Ijen geopark, the incorporation of environmental education into the school curriculum has enhanced pupils' ecological consciousness. Educational programs in the Bakony–Balaton geopark have effectively enhanced geological literacy and fostered active participation among youth on a worldwide scale (Maltesics 2020). To analyse academic developments related to this theme, a bibliometric study was conducted using the keywords (“Geopark” OR “UNESCO Global Geopark”) AND (“Educational Tourism” OR “Edutourism” OR “Heritage Learning”) sourced from the Scopus database for the period 2006–2025 and processed using the Biblioshiny package in R-Studio. The analysis, as illustrated in Fig. 1, indicates that while major themes such as geotourism, tourism development, and sustainable development dominate scholarly discourse, keywords like educational tourism, student learning, or heritage learning have yet to emerge as central clusters.

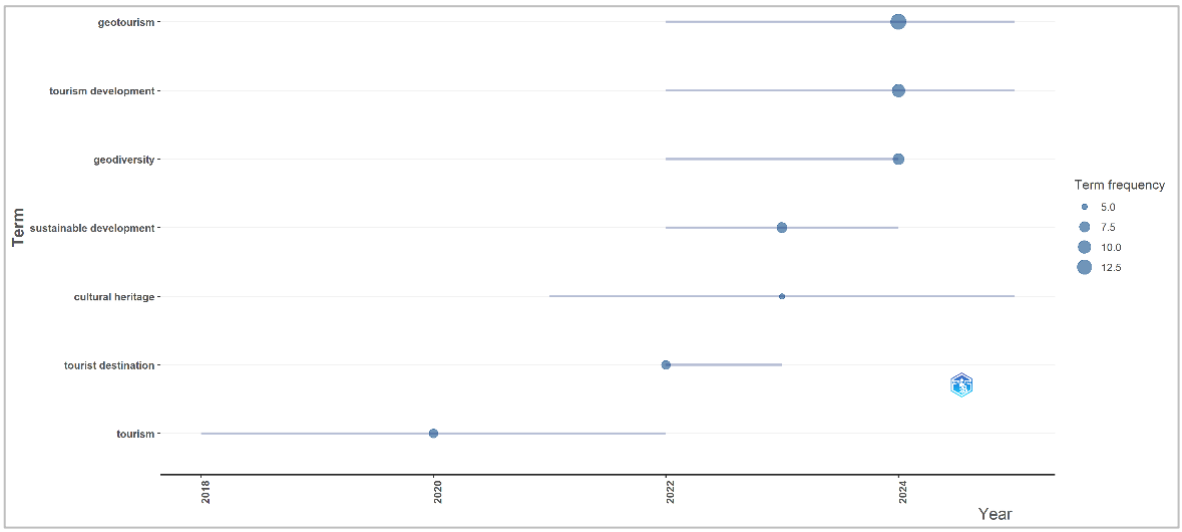

Fig. 1. Trend topics of sustainable educational tourism in geopark

This finding is corroborated by the co-occurrence network shown in Fig. 2, which highlights those terms such as education, student, and university are positioned peripherally within the topic network. This suggests that educational dimensions within geopark contexts have not yet received sufficient focus in the mainstream literature and remain marginal in the dominant paradigms of geopark development. Notwithstanding the growing interest in educational tourism, the use of novel technologies in geopark-based pedagogy remains limited. Recent research has commenced inquiries into edutourism methodologies; however, technologies such as augmented reality, mobile applications, and intelligent guide systems are still

underutilized, despite their potential to improve visitor interpretation and deliver real-time educational information (Insani et al., 2022). This underscores a critical need to use digital innovations to enhance academic and environmental goals within geopark contexts. This study proposes a framework for incorporating intelligent ICT into the Ciletuh–Palabuhanratu UNESCO global geopark to improve educational experiences and promote participatory, community-oriented environmental education.

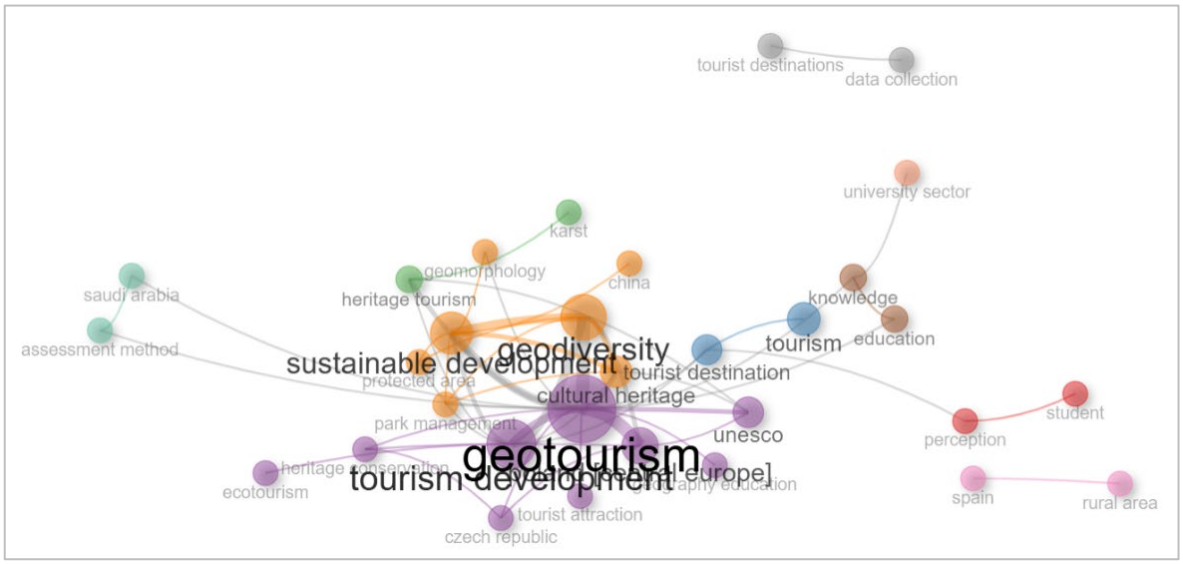

Fig. 2. Co-occurrence network

3.2 The Utilization of Smart Technologies in Educational Destinations

The use of advanced ICT has profoundly altered the administration of tourist sites, particularly those focused on educational experiences. Various ICT-based solutions, such as mobile applications, digital guides, visitor information systems, and augmented reality, have made educational content delivery more interactive, personalized, and sustainable (Gretzel et al., 2015). The integration of ICT also supports efficient destination management, particularly in geopark contexts where place-based education is essential. A bibliometric analysis using the keywords ("Smart ICT" OR "ICT") AND ("Tourism" OR "Educational Tourism") shows increasing scholarly interest in this area. As illustrated in Fig. 3, terms such as smart tourism, ICT, information and communication technologies, sustainable development, and tourism management have dominated the discourse from 2017 to 2024. This surge reflects global academic attention to technological applications in educational destinations.

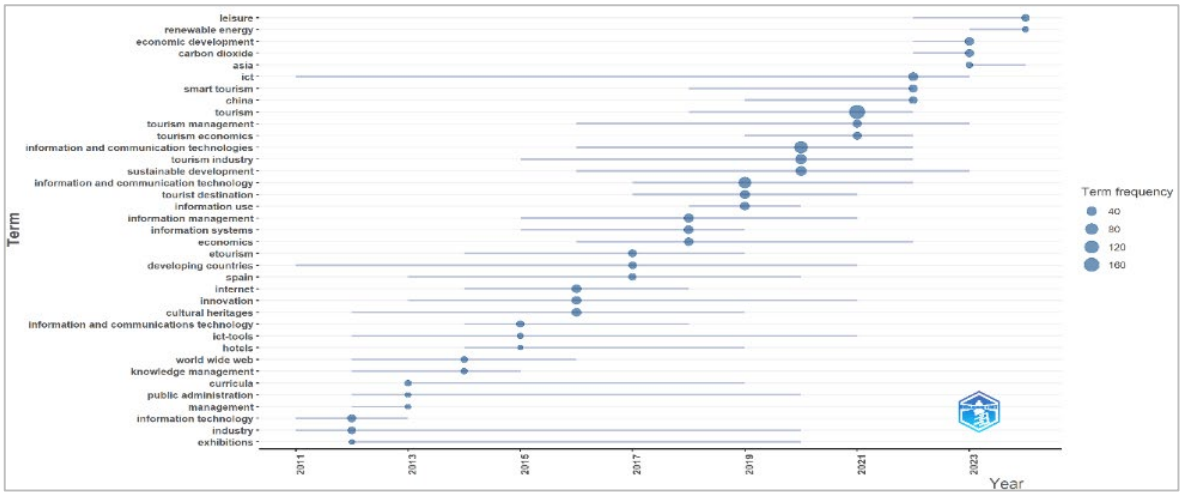

Fig. 3. Trend topics of the utilization of smart technologies (ICT).

The co-occurrence network in Figure 4 reveals two major clusters. The blue cluster focuses on smart tourism, mobile applications, smart city, and augmented reality, while the red cluster emphasizes tourism development, tourism economics, and sustainability. The strong correlation between "Information and Communication Technologies" and "Tourism" confirms that ICT has become a central component of educational infrastructure. However, educational tourism as a distinct and explicit application is still underrepresented, highlighting a relevant research opportunity.

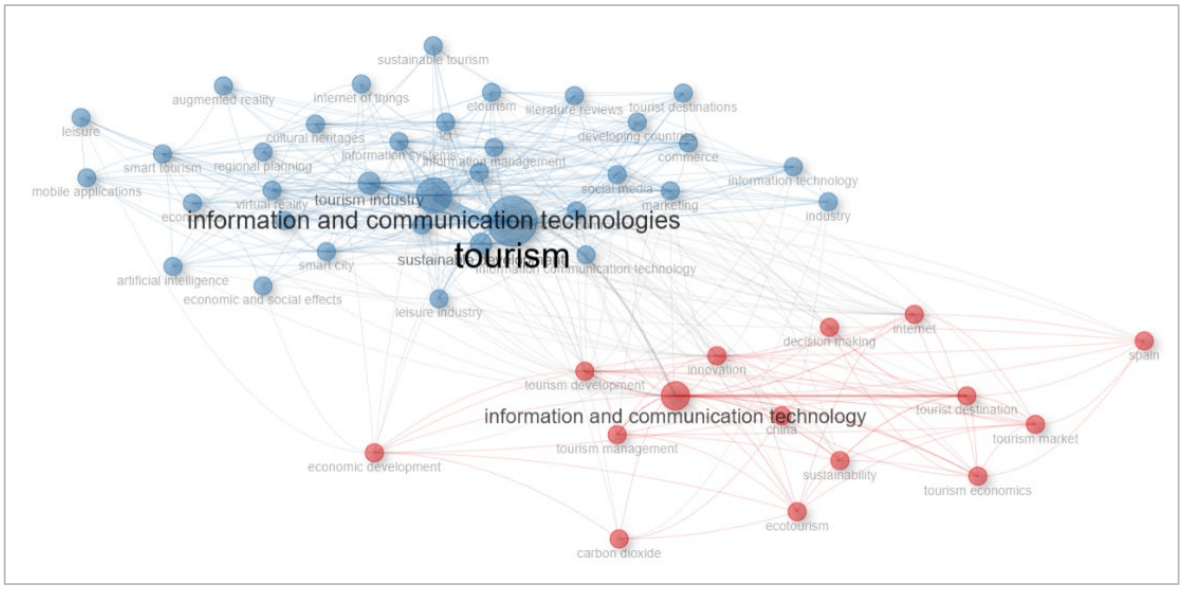

Fig. 4. Co-occurrence network.

The thematic map in Fig. 5 categorizes topics like “Information and Communication Technologies”, “Tourism Industry”, and “Smart City” as motor themes,conceptually significant and methodologically developed. In contrast, themes such as “tourism management” and “Information Technology” are basic themes,important but still evolving. This pattern suggests that although the application of ICT in tourism is well-established, its integration into educational tourism remains fragmented. The country collaboration map in Fig. 6 demonstrates that countries such as Spain, Italy, and China dominate research outputs in this domain. Indonesia ranks seventh, with most publications classified as single country publications, indicating limited international collaboration. This highlights an opportunity for advancing academic and institutional partnerships in the field of ICT-based smart tourism in geopark contexts. International examples show the growing implementation of smart technologies in educational destinations in response to challenges related to education, community involvement, and the demand for interactive visitor experiences. In the Napo Sumaco Aspiring UNESCO global geopark, Ecuador, a multi-platform application called “SumAppGeo” was developed using ArcGIS and Flutterflow technologies to deliver geospatial data, interactive maps, and geosite-based educational content to visitors and local communities (Salazar-Del-Pozo et al., 2025).

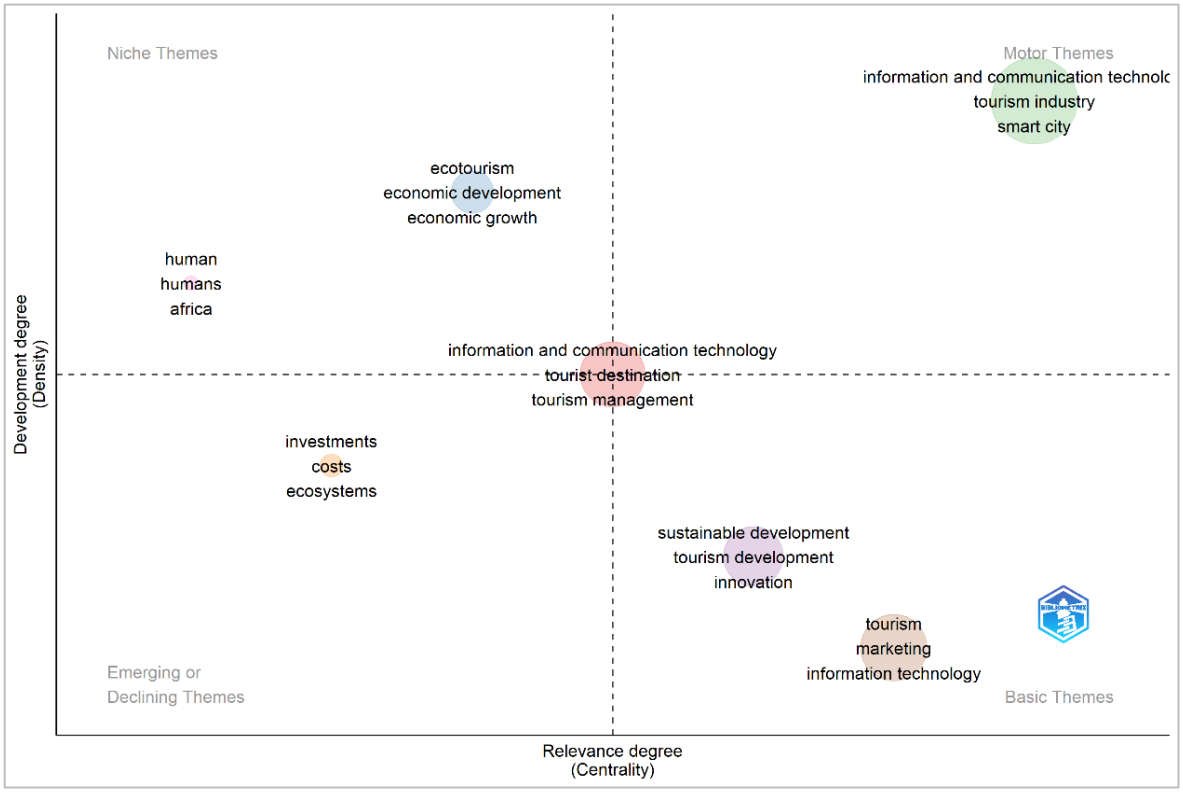

Fig. 5. Thematic map.

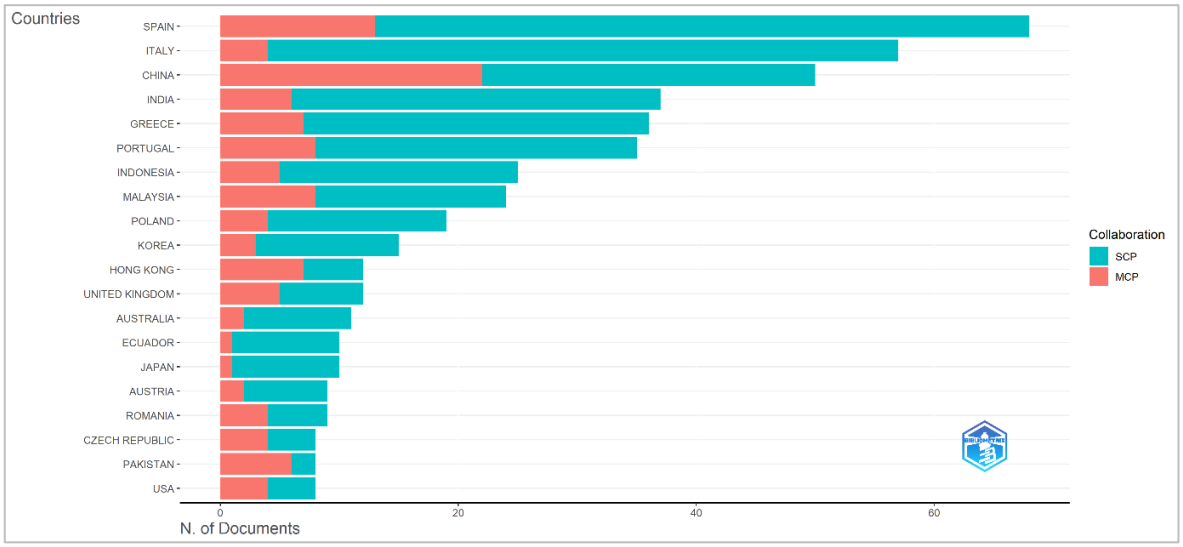

Fig. 6. Visualisation of country collaboration map.

The worldwide acceptance of smart ICT in educational tourism is progressing, but its implementation in Indonesia is still in its nascent phase, facing significant hurdles. Internationally, destinations such as the Psiloritis UNESCO global geopark in Greece have expanded digital tools post Covid-19 through story maps, virtual tours, and business directories to enhance interpretation and sustain global engagement (Fassoulas et al., 2022). The Zhangjiajie "smart travel" platform in China utilizes big data and collaborative filtering to provide customized tourist services and facilitate pandemic recovery (Fei & Zou, 2020). These advancements exemplify the comprehensive smart tourism experience concept, which prioritizes user engagement, system interoperability, and data-informed improvements (Femenia-Serra & Neuhofer 2018). Conversely, Indonesia's use of ICT in educational settings has concentrated chiefly on digital marketing and fundamental information accessibility, while nascent initiatives in real-time integration and mobile-based systems are enhancing service quality and destination branding (Yulianti et al., 2024). Nonetheless, persistent obstacles such as inequitable digital infrastructure, insufficient digital content management competencies, and community opposition to technology underscore the need for locally tailored ICT methods that promote participative and sustainable educational involvement.

3.3 Comparative Review of Technology Adoption Framework

Understanding the adoption and use of information technology requires the development of a comprehensive theoretical framework that explains how individuals and organizations accept technical advances. Over the years, researchers in fields such as tourism, education, and intelligent ICT systems have used various frameworks, including the technology acceptance model (TAM), the unified theory of acceptance and use of technology (UTAUT), the theory of planned behavior (TPB), the technology-organization environment (TOE), the diffusion of innovations (DOI), the theory of reasoned action (TRA), and the information systems success model (ISCM), to analyze user behavior in various socio-technical contexts. Each model offers a different analytical framework and perspective, with its appropriateness depending on the characteristics of the technology, user demographics, and contextual factors. This research, which examines the integration of intelligent ICT into sustainable and educational tourism, requires selecting an appropriate adoption model to effectively capture the interactions between user perceptions, behavioral intentions, and contextual factors specific to geopark environments. A comparative examination of these models, underpinned by bibliometric and theoretical analysis, is undertaken to ascertain the most relevant framework and to guarantee the methodological rigor of this study.

3.3.1 Bibliometric trends in technology adoption framework research

The bibliometric analysis presented in this study is based on a corpus of 1112 peer-reviewed scientific documents published between 2020 and 2025, as depicted in Fig. 7. The analysis specifically targets scholarly works that incorporate prominent technology adoption models, including the UTAUT, TAM, DOI, TOE, TPB, TRA, and ISCM. The dataset was systematically compiled from the Scopus database using carefully selected keywords representative of each adoption framework. To ensure consistency and academic rigor, the inclusion criteria were limited to English-language journal articles categorized as open access, thereby enhancing the transparency, accessibility, and reproducibility of the analytical process. The bibliometric profile of technology adoption research indicates robust academic cooperation, sustained relevance, and significant scholarly influence, notwithstanding a recent decrease in publication growth. A total of 282 publishing sources, including journals and conference proceedings, were found from the gathered data, with contributions from 3675 authors, of whom just 90 produced single-authored pieces, reflecting a collaborative and multidisciplinary research milieu. The mean number of authors per manuscript was 3.63, and 33.27% of the research had international cooperation, highlighting the worldwide interest in this domain. The papers averaged 2.5 years in age, indicating the research's recency, but the mean citation count per piece was

21.01, signifying substantial academic interest. Notwithstanding these advantages, the yearly publishing growth rate had a negative trend of -7.55%, presumably a correction after the publication boom during the Covid-19 epidemic, which had momentarily heightened interest in digital transformation. These bibliometric indicators provide a robust basis for assessing the theoretical models used in existing studies and underscore the need to examine their relevance to the contemporary research situation.

Fig. 7. Main information technology adoption framework.

3.3.1.1 Keyword Co-occurrence Network

A keyword co-occurrence network analysis was conducted to identify the conceptual structure and thematic relationships among the most frequently used terms in studies related to technology adoption models during the 2020–2025 period. The network visualization, as illustrated in Figure 8, displays the distribution of keywords into several distinct clusters, each represented by a different color. These clusters signify closely related research subthemes, thereby revealing the underlying intellectual organization and interconnectedness of topics within the scholarly discourse on technology adoption.

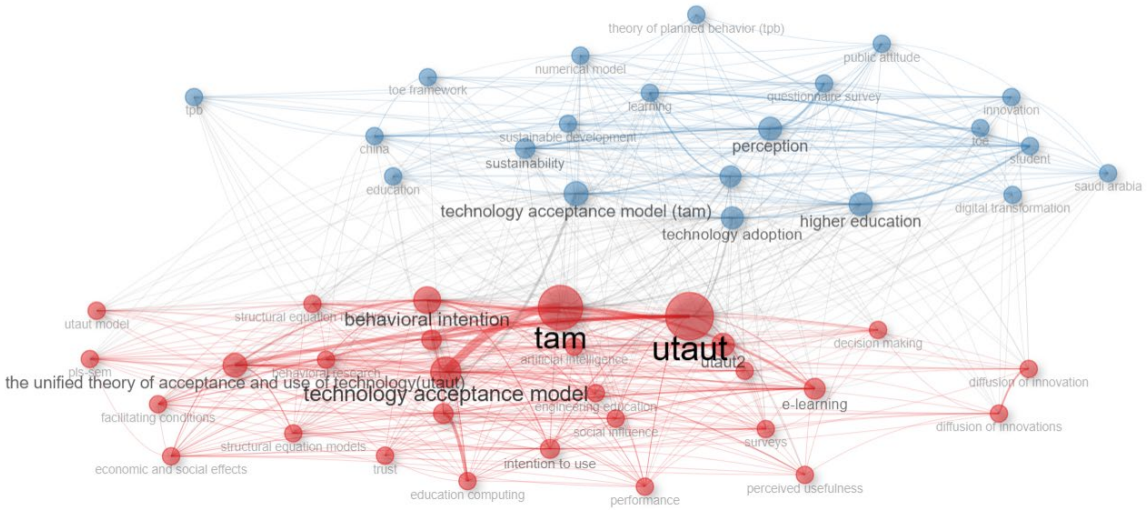

Fig. 8. Co-occurrence network of adoption model keywords.

Keyword co-occurrence network research identifies UTAUT and TAM as the most pivotal and often used frameworks in technology adoption literature, especially for elucidating user behavior. Nodes including “UTAUT”, “TAM”, “Behavioral Intention”, and “Technology Adoption” hold prominent roles within the network, with the red cluster highlighting UTAUT as the preeminent framework due to its robust associations with constructs such as performance expectancy and intention to use, underscoring a significant focus on individual-level psychological models and quantitative methodologies. Although models such as DOI, TOE, and TPB are included, their functions are more ancillary, indicating a secondary emphasis on macro-level and organizational adoption viewpoints. These findings confirm that UTAUT and TAM not only prevail in the conceptual framework of the field but also offer extensive thematic coherence, thus validating the choice of UTAUT3 as the principal framework for this study to elucidate user perceptions and behavioral intentions within ICT-based, sustainability-oriented educational tourism systems.

3.3.1.2 Wordcloud Analysis

A word cloud was employed as a visual representation to illustrate the most frequently occurring keywords in publications related to technology adoption models during the 2020–2025 period. As shown in Fig. 9, the visualization highlights the relative frequency of keywords used by researchers across the analyzed studies. The size of each word corresponds to its frequency within the dataset,the larger the word, the more frequently it appears, thereby providing an intuitive overview of dominant thematic elements and focal points in the scholarly discourse on technology adoption.

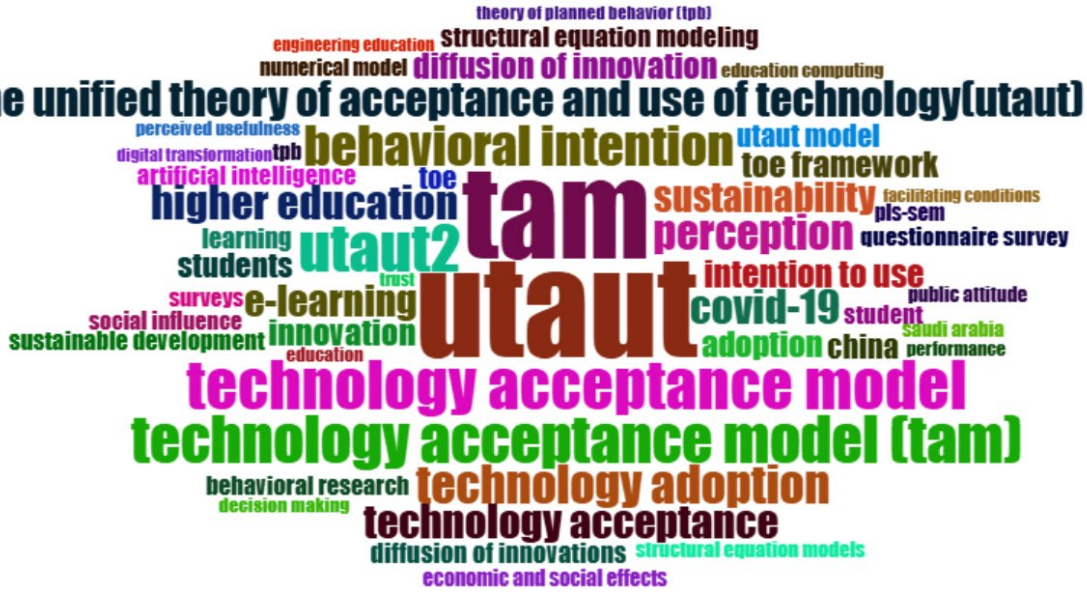

Fig. 9. Wordcloud of frequent keywords in technology adoption model studies.

The word cloud analysis underscores the prominence of UTAUT and TAM in contemporary technology adoption studies, while also emphasizing the increasing contextual significance of education, sustainability, and the post-COVID-19 digital transition. Prominent phrases such as “UTAUT”, “TAM”, “Technology Adoption”, “E-learning”, “Covid-19”, and “Sustainability” suggest that academic focus from 2020 to 2025 has shifted from theoretical frameworks to tackling practical issues in online education and digital transformation. The inclusion of phrases such as “Performance Expectancy” and “Perceived Ease of Use” indicates a growing emphasis on user experience and sustainable innovation. While other models like TOE, DOI, TPB, and ISCM are less often used, UTAUT and TAM remain predominant owing to their resilience and versatility across many settings. The word cloud corroborates the findings of the keyword co-occurrence network. It offers empirical validation for the selection of UTAUT3 as the principal framework in this study, especially in examining the dynamics of smart ICT adoption in experience-oriented and sustainability-driven educational tourism contexts.

3.3.2 Overview of major models

This study refines the bibliometric dataset to identify the most suitable technology adoption framework for ICT-based educational tourism. Adding the keyword “Tourism” yielded 24 relevant articles, as shown in Table 1. These studies explore the application of adoption models in smart tourism, sustainable tourism, and tourism education, enabling a more focused analysis of how frameworks address the sector’s unique technological challenges.

Table 1
Related studies on technology adoption frameworks in the context of tourism.

Sources	Framework used	Research object	Method	Key findings
(Yunita 2024)	PEPB (TPB-ext); TOE	405 tourism MSME actors in Labuan Bajo	Mixed methods (PLS-SEM + interviews)	Authority support and dominant environmental uncertainty; R^2=76%
(Sousa et al., 2023)	TOE	15 tourism managers in Portugal	Qualitative (interview + MAXQDA coding)	Willingness to invest and perceived impact of COVID-19 as a trigger for technology adoption
(Araújo Vila et al., 2021)	UTAUT2	810 potential spa visitors in Spain	Quantitative (PLSc-SEM)	PE and HM have the most influence; R^2 on purchase intention=53.3%
(Pinto et al., 2022)	UTAUT3	201 mobile AR tourism users in Portugal	Quantitative (SEM-PLS)	HB, HM, FC are significant to BI; R^2=74.8%
(Wu et al., 2024)	TAM; Flow theory	518 metaverse tourism users in Korea	Quantitative (SEM)	Flow to PU & PEOU to Attitude to BI; R^2=78%
(Bayona-Oré and Estrada 2021)	TOE (with individual factors)	116 tour operators (PYME) in Peru	SEM–AMOS	Most influential technologies and organizations; significant individuals; low environment
(Cheunkamon et al., 2020)	TAM; TPB; Trust; satisfaction	1333 domestic tourists in Thailand	Quantitative (SEM)	Attitude to BI; Trust is not significant; PU and PEOU to attitude

Table 2
Related studies on technology adoption frameworks in the context of tourism.

Sources	Framework used	Research object	Method	Key findings
(Wen et al., 2023)	UTAUT2; PIN; INV	538 tourists at 2 cultural heritage sites in China	SEM–AMOS	HM, PIN, INV dominan terhadap BI; HT and FC terhadap use; R^2 BI=60%
(Al Naim et al., 2023)	AMO; TPB	625 domestic tourists in Saudi Arabia	PLS-SEM	Green ability and attitude are significant towards GeWOM; intention is a strong mediator.
(Beştaş 2024)	DOI	Blockchain adoption in the tourism sector	Qualitative / Literature	Adoption is still in the early adopters stage; legal and integration challenges
(Mosbeh 2025)	UTAUT2; Trust; Innovativeness; Perceived value	The use of VR in Tunisian cultural sites	PLS-SEM	Trust, hedonic motivation, performance are significant to intention
(Yuce et al., 2020)	IS Success Model (DeLone and McLean)	The influence of VR quality on visit intention (Famagusta)	PLS-SEM	VR system quality to satisfaction to visit intention
(Tran and Vu 2024)	UTAUT2; Trust and security	Vietnamese Gen-Y in the use of tourism applications	SEM (AMOS)	Trust, security, and performance are significant; hedonics are not
(Nguyen et al., 2023)	TAM; Flow; SOR	VR features and tourist visit intentions (Vietnam)	SEM	Enjoyment and immersion drives visit intention
(Tamilmani et al., 2022)	Meta-UTAUT; Trust; Hedonic; Self-efficacy	Adoption of Airbnb by Indian travelers	SEM	Attitude and trust are significant; the model explains 65% of the variance in intention.
(Maulida et al., 2025)	UTAUT2; ETAM; T-WAM; DeLone and McLean	Use of the Go-Klotok application (Banjarmasin)	PLS-SEM + ANN	Social influence, benefit, info quality dominan
(Hamouda 2022)	TAM; Personal innovativeness; WOM	440 responden Tunisia (aplikasi pariwisata)	Survey, SEM (AMOS 21)	WOM is the strongest predictor of usage intention
(Yusoff et al., 2020)	TRA; Willingness to communicate	107 elementary school students on Perhentian Island	Survey, PLS-SEM	Attitude influences intention; social influence is not significant
(Marín Díaz et al., 2023)	TAM; AHP; Fuzzy logic	Digital tourist (simulation scenario)	Conceptual, multi-criteria model	Digital maturity impacts personalized services
(Hu et al., 2023)	TPB; Policy orientation; Pandemic response	895 residents of Shanghai	Survey, SEM	Policy orientation is significant; pandemic response is insignificant
(Li and Jiang 2023)	TAM; Memorable tourism experience	275 tourists in Beijing (AR Forest Park)	Survey, PLS-SEM	MTE influences attitudes and intentions to use AR

3.3.3 Comparative strengths and weaknesses

A comprehensive understanding of the advantages and constraints of various technology adoption models is essential for selecting the most suitable framework for empirical study, particularly in complex environments like ICT-based educational tourism. Each model exhibits unique theoretical underpinnings, constructions, and contextual flexibility, making comparison analysis essential for identifying pertinent features and revealing gaps that may need model development or integration. This technique guarantees the creation of a context-aware and theoretically sound framework that can encapsulate user perceptions, behavioral goals, and environmental influences. This section evaluates the merits and shortcomings of the predominant theories, namely UTAUT2, UTAUT3, and TAM, alongside supplementary models such as TPB, TOE, AMO, ISCM, DOI, TRA and flow theory, grounded in empirical data from 24 reviewed academic papers. The resultant synthesis underpins the rationale for the conceptual framework used in this research (Table 2). Every technology adoption model has distinct advantages and disadvantages, necessitating the alignment of framework choices with the particular requirements of the research setting. UTAUT2 is recognized for its comprehensive ability to include emotional and behavioral factors, such as hedonic motivation, habit, social impact, and enabling situations, exhibiting considerable predictive power for behavioral intention (Araújo Vila et al., 2021; Mosbeh 2025). The integration of external elements, including trust, innovativeness, security, and system design (Rui et al., 2024), enhances its adaptability; however, it frequently faces criticism for its structural complexity and the varying significance of constructs across different contexts. UTAUT3 refines this theory by focusing on immersive and interactive technology, such as mobile augmented reality, where elements like habit and hedonic motivation play a substantial role. Conversely, constructs such as performance expectancy and social influence provide context-dependent results (Wen et al., 2023), making them particularly relevant for experiential and user-focused research. The technology acceptance model (TAM) is a widely used foundational framework because of its simplicity and adaptability across many technology settings (Wu et al., 2024). The predictive capacity is often enhanced by integrating theories such as flow, TPB, trust, AHP, fuzzy logic, and memorable tourism experience to address more complex or immersive applications (Marín Díaz et al., 2023); however, its essential reliance on perceived usefulness (PU) and perceived ease of use (PEOU) may limit its applicability without additional constructs. Various technology adoption models have their advantages and limitations, so selecting the proper framework must be tailored to the technological context, user characteristics, and research objectives. Models such as the TPB and its variants, such as pro-environmental planned behavior (PEPB), are relevant for studying individual behavioral intentions, especially in the context of crises or environmental issues (Li and Jiang 2023; Yunita 2024), but are less able to capture technological and affective factors. TOE is helpful at the organizational level, such as in MSMEs (Sousa et al., 2023), while AMO focuses on user engagement in the context of eWOM (Al Naim et al., 2023). Flow Theory excels in immersive experiences, although it needs to be combined with formal models such as TAM or UTAUT (Wu et al., 2024). Additional models, such as the ISCM (Yuce et al., 2020), diffusion of invention (Beştaş 2024), and the theory of

reasoned action (Yusoff et al., 2020), fulfill distinct purposes. However, both are limited in explaining systemic and technical dimensions.

Table 3
Comparison of strengths and weaknesses of technology adoption frameworks**.**

Framework	Advantages	Disadvantages	Sources
UTAUT2 (Trust; Innovativeness; Security; Aesthetics; Design dimensions; Hybrid SEM-ANN)	Comprehensive, explains affective perceptions (HM, HB, SI, FC) High R^2 for BI (≥60%) Flexible and adaptive (Trust, innovativeness, perceived value, security) - Adaptable to local context (Hybrid SEM-ANN) - Captures design and aesthetic aspects	High complexity and large data requirements - Some constructs are sometimes insignificant in certain contexts (SI, EE, PV) If hybrid (ANN), prone to overfitting and difficult to interpret - Difficult to replicate outside the local context	(Araújo Vila et al., 2021; Maulida et al., 2025; Mosbeh 2025; Rui et al., 2024)
UTAUT3	Specifically developed for immersive and mobile AR technology. Habit (HB) and hedonic motivation (HM) are proven dominant.	The performance expectancy (PE) and social influence (SI) constructs are not always significant. Performance depends on user habits.	(Wen et al., 2023)
TAM (Flow; TPB; Trust; SOR; AHP; Fuzzy logic; Innovativeness; WOM; DOI; Mobility; Memorable experience)	Simple, predictive, and adaptable Widely tested across multiple contexts Flexible for combining Flow (immersive experience), AHP and Fuzzy (multi-criteria decision-making), and WOM (social influence)	PU/PEOU factors remain dominant Lack of capturing formal social aspects and external support like UTAUT. Complexity increases when combined with AHP/Fuzzy Logic.	(Hamouda 2022; Marín Díaz et al., 2023; Wu et al., 2024)
TPB (Pure, PEPB, Policy orientation, Pandemic)	Focus on behavioral intention and control (PBC) Relevant for pro-environmental behavior and policy studies (PEPB) Effective for eWOM and individual behavior	Does not measure perceived usefulness/effort Doesn't capture technology and affective factors Needs to be combined with other frameworks for ICT adoption	(Li and Jiang 2023; Yunita 2024)
TOE	Strong in organizational readiness, MSMEs, and managerial contexts Explains the external and internal environments	Not focused on end-user perception Less suitable for smart systems user experience	(Bayona-Oré and Estrada 2021; Sousa et al., 2023)
AMO	Effectively explain motivation in eWOM Highlight abilities, drives, and opportunities in a structured manner.	Does not explain users' perceptions of technology Not suitable for explaining ICT adoption intentions	(Al Naim et al., 2023)
Flow Theory	Capturing immersive experiences Suitable for entertainment-based tourism/metaverse technologies	Lacks a formal technology construct Must be integrated with TAM or another framework	(Wu et al., 2024)
ISCM	Focus on the quality of systems, information, and services Suitable for formal technology systems	Does not explicitly describe user behavioral intentions Does not capture social or affective aspects	(Yuce et al., 2020)
DOI	Easy to understand, suitable for new technology studies Popular for early stage studies	Less quantitatively predictive Does not capture deep psychological & social factors	(Beştaş 2024)

Through this comparative analysis, UTAUT2 and UTAUT3 are identified as the most comprehensive and contextually relevant frameworks for investigating digital technology adoption, highlighting user experience, hedonic motivations, and habitual behavior. TAUT2 demonstrates superior adaptability and predictive capabilities for emotional perception (Araújo Vila et al., 2021; Mosbeh 2025; Rui et al., 2024), while UTAUT3 is relevant to immersive and mobile technologies, including augmented reality (Wen et al., 2023). TAM retains its significance due to its straightforwardness and compatibility with other theories, such as flow, trust, and DOI (Marín Díaz et al., 2023), despite its limited range of constructs. Therefore, to facilitate this study's goal of building a new, immersive, sustainable edutourism environment, the integration of UTAUT3 with related components of UTAUT2 and TAM is suggested as the primary conceptual framework. The methodology aims to provide an in-depth understanding of users' views, motives, and behavioral intentions, thereby enriching the literature on technology adoption.

3.4 Technology Adoption Models in Educational Tourism: A UTAUT Perspective

A comprehensive theoretical framework is essential to explain the aspects influencing the adoption of Smart ICT in educational tourism destinations such as geoparks. The UTAUT model, first created by Venkatesh et al., (2003) and later refined into UTAUT2 Venkatesh et al., (2012), is one of the most widely used and comprehensive frameworks. This approach integrates many previous theories of technology acceptance and has proven effective in explaining behavioral intentions and actual technology use in various settings, including education and tourism.

3.4.1 Evolution and core constructs of the UTAUT model

The UTAUT framework and its evolution into UTAUT2 serve as a comprehensive and adaptive theoretical model for examining technology adoption behavior across domains such as education and tourism. The original UTAUT model combined eight major theories, including TAM, TRA, IDT, and SCT, with four fundamental constructs: performance

expectancy, effort expectancy, social influence, and enabling conditions, in addition to moderators such as age, gender, experience, and voluntariness of use (Venkatesh et al., 2003). UTAUT2 refined the model by incorporating hedonic motivation, price value, and habit, thus increasing its predictive efficacy, particularly regarding consumer behavior and mobile technology. Subsequent modifications illustrated the model's adaptability; for instance, Penney et al., (2021) included trust and perceived risk factors into a study of digital financial services and discovered that trust significantly affected adoption intentions. Despite the strong predictive validity of UTAUT2, criticisms persist regarding inconsistent moderator results and limited cross-cultural generalizability. Tamilmani et al., (2021), through a meta-analysis of over 60 studies, noted that the relationship between PE and behavioral intention was highly consistent. Still, other constructs were highly dependent on the context and type of technology. With their structural flexibility and substantial empirical support, UTAUT and UTAUT2 are highly suitable for evaluating the acceptance of innovative technology in the context of experiential and sustainable educational tourism.

3.4.2 Contextualizing the UTAUT model in educational tourism

The use of UTAUT and UTAUT2 in educational tourism, particularly in geoparks, is becoming increasingly relevant with the development of digital technologies aimed at facilitating interpretive learning and promoting sustainable tourism practices. In this environment, technology adoption is shaped by a unique blend of recreational, educational, and ecological incentives. Therefore, contextual modification of the UTAUT framework is crucial to accommodate the specifics of educational tourism environments. Dwivedu et al., (2020) conducted a comprehensive meta-analysis, highlighting the need to consider contextual aspects such as trust, perceived risk, and cultural dimensions when using the UTAUT model in experience-based technology environments. Im et al., (2011) also emphasized that cultural variables substantially impact consumers' views toward technology adoption in various nations.

3.4.2.1 Performance expectancy

Performance expectation (PE) is a crucial determinant affecting an individual's desire to use technology, especially regarding smart ICT in educational tourism, since it is seen to improve both the learning and tourist experiences. Venkatesh et al., (2003) define performance expectancy (PE) as the degree to which a person perceives that using technology would improve their performance. In the realm of geopark oriented educational tourism, technologies like augmented reality guides, interactive geospatial maps, and mobile learning platforms may augment tourists' comprehension of geological heritage and sustainability concerns. Elements influencing PE encompass information efficiency, educational enhancement via visualization and multimedia material (Chen and Tsai 2012), and travel facilitation via navigation functionalities and real-time updates (Ólafsdóttir and Tverijonaite 2018; Tamilmani et al., 2021). Chao (2019) underscores the significance of emotional experiences, including pleasure and satisfaction, alongside trust and risk perception, in mediating the link between perceptions about advantages and behavioral intentions to use technology. Empirical studies demonstrate that perceived ease (PE) is a reliable predictor of use intention (Tamilmani et al., 2021; Venkatesh et al., 2012). Consequently, in the Ciletuh–Palabuhanratu Geopark region, it is imperative to develop ICT solutions that exhibit concrete advantages, such as improved information access, augmented learning, facilitated exploration, and the reinforcement of sustainable practices rooted in geological heritage.

3.4.2.2 Effort expectancy

Effort expectancy (EE) is a crucial determinant of technology adoption as it encapsulates users' opinions about the ease of understanding and using a system, particularly in educational contexts such as the Ciletuh–Palabuhanratu Geopark. Venkatesh et al., (2003) stated that EE indicates the level of ease of use of a system, particularly relevant for individuals with varying age demographics, digital literacy, and technical familiarity. Intuitive interface design, clear directions, and prompt technical assistance are crucial for reducing the complexity of interactive elements and learning materials. Barry et al., (2024) further reinforced EE's status as a key predictor of intention to use e-commerce, surpassing performance expectations and trust. Lien and Lee (2024) emphasized the importance of interface simplicity and technical assistance in post-disaster tourism revival. Therefore, the development of new technologies in the Ciletuh Geopark must prioritize accessibility, inclusivity, and adaptability to ensure broad acceptance among all visitors.

3.4.2.3 Social influence

Social influence (SI) is a vital element in the UTAUT model, as it indicates the degree to which people believe that significant others around them are driving the adoption of a technology. This is particularly relevant in the context of educational tourism destinations such as the Ciletuh–Palabuhanratu Geopark. Venkatesh et al., (2003) define social influence (SI) as pressure or encouragement from friends, family, authority figures, local communities, or dominant cultural standards. In the context of sustainable tourism, Ali et al., (2024) note that social influence can arise from destination authorities promoting app-based education systems, thereby setting favorable standards for tourists. For the Ciletuh Geopark, social impact can be enhanced through public communication strategies, partnerships with local influencers or education ambassadors, and formal support

from UNESCO or local conservation agencies to foster trust, increase digital engagement, and reinforce social norms about digital learning-based conservation.

3.4.2.4 Facilitating conditions

Enabling conditions (FC) are a crucial foundation for successful technology adoption because they reflect the extent to which individuals believe that technical, organizational, and resource support is available to enable effective technology utilization (Venkatesh et al., 2003). In the context of Smart ICT-based educational tourism, such as in the Ciletuh-Palabuhanratu Geopark, FC includes the availability of infrastructure, internet connection, compatible devices, technical assistance, user training, and policy support from area management. The absence of these elements has the potential to hinder users, both tourists and educators, from utilizing available technology. Research by Lien and Lee (2024) underscores the importance of technical compatibility and operational support in post-disaster tourism recovery. Therefore, FC not only ensures technical access but also enables optimal and sustainable use of educational technology by diverse users. Without adequate supporting conditions, even the best technological innovations risk failure in practical implementation.

3.4.2.5 Hedonic motivation

Hedonic motivation (HM), the level of pleasure or enjoyment an individual experiences when using a technology, is an essential affective factor that significantly influences users' behavioral intentions, particularly in the context of voluntary technology use, such as in educational tourism and experiential learning (Venkatesh et al., 2012). In the development of Smart ICT for destinations like the Ciletuh–Palabuhanratu Geopark, HM is highly relevant because technology that is not only functional but also enjoyable, through features like gamification, augmented reality, visual storytelling, interactive quizzes, and dynamic geological simulations, can increase user engagement and encourage continued adoption. Research by Ali et al., (2024) also emphasized that HM directly shapes positive attitudes and behavioral intentions in the context of sustainable tourism and technology-based learning. Ali et al., (2024) even modified UTAUT by adding HM, perceived enjoyment, and sustainable attitude, showing that enjoyable experiences impact long-term adoption and positive attitudes toward sustainable technology. Therefore, in the context of geoparks, the implementation of interactive and enjoyable Smart ICT will play a crucial role in creating a more engaging and memorable learning experience and supporting sustainable education goals.

3.4.2.6 Habit

In the UTAUT2 paradigm, Habit (HT) denotes an individual's inclination to instinctively execute an action due to prior experience and repetition, illustrating a reflexive rather than cognitive or emotional dimension of behavior Venkatesh et al., (2012). In the realm of technology-driven educational tourism, HT demonstrates the degree to which consumers have adapted to engaging with and using digital platforms, including geopark apps, augmented reality, interactive QR codes, and location-based learning modules. Individuals who routinely engage with analogous technology in their everyday lives are more inclined to use it during visits to tourist destinations. Research by Ali et al., (2024) shows that HT is a robust predictor of use behavior, at times surpassing the impact of behavioral objectives. In sustainable tourism, HT is formed through repeated interactions with technological features such as online booking systems and location tracking. In the context of the Ciletuh–Palabuhanratu Geopark, HT is a crucial indicator that site managers can leverage to design sustainable strategies by implementing user-friendly interfaces and features. This strategy not only accelerates the adaptation of new users but also strengthens repeat experiences and long-term loyalty to the educational technology system, where positive behavior emerges not from rational motivation but from established habit patterns.

3.4.2.7 Trust

Trust in the context of technology refers to users' belief that a system is secure, reliable, and consistently protects privacy and personal data. This is a key factor in driving technology adoption, primarily when the system accesses sensitive data, location information, or digital transactions. In the UTAUT model, trust serves as an additional construct that strengthens the relationship between key variables such as performance expectancy, effort expectancy, social influence, and facilitating conditions on behavioral intention, particularly when users encounter new technologies that require high levels of security and reliability. As user trust increases, the influence of perceived usefulness on usage intention becomes more significant. In the tourism sector, trust has also been shown to be a key determinant of technology acceptance. In the Ciletuh–Palabuhanratu geopark, the implementation of smart ICT-based educational technology presents challenges related to user trust, particularly in applications that access location, personal profiles, or transaction features. Therefore, the security, transparency, and validity of the system and its content must be guaranteed to build trust, which in turn encourages users to try, explore, and actively interact with the technology.

3.4.2.8 Culture

Culture significantly moderates technological adoption, embodying collective values, social conventions, and beliefs that shape individual perceptions and attitudes toward new technologies Venkatesh et al., (2003). In the realm of innovative ICT

advancement inside the Ciletuh–Palabuhanratu geopark, local culture, encompassing the local populace, domestic visitors, and foreign tourists, might impact the efficacy of technology implementation. Cultural influences influencing technology acceptability and use include preferences for digital vs face-to-face communication, attitudes toward innovation, and inclinations toward collectivism or individuality. Empirical research indicates that cultural characteristics, like uncertainty avoidance and collectivist-individualist orientation, may either amplify or diminish the impact of constructs like performance expectation and effort expectancy on intentions to use technology. Simultaneously, emphasize that baby boomers in smart tourism have enhanced cultural sensitivity, including a preference for direct contact and a need for security and social support. Their conceptual approach highlights that culture functions as both a social norm and a determinant of generational responses to technology. Therefore, it must be considered in formulating an education-oriented bright ICT adoption plan.

3.4.2.9 Behavioural intention

Behavioral intention (BI) indicates an individual's deliberate intention to use technology in the future. It serves as an essential metric for assessing technology uptake in geopark environments, as illustrated by the Ciletuh–Palabuhanratu study (Venkatesh et al., 2003). In this case, BI assesses the level of active visitor engagement in Smart ICT-based educational experiences. Research conducted by Ali et al., (2024) using the UTAUT-Tourism model showed that Performance Expectancy, Hedonic Motivation, and Habit strongly influence Behavioral Intention. However, Effort Expectancy, Social Influence, and Facilitating Conditions have a relatively small impact. Consequently, the strategic development of innovative ICT applications in geoparks must take into account the diversity of visitor demographics to formulate digital interventions that are more inclusive, flexible, and appropriate for various user interaction patterns.

3.4.3 Strengths and limitations of the UTAUT model

A bibliometric study using Scopus data (2006–2025) was performed to augment the theoretical examination of the UTAUT model and its expanded variables within the realm of educational tourism. The analysis used the search keywords: (“UTAUT” OR “unified theory of acceptance and use of technology”) AND (“tourism technology” OR “educational tourism”). This research aimed to delineate patterns in conceptual growth, connections among keywords, and theme placement throughout academic literature. The co-occurrence network findings (Figure 10) indicate two major clusters in the UTAUT literature. The red cluster focuses on concepts like “technology adoption”, “behavioral intention”, and “social influence”, which are fundamental elements of UTAUT and UTAUT2. Terminology such as “UTAUT” and “perception” is likewise situated around this node, suggesting a significant focus on behavioral intention dimensions. The blue cluster highlights methodological techniques like “structural equation modeling” and user demographic characteristics like “human”, “male”, “female”, and “expectancy”. This trend indicates that several studies persist in examining technology adoption behavior from the perspective of individual user traits.

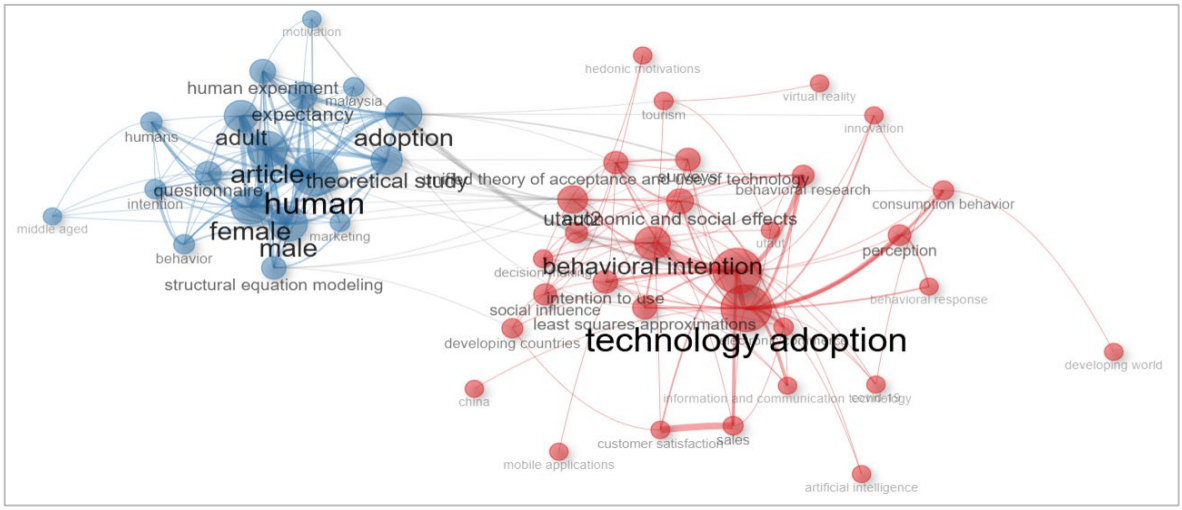

Fig. 10. Co-occurance network.

Additionally, the trend analysis shown in Fig. 11 reveals a significant rise in publication frequency since 2020, with repeating terms such as “UTAUT,” “UTAUT2,” “technology adoption,” “behavioral intention,” and “facilitating conditions.” This tendency solidifies UTAUT's status as a preeminent framework for elucidating technology use, particularly in educational and technology-driven tourist settings. Nonetheless, specific terms like “geo-heritage engagement” or “perceived learning value” are conspicuously missing, indicating that the incorporation of contextual educational aspects into UTAUT represents a research gap that needs additional investigation.

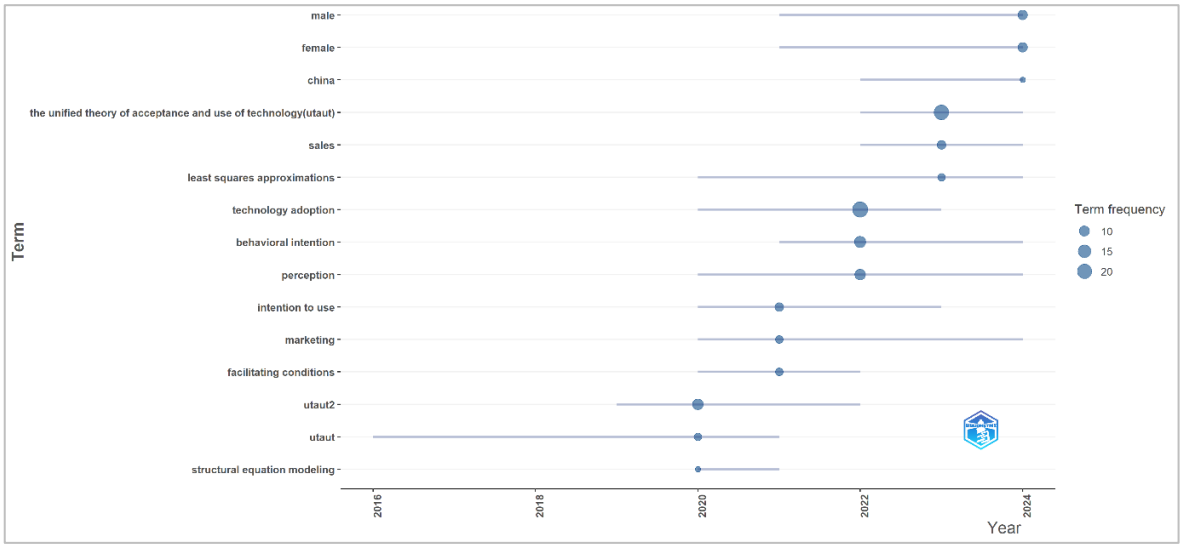

Fig. 11. Trend topics.

Additionally, the thematic map (Fig. 12) categorizes "technology adoption", "behavioural intention", and "UTAUT" as basic themes, indicating that while these concepts are central to the academic discourse, they require further methodological refinement and theoretical innovation. On the other hand, themes such as "innovation", "performance", and "users acceptance" are identified as niche themes, suggesting that derivative variables from UTAUT continue to evolve, although their application scope remains relatively limited.

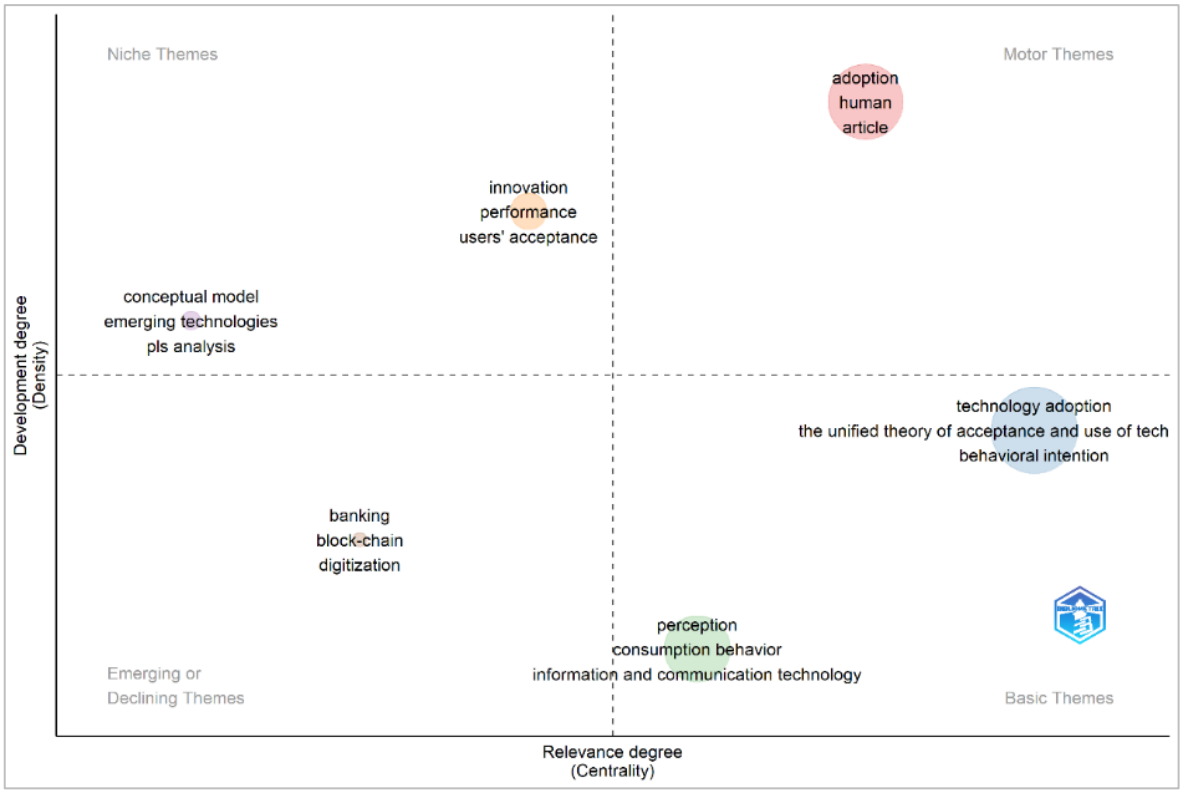

Fig. 12. Thematic map.

Although UTAUT remains a primary framework for technology adoption studies, its application in specific contexts such as educational tourism in geoparks remains rarely explored in depth. Bibliometric visualizations reveal that most global literature continues to focus on general technical and behavioral aspects, without integrating educational dimensions such as PLV and GHE, which are crucial for experiential learning. Therefore, future research is recommended to not only adopt UTAUT2 as the basis for analysis but also propose theoretical extensions by adding new constructs such as PLV and GHE, as well as moderating variables such as user education level and digital experience. This approach is expected to fill the research gap identified in bibliometric mapping and provide a more contextual understanding of innovative technology adoption in educational geopark tourism destinations.

3.5 Related work and research gap

The results of the preceding literature review and bibliometric analysis demonstrate a solid theoretical foundation for the use of UTAUT in explaining the adoption of smart ICT technologies within the broader domain of tourism and education (Fig. 13). However, several important research gaps persist, particularly in the context of smart educational tourism in geopark environments. Research on educational tourism and geopark-based learning rarely directly links it to the use of innovative technologies. However, ICT tools such as augmented reality, location-based apps, and digital heritage guides have begun to be used. Studies applying the UTAUT or UTAUT2 models in a tourism context are generally limited to general constructs such as performance expectancy and effort expectancy, without tailoring them to the learning objectives and geological heritage context of geoparks. Furthermore, essential constructs such as PLV and GHE have not been formalized as part of a technology adoption framework in this domain. The current literature also under-consider the influence of moderators such as user education level and digital experience, which are highly relevant in geopark settings with their demographically and educationally diverse visitor profiles.

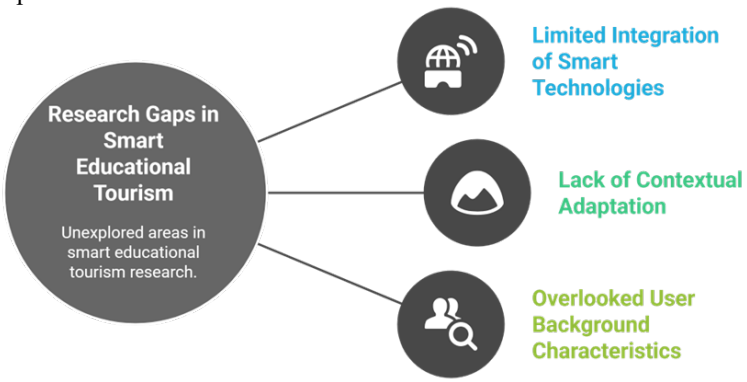

Fig. 13. Exploring research gaps in smart educational tourism.

Based on the identified research gaps, further studies are needed to develop a conceptual model that extends the UTAUT2 framework by adding two new constructs, namely Perceived PLV and GHE, and incorporating education level and digital experience as moderating variables. This model aims to provide a more contextual understanding of innovative technology adoption in educational tourism, particularly in the Ciletuh–Palabuhanratu UNESCO geopark. This approach is expected to provide theoretical contributions by bridging gaps in the UTAUT literature, while also giving empirical contributions through guidance on the implementation of ICT strategies that encourage educational engagement, sustainability awareness, and local participation in geopark destinations.

The developed conceptual model retains the core constructs of UTAUT2, namely performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit, and adds two new constructs, namely PLV and GHE, to capture users perceived learning value and emotional and cognitive engagement towards geological heritage and sustainability through innovative technology. In addition, two moderator variables, educational level and digital experience, are integrated to differentiate user responses based on formal educational background and comfort level in using technology for educational purposes. This structure is designed to foster a deeper understanding of technology acceptance within the context of educational geoparks. Based on the previous literature review, although UTAUT and UTAUT2 have been widely used in explaining user behavior towards digital technology (Ali et al., 2024; Venkatesh et al., 2012), there are still research gaps that open up opportunities for more contextual and relevant scientific contributions, especially in the development of learning technology in geopark destinations.

There are five key gaps in the literature that need to be addressed to develop relevant technology adoption models in geopark environments. First, most studies still focus on general destinations such as smart cities and tourism e-commerce, while technology adoption in the context of geoparks, which combine educational, ecological, and cultural aspects, remains rarely researched. Second, user motivation in the form of PLV has not received much attention, even though the perception of increased knowledge is a crucial driver of educational tourism (Chao 2019; Chen and Tsai 2012). Third, emotional and cognitive engagement with geological and cultural heritage, or GHE, has not been explicitly integrated into technology adoption frameworks. Fourth, research in the Indonesian context, particularly on geoparks that combine digital educational technology with natural and cultural heritage, is still minimal. Fifth, the UTAUT model needs to be contextually adapted to consider digital literacy levels, collective cultural norms, and sensitivity to trust to suit the characteristics of users in geoparks, including students and international tourists.

Based on the identified gaps, further research is needed to develop a more contextual and adaptive conceptual model for educational tourism needs in geopark areas. The main contribution of this research is the extension of the UTAUT2 model by adding two new constructs: PLV, which measures the perceived educational benefits of using Smart ICT, and GHE, which assesses users' cognitive and emotional engagement with geopark-specific geological and cultural content. The integration of these two constructs strengthens the functional and affective dimensions within the UTAUT2 framework, while adding

significant educational and local relevance, particularly in the Ciletuh–Palabuhanratu Geopark. Furthermore, this model considers the influence of local socio-cultural factors on users' behavioral intentions, thus offering conceptual and practical contributions to the development of inclusive, educational, and sustainable Smart ICT solutions in natural and cultural heritage-based tourism destinations.

3.6 Review of Conceptual Model UTAUT Extended

3.6.1 Perceived learning value

Perceived learning value (PLV) refers to the extent to which users perceive that the use of technology offers meaningful educational benefits and enhances their knowledge acquisition. In the context of geoparks, PLV encompasses the educational value derived from features such as interactive tours, geological content, audio-educational guides, and local knowledge quizzes that actively contribute to visitors' understanding of geoheritage and sustainability. Digital experiential learning that combines digital intelligence, sensory engagement, and interactivity has been shown to significantly increase visitors' PLV and creativity. However, studies on tourism MOOC adoption indicate that technological features alone do not necessarily correlate strongly with perceived learning; rather, high cognitive and emotional engagement play a key role in learning outcomes. Wu et al., (2024) also confirmed that perceived value, interactivity, and technological usefulness significantly influence users' behavioral intention to adopt an innovative tourism platform. Reinforcement of educational content was achieved through the integration of multimodal materials, text, images, audio, video, and interactive narratives such as quizzes, structured in an instructional manner from an introduction to geology to in-depth reflection. User surveys were used to assess the proportionality of educational benefits to effort expended, and the effectiveness of PLV as a predictor of user engagement may be moderated by academic background and learning interests, with users with higher education tending to report higher levels of PLV.

3.6.2 Geo heritage engagement

Geo-heritage engagement (GHE) refers to the extent to which visitors feel emotionally, interactively, and educationally engaged with geological heritage elements at a tourism site. In the context of this research, GHE denotes how Smart ICT through features such as augmented reality field tours, geology quizzes, 3D visualizations, and audio guides, enables visitors to interact directly with and better understand the geological significance of the Ciletuh-Palabuhanratu Geopark.

Recent research indicates that interactive and instructive methods, including 3D modeling, GIS applications, and augmented geovisualization, may improve tourist interaction with geological heritage and facilitate sustainable tourism growth. Research conducted in Fangshan Global Geopark, China, demonstrated that integrating geoheritage materials with interactive exploration methods significantly enhanced visitor engagement and comprehension of geological heritage (Wu et al., 2024). The Ciletuh–Palabuhanratu geopark enhances its GHE potential by incorporating immersive elements, such as augmented reality, digital geological trails, and 3D models, to facilitate educational exploration. Additionally, activities such as sulikeuizzes, geo-photography, and audio narration. Innovative apps can enhance conservation and local engagement by facilitating site condition reporting and community-based geo-storytelling. The assessment of GHE may be performed using metrics such as interaction length, completed quizzes, and user satisfaction ratings, which demographic characteristics like age, education level, and digital literacy may influence.

4. Conclusion

This study shows that a conceptual model formulation, derived from an extension of UTAUT2, incorporating the constructs of perceived learning value (PLV) and geo-heritage engagement (GHE), along with moderating factors of educational attainment and digital literacy, deftly addresses the intricacies of innovative technology adoption within the realm of geopark educational tourism. This concept offers a more contextual and relevant approach to user needs in locations such as the Ciletuh–Palabuhanratu UNESCO Global Geopark, which integrates elements of education, conservation, and local cultural engagement. Empirical research indicates that emotional elements, including hedonic motivation, geo-heritage engagement, and perceived educational value, significantly impact behavioral intentions and actual use of new technologies. Furthermore, habitual behavior and trust have been shown to enhance continued adoption, particularly among users accustomed to using digital applications in their regular routines.

Based on these results, further studies are recommended to assess the effectiveness of the model's application across geopark environments, both nationally and globally, to assess its generalizability and cross-cultural validity. Future efforts could expand the model's reach by integrating other components, such as Environmental Awareness, Community Engagement, and Gamification Experience, to encompass a more holistic learning experience. The application of a longitudinal, mixed-methods approach will enhance understanding of the dynamics of technology adoption over time, as well as its impact on environmental conservation behavior and local community empowerment through active engagement in a technology-based educational tourism ecosystem. This paradigm facilitates the evolution of geoparks into interactive learning environments and functional laboratories for sustainable and inclusive digital innovation.

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