

## A Scoping Review of Big Data Application in Assessing Rural Tourism Destination

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### **Abstract**

This scoping review explores the application of big data in assessing rural tourism destinations, with a focus on how AI-driven analytics, smart tourism tools, and digital platforms contribute to planning, management, and sustainability. Although digital innovation has advanced rapidly in urban tourism contexts, a significant research gap exists regarding its application in rural areas. Addressing this gap, the review synthesises recent empirical literature to provide thematic insights, and a conceptual understanding of how big data informs rural tourism development. Guided by the PRISMA-ScR framework, the study examines 11 articles sourced from Scopus and Web of Science. Three major themes emerged: (1) Technological Integration and Infrastructure Challenges, (2) Economic and Social Impacts, and (3) Policy and Governance. This review contributes to the discourse by mapping the digital transformation landscape in rural tourism and highlighting both opportunities and barriers. Future research directions and practical recommendations for policymakers and stakeholders are discussed to support inclusive and sustainable tourism development.

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## 1.0 INTRODUCTION

The swift and unprecedented advancement of digital technologies, particularly in the realms of big data and artificial intelligence (AI), has significantly reshaped the global tourism landscape, with increasingly visible impacts in rural contexts. Big data characterised by its volume, velocity, and variety combined with AI techniques such as deep learning, reinforcement learning, and natural language processing, enables tourism stakeholders to make more informed, data-driven decisions (Gretzel et al., 2015). In rural tourism specifically, these technologies contribute to smarter destination management, offer more personalised visitor experiences, and enhance analytical precision in tourism planning and marketing (Xie & He, 2022). By leveraging such digital tools, rural destinations can optimise resource use, respond more effectively to tourist demands, and support sustainable development goals.

Smart tourism solutions that harness big data are now being adopted in rural areas to address longstanding issues such as inefficient resource use, limited marketing reach, and unsustainable development practices. Applications range from geospatial mapping and GPS tracking to online review mining and mobile booking analysis. These innovations allow for more effective tourism demand forecasting, infrastructure optimisation, and environmental impact monitoring (Xie & He, 2022; Ranganai, Basera, & Muwani, 2022). In this way, big data not only enhances visitor satisfaction but also contributes to sustainable rural development through evidence-based policymaking and community-centred tourism planning.

However, the application of big data in rural tourism also presents a number of persistent challenges. These include the lack of digital infrastructure, low digital literacy among rural tourism operators, high implementation costs, and growing concerns around data privacy and governance (Xie & He, 2022; Tang et al., 2024). These barriers are particularly pronounced in low- to middle-income regions, where structural and resource limitations restrict the uptake of digital tools. Addressing these constraints requires coordinated efforts across public and private sectors, alongside robust policy frameworks that encourage ethical, inclusive, and context-sensitive adoption of smart tourism technologies (OECD, 2023).

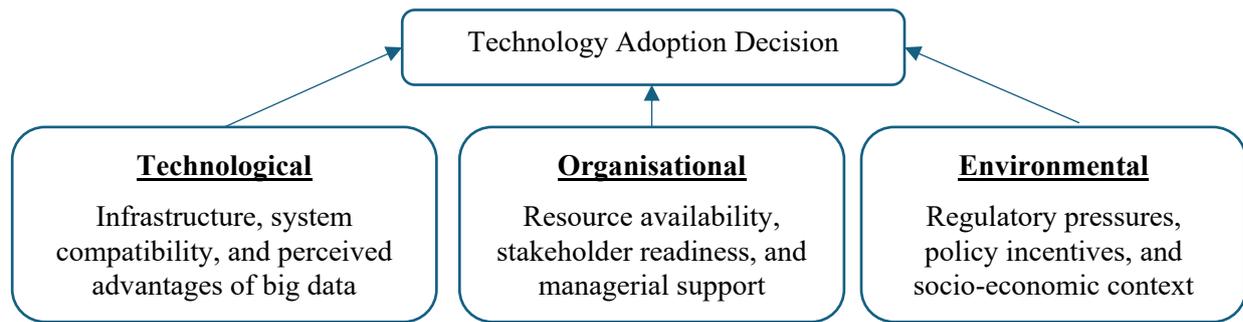
### 1.1 Research gap and justification

While the broader tourism literature has begun to acknowledge the potential of big data, there remains a limited scholarly synthesis that focuses specifically on its role in assessing rural tourism destinations. Existing reviews tend to examine smart tourism within urban or national contexts, often overlooking the unique infrastructural, socio-economic, and cultural characteristics of rural areas. Moreover, few studies attempt to systematically identify and classify the challenges and opportunities that emerge when applying big data analytics in rural tourism development.

This gap in the literature highlights the need for a dedicated scoping review that maps current research trends, evaluates the methodological approaches employed, and identifies the enabling and limiting factors affecting the integration of big data in rural settings. Such a review is critical not only for advancing academic understanding but also for informing policy, investment, and practice in rural tourism management.

### 1.2 Conceptual framework: Technological-Organisational-Environmental (TOE) Model

Despite these advancements, the adoption of big data in rural tourism remains uneven. Challenges such as digital infrastructure limitations, low data literacy, and insufficient policy frameworks continue to impede effective implementation (Xie & He, 2022; Tang et al., 2024). To conceptualise these complexities, this study adopts the Technological-Organisational-Environmental (TOE) framework, a well-established model in information systems research. The TOE framework categorises factors influencing technology adoption into three dimensions: technological, organisational, and environmental (Figure 1).



**Figure 1.** Technological-Organisational-Environmental (TOE) Framework.

By applying the TOE framework, this study systematically reviews how rural tourism stakeholders navigate opportunities and barriers in the adoption of big data. The framework serves as a lens to interpret findings and identify where gaps in practice and policy emerge across different rural tourism contexts.

Moreover, the utilisation of big data analytics within the context of rural tourism landscape planning is pivotal to advancing sustainable tourism development. The implementation of geospatial mapping, predictive modelling, and AI-assisted resource management significantly enhances land use planning, infrastructure development, and conservation efforts in rural settings (Baggio & Scaglione, 2018; Koo et al., 2019). These technological innovations ensure that tourism expansion remains economically viable, environmentally responsible, and culturally sustainable, thereby facilitating rural transformation and supporting local employment opportunities. When effectively integrated, big data tools enable planners to anticipate tourist flows, reduce pressure on ecologically sensitive sites, and align development with long-term sustainability goals. Big data-driven frameworks for landscape and tourism planning are instrumental in helping rural communities align tourism development with the preservation of cultural heritage and environmental conservation, thereby promoting a more balanced and sustainable approach to tourism growth (Gretzel et al., 2015; Koo et al., 2019). These tools enable planners to make informed decisions about land use, resource allocation, and tourist management by integrating diverse datasets and predictive models. Nonetheless, many rural destinations face significant barriers in adopting these technologies, including inadequate digital infrastructure, limited funding, and a shortage of technical expertise. Addressing these challenges requires coordinated efforts among governments, tourism stakeholders, and technology providers to expand the reach and inclusivity of smart tourism frameworks in rural areas (OECD, 2023).

While big data offers benefits such as improved demand forecasting, visitor segmentation, and sustainability planning, its potential remains underutilised in rural regions. The literature reveals scattered empirical insights, with limited synthesis on how AI and data analytics are deployed in rural tourism assessment. Moreover, few studies provide a consolidated overview of technological barriers, policy dynamics, or socio-economic implications specific to rural tourism.

This scoping review aims to fill the research gap by examining how big data is applied to evaluate rural tourism destinations. It systematically maps the literature using PRISMA-ScR guidelines and answers the research question: What are the challenges and opportunities associated with the application of big data in assessing rural tourism destinations? The review contributes to the discourse on digital transformation in rural tourism by identifying thematic trends, conceptual gaps, and practical implications for policymakers, researchers, and practitioners.

## 2.0 METHODS

This scoping review aims to map the state of empirical knowledge on big data applications in rural tourism assessment and to identify existing challenges and opportunities. Although several reviews explore smart tourism or big data in general, few focus specifically on the rural tourism context, where infrastructural, policy, and socio-economic challenges are more acute. Addressing this gap, our review synthesises recent empirical

studies to provide a structured understanding of how digital innovations are integrated in rural tourism strategies.

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses – Extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco et al., 2018). The review includes studies published between 2020 and 2024 that apply big data tools to assess or support rural tourism development.

## 2.1 Article Selection Process

To find the targeted literature, we searched two widely used digital academic databases related to big data and rural tourism; Scopus and Web of Science. These platforms were chosen due to their comprehensive coverage, high indexing standards, and wide inclusion of peer-reviewed publications across the fields of tourism, information systems, rural development, and technology studies. Both databases are commonly used in systematic reviews and are known for providing multidisciplinary and globally relevant content. The search terms were constructed with a Boolean logic. During the search process, the following selection criteria were set in the search engine; (a) article; (b) English; (c) 2020-2024. As the search engines of different databases have different ways of setting options, the search criteria settings were adjusted to suit each database. The initial search was completed on 11 February, 2025, as depicted in Table 1.

**Table 1.** The Search String for two databases

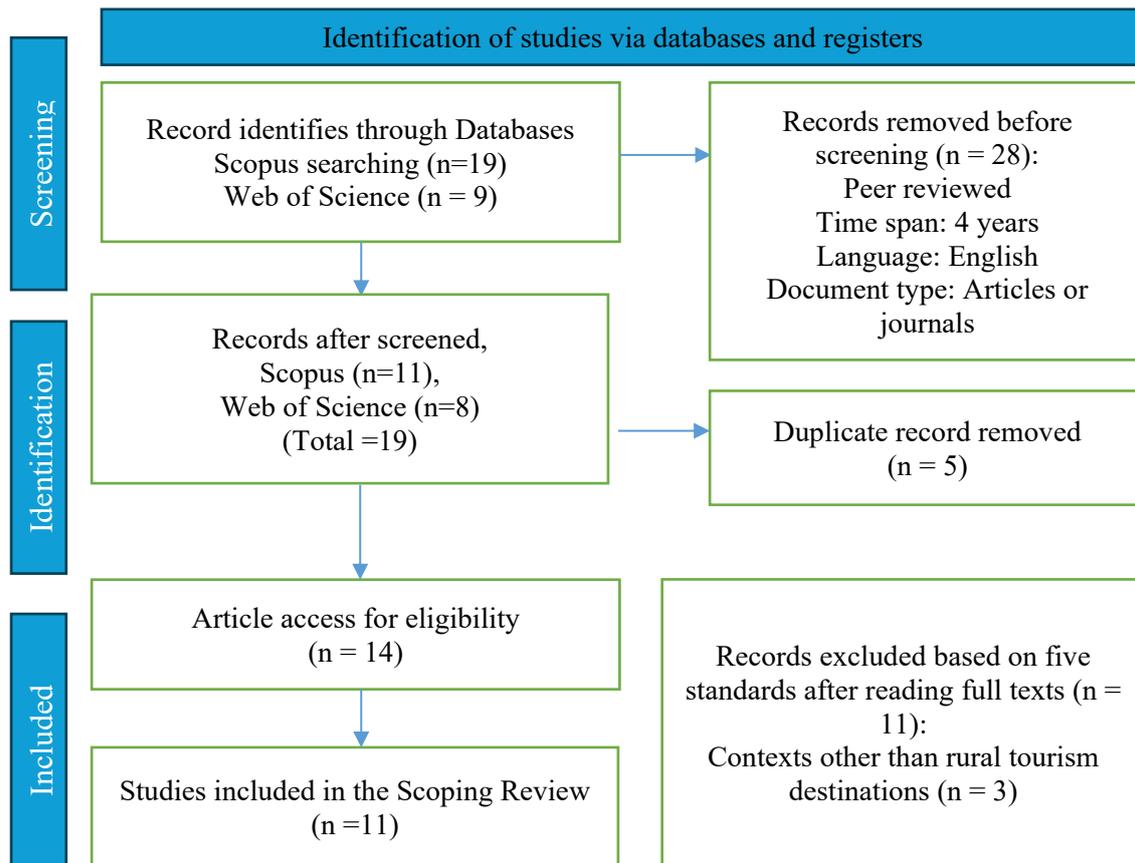
Scopus	TITLE-ABS-KEY ( ( "Big Data" OR "Data Analytics" OR "Machine Learning" OR "Artificial Intelligence" ) AND ( "Assess*" OR "Evaluat*" OR "Monitor*" OR "Measure*" OR "Analysis" ) AND ( "Rural Tourism" OR "Rural Destinations" OR "Rural Travel" OR "Rural Hospitality" ) AND ( "Application" OR "Utilization" OR "Implementation" ) )
Web of Science	TS=( ( "Big Data" OR "Data Analytics" OR "Machine Learning" OR "Artificial Intelligence" ) AND ( "Assess*" OR "Evaluat*" OR "Monitor*" OR "Measure*" OR "Analysis" ) AND ( "Rural Tourism" OR "Rural Destinations" OR "Rural Travel" OR "Rural Hospitality" ) AND ( "Application" OR "Utilization" OR "Implementation" ) )

## 2.2 Inclusion and Exclusion Criteria

The review focused on empirical studies published between 2020 and 2024. The following inclusion and exclusion criteria were applied as shown in Table 2. Likewise, Figure 2 shows the process of the selection.

**Table 2.** Inclusion and Exclusion Criteria

Inclusion	Exclusion
<ul style="list-style-type: none"> <li>Articles published in peer-reviewed journals</li> <li>Written in English</li> <li>Focused on rural tourism destinations</li> <li>Involving the application of big data or AI technologies in assessment or management</li> </ul>	<ul style="list-style-type: none"> <li>Theoretical or conceptual articles without empirical data</li> <li>Systematic literature reviews or meta-analyses</li> <li>Studies focusing exclusively on urban or national-level tourism</li> <li>Articles with inaccessible full texts</li> </ul>



**Figure 2.** Flow diagram of the proposed scoping review searching study.

### 2.3 Article Identification

The screening and inclusion procedures were then applied to select the appropriate article for three research questions formulated earlier. First, five duplicate articles were removed and eliminated for this study. Next, peer-reviewed articles are conducted to get through the big data applications and rural tourism, excluding some analyses, including systematic literature reviews and also meta-analyses. The full text of the remaining articles (n=14) was analysed for criteria for context other than rural tourism destination (n = 3). Most articles were published between 2021 and 2024, the final results will be n=11 articles as big data applications are more acceptable in rural tourism contexts, particularly in the university context. Table 3 shows the summary of articles excluded after full-text review:

**Table 3.** Summary of Articles Excluded After Full-Text Review

Reason for exclusion	Number of articles
Context not related to rural tourism	3
Theoretical or conceptual papers (no empirical data)	5
Focused on urban/national tourism or unrelated domains	2
Full text not accessible	1
Duplicate not previously identified	1

## 2.4 Coding and Analysis

A structured data extraction form was used to collect key information from each included article, such as: publication year, country of study, type of big data application, rural tourism context, and key findings. To ensure consistency, a collaborative coding process was undertaken by all authors, followed by validation from an independent reviewer. Data were then categorised thematically using the Technological-Organizational-Environmental (TOE) framework to guide synthesis. This enabled a structured analysis of the conditions that enable or constrain the adoption of big data in rural tourism, with results grouped into three overarching themes.

## 3.0 RESULTS AND FINDINGS

All articles were categorised based on three main themes, which are the technological integration and infrastructure challenges in big data for rural tourism (4 articles), economic and social impacts of big data on rural tourism (4 articles), and policy and governance in big data implementation (3 articles), with a total of 11 articles. The details are shown in Table 4.

### 3.1 What are the challenges and opportunities associated with the application of big data in assessing rural tourism destinations?

**Table 4.** The Summary of Authors, Year, Aim and Key Findings.

Authors	Year	Aim	Key Finding
Sang, Q., Hu, Y.	2024	Categorize rural ecotourism resources using AI and evaluate development potential for environmental protection strategies.	GIS database constructed for rural ecotourism resource evaluation.
Gan, L.	2024	Modernize rural tourism using artificial intelligence technology as well as support effective implementation of rural revitalization strategy.	Rural tourism boosts economic levels and social progress and significant increase in tourist numbers and income since 2014.
Chen, L.	2024	Improve rural tourism landscape planning using big data technology and promote rural transformation, development, and farmers' income.	Clustering algorithm improves rural tourism landscape planning accuracy.
Li, B.	2023	Drive rural revitalization through cultural tourism development.	Rural cultural tourism drives rural revitalization and farmer income.
Huang, Y and Li, EW	2023	Identify strategies for improving heritage performance.	Strategies identified to improve heritage utilization performance.
Aparicio Castillo, S., Basurto Hornillos, N., Arranz Val, P., Antón Maraña, P., Herrero Cosío, Á.	2022	Predict tourist recommendations for rural destinations.	Data balancing techniques improve learning from unbalanced datasets.
Xie, D., He, Y.	2022	Study marketing strategies using big data and AI and enhance rural tourism experience and revenue generation.	Many rural operators resist adopting smart tourism technologies.

Li, H.	2022	Develop rural smart tourism strategic model using big data and improve management, services, and rural economy through smart tourism.	Smart tourism enhances rural management and economic development. Big data improves tourist flow management and service quality.
Chen, L., Hu, H., He, X., Lyu, M.	2022	Study rural tourism development path using big data.	Clustering integration algorithm enhances rural tourism development path. Tourism revenue increased by over 300,000 yuan in 2021.
Yang, WL; Fan, B; Shao, T	2022	Explore and revive rural culture through tourism and analyze spatial characteristics of rural cultural landscapes.	Proposed solutions to enhance cultural quality in rural tourism.
Park, E and Kim, W	2021	Understand factors driving citations in scholarly articles.	Online media and sharing economy topics receive numerous citations.

### 3.2 Technological Integration and Infrastructure Challenges in Big Data for Rural Tourism

The integration of big data into rural tourism assessment offers a multitude of opportunities for advancing tourism management, visitor experiences, and environmental conservation. Nevertheless, a primary impediment to its effective implementation is the deficiency of technological infrastructure in rural regions. Numerous rural destinations encounter challenges with substandard digital infrastructure, exemplified by restricted access to high-speed internet, inadequate cloud computing capabilities, and the lack of Internet of Things (IoT) applications to foster smart tourism development. These technological deficiencies inhibit the capacity of tourism stakeholders to utilise big data for predictive analytics, real-time monitoring, and personalised service delivery. Among the 11 reviewed articles, four specifically addressed these infrastructure-related challenges, underlining how gaps in technological readiness hinder the broader adoption of data-driven tourism strategies (Xie & He, 2022; OECD, 2023).

Numerous studies underscore the necessity for advanced technological frameworks to optimise the utilisation of big data analytics within the context of rural tourism. For instance, Xie and He (2022) examined rural tourism marketing strategies supported by big data and artificial intelligence and found that while these technologies significantly improve service delivery and tourist flow management, inadequate digital infrastructure remains a substantial barrier to broader adoption. Similarly, Tang et al. (2024) investigated the integration of digital cultural tourism into rural revitalisation strategies and reported that although data-driven solutions offer benefits, infrastructure and connectivity limitations hinder implementation in under-resourced rural areas. The Organisation for Economic Co-operation and Development (OECD, 2023) also emphasises that while rural destinations can benefit from AI and big data applications, achieving full potential requires major investments in digital infrastructure and cross-sector partnerships to overcome technical and operational challenges.

Moreover, the integration of machine learning into rural tourism marketing strategies suggests that artificial intelligence and big data can significantly enhance promotional efforts and improve operational efficiency. These technologies enable targeted advertising, real-time customer interaction, and personalised content delivery, which are particularly valuable in attracting and retaining tourists (Xiang et al., 2021). Nevertheless, research highlights that many rural tourism operators remain hesitant to adopt such technologies due to high implementation costs, limited digital infrastructure, and insufficient digital literacy among stakeholders (OECD, 2023). These barriers underscore the importance of context-sensitive strategies that account for the financial and educational constraints facing rural tourism enterprises. The development of AI-based tourism marketing strategies in rural China further corroborates these observations, highlighting the critical need for human capital development and improved infrastructure to support sustainable digital tourism initiatives (Xie & He, 2022). Furthermore, investigations into the utilisation of heritage sites within historic

villages indicate that a deficiency in technological resources impedes the capacity to adopt data-driven cultural tourism strategies, thereby constraining the potential economic and social advantages of rural tourism (Li, 2022). A classification of technological challenges that emerged from the literature is shown in Table 5.

**Table 5.** The Classification of Technological Challenges

Category	Examples	Sources
Infrastructure gaps	Lack of broadband, cloud platforms, or IoT devices	OECD (2023); Xie & He (2022)
Capacity and literacy	Inadequate skills to operate big data tools	Gretzel et al. (2015); Xiang et al. (2021)

Recent research highlights that although clustering algorithms and predictive analytics can improve tourism flow management, many rural destinations lack the foundational digital infrastructure required for implementation (Xie & He, 2022). Studies examining smart tourism applications in rural East Asian contexts have shown positive outcomes where targeted investment and policy support exist, yet these cases remain highly context-specific and not easily replicable in resource-constrained settings (Tang et al., 2024). Moreover, much of the literature originates from technologically advanced regions such as China and South Korea, leading to a geographic skew in the evidence base and limited insights from the Global South, where infrastructure challenges are likely more pronounced (Gretzel et al., 2015). Small-scale rural operators often demonstrate reluctance to adopt digital tools, citing technical complexity, cost, and limited digital skills, whereas institutional actors and government-led projects show higher readiness and optimism regarding smart technology integration (OECD, 2023). This disparity underscores the importance of adopting differentiated strategies that reflect the varying capacities, contexts, and digital readiness of rural tourism stakeholders.

The summary of the reviewed articles highlights that although big data offers significant potential to revolutionise rural tourism, challenges in technological integration and infrastructure persist as a core issue (Xie & He, 2022). Overcoming these obstacles necessitates specific investments in digital infrastructure in rural areas, training stakeholders in AI and data analytics, and implementing supportive policies to encourage the broad use of smart tourism technologies. Lacking these initiatives, the advantages of big data in evaluating rural tourism will largely go unexploited, thereby restricting its ability to promote economic growth, sustainable development, and improved visitor experiences.

### 3.3 Economic and Social Impacts of Big Data on Rural Tourism

Big data technologies have demonstrated significant potential to generate economic and social benefits in rural tourism. Empirical evidence points to increased tourism revenue, enhanced job creation, and improved service delivery when data-driven approaches are successfully applied (Xiang et al., 2021; Koo et al., 2019). However, adoption remains uneven, and the broader impacts of big data depend heavily on local readiness, stakeholder digital literacy, and institutional support. The reviewed literature presents both opportunities and limitations, summarised as depicted in Table 6.

**Table 6.** Impact Dimensions, Outcomes, and Risks.

Impact dimension	Positive outcomes	Challenges or risks
Economic	Optimised pricing strategies, higher revenue, increased visitor flows	Digital divide; cost barriers for SMEs and local operators
Employment	Creation of new digital job roles (e.g., data analysts, digital marketers)	Skills mismatch; exclusion of older or less tech-savvy operators
Social inclusion	Targeted tourism experiences for niche and underserved groups	Risk of marginalising communities with low digital access

Studies show that AI-driven platforms can tailor tourism offerings to match visitor preferences, increasing customer satisfaction and encouraging repeat visitation (Gretzel et al., 2015; Xiang et al., 2021). Data-driven strategies have also demonstrated potential in boosting tourism-related income and job creation, particularly in digitally advanced destinations (Koo et al., 2019). However, these benefits are not evenly distributed. Many rural tourism stakeholders face significant challenges including limited digital literacy, insufficient funding, and inadequate infrastructure that hinder their ability to adopt advanced technologies (Xie & He, 2022; OECD, 2023). This has raised concerns about digital exclusion, wherein only well-resourced and tech-savvy operators can fully capitalise on big data, potentially widening economic disparities within the tourism sector.

One of the most critical gaps is the absence of longitudinal research. None of the studies assessed long-term economic outcomes, sustainability impacts, or post-adoption adaptation challenges. Furthermore, there is minimal evidence on how big data affects gender equity, youth employment, or cultural preservation, indicating directions for future inquiry.

### **3.4 Policy and Governance in Big Data Implementation**

The third major theme identified in the reviewed articles pertains to the influence of policy frameworks and governance in enabling the effective adoption of big data within the realm of rural tourism. Several studies have explicitly addressed the insufficiency of regulatory frameworks, concerns over data privacy, and the lack of coordinated governance mechanisms as primary obstacles to big data implementation (Xie & He, 2022; Tang et al., 2024; OECD, 2023). A principal concern in the application of big data within rural tourism is the lack of explicit policies governing data ownership and access rights. This regulatory vacuum creates legal ambiguities, which in turn discourage tourism stakeholders from investing in data-driven initiatives. Furthermore, privacy issues related to visitor tracking and AI-powered recommendations have raised ethical questions regarding transparency, informed consent, and data misuse (OECD, 2023). These concerns highlight the urgent need for robust governance frameworks that ensure responsible data usage. Opportunities exist to establish standardised governance models that promote equitable data-sharing agreements, protect consumer privacy, and foster transparency. Research suggests that collaboration between public authorities, technology providers, and rural tourism enterprises can support the development of ethical AI guidelines and sustainable data ecosystems (Gretzel et al., 2015). In addition, policy instruments such as government-backed infrastructure grants, digital literacy training, and regulatory oversight can help bridge the digital divide and enable smaller tourism enterprises to participate in the digital transformation.

### **3.5 Synthesis and Cross-Cutting Observations**

A comparative synthesis across the three thematic categories, which are technological integration, socio-economic impacts, and governance, reveals several recurring issues and gaps in the current literature on big data application in rural tourism assessment. While each theme presents unique challenges and opportunities, the following cross-cutting observations emerge.

First, the current body of empirical evidence is geographically concentrated, with the majority of studies originating from East Asian countries, particularly China. Although these contexts provide valuable insights into digital innovation and smart tourism deployment, this geographic skew limits the generalisability of findings to other rural settings, particularly in the Global South, where infrastructural and institutional constraints are often more pronounced. The absence of research from Africa, South America, and parts of Southeast Asia signals a critical need for more regionally diverse studies.

Second, a notable asymmetry exists among stakeholders involved in big data adoption. Government agencies and larger tourism operators are typically more capable of leveraging data-driven technologies due to greater access to funding, infrastructure, and expertise. In contrast, small- and medium-sized enterprises (SMEs), community-based tourism providers, and independent rural actors often face systemic disadvantages, including limited digital literacy, financial constraints, and inadequate policy support. This disparity not only limits widespread adoption but also exacerbates existing inequalities within rural tourism ecosystems.

Third, the reviewed literature tends to focus on short-term technological applications and outputs, such as revenue growth, visitor satisfaction, or system efficiency. Few studies evaluate the long-term or systemic impacts of big data adoption on rural tourism sustainability, cultural preservation, or community resilience.

Moreover, there is little empirical assessment of how digital tools reshape power dynamics among stakeholders or influence social equity outcomes.

Fourth, the methodological scope of the studies is relatively narrow. While several articles examine clustering algorithms, recommendation models, or basic data analytics tools, more advanced techniques, such as sentiment analysis, geospatial AI, blockchain integration, or digital twin simulations, are rarely discussed. This suggests an underutilisation of the broader range of big data capabilities that could enhance rural tourism planning and assessment.

Collectively, these cross-cutting observations underscore the complexity of integrating big data into rural tourism contexts. They also emphasise the importance of pursuing more inclusive, longitudinal, and methodologically diverse research to support evidence-based policymaking and digital capacity building in rural areas.

### **3.6 Discussion, Implications, and Future Directions**

The findings from this scoping review highlight the transformative potential of big data applications in assessing rural tourism destinations. However, several challenges related to infrastructure, economic and social adaptation, and governance frameworks need to be addressed for successful implementation. This section discusses the key implications of the study and outlines future research directions.

## **4.0 DISCUSSION**

The integration of big data and AI technologies in rural tourism presents both opportunities and significant challenges. On the one hand, the ability of big data to analyse visitor preferences, optimise tourism marketing strategies, and improve service efficiency has been widely acknowledged (Xie & He, 2022; Xiang et al., 2021). These technologies allow for more precise targeting, real-time feedback, and enhanced service delivery, which can benefit both tourists and local enterprises. On the other hand, concerns regarding data privacy, digital literacy, and economic disparities persist, raising questions about whether rural communities are adequately prepared to embrace these technological advancements (Tang et al., 2024; OECD, 2023). In particular, small operators in less-developed regions often lack the necessary skills, infrastructure, or financial resources to fully leverage big data tools, potentially exacerbating existing inequalities in the tourism sector.

A major issue is the technological divide between urban and rural areas, which continues to widen as digital infrastructures in rural tourism destinations remain underdeveloped. While urban tourism has benefited from sophisticated AI-driven solutions, many rural areas struggle with basic digital connectivity, thereby restricting the full-scale adoption of big data (Xie & He, 2022; OECD, 2023). This divide is further compounded by the limited technical expertise among rural tourism operators, who often lack the necessary training to leverage big data analytics effectively (Tang et al., 2024). Without proper technological investments and educational initiatives, the benefits of big data remain inaccessible to many small-scale tourism businesses operating in rural areas.

Beyond technical challenges, the socioeconomic consequences of big data-driven tourism require further scrutiny. Proponents argue that big data enhances tourism competitiveness and increases visitor engagement by providing real-time insights into market trends (Gretzel et al., 2015; Xiang et al., 2021). However, concerns about over-commercialisation and cultural dilution are equally legitimate and demand careful attention. Although few empirical studies directly address this issue, existing literature has raised cautionary notes. For example, some scholars have observed that digitalisation and data-driven planning may transform local cultural performances into staged, homogenised experiences designed to maximise tourist satisfaction rather than preserve authenticity (Korstanje & George, 2015). Such instances, while not yet widespread, highlight a potential risk: data-centric tourism models may inadvertently commodify culture, standardising experiences to optimise engagement metrics rather than safeguarding local identity. Therefore, longitudinal and cross-cultural research is urgently needed to evaluate whether these dynamics are isolated or indicative of systemic trends in rural smart tourism development.

The debate on ethical concerns surrounding big data is another significant dimension of this discussion. While AI-powered tools can improve visitor experiences and enhance sustainability efforts, they also raise fundamental questions about data ownership, consent, and surveillance. Studies indicate that many tourists remain unaware of how their data is collected and utilised by tourism businesses (OECD, 2023). Without strict

regulatory frameworks, there is a risk of data exploitation, where visitors' digital footprints are monetised without their explicit consent. The absence of comprehensive data protection policies in rural tourism further exacerbates these concerns, making it imperative for policymakers to establish robust data governance mechanisms.

#### 4.1 Implications

The implications of these findings extend across multiple dimensions, including policy formulation, industry practices, and academic research. One of the most pressing implications is the need for strategic investments in digital infrastructure. Rural tourism destinations must bridge the digital divide by expanding broadband access, enhancing cloud computing capabilities, and integrating Internet of Things (IoT) technologies. Collaborative efforts between governments, technology providers, and tourism stakeholders are essential to ensure that rural areas have the foundational infrastructure required to support and sustain big data applications effectively (OECD, 2023; Tang et al., 2024). Without such coordinated action, the transformative potential of big data in rural tourism may remain unrealised, exacerbating existing disparities between urban and rural destinations.

Moreover, the findings suggest a strong case for capacity-building initiatives. While big data presents numerous benefits, its full potential can only be realised if tourism stakeholders are adequately trained in AI literacy, data analytics, and smart tourism management. As Gretzel et al. (2015) emphasise, the successful implementation of smart tourism technologies depends not only on infrastructure but also on human capital capable of leveraging these tools effectively. This underscores the need for structured training programs targeting rural tourism operators, equipping them with the knowledge and skills to interpret and act on data insights. Such programs can empower local stakeholders to use data-driven strategies to enhance service delivery, optimise visitor experiences, and foster more resilient tourism enterprises.

The ethical concerns surrounding big data necessitate the formulation of transparent governance models. Policymakers must establish clear regulations that define data ownership, usage rights, and privacy protections to prevent misuse (Li, 2022). The absence of such frameworks risks creating an exploitative tourism ecosystem where data is extracted without benefiting local communities. Ethical AI principles should be embedded within tourism policies to promote responsible data practices while fostering trust among stakeholders.

#### 4.2 Future Research Directions

Given the evolving nature of big data in rural tourism, future research should explore how AI-driven personalization affects the authenticity of rural tourism experiences. While AI technologies can enhance visitor satisfaction by offering tailored recommendations and predictive analytics, their excessive use may risk diluting the organic and cultural distinctiveness that defines rural destinations (Gretzel et al., 2015; Xiang et al., 2021). For instance, hyper-personalization based on big data can lead to standardized tourist experiences that prioritize convenience over cultural immersion. Therefore, future studies should investigate how technological innovation can be balanced with cultural preservation, ensuring that smart tourism tools support rather than override the unique socio-cultural contexts of rural communities. This line of inquiry is critical to preventing rural destinations from becoming overly homogenized and losing their sense of place.

Additionally, more longitudinal research is needed to assess the long-term socioeconomic impact of big data in rural tourism. While existing studies often highlight short-term benefits such as enhanced tourist engagement, improved marketing efficiency, and short-term revenue growth (Xie & He, 2022; Xiang et al., 2021) the sustainability of these impacts remains uncertain. It is unclear whether data-driven tourism models truly foster enduring community development or if they risk creating dependencies on external technological providers and platforms. Future research should explore whether such innovations support inclusive growth and capacity-building among local stakeholders or instead reinforce digital divides and structural inequities within rural tourism economies.

Another critical research direction involves the development of governance models that ensure ethical big data practices in tourism. Policymakers must explore legal frameworks that balance innovation with privacy protection, ensuring that tourism stakeholders adopt fair and transparent data-sharing agreements (OECD, 2023). Additionally, future research should investigate the role of public-private partnerships in fostering

sustainable big data applications, examining how collaborative models can maximize benefits for both tourism businesses and local communities.

As rural tourism continues to evolve in the digital age, it is imperative that researchers, policymakers, and industry stakeholders engage in a critical dialogue on how to integrate big data responsibly. While the potential benefits of big data are undeniable, its implementation must be approached with caution, ensuring that rural tourism remains sustainable, inclusive, and ethically sound. Addressing these critical concerns will enable the development of data-driven rural tourism models that not only enhance economic opportunities but also protect the cultural and environmental integrity of rural destinations.

## 5.0 CONCLUSION

This scoping review examined the application of big data in assessing rural tourism destinations, identifying both its transformative potential and the multifaceted challenges that hinder its widespread adoption. The findings indicate that big data analytics, particularly when powered by AI tools, can significantly enhance tourism planning, personalise visitor experiences, and support sustainability goals. Moreover, smart data-driven frameworks offer opportunities to strengthen decision-making, optimise resource allocation, and improve competitiveness in rural destinations.

However, the review also reveals persistent barriers, particularly around digital infrastructure deficits, low technological literacy, and fragmented governance structures. These challenges disproportionately affect small-scale rural operators, thereby reinforcing existing inequalities in access to digital tools and tourism markets. Ethical issues surrounding data privacy, ownership, and algorithmic bias further complicate the adoption landscape. As such, the successful implementation of big data in rural tourism requires not only technical innovation but also strategic policy interventions, inclusive capacity-building efforts, and robust data governance mechanisms.

As with all literature reviews, this study has several limitations. First, the review was limited to peer-reviewed articles published in English between 2020 and 2024, retrieved solely from the Scopus and Web of Science databases. This selection, while methodologically consistent, may have excluded relevant studies published in other languages or indexed in alternative databases such as IEEE Xplore, Google Scholar, or regional repositories. This introduces a potential language and database bias, which may skew findings toward more developed and digitally advanced regions.

Second, the review focuses exclusively on empirical studies, intentionally omitting theoretical papers and systematic literature reviews. While this enhances relevance to practical implementation, it may have excluded conceptual insights that could enrich theoretical framing.

Third, the reviewed studies exhibit significant methodological heterogeneity, including variations in data types, analytical tools, and evaluation metrics. This diversity limits direct comparisons and complicates the identification of consistent trends across geographic and disciplinary boundaries.

Fourth, the geographic distribution of studies is highly uneven, with a strong concentration in East Asian contexts, particularly China. There is a marked underrepresentation of research from the Global South, especially sub-Saharan Africa, Latin America, and parts of Southeast Asia, where rural tourism often operates under vastly different constraints. This limits the generalisability of the findings and underscores the need for more inclusive research efforts.

Finally, this review does not include a meta-analysis or empirical verification of outcomes. As a result, the depth of quantitative insight is limited, and findings should be interpreted with caution, particularly where long-term or causal impacts are concerned.

To address these gaps, future studies should pursue interdisciplinary and mixed-method approaches, combining qualitative insights with longitudinal data and case-based validation. Particular emphasis should be placed on evaluating the long-term impacts of big data adoption on rural communities, cultural preservation, and environmental sustainability. Additional research is also needed to examine ethical implications, such as data surveillance, AI bias, and platform monopolies, in greater depth. Finally, researchers should explore strategies for capacity-building and inclusive technology transfer, ensuring that data-driven innovation aligns with the values, capabilities, and aspirations of rural communities.

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