Integrating spatio-temporal and psychological perspectives: A new research direction in smart tourism

This research note will be published in the Journal of Smart Tourism

Seongsoo Jang (ORCID iD: 0000-0002-5948-0876)*
Senior Lecturer, Cardiff Business School, Cardiff University, UK
Aberconway Building, Colum Drive, Cardiff, CF10 3EU, United Kingdom
Tel : +44 78 5979 2745. Email: JangS@cardiff.ac.uk.

Jinwon Kim
Associate Professor, Department of Tourism, Hospitality and Event Management, University of Florida, USA
190D Florida Gym | PO Box 118208, Gainesville, FL 32611-8208, USA
Tel: +1 (352) 294-1625. Email: jinwonkim@ufl.edu.

* Corresponding author

Declaration of competing interest: Authors have no conflict of interest to declare.

Any acknowledgements: Authors have no acknowledgements.

Integrating spatio-temporal and psychological perspectives: A new research direction in smart tourism

Tourism is inherently a spatial phenomenon, encompassing a complex assemblage of mobile technologies, infrastructure, online and networked spaces, and the various actors involved in different forms of mobility (Hannam, Butler, & Paris, 2014). Smart tourism refers to tourism that is supported by integrated efforts in an ICT-enabled destination (smart destination), offering ICT-mediated tourism experiences (smart experience), and interconnecting stakeholders within the business ecosystem (smart business) (Gretzel et al., 2015). A significant portion of tourism activities—before, during, and after travel—takes place in electronic markets and on digital/social media platforms, where ICT systems serve as spatial intermediaries between buyers and sellers, as well as among tourists. This is often referred to as 'geospatial smart tourism.' Smart tourism markets can reduce buyer search costs and enable optimal allocation of productive resources (Bakos, 1997). Advances in mobile, social, and location-based technologies have created new opportunities for researchers and practitioners to better manage tourism products and services relevant to space and time, influencing tourists' spatio-temporal movements (Tussyadiah, 2012). Therefore, it is critical to consider space, time, and history when explaining the uneven spatial development of tourism and economic factors, a concept known as spatio-temporal evolutionary economic geography (Jang & Kim, 2022a).

The main research streams in smart tourism focus on several key dimensions, including tourist experience design, psychological perspectives, resident engagement, spatio-temporal analysis, and stakeholder collaboration (see Table 1). First, studies on tourist experience design examine the processes shaping experiences, leveraging geotagged social media and mobile apps for personalization and real-time feedback (e.g., Liu et al., 2022). Second, psychological perspectives are integrated to explore how tourists' traits influence their actual behaviors (e.g., Jang & Kim, 2022b). Third, resident engagement, often underrepresented in research, emphasizes the importance of balancing tourism benefits with community well-being (e.g., Wei et al., 2024). Fourth, spatio-temporal analysis combines conventional statistical data from online booking platforms, and geospatial sources to model and predict tourist behaviors and spatial patterns (e.g., e Silva et al., 2018). Lastly stakeholder collaboration research highlights the need for aligning goals among tourists, firms,

governments, and residents to achieve sustainable development (e.g., Buhalis & Amaranggana, 2014). However, most studies focus on isolated spatio-temporal or psychological perspectives, providing limited evidence on the causal relationships between psychological factors (e.g., emotions) and spatio-temporal behaviors (e.g., movement patterns). Therefore, smart tourism research demands deeper insights into not only the spatio-temporal ("where + when") patterns of tourism supply, demand, and markets, but also the underlying causes and implications of these phenomena ("why + so what").

Table 1. Main streams of research in smart tourism

Research stream	Primary focus	Key insights	References
Tourist experience design	Understanding and enhancing tourist journeys and experiences through smart technologies	GPS and location-based social network data can be utilized for spatio-temporal destination marketing	Liu et al. (2022); Tussyadiah (2012)
Psychological perspectives	Investigating how psychological traits and perspectives influence tourist decision-making	Combining geo-psychological and spatio-temporal data offers new research opportunities	Jang and Kim (2022b); Teo (2015)
Resident engagement	Examining the role of local residents in shaping smart tourism ecosystems	Smart tourism destinations should increase travellers' experiences and residents' quality of life	Wei et al. (2024)
Spatio-temporal analysis	Understanding tourists' movements and behaviors in space and time	GPS, geotagged content, and big data model spatio-temporal patterns and segment tourist behaviors	e Silva et al. (2018)
Stakeholder collaboration	Exploring interactions between tourists, tourism firms, governments, and other stakeholders	ICT enables interconnectedness but requires aligning diverse stakeholder goals	Buhalis and Amaranggana (2014); Gretzel et al. (2015)

Critical psychology suggests that individual subjectivity, such as that of tourism firms and tourists, is deeply embedded in social, cultural, and historical contexts (Teo, 2015). This indicates that spatial configurations are intrinsically linked to how tourism firms and tourists perceive, decide, and behave. Geo-psychological research, which explores geographical differences in psychological characteristics, integrates both the causes and consequences of these variations. This type of research often presents challenges, requiring scholars to navigate unfamiliar data formats, sources, measures, and statistical issues unique to geographical analysis (Ebert et al., 2022). To date, no research has addressed geo-psychological issues in smart tourism. Therefore, future studies should investigate the causes and impacts of tourists' spatio-temporal behaviors at specific destinations by collecting both

behavioral (secondary) and intentional (primary) data and analyzing them through a causal lens.

Methodologically, emerging geospatial data sources and advanced analytical techniques offer significant opportunities for tourism scholars to analyze tourist and tourism activities from a geospatial perspective. Recent advances in ICT and the evolution of geospatial data are reflected in the increasing use of various big data sources that integrate geographic information, such as geotagged social media and mobile phone data. Geographic information system (GIS)-based analytical techniques and spatial econometric methods are also powerful tools for addressing complex spatial decision problems in tourism (Koo et al., 2023). The spatial analysis of tourists' movements and tourism supply and demand has long been a core component of the geographical approach to tourism (Kang, Kim, & Nicholls, 2014), given that tourists' movements are location-based and that spatial externalities and spillover effects in the tourism industry can arise from both supply and demand sides (Yang & Mao, 2019). The availability of various forms of big data—such as text, images, location data, and video—in tourism provides vast opportunities for researchers and practitioners to explore physical and online tourism markets, tourism supply, and tourists' perceptions and behaviors in a more holistic and sophisticated manner.

Recently, geospatial artificial intelligence (GeoAI), which refers to spatially explicit AI techniques (Janowicz et al., 2020), has emerged as a powerful tool by integrating spatio-temporal data with machine learning and deep learning methods to extract insightful knowledge (VoPham et al., 2018). GeoAI can develop intelligent computer programs that mimic human perception and spatial reasoning processes, allowing for a deeper understanding of geographical phenomena and the ability to solve complex problems involving human-environmental systems and their interactions (Gao, 2021). Consequently, applications of GeoAI can accelerate the real-world understanding of the smart tourism field by providing valuable place-based policy implications, addressing the critical question of 'so what' in the context of spatio-temporal analysis of tourism firms and tourist behaviors.

Given the multifaceted nature of smart tourism, we propose a conceptual framework that integrates spatio-temporal, psychological, and methodological perspectives (Figure 1). This framework builds on critical psychology, which posits that spatial configurations—including social, cultural, and historical contexts—inform psychological perspectives and, in turn, shape individual behaviors (Teo, 2015). We extend this geo-psychological approach to contemporary smart tourism systems, where tourist perceptions and behaviors are

increasingly identifiable through spatio-temporal big data and advanced analytical techniques (Ebert et al., 2022).

The first area of integration, *spatio-temporal analytics*, involves the use of fine-grained spatio-temporal data to develop sophisticated models for understanding tourist behaviors. As technology evolves, new data types and advanced analytical methods enable a deeper understanding of these behaviors (Caldeira & Kastenholz, 2020). For example, Li et al. (2019) combined GPS data with survey responses from Chinese tourists to identify factors influencing destination choices, while Liu et al. (2022) analyzed open GPS-trajectory data to examine the spatio-temporal movement patterns of tourists at Mount Huashan, China, clustering them into three distinct tourist segments.

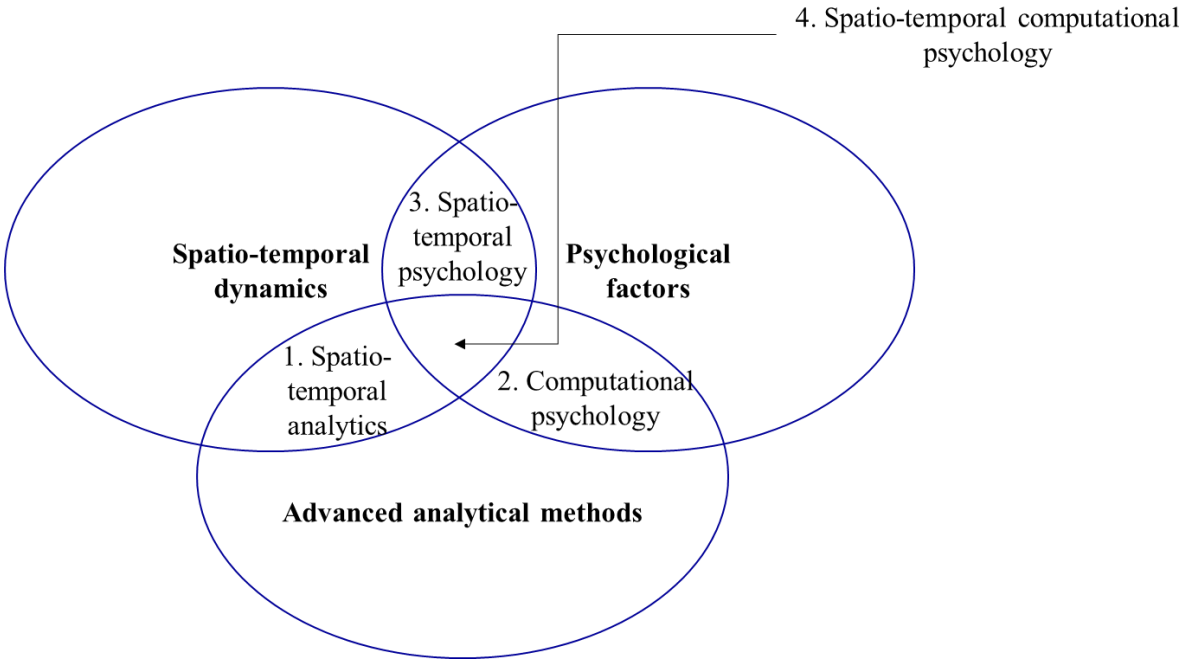

Figure 1. Conceptual framework of spatio-temporal-psychological approach in smart tourism

The second area focuses on *computational psychology* in tourism research, aiming to improve predictive accuracy and understand causal relationships (Hofman, Sharma, & Watts, 2017; Lazer et al., 2009). Researchers apply natural language processing, statistical techniques, and machine learning to analyze sentiment from large textual datasets, such as social media reviews (Cambria et al., 2017). For instance, Xiang et al. (2017) highlighted the challenges of predictive accuracy in social media analytics, incorporating data from platforms like TripAdvisor, Expedia, and Yelp, while Fu et al. (2018) used a meta-learning approach to explore the effects of design on predictive accuracy through sentiment analysis of Chinese travel news.

The third area, known as *spatio-temporal psychology*, merges psychology with spatio-temporal data in tourism studies. Some research, such as that by Jang and Kim (2022b), has explored the causes of spatial tourism behavior by integrating psychological mechanisms. These studies often use experimental methods, similar to those employed by Jang et al. (2021), alongside geospatial data analysis. However, most of this research relies on cross-sectional data, which limits the understanding of how psychological factors interact with longitudinal geospatial data. Consequently, there remains a gap in empirical research that combines geo-psychological factors with spatio-temporal dynamics in tourism. Addressing this gap could offer a more comprehensive view of tourist behavior over the long term.

The fourth area, *spatio-temporal computational psychology*, integrates granular spatio-temporal tourist mobility data with psychological information and advanced analytics (Lazer et al., 2009). While earlier studies have attempted to combine GPS data with survey responses to understand destination choices (e.g., Li et al., 2019), incorporating computational psychology techniques offers the poential to enhance the granularity and depth of findings (Fu et al., 2019; Hofman et al., 2017). However, this integration has faced challenges, including limited recognition of geo-spychological interactions, inadequate data integration, and the complexity of analyzing multi-dimensional data. AI techniques, such as deep learning and natural language processing (NLP), provide powerful tools to analyze large-scale data and uncover insights into the interplay between psychological states and spatio-temporal behaviors. Advances in data collection, analytical methods, and interdisciplinary collaboration are steadily overcoming these obstacles, paving the way for more holistic and dynamic models of tourist behavior.

In this research note, we encourage researchers and practitioners to integrate spatio-temporal dynamics, psychological factors, and advanced analytical methods in smart tourism research. First, smart tourism should examine how firms design and implement spatio-temporal products and services, evaluating their impact on performance. These insights can enhance customer satisfaction through personalized experiences, such as recommending low-crowd activities or emotionally significant locations, while optimizing revenue and fostering loyalty. Second, consumer behavior related to spatio-temporal services should be explored from a psychological perspective. Studying how spatio-temporal-psychological offerings influence attitudes and decision-making will help firms predict tourist reactions, design effective marketing, and build trust in tech-driven solutions. Third, researchers could develop effective tourism policies from a spatio-temporal-psychological perspective, particularly in the context of regional or global crises (e.g., earthquakes and pandemics). Such policies could

help mitigate the negative impacts on tourism and aid in recovery by considering how tourists and tourism providers psychologically respond to spatio-temporal dimensions during these events.

Finally, advancing research methodologies in smart tourism is crucial. Future studies could focus on creating tools to measure spatio-temporal-psychological tourist engagement, combining primary (intentional) and secondary (behavioral) data for a more comprehensive understanding of these dynamics. Advanced modeling techniques could also be employed to analyze spatio-temporal-psychological tourist behaviors, with efforts to improve the interpretability of GeoAI models in these contexts. Refining these methodologies would offer more actionable insights and better support the development of intelligent, adaptive, and resilient smart tourism systems.

References

Bakos, J. Y. (1997). Reducing buyer search costs: Implications for electronic marketplaces. *Management Science*, *43*(12), 1676-1692.

Buhalis, D., & Amaranggana, A. (2014). Smart Tourism Destinations. In Z. Xiang & I. Tussyadiah (Eds.), *Information and Communication Technologies in Tourism 2014* (pp. 553–564). Heidelberg: Springer.

Caldeira, A. M., & Kastenholz, E. (2020). Spatiotemporal tourist behaviour in urban destinations: a framework of analysis. *Tourism Geographies*, *22*(1), 22-50.

Cambria, E., Das, D., Bandyopadhyay, S., & Feraco, A. (2017). Affective computing and sentiment analysis. *A practical guide to sentiment analysis*, 1-10.

Ebert, T., Mewes, L., Götz, F. M., & Brenner, T. (2022). Effective maps, easily done: visualizing geo-psychological differences using distance weights. *Advances in Methods and Practices in Psychological Science*, 5(3), 25152459221101816.

Fu, Y., Hao, J. X., Li, X., & Hsu, C. H. (2019). Predictive accuracy of sentiment analytics for tourism: A metalearning perspective on Chinese travel news. *Journal of Travel Research*, *58*(4), 666-679.

Gao, S. (2021). *Geospatial artificial intelligence (GeoAI)*. New York: Oxford University Press.

Gretzel, U., Sigala, M., Xiang, Z., & Koo, C. (2015). Smart tourism: Foundations and developments. *Electronic Markets*, *25*(3), 179-188.

Hannam, K., Butler, G., & Paris, C. M. (2014). Developments and key issues in tourism mobilities. *Annals of Tourism Research*, *44*, 171-185.

Hofman, J. M., Sharma, A., & Watts, D. J. (2017). Prediction and explanation in social systems. *Science*, *355*(6324), 486-488.

Jang, S., & Kim, J. (2022a). 16. Tourism and regional economics. *A modern guide to tourism economics*, 277.

Jang, S., & Kim, J. (2022b). Enhancing exercise visitors' behavioral engagement through gamified experiences: A spatial approach. *Tourism Management, 93*, 104576.

Jang, S., Kim, J., Kim, J., & Kim, S. S. (2021). Spatial and experimental analysis of peer-to-peer accommodation consumption during COVID-19. *Journal of Destination Marketing & Management*, *20*, 100563.

Janowicz, K., Gao, S., McKenzie, G., Hug, Y., Bhaduri, B. (2020). GeoAI: Spatially explicit artifical intelligence techniques for geographic knowledge discovery and beyond. *International Journal of Geographical Information Sciences, 34*(4), 625-636.

Kang, S., Kim, J., & Nicholls, S. (2014). National tourism policy and spatial patterns of domestic tourism in South Korea. *Journal of Travel Research*, 53(6), 791-804.

Koo, C., Kim, J., & Alt, R. (2023). Spatial is special: Exploration for spatial approach in smart tourism cities. *Information Processing and Management, 60*(4), 103401.

Lazer, D., Pentland, A., Adamic, L., Aral, S., Barabási, A. L., Brewer, D., ... & Van Alstyne, M. (2009). Computational social science. *Science*, *323*(5915), 721-723.

Liu, W., Wang, B., Yang, Y., Mou, N., Zheng, Y., Zhang, L., & Yang, T. (2022). Cluster analysis of microscopic spatio-temporal patterns of tourists' movement behaviors in mountainous scenic areas using open GPS-trajectory data. *Tourism Management, 93*, 104614.

e Silva, F. B., Herrera, M. A. M., Rosina, K., Barranco, R. R., Freire, S., & Schiavina, M. (2018). Analysing spatiotemporal patterns of tourism in Europe at high-resolution with conventional and big data sources. *Tourism Management*, 68, 101-115.

Teo, T. (2015). Critical psychology: A geography of intellectual engagement and resistance. *American Psychologist*, *70*(3), 243.

Tussyadiah, I. (2012). A concept of location-based social network marketing. *Journal of Travel & Tourism Marketing*, 29(3), 205-220.

VoPham, T., Hart, J. E., Laden, F., & Chiang, Y. Y. (2018). Emerging trends in geospatial aritifical intelligence (geoAI): Potential applications for environmental epidemiology. *Environmental Health, 17*(1), 1-6.

Wei, W., Önder, I., & Uysal, M. (2024). Smart tourism destination (STD): developing and validating an impact scale using residents' overall life satisfaction. *Current Issues in Tourism*, *27*(17), 2849-2872.

Xiang, Z., Du, Q., Ma, Y., & Fan, W. (2017). A comparative analysis of major online review platforms: Implications for social media analytics in hospitality and tourism. *Tourism Management, 58*, 51-65.

Yang, Y., & Mao, Z. (2019). When spatial means special: Special issue on spatial economics and tourism development. *Tourism Economics*, 1-5.