Journal of Smart Tourism Vol. 1 No. 4 (2021) 3-7

DOI: https://doi.org/10.52255/smarttourism.2021.1.4.2

Journal of Smart Tourism

ISSN: 2765-2157 (Print) 2765-7272 (Online) Journal homepage: http://strc.khu.ac.kr/

Letter

Spatial Multicriteria Decision Analysis: A Powerful Tool for Participatory Decision-Making in Community-based Tourism Research

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Abstract

Although Geographic Information Systems (GISs) have commonly been employed as powerful tools for manipulating and displaying spatial data in community-based tourism, a variety of GIS functions still lack the capabilities required to assist multiple decision makers to come to consensual decisions. In this study, I propose an alternative approach: spatial multicriteria decision analysis (SMCDA) that could reflect diverse decision makers' preferences by integrating GISs and multicriteria decision analysis (MCDA). I review the small number of case studies that have employed SMCDA, with a focus on the roles of GISs and MCDA. The methodological integration of GISs and MCDA into multi-spatial decision support systems offers the potential to implement participatory decision-making to solve complex spatial problems in community-based tourism planning, development, and management.

Keywords

community-based tourism; spatial multicriteria decision analysis; participatory decision-making; GIS; MCDA

1. Introduction

Since 1997, when Elliott-White and Finn (1997) proposed the use of geographic information systems (GISs) in tourism, GISs have become one of the most widely employed spatial-decision tools used to solve complicated geographical problems in community-based tourism planning (Kang et al., 2014; Lee, Kim, & Jang, 2021; Lee, Kim, Jang, Ash, & Yang, 2021; Yeon et al., 2020), development (Brown & Weber, 2013; Hasse & Milne, 2005; Kim et al., 2018; McKercher et al., 2012; Yang, Kim, Pennington-Gray, & Ash, 2021), and management (Chen et al., 2021; Jang & Kim, 2022; Kim, Jang, et al., 2020; Kim, Yoon, et al., 2020; Xu et al., 2019, 2021; Yang, Kim, & Pennington-Gray, 2021).

The goal of GIS applications is to support complex spatial decision-making (Goodchild, 1992). However, decisions are made by people and not information or information systems such as GISs. Although GISs provide important capabilities for analyzing and visualizing spatial data (Lee et al., 2019; Park et al., 2020), however, several GIS functions still lack capabilities for incorporating diverse decision makers' preferences into GIS-based decision-making (Dhami et al., 2014). As Feick and Hall (2001) noted, "The capacity of commercial GIS to facilitate debate and achieve some measure of balance among different viewpoints has been identified as a major weakness" (p. 391). Densham (1991) noted that "when different people are faced with the same spatial decision problem, they are likely to place different values on variables and relationships and select and use information in different ways" (p. 404). Thus, integrating GIS techniques with diverse decision makers' preferences is required for implementing participatory decision-making.

Multicriteria decision analysis (MCDA) typically has been used to reflect diverse decision makers' preferences (Cegan et al., 2017; Chen, 2006; Huang et al., 2009). Recent studies have indicated the methodological integration of GISs and MCDA offers a solution for reflecting diverse decision makers' preferences to solve complex spatial problems (Anwarzai & Nagasaka, 2017; Karimi et al., 2019). Specifically, a variety of GIS techniques can play pivotal roles in analyzing and visualizing spatially referenced data, whereas MCDA can provide solutions for structuring decision problems and evaluating alternative decisions (Malczewski, 2006). Thus, the methodological integration of GISs and MCDA may be used as a spatial-decision supporting system to implement participatory decision-making to solve complex spatial problems. Community-based tourism planning and management is a multifaceted procedure that requires a complicated decision-making process that considers not only the geographical features of community resources but also the criteria weights presented by diverse stakeholders. Therefore, a methodological approach based on the integration of GISs and MCDA can be a solution to meet the requirements. Thus, in this study, I demonstrate the utility of spatial multicriteria decision analysis (SMCDA) that is an alternative approach for participatory decision-making by combining GISs with MCDA in community-based tourism.

2. SMCDA and Its Applications

SMCDA involves the methodological integration of GISs and MCDA. Malczewski (1999) defined SMCDA as "a process that combines and transforms geographical data (input) into a resultant decision (output)" (p. 90). Data on both criterion values and the geographical locations of alternatives are essential to conduct SMCDA. In this regard, GISs and MCDA have been used as

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Received 16 December 2021; Received in revised form 5 January 2022; Accepted 20 January 2022

primary SMCDA tools to obtain information for making that decision.

Community-based tourism planning or development is a multi-faceted and multidisciplinary procedure that requires more than one method to obtain successful results. It is based on complex and sometimes controversial decision-making processes that should consider both the geographical features of destinations and criteria weights presented by diverse stakeholders. The methodological integration of GISs and MCDA - referred to as SMCDA - is used broadly in a number of disciplines, including geography (Feick & Hall, 2001; Malczewski, 2006), environmental management (Graymore et al., 2009; Wang et al., 2009; Nobrega et al., 2009; Vahidnia et al., 2009; Xiaodan et al., 2010), and landscape and urban planning (Liu et al., 2007; Phua & Minowa, 2005) as a core methodology to solve complex and diverse spatial decision processes. For example, Feick and Hall (2001) developed a GIS-based multicriteria decision support tool, *TourPlan*, to assist in the decisions of site selection and impact evaluation for tourism planning in small island states. *TourPlan* offers two modules to guide users through the decision-making process. The first is "Site Selection Assistant," which allows users to specify tourism land-use pattern scenarios. The second is "Multiple Criteria Analysis (MCA) Assistant," which can determine criteria weightings from user input and compute the rank of each alternative scenario. Liu et al. (2007) developed an integrated GIS-based analysis system (IGAS) for supporting land-use management of lake areas in Wuhan City, China. They analyzed land-use suitability assessment and scenarios for potential land-use change through the integration of GISs, MCA, and dynamic modeling. The IGAS helped local authorities understand and address the complex land-use system and develop improved land-use management strategies that better balance urban expansion and ecological conservation.

Other researchers have used GISs and MCDA in site-selection issues. Vahidnia et al. (2009) determined the optimum site for a new hospital in Tehran, Iran, using GISs with the fuzzy analytical hierarchy process (FAHP). Wang et al. (2009) used GISs and the AHP to determine the location of a landfill site in Beijing, China. The researchers analyzed, ranked, and presented a number of environmental and economic factors based on local residents' preferences. These case examples demonstrate that GIS and MCDA methods considerably reduce deficiencies in the integration of geographical information with subjective values and preferences in diverse spatial decision-making processes.

Additionally, the methodological integration of GISs and MCDA can be used as a participatory GIS (PGIS) and has been used widely in areas such as resource management, conservation, and tourism planning. In resource management and conservation, a PGIS can support and facilitate public participation through providing visualized information (Sieber, 2006). It serves as a forum by which community-based issues are discussed. For example, Beazley et al. (2005) used a PGIS to assess existing biophysical data for resource conservation in Nova Scotia, Canada. Kyem and Saku (2009) used a web-based PGIS to develop a citizen-based watershed monitoring system in the Pamlico-Tar River and Basin in North Carolina. In tourism planning, a PGIS can play a pivotal role in balancing consensus and conflicts through realizing participants' diverse attitudes regarding tourism development. For example, Hasse and Milne (2005) used a participatory approach GIS to facilitate a better understanding of participants' attitudes toward tourism as well as to enhance participation and stakeholder interaction in tourism planning. By using participatory mapping and interviews, they visualized participants' attitudes and knowledge regarding Marhau, a small community in New Zealand.

3. Operationalization of SMCDA

3.1 Processes in SMCDA

Decision-making is a process; it involves a sequence of activities that starts with decision-problem recognition and ends with recommendations (Malczewski, 1999). SMCDA is a methodological tool for the decision-making process that is based on a sequence of activities. Malczewski's (1999) SMCDA framework (see Figure 1) outlines such a sequence of activities.

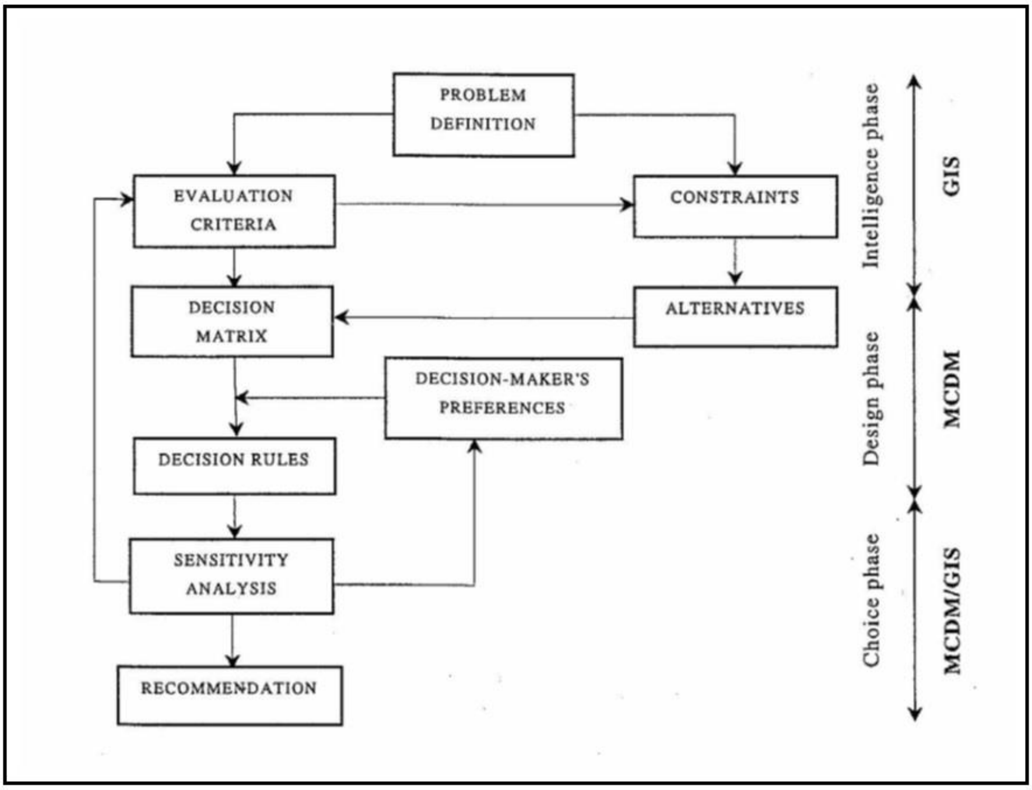

Fig. 1. Malczewski's framework of SMCDA (Malczewski, 1999, p. 96)

Malczewski's (1999) SMCDA framework originated from Simon's (1960) decision-making process model, including the intelligence, design, and choice phases. It integrates the major elements of GISs and MCDA via a combination of specified steps such as "problem definition," "evaluation criteria," "criterion weights," "outcome by decision rules," "sensitivity analysis," and "recommendation."

In the SMCDA process, the first step is defining the "decision problem." Malczewski (1999) argued that "the decision problem is a perceived difference between the desired and existing states of a system" (p. 96). Generally, the problem definition overlaps with the intelligence phase of decision-making, which gives a strong basis for establishing the decision environment and condition through data collection and processing for clues that may identify opportunities or problems.

Once the decision problem is defined, the next step is to specify the set of evaluation criteria. Specifying the evaluation criteria can be approached in two ways (Malczewski, 1999). The first approach is to specify a comprehensive set of objectives that reflects all concerns relevant to the decision problem (constraints), and the second is to specify the measures (attributes) for achieving those objectives (alternatives). Such evaluation criteria are represented as criterion maps, including an evaluation criterion map (attribute or thematic map) and a constraint map. In this process, most operations are dominated by GIS-related data handling and analyzing capabilities for generating inputs to SMCDA.

Eliciting the decision makers' preference for evaluation criteria is also important. In this step, the relative preferences are typically expressed in terms of weights of relative importance to the evaluation criteria with consideration of decision rules that dictate how best to rank the alternatives or attributes.

After evaluating the decision makers' relative preferences of the evaluation criteria, previous GIS-based criterion or constraint maps and judgment (preference) must be integrated, and an overall assessment of the alternatives should be ordered based on decision rules that "dictate how best to rank alternatives or to decide which alternative is preferred" (Malczewski, 1999, p. 98). Traditionally, "criterion" is a generic term that includes both the concepts of attribute and objective (Thill, 1999). According to Malczewski (2006), SMCDA can be distinguished as spatial multi-attribute decision analysis (SMADA) and spatial multiobjective decision analysis (SMODA). In SMADA, each objective is measured by means of a single attribute (one-to-one relationship), whereas SMODA assumes each objective is measured by means of multiple attributes (one-to-many relationship). Therefore, as a result of the decision taken by the decision rules, a decision outcome or criterion outcome is ordered with certain consequences (one-to-one relationship) and uncertain consequences (one-to-many relationship).

The output from previous steps should via verified by sensitivity analysis, which defined as "a procedure for determining how the recommended course of action has affected changes in the inputs of the analysis" (Malczewski, 1999, p. 97). In other words, sensitivity analysis identifies how changing the inputs affects the ranking of alternatives. If the change of input significantly influences the ranking, then the ranking is considered robust.

A recommendation is the last step of a decision-making process. The ranking of alternatives and the result of sensitivity analysis are essential elements to determine the recommendation. In this step, the recommendation involves both the description of one or multiple alternatives and its visualization to provide useful information for decision-making.

3.2 Role of GIS in SMCDA

In SMCDA, two distinctive research methods, GISs and MCDA, can benefit from each other (Feick & Hall, 2001; Graymore et al., 2009; Malczewski, 1999; Malczewski, 2006; Thill, 1999). GISs are powerful tools for handling spatial data, performing spatial analyses, and manipulating spatial outputs. As a spatial-decision supporting system, which is defined as an interactive computer-based system that can help use data and models to solve a decision problem (Lee et al., 2019), a GIS also provides a consistent visualization environment for displaying the input data and results of a model. This ability is useful in the decision-making process.

The generation of a criterion (attribute) map layer is central to implementing SMCDA. A criterion map is a thematic map that represents the degree to which its associated attribute is achieved (Malczewski, 1999). In this respect, completing and operating a set of criterion maps could be fundamental to representing the decision situation adequately. The procedure for generating criterion maps is based on GIS functions. Relevant data are acquired and stored in a GIS database, and then the data are manipulated and analyzed to obtain information on a particular evaluation criterion. For example, GIS-based network analysis and a related criterion map could be used to identify and visualize the degree of accessibility to tourism resources, which could be one of the criteria employed in community-based tourism planning.

However, despite the contribution of GISs to advanced spatial analysis, GISs have been criticized for their lack of consideration in structuring decision problems and designing, evaluating, and prioritizing alternative decisions originating from diverse stakeholders' perspectives. In other words, GISs have limitations concerning the analysis of the value structure.

3.3 Role of MCDA in SMCDA

MCDA is a decision-making tool used to estimate criteria weights. The general purpose of MCDA is to facilitate decision makers' choices of the most suitable option among alternatives (Malczewski, 1999). MCDA typically involves criteria of varying importance to decision makers. In other words, information about the criteria's relative importance is required. This is usually achieved by assigning a weight to each criterion. The derivation of weights is a central step in eliciting decision makers' preferences. A weight can be defined as a value assigned to an evaluation criterion that indicates its importance relative to the other criteria under consideration. The larger the weight, the more important the criterion. MCDA includes steps for defining, designing, evaluating, and prioritizing criteria and alternative decisions. A combination of diverse research methods operates these steps. According to Cengiz and Akbulak (2009), "MCDA includes qualitative or quantitative weights to rate or order criteria, and the arrangement of uses into single or multi-sets in terms of importance" (p. 288).

To conduct MCDA, a semi-structured interview and pairwise comparison method using the AHP via web survey is helpful. Once the decision problem is defined, a set of evaluation criteria should be identified. Next, a web survey should be employed to determine the relative importance of the evaluation criteria that emerged from the expert survey. Diverse local stakeholders, including residents and representatives from the private and public sectors, should be invited to participate.

Based on the criteria identified in the expert survey, MCDA can be used to estimate criteria weights. Among diverse techniques, the pairwise comparison method is recognized as the most popular and versatile; Saaty (1980) developed it in the AHP context. The AHP is one of the multihierarchy-layer comparison methods for MCDA and employs mathematical decision analysis to determine the priorities of various alternatives using pairwise comparison of different decision elements with reference to common criteria. According to Saaty (1980), "It can be used to make direct resource allocation, benefit/cost analysis, resolve conflicts, design and optimize systems" (p. 24). The AHP method is flexible in general and can be adopted to solve multi-hierarchy levels. Furthermore, the AHP procedure consists of three major steps: pairwise comparison matrix generation, criteria weights computation, and consistency ratio estimation. It facilitates decision makers' choice of the most suitable option among alternatives (Malczewski, 1999). Figure 2 outlines the AHP method's procedures. However, a key limitation of this technique is that it does not consider geographical dimensions.

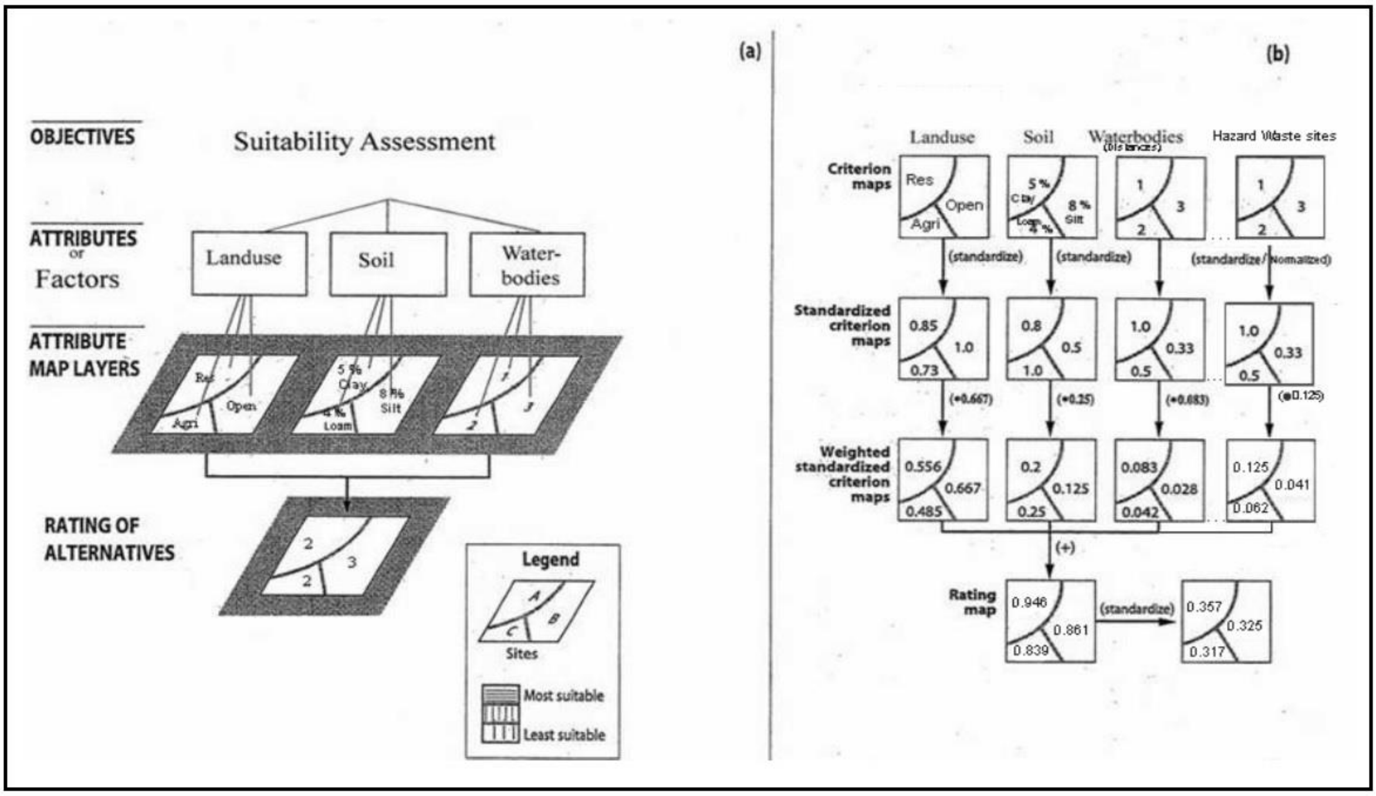

Fig. 2. AHP method (a: AHP procedure; b: GIS-based rating of attributes; Sadasivuni et al., 2009, p. 2)

4. Conclusion

With this paper, my purpose was to demonstrate the utility of SMCDA as an alternative spatial decision tool for participatory spatial-decision making in community-based tourism research. Through the combination of GISs and MCDA, SMCDA can be thought of as a process that transforms and combines geographical data and value judgements regarding decision makers' preferences to obtain information for spatial decision-making. Such complementary methodological integration also offers the potential to implement participatory decision-making to solve complex spatial problems in community-based tourism planning, development, and management.

Declaration of competing interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgements

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2019S1A3A2098438).

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References

Anwarzai, M. A., & Nagasaka, K. (2017). Utility-scale implementable potential of wind and solar energies for Afghanistan using GIS multi-criteria decision analysis. *Renewable and Sustainable Energy Reviews, 71*, 150–160.

Beazley, K., Smandych, L., Snaith, T., Mackinnon, F., Austen-Smith, P., & Duinker, P. (2005). Biodiversity considerations in conservation system planning: Map-based approach for Nova Scotia, Canada. *Ecological Applications, 15*(6), 2192–2208.

Brown, G., & Weber, D. (2013). A place-based approach to conservation management using public participation GIS (PPGIS). *Journal of Environmental Planning and Management, 56*(4), 455–473.

Cegan, J. C., Filion, A. M., Keisler, J. M., & Linkov, I. (2017). Trends and applications of multi-criteria decision analysis in environmental sciences: Literature review. *Environment Systems and Decisions, 37*(2), 123–133.

Cengiz, T., & Akbulak, C. (2009). Application of analytic hierarchy process and geographic information systems in land-use suitability evaluation: A case study of Dumrek village (Canakkale, Turkey). International *Journal of Sustainable Development & World Ecology, 16*(4), 286-294.

Chen, C. (2006). Applying the analytical hierarchy process (AHP) approach to convention site selection. *Journal of Travel Research, 45*(2), 167–174.

Chen, Y., Kim, J., & Mueller, N. (2021). Estimating the economic impact of natural hazards on shared accommodation in coastal tourism destinations. *Journal of Destination Marketing and Management, 21*, 100634.

Densham, P. (1991). Spatial decision support systems. In D. J. Maguire, M. S. Goodchild & D. W. Rhind (Eds.), *Geographical information systems: Principles and applications* (pp. 403–412). Harlow, Essex, England: Longman.

Dhami, I., Deng, J., Burns, R. C., & Pierskalla, C. (2014). Identifying and mapping forest-based ecotourism areas in West Virginia—Incorporating visitors' preferences. *Tourism Management, 42*, 165–176.

Elliott-White, M. P., & Finn, M. (1997). Growing in sophistication: The application of geographical information systems in post-modern tourism marketing. *Journal of Travel and Tourism Marketing, 7*(1), 65–84.

Feick, R. D., & Hall, G. B. (2001). Balancing consensus and conflict with a GIS-based multi-participant, multi-criteria decision support tool. *GeoJournal*, *53*, 391–406.
Goodchild, M. F. (1992). Geographical information science. *International Journal of Geographical Information Systems*, *6*(1), 31–45.
Graymore, M. L. M., Wallis, A. M., & Richards, A. J. (2009). An index of regional sustainability: A GIS- based multiple criteria analysis decision support system for progressing sustainability. *Ecological Complexity*, *6*(4), 453–462.
Hasse, J. C., & Milne, S. (2005). Participatory approaches and geographical information systems (PAGIS) in tourism planning. *Tourism Geographies, 7*(3), 272–289.
Huang, L., Chen, K., & Wu, Y. (2009). What kind of marketing distribution mix can maximize revenues: The wholesaler travel agencies' perspective? *Tourism Management, 30*(5), 733–739.
Jang, S., & Kim, J. (2022). Remedying airbnb COVID-19 disruption through tourism clusters and community resilience. *Journal of Business Research, 139*, 529–542.
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.
Karimi, H., Amiri, S., Huang, J., & Karimi, A. (2019). Integrating GIS and multi-criteria decision analysis for landfill site selection, case study: Javanrood County in Iran. *International Journal of Environmental Science and Technology, 16*(11), 7305–7318.
Kim, J., Jang, S., Kang, S., & Kim, S. (2020). Why are hotel room prices different? Exploring spatially varying relationships between room price and hotel attributes. *Journal of Business Research, 107*, 118–129.
Kim, J., Yoon, S., Yang, E., & Thapa, B. (2020). Valuing recreational beaches: A spatial hedonic pricing approach. *Coastal Management, 48*(2), 118–141.
Kim, Y. R., Kim, J., & Huh, C. (2018). The spatial clustering patterns of the US hotels during 1985–2017. *International Journal of Tourism Sciences, 18*(3), 192–201.
Kyem, P. A. K., & Saku, J. C. (2009). Web-based GIS and the future of participatory GIS applications within local and indigenous communities. *Electronic Journal of Information Systems in Developing Countries, 38*(1), 1–16.
Lee, Y. A., Kim, J., & Jang, S. (2021). Intertemporal tourism clusters and community resilience. *Professional Geographer, 73*(3), 567–572.
Lee, Y. A., Kim, J., Jang, S., Ash, K., & Yang, E. (2021). Tourism and economic resilience. *Annals of Tourism Research, 87*, 103024.
Lee, Y. J., Pennington-Gray, L., & Kim, J. (2019). Does location matter? Exploring the spatial patterns of food safety in a tourism destination. *Tourism Management, 71*, 18–33.
Liu, Y., Lv, X., Qin, X., Guo, H., Yu, Y., Wang, J., & Mao, G. (2007). An integrated GIS-based analysis system for land-use management of lake areas in urban fringe. *Landscape and Urban Planning*, *82*(4), 233–246.
Malczewski, J. (1999). *GIS and multicriteria decision analysis*. New York, NY: Wiley.
Malczewski, J. (2006). GIS-based multicriteria decision analysis: A survey of the literature. *International Journal of Geographical Information Science*, *20*(7), 703–726.
McKercher, B., Shoval, N., Ng, E., & Birenboim, A. (2012). First and repeat visitor behaviour: GPS tracking and GIS analysis in Hong Kong. *Tourism Geographies, 14*(1), 147–161.
Nobrega, R. A. A., O'Hara, C. G., Sadasivuni, R., & Dumas, J. (2009). Bridging decision-making process and environmental needs in corridor planning. *Management of Environmental Quality*, *20*(6), 622–637.
Park, S. B., Kim, J., Lee, Y. K., & Ok, C. M. (2020). Visualizing theme park visitors' emotions using social Media Analytics and geospatial analytics. *Tourism Management, 80*, 104127.
Phua, M., & Minowa, M. (2005). A GIS-based multi-criteria decision making approach to forest conservation planning at a landscape scale: A case study in the Kinabalu area, Sabah, Malaysia. *Landscape and Urban*, *71*(2–4), 207–222.
Saaty, T. (1980). *The analytic hierarchy process*. New York, NY: McGraw-Hill.
Sadasivuni, R., O'Hara, C., Nobrega, R., & Dumas, J. (2009, March 9–13). *A transportation corridor case study for multi-criteria decision analysis.* Proceedings of the 2009 Annual Conference on ASPRS, Baltimore, MD, United States.
Sieber, R. (2006). Public participation geographic information systems: A literature review and framework. *Annals of the Association of American Geographers, 96*(3), 491–507.
Simon, H. (1960). *The new science of management decision*. New York, NY: Harper & Row.
Thill, J. (1999). *Multicriteria decision-making and analysis: A geographic information sciences Approach*. London, UK: Harper & Row.
Vahidnia, M. H., Alesheikh, A. A., & Alimohammadi, A. (2009). Hospital site selection using fuzzy AHP and its derivatives. *Journal of Environmental Management*, *90*(10), 3048–3056.
Wang, G., Qin, L., Li, G., & Chen, L. (2009). Landfill site selection using spatial information technologies and AHP: A case study in Beijing, China. *Journal of Environmental Management*, *90*(8), 2414–2421.
Xiaodan, W., Xianghao, Z., & Pan, G. (2010). A GIS-based decision support system for regional eco-security assessment and its application on the Tibetan Plateau. *Journal of Environmental Management*, *91*(10), 1981–1990.
Xu, Y., Pennington-Gray, L., & Kim, J. (2019). The sharing economy: A geographically weighted regression approach to examine crime and the shared lodging sector. *Journal of Travel Research, 58*(7), 1193–1208.
Xu, Y., Pennington-Gray, L., & Kim, J. (2021). Spatial effect of crime on peer-to-peer lodging performance. *Journal of Travel Research*. Advance online publication. https://doi.org/10.1177/00472875211008255.
Yang, E., Kim, J., & Pennington-Gray, L. (2021). Social media information and peer-to-peer accommodation during an infectious disease outbreak. *Journal of Destination Marketing and Management, 19*, 100538.
Yang, E., Kim, J., Pennington-Gray, L., & Ash, K. (2021). Does tourism matter in measuring community resilience? *Annals of Tourism Research, 89*, 103222.
Yeon, J., Kim, S., Song, K., & Kim, J. (2020). Examining the impact of short-term rental regulation on peer-to-peer accommodation performance: A difference-in-differences approach. *Current Issues in Tourism*, 1–13.

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