EXPLORING THE DETERMINANTS OF SUSTAINABLE TOURISM IN KARST CAVE GEOTOURISM: IDENTIFYING CAVE TOURISM IN INDONESIA

Trio Yonathan Teja KUSUMA[*]
Universitas Sebelas Maret, Industrial Engineering Student Doctoral Program, Surakarta, Indonesia; Universitas Islam Negeri Sunan Kalijaga, Industrial Engineering Departement, Yogyakarta, Indonesia, e-mail: trio.yonathan@gmail.com

Susy SUSMARTINI
Universitas Sebelas Maret, Industrial Engineering Departement, Surakarta, Indonesia, e-mail: susy_susmartini2015@staff.uns.ac.id

Bambang SUHARDI
Universitas Sebelas Maret, Industrial Engineering Departement, Surakarta, Indonesia, e-mail: bambangsuhardi@staff.uns.ac.id

Lobes HERDIMAN
Universitas Sebelas Maret, Industrial Engineering Departement, Surakarta, Indonesia, e-mail: lobesherdiman@staff.uns.ac.id

Yandra Rahadian PERDANA
Universitas Islam Negeri Sunan Kalijaga, Industrial Engineering Departement, Yogyakarta, Indonesia, e-mail: yandra.perdana@uin-suka.ac.id

Himawan PUTRANTA
Universitas Islam Negeri Sunan Kalijaga, Physics Education Department, Yogyakarta, Indonesia, e-mail: himawan.putranta@uin-suka.ac.id

Abstract: Indonesia's vast karst landscape offers great economic potential through geotourism development. However, excessive exploitation poses a risk of environmental damage, making a sustainable approach essential to ensure environmentally, socially, and economically responsible management. This study explores the factors that influence the achievement of sustainable tourism in karst cave geotourism in Jomblang Cave, Gunungkidul, Yogyakarta. Its contribution is to develop a model to reveal the achievement of sustainable tourism in karst cave geotourism. This study adapts the Modified Geosite Assessment Model (M-GAM) variables with the addition of safety and enjoyment variables as a novelty. These factors have not been explicitly emphasized in prior geotourism evaluation frameworks, despite their strong influence on visitor satisfaction and behavior. Incorporating them addresses a critical gap and aligns the model more closely with real-world visitor expectations. It uses survey and non-probability methods, especially convenience sampling, and 310 valid respondents were obtained. Confirmatory factor analysis (CFA) was used to analyze the construct's validity and reliability, and partial quadratic structural equation modelling was used to test the hypothesis using SmartPLS 3 software. The analysis found that the model could explain 72.2% of the variance in achieving sustainable tourism. The tested factors, namely education, aesthetics, protection, function, tourism, safety, and enjoyment, significantly impact sustainable tourism in Jomblang Cave. This indicates that a multidimensional approach, combining environmental, social, and experiential values, is essential for karst geotourism success.Tourism management implemented in Jomblang Cave successfully moderates other factors in this direction. These results contribute to the existing literature on sustainable tourism and pave the way for further development of Jomblang Cave tourism to fit the karst geotourism strategy concept framework. This enrichment refines geotourism models by prioritizing visitor experience while maintaining conservation, and supports adaptive planning aligned with evolving visitor needs. This approach helps preserve Jomblang Cave's natural heritage while making it a valuable educational and experiential destination. Collaboration with local communities and conservationists promotes sustainable tourism that benefits the environment and the local economy.

Keywords: Sustainable tourism, Karst geotourism, Jomblang Cave, M-GAM, Safety, Enjoyment, Confirmatory factor analysis, Structural equation modeling, Geosite evaluation,

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INTRODUCTION

Indonesia has 154,000 km of karst, creating many cave chains that have developed into geotourism with tourist activities such as cave tours (Ministry of Environment and Forestry, 2017). One popular cave trekking is Jomblang cave, located in the karst mountains of Jetis Wetan hamlet, Pacarejo village, Semanu sub-district, Gunung Kidul, Yogyakarta. The characteristics of Jomblang Cave are unique, as it combines vertical and horizontal caves with a depth of about 80 meters from the ground. Jomblang Cave has a fascinating natural landscape, and the tradition of working together that continues to be carried out has become a natural tourist destination with local, domestic, and foreign tourists. However,

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* Corresponding author

cave trekking activities risk excessive exploitation and damage to nature, and the growing foreign culture will damage traditions if not appropriately managed. Several tourist destinations have experienced exploitation after becoming popular, including Bali. The present condition of Balinese society is a fundamental socio-cultural transition. The acceleration of the information wave of globalization has brought significant transformations to Balinese society, both at the surface structure level (attitudes and patterns of behaviour) and deep structure (value system, outlook on life, philosophy, and beliefs). If not managed properly, these problems will also occur in karst cave geotourism in the community and the environment.

Conversely, cave exploration is also categorized as a high-risk tourism activity for tourists. The closed terrain conditions, total darkness, complex cave systems, unique surface environment, surface environmental climate, character, and geological activity pose a risk to activists. Even so, when an accident occurs, it should not be blamed on natural factors because almost all are human errors, even though the threat comes from natural factors. The safety factor of tourists is crucial, considering the incidents of tourist accidents in several high-risk destinations. Tourists fell from a 40-meter cliff and suffered broken bones and legs at Broken Beach Cliff in Bali. Another accident also occurred at the Tumpak Sewu tourist destination, where tourists slipped from a 15-meter cliff and died. Accidents can also happen in Jomblang cave, with the vertical cave height reaching 80 m and the horizontal cave passage length reaching 260 m, threatening the safety of tourists. If considered, safety factors will protect the image and interfere with achieving sustainable tourism in Jomblang cave geotourism. Therefore, it is necessary to research sustainable tourism in karst cave geotourism. Sustainable tourism is the development of the concept of travelling that can have a long-term impact on the environment, society, culture, and economy (Ministry of Tourism of the Republic of Indonesia, 2009). This research is expected to provide recommendations to tourism managers in determining their marketing strategies and help the government formulate more appropriate policies. These facts can be the main reason for asking the following research questions: RQ1. What are the determining factors for achieving sustainable tourism in karst cave geotourism? RQ2. How can sustainable tourism in Jomblang Cave be achieved?

Sustainable tourism development in previous studies was developed by fulfilling four factors: attraction, amenity, accessibility, and ancillary called 4A (Christensen et al., 2021; Mundet et al., 2022). Meanwhile, the model development for karst-based tourist destinations that has been carried out is not limited to the 4A factors but also considers the conceptual framework of karst geotourism strategies, including educational, socio-economic, and protection perspectives (Cvetanović et al., 2024; Roig et al., 2023). Some studies use scientific, academic, aesthetic, recreational/tourism, functional, and protection factors (Nazaruddin, 2020; Reinhart et al., 2023; Yulian et al., 2023). The study adopted the Modified Geosite Assessment Model factors, which can measure and discover the potential of karst geotourism (Antić et al., 2020). Other research uses cultural, economic, and biological factors (Mastika et al., 2023; Tamang et al., 2023; Ziem et al., 2023), socio-politic (Singtuen et al., 2022), anthropogenic (Carrión-Mero et al., 2021). The research that has been done attempts to identify the potential of geotourism resources and their development so that managers can provide good tourism services for tourists while maintaining the geosite to achieve sustainable tourism. Previous studies have mostly focused on protecting sites to achieve sustainable tourism, while efforts to create memorable tourist experiences have not been widely discussed. The tourist experience will have an impact on the image of tourist destinations. Creating a tourist experience is approached by paying attention to tourist safety and enjoyment factors.

Safety is an important factor that travellers consider when making decisions, especially when visiting unfamiliar destinations (Peng et al., 2024). When safety indicators are lacking or do not meet expectations, tourists generally perceive a tourist destination as less safe (Zou & Yu, 2022). Previous research has shown that safety is part of a tourist destination's image (Chauhan et al., 2019; Xie et al., 2022). The enjoyment factor also impacts the tourist destination image, creating a travel experience that tourists will remember. A memorable travel experience can be key to tourism marketing and traveller retention (Chen et al., 2020). Many travellers intentionally look for unforgettable and unique travel experiences ((Chen et al., 2020; Marzo-Navarro et al., 2024) to fulfil satisfaction in travelling. Travel experiences are becoming a new strategy to create traveller loyalty (Bai et al., 2023; Stemmer et al., 2022).

Considering the existing gaps in the literature, this study aims to investigate the main determinants that explain the factors influencing the achievement of sustainable tourism in karst cave geotourism. This research focuses on achieving sustainable tourism in karst cave geotourism, as karst features are one of the most vulnerable geosites due to their fragility. Due to the many benefits that local communities can derive from geotourism, both marketing and planning of karst cave geotourism should be carefully applied to bring the concept of sustainable welfare into geotourism (Antić et al., 2020). According to the facts and literature above, using sustainable tourism as the dependent variable is appropriate for this study.

This research has four contributions to the present study. First, the literature on factors influencing tourism is adapted to the conceptual framework of karst geotourism strategies, including protection, education, and socio-economic perspectives (Fraga et al., 2023). This research combines education, protection, aesthetics, function, tourism, safety, and enjoyment across disciplines to expand the complete understanding of tourism needs in dimensions and structural components. Second, we offer safety and enjoyment factors in developing sustainable tourism in karst cave geotourism. To the best of our knowledge, the use of safety and enjoyment variables was examined in the literature separately from other factors in previous studies. Third, the actual use of tourism impact factors is motivated by tourism management factors. Our motivation is based on the fact that some sites can suffer significant degradation in the absence of proper management. Heavy visitation, lack of management, poor maintenance, and especially the absence of appropriate education and monitoring are challenges in geotourism management (Fang et al., 2024; Marescotti et al., 2022; Yakupova et al., 2024). The design of appropriate geotourism management, making geosite features can be protected and preserved as well as opened as a geotourism resource for economic drivers so that sustainable tourism is realized (Fang et al., 2024; Yakupova et al., 2024). Fourth, our study focuses on geotourism in Gunungkidul, Indonesia, which differs from most studies focusing on cities in Siberia, China, India, Ukraine, Australia, and Spain. Indonesia certainly has a socio-political, cultural, and economic infrastructure

different from other countries. The existence of local wisdom that develops in Indonesian society influences tourism activities that differ from those of other countries. The potential of culture and local wisdom in tourism development is part of the product of human creativity that supports the achievement of sustainable tourism. The geosite being researched is a karst cave with characteristics different from previous research objects that focus on rocks, hills, mountains, and cliffs.

Finally, the results of this study offer valuable insights for tourism managers and the government to develop more effective planning and policies by understanding the factors that influence the achievement of sustainable tourism in karst cave geotourism. By the conceptual framework of the karst geotourism strategy, this research paves the way for further development of karst cave geotourism, especially Jomblang Cave. Furthermore, the results show the impact of geographical and cultural influences and the influence of safety and enjoyment factors on achieving sustainable tourism in karst cave geotourism, which adds to the generalizability of previous research. Research gaps are explored, and suggestions are provided for future research studies to advance sustainable tourism in karst cave geotourism, especially Jomblang cave, more effectively. The following sections organize the theoretical framework and hypothesis development, research methodology, results, discussion, and conclusion in the following order.

RESEARCH FRAMEWORK
Karst geotourism development strategy

A crucial aspect of karst geotourism is building sustainable local development, including geo-knowledge and geoethical values (Vasconcelos et al., 2023). The conceptual framework of the karst geotourism strategy includes educational, socio-economic, and protection perspectives (Roig et al., 2023). These karst areas must be based on strong support from the community involving authorities, educational institutions, and research through an integrative approach, making social participation according to guidelines at the government level. Given the benefits that local communities derive from tourism, tourism marketing and planning should be implemented within the concept of sustainability (Antić et al., 2020). Several models have been created to fulfil the conceptual framework of karst geotourism strategies by introducing factors that can influence the achievement of sustainable tourism. One popular model is the Modified Geosite Assessment Model (MGAM), which can measure and identify geotourism potential (Cvetanović et al., 2024). The M-GAM model consists of core values and added values. The principal value is mainly generated by the natural characteristics of the geosite, which consists of two groups of indicators. Geo-educational indicators fulfil scientific/educational Value (VSE), geoethical indicators fulfil scenic/aesthetic Value (VSA), and protection indicators fulfil protection value (VPr). Added Value is generated from tourists' modified use of the geosite. Added Value is divided into two groups of indicators: functional values as functional values (VFn) and touristic values as touristic values (VTr). The leading indicators of this model explain the conceptual framework of the karst geotourism strategy, including 4A factors. The assessment of the M-GAM model involves a team of experts and tourists. This involvement provides good results in evaluating geosite objects (Cvetanović et al., 2024; Juárez et al., 2024).

Safety

Safety is a state of security or tranquillity of a person or group of people against the risk of danger from environmental factors. Safety comes from the word safe, which means free from danger, calamity, or disaster, or it can also mean the absence of interference from any party. Differences in the character of tourism will differentiate the potential risks between one place and another, thus requiring tourism managers to be able to perform in-depth risk estimation. This estimation will calculate the degree of risk, divided into three levels: high, medium, and low. In UU Number 10 of 2009 concerning Tourism article 26 (D) (Ministry of Tourism of the Republic of Indonesia, 2009), tourism entrepreneurs or tour managers must consider the safety and security of tourists. Security and safety in the tourism sector differ from those in other fields. Tourism is an unusual environment where tourists travel for sightseeing, recreation, entertainment, exploration, or the search for knowledge (Bichler & Pikkemaat, 2021). Significant differences exist between this unique situation and other fields, mainly reflected in the sensitivity of tourism motivation and the comprehensiveness of tourism activities.

Enjoyment

Enjoyment is a positive affective state that occurs when a person engages in an experience or activity that satisfies a desire, goal or need, including but not limited to the need for pleasure, meaning, security, safety, sustenance, self-esteem, belonging, or love (Smith et al., 2014). Enjoyment is a high-level term encompassing many low-level experiences, psychological processes, and affective responses. Enjoyment can be studied at varying levels of abstractness (Goetz et al., 2006). At the most general (macro) level, enjoyment can be defined as a positive affective state that occurs when a person engages in an experience that satisfies a desire, goal, or need. At the most specific (micro) level, researchers can assess people's enjoyment of concrete tasks or activities (e.g., sports or exercise). Enjoyment is an immediate and temporary affective response to a positive experience at this micro level. People usually feel enjoyment when they engage in satisfying activities. These activities may meet basic needs, such as physiological needs, security, belongingness, self-esteem, self-realization, and meaningful life, as well as higher-order needs, such as curiosity and passion (Deci & Ryan, 2008).

Tourism management

According to the World Tourism Organization UNWTO (1999), present economies are characterized by considerable competitiveness in most sectors, including the tourism industry. Therefore, organizations in this sector should strive to achieve a competitive advantage. To this end, companies must perform good organizational organizational management (Tamang et al., 2023). Public awareness of sustainability and governance in tourism is increasing gradually (Yulian et al., 2023). Thus,

sustainable tourism management relies on extensive collaboration between companies, local communities, governments, and other stakeholders (Reinhart et al., 2023). In this case, implementing appropriate practices and policies is critical to achieving success in this type of tourism, preserving the environment, and increasing competitiveness (Reinhart et al., 2023). The karst cave geotourism development model in this study adapts M-GAM with the addition of safety and enjoyment factors to the added value and tourism management as factors that moderate the achievement of sustainable tourism.

HYPOTHESIS DEVELOPMENT
Education and sustainable tourism

A crucial aspect of karst geotourism is building sustainable local development, including geo-knowledge and geoethical values (Vasconcelos et al., 2023). The conceptual framework of the karst geotourism strategy includes educational, socio-economic, and protection perspectives (Roig et al., 2023). These karst areas must be based on strong support. Tourists who know about the cave environment, especially Jomblang cave, unintentionally engage in holiday behaviour that has negative consequences for achieving sustainable tourism. This phenomenon is based on social sociology theory, which postulates that attitude influences behaviour (Lyu et al., 2024). However, in the context of environmentally friendly behaviour, having a positive attitude cannot be a good predictor of running an environmentally friendly tour. Nowak et al. (2024) state that people involved in environmental protection at home must be made aware of the impact of tourism on the environment. Green tourism has a clear attitude-behaviour divide (Loi & Duong, 2022; Ren, 2024). Specific criticisms also arise from research investigating green behaviour. For example, Sorrell et al. (2020) reported that "green attitudes (towards the environment and sustainability in general) do not significantly influence tourist travel" experimentally showed that 94% of respondents believed that "picking up litter is everyone's responsibility." However, only 1.4% picked up litter when exposed to litter. Interviews with some travellers indicated that the litter did not belong to them, and they felt disgusted if they had to pick it up. Several studies have identified possible causes for this gap, including: using escapism and relaxation as an excuse to ignore environmental considerations (Filep & Laing, 2019), being too busy to change behaviour (Donkers, 2022), blaming others, according to (Agiropoulos et al., 2024; Donkers, 2022) having faith in technological solutions (Agiropoulos et al., 2024; Scott et al., 2019); rejecting responsibility (Scott et al., 2019).

H1: Education (Ed) Hurts Sustainable Tourism.

Effect of aesthetics on sustainable tourism

Natural resources are the basic factor for creating tourism products; whether or not the tourism sector develops depends largely on this factor. The larger the scale of tourism resources, the higher the quality, and the more likely it is to become an attractive tourist destination and expand and develop the tourism market (Mai et al., 2020). One of the natural resources for tourism is the aesthetic value of the landscape. The aesthetic value of tourism is a priority for tourists to visit tourist destinations (Zgłobicki et al., 2021). The aesthetic value of the natural wealth of a tourist destination needs special attention to be developed and protected to create sustainable tourism (Zhang & Tavitiyaman, 2022). Aesthetic values can influence tourists' perceptions of tourist destinations and sightseeing experiences (Nie et al., 2022). When negative aesthetic perceptions of the landscape have affected travellers, they will transfer those perceptions to other parts of the trip and the destination. Aesthetic values can also influence ethical and economic values. When tourists feel that parts of the landscape are ugly, these feelings will lead to discomfort and resentment towards the trip. Negative feelings will affect tourists' buying and consumption habits, weakening economic Value. The goal of sustainable tourism is not achieved.

H2: Aesthetic Value (As) positively affects tourism value.

Effect of protection value on sustainable tourism

The development of effective nature-based tourism can benefit both the environment and people. However, the fragile ecological environment and the prominent contradiction between local economic development and the protection of natural resources make sustainable development challenging. Tourism activities have environmental impacts, including increased waste and conflicts of interest in natural resource utilization utilization (Štrba et al., 2022). The tourist environment, such as natural beauty, tourism environment, and geosite aesthetics, must be protected to maintain sustainable tourism. Protection activities are to deepen stakeholders' understanding and recognition of natural resources, establish a system for preserving the aesthetic value of natural resources, build a sustainable development model with distinctive karst characteristics, and conduct pilot demonstrations (Zhang et al., 2023). De Araújo et al. (2024) suggests a positive relationship between environmental concern and the selection of environmentally friendly tourism. This positive relationship shows that the existence of a tourism protection activity affects the achievement of sustainable tourism. Therefore, the following hypothesis is proposed.

H3: Protection Value (Pr) Positively Affects Sustainable Tourism.

Effect of functional value on sustainable tourism

Rosselló et al. (2020) investigated the role of transportation infrastructure in attracting tourists. The impact is the importance of transportation infrastructure on the influx of tourism to a destination. Sugiama et al. (2024) state that accessibility significantly positively affects tourists' intentions to revisit. These conditions support sustainable tourism and arouse the appetite of tourists to return to travel (Ariesta et al., 2020; Sharkhuu et al., 2020) state that tourism and transportation development allow the achievement of sustainable tourism. The more accessible tourism is and has a tourist network, the more sustainable tourism is achieved. Sustainable tourism is a way to maintain high tourist satisfaction levels while reducing adverse environmental impacts. A tourist network supported by accessibility infrastructure makes it easy for tourists to move to tourist sites. Back et al., 2024 suggest that the availability of transportation for tourists is defined as the

feasibility of a destination providing quality transportation to facilitate the movement of tourists from one tourist attraction to another. Hu et al. (2019) state that accessibility significantly impacts tourist satisfaction with a place. Through the quality effect, tourist satisfaction indirectly affects the behaviour or intention to see again (Loi & Duong, 2022).

H4: Functional Value (Fc) positively affects Sustainable tourism. Perceptions research respondents agree that when tourist destinations are more accessible and have a tourist network, sustainable tourism is increasingly achieved.

Effect of tourism value on sustainable tourism

Tourism values include promotion, number of tourist arrivals, tourism services, and tourism facilities. Tourism facilities, human resources, and service quality are important factors in tourism development (Mai et al., 2020). Tourism infrastructure includes equipment and other facilities needed to welcome tourists and places as well as entertainment and recreation venues. In addition, the quality of tourism is greatly influenced by the use of qualified labour because workers who work in tourism not only carry out their tourism expertise but also carry out their duties. It is important to exchange cultures and communicate with visitors so that visitors feel comfortable and excited when travelling. Tourism service quality is also one of the important factors that help tourism develop sustainably. Service quality is a key factor in creating a reputation and tourism brand. From the tourist side, the quality and quantity of tourists can increase environmental awareness (Pop et al., 2024). Travellers' understanding of ecological awareness significantly impacts attitudes when doing tourism activities (Ibnou-Laaroussi et al., 2020). Tourists will be more concerned and responsible for protecting the environment.

H5: Tourism Value (Tr) positively affects Sustainable tourism. Research respondents perceive sustainable tourism is increasingly achieved when tourist destinations have complete tourist-supporting infrastructure and good promotion.

Effect of safety value on sustainable tourism

Each tourism industry has its characteristics and specialities that attract tourists. Safety is a critical factor that keeps tourists visiting tourism (Bowen & Sotomayor, 2022). Safety is part of the image of tourist destinations (Chauhan et al., 2019; Xie et al., 2022). The high level of safety of the sustainable tourism development strategy is one of its advantages (Pitakaso et al., 2024). Tourist safety is a global concern for sustainable tourism since uncertainty about safety can lead to notable variations in visitor flows. Guiding principles and methods that seek to minimize tourism's detrimental consequences on the environment, local communities, and cultural heritage while maximizing its beneficial effects. (Jayasinghe et al., 2024). Traveler safety is a priority in tourism around the world.

H6: Safety (Sf) has a positive effect on Sustainable Tourism. Research respondents' perceptions agree that when tourist destinations are considered safe from various disturbances, sustainable tourism is increasingly achieved.

Effect of enjoyable value on sustainable tourism

When discussing the influence of the value travellers feel during their trip on their intention to recommend, Fatmawati & Olga (2023) found a positive relationship between the two. Enjoyable is a positive emotion that travellers feel. Positive emotions provide a memorable travel experience. The key to profitability is the creation of high-quality experiences (Zhang et al., 2024) because creating meaningful travel experiences can be a key factor in tourism marketing and customer retention; more and more travellers are consciously seeking memorable and unique travel experiences (Marzo-Navarro et al., 2024; Stone & Sthapit, 2024; Terziyska, 2024) Customer satisfaction is an important antecedent of loyalty (Stone & Sthapit, 2024). Research suggests that emotions are an important outcome of travellers' consumption experiences, and travellers' positive emotions are associated with their satisfaction and loyalty (Eid et al., 2019; Hu et al., 2019; Kulakhmetova et al., 2022). Tourist loyalty to tourist attractions will improve the economy and affect the achievement of sustainable tourism.

H7: Enjoyable Value (En) positively affects Sustainable Tourism. Research respondents' perceptions agree that sustainable tourism is increasingly achieved when tourist destinations are considered enjoyable.

The effect of value management on the moderating relationship between education and sustainable tourism

Geotourism can be a powerful instrument for sustainable tourism development, but if managed effectively, it can directly threaten geosite resources. Heavy visitation, lack of management, poor maintenance, and especially the absence of proper education and monitoring challenges to geotourism management (Fang et al., 2024; Marescotti et al., 2022; Yakupova et al., 2024). Some sites can suffer significant degradation due to poor management. Geotourism management guidelines may vary depending on the tourist destination type and the tourism form realized. Sustainable tourism is achieved by creating appropriate geotourism management standards that allow geosite features to be safeguarded and maintained while simultaneously being available as a geotourism resource for economic drivers (Jayasinghe et al., 2024). Based on this research, improving tourism management can increase the influence of education on sustainable tourism.

H8: The interaction effect of Management and Education variables (Ed-Mn) on Sustainable Tourism is positive. Increased tourism management can increase the influence of Education on Sustainable Tourism.

The Effect of Value Management on the Moderating Relationship Between Aesthetics and Sustainable Tourism

Preserving aesthetic values from destruction is an important prerequisite for developing tourism activities. Natural beauty cannot be reproduced, and landscape resources are very fragile. If not strictly maintained, the natural beauty formed over the years will be destroyed, causing the landscape to lose its original charm and reduce its attractiveness to tourists (Marshall et al., 2019). Tourism management plays a positive role in the protection of aesthetic values, which is reflected in tourism revenue, providing financial security for the protection of aesthetic values and encouraging stakeholders to protect the aesthetic values of the area and the ecological environment (Zoderer et al., 2019). Local

villagers gradually realize the importance of maintaining the beauty of the natural environment because it is based on the benefits of tourism and ecological protection. Tourists are largely motivated by their impressions of the quality and value of historical attractions (Yin et al., 2024). When visitors have a pleasant aesthetic experience, they self-regulate their behaviour to protect a heritage site's natural beauty and ecological environment.

H9: The interaction effect of Management and Aesthetics variables (As-Mn) on Sustainable Tourism is positive. Improved tourism management can increase the influence of Aesthetics on Sustainable Tourism.

The effect of value management on the moderating relationship between protection and sustainable tourism

The theory of planned behaviour and norm belief postulates that societal values and beliefs are key drivers of pro-environmental behaviour. However, in the context of tourism, most of these theories fail to predict pro-environmental behaviour. People committed to the environment and have pro-environmental beliefs in their home context behave less environmentally friendly on vacation (Liberato et al., 2021). The extent to which people consider the environment in their actions is also less evident in tourism (MacInnes et al., 2022), with environmental appeals proving unsuccessful in changing tourist behaviour (Juvan & Dolnicar, 2014). MacInnes et al. (2022) states that the most practical interventions the tourism industry implements to make tourists behave more environmentally friendly must be revised. Habit is a strong driver of tourists' sustainable behaviour. Currently, dominant approaches, such as providing information about environmental impacts and requests to change behaviour to be environmentally friendly, are unlikely to seep into tourists' consciousness (Gardner, 2024).

H10: The interaction effect of Management and Protection variables (Pr-Mn) on Sustainable Tourism is negative. Increasing tourism management can reduce the influence of Protection on Sustainable Tourism.

The effect of value management on the moderating relationship between functional and sustainable tourism

Infrastructure is important for sustainable development, especially tourism (Mai et al., 2020). The development of the tourism sector is closely related and depends on infrastructure development, especially the available accessibility. The role of infrastructure is vital because the development of infrastructure and the available infrastructure system can encourage the development of the tourism sector. States that the relationship between infrastructure and tourism activities is an integrated system. Some infrastructure is very important for developing the tourism sector, namely transportation infrastructure such as roads, public transportation modes, and parking lots. Infrastructure plays a vital role in land use planning. Infrastructure is based on bringing interest to tourists and subsequently will be able to increase the number of tourist visits to a destination and realize Sustainable Tourism Development.

H11: The interaction effect of Management and Functional variables (Fs-Mn) on Sustainable Tourism is positive. Improving tourism management can increase the influence of Functional variables on Sustainable Tourism.

The effect of value management on the moderating relationship between tourism and sustainable tourism

Promotion is one of the aspects of tourism value that positively affects tourists' intention to return to visit, which can increase tourism development. However, tourism development has beneficial and negative impacts on tourist destinations: negative attitudes of residents, commercialization of culture, religion, and art, growth of social problems, environmental pollution, and landscape degradation. Promotional management can increase the flow of tourist arrivals. The uncontrolled flow of tourists makes it difficult to make objective estimates and prevent excessive anthropogenic pressure on tourism (Kuklina et al., 2021). The allocation of land for the development of tourist infrastructure has the potential to damage nature, not taking into account the uniqueness of mixed forests, with trees up to 400 years old, or the presence of rare plants listed in the "Red Book."

H12: The interaction effect of Management and Tourism variables (Tr-Mn) on Sustainable Tourism is negative, which means that increasing tourism management can reduce the impact of Tourism on Sustainable Tourism.

The effect of value management on the moderating relationship between safety and sustainable tourism

Kumar et al. (2020) state that the third element is the enabling environment, which is preferable to the standard operating conditions in a nation. The business environment (with 12 indicators), safety and security (with five indicators), health and hygiene (with six indicators), human resources and the labour market (with nine indicators), and information and communication technology readiness (with eight indicators) are its five pillars. Tourism research shows that travel exposes people to various risk levels and that destination choice is not only based on price and destination image but also on perceptions of safety. Even with the best efforts, a tourist destination cannot develop or survive unless it offers high safety. Destination image affects the level of loyalty both directly and through satisfaction. The theoretical implication is the importance of tourists' value preferences as a cornerstone of sustainable tourist destination development.

H13: The interaction effect of Management and Safety variables (Sf-Mn) on Sustainable Tourism is positive, which means that improving tourism management can increase the influence of Safety on Sustainable Tourism.

The effect of value management on the moderating relationship between enjoyable and sustainable tourism

Enjoyable is an image of a tourist destination that can develop sustainable tourism by increasing the number of tourist arrivals. Kanwal et al. (2020) show that managing enjoyable aspects of tourism determines the increase in tourists and the intention to visit again. The better the management of the delightful elements, the higher the tourist satisfaction and the intention to visit again. Emphasizes that satisfaction with the destination image is necessary to create sustainable tourism. Tourism management affects increasing the Value of enjoyment and ultimately increasing sustainable tourism.

H14: The interaction effect of Management and Enjoyment variables (Ej-Mn) on Sustainable Tourism is positive, which means that an increase in tourism management can increase the influence of Enjoyable on Sustainable Tourism.

Conceptual model

This study extends the MGAM theory, which consists of 8 constructs where educational value (Ed), aesthetic value (As), protection value (Pr) of geosite, functional Value (Fc), tourism value (Tr), safety value (Sf) and enjoyment value (Ej) act as independent variables. This model only considers sustainable tourism (St) as the dependent variable. The independent and dependent variables are further moderated by the tourism management variable (Mn). This model explores the improvement and reliability of the geotourism model to achieve sustainable tourism in Jomblang Karst cave geotourism. Figure 1 describes the conceptual framework and hypotheses developed among the mentioned constructs.
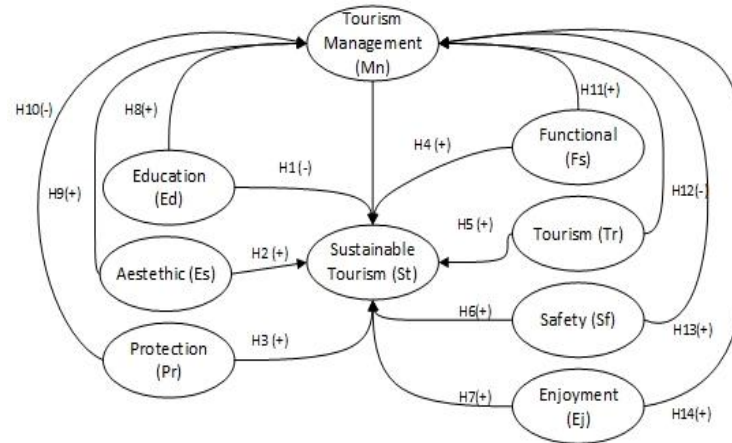

Figure 1. Proposed sustainable tourism model of karst geotourism (Source: Personal documentation of the researchers, 2024)

METHOD

The object of this research was conducted in Jomblang Cave. Jomblang Cave is located in the Gunung Kidul Regency, part of the Special Region of Yogyakarta, Indonesia. It is situated in the village of Jetis Wetan, Semanu District, approximately 50 kilometers southeast of Yogyakarta city. Jomblang Cave is a vertical cave with a depth of 80 meters, offering a unique adventure for visitors. At its base lies a lush underground forest, creating a striking contrast to the karst landscape above. Sunlight streaming through the cave's opening forms the stunning "light of heaven" phenomenon, making it a captivating attraction, as explained in Figure 2. The vertical cave is a cave that is 90º perpendicular from top to bottom. To enter the cave through a rope-assisted pulley technique.

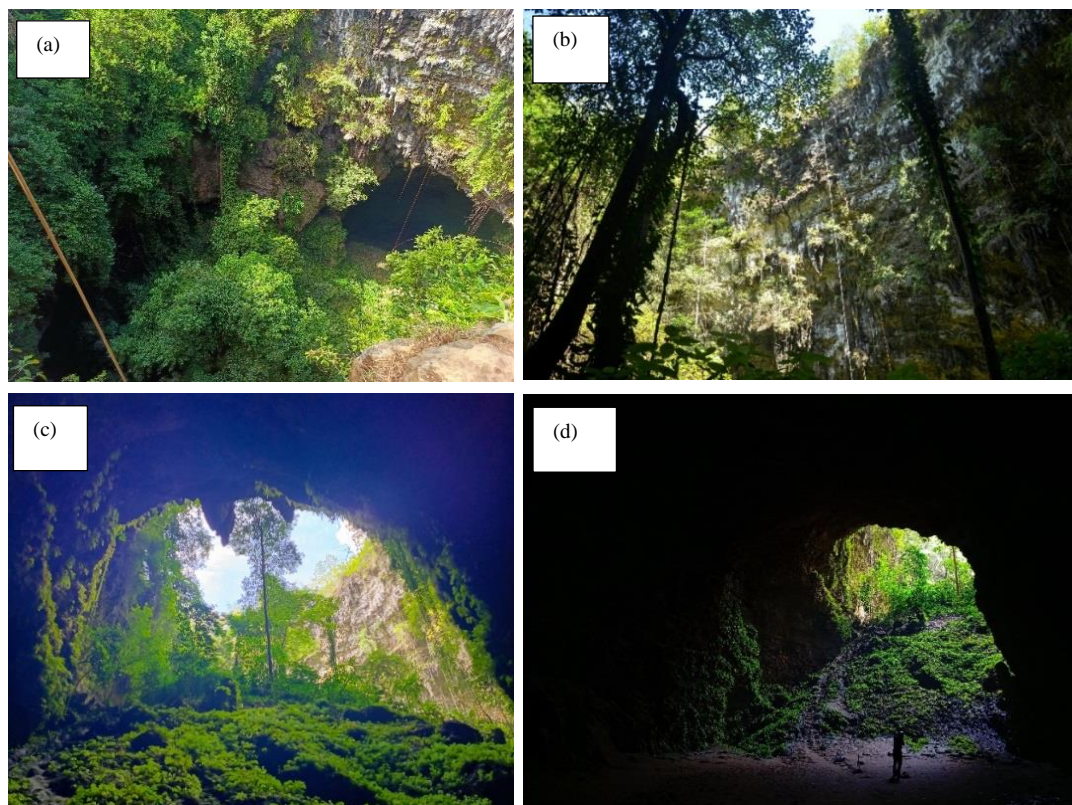Figure 2. (a) View from above Jomblang Cave (View of the forest and horizontal cave at the bottom of Jomblang Cave); (b) View from below Jomblang Cave (Vertical cave view from the bottom of Jomblang Cave); (c) Forest of Ancient Trees at the bottom of Jomblang Cave; and (d) View of the Bat Tunnel from inside the Horizontal Cave in Jomblang Cave (Source: Personal Documentation of the Researchers, 2024)

At the bottom of the cave is an ancient forest with thriving vegetation and a horizontal passage connecting Jomblang Cave and Grubug Cave. The horizontal cave passage is 260 meters long and can be walked. Inside the cave, there are ornaments, as in Figure 3. The cave ornaments are covered with geosite rocks, stalagmites, and stalactites, adding to the cave's beauty. At the end of the cave is an underground river with sunlight coming in from the cave opening above.
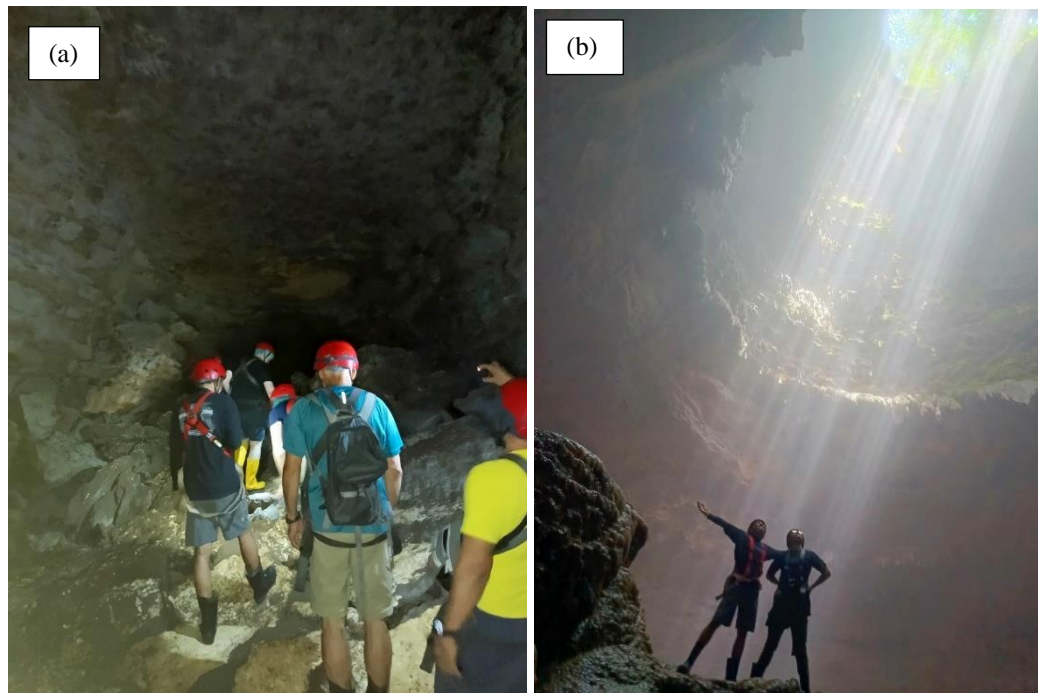

Figure 3. (a) View of cave walls and rocks inside the horizontal cave at Jomblang Cave; (b) View of sunlight entering from the cave hole "light of heaven" at the end of the horizontal cave of Jomblang cave (Source: Personal documentation of the researchers, 2024)

Item measurement

A quantitative approach is used to evaluate the influence of education variables (Ed), aesthetic value (As), site protection value (Pr), functional value (Fs), tourism value (Tr), safety value (Sf), and enjoyment value (Ej) on the achievement of sustainable tourism (St), and the influence of tourism management variables that moderate the relationship between independent variables and sustainable tourism. A total of 9 constructs and 56 items are used in the conceptual model, as described in Table 1.

Table 1. Measurement items for each construct and references (Source: Personal Documentation of the Researchers, 2024)

Construct	Indicator	Label	References	Construct	Indicator	Label	References
Education (Ed)	Uniqueness	Ed1	(Antić et al., 2020; Cvetanović et al., 2024)	Safety (Sf)	Risk	Sf1	(Pinthong et al., 2024; Toker & Emir, 2023; Zou & Yu, 2022)
	Representation	Ed2			Preparedness	Sf2	
	Publication	Ed3			Infrastructure maintenance	Sf3	
	Interpretation	Ed4			Conflict level	Sf4	
Aesthetics (Es)	Point of view	Es1	(Antić et al., 2020; Cvetanović et al., 2024)		Procedure	Sf6	
	Surface area	Es2			Clarity of instruction	Sf8	
	View Quality	Es3			Health infrastructure	Sf9	
	Geosite shape	Es4		Enjoyment (Ej)	Pleasure	Ej1	(Chen et al., 2020; Pei et al., 2020)
Protection (Pr)	Geosite state	Pr1	(Antić et al., 2020; Cvetanović et al., 2024)		Experience	Ej2	
	Protection level	Pr2			Relation	Ej3	
	Vulnerability	Pr3			Feelings flow	Ej4	
	Number of visitors	Pr4			Recommendation intention	Ej5	
Functional (Fs)	Accessibility	Fs1	(Cvetanović et al., 2024; Reinhart et al., 2023; Yulian et al., 2023)		Return intention	Ej6	
	Add nature tourism	Fs2			Calm	Ej7	
	Add culture tourism	Fs3		Sustainble Tourism (St)	Labor absorpstion	St1	(Bentley & O'Brien, 2024; Tena et al., 2021)
	Around city centre	Fs4			Income	St2	
	Around road network	Fs5			Tradition	St3	
	Public facilities	Fs6			Social	St4	
Tourism (Tr)	Promotion	Tr1	(Antić et al., 2020; Cvetanović et al., 2024)		Environmental sustainability	St5	
	OrganizedOrganized visits	Tr2			Hygiene	St6	
	Guides	Tr5		Management (Mn)	Satisfation	Mn1	
	Infrastructure	Tr6			Tools	Mn2	
	Annual visits	Tr7			Techniques	Mn3	
	Inn	Tr8			Service Amount	Mn4	
	Restaurant	Tr9			Environmental conditions	Mn5	

The measurement variables include Ed, Es, Pr, Fs, Tr, modified from (Cvetanović et al., 2024), Sf variable from (Zou & Yu, 2022), Ej variable from (Chen et al., 2020). The measurement items for each variable were modified and analyzedanalyzed according to the research objectives. Each measurement item of the latent variable was rated on a five-point Likert scale. The use of coarser scale points (with fewer scale points) will make it easier for respondents to read the complete scale list and answer specific problems compared to finer scales (which have many scale points) (Štrba et al., 2022; Zhang & Tavitiyaman, 2022). The scale ranges from one for strongly disagree to five for strongly agree.

Participant

Survey methodology is used to empirically investigate the relationship of the proposed model. Based on previously published works, the survey strategy is an appropriate method. That survey strategy is widespread in business and management research. It is usually used to collect large amounts of economic information from a sizable population (Viglia & Dolnicar, 2020). The second section contains demographics. The criteria for respondents selected were that the respondents had interacted with Jomblang cave at least once, the respondents were above 17 years old, and had done cave tours. Respondents included local government, tourism manager, speleological community, local people, and tourists. The sampling technique used in this research was snowball sampling. Respondents were selected based on their data in the questionnaire. The personal data confirmed the respondents' suitability for the requirements. If the respondents needed more qualifications, their responses were included in the study. This was done to ensure the broadest possible response and support the generalization of the research results. The questionnaire was written in Indonesian.

Instruments and data collection

The questionnaire was pre-tested several times to ensure that the format, wording, length, and sequence were appropriate based on expert opinion. During successive pre-tests, feedback was obtained from six experts: tourism researchers, karst researchers, policymakers, and speleology researchers. This helped refine the achievement of sustainable tourism through the proposed variables. A preliminary survey was conducted among 45 people to test the validity and reliability of the questionnaire. Concerning the 5% significance level (0.294; n=45), the correlation value obtained (r-calculated) was then compared with the product-moment correlation value (r-table). The reliability test is carried out to measure the consistency of the measurement instrument, using Cronbach's alpha formula with SPSS Statistics 25 software. An indicator is reliable if it has a Cronbach's alpha value of more than 0.6 (Hair et al., 2010). Based on the validation results, the outer loading of all items is above 0.4 and is acceptable.

Based on the reliability test results, each study variable is more than 0.6, which is considered reliable. This means that the variables used in this study have been entirely accurate and consistent, where if measurements are made on the same subject, the same results will be obtained (Hair et al., 2010), so the questionnaire is ready to use. The questionnaire was designed using Google Forms. The questionnaire was sent to respondents via email or WhatsApp obtained from the respondents. There needs to be more consensus regarding the recommended sample size for structural equation modelling (SEM). The critical sample size is 200. In addition, any number exceeding 200 is considered to provide appropriate statistical power for data analysis. A total of 372 respondents answered the electronic survey. After excluding unsuitable questionnaires, 310 questionnaires became the valid sample for analysis.

Data analysis

This study's analysis technique is Structural Equation Modeling with a Partial Least Square (SEM-PLS) algorithm approach. PLS's advantage is that it can predict behaviour in a situation where there are still limited theories explaining the context of sustainable tourism. The accumulated questionnaire data is processed using SmartPLS 3.2 software.

RESULTS

In this chapter, the results of data collection, validity and reliability tests, and SEM-PLS will be discussed, along with their explanations. The data collection results explain the characteristics of respondents, while the SEM-PLS analysis explains the evaluation of the measurement model and structural model. The analysis results are then associated with the theories and empirical research described in the literature review to test the hypothesis and formulation of research problems.

Result of describe

Table 2 is an overview of the characteristics of participating respondents. The respondent profile consists of gender, aThe profile includes occupation, visiting frequency, and domicile. Based on the demographic characteristics of the gender category, the questionnaire appraisers are dominated by men, 58%, while women are 42%. Demographic characteristics of the age category show that questionnaire appraisers are dominated by visitors aged 17-25 years as much as 40% compared to visitors aged 26-31 years, namely 28% and visitors aged> 31 years as much as 32%.

The demographic characteristics of the last education category show that the questionnaire appraisers are dominated by visitors with a previous education of S1 as much as 72% compared to visitors with a later education of SMA / SMK as much as 1%, Diploma as much as 7% and > S1 as much as 20%. The demographic characteristics of the job category show that the questionnaire appraisers are dominated by visitors with student jobs as much as 34%, compared to visitors with self-employed jobs, as much as 30%, private employees, as much as 15%, public employees with as much as 11% and others as much as 10%. The demographic characteristics of the visiting frequency category show that the questionnaire evaluators are dominated by visitors with a visiting frequency of 1 time as much as 85% compared to visitors with a visiting frequency of 2-3 times as much as 8%, and> 3 times as much as 7%.

Table 2. Profile of participating respondents (Source: Personal documentation of the researchers, 2024)

No	Category		Quantity	(%)
1	Gender	Male	179	58%
		Female	131	42%
2	Age	17-25	125	40%
		26-31	87	28%
		>31	98	32%
3	Latest education	High School	4	1%
		Associate Degree	21	7%
		Bachelor	222	72%
		>Bachelor	63	20%
4	Occupation	Student	104	34%
		Employee	47	15%
		Public Servant	33	11%
		Self-employed	94	30%
		Other	32	10%
5	Frequency of visits	1	265	85%
		2-3	24	8%
		>3	21	7%

Data analyst

Data analysis begins with confirmatory factor analysis (CFA) to build a structural model. Then, the validity and reliability of the measurement model (*outer model)* and the significance of the relationship between variables (*inner model*) are tested. Based on the conceptual framework that has been prepared, the structural model in this study is described in Figure 4 (SmartPLS Output, 2024). The structural model is created by designing the relationship between latent variables. The study's exogenous latent variables are educational attributes, aesthetics, protection, functional, tourism, *safety*, *enjoyment*, and management, which moderate the relationship between study variables. The study's endogenous variable is *sustainable tourism*.
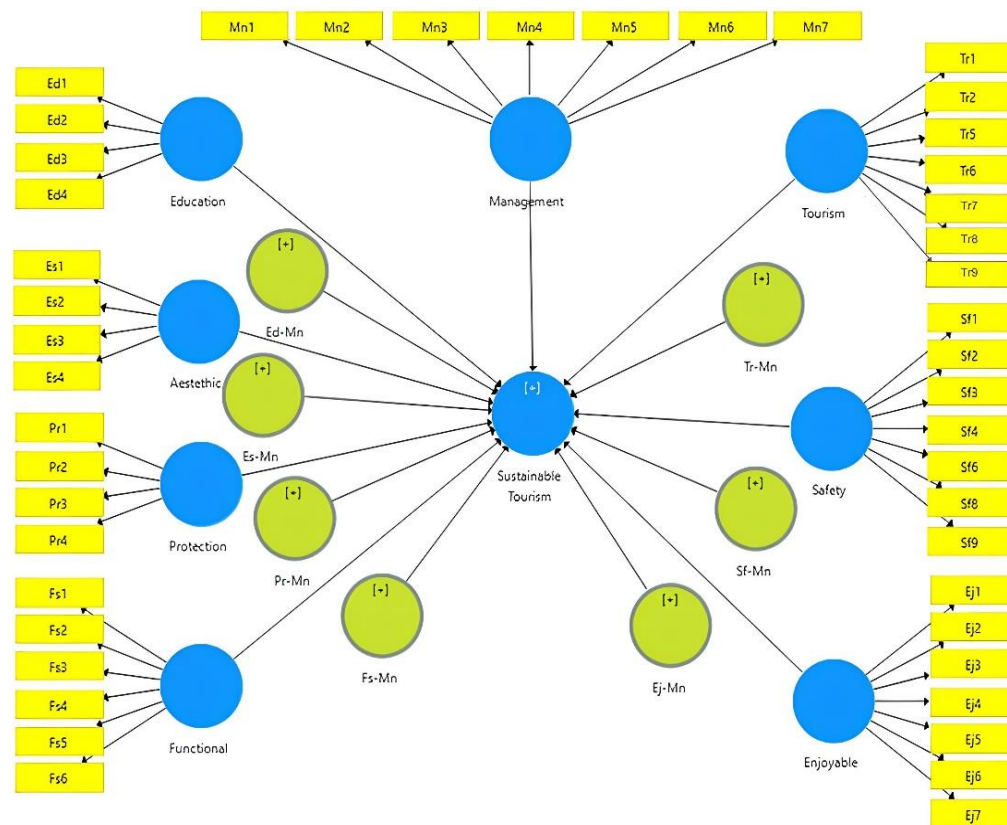

Figure 4. Proposed structural model (Source: Personal documentation of the researchers, 2024)

Evaluation of the measurement model (outer model)

The results of construct validity and reliability testing are described in the outer model stage in Figure 5. The convergent validity test is carried out by looking at each indicator's outer loading value on the latent variable. An outer loading value of >0.7 indicates that a variable has explained 50% or more of its indicator variance. However, the outer loading value of 0.5 to 0.6 can be sufficient for convergent validity requirements. Based on the evaluation results, the tourism value indicator (Tr7) has an outer loading value of less than 0.7. This Value means that the indicator does not meet the requirements of convergent validity. The model is modified by eliminating the Ws7 indicator to obtain the structural model, as shown in

Figure 3. Based on the evaluation results, it can be seen that all indicators have an outer loading value of more than 0.7. This indicates that each study variable can be explained by its indicators and meets the convergent validity requirements.
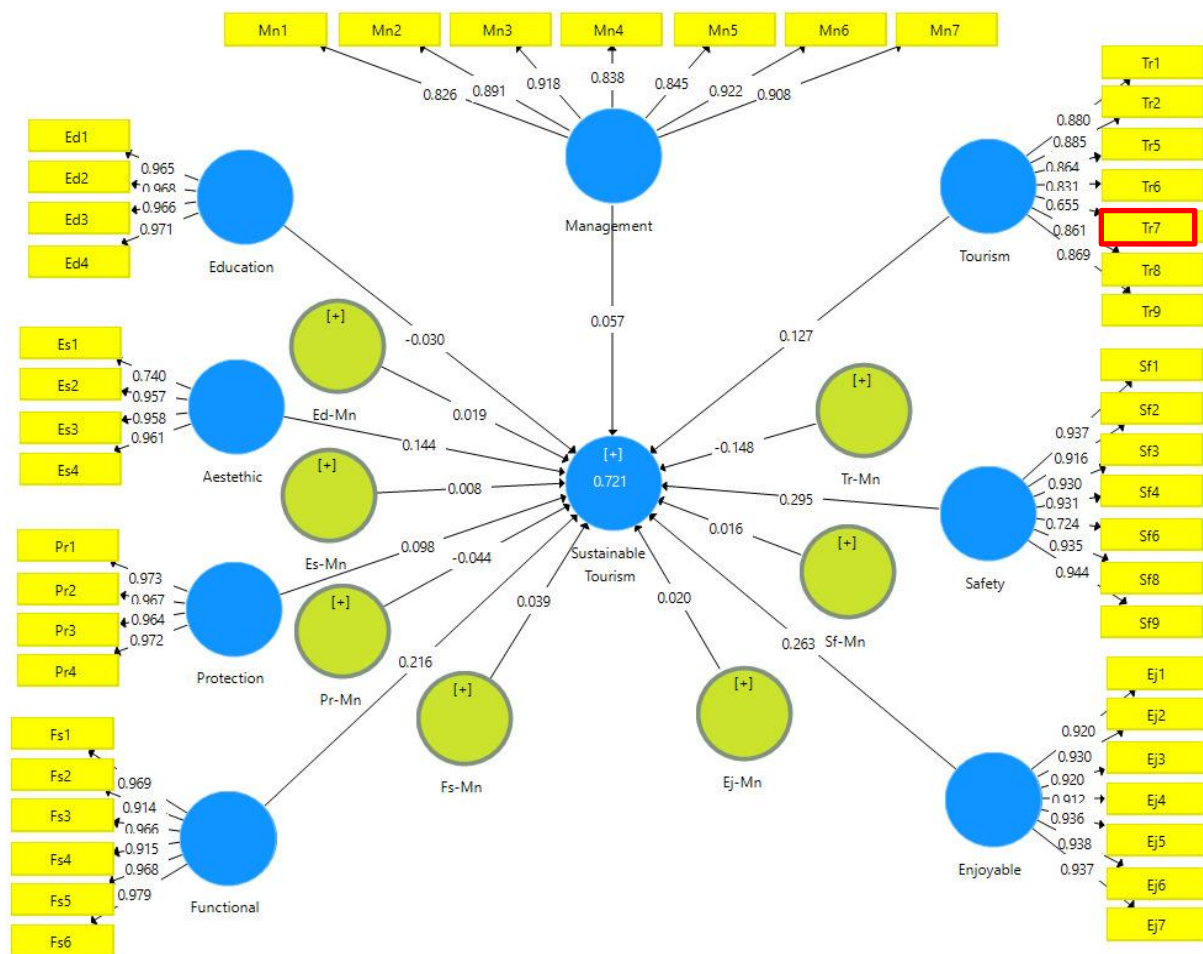

Figure 5. Measurement model evaluation results (Outer model) (Source: Personal Documentation of the Researchers, 2024)

Discriminant validity

The Fornell-Larcker Criterion (FLC) value and crossloadings are commonly used approaches in discriminant validity testing. The FLC value and cross-loadings of an indicator on its latent construct are expected to be greater than the cross-loadings on other latent constructs. The test results are described in Table 3. Table 3 shows that each indicator has the most considerable FLC value on its latent construct compared to the FLC values on other constructs. This explains that the indicators used in this study have good discriminant validity in forming their respective variables. Apart from the cross-loading Value, the results of the discriminant validity test can also be seen through the Average Variant Extracted (AVE) value. Each latent construct must have an AVE value> 0.5 to reflect a good measurement model. Based on Table 4, it is known that each indicator of the latent construct explains 50% or more of its variance (Sarstedt et al., 2017).

Table 3. Matriks Fornell-Larcker Criterion (FLC) (Source: Personal Documentation of the Researchers, 2024)

	Ej-Mn	Ej	As-Mn	As	Fs-Mn	Fs	Ed	Pr	Ed-Mn	Pr-Mn	Sf	Sf-Mn	St	Tr	Tr-Mn
Ej-Mn	1														
Ej	0.208	0.928													
As-Mn	0.377	0.357	1												
As	0.384	0.384	0.06	0.909											
Fs-Mn	0.364	0.355	0.585	0.225	1										
Fs	0.409	0.39	0.241	0.494	0.03	0.952									
Ed	0.313	0.425	0.235	0.255	0.253	0.308	0.967								
Pr	0.295	0.452	0.114	0.782	0.328	0.413	0.322	0.912							
Ed-Mn	0.349	0.316	0.351	0.255	0.352	0.294	0.121	0.286	1						
Pr-Mn	0.437	0.288	0.813	0.119	0.429	0.368	0.277	0.043	0.265	1					
Sf	0.494	0.366	0.246	0.508	0.201	0.619	0.412	0.416	0.238	0.374	0.905				
Sf-Mn	0.298	0.423	0.616	0.226	0.667	0.198	0.202	0.328	0.462	0.449	0.043	1			
St	0.341	0.657	0.28	0.592	0.279	0.631	0.404	0.586	0.294	0.286	0.648	0.283	0.898		
Tr	0.07	0.557	0.232	0.16	0.208	0.328	0.442	0.264	0.163	0.208	0.295	0.238	0.465	0.866	
Tr-Mn	0.439	0.069	0.103	0.243	0.191	0.234	0.157	0.208	0.337	0.168	0.271	0.198	0.097	0.231	1

Composite reliability

In SEM-PLS analysis, a construct is declared reliable if its composite reliability value is> 0.6 and is reinforced by a Cronbach's Alpha value> 0.7. Table 4 explains the composite reliability test results. The composite reliability value of 0.6 - 0.7 and Cronbach's alpha value of> 0.7 are considered good reliability. Based on the calculation results, all constructs have a composite reliability value and Cronbach's alpha> 0.7, so it is concluded that they are reliable.

Table 4. Model Validity and Reliability Test Results (Source: Personal Documentation of the Researchers, 2024)

Variable	Cronbach's Alpha	Composite Reliability	AVE
Ej-Mn	1	1	1
Enjoyable	0.973	0.977	0.861
As-Mn	1	1	1
Aesthetics	0.929	0.95	0.826
Fs-Mn	1	1	1
Functional	0.979	0.983	0.907
Education	0.977	0.983	0.936
Protection	0.933	0.952	0.832
Ed-Mn	1	1	1
Pr-Mn	1	1	1
Safety	0.962	0.969	0.82
Sf-Mn	1	1	1
Sustainable Tourism	0.952	0.962	0.807
Tourism	0.934	0.947	0.75
Tr-Mn	1	1	1

Structural model evaluation (Inner Model)

The structural model evaluation stage (inner model) tests the model's goodness (model fit) and hypothesis testing. The model goodness test is carried out by observing the R-square (R^2) value. Partial hypothesis testing is done by observing the significance value of the relationship between variables (direct and indirect effects). The R-Square (R^2) value is used to determine the predictive power of the structural model in SEM-PLS analysis. The criteria for the R-square Value that is close to or greater than 0.67 is considered strong, 0.33 is moderate, and 0.19 is considered weak (Hair et al., 2010). The R-square Value can be explained in Table 5.

Table 5. R-Square Value (Source: Personal Documentation of the Researchers, 2024)

Endogen Variable	R-Square	Criteria
Sustainable tourism	0,722	Strong

Based on the table, it can be seen that the R-square Value of the endogenous variable Sustainable Tourism is 0.722. This Value explains that the strength of these variables in predicting sustainable tourism is 72.2%. While the percentage of 28.8% is explained by other factors that are outside this research model, in addition to the R-Square Value, the Stone-Geisser Q-square value is also used to determine the goodness of the model; the higher the Q-Square value, the more the structural model fits the data (Tanwar et al., 2024). The Q-square test in this study can be seen in the following formulation:

$$Q^2 = 1- (1-R1^2) (1-R2^2) (1-R3^2)… 1-Rp^2$$

Explanation:

Q^2: The predictive ability of the model.

R^2: The coefficient of determination, which indicates the proportion of variance in the dependent variable explained by the independent variables. Interpretation:

$Q^2 > 0$: The model has good predictive ability.

$Q^2 \leq 0$: The model does not have predictive ability.

The sustainable tourism variable shows a R^2 value of 0.722. The Stone-Geisser Q Square value is calculated with the following equation;

$$Q^2 = 1- (1-0,722); Q^2 = 0,722$$

These results indicate that the model is considered strong and able to explain several variables that affect sustainable tourism with a contribution of 72.2%. Thus, this research model is declared to meet the requirements of goodness (model fit).

Hypothesis tests

Hypothesis tests are carried out by looking at the original sample estimates (O) value to determine the direction of the relationship between variables, as well as t-statistics (T) and p-values (P) to determine the significance level of the relationship. An original sample value close to +1 indicates a positive relationship, while a value close to -1 indicates a negative relationship (Sarstedt et al., 2017). A t-statistics value of more than 1.96 or a p-value more minor than the significance level (<0.05) indicates that the relationship between variables is significant. The results of hypothesis testing are described in Table 6. Table 6 shows that each variable has a significant relationship with sustainable tourism because each variable has a p-value < 0.05. In addition, the results show that the management variable is a moderating variable for

each relationship between each variable and sustainable tourism. This indicates that the management variable affects the strength or direction of the relationship between each other variable and sustainable tourism.

Table 6. Value of relationship between variables (direct and indirect effects) (Source: Personal documentation of the researchers, 2024)

	Hypothesis	O	T Statistics	P Values	Description
Ej-Mn -> Sustainable Tourism	H14	0.020	2.343	0.026*	Supported
Enjoyable -> Sustainable Tourism	H7	0.261	33.629	0.000*	Supported
As-Mn -> Sustainable Tourism	H9	0.015	1.687	0.102**	Supported
Aesthetics -> Sustainable Tourism	H2	0.131	22.248	0.000*	Supported
Fs-Mn -> Sustainable Tourism	H11	0.037	5.483	0.000*	Supported
Functional -> Sustainable Tourism	H4	0.218	43.290	0.000*	Supported
Education -> Sustainable Tourism	H1	-0.024	3.589	0.001*	Supported
Protection -> Sustainable Tourism	H3	0.105	19.430	0.000*	Supported
Ed-Mn -> Sustainable Tourism	H8	0.017	2.782	0.009*	Supported
Pr-Mn -> Sustainable Tourism	H10	-0.043	5.884	0.000*	Supported
Safety -> Sustainable Tourism	H6	0.295	53.322	0.000*	Supported
Sf-Mn -> Sustainable Tourism	H13	0.015	2.184	0.037*	Supported
Tourism -> Sustainable Tourism	H5	0.127	18.267	0.000*	Supported
Tr-Mn -> Sustainable Tourism	H12	-0.147	26.872	0.000*	Supported

* Significant at 0.05 , ** Significant at 0.10

The results showed that education negatively and significantly affects Sustainable Tourism. This shows that increasing education decreases its influence on sustainable tourism. The variables of aesthetics, protection, functionality, tourism, safety, enjoyment, and management significantly affect sustainable tourism. Increasing aesthetics, protection, functionality, tourism, safety, enjoyment, and management can increase its influence on sustainable tourism. The management variable moderates the relationship between each variable and sustainable tourism. Management variables hurt moderating the relationship between protection and tourism and sustainable tourism. This means that increasing management can reduce the influence of protection and tourism on sustainable tourism. Then, the management variable moderates each relationship between each variable and sustainable tourism. Management variables have a negative effect in moderating the relationship between protection and tourism and sustainable tourism. This means that increasing management can reduce the influence of protection and tourism on sustainable tourism. Then, the management variable positively moderates the relationship of Aesthetics, Safety, Enjoyable, and Protection to sustainable tourism. Increased management can influence the relationship between aesthetics, safety, enjoyment, and sustainable tourism protection.

DISCUSSION

This research tries to build a model to measure factors affecting sustainable tourism. The model is an adaptation of the M-GAM model, which in previous studies has been used to calculate the potential of geosites to achieve sustainable tourism. This study developed safety and enjoyable variables to complement the M-GAM variables. Several recommendations and considerations can be formulated. One of the study results is confirmation that safety and enjoyable management affect the achievement of sustainable tourism. This result is based on the theory that safety and enjoyable tourism are the image of a tourist destination that will increase tourist loyalty. Another study result is that the Value of education and the management of geosite protection hurt sustainable tourism. This is an important finding because it validates the multidimensional view of the Value of education and management of geosite protection more rigorously than previous studies.

The hypothesized relationships proposed in the structural model between latent variables were tested through the student T-test of association with the P value. As shown in Table 6, hypotheses and relationships between endogenous constructs are accepted. The results showed that the variables of aesthetics, protection, function, safety, tourism, and enjoyment can increase the achievement of sustainable tourism in Jomblang Cave. The education variable shows that tourists have a negative influence on the achievement of sustainable tourism. Tourists who know about the cave environment, especially Jomblang cave, are unintentionally involved in holiday behaviour that has negative consequences for achieving sustainable tourism. This phenomenon is based on social sociology theory, which postulates that attitudes influence behaviour. However, in the context of green behaviour, having a positive attitude is not a good predictor of practising green tourism. Green tourism has a clear attitude-behaviour gap.

The relationship between variables, when moderated by tourism management variables, the results obtained variables of education, aesthetics, function, safety, and enjoyment can increase the achievement of sustainable tourism. The more these variables are well managed, the more sustainable tourism is achieved. Meanwhile, the moderating influence of tourism management variables on the Protection and Tourism variables shows a negative impact on the achievement of sustainable tourism. This finding is based on research Viglia & Dolnicar (2020) which proves that environmental appeals have been unsuccessful in changing tourist behaviour (Viglia & Dolnicar, 2020). MacInnes et al. (2022) stated that most of the practical interventions the tourism industry implements to make tourists behave more environmentally friendly need to be revised. Habit is a strong driver of tourists' sustainable behaviour. Currently, dominant approaches, such as providing information on environmental impacts combined with requests to change behaviour to be environmentally friendly, are unlikely to sink into tourists' consciousness (Gardner, 2024). Uncontrolled promotional activities also affect the flow of

tourists. With an unchecked flow of tourists, it is difficult to make objective estimates and prevent excessive anthropogenic pressure on tourism (Kuklina et al., 2021). These results suggest that new ways of improving tourism management are needed. Habit-based interventions focus on the automaticity aspect of changing behaviour. The two main practical applications of habit-based interventions are stopping the automaticity of bad habits and strengthening the automaticity of good habits, which are proven effective methods for changing key habits (MacInnes et al., 2022). For example, multicompartment bins allow travellers to keep waste sorting automated.

Another example is reducing plate size to prevent tourists from taking too much food at the buffet. These ways can increase tourists' awareness of their behaviour while on the Jomblang cave tour. This study's findings will also enable academics and practitioners to take a broader view of the factors that influence the achievement of sustainable tourism. First, the applicability of the proposed theoretical model to the field of sustainable tourism has been confirmed. Second, the findings of this study will help scholars expand the literature and further develop theories in the field of sustainable tourism. Third, to the best of our knowledge, safety and enjoyment factors are examined in the literature separately from other factors in the tourism development model.

In contrast, this is the first integrated theoretical model that incorporates all the constructs that have been developed and empirically validated. Fourth, tourist safety and enjoyment should serve as the main tools to create a good image of Jomblang Cave, thus enhancing responsible management practices in the organization, creating a sense of accountability, and building trust (Kim & Chen, 2019). Fifth, with the insights gained from the theory of tourist behaviour, this study identifies the need for new ways to increase tourists' awareness to protect the environment of Jomblang Cave. Habit-based interventions focus on the automaticity aspect of changing behaviour. The two main practical applications of habit-based interventions are stopping the automaticity of bad habits and strengthening the automaticity of good habits, which are proven effective methods for changing key habits (MacInnes et al., 2022). For example, multicompartment bins allow travellers to keep waste sorting automated. Another example is reducing plate size to prevent tourists from taking too much food at the buffet. These methods can increase tourists' awareness of their behaviour while staying at Jomblang Cave.

This research has four valuable implications. First, the primary purpose of this research is to identify indicators and variables that influence sustainable tourism. This issue is important because by knowing the variables that influence sustainable tourism, the management of Jomblang cave tourism will be more effective. Secondly, the findings are helpful for all stakeholders in tourism management. They may face similar challenges while continuously looking for strategies to facilitate tourists. They can better evaluate their competitiveness based on the factors presented in this study. Third, the research opens new insights into the topic. This can increase tourist trust and improve the image of Jomblang Cave. Safety and enjoyment play an important role in the creation of sustainable tourism. Tourists will feel safe and have a pleasant experience while travelling in Jomblang Cave. The management of Jomblang Cave, with new interventions to increase tourist awareness and protect the environment, will create a preserved tourist environment. Thus, Jomblang cave tourism will gain the trust of tourists while still making sustainable tourism in the Jomblang cave environment.

CONCLUSION

Based on the results of the analysis, this research produces the following conclusions: This research was conducted through a field study by distributing questionnaires to 310 tourists who visited Jomblang cave. The results showed that the factors that influence the achievement of sustainable tourism are aesthetics, protection, functionality, safety, tourism, and enjoyment, which have a positive and significant effect on achieving sustainable tourism in Jomblang Cave. The education factor has a negative and significant influence on achieving sustainable tourism. When tourism management factors moderate the relationship of factors, the results of education, aesthetics, functional, safety, and enjoyable factors can increase the achievement of sustainable tourism. The more these factors are well managed, the more sustainable tourism is achieved.

Meanwhile, the moderating influence of tourism management factors on protection and tourism factors negatively influences the achievement of sustainable tourism. The proposed reflective model has a high predictive relevance concerning the endogenous factors of practical, sustainable tourism. Based on the results of this study, the management of Jomblang Cave should consider new ways to improve tourism management to achieve sustainable tourism. It is necessary to change tourist behaviour with habit-based interventions focusing on automaticity.

Habit-based interventions can stop the automaticity of bad habits and strengthen the automaticity of good habits. For example, providing multicompartment waste bins allows travellers to maintain the automaticity of waste sorting. These methods can increase tourists' awareness of their behaviour during the Jomblang cave tour. This research contributes the first integrated theoretical model that combines safety and enjoyment factors with other factors in the tourism development model and has been validated empirically. The results of this study will help scholars expand the literature and develop further theories in sustainable tourism.

Although this study has made significant contributions to the literature, there are still some potential limitations. The results are limited to tourists' perceptions. Generalizable results must be cross-validated with a larger sample size and various organizational/stakeholder settings. A larger sample size is needed to address the weak relationship between decision-making and public trust. This study is based on the results of a questionnaire survey. Further mixed methods will enrich the findings. The results of this study provide potential for future research development. First, because the topic of safety and enjoyment is relatively new, researchers can benefit from the findings of this study and apply them in their future observations. Second, future research exploring other similar tours will also benefit. Finally, this study outlines a path for future researchers to empirically investigate the impact of implementing safety and enjoyment factors and the form of implementation so that sustainable tourism is not disrupted.

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