Exploring the effectiveness of the current use of geographic information systems in sustainable tourism planning in the Sultanate of Oman

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Abstract

Geographic Information System stands to provide alternative perspectives to the conceptualization and visualization of sustainable tourism, particularly for emerging destinations such as the Sultanate of Oman. Nonetheless, it has been sparingly applied in sustainable tourism planning, implementation, and management of sustainable tourism, with unanswered questions surrounding its effectiveness. Hence, this study aimed to evaluate the current roles of geographic information systems in sustainable tourism planning in the Sultanate of Oman, explore the critical current capabilities available for geographic information systems to contribute to sustainable tourism planning in the Sultanate of Oman, and identify the plans that the Ministry of Heritage and Tourism (MHT) will follow to increase the contribution of geographic information systems in sustainable tourism planning in the Sultanate of Oman. This study applied a qualitative research approach, focusing on 12 in-depth interviews. 12 specialists in geographic information systems, sustainability, and tourism planning have at least two years of experience in the tourism sector. The results revealed that, first, the current roles of geographic information systems in sustainable tourism planning in the Sultanate of Oman still need to be improved due to some challenges faced by the Geographic Information Systems Department at the Ministry of Heritage and Tourism. Second, the current capabilities available to the Geographic Information Systems Department are insufficient, and the role of GIS in sustainable tourism planning cannot be highlighted with the current capabilities. The Third result is that the Ministry of Heritage and Tourism can efficiently use GIS in sustainable tourism planning by following a set of plans internally, such as creating a comprehensive and flexible geographic database that includes all spatial data from various departments within the Ministry and a set of plans externally, such as organized and joint work with other institutions that work in geographic information systems in the Sultanate of Oman. This research provides a comprehensive and integrated overview of the current status of GIS in sustainable tourism planning.

Keywords: Geographic information systems (GIS), sustainable tourism, planning, Sultanate of Oman.

1. Introduction

Technological sciences and their applications are no longer a luxury. Rather, they have become necessary and inevitable to facilitate the development of any economic sector.

According to Goodchild (1991), the geographical information system (GIS) is a modern science of interest that puts different things together: geography, mathematics, computer science, management, statistics, surveying, and mapping science, in one template. On the basis of geospatial data, supported by computer software and hardware, it collects, inputs, manages, analyses, queries, models, and displays spatial data and metadata (Green, 1988).

GIS provides timely access to a wide range of geographical and dynamic information in order to set up a computer technology system to support geography study and decision-making. It becomes an effective management decision-making tool due to its efficient data management, spatial analysis, multi-factor comprehensive analysis, and dynamic monitoring capabilities. And it is widely used in land management, urban planning, disaster prevention and mitigation, real estate development, commercial, and other areas (We, 2012). GIS is often made up of hardware and software systems. GIS hardware systems are made up of computer equipment and a network with some external device structure, with the computer serving as the GIS host .External devices include input and output devices, as well as data storage and transmission equipment (Land id, 2023). Data input, data preprocessing, data storage and administration, geographic analysis, and data output are the five subsystems of a GIS software system (Esri, 2023).

The primary functions of GIS include data collecting and editing, data storage and administration, data processing and transformation, spatial analysis and statistics, and product development and display (Pajorska, 2023).

GIS facilitates the visualization, analysis, and modeling of intricate relationships between location-based data points by fusing geographical information with advanced technologies. Applications for this revolutionary capability can be found in many fields, including public health, disaster management, urban planning, and environmental conservation (ArcGIS Story Map, 2022)

Since the tourism sector is one of the sectors on which the economies of most countries are based, the use of geographic information systems in this sector, specifically with regard to sustainable tourism development, adds value and effectiveness to the plans drawn up for sustainable tourism development (Kisi, 2019). In the realm of sustainable tourism development, GIS plays a pivotal role in informing decision-making processes (Singh, 2015).

Integrating spatial data with analytical tools, GIS empowers stakeholders to make informed, evidence-based choices that promote sustainable tourism practices. Geographic information systems have emerged as indispensable tools in the realm of sustainable tourism development planning. Through the acquisition, analysis, and visualization of spatial data, GIS empowers stakeholders to make well-informed decisions that balance economic growth, environmental protection, and cultural preservation. One of the critical strengths of GIS lies in its capacity for spatial analysis. Through a variety of tools and techniques, GIS enables the examination of spatial relationships, patterns, and trends (Minasi et al., 2020). In the context of sustainable tourism, this means assessing factors such as accessibility, environmental sensitivity, cultural significance, and economic viability. For example, GIS can be used to identify suitable locations for eco-friendly accommodations or to evaluate the impact of tourism activities on natural habitats (Farsari, n.d.). Sustainable tourism development is one of the concerns of the Ministry of Heritage and Tourism of the Sultanate of Oman in the next stage, and this is what was stated through the Ministry's vision in the next stage: "For the Sultanate of Oman to be among the leading countries in its national heritage, and one of the best sustainable tourist destinations that tourists visit to experience unique and diverse experiences" (Ministry of Heritage and Tourism, 2022).

Moreover, the Ministry of Heritage and Tourism established the Geographic Information Systems Department in 2006 to perform tasks related to spatial data analysis (Ministry of Heritage and Tourism, n.d.). However, the department's work in tourism planning still needs to be improved. Accordingly, this research will explore the effectiveness of the current uses of geographic information systems in sustainable tourism planning in the Sultanate of Oman. Since sustainable tourism development is one of the emerging trends and one of the main goals in the upcoming plans of the Ministry of Heritage and Tourism in the Sultanate of Oman, and given the effective role that geographic information systems can contribute to sustainable tourism development plans, this research aims to explore the most critical roles played by geographic information systems in

sustainable tourism planning in the Sultanate of Oman. In addition, it explores the most essential current capabilities available for geographic information systems to contribute to sustainable tourism planning in the Sultanate of Oman. The research also aims to identify the plans that the Ministry of Heritage and Tourism will follow to increase the contribution of geographic information systems to sustainable tourism planning in the Sultanate of Oman.

2. Literature Review

2.1. The Overview of the Geographic Information Systems

Geographic information systems are a terminology commonly used to refer to geographically oriented computer technology, integrated systems used in substantive applications, and more recently, a discipline that is garnering global attention (Maguire et al., 2015). As a concept, Geographic Information Systems has been defined from different perspectives. For some, such as Reddy (2018), Geographic Information Systems is composed of integrated computer systems that can receive input, storage, analysis, and generation of spatially referenced data. Other definitions emphasize the idea that it is an integration of a series of disciplinary orientations, including geography, computer science, mathematics, statistics, management, surveying, and mapping science (We, 2012). Inherently, these definitions demonstrate that geographic information systems are computer systems for entering and analyzing spatial data.

Based on the previous definitions, geographic information systems can be defined as computer systems that enter, process, and analyze spatial data. “a special case of information systems where the database consists of observations on spatially distributed features, activities, or events, which are definable in space as points, lines, or areas. A GIS manipulates data about these points, lines, and areas to retrieve data for ad hoc queries and analyses” (Dueker, 1979). “a database system in which most of the data are spatially indexed, and upon which a set of procedures operated in order to answer queries about spatial entities in the database” (Smith et al., 1987). Dueker and Smith's definitions can be summarized as saying that GIS are databases in which data are indexed spatially.

2.2. The application of GIS in tourism

GIS technology is a powerful tool for providing significant geographical insights for decision-making in a variety of economic sectors. It enables organizations and governments to make data-driven decisions that can result in enhanced efficiency, cost savings, and long-term development (Overman,

2006). There are various stages of tourism planning at each scale: determining planned objectives, analyzing existing situations, modeling and forecasting, planning development options, planning options selection, plan evaluation, monitoring, and implementation, as well as suggestions (Lichfield et al., 2016).

Infrastructure is one of the essential foundations on which the development and growth of tourism is based. GIS is used extensively in infrastructure management in the tourism industry, including utilities, transportation, environmental management, and urban planning (Vinodkumar, 2016). GIS allows for spatial analysis to understand better how various infrastructure elements interact with one another and with the surrounding environment. It can, for example, be used to examine traffic flow patterns, find the best places for new tourism infrastructure, or assess the impact of new development on existing infrastructure, operations, and maintenance, and GIS aids in the planning and scheduling of maintenance tasks (Rezvani et al., 2023).

According to Singh (2015), geographic information systems can be used to conduct spatial analysis of tourism resources to find patterns, linkages, and trends. Understanding the spatial distribution and interactions between different tourism assets can include proximity analysis, overlay analysis, and spatial querying. Also, GIS can be used to aid in tourism planning and zoning, identify ideal places for tourism growth, establish zoning restrictions, and plan infrastructure development (Acharya et al., 2022). Goodchild et al., 2019 stated that, GIS can be used to determine the fastest routes to strategic locations such as hotels, streets, hospitals, police stations, malls, supermarkets, terminals, universities, and stations. Wei (2012) discusses the most critical applications of geographic information systems in the tourism sector in terms of the facilities they provide to tourists, travelers will be able to click and get better travel services if they have a thorough tourist map. Because of space constraints, it is difficult to offer accurate scenic status on typical tourist maps. GIS has a significant benefit in that it is mighty. Text and image editing functions are available, as is data upkeep. It has the potential to significantly reduce the cost of the plans while avoiding the time-consuming procedure of traditional mapping (Goodchild et al., 2019). In comparison to conventional, the advantages of GIS developing tourism plans over paper tourist maps are evident (Kordha et al., 2019).

2.3 The overview of sustainable tourism

Many authors have defined sustainable tourism in various ways. while there is no universally accepted definition, the World Tourism Organization's definition is one of the most often used (Zolfani et al., 2015) .The World Tourism Organization defines sustainable tourism as “tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment, and host communities"(UNWTO, n.d.). Accordingly, to Mihalic (2016), Sustainable tourism, often known as responsible tourism, is a travel and tourism concept that attempts to limit negative environmental, social, and economic impacts while enhancing beneficial contributions to local communities and conservation initiatives. It entails making decisions and acting in ways that support the long-term health and well-being of destinations and their inhabitants in general, sustainable tourism focuses on the environmental, cultural, social, and economic aspects at the same time (Streimikiene et al., 2020) .Inherently, these definitions demonstrate that sustainable tourism is related to environmental conservation, maximizing economic benefits for host communities, and preserving the culture of communities.

2.4 Sustainable Tourism Applications in Oman

In Oman, sustainable tourism involves encouraging responsible travel behaviors that minimize harm to the environment, local communities, and culture while promoting economic growth and protecting the country's natural resources (Ray, 2018). There are many applications for sustainable tourism in Oman in various tourism businesses, such as:

Eco-friendly accommodations: encourage the creation and promotion of environmentally friendly hotels, resorts, and lodges that adopt sustainable practices such as energy and water preservation, decreasing waste, and the use of local products (Horng et al., 2017). For example, Kempinski Hotel_ muscat, since this hotel is considered one of the distinguished hotels in the Sultanate of Oman and one of the unique hotel destinations. Its application of the principles of sustainability reflects positively on the principles of sustainable tourism since hotel establishments are an integral part of the sustainable tourism system. Kempinski is the first institution to introduce an electric car to its fleet in Oman, combining performance and luxury to support sustainability objectives in the tourism and hospitality industry. Moreover, the hotel aims to support the local community through “priorities local produce and where they carry the journey from the fresh farms and markets of Oman to their

restaurants. So, their food source from a variety of Omani suppliers such as honey, fish, and other food items." (Sustainability & Corporate Responsibility KEMPINSKI HOTELS, 2020).

2.5. GIS in Sustainable Tourism Planning in Oman

Geographic information systems are one technological discipline that can contribute to sustainable tourism planning Mansour et al., 2019 stated that GIS can map Oman's diverse natural attractions, such as its mountains (e.g., Jebel Akhdar) and deserts (e.g., Wahiba Sands). This mapping helps identify areas suitable for eco-tourism activities. GIS facilitates the assessment of potential environmental impacts of tourism projects by analyzing sensitive ecosystems, water resources, and biodiversity (Colak, 2024). In addition, real-time data from GIS can inform capacity management strategies and enhance the visitor experience (Zubiaga, 2021). Moreover, Oman's tourism industry is subject to natural calamities such as cyclones (e.g., Cyclone Gonu). GIS aids disaster preparation and response planning by identifying high-risk locations and evacuation routes (Ruheili et al., 2023).

However, few studies have discussed the role and effectiveness of geographic information systems in sustainable tourism planning in the Sultanate of Oman; it can be said that they are nonexistent. It is clear from previous studies that geographic information systems are one of the important technological tools in all economic sectors, especially in the tourism sector, and that the use of geographic information systems provides a comprehensive view of all dimensions in the geographical space of the tourism project, which in turn maximizes the importance of geographic information systems in sustainable tourism planning. This is because sustainable tourism focuses on protecting the environment, maximizing economic benefits, participating local communities in the tourism industry, and maximizing the benefit of local communities from tourism. Therefore, geographic information systems provide the necessary analysis for all elements in the tourism planning stage to achieve the principles of sustainable tourism.

3. Methodology

3.1. Research design

An exploratory qualitative method was used for data gathering and analysis. This research approach involves collecting and analyzing interview data from specialists in geographic information systems, sustainable tourism specialists, and tourism planning specialists at the Ministry of Heritage and

Tourism in the Sultanate of Oman to gain a deep understanding of a research topic that has previously received little attention.

Exploratory qualitative research employs a variety of investigative techniques, such as in-depth interviews, observations, and Analytics. These Methodologies are effective techniques for gaining broad and complicated insights into the experiences, ideas, and views of participants in this study. This approach provides an ideal foundation for participants, allowing for a thorough comprehension of the topic matter. The open-ended interview, as well as the ability to ask probing questions during semi-structured interviews, enables interviewees to delve deeper into the matter and talk about their opinions, ideas, and aspirations regarding the effectiveness of geographic information systems in sustainable tourism planning. The researcher used this type of interview because it provided an opportunity to obtain information that cannot be obtained in more structured interviews, which in turn supports the research findings.

3.2. Data and sample

The study population was employees of the Ministry of Heritage and Tourism in the Sultanate of Oman. Purposive sampling was used to find more relevant responses. Accordingly, Setia (2016) purposive sampling is a non-probability sampling technique often used in qualitative studies. It is used to select participants according to specified criteria related to the research question and purpose. So that the participants' responses are related to the depth of the research questions .There is a set of criteria adopted in the research to select participants for interviews:

An employee at the Ministry of Heritage and Tourism and works in the Geographic Information Systems Department, or Sustainability Department, or Tourism Planning. In addition to the previous criteria, every specialized employee must have at least two years of practical experience in the tourism sector.

Considering these selection criteria, the researcher interviewed 12 of the specialists who were available and ready to talk about their opinions (see Table 1). Respondents were identified from personal relationships with specialists. Each participant was invited to attend the in-person interview at their suitable time. Interviews lasted from a minimum of 30 to a maximum of 55 min and were conducted in Arabic. The interview guideline was divided into two parts: the first part included common questions about academic specialization, and the years of experience in the tourism sector.

The second part included nine questions. Three of them were closed-ended interview questions, and six of them were open-ended questions related to the research questions, such as What are the current capabilities available for geographic information systems in the Sultanate of Oman, which may contribute to the participation of geographic information systems in sustainable tourism planning? What methods can be followed to increase the contribution of geographic information systems in sustainable tourism planning in the Sultanate of Oman?

Table1: The study respondents' profile (all names are anonymous)

Name	Functional title	Practical experience (years)
A GIS	Geographic information systems specialist	9
F GIS	Geographic information systems analyst	3
J GIS	Geographic information systems specialist	2
H GIS	Geographic information systems analyst	2
T Sus	Sustainability specialist	4
R Sus	Director of Sustainability Department	12
W Sus	Statistician	3
M Sus	Quality specialist	5
P M	Director of the Technical Planning Department	9
P S	architect	2
P A	architect	6
P H	Civil engineer	15

3.3. Data analysis

All interviews were recorded, transcribed, and analyzed manually. The researcher examined each interview up to three times to ensure that the transcribing was done accurately. The interview data was analyzed using thematic analysis. Thematic analysis is a qualitative research approach for identifying, analyzing, and reporting patterns or themes in a data collection (Braun & Clarke, 2006).

It includes an organized procedure of coding and categorizing data in order to identify patterns and themes that may then be used to acquire insights into the research question or topic (Ghaderi et al., 2023). Several steps applied in this study were involved in the thematic analysis, including:

Familiarization: with the data-reading through the data numerous times to obtain a complete understanding of what was said (Terry, 2016). A thorough knowledge of the data set is required for qualitative data analysis. Where the researcher was able to obtain in-depth knowledge about the effectiveness of the current use of GIS in sustainable tourism planning.

Identifying a thematic framework: The researcher coded the keywords in the research statement and objectives, then listened to the interviews again to link the information obtained from the interviews with the codes to obtain a deeper understanding of the interviews (See figure 1).

Reviewing themes :The themes were checked to make sure they appropriately represented the facts.

Writing up the analysis: finally, the results were summarized and presented in a logical and understandable form. The research findings were reported in the next section.

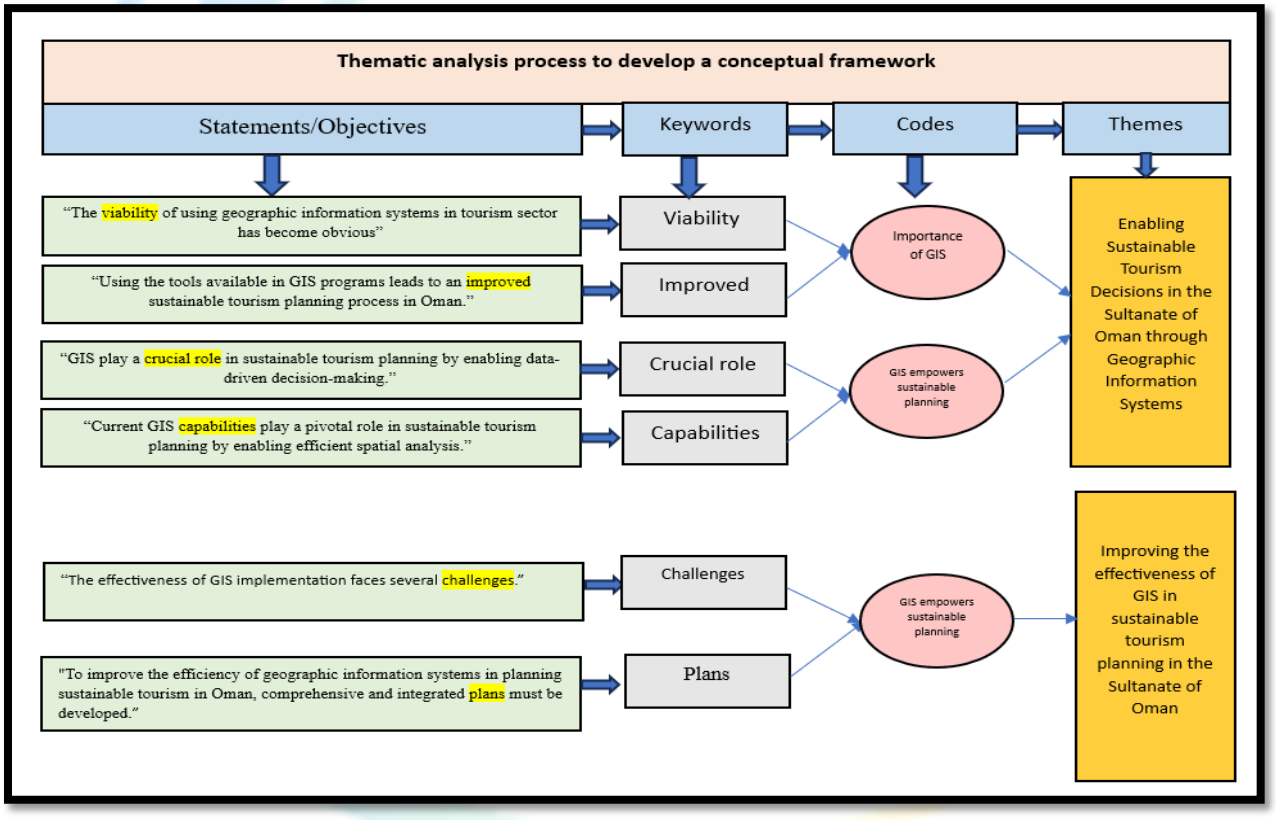

Figure 1: **Thematic analysis process to develop a conceptual framework**

4. Findings

Importance of GIS in Sustainable Tourism Planning in the Sultanate of Oman.

All interview participants agreed to answer (yes) with the importance of the GIS in Sustainable Tourism planning. This can be interpreted as being due to the practical experience of the participants in the field of tourism planning and their direct connection to the production of tourism plans and maps. This in turn reinforced the idea of the importance of using technical sciences in effective planning for sustainable tourism, such GIS.

The participants were asked about the reasons why geographic information systems are important in sustainable tourism planning. The participants' answers to this question were numerous, but the answer that was repeated by most of the participants was GIS can be used to study tourist sites in depth from all aspects. The suitability of the site for tourism development, the services and infrastructure that the site needs are studied. The human and natural elements and the characteristics of each are studied using the tools available in GIS programs, this is leads to an improved sustainable tourism planning process. Participant (J GIS) said: "To achieve sustainable economic growth from tourism, there must be geographical planning. Geographic information systems provide a clear future vision and highlight the opportunities and possibilities available to be able to achieve the principles of sustainable tourism". The participant (F GIS) stated: "If geographical information systems are optimally used in planning processes for sustainable tourism, all the principles of sustainable tourism can be achieved, thus ensuring the availability of economic strength from the tourism sector in addition to preserving local culture and empowering the community in the tourism sector as well. It provides the best methods for preserving the environment through analyses and future projections provided by geographic information systems programs".

Current capabilities available for GIS in Oman to ensure its contribution to sustainable tourism planning.

Participants were asked about the current capabilities available for geographic information systems and how these capabilities contribute to the participation of geographic information systems in sustainable tourism planning. The participant (A GIS) said: "The current capabilities available for

geographic information systems in the Sultanate of Oman are represented by the Ministry of Heritage and Tourism, as it is responsible for the tourism sector in the country, through a staff specialized in geographic information systems, and licenses have also been provided for some approved programs in conducting GIS analyses, in addition to providing computers that match the specifications of the programs used in terms of capacity and processor speed". Both (R Sus and P A) added: "currently capabilities available for GIS can't be limited to devices, programs and employees only, so the establishment of the geographic information systems department in the Ministry of Heritage and Tourism is an empowerment for this specialty and confirms on awareness of the importance of geographic information systems in the tourism sector, especially sustainable tourism". "We will see GIS more effective in planning for sustainable tourism. When they increase technical support for GIS specialists at the Ministry of Heritage and Tourism" (M Sus). The participants unanimously agreed that there are capabilities available for geographic information systems that enable it to participate effectively in planning processes for sustainable tourism, but the participant (H GIS) disagreed with them about that, as he said:

"Geographic information systems do not have the great potential, whether human or technical, that highlights its effectiveness in planning sustainable tourism. Unfortunately, geographic information systems are not sufficiently appreciated in the Ministry of Heritage and Tourism, and there is no real understanding of the capabilities of this specialty and what it can offer in the field of sustainability." Therefore, what is provided to the Geographic Information Systems Department in the Ministry of Heritage and Tourism cannot be called capabilities, and Geographic Information Systems cannot achieve the visions it aspires to achieve in the field of sustainable tourism unless its actual requirements are provided for it".

Current roles of GIS in the sustainable tourism planning process.

This question examines the current roles played by GIS in sustainable tourism planning. Both (P S and P H) said: "Geographic information systems play an important role in decision-making processes based on spatial analysis, which leads to appropriate tourism planning". (J GIS) added: "It is possible to highlight the effective role of geographic information systems in the National Survey Authority, and that it is possible to benefit from their experience and apply it in the tourism sector to highlight the role of geographic information systems in sustainable tourism planning." However, (A GIS) praised the role played by the Geographic Information Systems Department in the Ministry of

Heritage and Tourism and stated that: “The tasks that the Geographic Information Systems Department performs are such as collecting spatial and descriptive data that benefit the tourism sector, then analyzing it and then producing tourist maps for this is an important role and contributes to making decisions related to sustainable tourism planning”. All participants indicated that the actual role currently played by geographic information systems is to benefit from the tourism data available in the various departments of the Ministry of Heritage and Tourism and represent it spatially in maps that benefit decision makers in making decisive and effective decisions in sustainable tourism development.

(F GIS) said: “GIS analyses are an integral part of the planning stages for sustainable tourism, and GIS is sufficient to determine the principles that can be followed to achieve the principles of sustainable tourism in various tourist sites in the Sultanate of Oman. It also currently contributes to improving the tourist experience, such as clarifying the approved mountain paths. It also takes into account the environmental impact when conducting spatial analyses, and through population data, it can conduct analyzes about the possibility of the community benefiting from tourism projects in a certain area in the Sultanate of Oman.”

Challenges of GIS in Sustainable Tourism Planning in Oman.

Challenges facing GIS in the Sultanate of Oman affect it’s effectiveness in sustainable tourism planning in the Sultanate of Oman. Participant (P A) said: “The most important challenges are related to the lack of data and limited coordination between institutions concerned with and working in geographic information systems, in addition to the accuracy and security of data.” The participant (H GIS) stated: “The lack of awareness of the importance of geographic information systems in the Ministry of Heritage and Tourism is what considered an obstacle to the contribution of geographic information systems to sustainable tourism planning.” ."Both (R Sus & P M) agreed that geographic information systems can only be effective in sustainable tourism planning if there are equipment and devices that help conduct spatial surveys and provide programs that work on spatial analysis of data. Moreover, the need for a sufficient number of specialists in geographic information systems in the Ministry of Heritage and Tourism is one of the most critical challenges.

The participant (F GIS) emphasized: “The lack of staff specialized in geographic information systems in the Ministry reduces the effectiveness of GIS as a tool used in planning sustainable tourism.” All

participants agreed that the lack of training programs and the lack of financial allocations paid to the Geographic Information Systems Department in the Ministry are the most critical challenges to the emergence of the role of Geographic Information Systems in sustainable tourism planning.

Plans followed by the Ministry of Heritage and Tourism to enhance the contribution of geographic information systems in sustainable tourism planning.

Participants were asked to explain ways that could be followed to increase the contribution of GIS to sustainable tourism planning. (P A) said: "This can be achieved by creating flexible, integrated, and sustainable geographic databases. This ensures the availability of all the data that is relied upon to conduct analyses related to sustainable tourism planning". Moreover, (J GIS) said: "The contribution of GIS in sustainable tourism planning in the Sultanate of Oman can be increased by expanding the precise specializations of geographic information systems in universities and colleges. Thus, an effective and specialized person will be available to raise the efficiency of geographic information systems in tourism. We can also cooperate with other leading countries in the use of GIS in the tourism sector, such as Malaysia, and apply successful experiences in the Sultanate of Oman in a way that is compatible with the natural and human environment of the Sultanate of Oman". "I see that integration between the directorates and departments within the Ministry and the establishment of a unified management system for geographic data related to the tourism sector is one of the most important methods that must be followed to increase the contribution of geographic information systems to sustainable tourism planning" (T Sus). (M Sus) stated, "The existence of common and clear goals between the Geographic Information Systems Department and the Sustainability Department in the Ministry leads to increasing the contribution of Geographic Information Systems to the sustainable tourism business that the Sustainability Department is concerned with, and it will also enhance the role of Geographic Information Systems in all upcoming tourism sustainability plans". (P H) said: "Specialists in urban and architectural planning must be trained in the field of GIS in order to have a geographical perspective when working in sustainable tourism planning."

5-Discussion and Implications

This study sought to evaluate the current roles of GIS in sustainable tourism planning in the Sultanate of Oman. Additionally, the research aimed to explore the most important current capabilities available for GIS. Moreover, to identify the plans that the MHT will follow to increase the contribution of GIS

in sustainable tourism Planning in the Sultanate of Oman. Using a qualitative research approach, in-depth interviews occurred with employees from the Ministry of Heritage and Tourism specializing in GIS, sustainability and tourism planning. Every specialized employee must have at least two years of practical experience in the tourism sector. The results identified two significant themes, leading to understanding the study gap.

Enabling Sustainable Tourism Decisions in the Sultanate of Oman through Geographic Information Systems

The findings showed. GIS is of the important technical specializations in sustainable tourism planning, as it conducts comprehensive and integrated analyzes of tourist sites related to the natural, cultural, social and economic aspects. Using GIS programs, detailed maps can be produced, which appoint planners for sustainable tourism. It also plays a significant role in making future forecasts for tourism projects, and this, in turn, helps in making plans that help in the sustainability of tourist sites. This is consistent with what Singh, 2015 stated, the application of GIS in sustainable tourism planning is crucial for identifying appropriate sites for ecotourism and evaluating the environmental impacts of tourism activities. By utilizing GIS, planners can ensure that tourism development aligns with sustainability objectives, promoting responsible use of natural resources and minimizing negative effects on local ecosystems. Moreover, Singh, (2015) review found that, GIS can analyze the geographic distribution of sites and their proximity to tourism destinations.

The current roles of GIS in sustainable tourism planning in the Sultanate of Oman still needs to be improved due to some challenges faced by the GIS department at the Ministry of Heritage and Tourism. The most prominent of which is the lack of awareness of the importance of GIS in tourism planning, especially sustainable ones, as well as the lack of spatial data and the weakness of its management in an integrated and unified databases; this led to the dispersion of data, thus making it difficult for specialists in geographic information systems to process and analyze data. Acharya et al., 2022 presented in their research the importance of having spatial databases for data management, involves using a well-organized database to efficiently store, retrieve, and manage large amounts of geospatial data, such as satellite images, land use information, and tourism statistics. This capability is essential for performing thorough analyses and making informed decisions. As well as weak of internal coordination between the authorities concerned with the tourism sustainability process. In

addition to the insufficient hardware, equipment, and software provided to the department, and to the small number of staff specialized in GIS at the Ministry of Heritage and Tourism, this in turn, reduces the effectiveness and contribution of GIS in sustainable tourism planning. Externally, coordination between the Ministry of Heritage and Tourism and the institutions working in geographic information systems in the Sultanate of Oman is weak. This result may conflict with some of the results of the studies presented in the literature review section such as, Acharya et al., (2022) study demonstrates that GIS played a crucial role in assessing the suitability of geo-ecotourism sites in West Bengal, India, by enabling comprehensive geospatial analysis and effective mapping of potential zones. Furthermore, GIS provided valuable visual representations of the identified geo-ecotourism zones, which are essential for sustainable tourism planning and management, ultimately contributing to the preservation of the region's natural and cultural resources while promoting tourism development. perhaps due to the fact that the Sultanate of Oman is an emerging destination in the use of GIS applications in the tourism industry, especially in sustainable tourism planning.

the current capabilities available to the GIS Department at MHT are insufficient, and the role of GIS in planning sustainable tourism cannot be highlighted with the current capabilities. The capabilities referred by the participants are divided into, human potential: it is linked to the staff specialized in geographic information systems who are familiar with the ability of this specialty to lead the wheel of planning for sustainable tourism in the Sultanate of Oman. Material capabilities: represented by the devices, equipment and software used in spatial analyses. It can be pointed out that the efficiency of the roles played by GIS in sustainable tourism planning is linked to the capabilities available to it. The greater the amount of technical and human capabilities provided to the GIS department at MHT, the more effectively it can analyze, interpret, and visualize spatial data. Enhanced technical resources, such as advanced software and hardware, combined with skilled personnel, enable more sophisticated analyses, improved decision-making, and better overall outcomes in sustainable tourism development. Singh, 2015 addressed that the integration of advanced technical resources and skilled personnel is essential for fully leveraging GIS to achieve effective and sustainable outcomes in tourism development.

Improving the effectiveness of GIS in sustainable tourism planning in the Sultanate of Oman

The MHT is primarily responsible for the efficiency of GIS in sustainable tourism planning, and this is done through a set of procedures that the Ministry can follow internally and externally. Internally, this is done by creating a comprehensive and flexible geographic database that includes all spatial data from various departments within the Ministry. This in turn ensures the sustainability of the data and thus leads to clear and sound planning that leads to tourism sustainability. Also, through the integration between the goals and plans of both the GIS Department and the Sustainability Department at the MHT in order to follow a clear methodology that supports achieving sustainable tourism. In addition, training specialists in tourism planning on GIS programs will contribute to generating creative ideas for sustainable tourism because the planning will be based on a comprehensive geo-technical logic. Externally, this is done through organized and joint work with other institutions that work in GIS in the Sultanate of Oman, such as the National Survey Authority, the Ministry of Housing and Urban Planning, and the Environment Agency, in addition to various institutions whose data is an essential focus in analytical processes GIS. In addition, looking at the experiences of other countries that have achieved remarkable development in tourism sustainability based on planning that relied on GIS will enrich the Omani experience in the field of tourism sustainability. Singh, (2015) presented a set of benefits that users of GIS applications reap when there are flexible and integrated databases such as, Constrained queries enable users to search for specific patterns. These queries respond to any user request. For instance, a tourist might use them to search for hotels in a particular city. Moreover, designing functions or procedures for predictive purposes, such as determining the shortest route between two tourist sites.

This study carries significant social, cultural, economic, and environmental implications. Socially, it can enhance community engagement by fostering participatory decision-making processes that align with local needs and aspirations, promoting equitable development Relying on the capabilities of GIS in comprehensive spatial analysis. Culturally, the use of GIS can help preserve Oman's rich heritage by identifying and protecting cultural sites while integrating them into tourism strategies. Economically, effective GIS utilization can optimize resource allocation, boost tourism revenues, and support the diversification of Oman's economy, reducing its reliance on oil. Environmentally, GIS facilitates sustainable practices by enabling precise mapping and management of natural resources, mitigating ecological degradation, and promoting eco-tourism initiatives that align with Oman's

environmental conservation goals. Collectively, these implications underline the pivotal role of GIS in balancing growth with sustainability in Oman's tourism sector. The findings can serve as a case study for geography, tourism management courses, providing students with insights into the application of GIS in real-world planning. It can also inspire new curriculum content on integrating technology in sustainable tourism development practices.

6. Conclusion and limitations and directions for future research

What was presented in this research indicates that geographic information systems offer a lot in the field of sustainable tourism, as geographic information systems are an important tool for providing information to support decision-making in sustainable tourism planning. This research offers an opportunity to evaluate the current status of geographic information systems in the Sultanate of Oman. This is represented by evaluating the current role of GIS in sustainable tourism planning in the Sultanate of Oman, as well as the current capabilities available to it that enable it to participate effectively in sustainable tourism planning. Moreover, the research reviewed the most important methods that the MHT can follow to raise the efficiency and contribution of geographic information systems to sustainable tourism planning. This in turn leads to other future research topics in this field. There is a scarcity of studies that have reviewed how geographic information systems are used in sustainable tourism development in the Sultanate of Oman. Therefore, future research should focus on ways to apply geographic information systems in sustainable tourism planning and management. And how does its use affect decision-making in sustainable tourism development.

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