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CULTURAL-GASTRONOMIC GIS-BASED ROUTES FOR PLANNING EFFICIENT URBAN TOURISM

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Abstract: Gaziantep, with its gastronomy tourism, cultural heritage, and historical texture, is one of Turkey's most important tourism destinations. The study emphasizes that more effective and optimized tourism routes can be created in Gaziantep with GIS tools and analysis among its tourist attractions. These technologies can contribute to the balanced distribution of tourist density, reduction of environmental impacts, and improvement of transportation infrastructure. In planning tourism routes, the Geographic Information Systems (GIS) and network analysis enables spatial analyses within the tourism sector, establishing connections between tourist destinations, optimizing visitor movements, and ensuring more efficient planning of tourism activities. Network analysis offers significant solutions such as evaluating transportation networks, route optimization, and managing congestion. In the study, route planning was conducted for tourist locations in Gaziantep, both by vehicle and walking. A total of 5 route scenarios were created for one-day plans. Within the scope of these scenarios, locations such as breakfast, museums, cultural heritage sites, archaeological areas, and zoos were evaluated as tourist routes and planned to be offered to visitors. Daily routes ranged between 26 minutes and 163 minutes and between 49.60 km and 336.26 km in length. Route scenarios were planned for considering tourists' decisions based on car rentals, and travel plans. In conclusion, GIS stands out as a strategic tool in tourism management, offering significant opportunities to ensure the sustainability of tourism in cities with high tourism potential like Gaziantep. The wider adoption of such technologies will enhance Gaziantep's tourism competitiveness both locally and internationally, providing substantial economic and cultural contributions to the region.

Keywords: network analysis, tourism activity, tourism routes, cultural-gastronomic routes, Geographic Information Systems

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INTRODUCTION

The tourism sector is a multifaceted industry that requires the effective use of spatial data. Among these, GIS have emerged as powerful tools for spatial planning, route optimization, and sustainable tourism development. The use of GIS enables more accurate decision-making based on rich data sources for the tourism sector. In this context, studies on how GIS is integrated into tourism routes and its potential for more effective and sustainable tourism planning through spatial analyses have gained importance (Çalhan et al., 2020; Paolanti et al., 2021; Šoltésová et al., 2025). GIS-based approaches enable the integration and analysis of complex spatial data, facilitating the creation of efficient, thematically coherent tourism routes tailored to diverse visitor preferences. The creation of sustainable tourism routes has been shown to contribute significantly to reducing environmental impacts and improving the quality of life for local communities. Optimizing travel routes can enhance both tourist experiences and environmental outcomes (Albu, 2005; Păcurar et al., 2021).

GIS offers various solutions, such as locating tourist spots, calculating lengths, and determining the most suitable routes through spatial analyses. GIS allows for the visualization and spatial analysis of attractions, services, and infrastructure, providing decision-makers with dynamic tools to design optimal itineraries (Wenrui, 2019; Pei et al., 2022). Network analysis is essential to allow for the calculation of shortest paths, accessibility assessments, and the optimization of multi-stop travel plans. This method stands out as a critical tool for route optimization and logistical planning, especially in a dynamic sector like tourism (Curtin, 2007; Qin et al., 2023). GIS tools (such as Find Route and Find Closest Facilities) enable tourists to easily plan itineraries between tourist points while optimizing travel times and distances (ESRI, 2023). Particularly in large cities, GIS-based network analysis solutions are provided to help tourists save time and resources by suggesting preferred routes (Farooq et al., 2018; Lepetiuk et al., 2023; Carra et al., 2023).

GIS-based route optimization typically involves the identification of key attractions, the classification of sites based on thematic categories (e.g., cultural, gastronomic, natural), and the generation of itineraries that balance logistical efficiency with experiential richness (Pei et al., 2022; Mileti et al., 2022). Recent studies have incorporated real-time traffic data, tourist behavior analytics, and even machine learning techniques to further refine tourism route planning (Yu et al., 2022). The potential of GIS demonstrates to optimize mobility, reduce overcrowding, and enhance visitor satisfaction through real-time routing and thematic clustering of attractions (Ji et al., 2022; Alsahafi et al., 2023). However, in many emerging

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destinations, static data approaches remain predominant due to data availability constraints. In addition to cultural heritage, routes are planned to visit national parks and natural areas located away from city centers, defined as geotourism spots.

Such studies require better planning due to long distances and travel times, and network analyses are used to determine the most suitable routes (Gavilanes Montoya et al., 2021; Arca et al., 2022). Developing rural area and villages around city centers can contribute to the economic and social development of cities. Therefore, GIS is used to identify villages of potential tourist interest around cities and plan optimal routes for tourists (Lee et al., 2013). These routes are typically designed for a city, nature park, or specific area, but they can also include significant sites in surrounding cities for daily planning (Gungor et al., 2024). In an era of globalization and digital homogenization, technological methods are used to preserve and promote the rich culinary heritages as an important expression of their cultural identity. GIS also provide spatial data and environmental management to research, reduce negative impacts and promote sustainable tourism development by analyzing buffer zones and environmental impacts for places to be protected in more effective tourism planning (Cordova-Buiza et al., 2025; Ibarra-Núñez et al., 2025). Effective development of tourist routes in natural parks requires a comprehensive approach that combines research, strategic planning, infrastructure, marketing, training, monitoring, and economic assessment to ensure sustainable growth and preservation of regional heritage.

Ulytau National Park's natural features and attractions, focusing on how integrating GIS technology can enhance sustainable tourism and improve visitor experiences (Amangeldi et al., 2025). Transport infrastructure plays a critical role in regional tourism development and development of transport routes is necessary to increase tourist flow. GIS integration of transport networks and accessibility data is needed to identify transport routes with limited accessibility (Jasim et al., 2024). In addition, it is seen that tourism models can be determined with GIS integration of alternative data sources to improve tourism planning and sustainable destination management, how to optimize infrastructure and support evidence-based decision-making to increase destination competitiveness and sustainability (Šoltésová et al., 2025).

Gaziantep is one of Turkey's leading tourism destinations with its rich historical texture, fame in gastronomy, and various museums. Gaziantep, which offers visitors an experience filled with both flavor and history, was included in UNESCO's Creative Cities Network for gastronomy (Kaya et al., 2022; Akın et al., 2017; Yaldız et al., 2020). Key tourist spots, such as the Zeugma Mosaic Museum, Gaziantep Zoo, Gaziantep Castle, and the Coppersmith Bazaar, are primary stops for routes that can be more effectively planned using GIS-based analyses. Additionally, archaeological sites from ancient Roman cities along the Euphrates River also influence tourism (Bonini Baraldi et al., 2013; GoTürkiye, 2025).

This study aims to fill a critical gap in tourism planning by applying advanced GIS-based network analysis to mid-sized heritage cities, a relatively underexplored area in spatial technology research. By developing optimized one-day cultural and gastronomic tourism itineraries for Gaziantep, the research not only enhances tourist mobility and experience through precise, infrastructure-based route modeling but also promotes data-driven decision-making, offering a more effective and adaptable alternative to traditional planning methods. This approach holds significant potential to improve sustainable tourism development and strategic management in similar heritage destinations worldwide. This study specifically aims to leverage GIS-based network analysis to create efficient, user-centered tourism routes that reflect real-world infrastructure and visitor needs, thereby providing a replicable model for enhancing cultural tourism in mid-sized heritage cities like Gaziantep.

MATERIALS AND METHODS

Gaziantep surface area is 6,222 km², which is located between 36° 28' and 38° 01' east longitude and 36° 38' and 37° 32' north latitude (Figure 1). Gaziantep is one of the most preferred cities for weekend gastronomy and cultural tourism trips. In 2024, approximately 1.5 million tourists visited the city, and nearly 1 million tourists explored its museums (Gaziantep Provincial Directorate of Culture and Tourism, 2025). Gaziantep stands out as a destination that attracts both national and international attention with its gastronomy, cultural heritage, and museums. Included in UNESCO's "Creative Cities Network" in 2015 for gastronomy, Gaziantep has gained worldwide fame for its rich culinary culture and traditional flavors (Kaya et al., 2025). Baklava, pistachios, kebabs, and local dishes have made the city one of the significant centers of gastronomic tourism. Additionally, the Zeugma Mosaic Museum, one of the largest mosaic museums in the world, attracts archaeology and art enthusiasts with unique pieces such as the Gypsy Girl Mosaic. Historical inns, bazaars, and structures like Gaziantep Castle illuminate the region's past, offering visitors an impressive cultural experience (Ministry of Culture and Tourism Turkey Cultural Portal, 2025). Gaziantep provides tourists with a blend of historical, cultural, and gastronomic experiences with these features. In this context, the most appropriate route plans were carried out by integrating roads and touristic places into the GIS for tourist route planning. Figure 1 shows the work flow of the study. Determining the fastest and most suitable routes is crucial for visitors to experience food, cultural heritage, and archaeological sites.

Therefore, one-day route scenarios (ODRS) have been created for tourists arriving at the airport, and these route scenarios allow them to explore breakfast, cultural heritage, archaeological sites, museums, and the zoo. Within these route scenarios, it is planned for visitors to start their day with breakfast, followed by visits to the nearest cultural heritage sites, museums, and the zoo in the city center. Another route scenario involves creating a route to the most famous archaeological sites to engage in archaeological tourism after breakfast. Since cultural heritage locations and popular dining spots are located in the city center, the first destinations are typically in the central areas on the route after the airport. In this study, tourism spots and road data of Gaziantep were examined to create tourism routes. Tourism routes, based on the identified tourism spots, were planned using network analysis for one-day itineraries. To conduct the network analysis, OpenStreetMap (OSM) road data was obtained (OpenStreetMap, 2025) (Figure 2). The road types were analyzed, which included motorway, primary, residential, secondary, tertiary, track, and trunk. To create the routes, the maximum speed limits for each road type were evaluated for Turkey. Road speeds were revised based on information from the General Directorate of Highways (KGM, 2025).

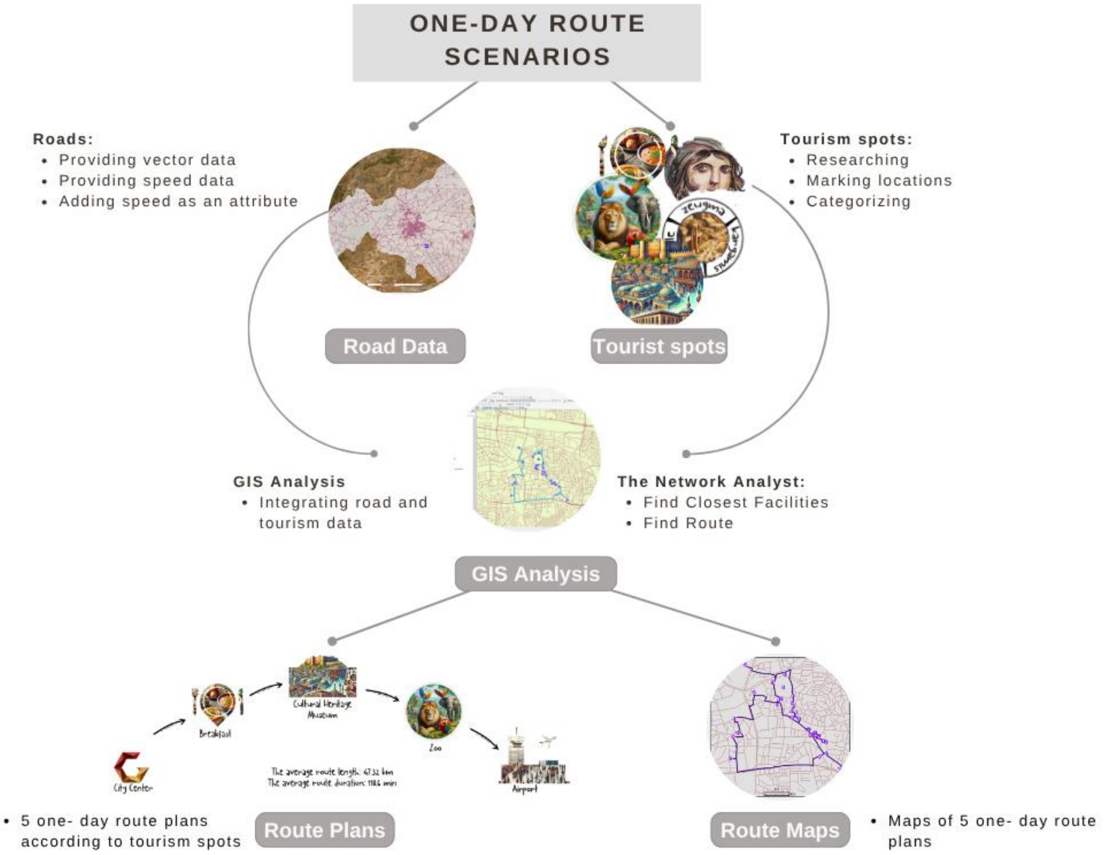

Figure 1. The workflow of the tourist route planning

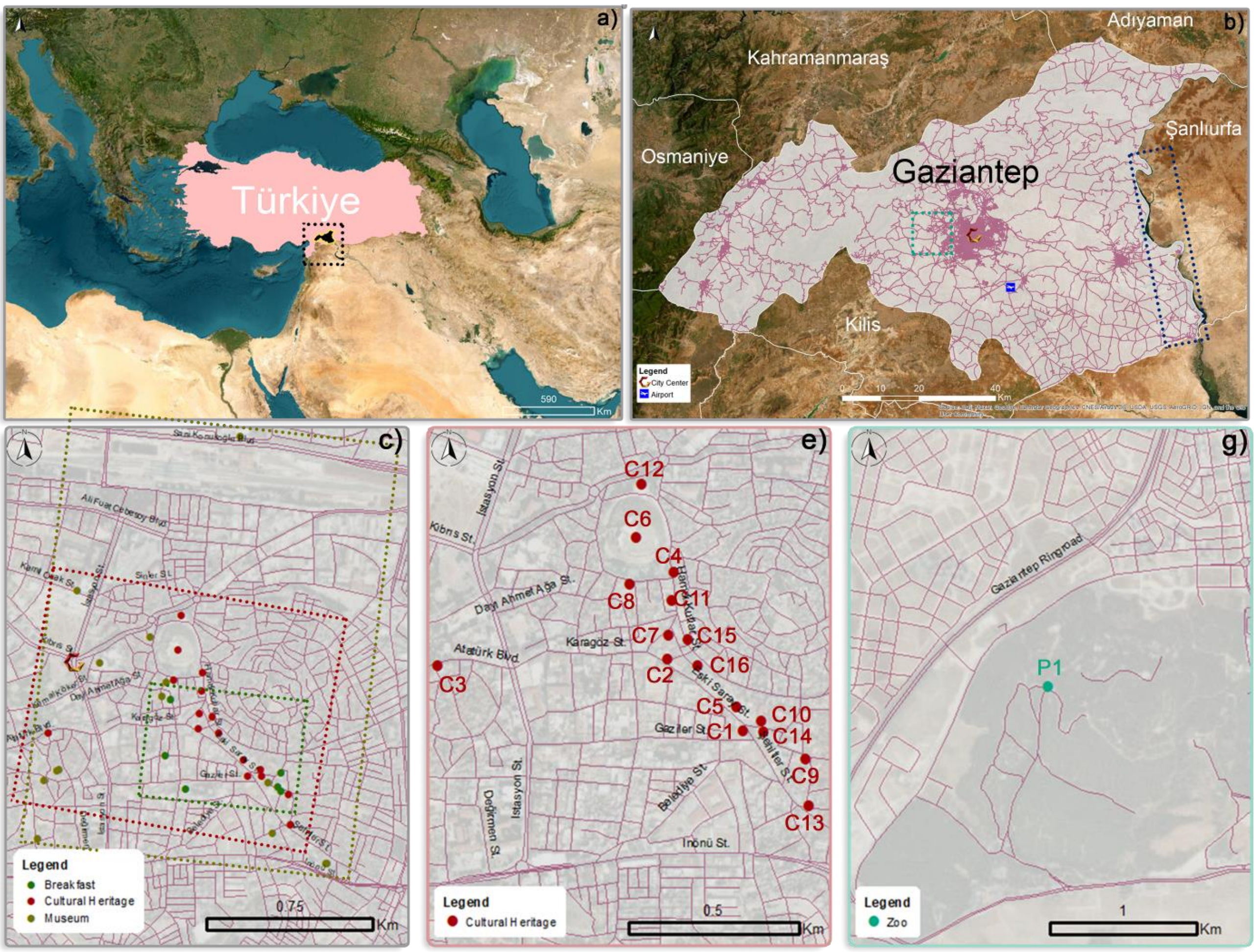

Figure 2. a) Turkey location, b) Gaziantep location, c) Tourist spots in city center, e) Cultural heritage, g) Zoo

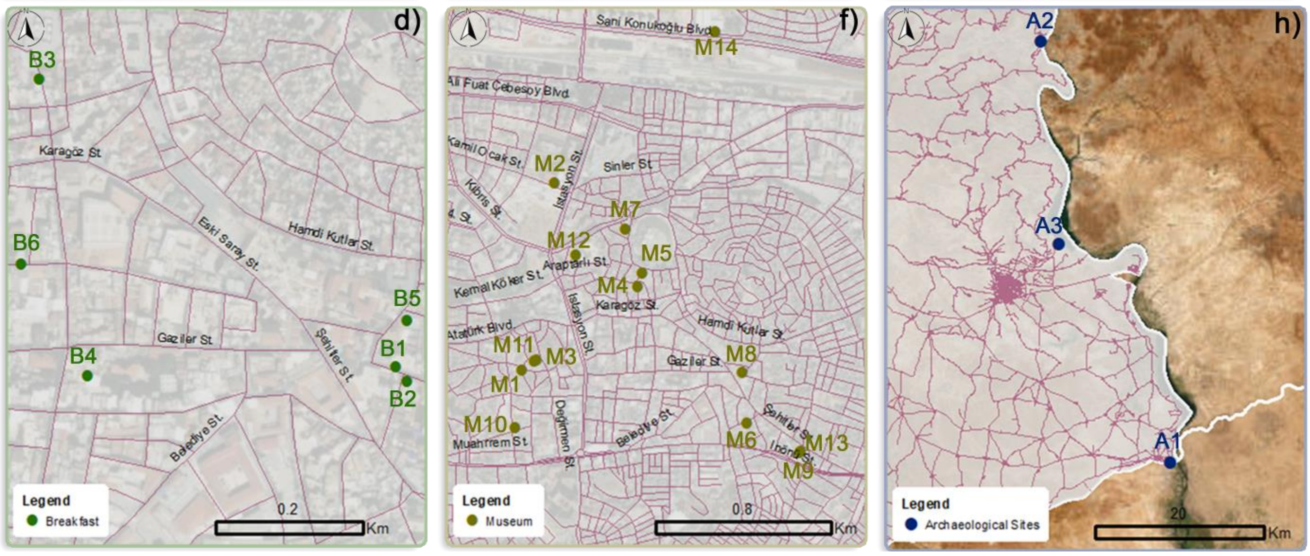

Figure 2. d) Breakfast, f) Museum, h) Archeological sites

Table 1 shows the maximum speeds for each road type. For determining walking routes, a walking speed established was integrated into the road data. However, OSM data does not include speed information related to traffic density. Since traffic density data for the city could not be obtained, route durations were calculated based on the speeds determined for each road type. The average human walking speed was reported to range between 4.3–5.4 km/h, varying depending on factors such as age, gender, physical condition, and environmental circumstances (Knoblauch et al., 1996; Bohannon, 1997). In this study, the walking speed was set at 4.8 km/h taking into account the average walking speed.

Table 1. Road class and maximum speed (OpenStreetMap, 2025; KGM, 2025)

Road Class	Motorway	Primary	Residential	Secondary	Tertiary	Track
Max Speed (km/h)	120	90	50	80	50	30

Tourist spots data were compiled from multiple verified sources, including GoTürkiye (2025), the Gaziantep Metropolitan Municipality (Yelken, 2025), and the Türkiye Cultural Portal (2025). Selection criteria for breakfast points, museums, cultural heritage sites, archaeological areas, and parks included popularity, visitor counts, thematic relevance to cultural or gastronomic tourism, and spatial accessibility. As a result of the research, tourism points were identified under five main categories: breakfast, museums, cultural heritages, archaeological sites, and parks. The locations of the identified tourism spots were verified using both official institution data and satellite imagery from Google Earth. In the study, the most preferred tourism spots were identified as 5 breakfast locations, 14 museums, 16 cultural heritages, 3 archaeological sites, and 1 park (GoTurkiye, 2025; Yelken, 2025; Türkiye Culture Portal, 2025; Gaziantep Provincial Directorate of Culture and Tourism, 2025). Specifically, the five breakfast spots included in the analysis were chosen based on their average Google user rating (minimum 4 out of 5), number of reviews (minimum 400), and listing in local gastronomy guides. Museums were selected if they were publicly accessible, listed on official government portals. Cultural heritage sites were included if they held national or local heritage status and were recognized by at least two official or scholarly sources. All spatial coordinates were verified using Google Earth to ensure locational accuracy, and duplicate or outdated entries were excluded. This multi-criteria, source-validated selection process ensured that the dataset reflected both the functional significance and popular appeal of the locations included in the route planning process. The tourism spots are presented along with their name and codes in Table 2.

Table 2. Tourist spots' name and code

Tourist Spot - Code	**Tourist Spot**	**Tourist Spot - Code**	**Tourist Spot**
Metanet Beyran Restaurant – B1	Metanet Katmer Restaurant – B2	Omaç Gaziantep Restaurant – B3	Durumcu Recep Usta - B4
Udma Cheese Museum & Restaurant - B5	Ali İhsan Göğüş Museum and Gaziantep Research Center - M1	Gaziantep Archaeology Museum - M2	Atatürk Memorial Museum - M3
Emine Göğüş Culinary Museum - M4	Bath Museum - M5	Hasan Süzer Ethnography Museum - M6	Medusa Glass Museum - M7
Mevlevi Lodge and Whirling Dervishes Foundation Museum - M8	Gaziantep War of Independence Museum - M9	Ömer Ersoy Cultural Center - M10	Gaziantep Toy and Game Museum - M11
Panorama 25 December Gaziantep Defense and Heroism Panorama Museum - M12	Şahinbey National Struggle Museum - M13	Zeugma Museum - M14	Almacı Bazaar - C1
Anatolia Caravanserais - C2	Bey Neighborhood - C3	Büdeyri Caravanserais - C4	Coppersmith Bazaar - C5
Gaziantep Castle - C6	Gümrük Caravanserais - C7	Hışva Caravanserais - C8	Kozluca Kastel - C9
Kürkçü Caravanserais - C10	National Caravanserais - C11	Naib Hammam - C12	Pişirici Kastel - C13
Tahmis Coffee House - C14	Yeni Caravanserais - C15	Zincirli Bazaar - C16	Karkamış Archaeological Site - A1
Rumkale Archaeological Site - A2	Zeugma Archaeological Site - A3	Gaziantep Zoo - P1	

In this study, the route optimization process was primarily based on two criteria, which are total travel time and total travel distance. These were selected as the most practical and measurable indicators for evaluating route efficiency, particularly in the context of short-term cultural and gastronomic visits. The Network Analyst tool was configured to minimize either time or distance across the transportation network, depending on whether the route was pedestrian- or vehicle-based. Cost factors such as fuel expenditure or entry fees were excluded from the optimization due to variability and limited data availability. A key limitation of the analysis was the absence of real-time traffic data.

As dynamic traffic information was not publicly available for Gaziantep, the optimization relied on static road conditions and average travel speeds. This may result in discrepancies between the modeled routes and real-world travel experiences, especially during peak tourism seasons or city-wide events. Additionally, waiting times at tourist sites—such as entrance queues, guided tours, or meal durations—were not factored into the models due to their unpredictable nature and lack of standardized data. Consequently, the proposed itineraries reflect idealized conditions and are best interpreted as baseline planning scenarios rather than exact predictive tools. Thus, route duration calculations assume standard traffic conditions and may deviate under real-world circumstances. In this context, cities, which have similar characteristics to Gaziantep, indicate that traffic congestion during the day causes an approximate half-hour delay in routes. Additionally, factors affecting traffic density (work and school) are absent on weekends, and traffic flows more smoothly during weekends (Jenelius et al., 2013; Chow et al., 2014; Wen et al., 2014). Therefore, tourists who will choose these routes in order to get closer to the current situation are advised to take traffic density into consideration. Route scenarios were developed for both one-day itineraries. Routes started from the airport, included breakfast experiences, and concluded with visits to museums, cultural heritage locations, and archaeological sites. Walking and vehicular segments were both considered, and each scenario was designed to match different tourist profiles based on transportation preferences and time availability.

GIS utilises network analysis as a powerful tool for understanding and optimizing spatial connections. This analysis is applied in various fields, including modelling and evaluating transportation networks, water distribution lines, electrical grids, and even social connections. Network analysis typically involves tasks such as finding the shortest path, optimal route planning, service area creation, and resource allocation on a network. It is particularly widely used in shortest path analyses and forms the foundation of real-time navigation systems. Additionally, service area analysis is employed to identify regions within a specific distance from a service point, which is critical for enhancing the accessibility of services such as healthcare facilities, schools, or fire stations (Fischer, 2003; Curtin, 2007).

In this study, ArcGIS software was utilised, specifically leveraging the "Find Closest Facilities" and "Find Route" tools. These tools were selected based on their proven effectiveness in short-term spatial optimisation tasks within urban tourism contexts. It has also been integrated with high-quality base maps and road network data, facilitating both pedestrian and vehicle travel simulations (Curtin, 2007; Yao et al., 2019). The Find Closest Facilities tool is an effective network analysis tool within GIS used to analyse distances from a specific starting point to the nearest facilities and determine the most optimal route. This tool is frequently preferred in fields such as emergency management, logistics, and urban planning. Users can employ this tool to identify the a multi-dimensional problem with nearest facilities (e.g., hospitals, fire stations, a traffic accident) and generate the shortest or fastest routes to these facilities (Yao et al., 2019; Silalahi et al., 2020; Aule et al., 2023). The Find Route tool is an effective GIS analysis tool used to determine the most optimal route between specific starting and ending points. This tool plays a significant role in optimizing routes, particularly in fields such as logistics, transportation planning, and tourism. Users can calculate the shortest or fastest route based on criteria such as travel time, distance, or cost. Additionally, it can perform real-time analyses by considering factors like traffic congestion, road closures, and other dynamic conditions. While facilitating route optimization, it also enables the identification of multiple stop points and service areas, offering a robust GIS solution for improving spatial decision-making (Papinski et al., 2011; Webster et al., 2016; ESRI, 2023).

RESULTS AND DISCUSSION

In the study, route scenarios were planned for tourists based on one-day itineraries. The route scenarios were created for tourists travelling by plane, and which were started from Gaziantep Airport, and after that to visit breakfast spots, cultural heritages, museums, archaeological sites, and the zoo. Walking routes were planned for the cultural heritage and museum spots after breakfast, taking into account walking speed. These route scenarios were optimised to determine the most suitable and fastest paths between tourism spots. Since the time tourists might spend at each tourism location could vary, the duration of the route scenarios was not specified.

Airport to Cultural Heritage Route (ODRS1)

As part of planning daily tourism routes for tourists visiting the city, it was initially considered that tourists would arrive at breakfast spots from the airport by renting a car or taking a taxi. Routes were planned to reach the five nearest breakfast spots. Based on the closest facility, the breakfast spots were B1, B2, B3, B4, and B5. The distances from the airport to these breakfast spots ranged between 17.9 km and 18.7 km, with travel times estimated at 7 minutes. Each breakfast spot was noted for offering unique dishes, allowing tourists to choose based on their culinary preferences. Once a breakfast spot was selected, the closest cultural heritage and museum locations were reviewed to plan the tourism route accordingly.

Following breakfast, walking routes to the nearest tourism spots were determined, and route scenarios were created. These route scenarios were built upon five routes starting from the breakfast locations, covering 29 tourism spots within the city’s central tourist zone on walking. After completing the walking routes, routes were made to travel to the Zeugma Mosaic Museum by vehicle. Then, tourists returned to the airport from the museum by vehicle. The route plans and maps are shown in Figure 3. When the most suitable routes based on breakfast spots were determined, the shortest distance was identified as 17.9 km for B5, and B3 was the farthest at 18.7 km. After breakfast, the walking route scenarios ranged between 6.8 km and 8 km in length, with durations varying between 85 and 99 minutes. The final destination was calculated as M2 for all walking routes. For the museum visit, the transportation length was 2.6 km, with a travel duration of 1 minute. The return trip from the museum to the airport is 21 km in 8 minutes.

The total route lengths for the scenarios ranged from 49.10 km to 50.10 km, with a 14-minute difference between the fastest and slowest scenarios. The differences in length and duration across the scenarios were influenced by the selected breakfast location and the corresponding walking route. Scenarios for the nearby breakfast points B1 and B5 were found to be similar. However, B3, the breakfast location farthest from the airport, had the fastest walking route. The longest walking route scenario began at the B4 breakfast location. Although B1 and B2 are located on the same street, directly across from each other and share the same length from the airport, their walking tour routes differed.

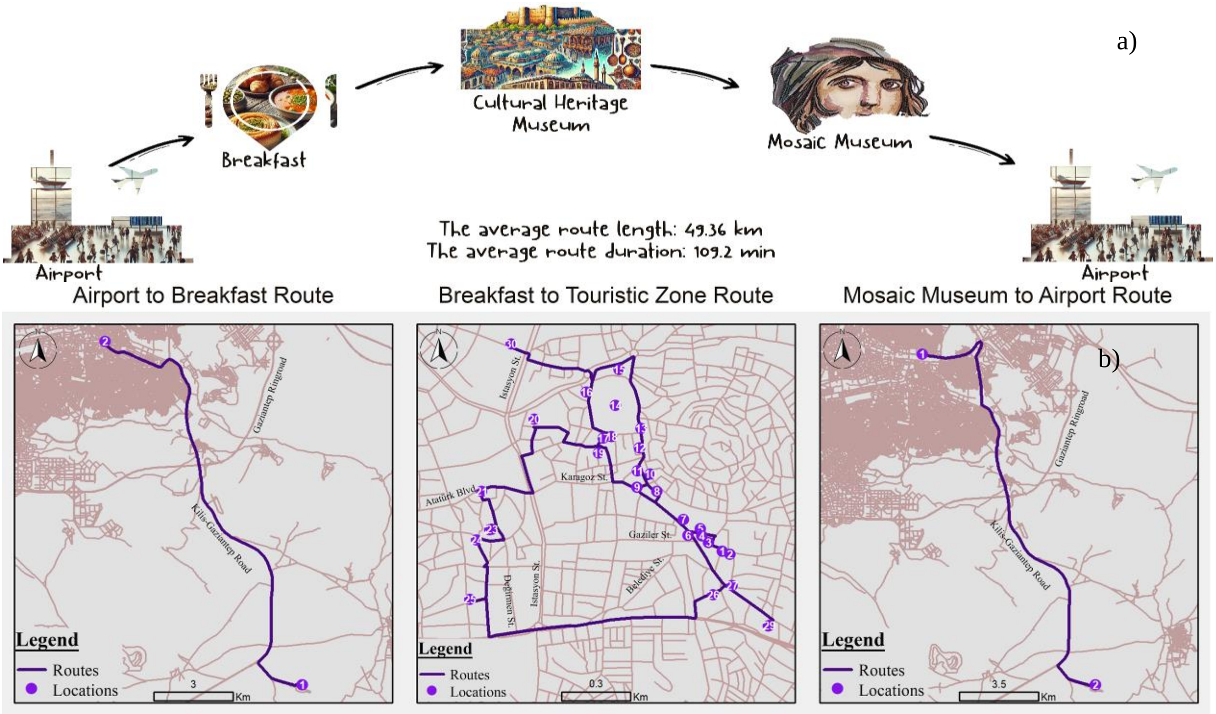

Figure 3. Airport to Cultural Heritage Route - ODRS1; a) route plan, b) maps

Archaeological Sites from North to South Route (ODRS2) and Archaeological Sites From South To North Route (ODRS3)

Tourism route included a destination for the city's famous breakfast spots, and continued with visits to significant archaeological sites. Route scenarios were particularly designed for tourists whose primary interest is exploring archaeological sites. In this context, each scenario started at the airport, first stopping at the nearest breakfast spot, and then continued to archaeological sites A1, A2, and A3 (Figure 4).

An analysis showed that the closest archaeological site to the breakfast locations was A3, which is located 58 km away from the breakfast spot. However, examining the positions of the archaeological sites reveals that all three were aligned along a north-south axis, and A3 positioned in the middle of the route. Considering a same-day visit to all three sites, this alignment might result in unnecessary distance and time loss. The route scenarios have been planned to proceed from north to either south or south to north after the breakfast spots. The route maps are illustrated in Figures 4.

The length from the airport to the initial breakfast spot was approximately 18 km with 7 minutes for all scenarios. The route then proceeds to the archaeological sites starting from the north for visiting A2, A3, and A1 sequentially, the archaeological site route length was 228 km in 117 minutes. Finally, each route scenario concluded with a return to the airport, total route lengths were 305.90 km to 307.70 km and total durations were 155 minutes. Interestingly, the choice of breakfast location did not impact the overall length or duration of the routes. These optimized route scenarios provide tourists with an efficient plan to explore Gaziantep's key archaeological sites following a breakfast experience tailored to their preferences.

The alternative route scenario for archaeological sites was planned from south to north. In this scenario, the initial breakfast spots from the airport were approximately 18 kilometres away, with 7 minutes. The routes began in the south and proceeded through archaeological sites A1, A3, and A2. The total length was 236 kilometers, with 114 minutes. Finally, all route scenarios concluded with a return to the airport, total length ranged between 335.90 km and 336.70 km. The total duration for all scenarios were calculated as 163 minutes. Therefore, it is evident that the selection of breakfast spots did not impact the length or duration of the routes. These route scenarios were designed to offer tourists an optimized itinerary that allows them to visit Gaziantep's key archaeological sites efficiently after enjoying their preferred style of breakfast. In the route scenarios planned for archaeological sites after breakfast within a single day, it was observed that the north-to-south route was approximately 30 kilometers and 8 minutes shorter than the alternative south-to-north scenario. This difference from the final archaeological site to the airport was longer. The airport was located further south and was closer to the A1 archaeological site. Therefore, the north-to-south archaeological route would be a more advantageous option for a one-day trip. The route map is illustrated in Figures 4.

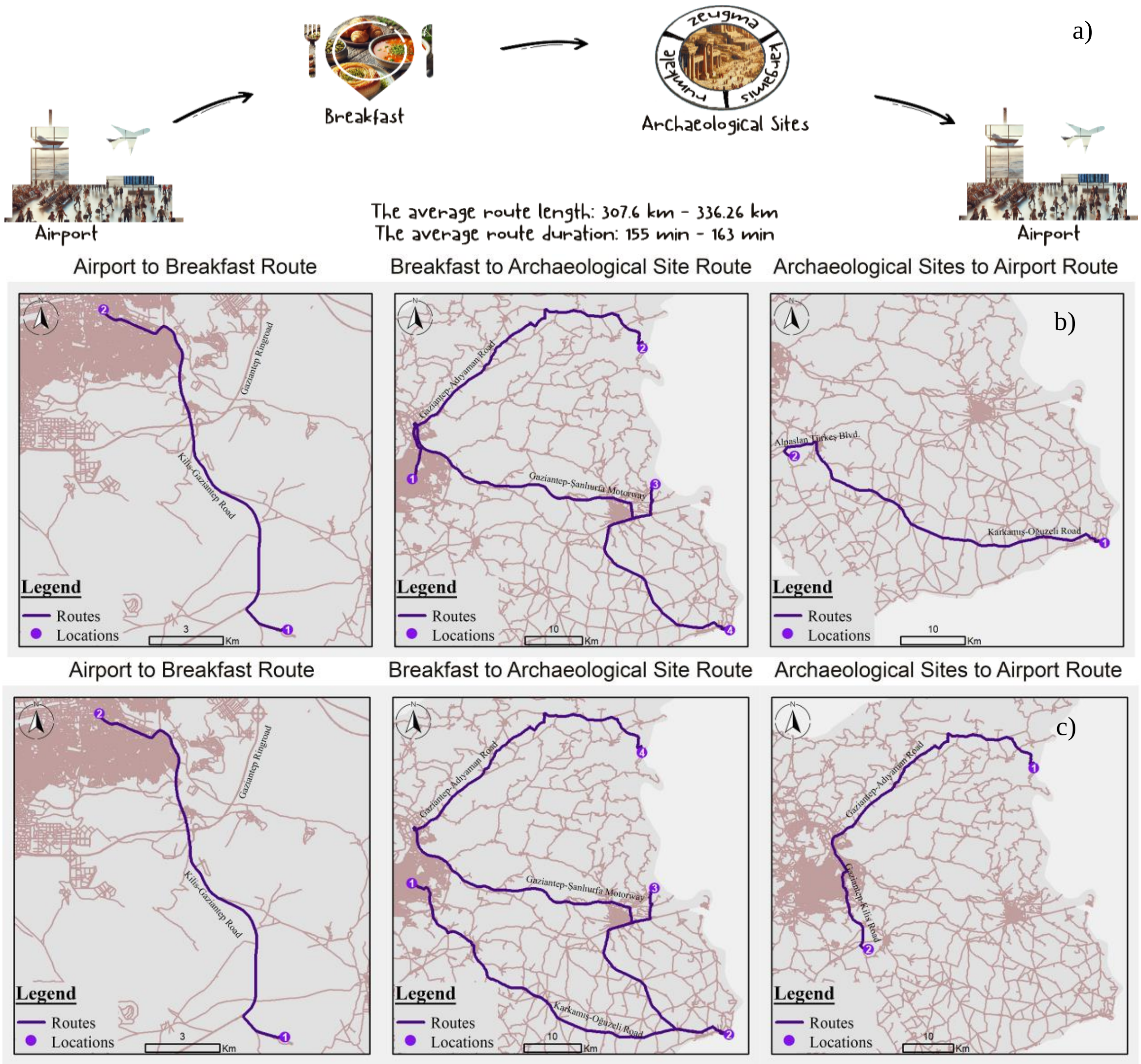

Figure 4. Archaeological Sites from North To South Route - ODRS2 and Archaeological Sites From South to North Route- ODRS3; a) route plan for both ODRS, b) ODRS2 maps, c) ODRS3 maps

Zoo to Mosaic Museum Route (ODRS4) and Mosaic Museum to Zoo Route (ODRS5)

Gaziantep has the country's largest zoo and mosaic museum, and tourism routes planned as one-day itineraries have gained attention. These routes began at the airport, and proceeded to the breakfast spots. After these routes, route scenarios included visits to these two prominent tourist attractions. Specifically designed for tourists who wish to provide their children with both exposure to nature and animals, as well as historical insights, these route scenarios have been tailored to meet these interests.

Each route scenario starts at the airport and initially heads to the closest breakfast spot again. The routes proceeded P1 and M14, or vice versa (M14 to P1). The length from the airport to the first breakfast location was approximately 18 kilometers for all scenarios, taking around 7 minutes. Subsequently, the route continued from P1 to M14, completing the circuit with a total length of 26 kilometers in 14 minutes. Finally, all route scenarios concluded with a return to the airport. The total distance for these routes ranged between 64.90 km and 65.70 km with 29 minutes. This analysis indicates that the choice of breakfast location did not affect the overall length or duration of the routes (Figure 5).

The alternative route scenario was designed with a museum visit first. Similar to the previous scenario, the length from the airport to the breakfast spot was approximately 18 km with 7 minutes for all routes. In these scenarios, the routes started with a visit to the M14 and followed by the P1. These museums to zoo route lengths were 16.5 km within 8 minutes. Finally, all route scenarios concluded with a return to the airport again. The total distance for these routes ranged between 61.30 km and 62.60 km with a total travel time of 26 minutes. This analysis confirmed that the choice of breakfast location did not influence the overall distance or duration of the routes.

Starting with the M14 offers an advantage of approximately 3.5 km and 3 minutes compared to the alternative route scenario. These route plans were optimized to provide tourists with an efficient way to explore both Turkey's largest zoo and the largest mosaic museum. Given the minimal difference in length and duration between the two route scenarios, the choice of route could be planned based on the tourists' individual priorities and preferences. This flexibility allowed for tailored itineraries that cater to varying interests while maintaining an efficient travel schedule.

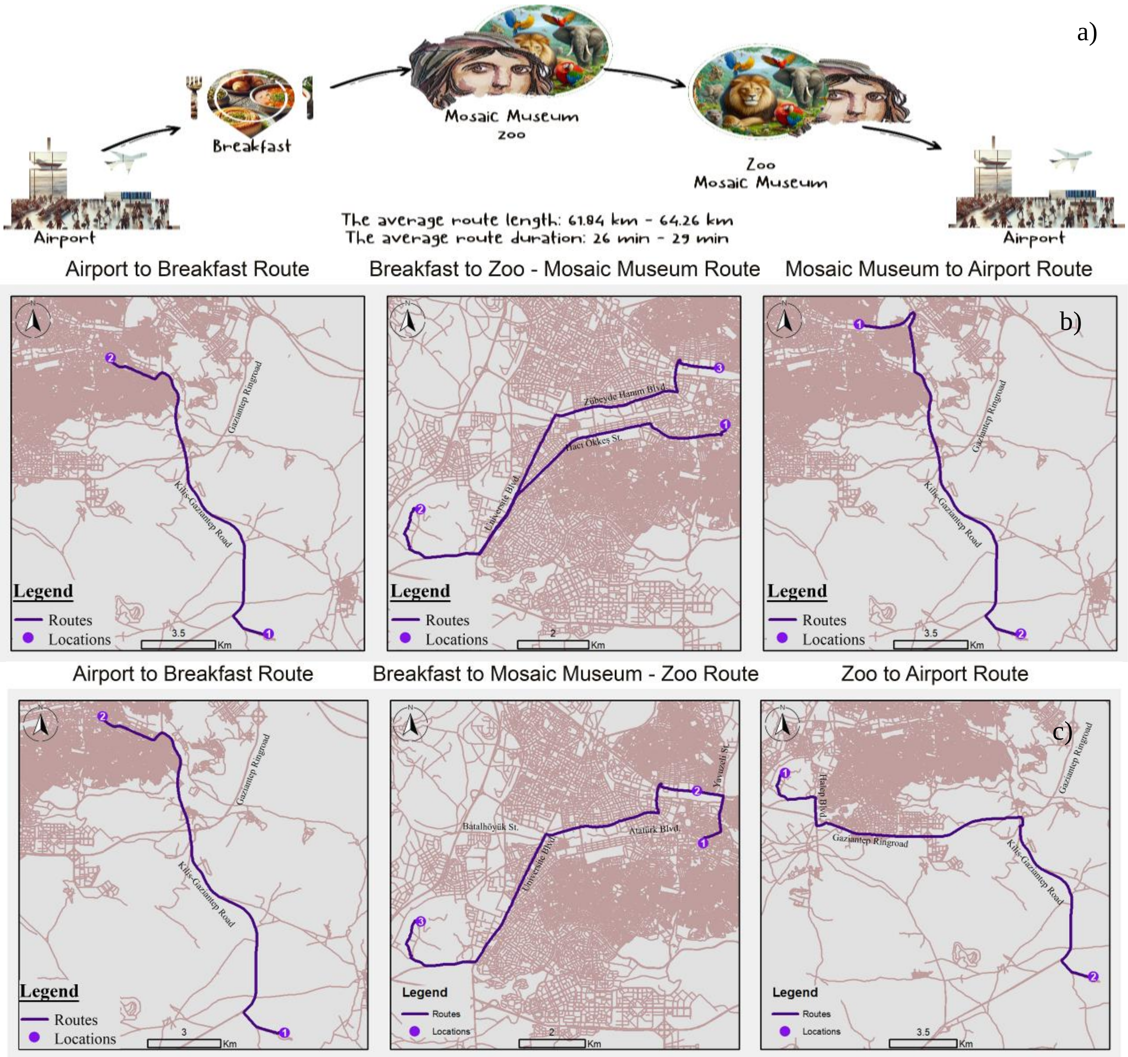

Figure 5. Zoo to Mosaic Museum Route - ODRS4 and Mosaic Museum to Zoo Route - ODRS 5;
a) route plan for both ODRS, b) ODRS4 maps, c) ODRS5 maps

In the one-day route scenarios, the fastest route was ODRS5 with a duration of 26.00 minutes. The closest alternative to this route was ODRS4, which lasted 29 minutes (Figure 6). These routes included a breakfast spot, followed by visits to the zoo and the mosaic museum, and then a return to the city center. Differences of the durations were 3 minutes for these routes. The third sub-scenario was the fastest among all sub-scenarios of the route scenarios (excluding ODRS1), due to the shorter length between the airport and the B3 breakfast spot. The ODRS1, which included cultural heritages and museum routes, was the third fastest route with an average distance of 49.60 km and an average duration of 109.20 minutes.

Figure 6. ODRS lengths/durations

The fastest sub-scenario started from the B3 breakfast spot after the airport. When examining the archaeological site routes (ODRS2-ODRS3), there was a difference of approximately 30.00 km and 8.00 minutes between the two routes. This suggests that route selection can be evaluated based on time and distance. For one-day archaeological site route scenarios, starting from the north after the airport appeared to be advantageous. In summary, the B3 breakfast spot consistently offered faster and shorter routes across various scenarios, it may be a strategic starting spot for tourists. Additionally, the choice between routes can be influenced by factors such as flight schedules, rental costs, and personal preferences.

One-day route scenarios general results:

- The arrival time from the airport to the breakfast points is the same for all breakfast spots and duration is 7 minutes.
- The walking route length ranges from 6.80 km to 8 km for the touristic zone.
- The archaeological sites' routes range from 227 km to 236 km.
- Since the airport is located to the south of the city center, starting the archaeological site tour from the north and heading south makes the journey to the airport 11 minutes faster.
- Due to the airport's location to the south of the city center, taking the route from the mosaic museum to the zoo before heading to the airport provides an approximately 6 km advantage compared to the reverse route.
- Visiting the zoo after the mosaic museum provides an advantage of about 10 km compared to the reverse route.
- Considering walking during the day, car rental (per km fee), and flight times, the most suitable route might be the city center and mosaic museum route scenario.

The application of GIS-based network analysis in this study highlights the potential for enhancing tourism route planning in medium-sized heritage cities such as Gaziantep. However, there are some limitations, the first of which is that the analysis is performed only with static data sets without considering real-time traffic conditions, seasonal congestion changes or special event effects. Such dynamics have been shown in previous studies (Curtale et al., 2021; Granja-Martins et al., 2024) to meaningfully affect the efficiency of tourism routes. Therefore, future work should aim to integrate live traffic data or develop adaptive, time-aware routing models to enhance practical usability.

The study prioritized logistical optimization (i.e., time and distance minimization) over multidimensional sustainability metrics. A comprehensive tourism route planning framework should evaluate the environmental footprint (e.g., CO_2 emissions), economic dispersion benefits (e.g., engagement of local businesses along routes), and socio-cultural impacts (e.g., preservation of heritage authenticity).

Incorporating such broader criteria would elevate GIS applications from operational tools to strategic instruments for sustainable urban tourism development (Benckendorff et al., 2013; Ibănescu et al., 2018). While the route scenarios offer a practical blueprint for tourists visiting Gaziantep, the scalability and transferability of the proposed model to other cities remain untested. Conducting comparative studies across multiple cities with diverse urban forms and tourism profiles could offer critical insights into the generalizability and robustness of the methodology.

In this study, GIS-based one-day tourist route scenarios have been prepared for visitors to Gaziantep, a city that has gastronomy and cultural heritage. The route scenarios were designed to begin by the city's cultural cuisine characteristics. The routes were planned based on tourists' preferences for visiting different locations, including cultural heritage sites, museums, archaeological areas, and possibly a zoo. In addition to the fastest and slowest route planning, scenarios have also been designed to allow tourists to visit all the existing tourist locations.

CONCLUSION

This study demonstrated the effective use of GIS and network analysis techniques for the planning and optimization of cultural and gastronomic tourism routes in Gaziantep, Turkey. By developing structured one-day itineraries, the research showcased how GIS-based modeling can enhance tourist mobility, improve access to diverse attractions, and support strategic tourism management. The spatial analysis capabilities provided by GIS play a critical role in establishing more efficient connections between tourist destinations, enhancing visitor experiences, and developing sustainable tourism policies. The analyses conducted specifically for Gaziantep demonstrate that the city's tourist attractions can be strategically managed, and tourist density can be distributed more evenly. This approach will not only facilitate better time management for tourists but also provide economic benefits to different parts of the city.

Furthermore, GIS-based analyses can identify gaps in transportation infrastructure, enabling improvements in areas such as public transport and parking facilities. The study also reveals that GIS is effective not only in tourism planning but also in promoting environmental sustainability and improving the quality of life for local residents. In a tourist city like Gaziantep, GIS-based network analysis can help promote lesser-known areas while planning tourist routes. This approach can highlight cultural richness and reduce overcrowding in popular areas. Additionally, such a strategy can minimize environmental impacts and contribute to the preservation of tourist zones.

However, the absence of dynamic traffic and visitor flow data limited the precision of the route optimization models. Future research should incorporate real-time datasets and develop adaptive routing algorithms to better reflect real-world conditions. Moreover, integrating sustainability indicators such as environmental impacts, community engagement, and cultural preservation metrics would significantly broaden the contribution of GIS in tourism planning. Despite its limitations, the study provides a foundational framework that can assist local tourism stakeholders in optimizing visitor experiences while promoting balanced tourism development. The methodological approach proposed here can be adapted and scaled for other heritage cities facing similar tourism planning challenges.

Moreover, by including centrally located yet often overlooked local sites in the optimized routes, the proposed model supports the revitalization of inner-city areas and promotes more equitable tourist flows, potentially generating economic benefits for small-scale businesses and enhancing community engagement. GIS and network analysis are powerful tools for managing tourism more efficiently and sustainably in cities like Gaziantep, which possess dynamic and rich tourism potential. Collaboration among local governments, tourism businesses, and academic institutions to utilize GIS more effectively can help the tourism sector achieve a more sustainable structure, both economically and environmentally.

Future studies can further enhance this potential by enabling more detailed analyses of real-time traffic data and tourist movements. The study further demonstrates the potential of GIS-based planning to accommodate diverse tourism objectives by integrating various types of attractions—such as cultural heritage sites, gastronomic venues, archeological sites and museums—into thematically coherent itineraries tailored to specific visitor interests and time constraints.

In this context, the widespread adoption of GIS applications and the more comprehensive use of network analysis in cities like Gaziantep will enhance the city's competitiveness in both local and international tourism. Future studies are encouraged to explore comparative applications across different cities, integrate mobile app-based routing solutions, and develop participatory planning frameworks that involve tourists and local communities in the route design process. Such advancements would contribute significantly to building resilient, sustainable, and smart tourism ecosystems.

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