



GIS based daily tourism route proposal for surrounding provinces and districts from Ankara's Çankaya district (Turkey)

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Abstract

With the dynamic evolution of the tourism sector, a multitude of shifts in tourism activities and traveler motivations have transpired. These changes, spurred by technological advancements, economic fluctuations, and geopolitical developments due to heightened global competition, have introduced a fresh dimension to tourism dynamics. Significantly, the strategic creation of new tourism itineraries has become pivotal, given the tourism sector's integral role in city branding. In this study, the focal point was the Çankaya district within the Ankara province, deemed a central reference. Positioned at the heart of Turkey, Ankara province boasts the second-largest population according to TUIK (2020) data. Within this province, Çankaya district stands as the most densely populated, rendering it the designated study area. In Çankaya, which is one of the most heavily employed areas by public workers in Turkey, strategically positioned and with high population potential, the tourism planning of day trips, especially on weekends, is crucial to be conducted within the framework of time–distance savings. Without such planning, it might be challenging to achieve an efficient travel organization, especially for tourists who allocate fewer resources to travel planning in recent years, have limited time, and are selective about tourism destinations. In line with the research problem, the aim of the study is to conduct a comprehensive analysis of tourism accessibility, using the example of Çankaya district in Ankara, and to visualize the results of the analysis within a quantitative methodology framework to present concrete outputs. The more specific objective of this study is to determine a tourism route that allows tourists to reach important tourist attractions in the shortest and most convenient routes within the framework of time–distance savings, with a maximum travel time of 3 h in the research area. The expected scientific contributions from the objectives are as follows: contributing to transportation optimization related to tourism, bringing attention to historical, natural, and cultural places within the determined tourism route that are still undiscovered, less known, or not evaluated as individual tourism destinations, providing valuable information to destination managers, raising awareness about tourism opportunities in each destination, and contributing economically to the region. Employing a quantitative methodology, the study hinged on time-based road matrix analysis, facilitated by Geographical Information Systems, to chart routes from Çankaya district to surrounding districts. During this analysis, preference was given to routes with

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gentle curves, mitigating negative impacts on vehicle speed compared to more convoluted alternatives. Subsequently, leveraging 21 distinct types of tourism attractions, tourism sites feasible for visits within 1, 2, and 3-h intervals were pinpointed. At the study's culmination, an assemblage of 841 daily tourist destinations in and around Ankara were meticulously delineated and cartographically depicted using MapInfo Pro 2019.3 version. This endeavor underscores a concerted effort to offer tourists, both local and beyond, a well-crafted roadmap to explore and relish the plethora of cultural, historical, and natural treasures that Ankara and its neighboring regions have to offer.

Keywords Geographic information systems · Tourism routes · Tourism venues · Ankara

1 Introduction

According to the United Nations World Tourism Organization's Dictionary of Tourism Terms, tourism embodies a multifaceted phenomenon that encompasses social, cultural, and economic dimensions, necessitating individuals to venture to countries or locations beyond their customary environments for personal or professional reasons. Those engaging in such activities are denoted as tourists (UNWTO, 2021). This robustly positions tourism as one of the planet's largest and swiftest burgeoning industries (Smith, 1993; De Freitas, 2003; Hamilton & Tol, 2004; Scott & Lemieux, 2010; Nagy & Piscoti, 2016; Hu et al., 2021; Gavilanes et al., 2021; Prameshwori et al., 2021). In actuality, tourism, a pervasive pursuit that attracts over 1.18 billion international tourists annually, serves as a pivotal economic sector, generating more than 284 million employments and yielding an excess of 7.2 trillion US dollars yearly (Lim et al., 2019).

Despite the ever-increasing significance of the tourism industry and the notable proliferation of research into tourism, scant attention has been directed towards comprehending the spatial and temporal conduct of tourists (Shoval & Isaacson, 2007). As expounded by Debbage (1991), the spatial behavior of tourists, encompassing the exploration of diverse geographic locales and attractions during their sojourn, can be categorized based on their typologies and travel predilections (Debbage, 1991). Consequently, tourism fundamentally revolves around a spatial framework, encapsulating the trajectory of the tourist from their point of origin to the sites of interest and back (Becken et al., 2007). Nonetheless, this voyage is intricate in its essence, owing to the heterogeneous spatial inclinations exhibited by different types of tourists (Lew & Mckercher, 2006).

In recent times, tourists have evolved into more intricate, discerning, and cost-conscious individuals, dedicating fewer resources to the intricacies of travel planning (Buhalis & Law, 2008). Indeed, a majority of tourists grapple with constraints in terms of both time and budget, necessitating judicious choices regarding the selection of captivating destinations to explore (Caldeira & Kastenholz, 2017; Vansteenwegen et al., 2011). Consequently, paramount for tourism entities is the provision of well-conceived tour routes and a diverse array of attractions that entice visitors, thereby augmenting the allure and popularity of these locales. The ongoing trend underscores the analysis of an increasing range of tour route offerings to accommodate the multifaceted preferences of tourists (Han et al., 2014).

During their journeys, tourists encounter the task of delineating travel destinations and navigating optimal routes to explore a multitude of attractions and historical sites within a finite time and budget, all the while striving to attain maximal satisfaction. For a subset of tourists, particularly those encountering a destination for the first time, the determination

of a suitable tour route can transpire prior to or during the trip itself (Abbaspour & Samadzadegan, 2011). In addition to consuming time, this process also entails challenges in identifying attractions that merit a visit and orchestrating efficient tour itineraries encompassing these chosen sites (Wu et al., 2017).

When devising travel itineraries, tourists first need to streamline their choices from a wide array of available points of interest, aligning their selections with personal preferences and travel constraints. Subsequently, they must identify tourism attractions suitable for inclusion in their daily tours, rationally determining the order in which these attractions will be visited during each tour, and effectively plan transportation between different tourist sites (Gavalas et al., 2017).

Crucially, the elimination of information gaps and the establishment of a functional route that highlights key attractions play a pivotal role in mitigating the primary challenges associated with tourists' attraction choices (Pedrana, 2014; Wolfgang et al., 2017). In the context of tourism, an information-intensive sector, contemporary tourists extensively harness technology to address their lack of knowledge about captivating destinations (Tussyadiah & Fesenmaier, 2005; Pedrana, 2014). The utilization of various computer software during this stage greatly enhances the convenience of planning a tourist route (Shcherbina & Shembeleva, 2014; Yun & Park, 2015).

The identification and mapping of tourist attractions can be effectively accomplished using spatial analysis software (Castillo-Vizuet et al., 2021). Among such software, Geographic Information Systems (GIS) technology presents valuable opportunities for modern tourism application development through map integration. GIS facilitates network analysis, which determines the shortest and most efficient routes, aiding in tourist planning and optimizing time and cost savings (Bahaire & Elliot White, 1999; Barringer et al., 2002; Bansal & Eiselt, 2004; Jovanovic & NJegus, 2008; Hall, 2008; Connell & Page, 2008; Kervankiran & Çuhadar, 2014; Yang et al., 2014; Prameshwori et al., 2021).

Network analysis involves the collection of relational data, its arrangement into a matrix, and the computation of parameters like density and centrality (Scott et al., 2008). The application of GIS network analysis aids in determining the optimal route within a road network between two locations, contributing to effective trip planning in terms of time and distance (Butler, 1993; Boyd et al., 1994; Dye & Shaw, 2007; Prameshwori et al., 2021). Consequently, the convenience provided by GIS, coupled with network analysis, has led to an upsurge in studies that propose alternative tourism routes based on GIS analyses in various countries across the globe (Abubakar et al., 2017; Astor et al., 2020; Benckendorff & Zehrer, 2013; Calderón Puerta & Arcila Garrido, 2020; Gill & Bharath, 2013; Hu et al., 2021; Liu et al., 2017; Nicolosi et al., 2018; Peng et al., 2016; Prameshwori et al., 2021).

Despite the increasing number of studies offering GIS-based alternative tourism route suggestions, the research focused on developing route suggestions for daily trips, considering scenarios involving time and distance from a central point to attractions in surrounding cities and districts, remains relatively scarce (Gill & Bharath, 2013; Hooper, 2014; Kang et al., 2018; Wang et al., 2019; Wu & Chen, 2022; Kranioti et al., 2022; Li et al., 2021; Li et al., 2022; Pei et al., 2022). This highlights certain gaps in the existing studies related to tourism accessibility, particularly aspects like distance, speed, and travel time, which may necessitate further exploration (Li et al., 2022).

Interestingly, given the accelerating urbanization, the growing significance of time-space relationships, and the increasing popularity of short-term weekend tourism trips, the dearth of academic investigations into daily access to tourist sites is noteworthy. It's worth mentioning that research on this topic is still relatively nascent in Turkey. Against the backdrop of especially the post-pandemic COVID-19, regional short distance

tourism has become more prevalent (Liao et al., 2023). The literature gap that constitutes the main motivation for the preparation of this study can be briefly summarized as follows: Although there are many studies that reveal accessibility through network analyzes on the basis of Geographic Information Systems, it has been noted that these analyzes are used in fewer studies, especially in terms of accessibility to tourism destinations. On the other hand, although the issue of determining alternative routes in tourism is frequently the subject of academic studies, GIS-based studies on the subject are more limited. In relatively fewer studies that are GIS-based and where network analysis is applied, the number of studies that deal with accessibility to tourist attractions to be visited on a daily basis in terms of time and distance is much less. Apart from this limited number of studies in the literature, it has been observed that the research topic has been almost completely neglected in Turkey. Aside from studies addressing the tourism route planning of Küre Mountains National Park and Nevşehir province (Arca & Mutlu, 2022; Sucu, 2022), little to no research on this subject has been identified. This conspicuous gap in the literature has served as the primary motivation behind the creation of this article.

In this study, the focus was on the Çankaya district within the Ankara province, considered a central reference. Positioned at the heart of Turkey, Ankara province boasts the second-largest population according to TUIK (2020) data. Within this province, Çankaya district stands as the most densely populated, rendering it the designated study area. Given its strategic position and high population potential, particularly for day trips on weekends, efficient tourism planning in terms of time and distance savings is crucial in Çankaya. Without such planning, it might be challenging to organize a productive travel experience, especially for tourists who allocate limited time and are selective about tourism destinations. Could unmet tourist expectations lead to disappointment? Based on these research problems, the sub-research questions of the study are as follows: Which tourist attractions can tourists from Ankara's Çankaya district, who want to visit important tourism attractions in the surrounding settlements, visit within a maximum of 3 h? What is the spatial distribution and density of these attractions? Are the districts and tourist attractions that are close to Çankaya in absolute distance, the same proximity in terms of time distance? Can tourist attractions that can be visited at distances of less than 1 h, 1–2 h, and 2–3 h be classified? Is it possible to create tourism routes in this regard?

In line with the main research problem and sub-research questions stated above, the aim of the study is to conduct a comprehensive analysis of tourism accessibility, using the example of Ankara's Çankaya district, and to visualize the results in a quantitative methodology, presenting concrete outputs. The specific objective of this study is to determine a tourism route that allows tourists to reach important tourist attractions within the Çankaya district, considering a maximum travel time of 3 h, with a focus on time–distance savings. The expected scientific contributions of this study, in line with the objectives, are as follows: contributing to transportation optimization related to tourism, introducing undiscovered, less-known, or individually undervalued historical, natural, and cultural attractions within the determined tourism route, providing valuable information to destination managers, raising awareness about tourism opportunities, and contributing economically to the region. In addition to the concrete scientific contributions expected to be presented directly related to the research area, contributing methodologically to similar studies on this topic in different regions and cities around the world is also a motivation for this study.

Çankaya holds significance as the epicenter of various consulates, public institutions with general directorates, and numerous educational establishments, making it a pivotal administrative hub within Turkey. This prominence underscores its potential to attract tourists who can conveniently explore adjacent provinces and districts. The study area was

meticulously chosen to encompass Çankaya district and its peripheries, reachable within a three-hour radius. The geographical layout of Ankara's Çankaya district is depicted in Fig. 1.

In the "Literature Review" section following the introduction of the article, previous academic studies on the subject and the findings of these studies are given extensive coverage. In the materials and methods section, which data were used and for what reasons, where the data sets were obtained and how the analyzes were carried out were discussed. In the Results section, the analysis results are presented with tables, graphs and maps. In the Discussions section, the main findings of this study are compared with the literature findings and the original value of the study is stated. In the Conclusions section, the most important outcomes of the study are summarized, and in the last section, some suggestions specific to the research topic are put forward.

2 Literature Review

The examination of tourist attractions with regards to route suggestions and accessibility in academic studies is still relatively new on the global scale. Notably, a study by Edwards et al. (2008) underscored that while academic research encompasses a wide array of tourism-related topics, the aspect of attractions accessibility often remains overlooked (Edwards et al., 2008). One of the pioneering works in this domain was conducted by Shih (2006), who employed network analysis to investigate the tourism characteristics of 16 attractions in Nantou, Taiwan. This study unveiled structural patterns among these attractions by analyzing metrics like degree, betweenness, and closeness centrality of each node.

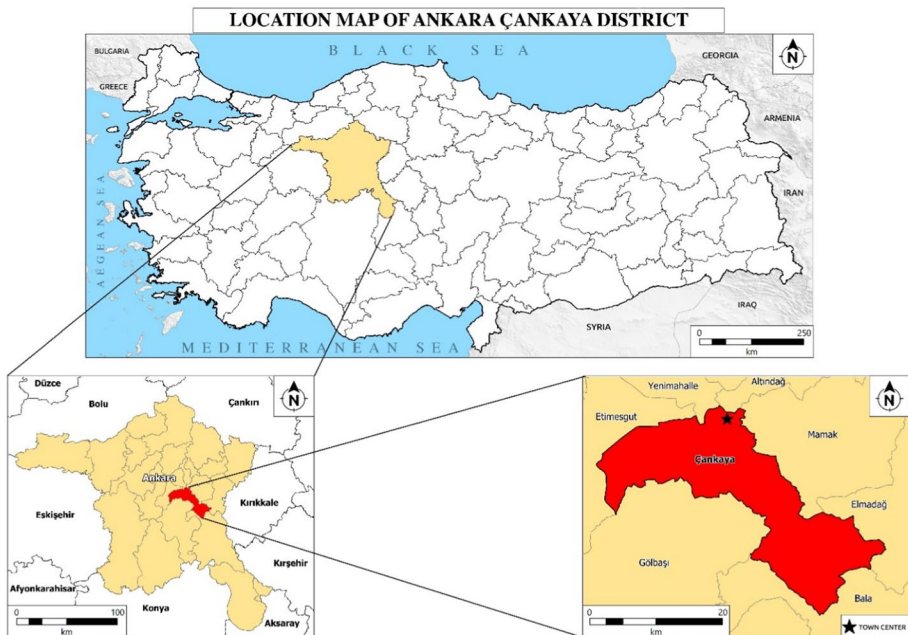


Fig. 1 Location map of the study area

This insightful analysis offered a basis for understanding the requisite tourist facilities for each attraction based on their characteristics. Shih (2006) stated in his study that each destination in the research area has development opportunities and constraints arising from the influence of other destinations in the region. He emphasized that this can be examined by measuring the structural configuration of destinations and focused on the complementarity of interesting places. Building on this foundation, Jin et al. (2009) utilized a shortest time-path selection algorithm to compute and analyze accessibility data for tourist attractions within Nanjing city, taking into account the city's highway network structure. Gill and Bharath (2013) extended this research by exploring GIS-based network analysis to optimize routes for touring attractions in Delhi city. The study not only identified optimal routes from the point of tourist origin to various attractions but also factored in visiting time for each attraction. As scientific contributions of their study, it is believed that time and distance savings will be achieved in terms of accessibility to tourism destinations, and the tourism potential and tourist satisfaction of destinations will increase. Furthermore, Pan and Li (2014) delved into the accessibility analysis of 2424 A-grade tourist attractions in China by scrutinizing their spatial distribution through the application of GIS technology. It has been suggested that the tangible outputs obtained from these analyses will contribute to accelerating the development of tourism in surrounding districts and coordinating the development of tourism for each region.

Numerous studies have been conducted to examine tourism accessibility and route suggestions, utilizing Geographic Information Systems (GIS) and various analytical techniques. Hooper (2014) developed a tourism accessibility model for Seoul, aiming to assess the level of accessibility of attractions for diverse types of tourists from different countries, with a specific focus on the influence of distance to attractions. The model developed by Hooper has been shown to provide significant benefits in tourism planning and targeting marketing strategies. Sadhu et al. (2017) explained that the Network Analysis extension aims to solve problems regarding routes related to travel and accessibility. According to the authors, by using the Network Analysis extension, a new route can be created from a point to a location that includes travel time and various other parameters. In this study, Jaisalmer and Sam Blocks of Jaisalmer District, Rajasthan (India) were selected as field research. The network analyses applied in the study are stated to contribute significantly to solving travel, flow, and routing problems. Kang et al. (2018) employed a combination of GIS, social network analysis, and spatial statistics to investigate tourist attraction networks in Seoul, South Korea. Their research aimed to discern spatial distribution patterns among 29 tourist attractions and their correlation with tourists' length of stay in the city. In their study, the importance of examining the spatial structure of tourist attraction networks has been emphasized to better formulate competitive tourism destination planning, development, and management strategies based on the research area.

Wang et al. (2019) systematically analyzed the accessibility of 56 scenic spots in Xi'an City, China, considering both car and public transport travel modes. They integrated real-time travel data from the Baidu Maps API with spatial analysis methods to evaluate accessibility, using indicators like the modal accessibility gap index. The study is anticipated to contribute to tourism-related transportation optimization, enhance travel efficiency linked to tourism, and provide practical benefits to encourage the development of tourism in the region. Astor et al. (2020) determined the effective routes for tourism mass transportation in Bandung City (West Java/Indonesia) using network analysis with impedance of travel time and distance from downtown and station or airport. The study has argued that determining effective routes connecting tourism destinations will provide transportation optimization for tourists. Li et al. (2021) evaluated the accessibility of suburban attractions in

Beijing, China, employing GIS network analysis. Their investigation examined the spatial disparities in reaching attractions by car, public transport, and bicycle, proposing strategies for tourism development in Beijing's suburban areas. In the study, scientific contributions that can ensure the accessibility, usability, and sustainability of tourism destinations through transportation network analyses have been emphasized.

Pei et al. (2022) focused on bicycling self-driving tourists, constructing a dataset of traffic road networks and assessing the accessibility of 217 tourism resources in the Lushunkou District, China. With their study, Pei et al. (2022) highlighted that significant contributions, such as optimizing tourism routes and providing time–distance savings for tourists, could be achieved. Kranioti et al. (2022) studied the cultural landscape of the Attica prefecture, Greece, employing network science principles. Overall, this study emphasizes the necessity for spatial planning and tourism management to be aware of the geographical, topological, and functional characteristics of the cultural tourism market. Li et al. (2022) assessed the spatial accessibility of tourism attractions in an urban setting, while Wu and Chen (2022) proposed an optimal accessibility path for tourist scenic areas based on circular design principles and the design of tourist traffic and facilities. Sucu (2022) conducted a study in the Nevşehir province of Turkey, determining tourism attractions within a maximum 3-h radius from Nevşehir Central District. The focus on a 3-h arrival time aligns with the context of daily tourism trips. Collectively, these studies underscore the significance of GIS-based approaches in enhancing tourism accessibility and route planning. In his study, Sucu (2022) anticipates that destinations facing the threat of disappearance in the tourism route, especially cultural destinations, will be preserved and supported in their promotion.

Bachtiar (2023) purposed to integrate Analytical Hierarchy Process (AHP) and GIS network analysis to generate a ranking of the potential of educational tourism objects based on the parameters of accessibility, amenities, and attractions according to Minister of Tourism Regulation Number 5 of 2017 and produce alternative routes. In this study, in which Jember Regency (East Java/Indonesia) was chosen as the field research, 3 route suggestions were made as a result of network analysis. The default travel time on these routes is determined as 7–8 h.

Li and Wang (2023) aimed to propose a new concept schema for implementing smart cities and big data applications by analyzing the spatial–temporal accessibility of various traffic modes. Analysis of their study in Huizhou West Lake's Scenic Area indicates West Lake's Scenic Area has a better regional transportation system and accessibility. Tourists can arrive at West Lake's Scenic Area by taxi/online car from the primary transfer stations nearby in about 30 min. Due to the many residential, commercial, and public stations around the scenic area, citizens can have a good sense of experience when traveling by bike. In this study, practical benefits in terms of spatial and temporal accessibility will be provided based on transportation modes. Liao et al. (2023) used Wuhan Urban Agglomeration (WUA) as the research area and explored spatial structure characteristics and road traffic accessibility issues of A-level tourist attractions within WUA. As a proposed solution to these problems, emphasis has been placed on the spatial distribution of tourist attractions and the accessibility of road traffic, which can play an effective role in overall regional development.

Dumitraşcu et al. (2023) aimed to evaluate the level of accessibility for seven of the most popular tourist attractions in Dobrogea (Romania), which were selected on the basis of their physical, geographic, religious, and historical significance. Moreover, the level of satisfaction among tourists who visit each attraction was also assessed. Methodologically, several working and data processing methods specific to accessibility analysis were used, and graphic materials were produced to highlight the results obtained. To analyze tourist

satisfaction, the researchers conducted interviews with 718 tourists who visited the attractions between June and September of 2022. The findings of this study can provide valuable information to local communities regarding the tourism potential of the region and the accessibility of its attractions. Building on the proposed model in the study, it is suggested that it will provide a valuable tool to identify not only the critical components requiring improvement in the tourist offer but also its strengths and potential new tourism products.

Based on the geographic coordinates of tourist towns, Hui et al. (2023) used the nearest neighbor index, geographic concentration index, location entropy and other research methods to quantitatively analyze the spatial distribution characteristics of 289 tourist towns in the Wuling Mountain area and summarize the influencing factors. The results show that the number of tourist towns varies by region, as does the level of tourism development. The distribution of tourist towns generally shows a certain degree of geographical concentration, forming multidensity centers and a large number of small settlements. An important contribution expected from the study is to recommend the establishment of a tour service center in the determined location where a structural gap in the tourism network of the government exists.

Upon reviewing the existing literature, it becomes evident that the majority of studies in this domain have been primarily conducted in countries including China, South Korea, Taiwan, Greece, and Turkey. These investigations have primarily centered on provincial and urban contexts. The terminology employed to define these sites has varied, encompassing terms such as "attractions," "tourism places," "tourism resources," and "tourism attractions." In this article, we have consistently employed the term "tourism attractions" to refer to diverse natural and/or man-made elements. This approach has been adopted to ensure clarity and prevent any potential ambiguity throughout the paper.

A distinctive aspect that sets this article apart from numerous preceding studies lies in its focus on devising route suggestions for sites that can be explored within a single day, rather than requiring overnight stays. This emphasis on daily excursions, particularly pertinent in regions marked by intense urbanization and high population density, caters to the needs of visitors seeking enjoyable and time-efficient experiences. This approach deviates from the conventional trend of exploring places that involve longer stays and lodging arrangements. By addressing the demand for short-term trips in such dynamic urban settings, this article offers a novel perspective on enhancing the overall tourism experience.

When examining the scientific contributions of academic studies on accessibility to tourism destinations and the expected scientific contributions from this study as a whole, it can be said that the focus is on efforts to provide practical benefits within an accepted evaluation axis for accessibility to tourism destinations through quantitative network analyses. Achieving time–distance savings for tourism destinations, making travel organizations more efficient, realizing undiscovered or less-known tourism destinations, activating local and regional tourism opportunities, providing a sustainable economic contribution to the region where destinations are located, and implementing transportation optimizations constitute the main contributions in question.

3 Material and methods

Tourism routes play a crucial role, particularly from the perspective of tourists, as they facilitate efficient exploration of a region, allowing visitors to make the most of their time. Additionally, these routes contribute to diversifying the range of tourism products along

specific paths. The emergence of various route types, such as ecotourism or gastronomic tourism routes, continues to evolve daily. The primary aim behind establishing these routes is to guide tourists along a designated path, enabling them to discover natural and cultural tourism treasures in a structured manner. In doing so, these routes also safeguard lesser-known historical and cultural assets, ensuring their preservation and transmission to future generations.

An added advantage for tourists is the freedom to opt for alternative tourism routes. This contrasts with organized tour participants who often have limited say in selecting the route. The concept of tourism routes seamlessly interconnects an array of areal, point, and linear scale tourist attractions and activities, fostering a sense of cohesion. This integration not only ensures a holistic experience but also enhances the appeal of tourism activities by extending them from specific points to a more comprehensive setting. This approach effectively transforms tourism activities into a more enticing and comprehensive experience.

The study focuses on the province of Ankara, situated at the heart of Turkey and boasting the second-largest population according to TÜİK's 2020 statistics. Within this province, Çankaya district holds the highest population count. Despite this, there exist numerous hidden, lesser-known, or underappreciated sites within the region that possess significant historical, cultural, and natural value. These overlooked gems deserve attention and recognition within the tourism realm. Developing alternative tourism routes becomes essential for showcasing these sites, not only contributing to the region's economic growth but also safeguarding and transmitting its treasures to future generations.

This study endeavors to utilize Geographic Information Systems to delineate tourism routes, subsequently evaluating their impact on tourism activities. Why GIS? Firstly, GIS technology offers significant opportunities for the development of modern tourism applications to analyze spatial data (Barringer et al., 2002; Connell & Page, 2008; Prameshwari et al., 2021). In addition, GIS provides numerous functions to evaluate and analyze morphological characteristics, such as the accessibility of tourist facilities to attractions or transport nodes, the spatial cluster or dispersion of activities in a resort, and the like (Liu & Wall, 2009). The ultimate goal is to offer these meticulously designed tourism route suggestions to a broader audience, taking into account the strategic location and population potential of Ankara's Çankaya district. Through this initiative, the aim is to encourage the exploration of these hidden treasures while enhancing the district's overall tourism appeal.

This study is dedicated to the identification of daily accessible tourism attractions in the vicinity of Ankara's central district. Employing quantitative research methods, the study harnesses the power of Geographic Information Systems (GIS). GIS serves as a critical tool for conducting topological assessments, network analyses, and map generation essential for route determination. The chosen GIS software for this purpose comprises Başarsoft Information Technology A.Ş.'s MapInfo Pro v.2019.3 and MapBasic v.2019.3 programs, which facilitate programmatic development within the platform.

The study's starting point is Çankaya District in the heart of Ankara Province. The foundational data required for pinpointing the tourism spots feasible for visitation within specific timeframes is furnished by Başarsoft Information Technology A.Ş., a pioneering entity in data collection in Turkey, and renowned for producing the nation's foundational map. The data, encompassing provinces, districts, roads, and vital landmarks, was acquired from this source. The dataset for the year 2020 encompasses essential geographical features such as provincial and district boundaries, road networks, and crucial points.

Başarsoft Information Technology A.Ş. further supplied the vital data concerning tourism attractions, provincial and district borders, and road networks utilized in the research. These datasets are predominantly in vector format, encompassing geographic features like

provincial and district boundaries, city centers, and road layouts. Simultaneously, data related to tourism attractions is stored in Excel format. The process of integrating tourism attractions into the map entailed transforming the latitude and longitude coordinates from the Excel data into vector-based points through the MapInfo Pro program. To validate the accuracy of these attraction locations, around 50 venues were cross-verified using the Google Maps platform.

The data sets used in this study also have some limitations. Although Başarsoft Information Technology A.Ş. has recorded the tourism attractions in and around Ankara in a remarkable manner, there may be tourism attractions that were overlooked during the determination or storage of these data sets. In addition, existing tourism attractions may lose their former importance over time and become unattractive to tourists. Road data in Vect or format may have topological errors or inconsistencies. Depending on the changing conditions of time, transportation routes may change, unexpected traffic congestion may occur on some routes, administrative border changes may occur for various reasons, and these situations may affect the time and distance in accessibility to tourism attractions. However, despite all these possibilities, it is possible to obtain concrete outputs that provide practical benefits as a result of the appropriate use and analysis of existing data sets. Below are details about the data sets and how the data is used.

Road data, pivotal for route calculations, is also acquired in vector format. This dataset comprises critical attributes such as maximum speed limits, average speeds under varying traffic conditions, lane counts, and road types (main road, highway, secondary road), along with the respective road lengths.

To ensure data integrity, topology control was diligently executed to identify any potential disruptions or discrepancies in the path data earmarked for network analysis. Topology control stands as a widely favored approach for identifying gaps, disconnections, or incongruities within vector data. The thorough control procedures yielded no indications of errors or inconsistencies.

In the creation of the road matrix, a comprehensive approach was adopted, incorporating variables such as the number of lanes on roads, a factor acknowledged to impact arrival distances. Particularly, a preference was granted to main roads over secondary ones. Within the calculation process, the highest speed limits attainable on roads and the average speeds applicable under various traffic conditions were factored in. Moreover, road curvature, a parameter known to influence travel time, was accounted for. The selection of less curved routes was made based on road curvature, a choice aimed at optimizing travel time to the most efficient extent possible.

In the first step of the analysis, starting from the Çankaya (Center) District of Ankara Province, the road matrix analysis was carried out using the Mapbasic v.2019.3 program to the district centers of all Turkey.

$$\text{Road Time} = \text{Path Length} / \text{Average Speed of the Road}$$

In the conducted analysis encompassing a total of 973 district centers, the maximal vehicle travel times were meticulously computed. Subsequently, leveraging these travel time determinations, the districts reachable within a 3-h timeframe were identified and cataloged as a distinct dataset. The 3-h threshold was set as the maximum duration viable for a daily excursion. Considering the round trip, this translates to a maximum of 6 h. Within this context, utilizing districts attainable within the 3-h constraint, tourism attraction points reachable within 1, 2, and 3 h were ascertained and organized via geographical queries. This comprehensive analysis unveiled the accessibility of 21 diverse tourism attractions

on a day-to-day basis. In alignment with this insight, the study then incorporated these 21 tourism attractions (as listed in Table 1) as pivotal components of its investigation.

The data utilized in this study were acquired through a combination of the company's dedicated field team and remote sensing techniques. To effectively communicate the outcomes of the analysis and underscore the significance of the findings, visual representations of the results and the location map were meticulously crafted within the framework of MapInfo Pro, a distinguished Geographical Information Systems (GIS) software, version 2019.3. These meticulously designed maps, acting as visual aids, serve the purpose of presenting daily travel recommendations aligned with the diverse attractions available to tourists.

4 Results

The study's analyses have culminated in the calculation of travel distances from Çankaya district to neighboring districts, categorized into three distinct time intervals. Given the study's focus on daily tourism excursions, the maximum travel duration was stipulated at 3 h. Within this temporal framework, it was ascertained that transport could be feasibly arranged to encompass a total of 16 provinces and 96 districts. The breakdown of tourism attractions across these provinces is extensively detailed in Table 2. A closer inspection of Table 2 reveals that Ankara boasts an impressive count of 306 tourism sites. This elevated count can be attributed to the starting point of the route being the province of Ankara itself. In the second and third positions, Eskişehir and Aksaray provinces emerge with 57 tourism attractions each, marking notable concentrations in this regard.

A more comprehensive breakdown of the statistical figures regarding tourism attractions on a provincial basis is presented in Table 3. This table furnishes detailed insights into the number of tourist attractions that can be accessed within a daily timeframe (up to a maximum of 3 h) in each province.

The outcomes of the analysis were categorized based on 1, 2, and 3-h intervals, as depicted in Fig. 2 and Fig. 3. A closer examination of the map reveals a gradation of colors from light to dark, corresponding to the districts that can be accessed from Çankaya district and its environs. Specifically, there are 224 tourism attractions within a 1-h or less travel time, followed by 170 attractions in the 1–2 h range, and a cumulative count of 841 attractions, of which 447 are situated within the 2–3 h timeframe (refer to Fig. 2 for visualization and Fig. 3).

Table 1 Tourism attractions used in the study

Tourism attractions		
1. National Park	8. Waterfall	15. Beach
2. Museum	9. Ancient Cities	16. Scenic Places
3. Martyrdom	10. Monument	17. Rafting
4. Cave	11. Castle	18. Ski Resort
5. Lake	12. Palace and Pavilions	19. Synagogue
6. Square	13. Cable car	20. Holiday Village
7. The Tomb	14. Site	21. Historical Artifact

Source The data concerning tourism attractions of Başarsoft Information Technology A.Ş

Table 2 Number of provinces and tourism attractions reachable in 3 h

Province name	Number of tourism attractions	Province name	Number of tourism attractions
Ankara	306	Corum	39
Eskisehir	57	Kirsehir	33
Aksaray	57	Konya	31
Bolu	56	Yozgat	20
Cankiri	55	Kirikkale	13
Afyonkarahisar	53	Kastamonu	11
Karabuk	50	Zonguldak	10
Duzce	41	Nevsehir	9

Source The data concerning tourism attractions of Başarsoft Information Technology A.Ş

The thematic representation of the analysis on the map unveils an interesting observation: some districts, despite being closer to Çankaya in terms of direct distance, are not attainable within a 3-h timeframe. Notably, this circumstance is particularly evident in districts like Eskişehir, Konya, Bolu, and Aksaray. The underlying reasons for this discrepancy can be attributed to the conditions of the roads that lead to these districts, including factors such as maximum speed limits and the presence of curved pathways (Fig. 3).

The statistical information of the tourism points shown on the map on the basis of districts is given in Table 4.

5 Discussions

In today's world, numerous factors, including the rise of urbanization, climate alterations, reduction in green spaces, and the proliferation of concrete structures, exert direct impacts on people's quality of life. Consequently, individuals are increasingly turning to tourism as a means to escape the negative consequences of these unfavorable environmental conditions and to rejuvenate their well-being. Consequently, the tourism sector has emerged as one of the most rapidly expanding industries worldwide, with tourism attractions assuming greater significance than ever before (Smith, 1993; De Freitas, 2003; Hamilton & Tol, 2004; Scott & Lemieux, 2010; Nagy & Piscoti, 2016; Hu et al., 2021; Gavilanes et al., 2021; Prameshwori et al., 2021). However, the constraints of tourists' limited time and heightened price sensitivity contribute to their increased selectiveness in choosing attractions (Buhalis & Law, 2008; Vansteenwegen et al., 2011). Consequently, the necessity arises to meticulously establish the most rational tourism routes that encompass the most captivating destinations well in advance of any travel arrangements.

The intricate relationship networks that have become increasingly complex across diverse spaces, driven by advancements in technology, transportation, and communication, can be effectively analyzed using Geographic Information Systems (GIS), a prominent spatial analysis software. Particularly through network analysis, GIS facilitates the identification of the shortest and optimal routes, resulting in savings in terms of both budget and time. This renders Geographic Information Systems highly

Table 3 Tourism attractions and numbers that can be reachable on a daily (maximum 3 h) based on province

Province name	Attractiveness	Total number	Province Name	Attractiveness	Total number	Province Name	Attractiveness	Total number
Afyonkarahisar	National Park	4	Çankırı	Martyrdom	4	Kastamonu	Tomb	6
	Lake	2		Lake	8		National Park	3
	Martyrdom	4		Square	5		Martyrdom	1
	Tomb	25		Tomb	18		Square	1
	Museum	5		Monument	5		Lake	2
	Square	3		Museum	3		Tomb	3
	Monument	2		Ski resort	1		National Park	1
	Ancient Cities	1		Cable car	1		Martyrdom	3
	Scenic Places	1		Scenic Places	1		Square	3
	Castle	1		Castle	2		Monument	1
	Historical artifacts	5		National Park	3		Square	3
	Square	7		Historical artifacts	4		Monument	7
Aksaray	Martyrdom	2	Çorum	Ancient Cities	2	Kırşehir	Tomb	9
	Lake	4		National Park	3		Museum	3
	Tomb	18		Monument	3		Martyrdom	3
	Palace and Pavilions	1		Tomb	14		National Park	2
	Museum	5		Museum	4		Beach	1
	Scenic Places	1		Scenic Places	1		Sit Alanı	1
	Monument	7		Martyrdom	3		Castle	1
	Sit Alanı	2		Sit Alanı	1		Ancient Cities	1
	Ancient Cities	1		Castle	1		Lake	1
	Historical artifacts	9		Square	2		Historical artifacts	1
	Museum	69		Lake	2		Cave	1
	Cave	2		Historical artifacts	3		Museum	4
Ankara	Tomb	52	Düzce	Lake	3		Tomb	6

Table 3 (continued)

Province name	Attractiveness	Total number	Province Name	Attractiveness	Total number	Province Name	Attractiveness	Total number
Bolu	Waterfall	9	Nevşehir	National Park	2	Nevşehir	Lake	6
	Lake	17		Martyrdom	3		Square	5
	Square	55		Tomb	8		Ancient Cities	2
	Monument	35		Museum	4		Resort	1
	National Park	14		Monument	6		Martyrdom	2
	Castle	4		Rafting	4		Palace and Pavilions	1
	Cable car	8		Square	3		Historical artifacts	3
	Martyrdom	9		Waterfall	5		Square	1
	Sit Alani	2		Historical artifacts	3		Tomb	4
	Ski resort	4		Lake	5		Ancient Cities	1
	Synagogue	1	Eskişehir	Museum	18		Museum	3
	Scenic Places	3		Tomb	9		Tomb	6
	Ancient Cities	3		Square	5	Yozgat	National Park	3
	Historical artifacts	19		Monument	7		Monument	3
	Museum	5		Martyrdom	3		Lake	1
	Martyrdom	2		Beach	1		Martyrdom	2
	Monument	4		Sit Alani	1		Museum	1
	Lake	21		Ancient Cities	1		Palace and Pavilions	1
	Tomb	7		National Park	2		Square	1
	National Park	9		Historical artifacts	5		Historical artifacts	2
	Scenic Places	2	Karabük	Tomb	8	Zonguldak	Museum	1
	Ski resort	3		Lake	1		Square	1
	Square	1		Monument	5		Monument	4
	Cable car	1		Square	9		Tomb	2
	Historical artifacts	1		Ancient Cities	1		Waterfall	2

Table 3 (continued)

Province name	Attractiveness	Total number	Province Name	Attractiveness	Total number	Province Name	Attractiveness	Total number
				Museum	2			
				National Park	3			
				Scenic Places	3			
				Martyrdom	1			
				Historical artifacts	17			

Source The data concerning tourism attractions of Başarsoft Information Technology A.Ş

Fig. 2 Total number of tourism attractions by arrival time.

Source This graphic was produced by the data concerning tourism attractions of Başarsoft Information Technology A.Ş

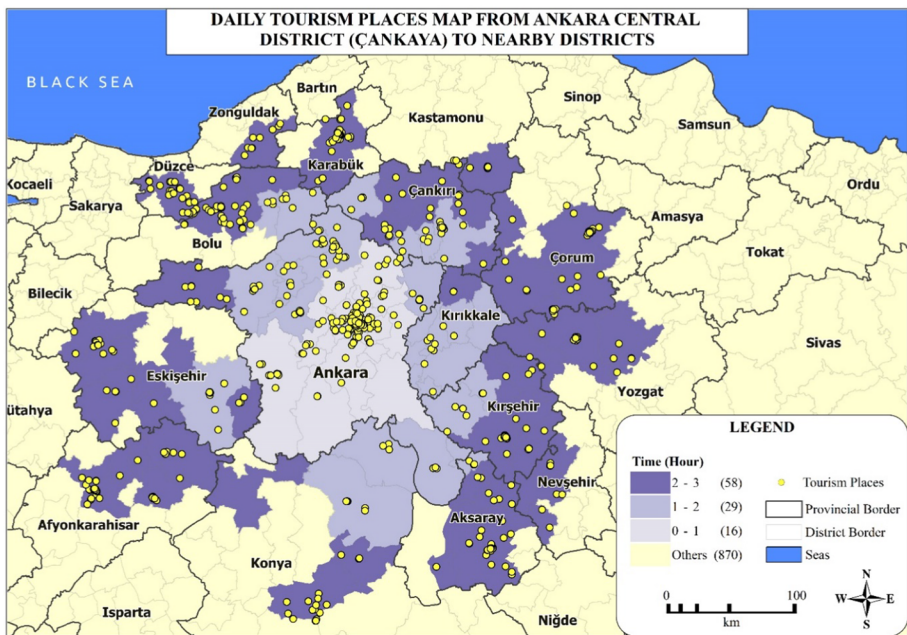
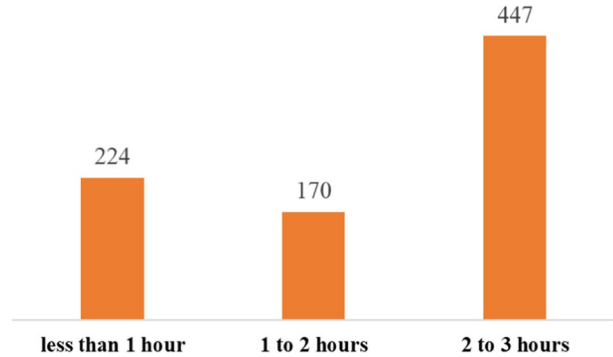


Fig. 3 Daily tourism attractions map from Ankara Çankaya district to surrounding districts. *Source* This map was produced by the data of Başarsoft Information Technology A.Ş

valuable not only in determining tourism attraction routes but also in various other domains of life (Barringer et al., 2002; Connell & Page, 2008; Prameshwori et al., 2021; Scott et al., 2008). The escalating number of studies focusing on GIS-based tourism routes underscores its growing significance (Abubakar et al., 2017; Astor et al., 2020; Benckendorff & Zehrer, 2013; Calderón Puerta & Arcila Garrido, 2020; Gill & Bharath, 2013; Hu et al., 2021; Liu et al., 2017; Nicolosi et al., 2018; Peng et al., 2016; Prameshwori et al., 2021). Yet, it is worth noting that the pool of studies crafting route suggestions for single-day excursions, while considering variables of time and distance from a central point to attractions in neighboring provinces and districts, remains relatively scarce (Gill & Bharath, 2013; Hooper, 2014; Kang et al., 2018; Wang

Table 4 Number of districts and tourism attractions reachable in 1, 2 and 3 h

Tourism attractions that can be reached in less than 1 h			Tourism attractions that can be reached in 1–2 h			Tourism attractions that can be reached in 2–3 h		
Province name	District name	Number of tourism attractions	Province name	District name	Number of tourism attractions	Province name	District name	Number of tourism attractions
Ankara	Altındağ	60	Aksaray	Sarıyahşi	4	Afyonkarahisar	Merkez	35
	Çankaya	45	Ankara	Kızılcahamam	20		Bolvadin	10
	Yenimahalle	23		Beypazarı	16		Emirdağ	6
	Keçiören	20		Kalecik	11		Bayat	1
	Mamak	16		Ayaş	9		İncehisar	1
	Polatlı	14		Gütütlü	8	Aksaray	Merkez	44
	Sincan	10		Çamlidere	7		Ortaköy	6
	Çubuk	8		Şerefikoğuşisar	3		Ağaçören	2
	Etimesgut	8	Bolu	Gerede	7		Sultanhanı	1
	Kahramankazan	5		Yeniçağa	3	Ankara	Nallıhan	8
	Gölbaşı	4		Dörtdivan	2	Bolu	Merkez	43
	Pursaklar	3	Çankırı	Merkez	20		Mengen	1
	Haymana	3		Orta	6		İlgaz	5
	Akyurt	3		Eldivan	4		Yapraklı	4
	Elmadag	2		Çerkeş	4		Atkaracalar	2
				Şabanözü	3		Kızılırmak	1
				Korgun	2		Kurşunlu	1
				Merkez	2		Bayramören	1
			Eskişehir	Sivrihisar	13	Çorum	Merkez	19
			Kırıkkale	Merkez	8		Boğazkale	7
				Bahşili	1		Alaca	6
				Balıeseyh	1		Sungurlu	5

Table 4 (continued)

Tourism attractions that can be reached in less than 1 h			Tourism attractions that can be reached in 1–2 h		Tourism attractions that can be reached in 2–3 h	
Province name	District name	Number of tourism attractions	Province name	District name	Province name	District name
Kırşehir	Çelebi	1	Kırşehir	Kaman	Düzce	Bayat
	Akpınar	2		Kulu		Dodurga
	Cihanbeyli	5				Merkez
		3	Konya			Kaynaşlı
						Cumayeri
Eskişehir			Eskişehir		Eskişehir	Gümüşova
						Çilimli
						Odunpazarı
						Tepebaşı
						Seyitgazi
						Günyüzü
						Çifteler
						Safranbolu
						Merkez
						Eskipazar
						Tosya
Kastamonu			Kastamonu		Kastamonu	Merkez
						Sulakyurt
						Merkez
						Mucur
						Çiçekdağı
Kırkkale			Kırkkale		Kırkkale	Boztepe
Kırşehir			Kırşehir		Kırşehir	

Table 4 (continued)

Tourism attractions that can be reached in less than 1 h			Tourism attractions that can be reached in 1–2 h			Tourism attractions that can be reached in 2–3 h		
Province name	District name	Number of tourism attractions	Province name	District name	Number of tourism attractions	Province name	District name	Number of tourism attractions
						Konya	Akçakent	1
							Selçuklu	19
							Altınekin	4
						Nevşehir	Hacıbektaş	5
							Acıgöl	2
							Gülşehir	2
						Yozgat	Merkez	12
							Sorgun	6
							Yerköy	2
						Zonguldak	Devrek	8
							Gökçebey	2

Source The data concerning tourism attractions of Başarsoft Information Technology A.Ş

et al., 2019; Wu & Chen, 2022; Kranioti et al., 2022; Li et al., 2021; Li et al., 2022; Pei et al., 2022). In spite of this constraint, these existing studies have yielded significant findings on the subject. Shih (2006) demonstrated the utility of network analysis in tourism by successfully applying methodologies that assessed destination development from a multi-destination network perspective. Shih's study has demonstrated that the opportunities or deficiencies of destinations in the research area can be better understood through the complementary features of destinations.

Jin et al. (2009) revealed that over 80% of the study area exhibited access to Nanjing's scenic spots within 40 min, with downtown attractions being notably more accessible than those on the city's periphery. Gill and Bharath (2013) emphasized that network analysis not only amplifies the potential of tourism but also enhances tourist satisfaction. Internet GIS and its applications in tourism network analysis facilitate optimal tourism planning. The scientific contributions they expect from their studies, above all, involve achieving certain savings that will increase tourist satisfaction. Among these, time and distance savings are paramount.

Pan and Li (2014) established that human-centric scenic spots tend to be more concentrated. The average accessibility stands at approximately 125.88 min, with 60% of the area having scenic spot accessibility within 90 min, while 26.65% of the area boasts accessibility within 30 min; the longest time requirement, 1260 min, is observed at the central Tibetan Plateau. The study emphasizes that the route created through tourism attractions will play an active role in regional development.

Hooper (2014) endorsed the validity of the tourism attraction accessibility model as a framework for gauging an attraction's accessibility. In Hooper's study, it is indicated that the proposed model will assist in developing important strategies in the planning and implementation stages. Kang et al. (2018) underscored the relevance of centrality measures as a data analysis technique for identifying key attractions situated within an attraction, surpassing mere frequency counts. According to these authors, although not all tourists might visit a single attraction during their trip, certain tourists tend to explore multiple attractions within a single journey. Kang et al (2018), They stated that their studies would contribute to the development of planning and management strategies for competitive tourism destinations.

Wang et al. (2019) indicated that the accessibility of scenic spots, whether by cars or public transport, exhibited a spatial trend of increasing travel time from the center to the periphery. Within the study area, approximately 85.78% was reachable by car within an 80-min timeframe, whereas a mere 1.64% of the total area could be accessed by public transport within the same duration. Accessibility via public transport extended to cover around 90.52% of the entire area within a 300-min window. In their studies, it is thought to enhance travel efficiency in the researched region and improve regional tourism through transportation optimization. Li et al. (2021) discovered that the distribution of suburban tourist attractions in Beijing displayed a fan-shaped pattern, with tourism resources predominantly clustering to the north, west, and south of the city. In the study, recommendations were put forward for the destinations under research to be functional and sustainable. Pei et al. (2022) unveiled the potential of the ArcGIS accessibility evaluation model for resource integration in tourism areas, coupled with the utilization of the Vehicle Routing Problem for route optimization, allowing for the distinction of various tourism types. The main contribution they expect from their studies is to enable travel agencies and tourists to design optimal tourism routes.

Li et al. (2022) observed distinct spatial disparities in the landscape of tourism accessibility in Nanjing. Notably, attractions with relatively high accessibility were concentrated in the southern regions of the city, while those in the urban area exhibited lower accessibility, particularly historical tourist attractions in the urban core. The outcome of spatial hotspot

analysis, factoring in estimated tourist demands, underscored better tourism resource availability in the central urban areas of Nanjing. Wu and Chen (2022) unveiled the generally low spatial accessibility of various types of tourist attractions in Inner Mongolia, with temporal accessibility displaying an inverted U-shaped distribution over time. The county-level accessibility of distinct scenic spots in Inner Mongolia demonstrated a relatively poor pattern, exhibiting an oblique distribution with lower accessibility in the western regions and higher accessibility in the eastern areas. This study has provided noteworthy suggestions for finding the most suitable way for accessibility based on the design of tourist landscape areas within a circle, tourist traffic, facility construction, and the connection design of tourist routes.

In a study focused on Nevşehir, Sucu (2022) ascertained a total of 745 tourism attractions that can be accessed within 1, 2, and 3 h, spanning 20 different categories of tourism attractiveness. This timeframe allowed for travel across a total of 15 provinces and 102 districts. Notably, the study revealed that among the districts with the highest levels of attractiveness, Nevşehir Central District hosted 46 tourism venues, Aksaray Central District featured 44 tourism sites, and Adana Seyhan District contained 42 tourism destinations. In Sucu's study (2022), it is expected that the better promotion of overlooked or endangered destinations in the tourism destinations of the neighboring provinces and districts of Nevşehir, the recognition of tourism attractions in the region, and most importantly, the contribution to tourism-oriented sustainable regional development will be achieved.

Prior research has unequivocally demonstrated that the duration of a tourist's stay or journey significantly influences their propensity to visit renowned attractions. Essentially, a correlation between the number of tourist destinations visited during a travel venture and the corresponding travel duration has been firmly established. This pattern holds true for Ankara as well. Furthermore, akin to findings from previous studies, the tourism accessibility landscape in Ankara also exhibits distinct spatial disparities. Specifically, concerning tourism attractions, those easily accessible are predominantly concentrated in the northern sectors of Ankara. Delving into the realm of academic investigations employing network analyses via Geographic Information Systems (GIS), it's evident that these spatial assessments play a pivotal role in devising optimal routes for tourism attractions. Remarkably, the network analyses conducted in this article have yielded results that align significantly with existing literature.

In this study, the main scientific contributions consist of developing an efficient day-trip route from Çankaya (Ankara) to neighboring districts and provinces, providing time and distance savings, and visualizing this route with a quantitative methodology. What practical benefits will these scientific contributions provide in the future? Undoubtedly, similar to the expected contributions from studies on accessibility to tourism destinations, this study is also expected to provide some noteworthy contributions. These contributions can be summarized as follows: raising awareness of lesser-known destinations along the route that need to be introduced, activating opportunities for tourism-focused regional development, contributing to the region's economy, providing useful information to local and regional decision-makers and travel agencies organizing tourist trips, developing marketing strategies, and, most importantly, ensuring the sustainability of these practices.

6 Conclusions

In the context of the time-based road matrix analysis from Çankaya district to all other districts, priority was given to less curved roads rather than curved roads that could adversely impact vehicle speed and alternative routes. The outcome of this analysis revealed a total of 841 tourism attractions that can be explored within 1, 2, and 3 h,

encompassing 21 diverse categories of tourism attractions. Another important result was that tourist attractions showed a rather uneven spatial distribution. Easily accessible places are concentrated in the north of Ankara. It has been observed that some of the districts and tourist attractions that are close to Çankaya in terms of absolute distance are not the same in terms of time distance. Çankaya, being a vital administrative hub of Turkey, boasts a substantial presence of consulates, various public institutions, and educational establishments. This unique attribute positions Çankaya as a potential hub for tourists, enabling them to journey to nearby provinces and districts. Thus, this study is anticipated to offer practical benefits to tourists in planning expeditions from Çankaya to adjacent regions. The abundance of diverse tourism destinations both within and around Ankara presents a significant potential for revitalizing tourism in this particular area.

6.1 Suggestions

The escalating pressures on urban areas due to rapid population growth have sparked increased interest in tourist attractions located in the vicinity of these cities. Consequently, comprehending the accessibility of attractions comprising natural and/or man-made elements within the local environment or region can furnish valuable insights for stakeholders, particularly municipal authorities. This aspect holds pivotal significance in terms of raising awareness about tourism attractions, optimizing time and budget, and devising robust plans and strategies. As such, tourism accessibility serves as a pivotal tool for grasping the interplay between tourism elements and tourists, thereby fostering the advancement of tourism attractions and augmenting tourist contentment. Network analyses facilitated by Geographic Information Systems (GIS) emerge as indispensable in designing the most efficient and suitable routes to access these tourism attractions. With the expanding adoption of such software, tourism planners and decision-makers are poised to formulate tailored programs for tour routes, whether in close proximity or at distant points within a specific geographical region.

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Declarations

Conflict of interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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