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## GIS-Based Multi-Criteria Walkability Analysis in the City Centre of Çanakkale

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### Abstract

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Walkability has attracted growing attention in recent years, particularly since the pandemic. In Turkey, this shift has mainly been visible in metropolitan cities through SUMP-related policies. In this context, this study focuses on the city centre of Çanakkale, and it proposes an approach that can both support the development of rapid walkability assessment tools for SUMP-related planning and help analyse walking potential in mid-sized settlements. The study examines seven neighbourhoods in the city centre. Using the AHP technique, four experts working on urban design defined a parameter hierarchy based on land use, accessibility, street network, pedestrian comfort, safety, aesthetics, and environmental quality. These dimensions were then integrated with GIS, space syntax, and field-based observation to generate street-level walkability scores. For each street, land-use diversity, accessibility, connectivity, local integration, slope, night-light conditions, derelict buildings, blue views, historic streetscape elements, landmarks, green density, and noise level were quantitatively calculated. The findings reveal clear spatial disparities between neighbourhoods and identify four hierarchical categories ranging from low to moderately high walkability.

**Keywords:** walkability, GIS; space syntax; walk score; accessibility.

### 1. Introduction

Since the 1960s, urban planning literature has increasingly taken a critical position against automobile-oriented urbanization (Jacobs, 1961). With the growing body of public space studies in the 1980s (Gehl, 2010, 2011; PPS, 1975; Whyte, 1980), European charter on pedestrian rights and pedestrian level of service concepts (Fruijn, 1971; The European Parliament, 1988), the rise of the New Urbanism movement in the 1990s, and the adoption of sustainable urbanization principles by many countries in the 2000s, walkability has become a prominent concept in urban planning and design debates. Particularly since 2009, Sustainable Urban Mobility Plans (SUMP), which have gained ground in Europe (Karaçor et al., 2024), have become an important tool supporting the policy dimension of active mobility. Following the pandemic, interest in proximity-based planning has also increased considerably, with attention on X-minute city models (Allam et al., 2022; Moreno, 2021). These trends reflect themselves on the local agenda with a certain delay in Turkey.

In post-pandemic conditions, interest in walkability and micro-mobility has increased, while X-minute city approaches have come to the fore in local governments (Bodrum Municipality, n.d.; Istanbul Metropolitan Municipality, n.d.). In this process, several fragmented interventions and analyses focusing on pedestrian, open spaces and green areas have also been proposed or implemented. However, in terms of developing a more comprehensive approach within the policy context, studies related to SUMP have only gained momentum, particularly after 2022 (SKUP Türkiye, 2023b). The SUMP Turkey Network was established by the Union of Municipalities of Türkiye (TBB) to support cities in Turkey in developing Sustainable Urban Mobility Plans. However, the majority of the cities included in this network are metropolitan municipalities (SKUP Türkiye, 2023a), while many medium- and small-sized cities have not yet widely initiated such studies. In this context, the resources of these municipalities are also limited, considering the number of qualified staff, financial constraints, and other bureaucratic obstacles (Karaçor et al., 2024).

Considering these problems, this research proposes an objective analytical framework that can support the assessment of walkability in medium- and small-sized cities and thereby help identify intervention areas for pedestrian-oriented projects. The proposed analysis also has the potential to support the selection of pilot project areas within the scope of active mobility actions included in SUMP.

The parameters and datasets used in the study were developed based on basic spatial data available in local governments and open-source data. Therefore, the study can be considered as a quick urban walkability analysis kit. Within the scope of the research, Çanakkale city centre was selected as the case study area. The selection of Çanakkale is based on the

absence of a published SUMP for the city and on the spatial diversity it offers for different walkability typologies due to its landscape, topography, and urban form. Accordingly, the research aims to:

- establish a multi-criteria, evidence-based tool for assessing walkability at the neighbourhood;
- reveal spatial disparities in walkability scores in order to inform equitable urban design decisions;
- support urban planners and policymakers in integrating walkability into local planning and mobility policies.

In this context, the study is guided by three main research questions. It first asks which physical and environmental parameters most strongly influence walkability in medium-scale Turkish cities such as Çanakkale. It then examines how objective and quantifiable indicators can be used to assess and compare walkability conditions across different neighbourhoods. Finally, it explores what typologies of walkability issues can be identified based on land use, accessibility, safety, and urban design characteristics.

## 2. Materials and Methods

Objective walkability assessment analyses the extent to which the urban environment supports and encourages walking through concrete and measurable physical characteristics and geographical data. In this assessment approach, parameters related to the physical environment, such as land use, connectivity, and accessibility, are frequently taken as a basis. The development of geographic information systems (GIS) has supported walkability measurement strategies in which the spatial equivalents of multiple parameters are evaluated (Wang & Yang, 2019; Amen et al., 2023; Aziz Amen & Ali, 2025), and space syntax is another tool of interest with the spatial dimension of walkability (Yildirim et al., 2024). Indexes such as Walk Score and the Walkability Index can also be used for different purposes, such as measuring proximity to amenities, transit, and cycling friendliness, and are widely used for real-estate and city benchmarking; also, they may be supported by web-based interfaces. Huang et al. (2024) define such tools as “evaluation results-oriented.” In general, objective measurements are considered strong indicators for predicting individuals’ walking behaviours and physical activity levels.

Based on this foundation, this research constitutes a pilot study conducted within the scope of a doctoral dissertation. In the later stages of the research, the findings will be supported by perceptual attitude data, while the objective analyses will be further optimized through different measurements, and statistical approaches. Within the scope of this paper, seven neighbourhoods located in Çanakkale City Centre were examined (Esenler, Cevatpaşa, Kemalpaşa, Fevzipaşa, İsmetpaşa, Namık Kemal, Barbaros). In these neighbourhoods, an objective walk score determination was developed based on seven main parameters and fourteen sub-parameters, namely land use, accessibility, street network, pedestrian comfort, safety, aesthetics, and environmental quality (Table 1).

**Table 1:** Main parameters used for analysis.

Main Parameter	Sub-parameter	Detail of measurement	Data Source
Land-use	Land Use Diversity	Number of different land use types along each street	Municipal Data
Accessibility	Public Transport	Number of bus stops within 400 m buffer of each street	Public transport stops: Çanakkale Open Data Portal,
	Schools (Primary schools)	Number of schools within 400 m buffer of each street	Schools (Primary) & Health Facilities: Municipal Data
	Health Facilities	Number of health facilities within 400 m buffer of each street	
Street Network	Connectivity	Connectivity value of each street segment derived from DepthmapX analysis	DepthmapX process through 2015 municipal data
	Integration [Local Integration r3]	Spatial integration value of each street segment derived from DepthmapX analysis	
Pedestrian Comfort	Slope	Average slope (%) of each street and classifications (inverse normalization)	Copernicus DEM
Safety	Night Lighting	VIIRS Nighttime Lights	VIIRS- Nighttime light data (EOG, n.d.)
	Ruined areas/ abandoned buildings	Number of derelict or ruined buildings, under-construction areas within 25 m buffer of each street (inverse normalization)	Municipal Data
Aesthetics	Sea View / streets leading to the sea	Presence of blue-view	
	Historic Streetscape	Number of historical buildings and monuments along or adjacent to the street	Municipal Data
	Landmarks/Monuments	Presence of distinctive urban landmarks (e.g., statues, monuments, memorials)	
Environmental Quality	Green Density	Normalized Difference Vegetation Index (NDVI)	Sentinel-2, 2026
	Noise Level	Average noise level intersecting each street segment (inverse normalization)	Scientific Report-5218902, 2021 (TÜBİTAK, 2021)

Although the parameter set was developed with reference to the advanced walkability literature, it was ultimately reduced and finalized due to limitations related to local government data and open-source data availability. Similar data-related problems are widely observed in medium- and small-sized cities in Turkey, creating additional research limitations in terms of data collection, recording, continuity, and inter-institutional sharing. Therefore, instead of micro-scale data such as lighting conditions and the number of trees, which could not be accessed citywide from the local government, broader-scale datasets such as VIIRS and NDVI were used, alternatively.

Street network analyses were conducted through axial approach using the DepthmapX software, while the remaining spatial analyses were processed in QGIS. Within the scope of the pilot study, the main parameter weightings were determined using the AHP technique with four urban design experts, and the Super Decisions software was used in this process (Super Decisions, 1996). However, since the AHP application was carried out with a pilot expert group (n=4), the number of experts needs to be increased in the subsequent stages of the research. All sub-parameters were normalised based on whether their effects on walkability were positive or negative, while some indicators (slope, noise, NDVI, etc.) were first classified into meaningful value ranges before scoring. The weights obtained from the AHP results were assigned as coefficients to the main parameters, while the sub-parameters were assumed to have equal weights. In this way, an overall walk score was obtained.

### 3. Results

The overall walkability score across the study area was classified into four main levels based on natural breaks, ranging from low to high, indicating a moderate level of spatial variation in walkability (Figure 1). This variation reflects differences in land-use diversity, accessibility, and environmental quality among neighbourhoods. Considering the AHP results, safety, accessibility, and land use were identified as the most prominent main parameters.

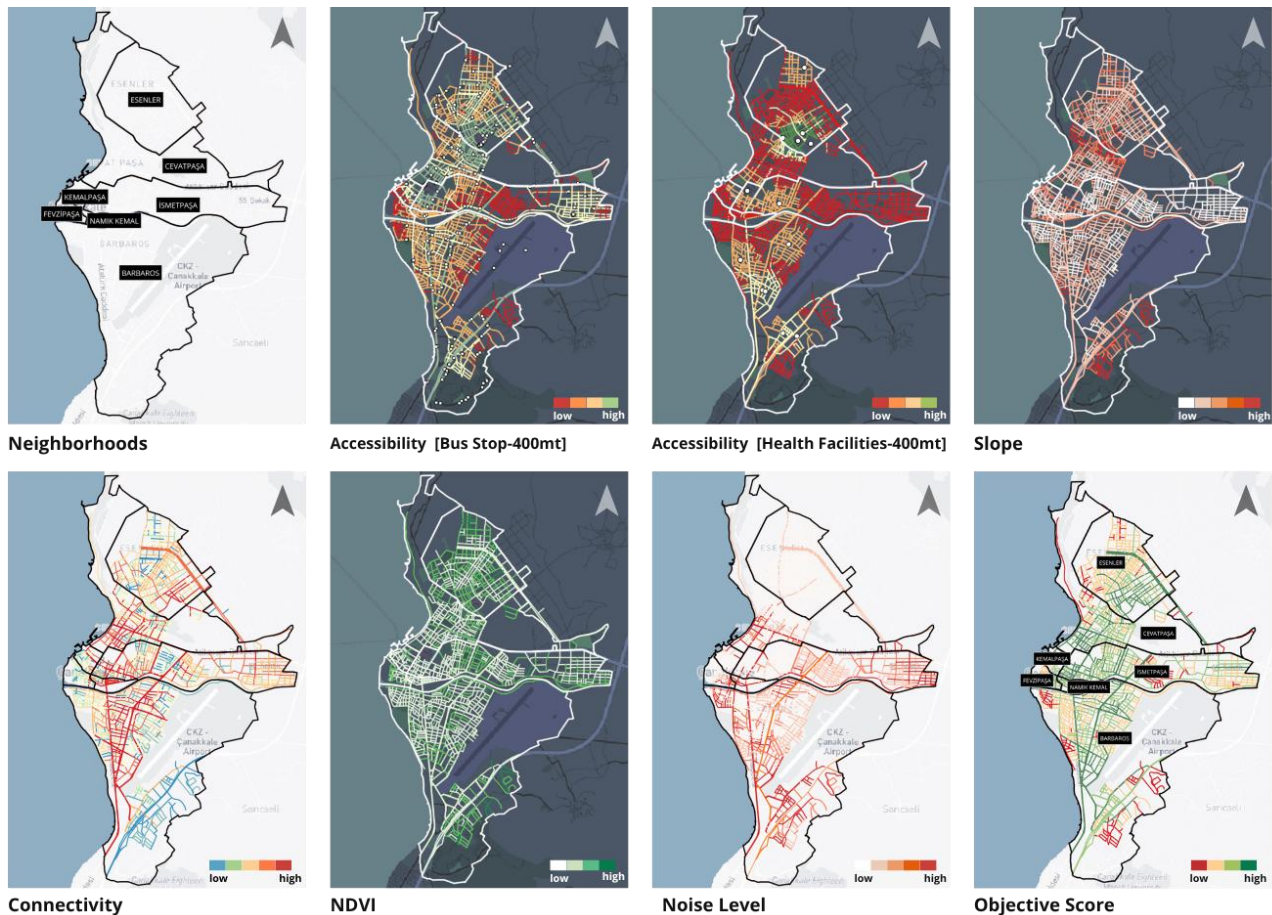


Figure 1. Parameter-based distributions in neighbourhoods.

Overall, the streets in Kemalpaşa, as well as the western part of Cevatpaşa, and the northern section of Barbaros, show higher levels of walkability, continuing the pattern of the central area. In contrast, a part of the residential areas in Esenler neighbourhood and some zones in İsmetpaşa show low walkability levels, largely due to dispersed land-use patterns. This finding also overlaps with the transportation parameter identified as a priority need for Barbaros and Esenler neighbourhoods in the 2024 report published by the Urban Life Improvement Working Group (Çanakkale Kent Konseyi, 2024).

Considering parameter-based dynamics, although the Fevzipaşa neighbourhood benefits from strong spatial connections to the waterfront, its walkability score remains relatively moderate in some parts of the neighbourhood. The eastern sections of İsmetpaşa neighbourhoods also present relatively low walkability scores; however, this condition can be considered acceptable given their predominantly low-activity, low-density land-use patterns and small-scale industrial uses.

In addition to them, the main corridors with diverse land uses spatially overlap with higher network connectivity and integration, in most sense. Public transport accessibility is more limited in the southern neighbourhoods compared to other parts of the study area. In terms of slope and pedestrian comfort, high slopes in newly developed northern areas reduce walking comfort. Safety, identified by experts as the most influential parameter, shows weaker conditions in eastern zones where lower lighting levels are linked to land-use. Aesthetic quality is concentrated in coastal and historic central areas, although further perceptual street scoring is needed. Finally, green density increases toward the residential zones on the northern side of the city.

#### 4. Discussion

The findings show that walkability in Çanakkale's city centre varies considerably across neighbourhoods. Higher scores are concentrated in the city centre and in areas where land use is more diverse, accessibility is better, and the street network is more connected. In contrast, lower scores are observed in some peripheral areas, where dispersed land use, weaker accessibility and, particularly in the north, additional limitations regarding slope and comfort reduce walking potential. The AHP results indicate that safety, accessibility and land use are the most influential parameters in the overall walkability score. This suggests that walkability should be evaluated as a multi-dimensional urban quality shaped by safety, functional diversity, spatial accessibility, environmental comfort, and, rather than solely based on physical conditions. Indices are commonly critiqued for being black box. Relatedly, this study also has several limitations, as with many walkability-index models, the selection, normalisation, and weighting of variables may influence the final scores. Also, some assumptions remain embedded in the model, particularly due to data availability and interoperability problems. Therefore, the results should be interpreted as a rapid diagnostic assessment rather than a definitive measurement of walkability. Future studies should further improve the model with more detailed micro-scale data, larger expert groups, and perceptual or behavioural walking data.

#### 5. Conclusions

This study developed a rapid walkability assessment framework for Çanakkale city centre by combining GIS-based spatial analysis, space syntax, field observation, and expert-based AHP weighting. The results show that safety, accessibility, and land use have a stronger influence on the overall walkability score. By using local government and open-source data, the framework provides a quickly producible diagnostic score that can support SUMP-related planning. It also helps approximate and identify neighbourhood-specific spatial problems. When combined with perceptual scoring in later stages, it can offer a stronger basis for problem detection, monitoring, and tactical solutions related to active mobility. At the same time, the study should be read as a pilot assessment. Data gaps, mismatches between different datasets, equal weighting of sub-parameters, and the exclusion of perceptual variables limit the precision of the results. Despite these limitations, the proposed framework provides a practical starting point for medium-sized cities where detailed walkability data and comprehensive mobility planning processes are still developing.

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#### Conflicts of Interest

The authors report no conflicts of interest.

#### CRedit Author Statement

Conceptualisation: AOT, CH; Methodology: AOT; Writing – original draft: AOT; Writing – review & editing: AOT, CH. All authors have read and approved the final manuscript.

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