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바쿠 소구역의 보행 가능성 형성에 대한 도시 형태의 영향

Influence of Urban Form on Shaping Walkability in Microdsitricts of Baku

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Abstract

Modern cities are being dominated by car-centric designs, leading to environmental and social issues. Walkable neighborhoods, conversely, promote public health, social cohesion, and sustainable development. This study explores the relationship between urban form and walkability in Baku, Azerbaijan's microdistricts, a common post-socialist residential typology. Using the Walkability Index framework, we analyze 3 Baku microdistricts. GIS-based analysis and urban block typology are used to understand how street networks, land use mix, and residential density impact walkability. Microdistricts with a more regular grid pattern exhibited higher walkability scores compared to those with organic layouts. This study offers valuable insights into walkability in post-socialist cities, offering a case study for future research and practical applications.

Keywords : Walkability, Urban Form, Walkability Index, Microdistricts, Post-Socialist Cities, Baku, Azerbaijan

1. Introduction

Modern cities are often designed to prioritize cars, which leads to several environmental issues. These include increased traffic congestion, air pollution, and loss of public space which negatively influences citizens' quality of life. Cities planned around the automobile, are no longer considered sustainable and are not considered good cities (Montgomery, 1998). However, recent studies showed that cities prioritizing pedestrians have several benefits. Walkable neighborhoods can improve public health by encouraging physical activity and social cohesion, leading to more sustainable urban development (Tran, 2016).

This research aims to understand the relationship between urban form and walkability in microdistricts of Baku, Azerbaijan. Microdistricts are a common type of residential area in post-socialist cities. Originally designed to offer efficient and affordable housing for residents, while providing essential amenities within proximity, these neighborhoods often lack the people-centric infrastructure that is essential for walkability.

While there is a growing interest and extensive research on walkability, it is mainly focused on western cities in Europe and the USA. However former soviet countries in Eastern Europe and Western Asia, like Azerbaijan are often overlooked.

Moreover, the topic of walkability in Azerbaijan, particularly in Baku city microdistricts, hasn't received significant recognition. Therefore, this study aims to fill this research gap and contribute to walkability research in the specific context of microdistricts in Baku, Azerbaijan.

The main research objective is to analyze the relationship between urban form and walkability in Baku's microdistricts. This will be done by identifying key characteristics of walkable neighborhoods. The study results are expected to contribute to the existing literature on walkability by providing insights from a post-socialist, developing country context.

Furthermore, this research will provide recommendations for decision-makers and stakeholders in Baku on creating more walkable and sustainable urban neighborhoods. By analyzing walkability through the Walkability Index framework developed by (Frank et al., 2010) and GIS-based analysis, results will contribute to a better understanding of how urban blocks can impact walkability and promote pedestrian-friendly environments in cities like Baku.

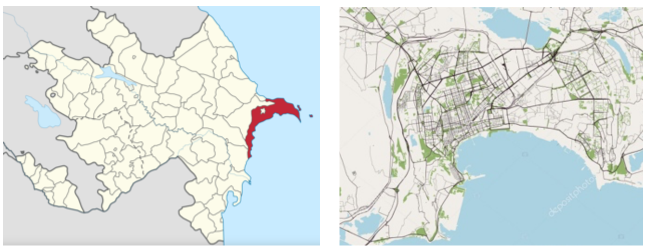

Figure 1. Baku, Azerbaijan map

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2. Literature Review

2.1 Urban form and walkability

Several studies have established a strong correlation between urban form and walking behavior. Ewing & Cervero (2010) found that residents of neighborhoods with higher residential density, intersection density, and land use mix were more likely to walk for both utilitarian and recreational purposes. Similarly, Saelens et al. (2003) demonstrated that proximity to destinations and access to attractive pedestrian infrastructure significantly influenced walking frequency.

It has been found that the built environment, particularly the urban form, has a great impact on walking and its many benefits. Research demonstrates that aspects such as the ease of getting to locations and being close to attractive open areas can have an impact on the levels of physical activities, e.g., walking. The urban form is acknowledged as one of the important elements that can support and accelerate active modes of transport, thus underlining its significance in the process of building walkable environments (Frumkin, 2002).

The built environment plays a crucial role in shaping walking behavior. A connected layout with different block sizes and intersections encourages walking by offering direct paths for pedestrians. But sprawling areas without enough sidewalks discourage walking. Land use mix, such as a variety of residential, commercial, and recreation areas nearby promotes walking, while separating those apart requires more driving (Ewing & Cervero, 2010). Moderate to high housing density also helps walkability by clustering destinations close together. Very low density or lack of pedestrian features can make walking difficult.

Walkability is now a major focus for urban planners and serves as the foundation for creating sustainable cities (Ariffin & Zahari, 2013). Walkability can make places lively, enhance sustainable transportation options, and induce exercise, contributing to better urban design (Forsyth, 2015). Walking is also associated with a very large number of benefits not only to the active person but also to the community: it reduces pollution emissions, reduces obesity-related health problems, and creates more “livable communities” (Cambra, 2012). A 5% increase in walkability is associated with increased physical activity, reduced obesity, fewer vehicle miles, and better air quality, impacting several chronic diseases. Community design, including land-use mix, residential density, and street connectivity, is significantly associated with moderate levels of physical activity (Frank et al., 2010).

Different tools and measures can be applied to measure walkability. The Walkability Index, proposed by Frank et al. (2010), incorporates essential urban form characteristics (land use mix, net residential density, and intersection density) into a single score. Spatial analysis using GIS enables the analysis of spatial data on urban form traits and their impact on walkability (Giles-Corti & Donovan, 2002).

2.2 Baku and Microdistricts

Baku, the capital of Azerbaijan, is situated on the Caspian Sea coast. Its urban landscape is heterogeneous; it has been influenced by factors that include its position as a trade center along the Silk Road, Soviet-era planning principles, and more recent developments. During the Soviet period, the city of Baku experienced a significant expansion of the urban territory with the construction of microdistricts. The concept of microdistrict, or microregion, emerged as a result of rapid urbanization in the Soviet time. These microdistricts were self-sufficient neighborhoods, which were designed to provide necessary services and amenities like housing, schools, and shops within walking distance for the residents (Alexander, 2007). And others say that these microdistricts are more functionally oriented and car-centric rather than pedestrian-friendly due to the lack of walkability. Microdistricts are one of the key elements of Baku's urban fabric. Understanding their design features, strengths, and weaknesses in promoting walkability is important for this research. There is a lack of research conducted especially dedicated to the walkability in Baku's microdistricts. Nevertheless, the studies carried out in post-Soviet cities or in developing countries keeping the same context can be useful. Many post-Soviet cities, including Baku, have faced challenges in promoting walkability due to their legacy of soviet era urban planning principles. Research on this topic in other post-socialist cities can help us understand the common challenges and chances of walkability in these contexts.

3. Methodology

3.1 Study area and data source

The study area for this research is Baku, Azerbaijan. The focus will be on 3 specific microdistricts within Baku: 1st, 3rd and 5th microdistricts. The selection of microdistricts was based on the intention to find common features present in all post-socialist cities, which enables broader insights applicable in similar urban contexts. Also, the microdistricts were chosen according to data availability. The preference in selection was given to existing infrastructure over new developments, in order to facilitate future adaptation towards a walkable or 5-minute city concept.

Most of the data used in the research was obtained from the geo-crowdsourcing database of Open Street Map (OSM), as it is a source of detailed and accurate data that is freely accessible. In addition to the OSM data, supplementary data was collected through site observations and masterplans.

3.2 Walkability Index (WI)

The analysis of walkability in this study was based on the Walkability Index developed by Frank et al. (2010) This index uses 3 main components:

- Residential Density
- Street Connectivity
- Land Use Mix

Walkability Index (WI) = (6 x z-score of Land Use Mix) + (z-score of Residential Density) + (z-score of Street Connectivity)

Each factor is standardized using a z-score formula:

$$z = (x-\mu)/\sigma$$

Where x is the raw score for the factor, μ mean of the sample data for that factor, σ standard deviation of the sample data for that factor.

Residential density was measured as the number of residential units per unit area. Street connectivity was measured as the number of intersections per unit area. The land use mix was measured using Entropy derived from the Shannon index:

$$LUM = -1\left(\sum_{i=1}^{n} pi \times \ln(pi)\right) \Big/ \ln(n)$$

Where pi is the proportion between the floor area covered by single land use (i) and the summed area for land use, n is the number of land use functions (n = 4).

3.3 GIS-based analysis and urban blocks

The data collected for this research was analyzed using Geographic Information Systems. Particularly QGIS was used to gather spatial data on street networks, sidewalks, buildings, land use, and other relevant data for this study. GIS tools were used to analyze and visualize data, such as the acquisition of street network data, calculation of street connectivity nodes, and mapping it out.

To find out the type of urban block patterns present in the microdistricts of Baku, the study employed a method called urban block typology analysis. This involved categorizing the urban blocks based on their size, shape, and internal layout.

4. Results

4.1 Components - RD, SC, LUM

Residential Density (RD) was calculated by taking the total area of each microdistrict and the number of residential units per hectare (units/ha). The results for each microdistrict are given in Table 2. In the microdistricts with the higher residential densities, such as the 1st one with 1.97 units/ha, walkability was shown to be possible because of the shorter distances to amenities.

Street Connectivity (SC) was assessed by the number of nodal points in the street network. The results for Street Connectivity are shown in Table 1. The 3rd microdistrict has the highest score of 2.42, which positively influenced to its overall Walkability Index.

Land Use Mix (LUM) was determined utilizing GIS to analyze the distribution of different land uses around each microdistrict. The 4 components of the land use mix are residential, public, commercial, and green spaces. The 1st microdistrict has the most balanced land use mix, potentially reducing reliance on cars.

Figure 2. Street network nodal points

Table 1. Values of Street Connectivity (SC)

	Microdistrict	Number of nodal poits	SC Index (number of intersections /ha)
1	1st Microdistrict	39	2.078
2	3rd Microdistrict	79	2.42
3	5th Microdistrict	74	1.9

Table 2. Values of Residential Density (RD)

	Microdistrict	Residential Density
1	1st Microdistrict	1.97
2	3rd Microdistrict	1.90
3	5th Microdistrict	1.51

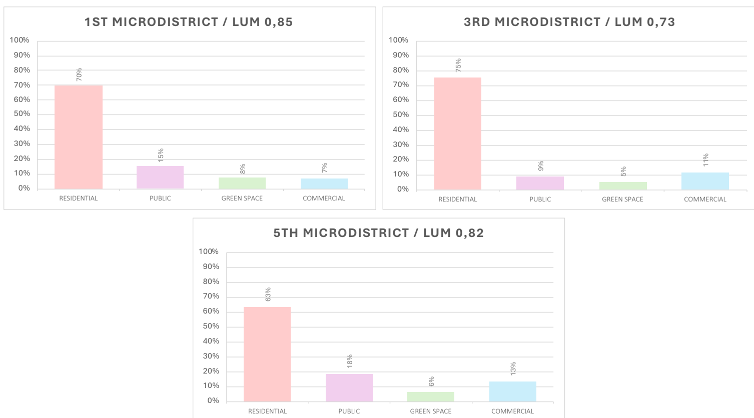

Figure 3. LUM values and their components in the selected areas

Table 3. The calculation of the Walkability Index (WI)

	Microdistrict	Z-score of RD index	Z-score of SC index	6 x Z-score of LUM index	WI
1	1st Microdistrict	0.2	0.312	-2.51	1.322
2	3rd Microdistrict	0.17	1.68	0.5	2.35
3	5th Microdistrict	-0.79	-0.4	0.7	-1.09

4.2 Overall Walkability Index (WI) results

It's interesting that the 3rd microdistrict although its Residential Density is slightly lower than the 1st microdistrict, scored the highest, on the Walkability Index (WI). This suggests that having a connected street layout and a good mix of land use can boost walkability. These findings emphasize the significance of taking multiple urban form factors into account when assessing a city's walkability. Such insights can inform planning efforts aimed at fostering pedestrian settings.

Figure 4. Urban blocks of each microdistrict

In the case of Baku's microdistricts, when viewed within the overall urban plan of the city (macro level), they fall within a larger grid system. However, on a micro level, their grid types slightly differ from each other. The 1st microdistrict resembles an irregular grid or an organic grid. The 3rd and 5th microdistricts are considered hybrid grids, featuring a mix of more regular grid patterns in some areas and organic layouts in others. The 3rd microdistrict has a larger proportion of the regular grid compared to the 5th microdistrict.

The main findings of this research emphasize the influence of urban forms on walkability. Overall results show that microdistricts with a more regular grid have higher walkability scores than organic grids. For instance, the 3rd microdistrict which has a hybrid urban grid and higher street connectivity, achieved the highest walkability score. On the other hand, 1st and 5th microdistricts ranked relatively lower in terms of walkability, potentially because of their organic grid pattern and lower street connectivity. These findings support the idea that urban form plays a significant role in the walkability of a city and should be considered during the urban planning and design process.

5. Conclusion

Through entering a post-socialist context in the course of rapid urbanization, the paper extends the discussion on walkable neighborhoods, providing new insights that are usually neglected in walkability research. Employing the case study method, the walkability feature microdistrict of Baku is uncovered and the experience from these case studies can be used by those working in the urban development of Azerbaijan in practical ways. These discoveries help us build a general image of post-socialist cities' walkability, where they are likely to encounter both challenges and opportunities for pedestrian feature improvement. The study seeks to address the deficit of knowledge and promote cross-cultural learning leading to empowering stakeholders implementing city-specific strategies designed for Baku's unique urban view that will advance the establishment of pedestrian-friendly environments in the region.

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