

A GIS-based 15-Minute City accessibility framework for sustainable urban mobility planning in Jizzakh

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Abstract: *The 15-minute city (15MC) reframes urban mobility around access to daily needs rather than the volume of motorised travel. This paper develops a research framework for adapting the concept to Jizzakh, Uzbekistan, where previous mobility studies have identified rapid motorization, limited public-transport spatial coverage and concentration of bus routes on common corridors. The article does not present a completed 15-minute accessibility map; instead, it integrates recent GIS-based 15mC methods with the author's existing research on population mobility and public transport to define a reproducible study design. The framework measures walking access to essential destinations through network-based 5-, 10- and 15-minute isochrones, evaluates public-transport supply as a complementary accessibility layer, and identifies underserved residential areas through population-weighted indicators. Six destination groups are proposed: education, healthcare, food and daily retail, public services, recreation/green space, and public transport. A scenario stage then tests whether targeted facility placement, pedestrian-network improvement and public-transport reconfiguration reduce accessibility deficits. The framework is designed for a medium-sized Central Asian city and explicitly avoids treating a uniform 15-minute threshold as proof of equitable access. Its contribution is a transparent methodological bridge between Jizzakh's existing transport-network evidence and a future proximity-based urban planning study.*

Keywords: *15-minute city, urban accessibility, GIS, walkability, public transport, sustainable urban mobility, Jizzakh*

Introduction

Urban transport planning has traditionally focused on movement: traffic volume, speed, capacity and travel time. The 15-minute city shifts the analytical question from how far people travel to whether essential daily functions can be reached locally by walking, cycling or short public-transport connections. This proximity-based perspective is relevant to cities experiencing motorization because it links land-use distribution, active mobility and public transport within one accessibility framework. Jizzakh provides a useful case for such research. The author's earlier mobility work examined population growth, private-vehicle occupancy and public-transport network service. In the accepted ETSSIS study, the observed share of single-occupancy private-car trips increased from 29.1% in 2021 to 57.6% in 2025, average vehicle occupancy declined from 2.4236 to 1.5272, and the existing public-transport network was reported to have only 26.3% spatial coverage with substantial route concentration on one corridor. These results do not by themselves measure 15-minute accessibility, but they motivate a land-use-and-accessibility perspective complementary to network supply analysis.

The objective of this paper is to design a GIS-based methodology for assessing the 15-minute city potential of Jizzakh without inventing unmeasured accessibility results. The research questions are: Which daily services should a locally meaningful 15-minute assessment include? How should walking and public-transport accessibility be measured? How can population exposure prioritise

spatial deficits? And how can the method support scenario testing for sustainable urban mobility planning?

Literature

Recent research treats the 15-minute city as an accessibility framework rather than a literal guarantee that every urban function must be located within one universal radius. Pozoukidou and Angelidou (2022) describe proximity, density, diversity, connectivity and human-scale planning among the concept's core principles. Teixeira et al. (2024) show that implementation practices vary widely across cities, indicating that operational definitions must be context-specific. Mouratidis (2026) proposes a GIS workflow that separates proximity-based walking accessibility from accessibility created by nearby public-transport supply. Newer methodological studies also emphasise network-based isochrones, facility distribution and the quality of pedestrian infrastructure rather than simple circular buffers.

15-minute city: proximity to essential daily functions

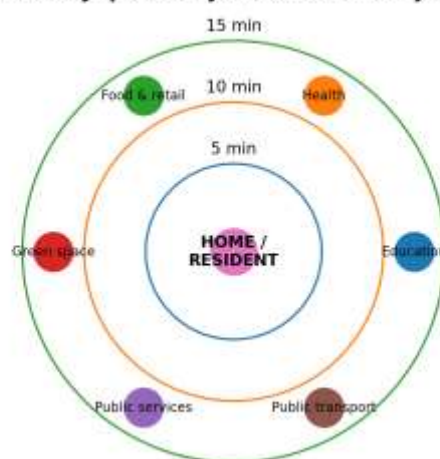


Figure 1. Conceptual structure of a 15-minute city around essential daily functions

For Jizzakh, this paper adopts a pragmatic definition: a residential location has stronger 15-minute accessibility when a useful set of essential destination categories can be reached within a 15-minute walk along the actual street network, with public transport assessed as a complementary layer for access beyond the immediate neighbourhood. The framework is therefore not a claim that Jizzakh currently is, or is not, a 15-minute city. It is a method for measuring the degree and spatial distribution of proximity-based access.

3 Proposed data model

Table 1.

Minimum GIS data structure for the proposed Jizzakh 15-minute-city assessment.

Data layer	Minimum attributes	Purpose
Residential population	Population by block/grid or building proxy	Weight accessibility by residents affected
Pedestrian network	Walkable links, crossings, barriers, link length	Network travel-time calculation
Essential destinations	Category, coordinates, service type	Destination accessibility
Public transport	Stops, routes, service frequency if available	Complementary PT accessibility
Land use / built form	Residential, commercial, institutional, green space	Interpret spatial structure

Observed mobility evidence	Private-vehicle occupancy and PT network indicators	Connect accessibility findings with existing mobility research
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4 Accessibility methodology

4.1 Destination categories

The framework uses six destination groups selected to represent frequent daily needs while remaining feasible for GIS inventory: (1) education; (2) primary healthcare and pharmacies; (3) food and daily retail; (4) public/administrative services; (5) parks, recreation and green space; and (6) public-transport access points. Employment can be analysed separately because job destinations are more specialised and cannot reasonably be assumed to be locally substitutable.

Table 2.

Proposed destination taxonomy. Final facility lists require local validation.

Category	Illustrative facilities	Measurement rule
Education	Schools, kindergartens	Nearest facility and category availability
Healthcare	Clinics, pharmacies	Nearest facility / count within threshold
Daily retail	Food shops, markets	Nearest facility / diversity within threshold
Public services	Administrative and community services	Availability within threshold
Recreation	Parks, sports and public open space	Network access to entrance points
Public transport	Bus stops and route access	Walk time plus service-supply indicator

4.2 Network travel time and isochrones

Walking accessibility should be calculated on a routable pedestrian network rather than by Euclidean radius. For each origin i and destination j , walking time can be expressed as $t_{ij} = d_{ij} / v_i + p_{ij}$, where d_{ij} is shortest-path network distance, v_i is an assumed or group-specific walking speed, and p_{ij} represents documented crossing or barrier penalties when such data are available. The analysis should generate 5-, 10- and 15-minute isochrones so that accessibility is represented as a gradient rather than a binary threshold.

Illustrative 5-10-15 minute network-accessibility zones

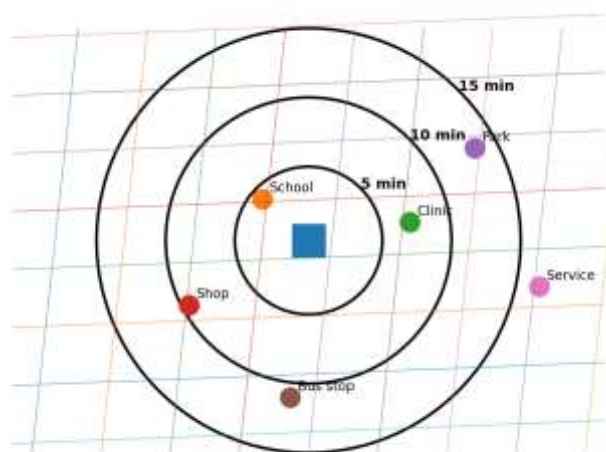


Figure 2. Illustrative 5-, 10-, and 15-minute pedestrian accessibility zones

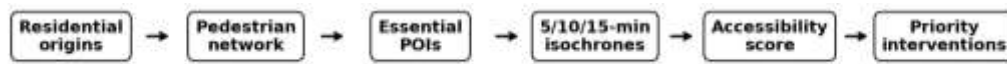
A category score can be defined as the share of required destination categories accessible from origin i within 15 minutes. A population-weighted city indicator can then aggregate origin scores using residential population weights. The exact category weights should not be fixed before stakeholder or

policy validation; equal weights provide a transparent baseline, while sensitivity analysis can test alternative assumptions.

4.3 Public transport as a complementary layer

Public transport should not be counted merely because a stop is nearby. Where timetable or frequency data are available, the PT layer should combine walk access to stops with service availability. Where frequency data are unavailable, the study should report stop and route accessibility separately and avoid interpreting them as realised travel opportunities. This distinction is especially important in Jizzakh because earlier work identified route overlap and limited spatial network coverage.

5 Proposed analytical workflow



GIS-based 15MC assessment framework proposed for Jizzakh

Figure 3. Proposed GIS workflow for the Jizzakh 15-minute-city assessment.

Table 3.

Seven-stage GIS workflow proposed for Jizzakh

Step	Operation	Output
1	Define study area, origin grid and destination taxonomy	Reproducible project specification
2	Clean pedestrian network and geocode facilities	Analysis-ready GIS database
3	Calculate 5/10/15-minute network isochrones	Accessibility surfaces
4	Compute category and population-weighted scores	Spatial accessibility index
5	Overlay PT supply and existing mobility indicators	Multimodal accessibility diagnosis
6	Identify clusters of insufficient accessibility	Priority neighbourhoods
7	Test planning scenarios	Change in residents and categories served

Illustrative GIS accessibility mapping for Jizzakh

The following author-produced maps were prepared in QGIS using the ORS Tools plugin and OpenRouteService routing on OpenStreetMap data. They illustrate travel-time reachability from a selected origin for walking, cycling and driving. These single-origin maps do not measure citywide access to essential services.

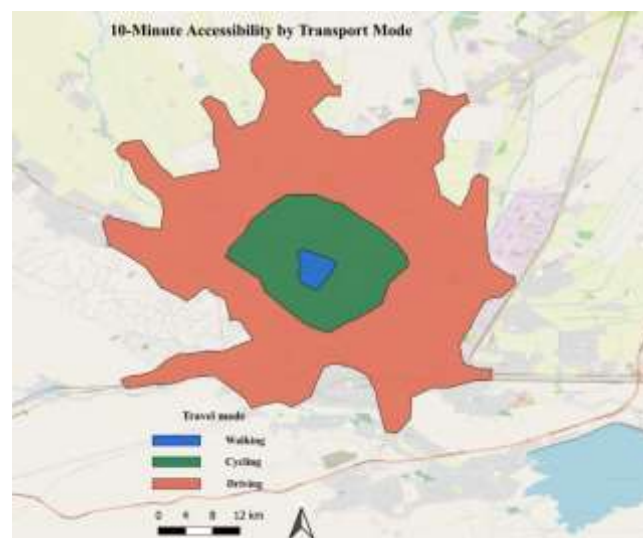


Figure 4. Ten-minute accessibility by transport mode in Jizzakh (walking, cycling and driving).

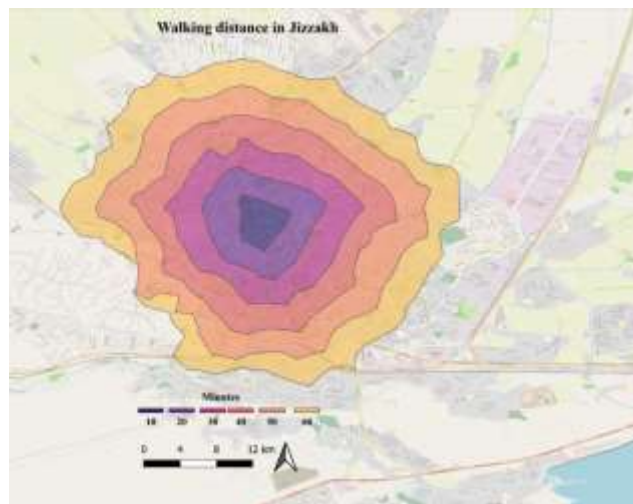


Figure 5. Walking travel-time accessibility from the selected origin in Jizzakh (10-60 minutes).

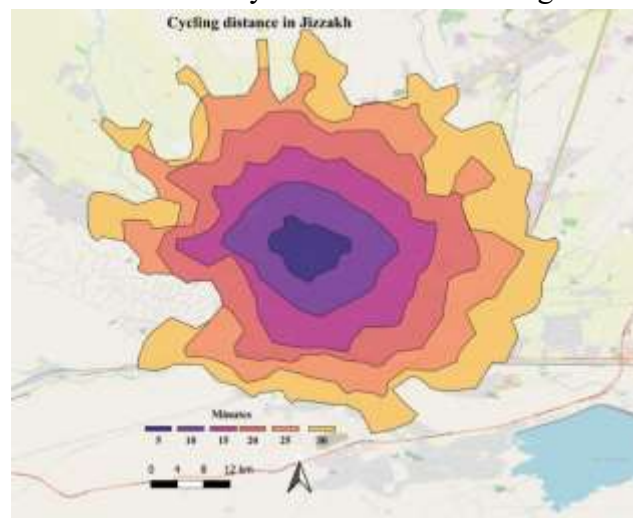


Figure 6. Cycling travel-time accessibility from the selected origin in Jizzakh (5–30 minutes).

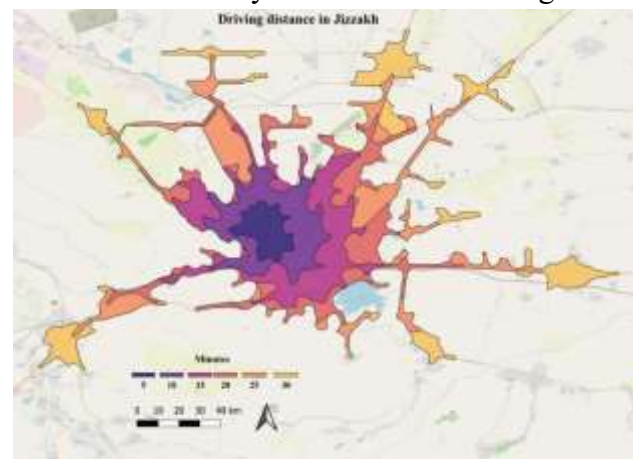


Figure 7. Driving travel-time accessibility from the selected origin in Jizzakh (5–30 minutes)..

6 Discussion and research hypotheses

The value of the framework lies in scenario comparison rather than in producing a single map. Three intervention families are proposed. The first changes proximity by adding or relocating selected local services in underserved areas. The second changes effective walking time by improving pedestrian connections, crossings and barrier permeability. The third changes network reach by adjusting public-transport routes or stop access. Each scenario should be evaluated with the same origin population

and destination definitions so that changes in accessibility can be attributed to the intervention rather than to a changing metric.

A useful scenario indicator is the number and percentage of residents whose accessible destination-category count increases within the 15-minute threshold. A second indicator is the reduction in population living in low-access clusters. A third compares public-transport access with proximity access to determine whether PT compensates for weak local service distribution or merely reproduces the same spatial inequalities.

The proposed study complements, rather than duplicates, existing Jizzakh mobility research. Previous work measured private-vehicle occupancy and public-transport network service, whereas the 15-minute framework measures access to destinations through the spatial relationship between residents, services and transport networks. If future analysis finds that neighbourhoods with weak proximity and PT access also exhibit higher car dependence, that relationship should be tested statistically; it should not be assumed in advance. This separation between hypothesis and result is essential for a defensible research design.

The methodological contribution is a locally adaptable, GIS-based structure for moving from transport-network description to accessibility planning. Three hypotheses are proposed for later empirical testing. H1: accessibility to essential daily services is spatially uneven across Jizzakh when measured on the pedestrian network. H2: public-transport supply only partially compensates for neighbourhoods with weak proximity-based access. H3: targeted pedestrian, facility-location and PT scenarios can improve population-weighted accessibility more efficiently than uniform citywide interventions. These are research hypotheses, not reported findings.

The framework depends on the completeness of facility and pedestrian-network data. Open mapping sources may omit entrances, informal paths, crossings or recently opened services. A nominal walking time also does not fully represent heat, slope, disability, perceived safety or street quality. Recent literature therefore recommends combining spatial measures with perceptible and behavioural attributes where feasible. For Jizzakh, field verification of priority areas should follow the GIS screening stage. Accessibility should also be tested using alternative walking speeds and destination definitions to determine whether conclusions are robust.

Conclusion

The 15-minute city concept can be useful for Jizzakh when treated as a measurable accessibility framework rather than a slogan or fixed-radius map. Building on existing evidence of motorization and public-transport limitations, this paper proposes a seven-stage GIS workflow that measures network-based walking access, incorporates public-transport supply, weights deficits by residential population and evaluates targeted planning scenarios. The framework deliberately separates existing evidence from future measurements. Its next step is the construction and field validation of a Jizzakh GIS database, followed by 5-, 10- and 15-minute accessibility mapping and scenario analysis. This approach can connect sustainable urban mobility planning with concrete spatial priorities while avoiding unsupported claims about the city's current 15-minute performance.

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