European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

ASSESSMENT OF PEDESTRIAN ACCESSIBILITY IN THE DISTRICTS OF TASHKENT

Pulatova Zulfiya 1*,
Sadikov Ibragim 2
1*Tashkent State Transport University, Department of Urban Roads and Streets, Faculty of Road Engineering, 1-house of Temiryulchilar street of Mirabad, 200100 Tashkent, Uzbekistan, zulya1787@gmail.com
2*Tashkent State Transport University, Department of Urban Roads and Streets, Faculty of Road Engineering, 1-house of Temiryulchilar street of Mirabad, 200100 Tashkent, Uzbekistan, jaamm.ru@gmail.com
*E-mail of corresponding author: zulya1787@gmail.com
Author ORCID IDs:
Pulatova Zulfiya: https://orcid.org/0009-0004-0270-6741

Abstract
This article examines the issue of assessing pedestrian accessibility in the city districts, taking into account the street and road network. Isochrons were created for each district of Tashkent, a pedestrian accessibility index was determined for distances of 400, 800 and 1200 meters, these indicators were compared and, as a result, a cumulative graph was compiled for this indicator.

Keywords: Pedestrian, destination arrival, isochrons, pixels, centroid, destination arrival index.

Introduction

In accordance with Resolution No.PP-6099 of the President of the Republic of Uzbekistan dated October 30, 2020 "On measures for the widespread introduction of a healthy lifestyle and the further development of mass sports" from January 1, 2022 through the "Healthy Lifestyle Platform (1hls.uz)" payment is made for hiking. The decree also provides for the construction of pedestrian and bicycle paths in each regional center and city of the republic.

All this indicates that special attention is paid to promoting a healthy lifestyle, creating conditions for pedestrians and other road users.

In accordance with Decree No.UP-60 of the President of the Republic of Uzbekistan dated January 28, 2022 "On the development strategy of new Uzbekistan for 2022-2026", it is planned to introduce the "Urban Comfort Index", improve the life of the population in cities, improve the quality of life of the population. the quality of work on digitalization, construction and design of cities, their development within the framework of the "Smart City" concept.

The decree also provides for further improvement of the tourist infrastructure of the city.Strengthening the ties of disabled people with their families, society and the state, their stay in comfortable conditions, creating the necessary conditions for unhindered movement, access to passenger transport, social and other infrastructure of the city. It is planned to turn Tashkent into a well-maintained, ecologically clean territory for the population with all living conditions, increase the level of landscaping to 30%, create "squares" for every 50-100

thousand people in cities and regional centers. However, it should be noted that all of the above activities cannot be carried out without ensuring pedestrian accessibility.

A pedestrian is a person who moves with the help of his legs, using various ways of walking. A pedestrian is usually considered to be a person walking or using a non-motorized vehicle or wheelchair, who cannot move at a speed of more than 10 km/h.

Pedestrians include people of all ages, both sexes, all races and religions, as well as representatives of all walks of life. A pedestrian is a road user along with drivers, passengers of vehicles, cyclists, motorcyclists and others. The most important thing is that all road users can become pedestrians during their movement at a certain time. That is, the driver can travel by car, but at some point the driver becomes a pedestrian in order to walk a short distance, for example, when moving from a parking lot to an office, store or other place.

Article 24 of the Law of the Republic of Uzbekistan "On the Rights of Persons with disabilities" states that "Pedestrian crossings and intersections, public streets and motorways are implemented based on the needs of persons with disabilities and their accessibility," that is, this Law indirectly includes persons with disabilities in the category of pedestrians.

At a meeting on January 30, 2024, President of the Republic of Uzbekistan Sh.M. Mirziyoyev instructed all heads in charge of urban planning and road traffic to adopt the motto "The city is for pedestrians" as their main principle.

The information contained in this article was created within the framework of the tasks defined in Decree No. PF- 60 of the President of the Republic of Uzbekistan dated January 28, 2022 "On the development strategy of new Uzbekistan for 2022-2026" and serves to solve these tasks from a practical point of view.

The Main Part

To compare the level of pedestrian accessibility in 12 districts of Tashkent city, it is appropriate to use the centroids of each district. A centroid is a geographical center, that is, a point equidistant from the boundaries of the district. Although this point is not a shopping mall or a collection of various shopping and entertainment venues, it is the most effective approach for comparative analysis. Using centroids to determine pedestrian accessibility can be an effective and practical way to compare pedestrian accessibility between different areas (Fig. 1).

The QNEAT 3 algorithm connected to the QGIS software was used to assess pedestrian accessibility in Tashkent. Figure 2 shows the results of the analysis. As can be seen from this figure, the isochrons of pedestrian accessibility have different shapes. The closer the shape of the isochrons is to the circle, the higher the probability that pedestrian accessibility in this area is also high. It should be noted that the closer the studied area is to the city center, the closer the shape of the isochronous pedestrian accessibility is to the circular one. This confirms the initial theory that areas closer to the city center have higher pedestrian accessibility. The study examined 12 district centers and the center of Tashkent (Amir Temur Square).

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

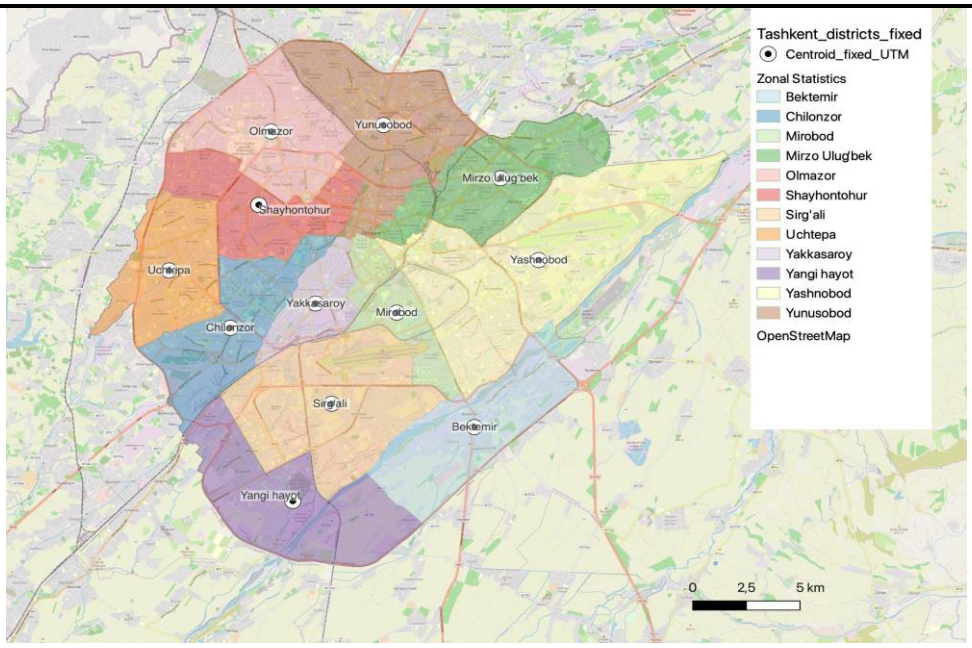

Fig.1, Definition of centroids for certain districts of Tashkent.

The pedestrian accessibility index is proposed to be defined as follows:

1. The ideal pedestrian accessibility is to cover a circle with a radius of R = 1200 meters.

2. The area of this circle is equal to: $S_f = \pi \times R^2$

Here Sf – is the area of the circle, R – is the radius of the circle.

3. The area of the isochron is defined by the following expression:

Si =100×N, where N is the number of cells (pixels) in the isochron.

4. The pedestrian accessibility index can be expressed by the ratio of the isochron area to the area of a circle with a radius of 1200 m, that is:

$$P_i = 100 \times \frac{S_i}{S_f},$$

where P_i _ is the pedestrian accessibility index.

The proposed scale of pedestrian accessibility

Table 1

Н/п	Walkability index	Characteristics of pedestrian accessibility
1	90-100	Perfect
2	80-89	Well
3	70-79	Average
4	60-69	Satisfactory
5	Less than 59	Unsatisfactory

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

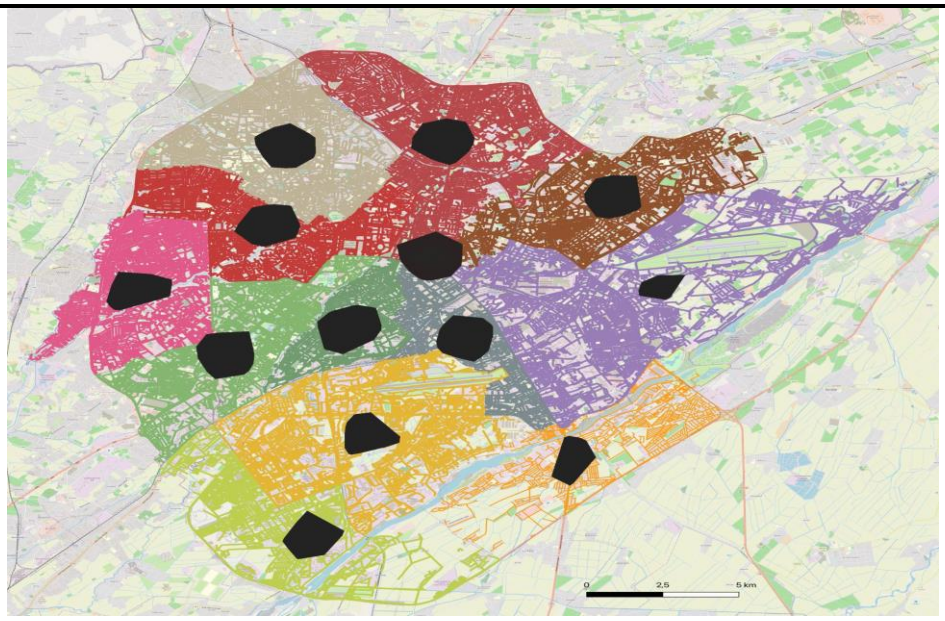

Fig.2. Pedestrian accessibility in Tashkent.

In order to study pedestrian accessibility by city districts, maps of districts were created on a large scale, i.e. 1:12000, as well as in time intervals of 5, 10 and 15 minutes walking distance. Almazar district is an administrative and territorial unit within the city of Tashkent. This area is located in the northwestern part of the capital. The current (2022) area of the district is 3378 hectares, the population is 387.7 thousand people. This is the largest district of Tashkent in terms of population.

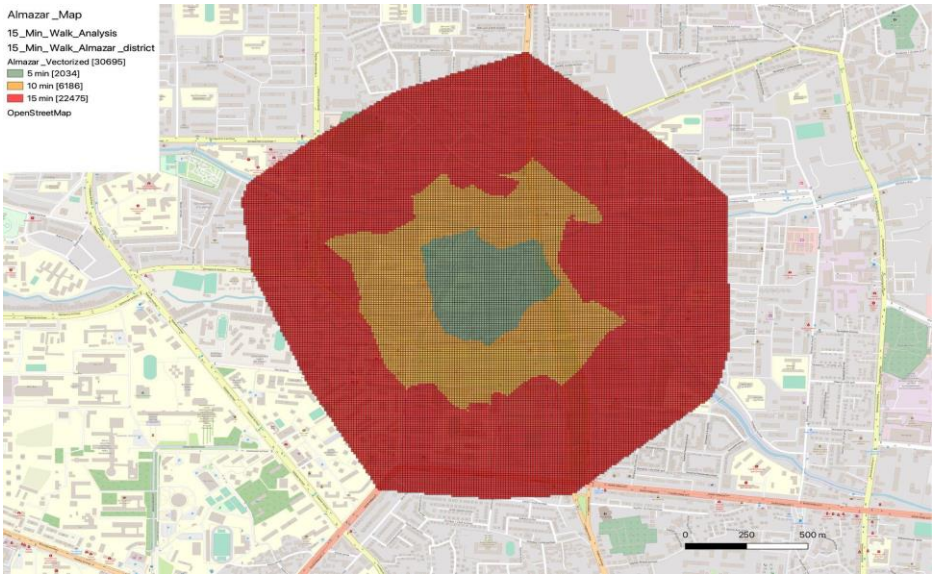

Fig. 3. Isochrons of pedestrian accessibility in the centroid of the Almazar district of Tashkent.

Figure 3 shows the isochrons of 5-minute, 10-minute and 15-minute pedestrian accessibility for Almazorsky district, corresponding to distances of 400 m, 800 m, 1200 m. Isochrons consist

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

of pixels (squares) measuring 10x10 m, i.e. an area of 100 m2. The total number of pixels is 30,695, which means that their total area is 3,069,500 m2. Ideally, if pedestrian accessibility were 100%, a circle with a radius of 1200 m would have a total area of 4,523,893 m2. Accordingly, the probability of reaching the destination (i.e. pedestrian accessibility) a 15-minute walk for Almazorsky district is 68%.

Bektemir district is located in the southern and southeastern part of the capital, mainly outside the Tashkent Ring Road, on the left bank of the Chirchik River. The modern (2009) area is 2050 hectares, the population is 27.5 thousand people.

Fig. 4. Isochrons of pedestrian accessibility in the centroid of the Bektemir district of Tashkent.

Figure 4 shows the isochrons of 5-minute, 10-minute and 15-minute pedestrian accessibility for the Bektemir district, corresponding to distances of 400 m, 800 m, 1200 m. Isochrons have an elongated shape and indicate the most suitable places for pedestrians, depending on the area. The total number of pixels is 20,192, that is, their total area is 2,019,200 m2. Accordingly, for the Bektemir district, the probability of reaching your destination in 15 minutes on foot is 45%.

Fig. 5. Isochrons of pedestrian accessibility in the centroid of the Mirabad district of Tashkent.

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

Figure 5 shows the isochrons of 5-minute, 10-minute and 15-minute walking distance for Mirabad district, corresponding to distances of 400 m, 800 m and 1200 m. The isochrons have a close to rounded shape, which indicates relatively good walking comfort for pedestrians. The total number of pixels is 30,262, which means that their total area is 3,026,200 m2. Accordingly, the probability of reaching the destination within a 15-minute walk for the Mirabad district is 67%. Mirzo-Ulugbek district is located in the northeastern part of the capital. The modern (2012) area is 3,515 hectares, the population is 245.5 thousand people.

Figure 6 shows isochrons of 5-minute, 10-minute and 15-minute walking distance for Mirzo-Ulugbek district, corresponding to distances of

400 m, 800 m, 1200 m. The isochrons are close to circular, indicating that pedestrians have a relatively good chance of reaching their destination. The total number of pixels is 29,681, which means that their total area is 2,968,100 m2. Accordingly, for Mirzo-Ulugbek district, the probability of reaching the destination in 15 minutes on foot is 66%.

Fig. 6. Isochrons of pedestrian accessibility in the centroid of Mirzo Ulugbek district of Tashkent.

Fig. 7. Isochrons of pedestrian accessibility in the centroid of the Sergeli district of Tashkent.

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

Sergeli district is one of the largest districts of the city in terms of area. This area is located in the southern part of the capital. Its current (2020) area is 5,600 hectares, and its population is 167,600 people.

Figure 7 shows the isochrons of 5-minute, 10-minute and 15-minute pedestrian accessibility of the Sergeli district, corresponding to distances of 400 m, 800 m and 1200 m. The isochrons have a triangular shape and indicate the most accessible areas for pedestrians, depending on each zone. The total number of pixels is 24,251, that is, their total area is 2,425,400 m2. Accordingly, the probability of reaching your destination in 15 minutes on foot for Sergeli district is 54%.

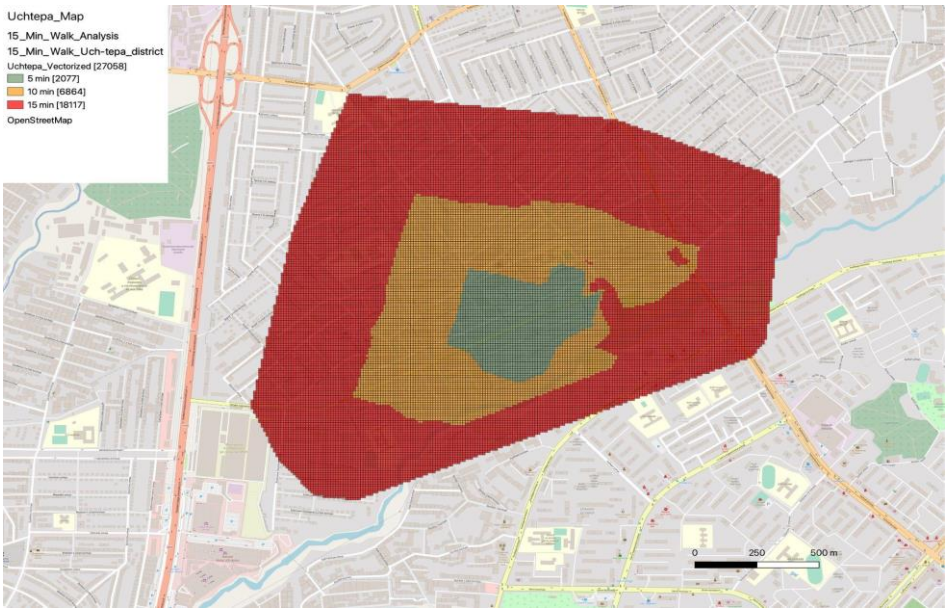

Fig. 8. Isochrons of pedestrian accessibility in the centroid of the Uchtepa district of Tashkent.

The Uchtepa district of Tashkent is located in the western part of the capital. The current (2009) area is 2,400 hectares, the population is 265.9 thousand people.

Figure 8 shows 5-minute, 10-minute and 15-minute isochrons of pedestrian accessibility, corresponding to distances of 400 m, 800 m and 1200 m for the Uchtepa district. The isochrons have a triangular shape and indicate the most accessible areas for pedestrians, depending on each zone. The total number of pixels is 27,058, which means that their total area is 2,705,800 m2. Accordingly, for the Uchtepa district, the probability of reaching your destination in 15 minutes on foot is 54%.

Chilanzar district is located in the southwestern part of our capital. The current (2009) area is 2,994 hectares, the population is 217.5 thousand people.

Figure 9 shows isochrons of 5-minute, 10-minute and 15-minute walking distance for Chilanzor district, corresponding to distances of 400 m, 800 m, 1200 m. The isochrons have a close to rounded shape, which indicates relatively good walking comfort for pedestrians. The total number of pixels is 33,260, which means that their total area is 3,326,000 m2. Accordingly, for the Chilanzar district, the probability of reaching your destination in 15 minutes on foot is 74%.

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

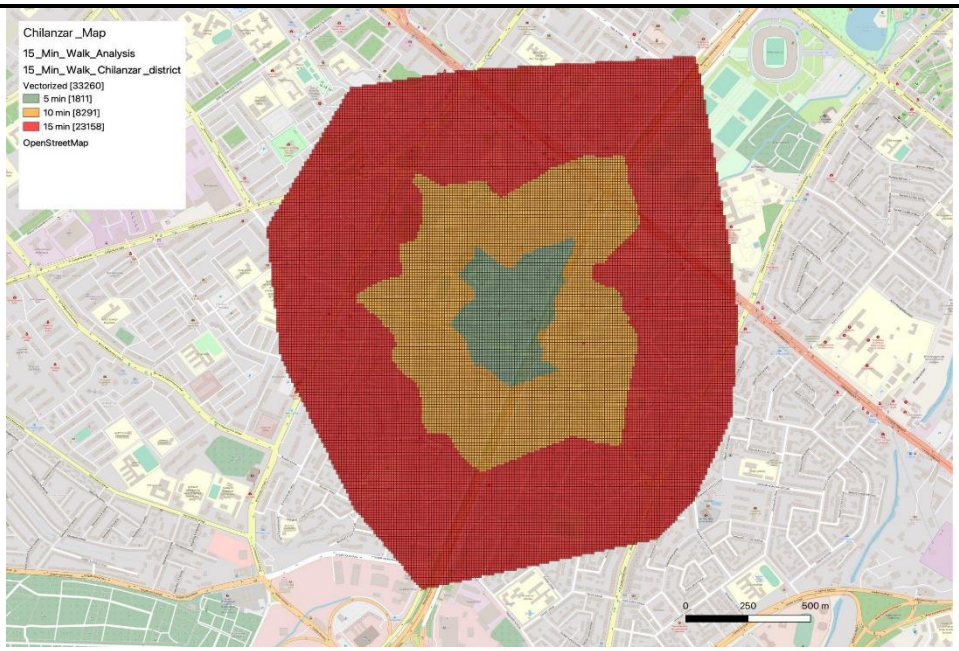

Fig. 9. Isochrons of pedestrian accessibility in the centroid of the Chilanzar district of Tashkent.

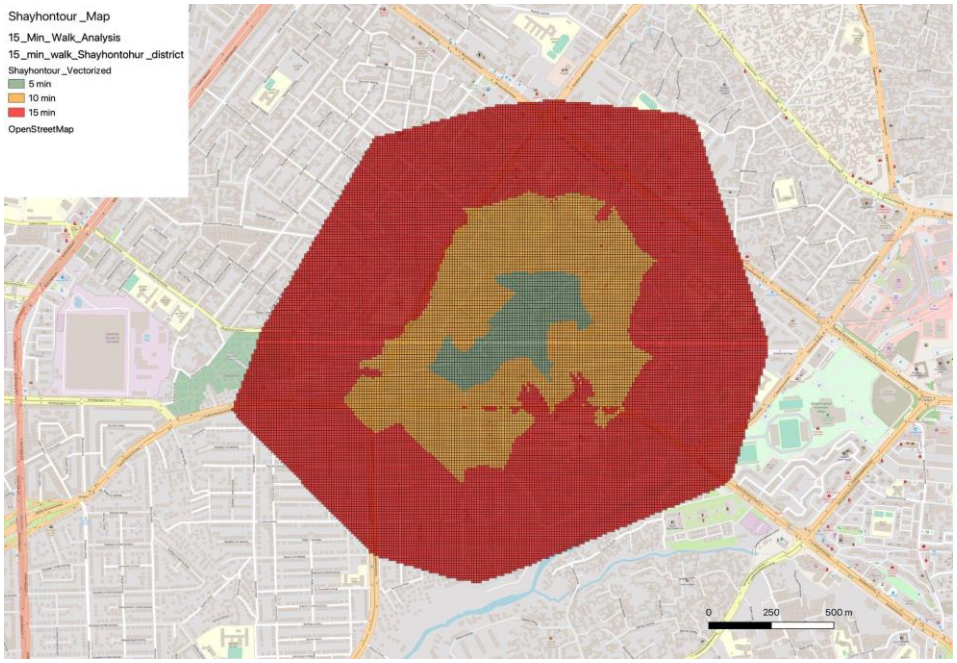

Fig. 10. Isochrons of pedestrian accessibility in the centroid of the Shaykhontokhursky district of Tashkent.

Shaykhontokhur district is located in the northwestern part of our capital. The modern (2009) area is 2,970 hectares, the population is 286.4 thousand people.

Figure 10 shows isochrons of 5-minute, 10-minute and 15-minute walking distance, corresponding to distances of 400 m, 800 m and 1200 m for the Shaykhontokhur district. The isochrons have a close to rounded shape, which indicates relatively good walking comfort for pedestrians. The total number of pixels is 30,459, that is, their total area is 3,045,900 m2.

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

Accordingly, the probability of reaching the destination in 15 minutes on foot for the Shaykhontokhur district is 67%.

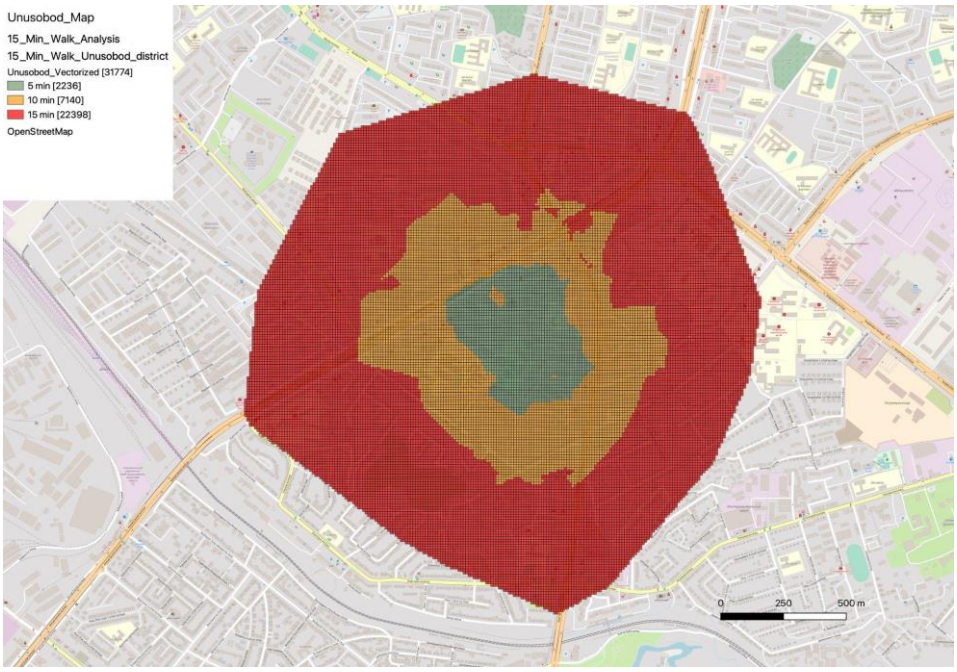

Fig. 11. Isochrons of pedestrian accessibility in the centroid of the Yunusabad district of Tashkent.

Yunusabad district is one of the twelve districts of the modern city of Tashkent, located in the northern part of the city from Amir Temur Square to the Tashkent Ring Road. Yunusabad district ranks second in the city of Tashkent in terms of population and area. The population of the district in 2022 was 360.9 thousand people, the area of the district was 40.6 km2 (63.5% of them are residential, the green zone occupies 36.5% of the area of the district, the population density is 8,889 thousand people/km2). .

Figure 11 shows the isochrons of 5-minute, 10-minute, 15-minute pedestrian accessibility of Yunusabad district, corresponding to distances of 400 m, 800 m, 1200 m. The isochrons have a close to rounded shape, which indicates relatively good walking comfort for pedestrians. The total number of pixels is 31,774, that is, their total area is 3,177,400 m2. Accordingly, the probability of reaching the destination in 15 minutes on foot for Yunusabad district is 70%.

Yakkasaray district is the smallest district of Tashkent city in terms of area and the only district of the capital that does not have a common border with the Tashkent region. This area is located in the central part of the capital. The current (2009) area is 1,460 hectares, the population is 115,000 people.

The isochrons of 5-minute, 10-minute, 15-minute walking distance, corresponding distances of 400 m, 800 m, 1200 m for Yakkasarai district are given. The isochrons have a close to rounded shape, which indicates relatively good walking comfort for pedestrians. The total number of pixels is 34,539, that is, their total area is 3,453,900 m2. Accordingly, the probability of reaching your destination in 15 minutes on foot for Yakkasarai district is 76%.

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

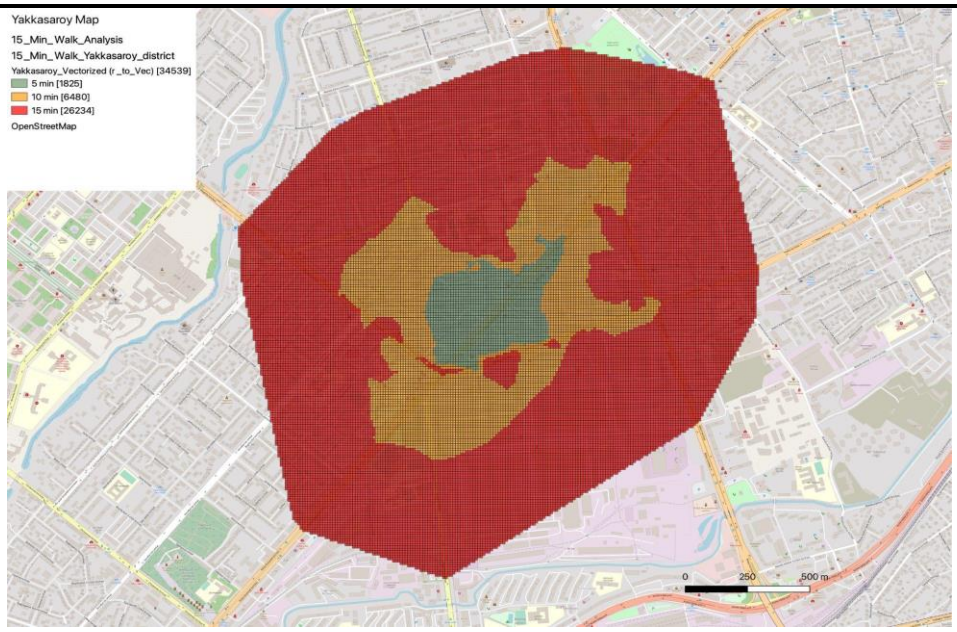

Fig. 12. Isochrons of pedestrian accessibility in the centroid of the Yakkasaray district of Tashkent.

Yangikhaet district is an administrative and territorial unit within the city of Tashkent. The area of the district at the time of creation (2020) was 4419.6 hectares. There are 115 industrial enterprises, 277 service enterprises, 1148.8 hectares of agricultural land and 388.8 hectares of residential land in this area.

Fig. 13. Isochrons of pedestrian accessibility in the centroid of the Yangikhaet district of Tashkent.

Figure 13 shows the isochrons of 5-minute, 10-minute and 15-minute walking distance for Yangihaet district, corresponding to distances of 400 m, 800 m and 1200 m. Isochrons have a pentagonal shape and indicate the convenience of walking pedestrians on this site. The total

number of pixels is 28,852, which means that their total area is 2,685,200 m2. Accordingly, the probability of reaching your destination in 15 minutes on foot for Yangihaet district is 59%.

Yashnabad district is located in the southeastern part of our capital. The modern (2017) area is 3370 hectares, the population is 227.4 thousand people.

Figure 14 shows isochrons of 5-minute, 10-minute and 15-minute walking distance, corresponding to distances of 400 m, 800 m and 1200 m for the Yashnabad district. Isochrons have the shape of a drop, which indicates the convenience of pedestrian movement in a certain area. The total number of pixels is 11,751, that is, their total area is 1,174,100 m2. Accordingly, the probability of reaching the destination within a 15-minute walk for the Ashgabat district is 26%.

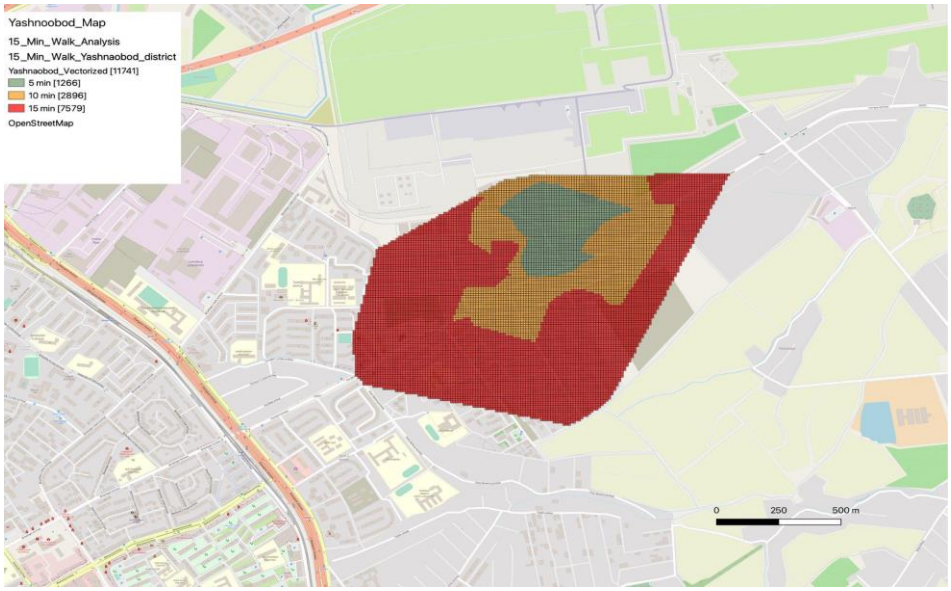

Fig. 14. Isochrons of pedestrian accessibility in the centroid of the Yashnabad district of Tashkent.

Amir Temur Square is the center of Tashkent city, on this square there is a statue of Amir Temur, the leader of the 14th century, paths and trees are laid around the statue. This place is considered the center of Tashkent city.

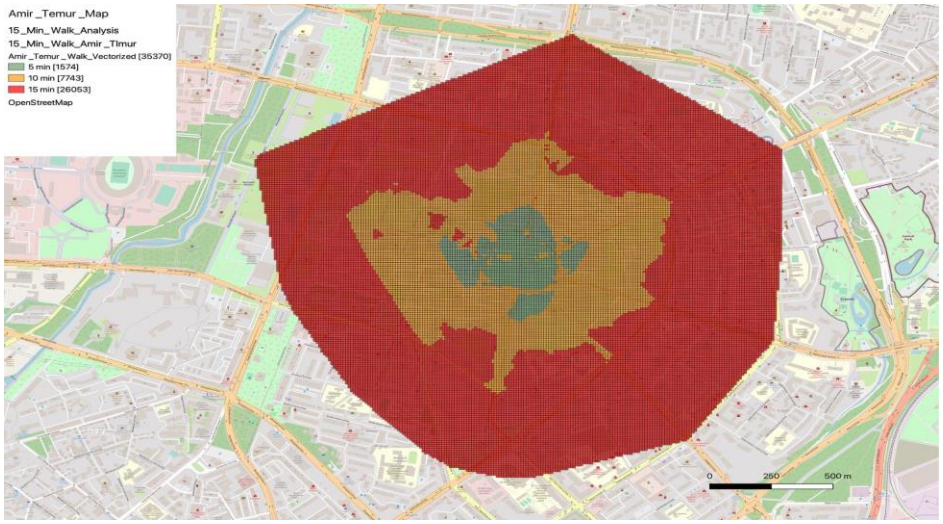

Fig. 15. Isochrons of pedestrian accessibility in the centroid of Amir Timur Square in Tashkent.

European Journal of Emerging Technology and Discoveries
ISSN (E): 2938-3617
Volume 2, Issue 10, October - 2024

Figure 15 shows isochrons of 5-minute, 10-minute, 15-minute pedestrian accessibility for Amir Temur Square, corresponding to distances of 400 m, 800 m, 1200 m. The isochrons have a close to rounded shape, which indicates relatively good walking comfort for pedestrians. The total number of pixels is 35,370, which means their total area is 3,537,000 m2. Accordingly, pedestrian accessibility on the territory of Amir Temur Square with a 15-minute walk is 78%.
A comparison of pedestrian accessibility by district showed interesting patterns and different levels of pedestrian accessibility by district. A line graph was used to compare the probability that pedestrians would reach their destination in 5, 10 and 15 minutes of walking (Fig. 16).

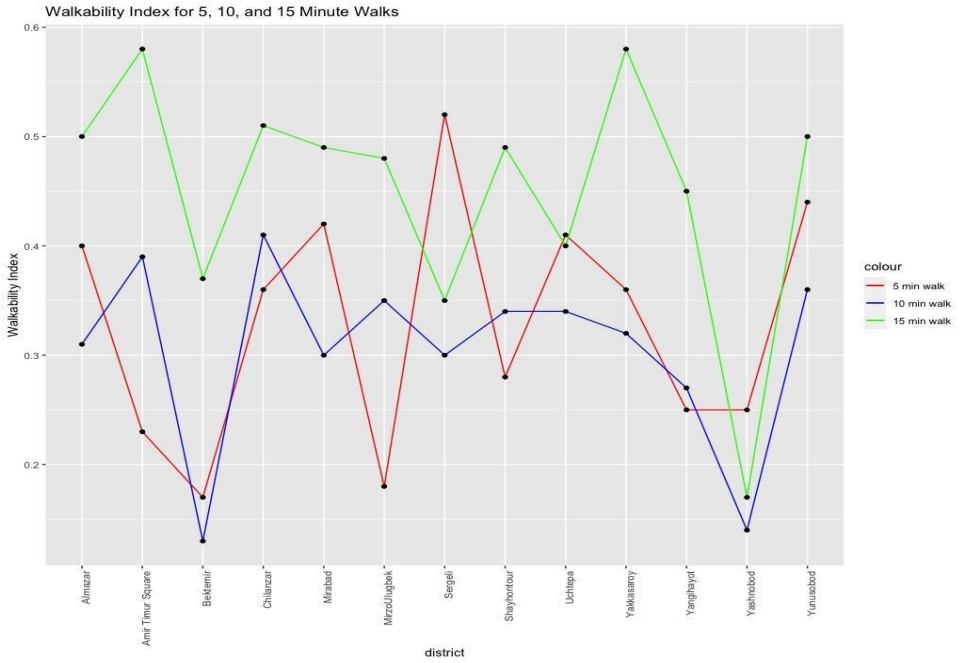

Fig. 16. Pedestrian accessibility in the districts of Tashkent.

16 shows that the leaders in pedestrian accessibility in 5 minutes on foot are Almazar, Mirabad, Uchtepa, Yunusabad, Sergeli districts. The highest indicator for this indicator is in the Sergeli district, which means that more than 50% of pedestrian accessibility is provided. According to the 10-minute walking distance, the highest figure is more than 40% in Chilanzor district, about 40% in Amir Temur Square. The leader in 15-minute accessibility is Yakkasarai district with more than 70% and Amir Timur Square with more than 75%. The following districts showed almost 50% of pedestrian accessibility with a 15-minute walk: Chilanzar and Yunusabad districts, slightly less than 50% - Mirabad, Mirzo-Ulugbek and Shaikhontokhur districts.
As can be seen from the data presented in Fig. 16, the level of pedestrian accessibility varies greatly in different areas of the city. It is worth noting that as the walking time increases, the area where the pedestrian has the greatest accessibility to the destination changes. This suggests that different areas of the city may have different levels of infrastructure and pedestrian accessibility. The difference in a pedestrian's ability to reach their destination in a 5- and 10-minute walk does not exceed the difference between 15-minute accessibility. This may indicate that areas with high pedestrian accessibility in 5-10 minutes are well developed and have a relatively dense street network.This indicator allows people to reach their destination on foot in 5-10 minutes.

In addition, in some areas, the 15-minute walking distance is slightly less than 50%, which indicates the need to improve pedestrian infrastructure in these areas. This helps to create a livable and inclusive city for residents who prefer hiking.

Conclusion

Thus, the data presented in Figure 16 provides valuable information about the current state of pedestrian accessibility in various areas of the city. This information can be used to justify urban planning decisions and implement measures to create a more pedestrian-friendly city. In some areas, the 15-minute walking distance is just under 50%, which indicates the need to improve pedestrian infrastructure in these areas.

References

1. The street and road network. https://ru.wikipedia.org/wiki/Street and road_network
2. Ozhegov's explanatory dictionary. https://slovarozhegova.ru/
3. The 4th CAREC Manual on Road Safety Engineering. Pedestrian safety. 2021. https://www.carecprogram.org/uploads/CAREC-Road-Safety-Engineering-Manual-4_Russian_2nd-proof_rev2final-version.pdf
4. Americans with Disabilities Act (ADA), https://adata.org/
5. Decree of the President of the Republic of Uzbekistan dated October 30, 2020 No. UP–6099 "On measures for the widespread introduction of a healthy lifestyle and the further development of mass sports", https://lex.uz/ru/docs/5077669
6. The theory of the central place, https://www.britannica.com/topic/central-place-theoryBriney A. An Overview of Christaller's Central Place Theory. 2020 https://www.thoughtco.com/central-place-theory-1435773
7. Altaweel M. Geography Realm. 2020 https://www.geographyrealm.com/central-place-theory/
8. Traffic in Towns: A Study of the Long Term Problems of Traffic in Urban Areas - Reports of the Steering Group and Working Group appointed by the Minister of Transport. 1963
9. PIARC: XXth Wold Road Congress. Montreal, Transportation and Urban Space Planning. / National Reports. 20.22.E – 1995.
10. Liveable neighbourhoods. edition 2, 2000. A Western Australian government sustainable cities initiative
11. Liveable Neighbourhoods. Street Layout, Design and Traffic Management Guidelines. Western Australian Planning Commission. 2000.