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5. ANALYSIS OF PUBLIC TRANSPORT ACCESSIBILITY – A CASE STUDY OF TYSIĄCLECIA GÓRNE ESTATE IN KATOWICE, POLAND

5.1. Introduction

Smart cities are the cities open to the problems of their inhabitants. The main subject of these part of manuscript is the analysis of public transport accessibility within selected estate of Poland. The aim of this chapter is to draw attention to the problems of residents of selected areas related to transport accessibility, as well as to present the selected method of collecting data and analysing the situation. The chapter does not concern sociological analyses, but focuses on problems with movement, in particular of parents with small children, the elderly and the disabled.

Accessibility of public transport has been the subject of an increasing number of studies in many countries including India[2], Slovakia[3], Ghana[4] and Poland[5]. Scientists have focused on job accessibility[6], accessibility to supermarkets[7], and temporal

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[2] Adhvaryu B., Kumar S.: Public transport accessibility mapping and its policy applications: A case study of Lucknow, India. Case Studies on Transport Policy, 2021, Vol. 9, No. 4, pp.1503–1517.
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[4] Asabere S.B., Acheampong R.A., Ashiagbor G., Beckers S.C., Keck M., Erasmi S., Schanze J., Schanze J., Sauer D.: Urbanization, land use transformation and spatio-environmental impacts: Analyses of trends and implications in major metropolitan regions of Ghana. Land Use Policy, 2020, Vol. 96, 104707.
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[6] El-Geneidy A., Levinson D., Diab E., Boisjoly G., Verbich D., Loong C.: The cost of equity: Assessing transit accessibility and social disparity using total travel cost. Transportation Research: Part A, 2016, Vol. 9, pp. 302–316.
[7] Widener M.J., Farber S., Neutens T., Horner M.: Spatiotemporal accessibility to supermarkets using public transit: an interaction potential approach in Cincinnati, Ohio. Journal of Transport Geography, 2015,Vol. 42, pp. 72–83.

variability of accessibility[8]. Challenges in public transport accessibility are of concern across societies and impact not only the disabled but also for people without physical disabilities. Especially in aging societies, architectural barriers are becoming an obvious and urgent problem.

In an aging society like Poland many infrastructure upgrades have been completed, but there is still a problem with public transport accessibility in many cities. For example, in Katowice, one of the highest populated cities in Poland, the public transport network reaches every district; however, there are places where residents are hindered by architectural barriers that make it difficult or even impossible to reach bus and tram stops. An example of such a district is the Tysiąclecia estate, located on the border between two cities: Katowice and Chorzów.

Tysiąclecie estate was created as a bedroom community to Katowice. The Tysiąclecia estate with an area of 2 km^2 consists of two parts: Tysiąclecie Górne estate and Tysiąclecia Dolne estate. A part of the estate (Tysiąclecie Górne) is located on the border with Chorzów which is an area with many public transport and urban planning problems that have not been addressed for many years. Currently, there are approximately 22,000 residents who live in who predominantly live in residential building of 4 to 25 floors.

The decision to build a housing estate for 20,000 people on the border of Katowice and Chorzów was made on July 7, 1959. Later the target number of residents increased to 30,000. Currently, many of the residents of this estate are parents with young children and elderly people with mobility problems. Public transport challenges have already been discussed by Komar[9], who extensively analyzed problems in the estates. In the current study only barriers that can limit access to bus and tram stop were identified and investigated.

A new application (https://arcg.is/1nnrjL) was created to collect geoinformation about architectural barriers. This database can be a critically important and useful tool for future city authorities and decision makers. The volunteered geographic information (VGI) can be harnessed to create, assemble, and disseminate geographic data provided voluntarily by individuals and will be used in future analyses.

To conduct this study it was necessary to consider different types of challenges including location of bus or tram stops and the speed and movement of different groups.

[8] Stępniak M., Goliszek S.: Spatio-Temporal Variation of Accessibility by Public Transport – The Equity Perspective. [In:] Ivan I., Singleton A., Horák J., Inspektor T. (ed.): The Rise of Big Spatial Data. Lecture Notes in Geoinformation and Cartography. Springer, Cham 2017, pp. 241–261.

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Usually, elder people move slower and transitions take more time. Distance can also be a barrier for those who have mobility problems. The figures below show the speeds at which pedestrians can cover particular distances and the time needed to cover 1 km given a specific speed they are moving at (Fig. 5.1).

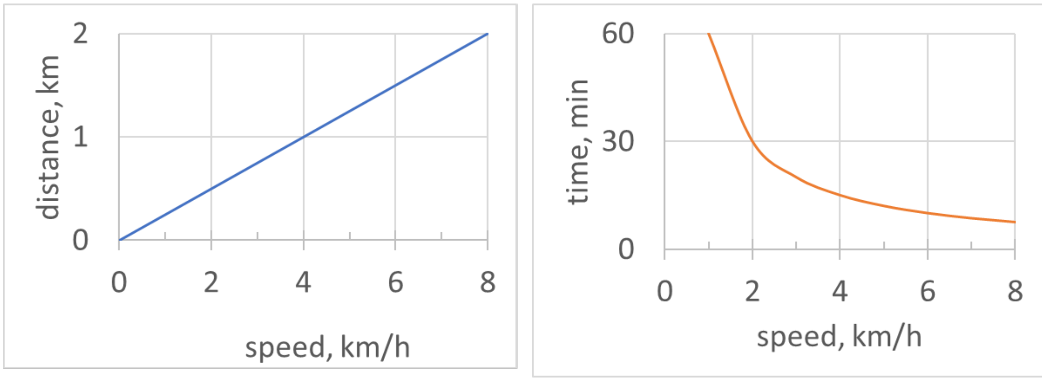

Fig. 5.1. Dependences of (a) the traveled distance (traveled over 10 mins) on speed (b) time, needed to travel 10 km, on speed
Rys. 5.1. Zależności (a) przebytej drogi (w ciągu 10 minut) od prędkości (b) potrzebnego czasu (do przebycia dystansu 10 km) od prędkości
Source: Own elaboration, 2022.

The speed of human movement is unique to each person and usually ranges from 4 km/h to 7 km/h. Speed depends on many factors (e.g., health condition, aspects, favorable or unfavorable weather conditions, road condition). It is assumed that the speed of brisk walking is approximately 6–7 km/h and normal walking is approx. 4–5 km/h. Elderly or sick people walking with a cane or walker, and those burdened with shopping bags or luggage, move more slowly. The distance a pedestrian must traverse also depends on whether a given architectural barrier is an obstacle and creates a less direct, more circular route.

5.2. Material and methods

5.2.1. Research area

This study's aim was to analyze the accessibility of public transport for residents of Tysiąclecia Górne (Katowice, Poland, Fig. 5.2) estate taking into account: (1) the location of stops; (2) different modes of transportation: bus (B) and trams and two different directions of travel: a way from Tysiąclecie Górne estate to Katowice city center (TK), and a way back from Katowice city center to the Tysiąclecie Górne estate (KT), due to a fact that localization of the bus stops in these two cases is different. (T); (3) infrastructure elements in the vicinity of stops that limit or even prevent access to stops; and (4) timetables and the number of bus and tram lines. The problems of public transport accessibility for residents of Tysiąclecia estate concern not only people for whom architectural barriers (stairs, high curbs, no ramps) constitute a problem in moving (PPM) (i.e., people on crutches, people using a walker with reduced mobility, or parents with small children) but also people for whom architectural barriers are not a problem (PNP).

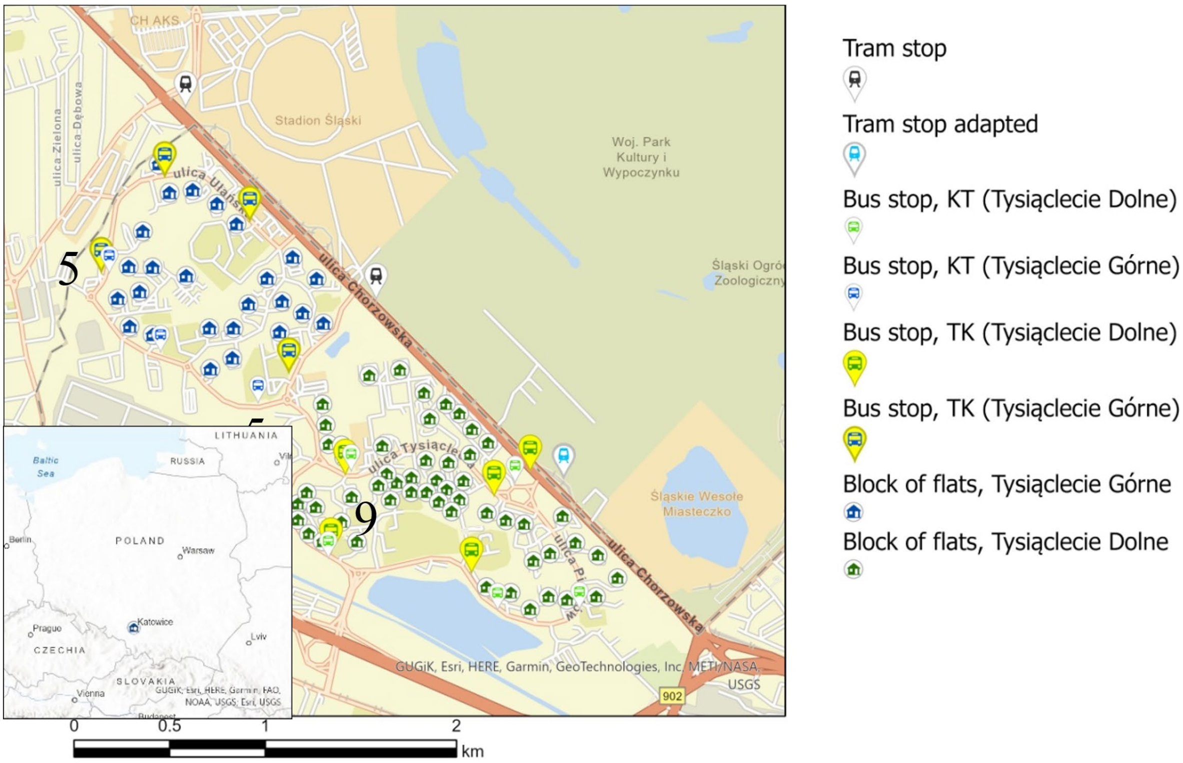

Fig. 5.2. Location of the blocks of flats in Tysiąclecie estate, with division to Tysiąclecie Górne and Tysiąclecie Dolne, bus and tram stops (only one tram stop (blue) has been adapted for people with special needs). Two different direction of travel has been analysed (1) from Tysiąclecie Górne estate to Katowice city center (TK), and (2) from Katowice city center to the Tysiąclecie Górne estate (KT). The numbers indicates the number of bus and tram lines that reach selected stops.

Rys. 5.2. Lokalizacja bloków na osiedlu Tysiąclecie Górne i Tysiąclecie Dolne, przystanków autobusowych i tramwajowych (kolorem niebieskim oznaczono jedyny przystanek tramwajowy przystosowany dla osób o szczególnych potrzebach). Na rysunku wyszczególniono dwa kierunki podróży (1) z Tysiąclecia Górnego do centrum Katowic (TK) oraz (2) z centrum Katowic do os. Tysiąclecia Górne (KT). Liczby wskazują na ilość linii autobusowych i linii tramwajowych dojeżdżających do wybranych przystanków

Source: Own elaboration, 2022.

5.2.2. Methods

The analysis was preceded by a study of the location of stops and the number of bus and tram lines all residents have access to (with and without architectural barriers) within the estate, as well as a survey of residents of Tysiąclecia Górne estate. In summary, in Tysiaclecia estate there are a lot of bus stops in both directions (TK, KT) and only three tram stops. Tram stops in both directions (TK, KT) are located on opposite sides of each other, whereas bus stops to and from city center are not located in close vicinity.

To conduct this study the following methods were used (1) survey – to learn the opinions of estate residents about the accessibility of public transport; and (2) geographical information systems (GIS). GIS tools and technique were used to perform time-distance and buffer analyses of public transport network connections and accessibility. GIS also was used to analyze the profiles of trackway based on data acquired from airborne laser scanning (ALS). Time-distance analyses were performed using ArcGIS. The ALS data was analyzed using the geoportal.gov database and point cloud viewer (geoportal.gov.pl).

5.2.2.1. Interview

The survey was used as a data collection tool to obtain opinions about public transport from residents. The survey included a mix of closed and open-ended questions. On February 1–14, 2022, 30 citizens of Tysiąclecia Górne estate were asked within interview face to face meeting the following questions:

1. Do you think there are any problems with access to public transport in Tysiąclecia estate?
   YES / NO
2. If the answer was “YES” to question 1, then:
   a) Do the problems relate to the location of the stops: YES / NO
      What do you think is the most important problem?
   b) Do the problems relate to infrastructure: YES / NO
      What do you think is the most important problem?
   c) Do the problems concern the timetables: YES / NO
      What do you think is the most important problem?

GIS: Time-distance analyses (buffer and network connection)

Generating Service Areas tools were used to analyze transportation problems related to accessibility and the determination of service areas. Analyses of distance and walking-time were performed using different tools (such as buffer and walking-time area and closest facility) in ArcGIS software. With ArcGIS it is possible to conduct research that considers not only distance but also topography and other features of the research area, as well as the speed and direction of pedestrian movement.

ArcGIS tools linked to Network Analysis such as “Buffer” and “Walking-time area” were used to find the area that covers a given distance from a selected point (bus/tram stop), to answer the following questions: where can people go within a set period of time and what areas are within a given distance of selected bus or tram stops? The areas were calculated based on travel mode (walking) and measure (time or distance). The point features around which areas were calculated included: bus stops toward Katowice city center, bus stops away Katowice city center, tram stops toward Katowice city center, tram stops away from Katowice city center.

Using the Overlay Layers tool to overlay the buffer with the layer containing stops, the following question was investigated “Which buildings are within selected distance of the bus stop or tram stop?” The answer was obtained by creating a selected distance buffer around the stops. The result was a layer of those buildings within selected distance of the stop, or a walking-time area that can be covered within a specified time or walking distance. “Closest facility” tool was used to find the nearest features and rank the distance to them. Results from this tool were used to answer the following questions: What are the road distances between places, what is the nearest bus stop from a selected building, and which buildings can be reached in the shortest walking time from a selected bus/tram stop? How long would the trip be?

To find what's nearest, the tool can measure using either a straight-line distance method or a selected travel mode. In this analysis a straight-line distance method couldn’t be used to analyze public transport accessibility due to the fact that straight lines between two points can be significantly shorter than the real distance of network lines. Measurements must be made along walkways.

In this analysis available travel modes (attribute and parameters) were determined as follows: preferred for pedestrian, avoid roads unsuitable for pedestrians, and avoid private roads. Find Nearest returned a layer containing the nearest features and a line layer that linked starting locations to their nearest locations. These tools were used to determine the area that covers a given distance or time that could be traveled by a pedestrian from bus or tram stops.

GIS: Analysis of the ALS data to understand profile of the trackway

Airborne Laser Scanning (ALS) also known as Light Detection And Ranging (LiDAR)[10] (Wehr and Lohr, 1999) was used as a rapid, highly accurate, and efficient method of capturing 3D data for the trackway next to the tram stop. Airborne laser scanning was used to collect high-resolution data for generation of a digital surface. The ALS data originated from LIDAR PL-EVRF2007-NH symbol: 6.130.29.14.1 (actualization: 2020/05/08). The analysis was done in geoportal.gov.pl.

5.3. Results

There have been many studies of public transportation accessibility in different part of the world[11]; however, scientists usually focus on accessibility to supermarkets[12], selected public services and jobs[13], and temporal variability of accessibility[14]. Some studies have focused on public transport accessibility for wheelchair users and disabled people[15]. Despite increasing public investment in transport, and implementing large projects that give residents more opportunities for efficient movement, there are still many locations where access to public transport is difficult[16]. This study focused on one of these locations – Katowice, Silesian Agglomeration.

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[12] Widener M.J., Farber S., Neutens T., Horner M.:Spatiotemporal accessibility to supermarkets using public transit: an interaction potential approach in Cincinnati, Ohio. Journal of Transport Geography, 2015, Vol. 42, pp. 72–83.

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[16] Stachyra R., Roman K.: Analysis of Accessibility of Public Transport in Warsaw in the Opinion of Users. Postmodern Openings, 2021, Vol. 12, No. 3, pp. 384–403.

5.3.1. Interview

When surveyed, residents for whom architectural barriers do not pose any problems (PNP) most frequently reported the following difficulties with public transport accessibility:

1. inadequate public transport timetables in the evening, night, and weekend hours including too few connections between the Tysiąclecie Górne estate and Tysiąclecia Dolne estate, and a small number of bus connections from the centre of the neighbouring city of Chorzów.
2. location of stops – the distance from stops is a problem for people returning with shopping bags or wanting to get to the train station or airport with heavier luggage; also the long distance to stops affects the sense of safety of residents returning from work at night and is burdensome in unfavourable weather conditions.

The second group of respondents were people with mobility problems (PMP) due to architectural barriers. This group included people on crutches, people with mobility impairments using a walker, or parents of young children. When surveyed, residents for whom architectural barriers such as stairs, high curbs, or no existing ramps were a problem in moving (PPM), the most frequently reported problems with public transport accessibility were:

1. architectural barriers – physical barriers to, or no access at all, to tram stops in the Tysiąclecie Górne estate, numerous stairs, no ramp, no handrails on both sides of the stairs, paved sidewalks with passenger vehicles, and high curbs
2. location of stops – the distance from stops is a problem for people returning with shopping, wanting to get to the train station or airport, or traveling with a child in a pram; the long distance from stops affects residents' sense of safety when returning at night, and the long distances are troublesome in unfavourable weather conditions
3. unadjusted public transport timetables in the evening, night, and weekend hours

Survey responses suggest the city does not respond to the public transport needs of its citizens. The estate is located within Katowice but stops located on the border of the zones seem to belong to "nobody". For example, tram stops located exactly on the border of cities are not adapted to the needs of the disabled, the elderly, or people with mobility problems and may even be completely inaccessible. Existing tunnels with steep stairs, high curbs, and no gentle declines or lowering ramps adapted to people on crutches, wheelchairs, children's prams, or walkers are an insurmountable obstacle to accessing the stop. A simple solution to this lack of access – creating a crossing at a nearby crossroad – would facilitate access to public transport for everyone but has never been tried.

5.3.2. Accessibility of the tram stop – case study 1

The tram stops at Tysiąclecie Górne estate are accessible only for those people who have no mobility problem. Both tram stops (Chorzów Stadion Śląski – Chorzów Silesia Stadium and Park Śląski Wejście Głowne – Chorzów, Silesia Park, Main entrance) near Tysiąclecie Górne estate have been inaccessible for Group PPM. The detailed analysis of the area nearby Chorzów Stadion Śląski – Chorzów Silesia Stadium, showed that the tram stops located exactly on the border of cities are not adapted to the needs of the disabled, the elderly, people on crutches, people using a walker, nor parents with their babies. Existing tunnels have steep stairs, high curbs, and a lack of gentle declines and ramps adapted for people on crutches, wheelchairs, people with walkers, and children's prams.

Fig. 5.3. Comparison of the distance to go as a linear and along network that must be passed by people (PNP and PPM) and existing architectural barriers
Rys. 5.3. Porównanie odległości, którą muszą pokonać piesi (PNP i PPM) w linii prostej oraz wzdłuż ulic uwzględniając istniejące bariery architektoniczne, by dotrzeć z wybranego bloku do przystanku tramwajowego
Source: Own elaboration, 2022.

Moreover, usually, people, with mobility problem (PPM) must travel at least twice as long compared to others (PNP) due to the steep stairs leading to tram stops ("Chorzów Silesia Stadium" and "Chorzów Silesian Park, main entrance"). The drawings show the differences between the distance in a straight line from one of the buildings and the actual distance pedestrians PNP and PPM must travel. The actual distance is greater than the straight line. In the case of people PPM, with architectural barriers this distance may be even doubled (Fig. 5.3).

Concerning the "Chorzów Silesian Stadium" tram stop, people can get to the tram in the direction of Chorzów; however, people traveling from the estate to the Chorzów Stadion Śląski tram stop and to Katowice by tram have to overcome high curbs next to the trackway. Moreover, the trackway has stone track without a pedestrian crossing.

Based on the analysis of the height profile within the trackway using LAS data (Fig. 5.4) it is evident there is no lowering capability; the difference in height is at least 20 cm which makes the transition inaccessible for the most PPM people. At the "Chorzów Silesian Park, main entrance" it was observed that the tram stop was suitable and favorable for PPM people as there was a pedestrian crossing from one site to another site of trackway.

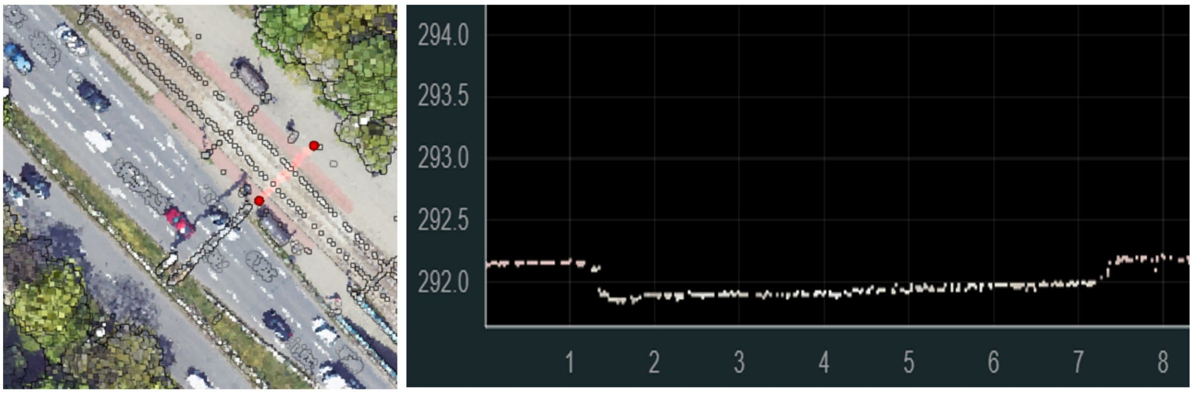

Fig. 5.4. Height profile of the trackway (based on ALS data, created at geoportal.gov.pl), y-axis presents the height of the trackway in centimeters, while x-axis presents the distance in meters. This stop is not adapted to people with special needs

Rys. 5.4. Profil wysokości torowiska (na podstawie danych ALS, utworzonych na geoportal.gov.pl), oś y przedstawia wysokość torowiska w centymetrach, a oś x odległość w metrach. Przystanek ten nie jest przystosowany dla osób o specjalnych potrzebach

Source: Own elaboration.

Another problem for PPM was evident from the survey: when PPM people tried to get into the tram at Chorzów, Silesian Stadium the distance between the sidewalk and the stairs to board the tram is too far (a distance of about several tens of centimeters (Fig. 5.5). It has happened that the wheels of the trolleys get stuck between the car and the stop.

Fig. 5.5. Example of the architecture barrier: a long distance between tram and sidewalk makes this stop not adapted to people with special needs

Rys. 5.5. Przykład bariery architektonicznej: duża odległość między tramwajem a chodnikiem sprawia, że przystanek ten nie jest przystosowany dla osób o specjalnych potrzebach

Source: Own elaboration.

5.3.3. Determination of the service areas: temporal and spatial analysis – case study 2

The Generating Service Areas tools were used to determine the service areas that cover a given distance from the bus or tram stops to the residences. The analysis took into account:

- two different modes of transportation: buses (B) and tram (T),
- two different directions of travel (1) a way from Tysiąclecie Górne estate to Katowice city center (TK), and (2) a way back from Katowice city center to the Tysiąclecie Górne estate (KT), due to the fact that the location of bus stops in these two cases is different.

The cutoff range in this analysis was between 0 km to 0.1 km, 0.1 km to 0.25 km, and 0.25 km to 0.5 km. It was observed, in case of travel mode (B,TK), that the distance to the bus stop from the block of flats was less than 0.5 km, but for PMP the actual distance from house to bus stop can be up to 1 km with architectural barriers. If the speed of this person is 5 km/h, this person must go on foot for nearly 10 minutes to get to the nearest stop (Fig. 5.6).

In the case of B,KT travel mode (Fig. 5.7) it was observed that for many people the distance from the bus stop in the city center to their house can be significantly longer than the B,TK travel mode of going from the city center to their houses. Moreover, the areas of the cutoff range of 0.5 km from bus stops to the houses doesn't cover whole areas of the estate. That can be a problem for people, especially for people with special needs (PMP). An actual distance from house to bus stop can be up to 1 km, and the time needed to get there can be up to 10 minutes (if speed of the motion is 5 km/h).

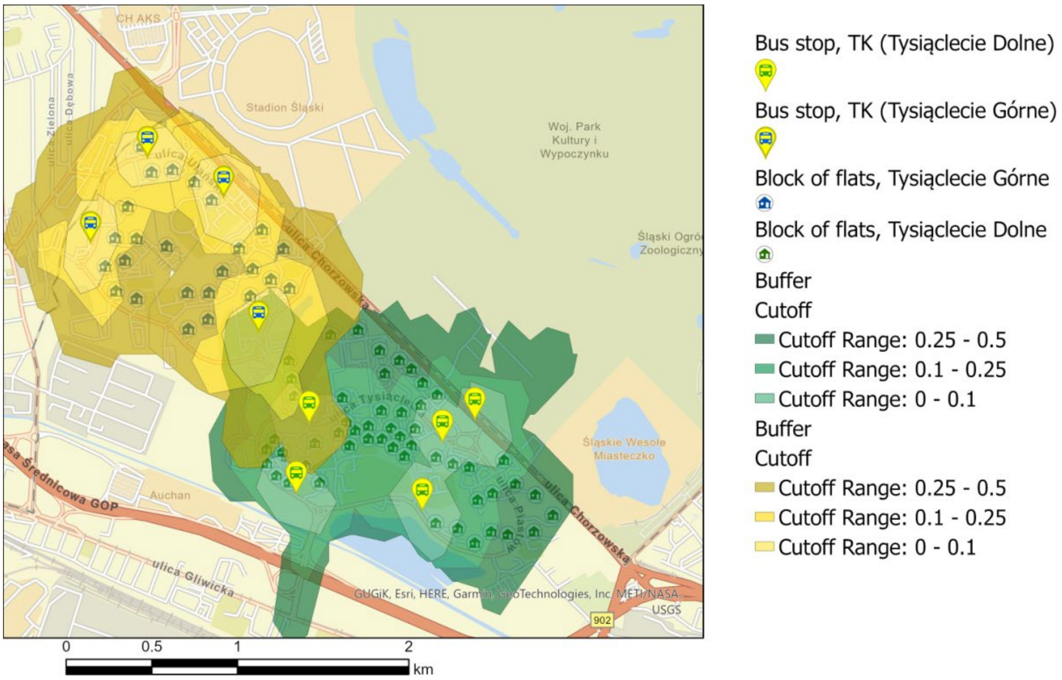

Fig. 5.6. Analysis of public transport accessibility (B, TK). The distances ranged from 0 km to 0.1 km, 0.1 km to 0.25 km, and 0.25 km to 0.5 km

Rys. 5.6. Analiza dostępności do środków transportu publicznego – przystanków autobusowych (B, TK). Odległości: od 0 km do 0,1 km, 0,1 km do 0,25 km i 0,25 km do 0,5 km

Source: Own elaboration.

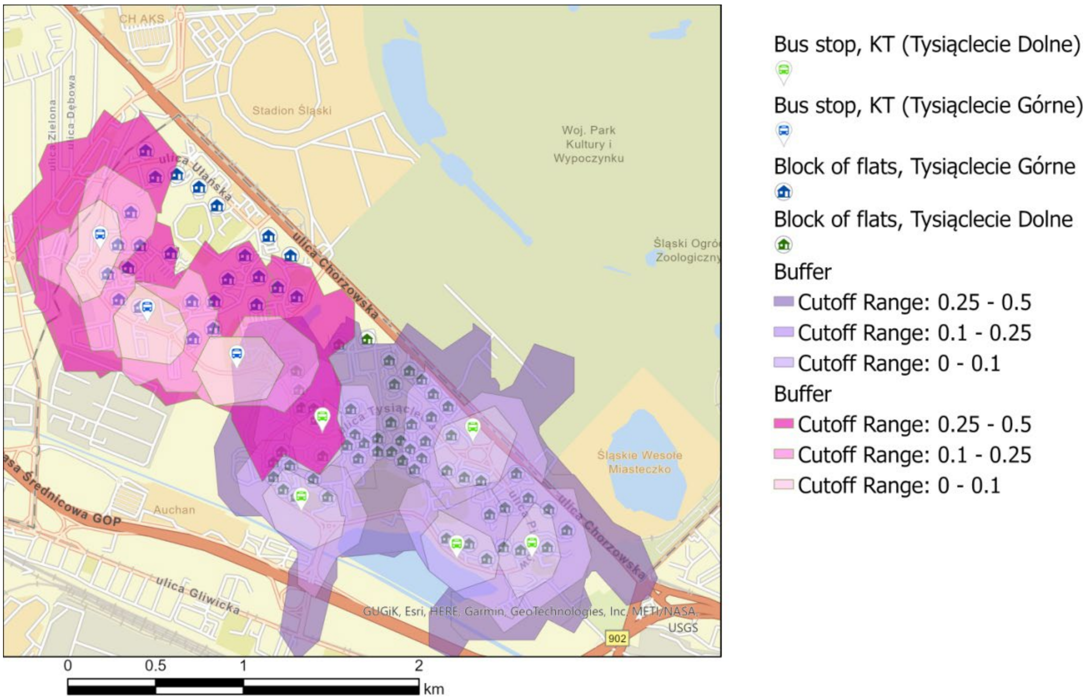

Fig. 5.7. Analysis of public transport accessibility (B, KT). The cutoff ranged from 0 km to 0.1 km, 0.1 km to 0.25 km, and 0.25 km to 0.5 km

Rys. 5.7. Analiza dostępności do środków transportu publicznego – przystanków autobusowych (B, KT). Odległości: od 0 km do 0,1 km, 0,1 km do 0,25 km i 0,25 km do 0,5 km

Source: Own elaboration.

The analysis of tram stop accessibility (T, TK and KT) showed two tram stops were not adapted to PMP. A distance to the nearest tram stop accessible for PMP can be a few kilometers (Fig. 2.8), whereas for PPN a distance can be as short as 0.5 km, but only for residents from a small number of blocks of flats; for the rest of the residents these distances were much farther.

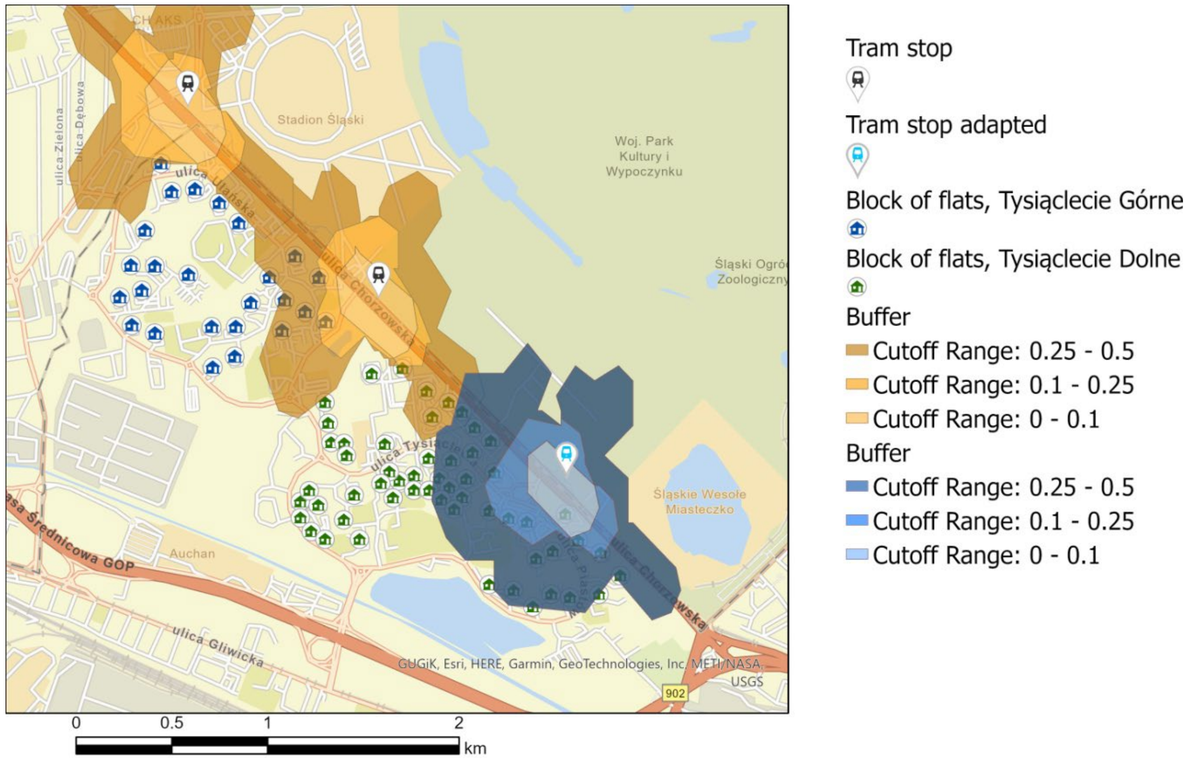

Fig. 5.8. Analysis of public transport accessibility (T, TK and KT). The cutoff ranged from 0km to 0.1 km, 0.1 km to 0.25 km, and 0.25 km to 0.5 km

Rys. 5.8. Analiza dostępności do środków transportu publicznego – przystanków tramwajowych (T,TK i KT). Odległości: od 0 km do 0,1 km, 0,1 km do 0,25 km i 0,25 km do 0,5 km

Source: Own elaboration.

Because tram stops adapted for people with special needs are far from Tysiąclecie Górne estate, upon further analysis the author decided to focus only on travel modes accessible to everyone. Temporal analysis enabled the author to observe how much time someone needs to get from the residence to the nearest bus station. Most of the citizens who move with a speed at least of 5 km/h need about five minutes to get to the nearest bus stop towards the city centre, whereas people who travel from the city centre to their residences need much more time to travel the distance between the nearest bus stop to their homes. Less than 50% of the block of flats were situated where walking time was up to five minutes (Fig. 5.9).

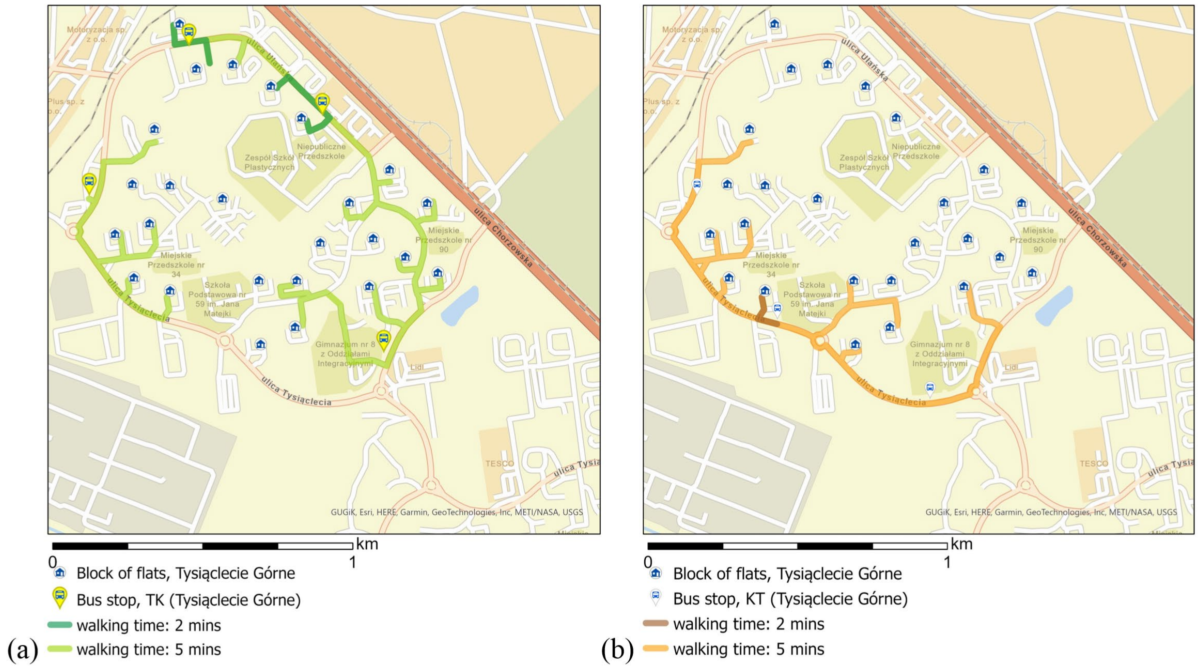

Fig. 5.9. The analysis of the time and distance needed to get to the bus stop towards the center of Katowice (a) and from the city center (b), if a speed of the pedestrian is 5 km/h

Rys. 5.9. Analiza czasowa i przestrzenna: czas potrzebny na dotarcie do przystanku autobusowego i odległość pomiędzy blokami a przystankami autobusowymi, dla linii komunikacji miejskiej (a) w kierunku centrum Katowic oraz (b) z centrum Katowic (b), przy założeniu, że pieszy porusza się z prędkością 5 km/h

Source: Own elaboration.

5.3.4. Connection between Tysiąclecie Dolne and Tysiąclecie Górne estate in the evening and during weekends – case study 3

In studying the location of stops it was clear that bus routes were different for buses from the city center and to the city center of Katowice. Two tram stops closest to the Tysiaclecie Górne estate were not adapted to the needs of the disabled, the elderly and the sick, those who use crutches, people with mobility issues, or parents with young children for whom architectural barriers are a huge obstacle. One can get to the Tysiaclecie Dolne estate from the city center using nineteen bus lines, while Tysiąclecie Górne estate was serviced by only five lines.

Analyzing the bus timetables between Tysiąclecie Dolne estate and Tysiąclecie Górne estate, it was clear that on weekends, and during the night and evening hours on working days, a passenger often must wait almost half an hour to cover a distance of about 2 km by public transport connecting both parts of the estate. It often happens that buses go like a "herd" within a few minutes, followed by a break of about half an hour in communication. The time needed to get on foot from Tysiąclecie Dolne estate to

Tysiaclecie Górne estate (the blocks located near the border with Chorzów, northwest) depend on the speed of motion. If someone moves with a speed of 6 km/h walking time can be about 15–20 minutes. If someone moves slower, the time increases to 25 minutes or more (Fig. 5.10).

Further, more detailed distance-time analysis presented the distance that could be reached by people if they moved with a different speed. This concerned situations where someone is travelling (B, KT and B, TK) in the evening or during the weekend and decides to walk on foot from Tysiąclecie Dolne to Tysiąclecie Górne. In this case, the following variables were taken into account: (1) human movement speed between 3 km/h and 6 km/h (2) location of the bus stops and houses (3) architectural barriers and network connections accessible for PPM people (4) slope and topography, and (5) time of the motion: between 10 and 20 mins.

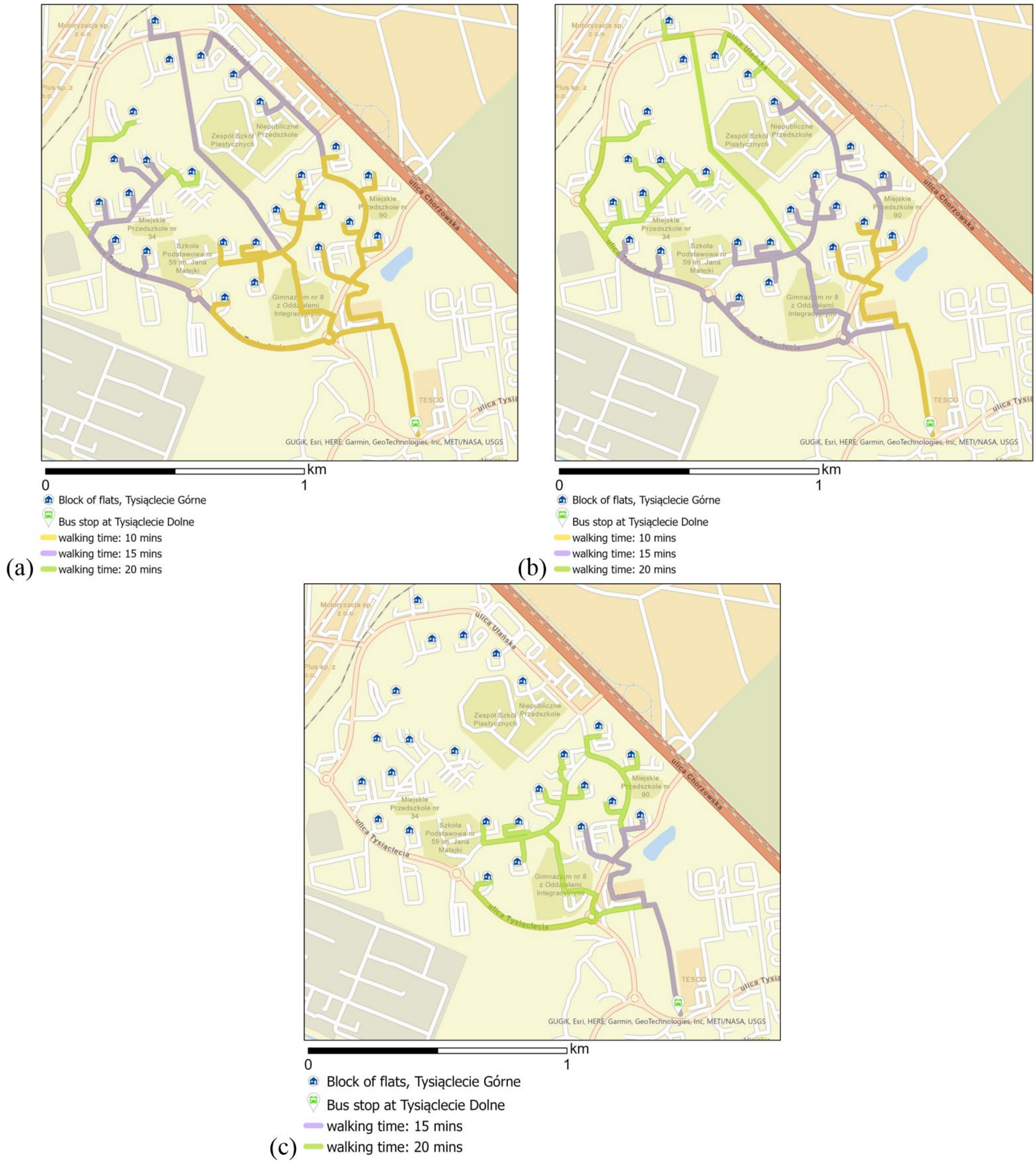

Fig. 5.10. The distance that can be reached by pedestrian depends on the speed (a) 6 k/m; (b) 5 km/h, and (c) 3 km/h, respectively), if they move from Tysiąclecie Dolne to Tysiąclecie Górne estate on foot, due to a lack of connection between two parts of the estate

Rys. 5.10. Odległość, jaką może pokonać pieszy, w zależności od prędkości z jaką się porusza (a) 6 k/m; (b) odpowiednio 6 km/h i (c) 3 km/h), w ciągu 10, 15 i 20 minut, podróżując z ostatniego przystanku zlokalizowanego na Os.Tysiąclecie Dolne w kierunku Os. Tysiąclecia Górnego, w przypadku braku połączenia między obydwiema częściami osiedla

Source: Own elaboration

5.4. Conclusions

This study of public transport accessibility based on a survey and GIS analysis identified the most significant problems in Tysiąclecie Górne estate. Residents indicated the most significant problems were inadequate public transport timetables and the location of stops. The distance from or to stops is a problem not only for people returning from shopping or wanting to get to the train station or airport with heavier luggage, but also for people with mobility problems. Only some stops are adapted to people with special needs.

Architectural barriers make it impossible or difficult to get to certain stops (e.g., numerous stairs, no ramp, no handrails on both sides of the stairs, paved sidewalks with passenger vehicles, high curbs). The long distances from stops affect residents' sense of safety when returning at night. These problems are known but have not been addressed. Adaptation of routes to address the needs of residents should be undertaken as soon as it is possible. The different methods for the analysis of public transport accessibility were presented in this part of monography. To help city authorities and decision makers a new application (https://arcg.is/1nnrjL) has been also created by the author of this monography to collect geoinformation about architectural barriers. This database might be used as a critical tool for decision makers who wish to make public transport more accessible. The volunteered geographic information (VGI) can be harnessed and used as a tool to create, assemble, and disseminate geographic data provided voluntarily. The assembled data will be analysed in the future.