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Pedestrian accessibility of services as a measure of territorial cohesion at the neighbourhood level

Łukasz Damurski[1, CDFMR], **Jacek Pluta**[2, CDFMR], **Wawrzyniec Zipser**[3, CDFMR]

Wrocław University of Science and Technology, Faculty of Architecture, Urban Planning and Design and Settlement Processes, Wrocław, Poland, phone: +48713206240, e-mail: lukasz.damurski@pwr.edu.pl *(corresponding author)*, https://orcid.org/0000-0002-9384-9075; *University of Wrocław*, Institute of Sociology, phone: +48713755124, e-mail: jacek.pluta@uwr.edu.pl; *Wrocław University of Science and Technology*, Faculty of Architecture, Urban Planning and Design and Settlement Processes, Wrocław, Poland, phone: +48713206240, e-mail: wawrzyniec.zipser@pwr.edu.pl

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Abstract. Territorial cohesion, despite its initial ambiguity, has been successfully implemented in national and regional policies across the EU. However, its operationalisation on the local level remains a major challenge. This paper asks whether pedestrian accessibility of services and public transport nodes can be used as a measure of territorial cohesion at the local level. The presented research was conducted in 2016–19 in five neighbourhoods in Poland representing various settlement contexts: large cities, medium-sized towns and suburban areas. It adapted particular indicators of territorial cohesion established by ESPON to the neighbourhood scale. The highest levels of territorial cohesion expressed by users' satisfaction were achieved in a neighbourhood in a medium-sized town, whereas in geographical terms, territorial cohesion reached higher levels in large cities. Despite those differences, the proposed research method based on pedestrian accessibility offers quantifiable and comparable results on territorial cohesion on the neighbourhood level.

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1. Introduction

In 2007 Faludi described territorial cohesion (TC) as a purposely vague, negotiated concept, which allows governments and EU institutions to define it in accordance with their own interests, preferences and development challenges. Due to its multidimensional and dynamic nature and the heterogeneity of its users, TC lacked clarity and generated endless disputes about its definition, measurement and application (Dao *et al.*, 2017).

During the last decade the ambiguity of "territorial cohesion" has mostly been resolved, although its implementation still represents a major challenge to regional actors needing to respond to European Union directives within their policy agendas (Sá Marques *et al.*, 2018). Drevet (2007) and Van Well (2012) describe it as a "moving target" that is hard to hit and hard to grasp. Policy-makers are forced to define their approaches towards achieving territorial cohesion but the European guidelines are elusive in terms of what creating a "cohesive territory" entails (Sá Marques *et al.*, 2018).

Despite those difficulties, several spatial developmental strategies are required at the regional level to pursue the objectives of territorial cohesion policy (Luukkonen & Moilanen, 2012). The local level remains unaddressed, however.

In this paper we discuss the existing measures of TC used on the national and regional levels and select three indicators to be adapted to the local level (accessibility of schools, grocery services and rail). The general research question of this study is: "Can accessibility of local (everyday) services be used as a measure of territorial cohesion in urban neighbourhoods?" In order to answer this question we analyse five case studies in Poland representing various geographical contexts (urban and suburban). A multi-disciplinary research programme, including social research and advanced GIS modelling methods, provides novel, comprehensive knowledge on how the concept of TC can be operationalized at the local level. Our conclusions suggest that local (neighbourhood) service centres are necessary in order to shape TC in urban neighbourhoods.

2. Territorial cohesion: core interpretations of the concept

Territorial cohesion is an essential goal for the 27 Member States and it is written into the Treaty of Lisbon as an aim to be pursued in order to ensure development in all regions – be they urban, rural, sparsely populated, peripheral, coastal, mountainous, in New Member States or in Old Member

States – in accordance with their own territorial capital (Van Well, 2012). Article 16 of the current Treaty establishing the European Community already refers to this concept, but merely as a rationale for maintaining "services of general economic interest" (European Union, 2002).

Faludi (2007) argued that the logic of territorial cohesion might be found in the Third Cohesion Report (European Commission, 2004), which stated that people should not be disadvantaged by wherever they happen to live or work in the Union. Territorial cohesion is thus about a just distribution of opportunities in space, seen as a precondition to achieving growth, competitiveness, employment and sustainable development (Nosek, 2017).

One important strand of territorial cohesion is citizen access to affordable public infrastructure services. Accessibility problems may arise in areas where geographical isolation or lower population density makes provision less profitable, such as peripheral regions and rural areas. Even where supply networks are built and problems of accessibility reduced, affordability issues may occur as market-oriented provision in areas associated with lower profitability means that citizens bear the extra costs (Clifton *et al.*, 2016). As a result, the implementation of cohesion policy focuses on supporting both growth poles and regions that are lagging behind. The units of intervention are mainly functional areas rather than administrative units; strategies are more integrated, and different levels of government become more engaged in policy-making processes (Nosek, 2017). In this context, scalability and adaptability become critical factors for the effectiveness of cohesive urban planning in the EU.

2.1. Scalability of territorial cohesion

Territorial cohesion may also be viewed as a feature (or a set of features) of a particular area. In other words, each territory is characterised by a higher or lower level of cohesion. Taking this perspective, TC can be analysed at macro, meso and micro scales, and its measures and indicators should be adjusted to the analysed area.

Depending on the scale, TC analysis may take a more functional or more structural approach. The functional analysis is always conducted for a particular spatial unit (e.g. a district or a neighbourhood) where borders are clearly defined. Such analysis describes the functional structure of the selected area, and depending on the researcher's perspective (be it an expert or a user) it can be objective or subjective.

In the structural approach the properties of particular spatial elements are analysed. The role of the social component is reduced in favour of the material infrastructure. Delimitation of particular areas is not necessary to conduct such analysis and this approach is always objectivistic (see Table 1).

The two perspectives, functional and structural, are attached to different levels of analysis. They do not exclude each other, but are complementary and provide information on different aspects of territorial cohesion.

For research practice it is important to define the resources and functions that are relevant to TC on a particular level. At the macro and meso scale TC will refer to measurable, concrete characteristics of the selected area, such as urbanisation, population density, transportation network, railway network, GDP *per capita*, employment, unemployment, age structure, education, internal and external migrations (see Prażniewski, 2009). In those scales territorial policies will focus on strengthening particular statistical characteristics of a given area. At the micro level, TC includes more social features, focusing directly on people and their needs, expressed by quality of life, neighbourhood satisfaction, activities in public spaces, image of a place, etc.

Table 1. Three levels of territorial cohesion and their characteristic features

Level (scale)	Dominating approach	Subject of the analysis	Object of the analysis	Area	Methods	Research perspective
macro and meso	structural	space, territory	material resources	abstract, unlimited	quantitative	objectivistic
micro	functional	people, community	satisfaction of needs	concrete, limited	quantitative and qualitative	objectivistic or subjectivistic

Source: authors' own research

2.2. In search of indicators

A strong methodological *modus procedendi* for operationalising TC has been proposed by Dao *et al.* (2017), who noted that particular indicators should be used to understand a situation, to design solutions, to take decisions, to evaluate their implementation and to communicate results. In line with this approach, 32 main indicators of TC within six territorial priorities were introduced and adopted at the EU level (ESPON, 2012).

In the perspective of scalability issues presented above not all of the indicators proposed by ESPON (2012) can be directly applied at the local scale. Some of them can be considered in wider contexts only, and some are too general and do not give representative results for urban neighbourhoods. Eventually, three indicators within the territorial priority "Fair access to services, market and jobs" were selected for detailed analysis: Access to compulsory school; Accessibility of grocery services; and Accessibility potential by rail.

The adoption of the selected TC indicators to the local scale required a minor revision of their range and content, taking into account the specific context of urban neighbourhoods. In this study they have been adapted in the following way:

- "Access to compulsory school" has been replaced by access to all public services typically existing in urban neighbourhoods, i.e. schools, kindergartens, basic healthcare facilities, sports and leisure facilities, parks, culture, churches, libraries, social service and security, administration;
- "Accessibility of grocery services" has incorporated also other non-public services;
- "Accessibility potential by rail" has been extended to urban public transport in general.

The changes introduced do not affect the very nature of the three indicators, as they retain basic values and are representative for the concept of territorial cohesion in general.

2.3. Measuring accessibility

Provision of services and public transport to citizens in urban areas can be considered from various perspectives (e.g. social, geographical, economic, administrative), each of which uses its own methods and brings different information. Such multiplicity of approaches may be summarised with three terms: availability, accessibility, and affordability.

Availability describes the range and diversity of services offered in a particular location. It embraces the existing branches of the service sector, as well as their spatial and organisational form. Availability is modulated by market conditions (including competition processes) and by customers' needs and expectations. It is usually characterised by big dynamics in time.

The second term – accessibility – is connected with travelling between "sources" and "targets" in the neighbourhood. Accessibility studies produce maps with time–space zones (isochrones) for certain facilities that are determined by particular means of transport (on foot, by bike, by car, by public transport – see for example Mao & Nekorchuk, 2013). Such maps may help to evaluate the number of residents within selected time zones and thus to define the level of accessibility of various services. It is quite obvious that various types of services, due to their specific character and particular users' demand, have different accessibility zones. It is also important to distinguish between "local" services, which should be reachable on foot, and other services.

Ultimately, the term "affordability" is used within the economic approach and describes the probability of using particular services considering their price and taking into account the affluence of customers. It serves to answer the question of whether the amenities offered in a given location are not too expensive for the clients.

In this paper we focus on accessibility of services defined as a possibility to reach a particular target in space, satisfying essential, everyday needs of users. Such definition locates accessibility on the intersection of territorial (geographical) measures of urban structures and social studies related to customers' satisfaction in daily interactions. Accessibility is more than just a measure of vehicle speed: it incorporates a focus on the proximity of origins to destinations, the concentration or spatiality of activities, the quality of mobility systems available to overcome spatial separation, and the perceptions, interests and preferences of people who live and

work there (Hull *et al.*, 2012). Accessibility has also a positive relationship with neighbourhood livability (see Lovejoy *et al.*, 2010; Mouratidis, 2018): residents in "compact cities", where density of housing is relatively high, accompanied with various facilities and offering easy access to public transport, appear to be significantly more satisfied with their neighbourhood compared with residents of sprawling suburbs.

According to Cresswell (2010), in the daily experience of urban space we can encounter several aspects of mobility: "How fast does a person or thing move?"; "What route does it take?"; "How does it feel?"; and "When and how does it stop?". However, in her discussion on accessibility and mobility, Susan Handy (2002) suggested that mobility is merely the potential for movement, the ability to get from one place to another, while accessibility is the potential for interacting among different and distributed urban activities. According to this view the final aim of accessibility planning is to increase the number of opportunities within a fixed time zone, and mobility aims only at increasing the number of kilometres travelled. In other words, mobility represents the "ease of movement" whereas accessibility describes the "ease of reaching the desired activities" (Rosetti *et al.*, 2015).

After considering various arguments and analysing preliminary results of the social survey in this paper we decided to focus on pedestrian movement to services and to public transport nodes. The reasons for such decision are as follows: (i) local services by definition should be accessible to neighbourhood residents on foot, possibly on their way home from work (Korzeniewski, 1989; Busi, 2009), (ii) a bike is ineffective for short distances, (iii) travelling by car to neighbourhood services is unusual and statistically rare.

Another argument stems from the recent trend in urban planning, pointing at the need to design pedestrian-friendly environments in order to raise the "walkability" of urban areas (see for example Zhang & Mu, 2019). Beyond improving public health, walking reduces traffic congestion, energy consumption, air pollution and related expenses. It also offers more livable communities with more efficient short errand trips and economic benefits to the local business and real estate. Yet, walkability can mitigate the unequal accessibility for economically, socially or physically disadvantaged people. It is more than just a mode of transportation: it can be a social choice, a recreational workout, or even an aimless activity (Litman, 2018).

Bearing in mind the considerations presented above the main challenge of this paper is to link services' accessibility with the TC concept at the local (neighbourhood) level. This task is addressed on a multi-disciplinary basis, integrating social research and geographical analysis within a GIS environment. We ask the following detailed research questions:

1. What is the subjective (perceived) accessibility of everyday services by the users in various settlement contexts? How do customers evaluate their neighbourhoods in terms of services availability? What are the mobility patterns in reaching essential amenities?
2. What is the objective picture of pedestrian accessibility in particular neighbourhoods? How can users' preferences regarding time–space relations be included in geographical research? What measures can be used to describe territorial cohesion at the local level?

The three-step research method used in this study is expected to offer quantifiable results describing the TC level in urban neighbourhoods.

3. Materials and methods

3.1. The three-step research method: initial remarks

In this paper we adopt a mixed-methods research strategy (Venkatesh *et al.*, 2016), taking advantage of several, complementary research techniques and using both place-based and people-based measures of accessibility. In its essence it appeals to the Perceived importance and Objective measurement of Walkability in the built Environment Rating (POWER), which captures both perceived and objective aspects of the built environment (Zhang & Mu, 2019).

The proposed three-step interdisciplinary approach includes inventory, social research and GIS studies. The desk research and field research was

conducted in the years 2017–19 in five locations in Poland representing various geographical settings (large cities, medium towns and suburban areas – see the details of the research sample below). The selection procedure started at the country level and followed several criteria, including: (i) availability of data; (ii) dynamics of spatial development; (iii) administrative functions; (iv) spatial policy analysis. After a preliminary selection of case studies, additional criteria were adopted at the local level, such as distance from larger concentrations of services, settlement structures or attitudes of local authorities towards service centres planning. A detailed description of the selection procedure is provided in a book by Ł. Damurski (2020).

In general, the research programme comprised of the following stages:

1. In the first step, a thorough inventory of selected locations was carried out, including delimitation of research areas (local service centres and their surroundings), typology of available services and their spatial distribution.
2. In the second step, social surveys (paper-and-pencil interviews) were conducted among two groups of respondents: residents and users of public spaces. The questionnaires provided detailed information on the average distances in everyday journeys to local services and the most popular means of transport.
3. In the third step, extensive mapping data was analysed, including spatial distribution of neighbourhood population and paths available to pedestrians. Accessibility analyses based on this data indicated the number of population within particular time zones and outlined some positive and negative aspects of everyday travelling patterns.

The details of the method are presented below.

3.2. The five case studies

The basic research unit of the presented research is a neighbourhood with its local service centre (LSC). Such delimitation of research subject carries particular connotations with the concept of the "neighbourhood unit" proposed in the 1920s by C. Perry (1998) as an answer to the mass-scale urban development of the industrial age. The neighbourhood unit offered a functional, self-contained and desirable living environment. Its characteristic feature was a community centre placed in the middle of a residential area, including a school so that a child's walk to school was only about one quarter of a mile and could be achieved without crossing major arterial streets.

Moving this concept forward, Vincenzo Columbo (1966) defined urban elementary units in relation to the daily movements of their inhabitants. According to his "organic urban planning vision", the neighbourhood is the place of proximity, where the elementary functions of daily life are located (basic shops, kindergartens ...), while in the district the social life takes place and life centres (civil, religious and commercial functions) are located. Thus the concept of neighbourhood incorporates the fact that the system of local mobility is walking. As reiterated by Busi (2009), life centres tend to align themselves along an axis, which is called the "axis of life". The axis of life is essentially characterised by pedestrian movement.

For the purpose of this paper a neighbourhood service centre is defined as a specific urban structure including multi-functional public space and surrounding buildings providing access to local (everyday) services (Damurski *et al.*, 2019). In this paper we focus on five LSC's in Poland, representing various settlement contexts: large cities (Warsaw, Wrocław), medium-sized towns (Ostrów Wielkopolski) and suburban areas (Siechnice, Zabierzów). This research sample is not random nor representative in statistical terms, but reflects the purposive approach to community resources research (Ohmer *et al.*, 2019) and offers a good insight into different locations.

3.3. Inventory

The first task was to define the range of each local service centre. Local Service Centre borders were drawn by the buildings with services in the ground floor, including public spaces between them (streets, squares, pathways, greenery areas – see Fig. 1).

The second task was to build a spatial database of existing facilities based on maps retrieved from

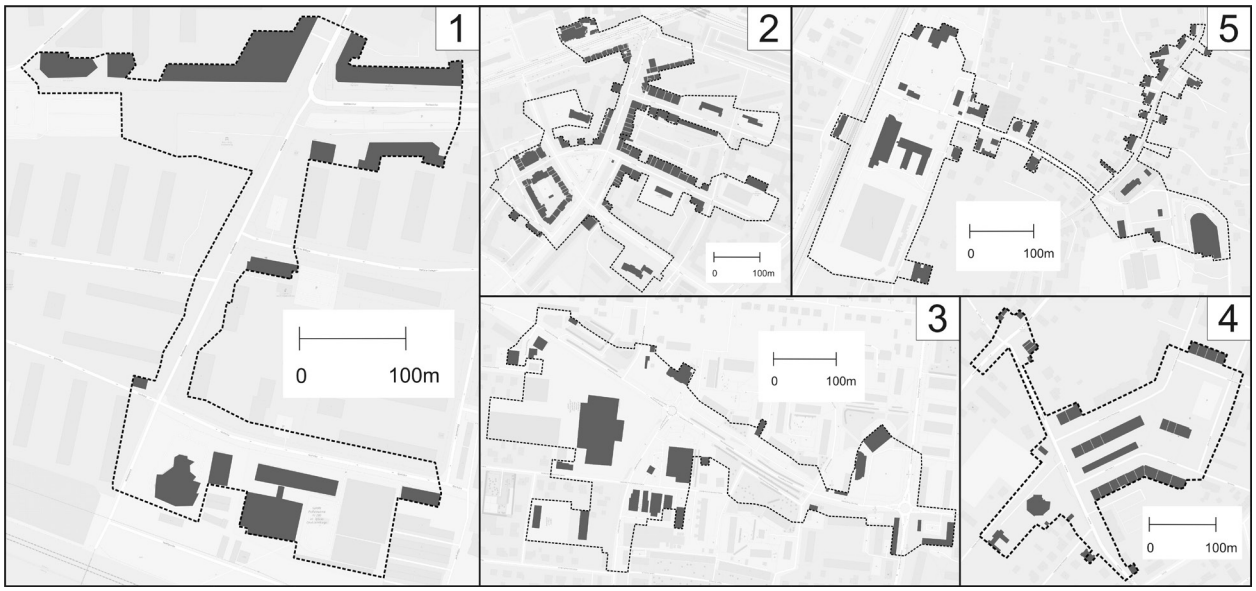

Fig. 1. Local service centres selected for the study: (1) Mołdawska street in Warsaw, (2) Pereca Square in Wrocław, (3) Waryńskiego, Śmigielskiego and Paderewskiego streets in Ostrów Wielkopolski, (4) Rynek in Siechnice, (5) Kolejowa and Krakowska streets in Zabierzów

Source: authors' own research. Sources of background maps: https://www.openstreetmap.org

various sources (geodesy and cadastral institutions, as well as Open Street Map). In order to systematise the study and to ensure its comparativeness we adopted a single standardised typology of services in all the case studies, including seven categories: grocery shops, postal and financial services (post office, bank), healthcare (GP, clinic, walk-in clinic), gastronomy (café, bar, pub, restaurant), education (schools, kindergartens), administrative (institutional) services, other services (culture, hairdresser, beauty, fitness, etc.). Table 2 shows the distribution of particular categories in the five analysed LSCs.

Table 2. Statistics on amenities and public transport nodes available in the five studied locations

Amenities	Warsaw	Wrocław	Ostrów Wlkp.	Siechnice	Zabierzów
grocery shops	43	24	11	6	6
specialized services	35	45	37	7	23
healthcare	2	10	5	3	3
gastronomy	6	6	4	5	4
education	2	4	5	2	5
institutional services	5	7	6	7	12
other services	12	24	13	7	8
Total	105	120	81	37	61
area [ha]	6.73	10.45	12.63	5.23	9.19
density of amenities [per 1 ha]	15.6	11.48	6.41	7.07	6.64
Public transport nodes	Warszawa	Wrocław	Ostrów Wlkp.	Siechnice	Zabierzów
bus stops	9	9	5	5	3
tram stops (rail stop)	(1)	3	0	0	(1)
Total	10	12	5	5	4
density of public transport nodes [per 1 ha]	1.34	1.15	0.4	0.96	0.44

Source: authors' own research

As Table 1 shows, the number of services decreases with the size of the settlement in which a particular LSC is located. The highest density of amenities is observed in Warsaw, and the lowest in Ostrów Wielkopolski, due to the quite wide spatial range of this LSC.

3.4. Social survey

In the second step, paper-and-pencil interviews (PAPI) were conducted among two (partly overlapping) groups of adult respondents: residents and users of public spaces. Residents were interviewed in their homes (representing the factual local community members) whereas users were interviewed in public spaces (reflecting the factual customers of services). The questionnaire included 12 main questions dealing with customers' habits and preferences about local services, plus five "metrics" questions including age and family situation of respondents.

The questionnaires were distributed in each LSC by students of the Wrocław University of Science and Technology in selected public spaces and residential areas. The distribution was systematically organised: it was conducted in the spring–summer season, on selected weekdays (usually Wednesday and Sunday), at various times of the day (9:00–12:00 and 16:00–19:00), recruiting one pedestrian in three (every second resident) for interview. This approach provided necessary standardisation of research and allowed the variety of local population and its daily routines and behaviours to be captured.

A total of 618 filled questionnaires were collected (295 from public space users and 323 from residents – see Table 3), providing detailed information on the average distances in everyday trips to local services, and the most popular means of transport. We present them in three generalised groups, representing different levels of urbanisation: large cities (Warsaw, Wrocław), medium-sized towns (Ostrów Wielkopolski) and suburban areas (Siechnice, Zabierzów). This research sample is not representative in statistical terms, which means that the results cannot be generalised to the whole population. However, it is reliable in methodological terms and allows some general remarks on LSC characteristics to be made. The detailed description of the respondents' characteristics has been provided in a separate publication (Damurski *et al*., 2020).

3.5. GIS analysis

The accessibility analyses presented in this paper are based on a classic time- and space-related geography (Hägerstrand, 1970), which aims to describe space by using distance-based indicators expressed in time units (Bryniarska & Starowicz, 2010). Juxtaposition of destinations (e.g. service points or public transport nodes) and constraints that affect the space penetration (e.g. buildings or highways) al-

Table 3. Number of questionnaires filled in particular locations

Local service centre		Number of respondents					
location	name	Street survey in public spaces		Self-administered survey in homes		Total	
		number	%	number	%	number	%
large cities	Warsaw: Mołdawska street	79	26.8	82	25.4	161	26.1
	Wrocław: Pereca square	64	21.7	95	29.4	159	25.7
medium towns	Ostrów Wielkopolski: Waryńskiego street and surroundings	66	22.4	69	21.4	135	21.8
suburban areas	Siechnice: market square	30	10.2	43	13.3	73	11.8
	Zabierzów: Kolejowa street and surroundings	56	19.0	34	10.5	90	14.6
Total		**295**	**100.0**	**323**	**100.0**	**618**	**100.0**

Source: authors' own research

low comparative analysis of various areas to be conducted.

Thus, if we link the speed of pedestrian movement, the diversity of possible routes and the impedance of space existing in a particular area, we will obtain quite a realistic picture of time-space accessibility expressed by isochrones. Such a study requires: 1) source points representing the location of customers; 2) target points representing the distribution of service nodes and 3) means of transport, including their routes and the morphology of a particular territory (Guzik, 2003).

In this research the accessibility analysis was performed using ArcGIS tools, based on the Network Analyst module, which allows "shortest path" analysis to be conducted and the catchment areas of services to be designated. The network of pedestrian transport was created covering all LSC areas where walking is possible (including sidewalks, park alleys, gates in buildings, squares, stairs, etc.). The potential speed of movement assigned to particular sections of the network was estimated at an average value of 3,500 metres per hour.

Another key parameter of accessibility is the "critical range of contact", i.e. the maximum isochrone for trips to services. This critical range is related to several factors: spatial distribution of services, quality of transportation system, average speed of users and ultimately the customers' preferences. Another important parameter for accessibility analysis is the number of population within specified isochrone. It can be obtained directly from public statistical resources or estimated by considering the average population density and types of residential buildings.

4. Research findings: accessibility of local services evaluated subjectively by users

4.1. Local (everyday) services: what are they?

In order to precisely distinguish essential local services from higher-order services we asked the respondents to allocate particular functionalities they realise in their neighbourhoods into one of four categories: in this LSC, near this LSC, in another neighbourhood/district, or in another town/city. The results show that the most common functions realised in local service centres are: small (everyday) shopping (60.2%), postal services (59.5%), financial services (banks, cash machines, 41.5%), larger (weekly) shopping (32.4%), and spending free time with family (25.9%). Near the LSC, respondents use healthcare services (GP, walk-in clinic, clinic, 35.5%) and other services (culture, hairdresser, beauty, fitness, florist, 31.8%). Functions conducted mostly outside the LSC are meeting friends (32.7%) and eating out (bar, restaurant, café, 27.3%). Other categories, such as walking with children, open-air physical activity (jogging, Nordic walking), walking the dog or taking children to and from school/kindergarten remain unclassified due to the low number of respondents who referred to them.

The number of needs satisfied inside the LSC may be a useful measure of how self-contained LSCs are in various settlement types. The so called "balance of functions" is presented in Table 4.

The results are surprisingly different from the statistics presented in Table 2. In general, LSCs satisfy most of the analysed needs within or near their borders. However, despite relatively low density of amenities available in the LSC located in the medium-sized town, this centre satisfies most of the users' needs in place. Conversely, large-town examples are less self-contained in the users' opinion, despite the high number of service points located within their borders. This observation will be important when evaluating the indicators of territorial cohesion in neighbourhoods in various types of settlements.

4.2. Mobility patterns in local service centres

Most of the respondents arrive at the LSC on foot (453 persons – see Table 5), and some by car (117 people, mainly in Ostrów Wielkopolski) and by public transport (100 people). Only a few respondents (59) arrive by bike. These results prove the unquestioned role of pedestrian movement in the LSC.

The distribution of the declared time of travel (Table 6) shows that, notwithstanding the means of transport, most users reach the LSC in five minutes (58.6% of answers). The majority of them come to the centre on foot, which means that they are local

Table 4. Balance of functions realised by respondents inside and outside the LSC, by settlement type

Feature	LARGE CITIES (Warsaw and Wrocław)	MEDIUM-SIZED TOWN (Ostrów Wielkopolski)	SUBURBS (Siechnice and Zabierzów)	Average
Average number of needs satisfied in the LSC and near the LSC (range 0–13)	5.8	9.5	6.8	6.8
Average number of needs satisfied outside the LSC	3.2	0.3	4.7	3.0
Difference between the average number of needs satisfied in the LSC and outside the LSC	2.6	9.1	2.0	3.9

Source: authors' own research

Table 5. Ways of accessing local service centres by settlement type. The values for all categories do not sum to 618 (total number of respondents) as interviewees could give more than one answer

Means of transport		LARGE CITIES (Warsaw and Wrocław)	MEDIUM-SIZED TOWN (Ostrów Wielkopolski)	SUBURBS (Siechnice and Zabierzów)	Total number of answers
on foot	number of answers	230	101	122	453
	% of respondents	72.78%	76.52%	77.22%	
by public transport	number of answers	78	12	10	100
	% of respondents	24.68%	9.09%	6.33%	
by bike	number of answers	32	15	12	59
	% of respondents	10.13%	11.36%	7.59%	
by car	number of answers	41	40	36	117
	% of respondents	12.97%	30.30%	22.78%	
Total number of respondents who answered the question		**316**	**132**	**158**	**606**

Source: authors' own research

Table 6. Travel time to local service centres from homes. Compound data for all locations. The values for all categories do not sum to 618 (total number of respondents) as interviewees could give more than one answer regarding the means of transport.

Travel time to LSC	on foot		by public transport		by bike		by car		Total	
	number	%	number	%	number	%	number	%	number	%
up to 5 minutes	285	62.9	42	42.0	34	57.6	66	56.4	427	58.6
6–10 minutes	88	19.4	23	23.0	7	11.9	21	17.9	139	19.1
11 minutes or more	45	9.9	29	29.0	16	27.1	25	21.4	115	15.8
no answer	35	7.7	6	6.0	2	3.4	5	4.3	48	6.6
Total	**453**	**100.0**	**100**	**100.0**	**59**	**100.0**	**117**	**100.0**	**729**	**100.0**

Source: authors' own research

residents. However, there is quite a big group of users who arrive from larger distances by public transport, bike and car (263 respondents, 36.0%). This group probably uses the services in the particular LSC due to the low accessibility of services in their own neighbourhoods or due to high attractiveness of services offered in the studied LSC.

4.3. Preferred and acceptable distance of pedestrian accessibility

In this section we focus on pedestrian movement only in order to link accessibility with the concept of "walkability". The distances presented in Table 6 are evaluated differently in different locations (Table 7). Generally, most of the respondents are satisfied with the time it takes to walk to the LSC, though some interesting patterns may be observed depending on the type of settlement. It seems that in large cities people are used to walking longer distances – they do not mind going up to 11 minutes to reach everyday services. In the medium city the accepted distance is much shorter (from 4.4 to 5.3 minutes) which may be partly explained by the higher rate of car trips. And in suburbs, where physical distances are naturally longer due to the dispersion of urban land-use, respondents are willing to undertake slightly longer trips than in medium cities (up to almost 9 minutes). This uneven distribution of opinions may be explained on one hand by the differences in perception of space in various locations, and on the other by available infrastructure for pedestrians (sidewalks, footpaths, etc.).

Notwithstanding the reasons, it may be concluded that the preferred (close) distance from the place of residence to the local service centre is about five minutes, whereas the acceptable (optimal) distance is about ten minutes. These two time zones comply with the results of other authors (e.g. Gehl, 2009) and will be applied in the GIS mapping tool in the following section in order to conduct an accessibility analysis.

5. Research findings: accessibility of local services evaluated objectively by GIS tools

5.1. Pedestrian isochrones

As stated in the methodological section, in this paper we focus on pedestrian movement as the most natural way of penetrating neighbourhoods. In the last step of our study we applied the 5-minute and 10-minute walking zones indicated by the LSC users into a GIS accessibility analysis. The resultant maps (Fig. 2) show spatial ranges of the isochrones in each LSC. Residents living in particular zone have access to at least one of the services located within a particular time distance.

A simple observation of the urban tissue in each of the time zones suggests that areas situated closer to the LSC are characterised by higher density of buildings than those located further away. This observation is proven in population distribution: in each LSC the size of population decreases with distance from the concentration of services (Fig. 3).

Such relationship between services accessibility and housing structure reflects a natural concen-

Table 7. Pedestrian accessibility of local service centres and its evaluation (by settlement type). Table juxtaposes the answers to the questions "How long does it usually take to get to the LSC?" and "How do you evaluate this distance?"

	LARGE CITIES (Warsaw and Wrocław)		MEDIUM-SIZE CITY (Ostrów Wielkopolski)		SUBURBS (Siechnice and Zabierzów)		TOTAL	
Distance evaluation	**% of respondents ***	**Average declared distance in minutes**	**% of respondents ***	**Average declared distance in minutes**	**% of respondents ***	**Average declared distance in minutes**	**% of respondents ***	**Average declared distance in minutes**
far	1.8	9.5	1.0	20.0	0.8	12.0	1.3	13.8
acceptable	27.3	11.1	27.7	5.3	33.1	8.9	29.0	8.5
close	63.0	6.1	69.3	4.4	64.5	4.1	64.8	4.8
I have no opinion	4.4	6.9	2.0	17.5	0.8	no data	2.9	12.2

Source: authors' own research. * Values for all categories do not sum to 100% as not all interviewees answered all the questions

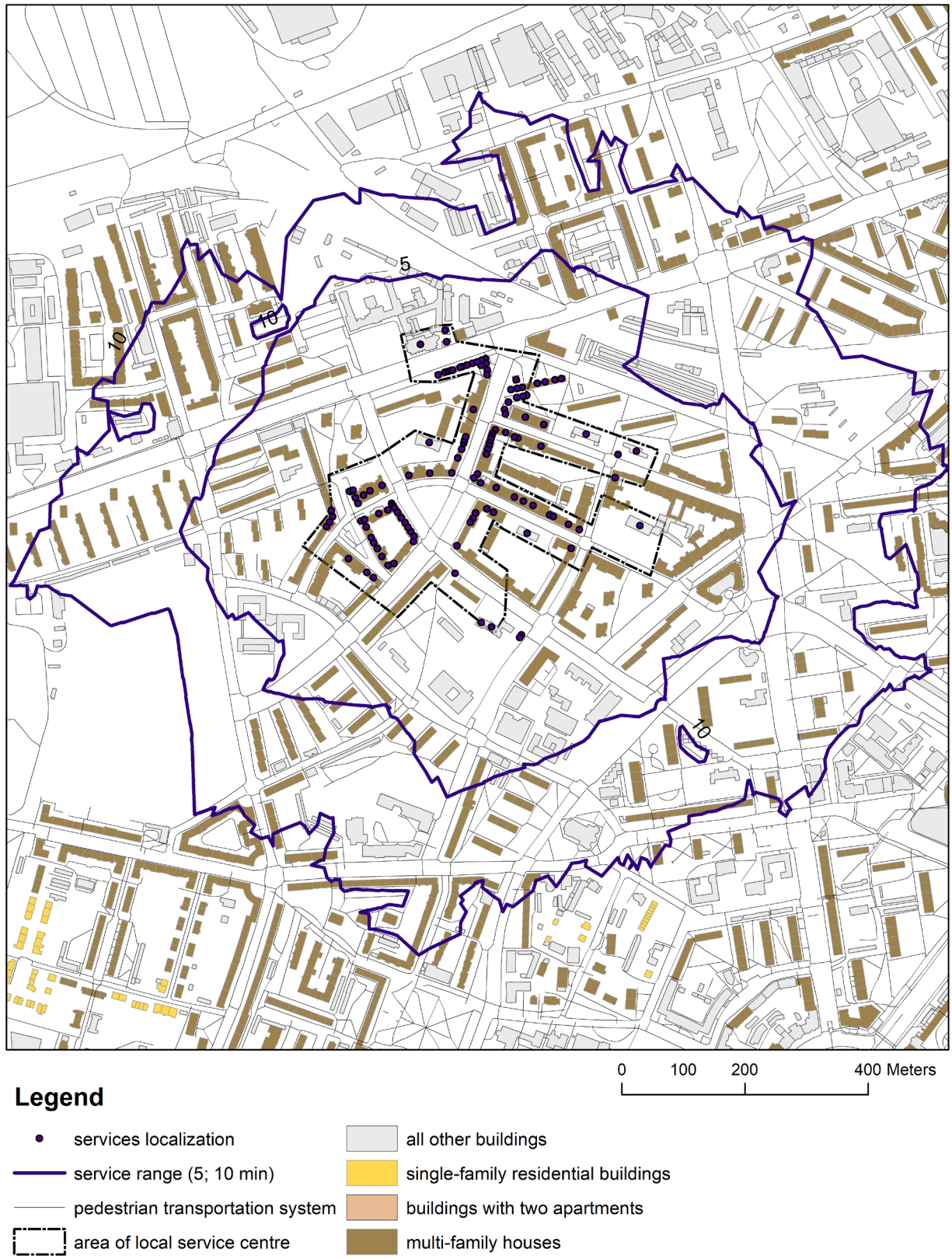

Fig. 2. Sample map of the 5-minute and 10-minute pedestrian isochrones for LSC Wroclaw: Pereca square
Source: authors' own research

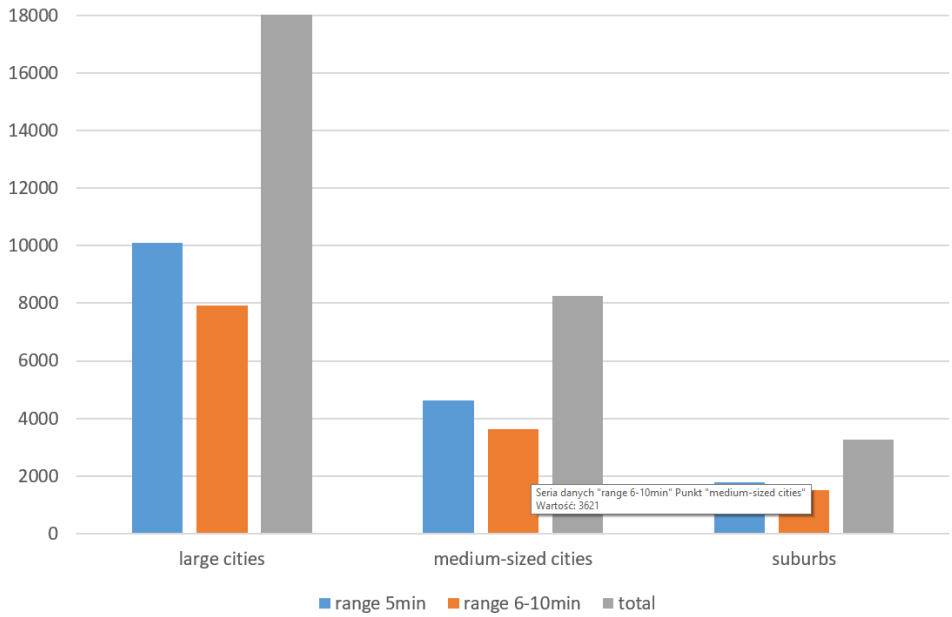

Fig. 3. Average population size in accessibility zones by settlement type
Source: authors' own research

tration mechanism present in human settlement processes. It also confirms the "compact city" postulates: providing access to local services within particular isochrones seems to be easier in high-density residential areas. This may be an important input into the debate on territorial cohesion.

5.2. Public transport and services: synergy effects

Tira (2011) states that the optimal distance of housing from public services is approximately the same as the optimal bus-stop range. The neighbourhood may therefore be an elementary urban unit and at the same time an effective area of influence of public transport. According to this view, another GIS analysis has been conducted to show the relationship between places of residence, bus/tram stops and services.

The number of public transport nodes is very different in each LSC (Table 2), but when confronted with the types of settlements (large cities, medium city and suburbs) their distribution seems to provide fairly adequate access to public transport. In this section we focus on the relationship between location of bus stops (and tram stops) and location of services. Within the areas served by the LSCs it is possible to indicate places where the relatively small distance between the service points and the public transport nodes generates synergy effects and creates hierarchically important spaces.

Figure 4 shows simplified pedestrian links in two modules: place of residence – local services; local services – public transport. Most of them get crossed in the middle of the LSC, proving its vital role in shaping the livability of the neighbourhood. Accessibility from home and accessibility from public transport nodes interfere in public spaces, forming a zone of everyday human interactions.

Pedestrian pathways generated by the Network Analyst can also be counted and juxtaposed with the estimated number of residents and public transport passengers in an LSC. Cumulated values for each LSC are represented by mean time necessary to reach service points from residential areas and from public transport nodes by walking (Fig. 5). They clearly reflect the natural trend in settlement processes where large cities (with high population density, variety of public transport opportunities and many service points) provide the best accessibility while peripheral suburban areas are characterised by much longer distances needed to reach services.

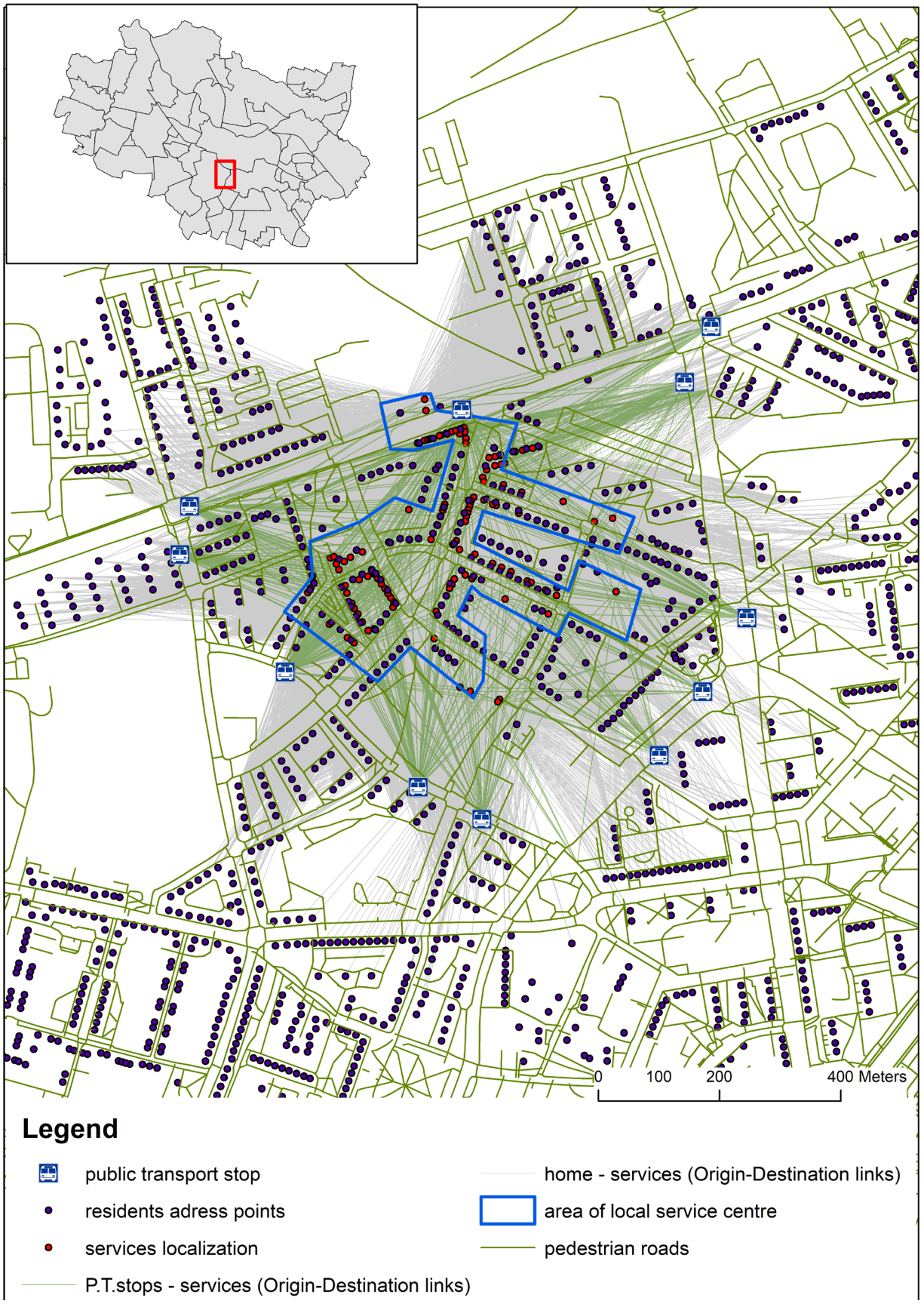

Fig. 4. Sample map of the pedestrian links between services, residential areas and public transportation for LSC Wroclaw: Pereca square (simplified as linear connections for better visualisation)
Source: authors' own research

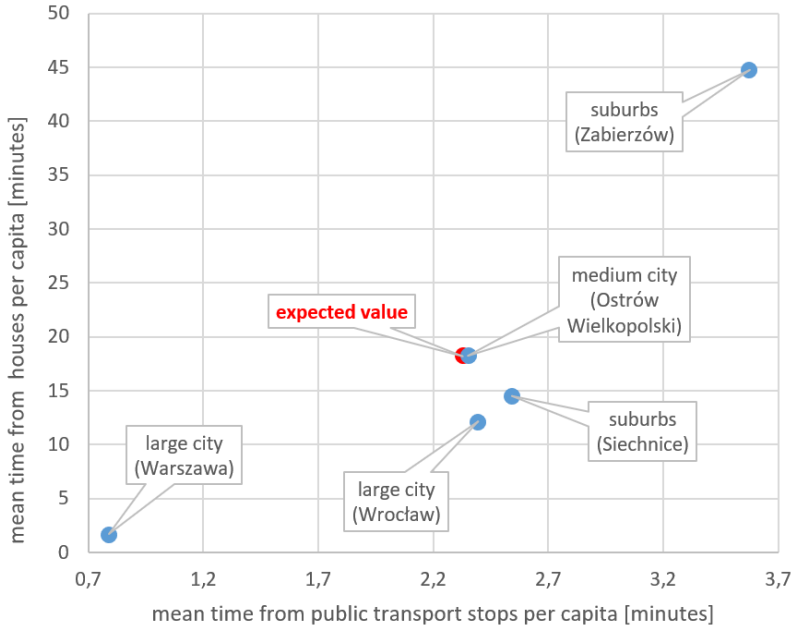

Fig. 5. Relationship between accessibility of services from residential areas and from public transport nodes
Source: authors' own research

6. Conclusions and discussion

Territorial cohesion is a constantly evolving principle of EU policy, gaining more and more attention among policy-makers and researchers. Despite its initial ambiguity, in recent years it has been successfully implemented in national and regional policies across the EU. However, its operationalisation on the local level still remains a major challenge.

This paper contributes to the state-of-the-art in both theoretical and empirical aspects. In its theoretical component we developed the question of scalability of territorial cohesion. We introduced three levels of TC: macro, meso and micro. The first two take a more structural perspective while at the local scale a functional approach is required.

In line with this conceptual framework we conducted empirical research in five neighbourhoods in Poland. We adapted three existing indicators of TC (accessibility of schools, of grocery services and rail – see ESPON 2012) to the neighbourhood scale using a three-step mixed-method research approach.

6.1. Measuring territorial cohesion at the neighbourhood level

There is no universal "reference level" of territorial cohesion. The TC is a relative, comparative matrix for evaluating the distribution of opportunities in space in various territories.

In order to grasp this diversity our study has been embedded in particular spatial contexts: large cities, a medium-sized town and suburban areas. Each of the studied local service centres had different borders, different numbers and ranges of amenities; its users expressed different attitudes towards the local services system and had different habits in using it. However, due to consistently obeyed methodological rigour, comparisons between those various settlement types were possible, providing a good overview of various contexts in which territorial cohesion can be measured.

The highest level of TC, as expressed by users' satisfaction, has been achieved in a neighbourhood located in a medium-sized town, where the socio-spatial relations are optimal for meeting human everyday needs. It is more self-contained in both functional and spatial terms than the other studied

locations. However – paradoxically – LSC users in large cities and in suburbs are more willing to travel further to use everyday services. As a result, it may be easier to achieve user satisfaction in large cities and in suburbs than in medium-sized towns, where residents' expectations regarding accessibility may be higher.

When considered as a geographical attribute of space, TC reached relatively higher levels in large cities and a significantly lower level in suburban areas. The spatial distribution of services and of human population reflects the natural concentration mechanisms and strengthens the value of centrality. It confirms the natural trend in settlement processes where higher population density, variety of public transport and service points provide the best accessibility values.

The disparities between "subjective" and "objective" measures of TC outlined above should be further investigated by convergence analysis and synthetic presentation (as in ESPON, 2012). Nevertheless, the proposed research method based on pedestrian accessibility of essential amenities offers quantifiable and comparable results on territorial cohesion on the neighbourhood level. If necessary, it can be modified, extended and applied to other locations to capture the local dimension of territorial cohesion.

And of course, the approach adopted in this paper has particular limitations. The main one is its application in only five Polish neighbourhoods, with no other comparative contexts. Indeed, this research sample is not representative in statistical terms, which means that the results cannot be generalised to the whole population. The conclusive potential of the paper is also constrained by the relatively small number of TC indicators (only three of 32) considered in the empirical research. Such limitation may bring into question the legitimacy of statements regarding the whole concept of territorial cohesion. However, those weaknesses are counterweighted by the pioneering character of the study, which opens a new research area: TC considered at the local level.

6.2. Implications for urban planning

Optimisation of distribution of services is one of the core topics in the contemporary urban planning debate. It does not imply, however, that services should be evenly located across each territory (which would result in dispersion) but it endeavours to raise the factual accessibility of facilities for citizens. According to our research, services and public transport play a vital role in shaping neighbourhood livability. They provide functional relations that are necessary to satisfy everyday needs of residents. Spatial concentration of amenities seems to stimulate both satisfaction and accessibility in each of the studied LSCs. The synergy effects obtained due to relatively short distances between service points and public transport nodes have great importance in shaping the residents' spatial behaviours. Thus, appropriate urban planning can frame the issues of mobility and accessibility by promoting certain locations (and densities) and through investments in infrastructure for walking or cycling (Van Neste & Sénécal, 2015).

Indirectly, the presented research demonstrates the fundamental role of local service centres in providing territorial cohesion. Establishing a network of service nodes in urbanised areas would enable synergy effects, generate advantages of scale and enhance economic effectiveness. LSCs have an undoubted potential to offer optimal accessibility to everyday services in urban neighbourhood, and thus, in a wider perspective, to raise the general level of territorial cohesion in Europe.

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