Spatial Analysis of Commercial Services in Poland

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Abstract. Trade is the subject of interest in many areas of science, such as geography, economics, marketing, sociology or urban planning. In many countries in Europe and the USA, studies of trade usually focus on the location of commercial outlets in urban space, accessibility (time, cost) of the trade for customer, selection of assortment offers and innovations in trade. A recent decade of spatial studies on trade in Poland concerns mainly new large-selling area formats and the importance of trade in the development of the suburbanization process and appropriation of public space by new trade formats. The aim of the article is to identify the main rightness of the locations of commercial and service buildings in Polish towns and rural areas and to determine the percentage of the population living in areas with difficult access to the trade. Conducted statistical and spatial analysis with the use of information obtained from Database of Topographic Objects is a method of diagnosis of accessibility that has not been applied before for its entire area of Poland and constitutes the introduction for further in-depth studies in this sphere. Trade is one of the most important sectors of the national economy in Poland and an essential market component both on regional and local scale. It is also a vital element of the expanded distribution system and thus it affects the quality of people’s lives while satisfying their consumer needs in the sphere of buying goods in convenient time, place and conditions guaranteeing a high quality of provided services. The city remains a natural environment of commercial activity as the development processes constantly proceed there, new consumer needs occur and new trade forms (e.g. large selling area super and hypermarkets as well as shopping malls) emerge there. Commercial activity depends on other city functions, including communication as well as social and economic functions, thus it directly affects the shaping of the majority of functional elements in the city and conditions of its competitiveness as the center of the settlement system. Distribution of commercial outlets in a given area determines the availability of goods and creates conditions for efficient provision of services for residents. The paper is a statistical and spatial analysis of commercial services in Poland.

1. Introduction
Trade is one of the most important sectors of the national economy in Poland and an essential market component both on regional and local scale. It is also a vital element of the expanded distribution system and thus it affects the quality of people’s lives while satisfying their consumer needs in the sphere of buying goods in convenient time, place and conditions guaranteeing a high quality of
provided services [1]. The city remains a natural environment of commercial activity¹ as development processes constantly proceed there, new consumer needs occur and new trade forms (e.g. large selling area super and hypermarkets as well as shopping malls) emerge there. Commercial activity depends on other city functions, including communication as well as social and economic functions, thus it directly affects the shaping of the majority of functional elements in the city and conditions of its competitiveness as the center in the settlement system.

Distribution of commercial outlets in a given area determines the availability of goods and creates conditions for an efficient provision of services for residents. The paper is a statistical and spatial analysis of commercial services in Poland, and for this purpose, it applies information gained from Database of Topographic Objects of 2015. The list of buildings of commercial function (or commercial and service-providing function) became the basis for the diagnosis of commercial availability in Poland.

Commercial and service-providing activity is usually located according to market criteria and takes into consideration the size of settlement unit, economic and financial situation, transport conditions and residents’ preferences. Therefore, in Poland, yet not only there, the largest cities and agglomerations offer the best conditions for the development of commercial and service providing chains. The assumption is confirmed by the results of the conducted statistical and spatial analysis which shows that over 30 % of buildings of commercial and service-providing purposes are located in the largest cities and in municipalities forming the heart of urban functional areas in the capital cities of voivodships. According to the classical theory of services, the location and distribution of individual categories of goods are based on the principle of hierarchy². Distribution of commercial services in Poland is highly correlated with the distribution of settlement and transport networks, as well as economic (income) conditions in the country. Presented results of statistical and spatial analysis constitute the introduction for further in-depth studies in this sphere.

2. Theoretical background and literature review
Trade is the subject of interest in many areas of science, such as geography, economics, marketing, sociology or urban planning. Studies of trade in Poland mostly refer to functioning of traditional commercial chains and usually concern the location of outlets, their assortment, the scope of activity and service for customers/residents of a given area (including for example planning of commercial chain for a given city or settlement). Political changes caused far-reaching proprietary, quantitative and qualitative consequences in the structure of retail trade chains. New types of outlets occurred, assortment offer expanded, and new ways of distribution and sale were implemented (including e-trade) as well as new customer service methods [2, 4, 5].

For many years, trade has been the subject of spatial studies that mainly concerned the analysis of the development of new retail trade format and distribution of commercial and service-providing chains in the structure of a given city (example of Lublin [6], example of Wrocław [7], example of Lodz [8], cities of Upper Silesian Agglomeration [9-12], Kraków [13], Poznań [14], example of Warsaw [15]). Most frequently addressed subjects in the sphere of spatial analyses comprise such issues as the hierarchy of cities in commercial chains, including the application of the concept of the network for studies of services [16, 14], studies of transport accessibility of commercial chains in selected areas [17-19], integration and spatial concentration of trade [20, 21], importance of trade in the development of suburbanization process and appropriation of public space by new trade formats

¹ In this case, commercial activity represents trade in institutional approach, i.e. all commercial enterprises the activity of which consists exclusively or primarily in purchase of goods for the purpose of their further resale. It takes place in retail and wholesale outlets. More on the subject in [2].
² Hierarchy – order, sequence, refers to differentiation between individual elements on the principle of ranking from the most important to the least important, from the biggest to the smallest. More on this subject at [3].
A recent decade of spatial studies on trade concerns mainly new large-selling area formats, mostly shopping centers and discount chains that considerably affect the structure of the sector in Poland. The growing process of concentration and integration in the trade leads to decline in the number of traditional stores, especially in the areas of intensified market competition and chain formation (integrated chains, franchising) as well as visual unification [1, 24, 25].

In many countries in Europe and the USA, studies concerning qualitative changes that occur in the urban service-providing network in relation to realization of commercial buildings, distribution of commercial chain in a given area are conducted on a large scale, and main researchers working on this issue include C. Guy [26, 27], N. Wrigley [28, 29] or Franke [30], Pump-Uhlmann [31] and many others. The studies usually focus on the location of commercial outlets in urban space, accessibility (transport) of trade for customer, selection of assortment offer and innovations in trade.

Conducted statistical and spatial analysis with the use of information obtained from Database of Topographic Objects that includes the list of buildings performing commercial function (or commercial and service-providing function) is a method of diagnosis of commercial accessibility in Poland that has not been applied before.

3. Research method
The basis for calculations were centroids over 14.7 million buildings constituting one of the layers of the Database of Topographic (BDOT10k) according to the 2015 update. Centroids were determined in the QGIS ver. 2.14.3 Essen. The area of the whole country was analyzed in the administrative system of communes (according to the PRG data), provinces and in accordance with the classification proposed in the work of P. Gibas and K. Heffner [35].

The basis for calculations was the appointment of the orthodrome (the shortest Euclidean connections) between residential buildings covering the category of single-family housing (1110), two-family dwellings (1121), housing buildings with three or more apartments (1122) and collective housing (1130) and commercial buildings -services (1230). Then a typical area of variability was determined (the national orthodrome average increased by the standard deviation) thus determining the areas with difficult access to the retail and service network. In order to better visualize the distances that exist, supra-range values were presented in the above and below the median of supra-range value (its value in meters was shown in the legend of figures). It should be noted that spatial measures based on the shortest distance are particularly used in urban pattern dispersion tests [36-38].

4. Research results
In Poland, according to the Topographic Object Data Bank (BDOT10k), in 2015, there were 225 757 commercial and service buildings located (1.53 percent of all buildings). The most represented group of retail and service pavilions constituted up to 80.22 percent of the number of commercial and service buildings. The following categories are: department stores or commercial (constituting 8.39 percent of the number of buildings described), petrol stations (3.26 percent), pharmacies (2.47 percent), hypermarkets or supermarkets (1.35 percent), vehicle service stations (0.89 percent), shopping centers (0.26 percent), market halls and exhibition halls (respectively: 0.11 and 0.05 percent). The remaining 3 percent of these buildings also have other functions, including service headquarters (0.73 percent), residential (0.6 percent), serving as bank (0.54 percent) restaurants (0.53 percent). In general, the distribution of commercial and service buildings coincides with the network of Polish cities and towns.

3 The structure of the database is described in the item [32] more about creating this database in [33]
4 The possibilities of using GIS in the study for retail location assessment are analyzed by Abdulkader A. Murad [34]
Generally, these buildings are located in large cities (32.36 percent of them). It can be noticed, however, that only 24.76 percent of them are located in peripheral systems. The direct and indirect zones of the impact of the big city cover a further 24.13 percent of the buildings described, while the areas closely related to the large city are 18.76 percent (see Table 1). It is also possible to notice the concentration of these buildings in relation to each other in peripheral systems, the average distance between these buildings is 204.73 meters with a standard deviation of 306.88 meters (for comparison in large cities, the distance is 664.89 meters (m) with a standard deviation equal to 4065.22 m, in a typical multifunctional city, respectively 352.48 m and 774.34 m).

Table 1. Arrangement and average distances between commercial and service buildings in the classification of rural areas

| commune particulars (functional type) | number of buildings | percentage of commercial and service buildings | average distance from each other in meters | standard deviation of distances in meters |
|---------------------------------------|---------------------|-----------------------------------------------|------------------------------------------|----------------------------------------|
| [1] big cities                        | 73049               | 32.36                                         | 664.89                                   | 4065.22                                |
| [2] areas closely related to big cities| 42344               | 18.76                                         | 345.79                                   | 1786.47                                |
| [3] areas of direct and indirect impact of big city | 54468 | 24.13                                         | 318.49                                   | 716.15                                 |
| [4] peripheral structures             | 55896               | 24.76                                         | 204.73                                   | 306.88                                 |

Analyzing the distribution of the centroids described in relation to residential buildings, it can be seen that the average distance between these buildings in a communal system is 714.76 m, with a standard deviation of 358.36 m. The median average distances between these buildings at a communal level is 686.92 m, one-quarter of communes have them at the level of 465.82 m, and 3/4 of them at the level below 912.60 m. The closest to the commercial facilities are residents of large cities and "banana" extending from the eastern part of the Lubuskie Voivodships and the western part of the Wielkopolska through the north-western part of Lower Silesia, southern Opolskie, the Śląskie and the western part of the Małopolskie to the northern part of the Podkarpackie. The inhabitants of the eastern part of the west and mid-western of Pomorskie are the furthest, while the communes are concentrated in the northern and eastern parts of the Warmińsko-mazurskie, most of the Podlaskie, northern and eastern voivodships of Mazowieckie and eastern part of Lubelskie. The retail and service network is also far away from places of residence in the foothill areas, i.e. the band of the Sudety and Bieszczady Mountains (see Figure 1).
In general, the closer to a large city, the average distance between residential buildings and commercial and service buildings is smaller (204.01 m for large cities compared to 838.79 m for municipalities of the peripheral system). Similarly, the distribution of typical variability distributions is distributed, the limit values for large cities vary from 150.95 m to 257.08 m, while for peripheral systems they amount to 508.78 m to 1168.80 m, respectively (with the standard deviation in the direct zones and indirect impact of large cities is even greater because it is 374.79 m compared to 330.01 m for peripheral systems) (see table 2).

**Table 2.** Statistical parameters of distances between residential and commercial buildings in the classification of rural areas

| commune particulars (functional type) | minimal average | maximum average | mean average | average of standard deviation |
|-------------------------------------|-----------------|----------------|-------------|-----------------------------|
| [1] big cities                      | 98.50           | 382.12         | 204.01      | 53.07                       |
| [2] areas closely related to big cities | 104.71         | 1826.36        | 536.33      | 247.85                      |
| [3] areas of direct and indirect impact of big city | 113.05         | 2064.57        | 617.16      | 374.79                      |
| [4] peripheral structures           | 128.99          | 2401.79        | 838.79      | 330.01                      |
The median of areas with an extraordinary shortest distance between residential buildings and commercial and service buildings is 582 meters, while its maximum size is at the level of 9641 meters. The above-average orthodromes between the above-mentioned buildings do not occur in the area of 75 Polish municipalities. The area of occurrence of the above-typical orthodrome inhabits an average of 22.29 percent of the population in gminas with a standard deviation of 15.34 percent. A quarter of communes with over-typical shortest distances to commercial and service buildings in Poland have this index below 10.38 percent, half below 20.45, and three-fourths at the level below 32.30 percent.

Municipalities characterized by the percentage of the population inhabiting buildings with an orthodrome below 10.38 percent are located mainly in large cities and their functional areas. They are relatively numerous in the belt connecting the area of Szczecin, through the area of Gorzów Wielkopolski and south-west and the southern part of Wielkopolska, around Wrocław, Opole to the area of almost all communes of the Słaskie Voivodship, and western and southern part of Małopolska. The end of such a defined belt takes place in the central and northern parts of Podkarpackie. Similar band-like character to the percentage of population above the third quartile living in areas from the eastern and northern parts of Lublińskie, through almost the entire Podlasie to the northern part of Warmińsko-mazurskie, the second band of municipalities with such features runs from the north-western part of Łódzkie, through the Kujawsko-Pomorskie and north - the western part of Mazowieckie to Podlaskie (merging with the previously distinguished band in this province) (see Figure 2).

5. Conclusions
Trade is one of the fundamental services shaping the quality of residents’ life in a given settlement unit. Conclusions arising from the reading of presented papers and scientific works allow stating that changes that had proprietary, quantitative and qualitative character have been observed in the sector in Poland over the last three decades. The number of commercial outlets, mainly domestic individual entities, foreign supermarket, hypermarket chains, shopping centers and discount stores has grown
significantly. Intense competition in the form of e-trade has also occurred. Small traditional shops together with modern chain outlets create conditions for the provision of services for local markets. Efficiently functioning commercial chain guarantees the satisfaction of the consumer needs of various groups of buyers in convenient conditions, form and time.

Conducted statistical and spatial analysis shows disparities in the distribution of buildings of predominant commercial function in various areas of the country. The concentration of commercial services is observed in large and medium-size cities in Poland and in the nearest environment of big cities and agglomerations. It is closely related to direct and indirect relationships between the external zone and the core city economy. Approaching this phenomenon on a macro-economic scale, it can be assumed that the concentration of commercial chains has a linear character and is observed in the south-western part of the country. On the other hand, the northern and eastern parts of Poland are characterized by high dispersion of commercial objects which translates into poorer accessibility of services for residents of these areas. Economic and transport conditions, as well as the density of settlement network and predominant agricultural function in the eastern part of the country, constitute a barrier for the development of new investments, including commercial investments. Economic conditions, especially incomes lower than average of the residents of voivodships in eastern Poland, are also vital in this respect (the lowest incomes per capita in 2016 and 2017 – Podlaskie, Podkarpackie and Lubelskie voivodships) [39]

Distribution of commercial and service-providing buildings is determined by the distribution of residential buildings among others. The distance between them (in the paper described in distance approach – the shortest Euclidean path) often determines the accessibility of services in a given location. The smallest distances between buildings are observed in large cities and in the south-western part of the country, whereas the largest distances between places of residence and commercial and service-providing chain are reported in rural areas in north-eastern Poland and in foothill areas. Despite spatial concentration process of retail trade observed for a few years that is expressed by a decline in the number of shops and growth of the average selling area, the proximity of an outlet to the house/flat remains the question of customer’s convenience and spatial accessibility (i.e. the distance of 5 minutes on foot). Large cities and their functional areas are the best in terms of commercial services and they offer the most convenient buying conditions. Rural areas most often classified as peripheral areas form a scarce commercial network which results in low availability of services for customers (especially in north-eastern Poland). However, it must be noticed that the areas of poorer provision of commercial services are found in almost all municipalities, also in big and medium-size cities and their direct environment, which is proved by the distribution of Euclidean supra-typical distance between residential buildings and commercial and service-providing buildings. Calculated distances, when the morphological structure of the transport network and physiographic determinants of the area are taken into consideration, are inherently longer. The scale of impact of these determinants in the whole country is not recognized yet, even though in cognitive terms, it is interesting and potentially valuable (also for the entities providing described services).

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