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CHANGES IN TRANSPORT AND CONSUMER BEHAVIOUR AS A RESULT OF RETAIL RESTRICTION ON SUNDAYS ON THE EXAMPLE OF ŁÓDŹ (POLAND)

Zmiany w transporcie i zachowaniach konsumentów w wyniku ograniczenia handlu w niedziele na przykładzie Łodzi (Polska)

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Abstract: The goal of the study is to show how the restrictions on commercial businesses affected travel behaviour among residents of a large city in Central Europe (here: Lodz, Poland). To achieve this objective, a survey was conducted in autumn 2021 on a cohort of over 6,000 Lodz residents aged 13+ using the mixed-mode CATI (Computer Assisted Telephone Interviewing) and CAWI (Computer Assisted Web Interviewing) techniques. The research sample size reflected the population demographics was representative. The results were utilised to identify particular groups of residents with specific transport and consumer behaviour using the clustering method. Five clusters were determined in which a correlation between the respondents' traits (i.e., age and occupation) and transport and consumer behaviour could be discerned. Since both the oldest and the youngest respondents display low mobility (especially on Sundays), the Sunday retail restrictions have had little impact on the way they organise their time. People of working age (30-44 and 45-64 years old) exhibit different patterns, however. Being the most mobile population group, they declare that the restrictions have had a negative impact on their time management.

Keywords: retail restrictions, transport behaviour, CATI, CAWI, Lodz

Acknowledgment

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1. Introduction

Regulations on shop opening hours, on Sundays in particular, have been widely deliberated on in many European countries over recent years. These discussions have typically resulted in the softening of relevant legal restrictions. However, restrictions still differ substantially among European countries (Dijkgraaf and Gradus, 2006; Pierluigi, Paola and Dario, 2020). In that respect, Poland is now similar to Austria and Germany, where strict Sunday retail restrictions are still in force. In 2018, shops in Poland were open on two Sundays and in 2019 on only one a month. Since 2020, the retail restrictions have been extended to all but seven Sundays per year. Although an extra trading Sunday was added in 2020 (6 December) in response to the COVID-19 pandemic. As a result of these changes, the transport needs of people with regard to accessing shopping facilities has become more problematic.

The goal of the study is to show how the restrictions on commercial businesses affected travel behaviour among the residents of a large city in Central Europe (here: Lodz, Poland). To achieve this objective, a survey was conducted in autumn 2021 on a cohort of over 6,000 Lodz residents aged 13+ using the mixed-mode CATI (Computer Assisted Telephone Interviewing) and CAWI (Computer Assisted Web Interviewing) techniques. Here, it must be stressed that although the Sunday retail restrictions did overlap with the COVID 19 pandemic, they had initially been implemented almost two years prior to its outbreak. This article will bring new knowledge on the changes in transport behaviour of inhabitants of large cities following the introduction of trading restrictions. This type of population research is necessary for conducting a rational transport policy, since transport development management in a way which meets the real needs of inhabitants requires the understanding of their everyday transport behaviour. It seems justified to expect that this behaviour has undergone change as a result of the introduction of statutory trading restrictions. Therefore, it seems necessary to supplement the set of quantitative data collected in the literature so far (including spatial and time structure of vehicle traffic volume) concerning the Lodz transport system with research using a survey questionnaire. This allows greater comprehension of the motivations for movements which are undertaken by people in space and time using their chosen means of transport. The results of this study can be compared with data from other large cities in countries with similar restrictions. However, their major purpose is to show that the implementation of the said restrictions have impacted, *inter alia*, changes in the city's traffic density on a daily and weekly basis.

The remaining sections of the manuscript are organized in the following manner. The second section discusses the relevant literature, with a primary focus on the transport and consumer behaviour of residents in large cities. The third section elaborates more on the characteristics of the study area. The fourth section provides a detailed description of the research methodology that was adopted in this study. The fifth section presents the results after conducting the supporting analyses. The sixth section discusses the major insights, while the seventh section provides the main concluding remarks and provides some directions that could be considered by the future studies.

2. Mobility and shopping

Generally, observations of mobility trends in a highly urbanised environment are on the balance between public transport systems and individual means of transport (mainly passenger cars, but also cycling or walking, etc.). Despite the issues caused by the increasing growth of individual vehicle mobility due to the undisputable comfort of the passenger car (Woods and Masthoff, 2017; Gössling, 2020), many modern European cities have seen a growth in public transport utilisation since 2000, as claimed, for example, by Buehler *et al.* (2017). Travel behaviour trends in cities of Central Europe may show differences when compared to Western cities (Šimeček *et al.*, 2018; Radzimski and Gadziński, 2019; Schlosser *et al.*, 2019). Among these is the unprecedented growth of traffic flows between cities and their hinterlands due to extremely rapid sub-urbanisation, as revealed, for example, by Nemeškal, Ouředníček and Pospíšilová, (2020) and Dujava and Kališ (2021). This is also compounded by the escalating motorisation rates in societies of Central Europe, which have now reached levels typical for Western societies and all within a very short space of time. Cycling is, however, still less frequent compared to Western Europe (Šimeček *et al.*, 2018; Radzimski and Gadziński, 2019).

In Central European cities of a similar size to Lodz, individual car transportation seems typically to have become dominant or at least equal in performances to public transport systems. Nevertheless, Jaśkiewicz and Besta (2014), Wójcik (2019), Šimeček *et al.* (2018) and many others focusing on Central-European cities provide evidence that specific groups of travellers have different transport preferences (depending on age, gender, health, income, place of residence/work, etc.). For example, a significant number of commuters from sub-urban belts tend to prefer passenger cars to public transport (Dujava and Kališ, 2021) whereas students and senior age groups still show a much greater preference for public transport services (Silm, Ahas and Nuga, 2013; Paradowska, 2019).

Evidence on mobility trends in Poland's metropolitan areas has been reported by numerous documents, including so-called SUMP (Sustainable Urban Mobility Plans). The urban public transport strategy for Lodz (*Plan zrównoważonego rozwoju publicznego transportu zbiorowego dla miasta Łodzi do roku 2025*, 2018) and regional statistical data on transport and mobility development (*Transport w województwie łódzkim w 2020 r.*, 2021) suggest a growing popularity of passenger cars. Despite the fact that long-term and systematic scientific research is lacking for many Central European cities, there are studies (Radzimski and Gadziński, 2019) doing research on the Poland's city of Poznan which indicate that trip frequency (i.e. number of trips per day) in the urban environment has been increasing on average. This specifically refers to the willingness of road goers to use passenger car for shopping trip purposes. Due to the significant spatial transformation of retail services in post-socialist cities, we have observed a growth of individual car trips for shopping activities (Garb, 2007; Maryáš *et al.*, 2014; Kunc *et al.*, 2016; Krizan *et al.*, 2018; Bartosiewicz and Pieleśiak, 2019; Sikos, 2019; Trembošová and Jakab, 2021; Sikos and Kovács, 2022). Unlike commuting to work or school, shopping journeys are less likely to follow a set pattern as they depend on individual shopping habits and preferences, mobility means affordability, place of residence and many other factors (Borowska-Stefańska, Kowalski and Wiśniewski, 2020). Recently, the COVID-19 pandemic has triggered new shopping habits, such as less frequent shopping during lockdown periods and the growing popularity of online-shopping (Shamshiripour *et al.*, 2020; Eger *et al.*, 2021; Gębski, 2021). Traditionally, the distinct differences between working days and weekends in Western societies have led to well-established and virtually immutable behavioural patterns, including mobility behaviour routines specific for Monday-to-Friday week period (related to work commute and attending schools, typical for substantial segments of the population) and those specific for the weekend (Raux, Ma and Cornelis, 2016). In the European cultural environment, moreover, Sundays have always had a specific status in the weekly regime, including mobility that is often related to religion (Siguaw and Simpson, 1997) or family-related traditions and habits (Scheiner, 2006; Raux, Ma and Cornelis, 2016). Special non-working days (e. g. state holidays, often including shopping ban) may in most of the countries have regime patterns similar to Sundays.

The recent COVID-19 pandemic, accompanied by its various lockdown restrictions, has had a huge and unprecedented impact on mobility in all countries and communities. The rapid growth in cases of

infection were usually followed by a raft of statutory restrictions imposed by national, regional or local authorities to control the transmission of the virus. These restrictions have provoked extensive shifts in the behaviour of residents, including changes in consumer behaviour (Eger *et al.*, 2021) and transport organisation and mobility regime transformation (Shamshiripour *et al.*, 2020; Taczanowski and Kołoś, 2020; Thombre and Agarwal, 2021). In the urban environment, the changes in mobility patterns caused by the COVID-19 pandemic have led to a decrease in public transportation use and a growth in individual means of mobility, such as passenger cars or bicycles (Barbieri *et al.*, 2021; Buehler and Pucher, 2021; Thombre and Agarwal, 2021). For example, remote working (or home-office work) introduced in the services sector (including education) vastly impacted overall mobility, with the large downturn mainly being in large cities, as reported by Barbieri *et al.* (2021) and Borkowski *et al.* (2021) examined the impact of COVID-19 on mobility specifically in Polish society.

In addition to the mobility shift from COVID-19, the Sunday shopping restrictions have had a profound impact on the behaviour and mobility of individuals and households with regard to their weekly routines. A study by Borowska-Stefańska *et al.* (2020), who focused specifically on the responses of Lodz residents to the Sunday retail restrictions, shows a number of similarities with previous studies carried out in Western cities and societies. Generally, any political or organisational measures imposed on the Sunday shopping regime (no matter if restrictive or supportive) in recent decades have induced certain changes in residents' travel behaviour (Heilig *et al.*, 2018). The above-mentioned studies, however, emphasise that the mobility-related response to the Sunday shopping restrictions depends very much on a combination of elements, such as education, age, gender, and religion; the type of environment (rural vs urban), employment or lifestyle.

3. Characteristics of the study area

The transport layout in Lodz can be represented by the shape of a grid (a framework layout) in the city centre, which becomes gradually less regular the farther out one goes (Kowalski and Wiśniewski, 2017). Lodz is a city where the subsystem of private vehicle transport plays a significant role in the entirety of transport relationships. According to the 2020 TomTom Traffic Index (*TomTom Traffic Index*, 2020), Lodz was the most congested city in Poland. The highest load is observed on the main roads of the city's transport system (Fig. 1).

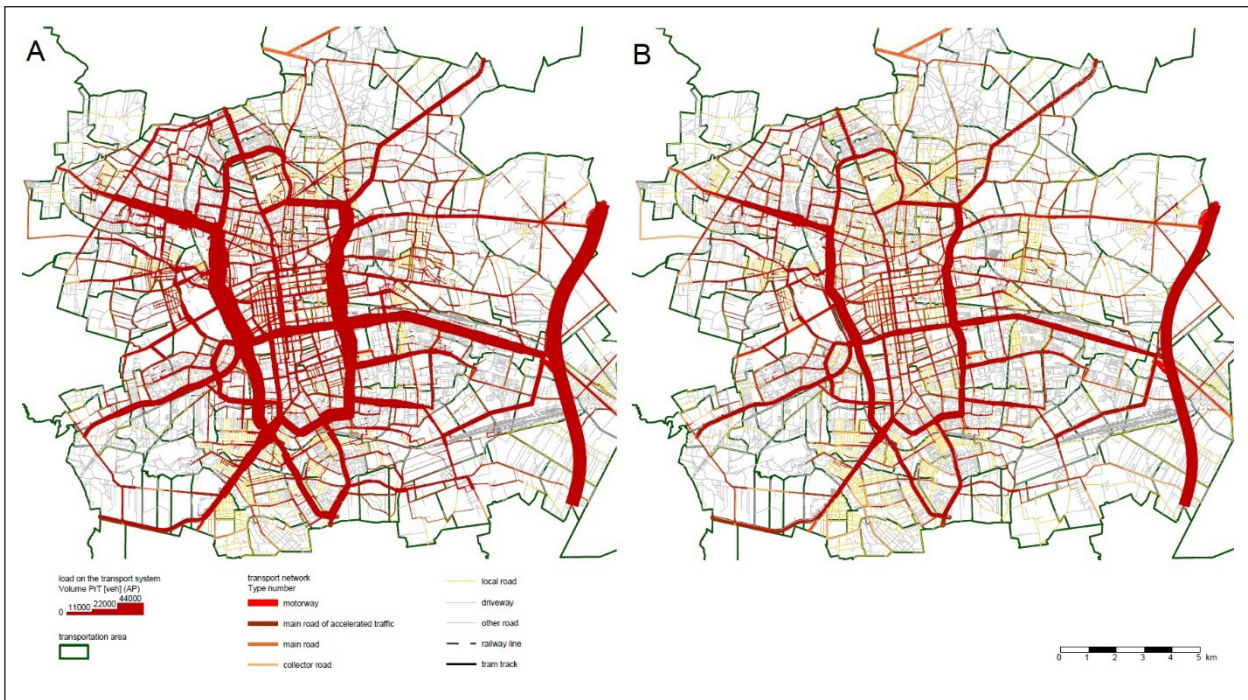


Fig. 1. The load of the urban road network by private vehicles on weekdays (A) and Sundays (B)

Source: own elaboration based on a local traffic model for Lodz

The population and its distribution are key factors affecting the time, place, and directions of emerging transport needs. With 658,573 residents, Lodz is Poland's third largest city, boasting two population axes running north-south and east-west (Fig. 2). To study its patterns of transport behaviour following the Sunday retail restrictions, only those aged 13+ were selected (those younger than 13 do not have legal capacity in Poland). Children under the age of 13 do not have legal capacity. This means that they cannot effectively incur liabilities or acquire rights on their own. This is stated in Art. 14 § 1 of the Civil Code: A legal act performed by a person who does not have legal capacity is invalid. The introduction of the group of seventeen-year-olds resulted from

the use of retrospective questions. It was necessary to identify a group of respondents who did not yet have the right to make purchases on their own before the introduction of trade restrictions. The number of these residents in the area amounts to 617,313 (Tab. 1).

When analysing transport needs, the location of residential areas as well as industrial and service (workplaces and commercial businesses) also plays a crucial role. The analysis of the functional structure of built-up areas in Lodz reveals that the main type of development is housing (61%), more specifically multifamily buildings (51% of the total built-up area of the city), while the share of commercial and service areas amounts to 8% (Borowska-Stefańska, Kowalski

Tab 1. Population of Lodz aged 13+ displayed by age

Age	Number of people	Percentage
13-16	21514	3.49
17	4846	0.79
18-29	62800	10.17
30-44	142728	23.12
45-64	171297	27.75
65 and more	214128	34.69
Total	617313	100

Source: own elaboration based on data from Lodz City Hall.

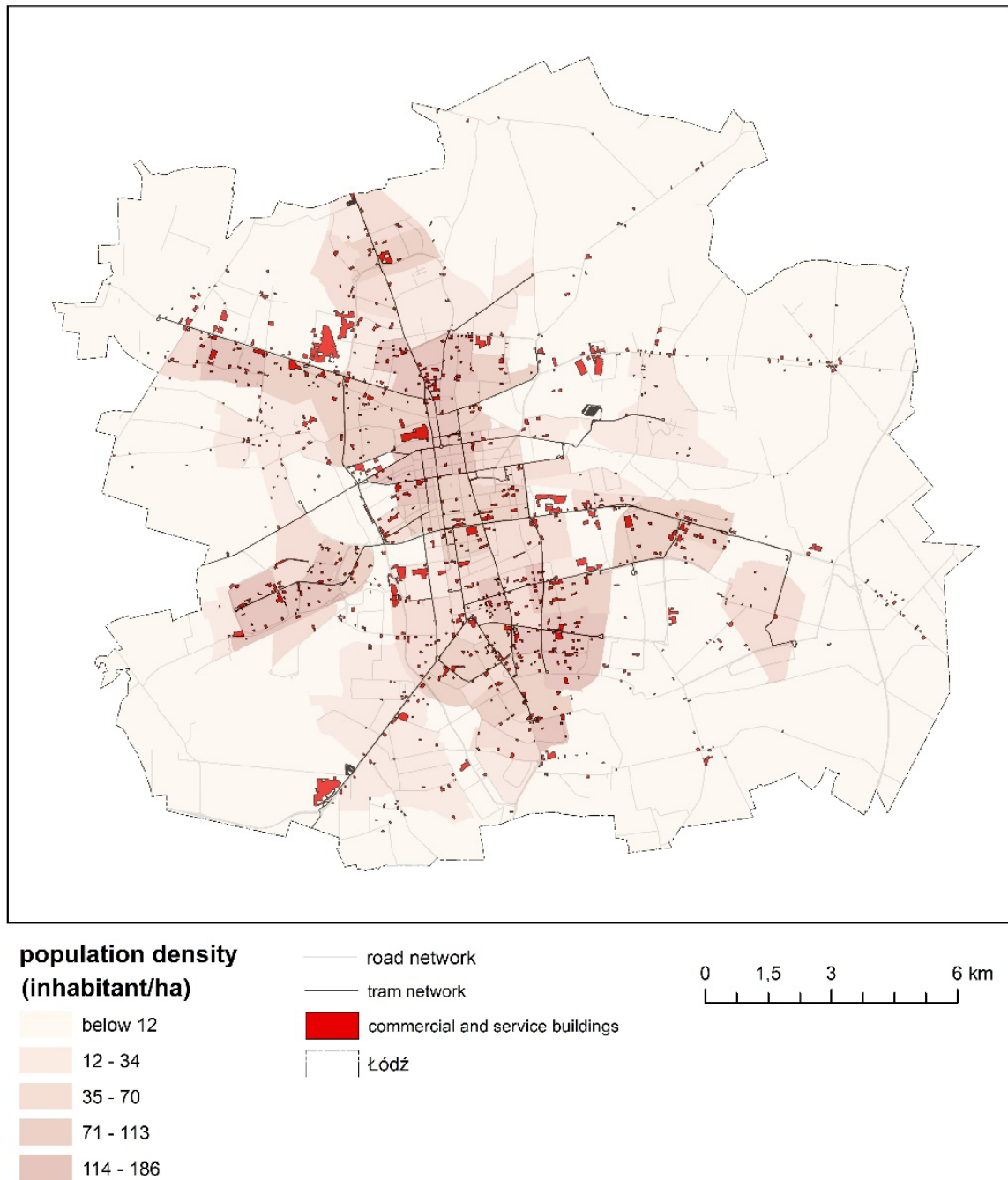


Fig. 2. Location of retail and service facilities against the background of the city's transport network and the spatial distribution of the population

Source: own elaboration

and Wiśniewski, 2020) comprising approximately 1,000 structures (Fig. 2).

In Łódź, most trips are made by non-pedestrian means (87.67%), with private vehicle transport being the most common mode (both on working days and Sundays), with this situation intensifying in recent years. As shown by *Pilot Study...* (2015), 79.3% of trips in Łódź were made by motorised transport, of which 42.4% were by private vehicles and 35.3% by public transport. The decline in the popularity of public

transport in favour of private transport has probably been partially induced by the COVID-19 pandemic, since people preferred to travel by their own car transport due to fear of infection, as confirmed by researchers, including Shakibaei et al. (2021).

The respondents to the questionnaire also travel by car as passengers on Sundays more often than on weekdays. Unfortunately, car-pooling is not popular with citizens of Łódź (Tab. 2).

Tab. 2. Selected parameters of transport behaviour of Lodz residents on working days and Sundays

	working day	Sunday
average number of daily trips per capita	1.37	0.82
percentage of non-motorised journeys (including bicycle, scooter, etc.)	12.33%	19.77%
percentage of motorised journeys	87.67%	80.23%
percentage of trips by private car in all trips	70.74%	70.43%
percentage of trips by public transport in all trips	16.93%	9.80%
percentage of trips by private car in all non-motorised journeys	80.69%	87.79%
percentage of trips by public transport in all motorised journeys	19.31%	12.21%
average vehicle occupancy	1.27	2.01

Source: own elaboration based on the questionnaire survey on transport behaviour among Lodz residents

4. Research methodology

4.1. Questionnaire survey

To assess the impact of the Sunday retail restrictions on the transport behaviour of Lodz residents, a survey was conducted using the mixed-mode technique that combined CAWI (Computer Assisted Web Interviewing) and CATI (Computer Assisted Telephone Interviewing). For this study, this technique was primarily applied for minors, who were surveyed using the CAWI technique directly at schools. Other residents were polled by the CATI technique.

The surveys were conducted during selected weeks in October, November and early December 2021, from Tuesday to Saturday. These periods were chosen as they were devoid of events that could impact the analysed behaviour while retaining all travel motivations and the typical frequency of trips related to them.

The survey questionnaire consisted of three parts. The first was the respondent's particulars (the details

of the respondent and their household), followed by questions on the history of transport and consumer behaviour by 2017 (having been the last year without the Sunday retail restrictions). The final section consisted of two travel logs, where the respondent was asked about trips taken during the preceding weekday and on the preceding Sunday.

4.2. Description of respondent characteristics

The survey was conducted on a sample of 6,118 residents aged 13+ (4,220 respondents interviewed with the CATI technique; 1,898 secondary school students with the CAWI technique), which is approximately 1% of the city's total population within that age bracket. The respondents' profile is presented in Tab. 3. The sample was selected to be representative with regard to the place of residence in relation to the various districts of the city.

Tab. 3. The respondents' characteristics

Characteristics N=6118	Total sample [%]	Characteristics N=6118	Total sample [%]
Sex		Household size	
Female	48.47	1	10.43
Male	51.53	2	25.86
Education		3	23.44
none	2.54	4	30.77
Primary	27.94	5 or more	9.51
Junior high school	1.09		
Vocational		The number of people in age less than	
Secondary	4.64	6 years old in household:	
Post-secondary	22.55	0	87.55
Higher	1.58	1	9.78
	39.65	2	2.33
Age		3 or more	0.34
13-16			
17	21.35	Net monthly income per person in the	
18-29	8.20	household in EURO: ¹	
30-44	6.90	109.3781	0.89
45-64	25.36	109.3781-218.7562	4.84
65 and more	26.53	218.7562-437.5123	17.80
	11.66	437.5123-875.0246	28.67
Residential building type:		875.0246 or more	21.99
Single Family		Not known	25.81
Multifamily	20.75		
	79.25	Basic activities (in the last 7 days):	
Driving licence (N=5530)		unemployed	
Yes		vacation / sick leave	0.81
No	66.15	work outside the home	4.87
	33.85	hybrid work	37.37
The number of cars owned by		remote work	4.96
household of respondents:		pension/retirement	7.01
0		student	12.46
1		pupil	0.76
2	12.01	housekeeping	30.44
3	53.55		1.31
4 or more	27.93	Business sector (working respondent):	
	4.72	Administration	
The number of bicycle	1.79	Construction	4.03
owned by household of		Education and Science	7.81
respondents:		Trade	6.33
0		Other services	16.71
1		Culture	42.49
2		Healthcare	1.69
3	31.94	Industry and small	8.25
4 or more	17.44	manufacturing	8.09
	26.85	Agriculture	
	14.51	Transport	0.24
	9.26		4.36

Source: own study.

¹ Data from NBP, access 27.01.2022, 1PLN= 4,5713

4.3. Cluster analysis

To determine the patterns of transport and consumer behaviour, a cluster analysis was performed. The fundamental premise of the cluster analysis is to classify findings on the basis of their similarity to a certain set of features so as to maximise the similarity within each cluster while minimising the similarity between clusters. Kaufman and Rosseeuw (2009) describe this as classifying observations into groups whose number and form may not be known. For calculations we have used Python language, along with its libraries: scikit-learn for clustering (Pedregosa *et al.*, 2011) and pandas for data processing (McKinney, 2010).

For the cluster analysis, the authors selected answers to 30 survey questions where the number of valid responses significantly exceeded 50% of all observations. Where the type of response did not allow for gradation, projection onto the vertices of an L-dimensional simplex was employed (where L is the number of acceptable responses). The data was then subjected to the following min-max standardisation:

$$y = \frac{(x - \min_x)}{(\max_x - \min_x)}$$

Transforming all data into continuous-type variables allowed the application of k-means clustering (Lloyd, 1982).

4.4. The k-means algorithm

Below we provide a short description of this technique. We start by randomly selecting initial cluster centroids c_j (i.e. their geometrical middle points) for $j \leq K$ using sampling based on an empirical probability distribution of the contribution of points to the overall inertia. This technique, known as 'K-means++' (Gan, Ma and Wu, 2020) speeds up the convergence of the following, standard, learning process of K-means. The following two steps are performed alternately until the point at which this procedure stops modifying the assignment:

1. Assign each point x_i of the dataset to the cluster whose centre c_j is the closest in terms of distance to x_i .
2. Recalculate each centroid position, by setting c_j equal to the mean value of all data points which belong to the j -th cluster.

We also wish to point out that the algorithm itself does not guarantee that a global optimum will be obtained, which would be the optimum allocation to the clusters minimising their aggregate distances from the centres (Gan, Ma and Wu, 2020).

The K-means algorithm is a well-known and celebrated clustering technique, but it requires the user to specify the number of clusters at the start of the procedure. This seems to be a huge disadvantage – after all, how do we know the appropriate number of clusters beforehand? To remedy this issue, several heuristic approaches were developed for determining the final number of clusters. What we do is perform K-means procedure several times for different values of K (in our case, ranging between 3 and 20). For each obtained clustering we calculate several measures of the quality of the resulting clusters. Some exemplary indexes which one can use are Generalized Dunn Index (GDI), silhouette index and Davies-Bouldin index. For K-means, however, best results are usually obtained with a rather simple tool, which is inertia (also known as WSS, which stands for the sum of squared distances from data points to centroid within each cluster). In our case, using the classical heuristic of elbow method (according to which, the best number of clusters is the one where WSS stops falling rapidly), the number of clusters was decided on as 5. The well-established scikit implementation was used for clustering (Pedregosa *et al.*, 2011).

4.5. Variable dependency analysis

In order to determine the relation between the influence of the Act on the ban on Sunday trading on the transport and consumer behavior of the inhabitants of Łódź, in each of the separate clusters separately, including Chi-squared independence test. Thanks to the use of Chi-squared test statistics, a total discrepancy was measured between the recorded numbers of observation, for each combination of answers and the numbers expected, assuming that the proportions in each line correspond to the proportions in the entire group (between questions referring to transport and consumer behavior from 2017 and the situation current - state for 2021). The greater the value of chi-square statistics, the greater the divergence between the observed and expected numbers of observation - this is better proof that the variables taken for the study are related.

To determine the strength of the relation between two quantitative variables, Kendall's Tau Correlation Coefficient was used. Kendall's Tau Correlation Coefficient takes values from -1 to 1, where -1 means a strong negative monotonic dependence – decreasing, and 1 means a strong positive monotonic dependence - growing. They were designated for questions with an ordering scale.

5. Results

5.1. The impact of Sunday retail restrictions on journeys taken

5.1.1. Destinations and frequency

Analysis of the questionnaire results on travel motivation during weekdays showed that trips made to shopping centres account for 15.36% of all daily trips. In this respect, they are second to commuting, while on Sundays the percentage amounted only to 5.02% (Tab. 4). More than 57% of those who did not travel on Sundays declared that it was because there was no need.

The survey revealed that as many as 84.24% of the respondents visited commercial facilities on Sundays by 2017 prior to the implementation of the retail restrictions (13.02% of Lodz residents did not regularly go to such facilities, while 2.74% replied that they could not remember if they did). By 2017, Lodz residents were most likely to visit shopping facilities at least twice a month – a total of over 64% of respondents visited these facilities on Sundays (Fig. 3).

By 2017, the most common motivation behind visiting retail facilities on Sundays was shopping, as seen by the reply given by over 86% of those respondents who frequently visited retail facilities on Sundays by 2017 (Fig. 4). The interviewees indicated that shopping was done mainly in those facilities which are

Tab. 4. Travel motivations among Lodz residents on workdays and Sundays

		Share (%) on working days	Share (%) on Sunday
trip motivation	employment purposes outside home	42.42%	8.92%
	shopping purposes in a shopping centre	15.36%	5.02%
	education purposes	8.41%	0.24%
	dropping off or taking dependants on foot	6.64%	1.90%
	using services (hairdresser, doctor, bank, etc.)	6.30%	0.88%
	social purposes (visiting friends or family in their home)	5.29%	28.44%
	shopping purposes in facilities unaffected by retail restrictions	4.54%	8.14%
	leisure purposes / hobby / sport	4.09%	18.60%
	other purposes	6.95%	27.86%
reason for abstaining from travelling	no need	42.81%	57.24%
	sickness / quarantine / isolation	31.94%	18.10%
	working from home	9.51%	2.04%
	adverse weather	5.10%	8.63%
	Other	4.03%	3.97%
	I was visited by friends / family	1.37%	6.74%
	insufficient funds	0.61%	0.23%

Source: own study.

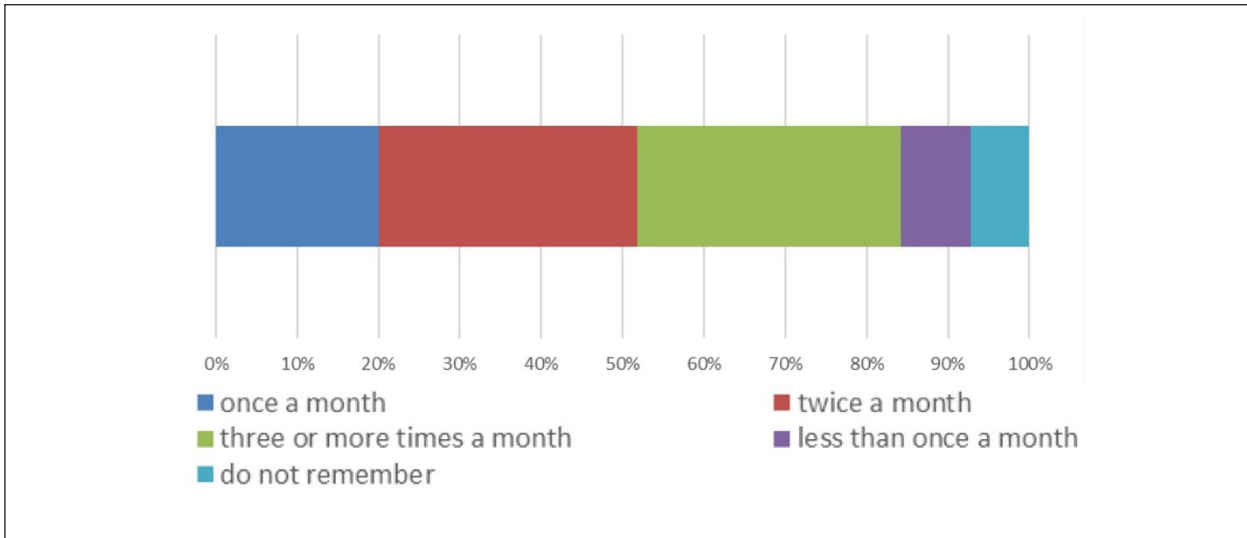


Fig. 3. Frequency of visits to retail facilities on Sundays prior to the implementation of Sunday retail restrictions

Source: own elaboration

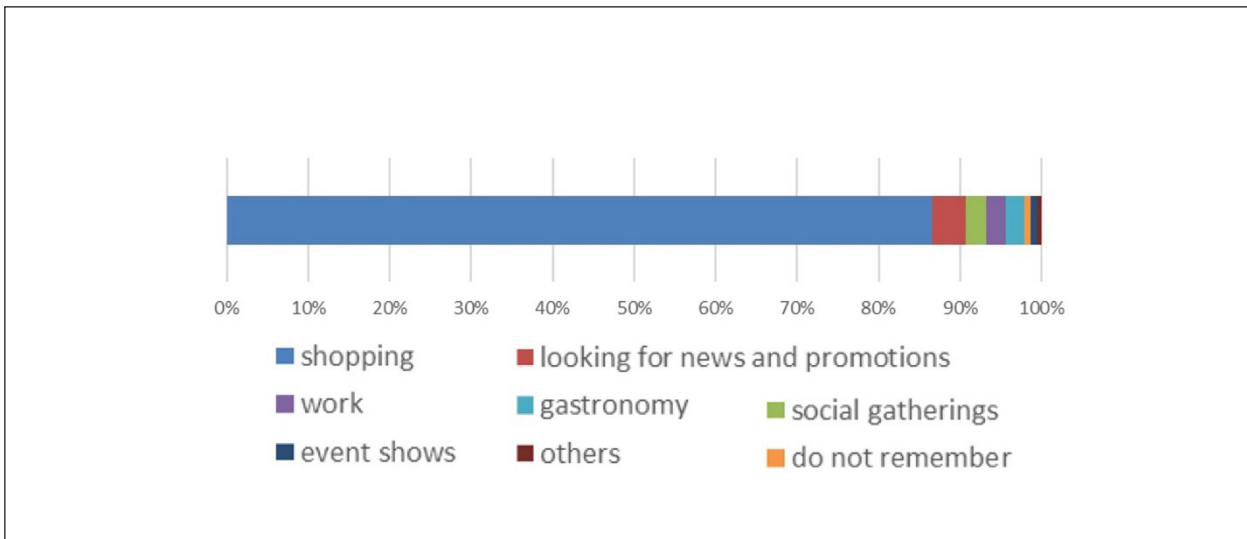


Fig. 4. The main reason behind Sunday visits to retail facilities prior to the implementation of restrictions

Source: own elaboration

currently subject to retail restrictions (57.42%). By 2017, 37.04% of Lodz residents shopped in facilities which are currently either affected or unaffected by the restrictions. The remaining group declared that either they mainly used facilities under restrictions (3.09%), or they do not remember which retail facilities they shopped (2.44%).

Nearly 67% of respondents used to shop at least twice a month in facilities which are now under retail restrictions (34.95% twice; 31.67% three or more times a month). Upon the implementation of the Sunday retail restrictions, Lodz residents had to change their shopping habits, with current data showing they shop either during the week (40.78%) or on Saturdays (40.61%).

5.1.2. Travel times and the various destinations of journeys undertaken

As shown in the survey, people usually take up to 30 minutes to reach shopping centres or other retail facilities – 75.96% and 80.77%, respectively, on weekdays, and 59.38% and 72.72%, respectively, on Sundays (here, a shopping centre is taken as a large facility that has a wide range of products, while other (small) retail facilities have a more limited product selection) (Tab. 5).

Upon analysis of the various destinations of journeys undertaken, it was revealed that for the highest percentage of respondents who shop in a shopping centre during the week, this would be their first or

Tab. 5. Travel times to shopping facilities on working days and Sundays

		Working days	Sundays
travel time to a shopping centre	< 15 min	35.52%	31.25%
	15-30 min	40.44%	28.13%
	30-45 min	16.94%	26.56%
	45-60 min	1.64%	3.13%
	> 60 min	5.46%	10.94%
travel time to other shopping facilities	< 15 min	46.15%	37.37%
	15-30 min	34.62%	35.35%
	30-45 min	13.46%	18.18%
	45-60 min	3.85%	4.04%
	> 60 min	1.92%	5.05%

Source: own study.

second trip (a total of 79.66%). Similarly, this is the case when shopping is done on Monday to Friday in other retail facilities – 78.26% (Tab. 6). The most frequent trip motivator is obviously commuting to work, which

was true for all analysed cases (Tab. 7). For Sundays, a trip to shopping centres and other retail facilities is most often the first journey – 63.51% and 60.42%, respectively (Tab. 6).

Tab. 6. Order of trips to retail facilities on working days and Sundays

		Working days	Sundays
order of trips including a shopping centre	First	44.40%	63.51%
	Second	35.26%	21.62%
	Third	13.51%	8.78%
	Fourth	3.47%	2.70%
	Fifth	2.45%	2.03%
	Sixth and more	0.90%	1.35%
order of trips to including another shopping facility	First	48.26%	60.42%
	Second	30.00%	24.17%
	Third	15.65%	9.17%
	Fourth	3.48%	2.50%
	Fifth	2.17%	2.50%
	Sixth and more	0.43%	1.25%

Source: own study.

Tab. 7. Destinations directly preceding a visit to retail facilities on working days and Sundays

		Working days	Sundays
destination directly preceding a visit to a shopping centre	employment purposes outside home	48.47%	6.25%
	returning home	14.12%	6.25%
	visiting shopping centres	9.41%	29.17%
	using services (hairdresser, doctor, bank, etc.)	7.06%	0.00%
	dropping off or taking dependants on foot	5.18%	0.00%
	social purposes (visiting friends or family in their home)	3.76%	16.67%
	Other	12.00%	41.67%
destination directly preceding a visit to another retail facility	employment purposes outside home	32.20%	6.52%
	returning home	19.49%	16.30%
	education purposes	11.02%	0.00%
	using services (hairdresser, doctor, bank, etc.)	9.32%	1.09%
	other shopping purposes in facilities unaffected by retail restrictions	8.47%	18.48%
	visiting shopping centres	6.78%	1.09%
	Other	12.71%	56.52%

Source: own study.

5.1.3. Modal division

The data from the survey shows that the car is the vehicle of choice for Lodz residents when making these trips, with its share in the modal division amounting to 70.67% on weekdays and 70.59% on Sundays (Tab. 8). This translates into a low percentage of trips by public transport, where the respondents are much more likely to travel by bus than by tram, both on working days and during weekends (Tab. 8).

The analysis of the public transport load on trading and non-trading Sundays reveals that it is only marginally higher on the former (Fig. 5).

5.2. The impact of Sunday retail restrictions on residents' activity

By 2017, 47.7% of Lodz residents going to a retail facility also pursued other activities. Shopping was most often combined with a visit to friends/family (25.56%) and/or to an eating establishment (23.62%). It is interesting to note that 68.78% of respondents declared that they still continue to do the activities they did on Sundays on their way to retail facilities, with a third of these activities still undertaken on Sundays, and a significant number on Saturdays (23.3%).

Tab. 8. Modal division of trips made by Lodz residents on working days and on Sundays

Modal division	Share (%) on working days	Share (%) on Sundays
Car (as driver)	65.18%	54.61%
Walking	10.80%	16.79%
City or suburban bus	9.00%	4.14%
Tram	6.36%	3.75%
Car (as passenger)	5.49%	15.98%
Own bicycle	1.35%	2.13%
Other	1.82%	2.60%

Source: own study.

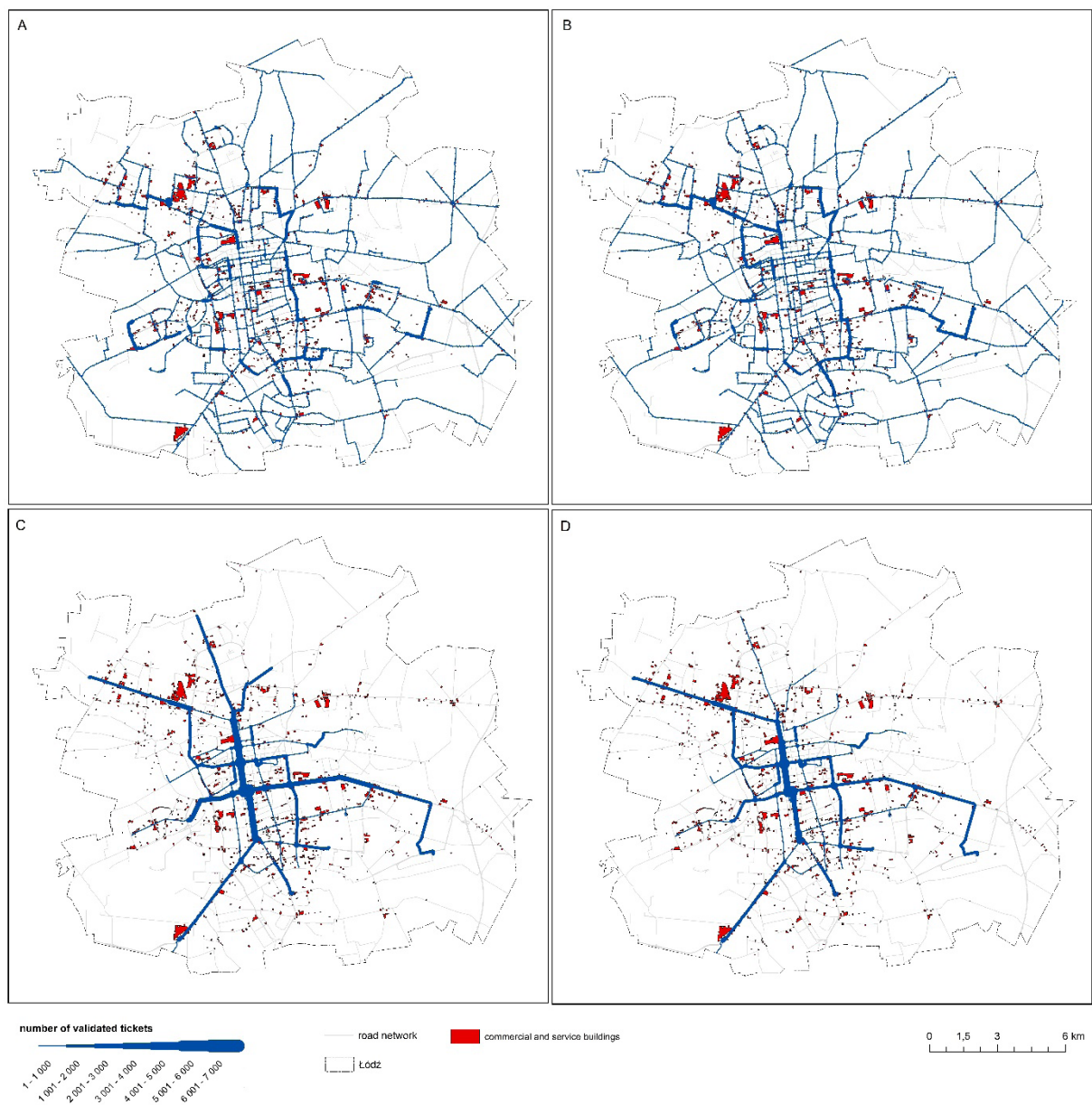


Fig. 5. The average load on the city's transport systems of public buses (A and B) and trams (C and D) on non-trading (A and C) and trading (B and D) Sundays

Source: own elaboration based on data from Lodz City Hall

The questionnaire survey conducted in Lodz also showed that 58.19% of respondents devote time on Sundays that was previously spent on shopping to other activities. Within this group the most frequently indicated purpose pursued instead of shopping is recreation, sport, or hobby (37.19%), socialising (15.32%), or culture and entertainment (11.28%), with other activities not exceeding 6%. Visiting friends or family was high on the list, as well as recreation, walking or visiting a tourist attraction. In contrast, 38.97% of respondents admitted doing nothing during the time they would normally spend shopping on Sundays.

Finally, it must be stressed that despite residents' obvious 'acclimatisation' to the restrictions, as many as 73.8% of them declare that if it were possible to shop on Sundays, they would. This is an important finding in the ongoing debate on retail restrictions. All the more so since almost half of the respondents (46.13%) believe that these restrictions have had a negative impact on their time management, while only 10.8% view this influence as positive.

5.3. Profiles of respondent groups and their transport and consumer behaviour

The present research identified 5 separate clusters of a similar size but distinguished by different consumer profiles. The most significant traits that impact the shopping-related transport behaviour among Lodz residents were found to be age and occupation.

5.3.1. Changes in transport and consumer behaviour of respondents in cluster 1

1 – Consumers in cluster 1 are mainly the elderly who are retired (aged 65+) or those who receive a disability pension (62.67%). By 2017, prior to the implementation of the Sunday retail restrictions, they would most often visit shopping facilities twice a month on Sundays and their trips were predominantly shopping-related (89.61%). Currently, they do their shopping mainly from Monday to Friday (60.55%). The highest percentage of respondents within this group declared that the restrictions have not affected their time management (42.44%). The majority did not travel on Sunday (60.37%) and show little mobility on weekdays, as approximately 42% did not take any trip on a working day.

It was also examined whether there was a relationship between the frequency of visits of the respondents to shopping objects on Sundays by 2017 and the purpose of these visits. Clearly, a correlation between these variables exists (as the p-value is strictly below the assumed level of confidence), unlike in the case of the relationship between frequency and type of

objects where purchases were made by 2017. This means that we are unable to differentiate whether the type of the shopping objects has any impact on the frequency of Sunday visits to the shopping objects before the introduction of the trading restriction with any level of confidence.

As expected, an extremely strong correlation was observed between the answers to questions of the frequency of visits to the shopping malls and of the frequency of shopping. We clearly see from the results of the respondents in cluster 1 that the frequency of visits to shopping malls almost directly corresponds to the frequency of shopping done there (with the exception of no answer given, which is denoted here by 0). Those people who were more frequent visitors to shopping malls by 2017 tend to now make these shopping trips on Saturday or on working days (in 2021), while people who visited malls once a month or less often by 2017 tend to make their purchases only on working days (in 2021). Among the representatives of this cluster, large shopping malls and discount supermarkets were most frequently used on Sundays before the bill restricting Sunday shopping. The more often the respondents of this cluster visited shopping malls on Sundays, the more likely they are to use alternatives now the shops are closed on this day. These include Internet shopping or using shops which are not subject to the restrictions. The correlation is statistically significant regardless of whether we consider blank answers or not.

Respondents of this cluster tend to answer negatively ("no") more often to the question of whether the time spent on Sunday shopping is now spent on other activities. However, there is seemingly no correlation between the answer to this question and the frequency of previous visits to the shopping objects.

Looking at the results of the Kendall test and Spearman test (which are strongly connected), we clearly see the connection between the frequency of visiting shopping facilities by 2017 and the impact of the introduced trade restrictions on the way time is organization (in 2021 on Sundays). The more often respondent visited shopping malls on Sundays by 2017, the more likely they were to describe their time management as worsened due to the restrictions on Sunday trade (those who were less likely to visit shopping facilities tended to answer 'unaffected' rather than 'positive change'). An interesting observation is that people who selected 'work' as their main reason for going to shopping objects on Sundays were more likely to respond positively to questions on the effects of the restrictions on their Sunday time management. Amongst respondents in this cluster it can be statistically shown that the correlation between the type of

object visited on those Sunday trips had an impact on their answer to the question regarding Sunday time management. People visiting shopping malls and hypermarkets were slightly more likely to say that the quality of their Sunday routine had worsened due to the restrictions than those who checked 'supermarkets and discount supermarkets'.

In addition, there is no surprise in the fact that the more often respondents visited shopping malls on Sundays, the more positively they responded to the question on whether they would go shopping on Sundays if it was again possible. This is clearly confirmed by the p-value of the Pearson test. The percentage of people eager to shop on Sundays if there was such a possibility was larger in this cluster among those people who are now doing (in 2021) their usual Sunday shopping on Saturday (or those who have turned to objects not affected by the trade restrictions) instead.

5.3.2. Changes in transport and consumer behaviour of respondents in cluster 2 – Consumers in cluster 2 are mainly middle-aged citizens (aged 30-44) who are employed across different sectors of the economy (outside home – 67.29%, remotely – 20.87%, hybrid mode – 11.85%). By 2017, prior to the implementation of the Sunday retail restrictions, they would most often visit retail facilities three or more times a month on Sundays, and their visits were predominantly shopping-related (89.99%). Currently, they mainly shop on Saturdays (41.61%). The highest percentage in this group states that the restrictions have had a negative impact on their time management (52.17%). 50.85% took multiple journeys on Sunday, most often taking two trips. On weekdays, more than 78% also travelled, again the number of trips was most often two.

Respondents in this cluster tended to mostly visit either solely the restricted objects or all types of objects by 2017. Among the representatives of this cluster, large shopping malls and hypermarkets were more popular than discount supermarkets. This is stronger amongst those who visited shopping malls almost every Sunday, and the p-value for this χ^2 test is below 10^{-5} . As expected, an extremely strong correlation was observed between the answers to questions on the frequency of visits to shopping facilities by 2017 and the frequency of shopping. The frequency of visits to shopping malls is almost linearly correlated to the frequency of shopping done by this group, with Pearson correlation coefficient exceeding 0.7 (p value below 10^{-15}).

People who visited shopping malls more often on Sunday by 2017, replaced these shopping trips with trips on Saturday or on working days (in 2021),

while people who visited malls once a month or less often on Sundays by 2017 tend to now make their purchases only on working days (in 2021). Moreover, the most frequent shoppers had a slight tendency to use alternative shopping methods on Sundays, such as Internet purchases or shops which are not subject to the restrictions (although the tendency is still higher than for the other groups of respondents who shopped less frequently on Sundays by 2017).

The respondents of this cluster tend to answer negatively more often than not to the question of whether the time spent on Sunday shopping is now spent on other activities, with the exception of the subgroup which shops less often than the majority of this cluster. The tendency increases along with the frequency of visits to shopping malls (p-value below $\alpha = 0.05$). The results of χ^2 test, Kendall τ test and Spearman ρ test (which are strongly connected) clearly indicate the connection between the frequency of visits to commercial facilities on Sundays by 2017 and the impact of the restrictions on the organisation of time. The more often respondent visited shopping malls on Sundays, the more likely they were to describe their time management as worsened due to the restrictions on Sunday trade (those who visited malls on Sunday less often tended to answer 'unaffected' rather than 'positive change'). There is also no surprise in the fact that the more often respondents visited the shopping malls on Sundays, the more positively they respond to the question on whether they would go shopping on Sundays if it was again possible. This is clearly confirmed by the p-value of the Pearson χ^2 test. Surprisingly, people who had either a neutral or positive attitude towards the changes this law had induced by their Sunday time management had a greater tendency to respond negatively regarding the possibility of returning to their Sunday shopping routine.

People who now do their shopping on Saturday (or have turned to methods unaffected by the trade restrictions) tended to have a more negative view of the impact of trade restrictions on their time management than those who now shopped on working days or chose not to give an answer. A statistically significant correlation was detected between the types of objects visited during Sunday shopping trips and the answer to whether the time spent on these activities has been redirected towards other tasks. People who mainly visited supermarkets and discount supermarkets were almost twice as likely to give a negative answer to this question than positive, while the majority of those who mainly visited shopping malls and hypermarkets gave evenly balanced answers to this question.

5.3.3. Changes in transport and consumer behaviour of respondents in cluster 3

3 – 51.45% of the respondents in cluster 3 are minors (aged 13-16) who are still studying. By 2017, prior to the Sunday retail restrictions, 38.04% of these individuals were unable to shop independently (age restrictions), did not shop in general (53.03%), or could not remember if they did, and thus, were not asked any follow-up questions on the history of their consumer behaviour. Since the respondents in this cluster did not shop, the highest percentage declare that the restrictions have not affected their time management (50.27%). An overwhelming majority did not travel on either a Sunday (72.24%) or on a weekday (59.88%). For this group of respondents, analysis comparing transport and consumer behaviour by 2017 with the current situation were not possible (because, as mentioned, these were people who could not or did not make purchases by 2017).

5.3.4. Changes in transport and consumer behaviour of respondents in cluster 4

4 – **95.8% of the respondents in cluster 4 are minors (aged 13-16) who are still studying.** By 2017, prior to the Sunday retail restrictions, they would most often visit retail facilities twice a month on Sundays, and predominantly for shopping-related purposes (79.2%). Currently, they mainly shop (55.6%) on Saturdays. The highest percentage of the respondents within this group declares that the restrictions have had a negative impact on their time management (63.2%). This is the least mobile group, with as much as 78.3% not travelling on the previous Sunday. People in this cluster also declare the lowest mobility on weekdays, as approximately 66.8% did not travel.

As expected, a strong correlation was observed between the answers to questions on frequency of visits to shopping malls and the frequency of shopping by 2017. The frequency of visits to shopping malls is almost linearly correlated to the frequency of shopping done by this group, with the Pearson correlation coefficient exceeding 0.5 (p value below 10^{-15}). However, for each frequency of visits to shopping malls by 2017 selected by the respondents, there is a noticeable group of people who refused to provide an answer, which heavily impacts the Pearson correlation coefficient – otherwise it would be close to 1.

The majority of the group that chose shops as the main destination on Sundays by 2017 in facilities now subject to trade restrictions used shopping malls or discount stores (in almost equal proportions), the remaining respondents who chose “meeting with colleagues and friends” as the main reason for a Sunday

trip, had a strong tendency to opt for hypermarkets and shopping malls only (this is also statistically significant, p-value below 10^{-15}). In this cluster the vast majority have switched their shopping which was done on Sundays by 2017 to Saturdays). People who rarely attended shops on Sundays by 2017 in this particular cluster are an interestingly large subgroup who turned to Internet purchases instead.

There is a statistically significant correlation (since the p-value is below 10^{-7}) between the answer to the question on the purpose of visits to commercial facilities by 2017 and answer to the question of now devoting this time to other activities. Namely, people who chose “meeting with friends/relatives” by 2017 were slightly more likely to give a positive answer to the question of whether the time they spent visiting shopping facilities by 2017 is now devoted to other activities.

Interestingly, again we observe a small percentage of respondents who selected either shopping or looking for bargains as major reasons for visiting shopping malls that answered positively on the impact the trade regulations had on their Sunday time management. Nonetheless, the majority responded negatively with a strong majority of neutrality or a refusal of answer. The negative impact of these regulations can be clearly seen on people who used to work in such objects before the law was introduced as well as among those who sought to meet with their relatives and friends in shopping malls. It can be statistically shown that amongst respondents in this cluster the correlation between the type of object visited on those Sunday trips had an impact on their answer to the question regarding Sunday time management. In general, people visiting shopping malls and hypermarkets by 2017 were slightly less likely to say that the quality of their Sunday routine had worsened due to the restrictions than those who checked ‘supermarkets and discounts supermarkets as facilities visited by 2017 (in both these subgroups a negative impact is the dominant answer, however). The percentage of people reporting a positive reaction to the benefits of these regulations on their Sunday time management was negligible in both subgroups. These results are statistically significant (p-values below 0.05). Almost every person who reported a negative impact from the trade regulation on their Sunday routine answered affirmatively when asked if they would shop on Sunday were it possible. People who had a neutral view of the impact of trade regulations on their Sunday time itinerary were also more neutral when asked about returning to shopping on Sundays, although a positive attitude prevails in all subgroups. The more often respondents visited shopping malls on Sundays by 2017, the more positively they respond to the question of whether

they would go shopping on Sundays if it were again possible. This is clearly confirmed by the p-value of the Pearson χ^2 test (although being against a return to the Sunday shopping routine were insignificantly low, neutral answers did appear from time to time).

5.3.5. Changes in transport and consumer behaviour of respondents in cluster 5

5 – Consumers in cluster 5 are predominantly middle-aged citizens (45–64 years old) who are professionally active (81.8% work outside the home, 9.6% remotely, and 8.6% in a hybrid mode) across a wide spectrum of the economy with no single one dominating (none work in services classified as ‘other’). By 2017, prior to the implementation of the Sunday retail restrictions, they would most often visit retail facilities three or more times a month on Sundays, and mainly for shopping-related purposes (90.4%). Currently, they mostly do their shopping from Monday to Friday (44.8%). The highest percentage within this group declares that the restrictions have had a negative impact on their time management (46.9%). 53.1% of respondents made at least one trip on the previous Sunday and 80.3% on a weekday (in both cases it was usually two trips).

Once more, as expected, a strong correlation was observed between the answers to questions on the frequency of visits to shopping malls and the frequency of shopping by 2017. The frequency of visits to shopping malls is almost linearly correlated to the frequency of shopping done by this group, with the Pearson correlation coefficient exceeding 0.7 (p value below 10^{-15}). However, for each frequency of visits selected by the respondents, there is a small group of people that refused to provide an answer, which impacts the Pearson correlation coefficient – otherwise it would be close to 1.

Among the representatives of this cluster, large shopping malls and hypermarkets were also more popular than discount supermarkets. This tendency is significant amongst all subgroups, albeit with slightly different proportions. The p-value for this χ^2 test is below 10^{-3} , which signals a statistical significance.

A statistically significant correlation is detected between the frequency of visits to shopping malls by 2017 which is now devoted to other activities (p-value below 10^{-7}). A positive answer to the question of whether this time has been devoted to other activities is prevalent among respondents who visited malls once a month or less often, while a negative response is almost twice as likely to be selected than a positive one amongst the most frequent shoppers.

Respondents who were more likely to negatively assess the impact of the trade restrictions on their Sunday time management were those people who

visited malls more often. Among infrequent visitors the dominant answer is ‘hard to tell’, followed by a positive impact, which is rather surprising. Statistical significance is obvious, as the p-value is below 10^{-15} .

There is also no surprise in the fact that the more often respondents visited shopping malls on Sundays, the more positively they respond to the question on whether they would go shopping on Sundays if it were again possible. This is clearly confirmed by the p-value of the Pearson χ^2 test. For this cluster, few people were neutral to this issue.

While the majority of the group who chose facilities subject to trade restrictions as the main destination on Sundays by 2017 used either shopping malls or discount shops (in almost equal proportions), the remaining respondents had a strong tendency to opt for hypermarkets and shopping malls only (this is also statistically significant, with a p-value below 10^{-7}), most noticeably amongst people who chose the main reason for their Sunday trip to be ‘meeting with colleagues and friends’.

Finally, the purpose of visits to shopping facilities by 2017 and whether or not they would shop on Sundays if possible are also correlated, as the p-value is well below our assumed confidence level of $\alpha=0.05$ (the majority of responses were, obviously, positive). All but a few respondent among the frequent buyers opted for the possibility Sunday shopping again. It is worth noting, however, that over 10% of the largest subgroup negatively perceived the possibility of returning to Sunday shopping. Lastly, respondents who wished to return to Sunday shopping assess the impact of the regulation negatively.

6. Discussion

Upon the implementation of the Sunday retail restrictions, Łódź residents were forced to change their shopping habits. Currently, they shop during the week (40.78%) or on Saturdays (40.61%). This is further confirmed by traffic observations in 2021, which recorded a distinct increase in the number of vehicles on the city’s road and street network on Saturdays preceding non-trading Sundays (Borowska-Stefańska *et al.*, 2022). However, one must emphasise that Łódź residents (just like the citizens of other cities in Poland) have had 3 years to become accustomed to the new restrictions. Borowska-Stefańska *et al.* (2020) show that in the first few months after the introduction of Sunday retail restrictions, some consumers who were unaccustomed to the newly imposed ban shopped last-minute (seen in the high congestion on the road network on Saturday late afternoons). During this time, significantly higher traffic was recorded on Saturdays preceding non-trading Sundays. However, analyses

over a longer time horizon returned different results, confirming that people had become accustomed to shops being closed on Sundays. It is important to stress that people do generally prefer to shop at weekends, which is confirmed by the studies conducted in Italy, as shown by Passaro et al. (2020). Studies conducted in Germany are consistent with the results of the Lodz-based survey. They show that following the introduction of Sunday retail restrictions in Germany (also seen in other parts of the world), longer opening hours on Saturdays have become an accepted alternative (Grunhagen, Grove and Gentry, 2000). Research conducted by Choi and Jeong (2016) showed that the manner of restrictions affects the change of decision regarding the day of shopping.

It has also become clear that the larger the shopping centre, the longer the acceptable travel time, particularly on weekends, when people have more free time. This is also true for shops that offer a greater product range – the wider the choice of products and services, the greater the catchment area (Mikołajczyk, 2012; Twardzik, 2014). The fact that a 'weekly shop' has become common is mostly due to the greater mobility of city dwellers, the increased presence of women in public life, the considerable time constraints of full-time work, and even the volume of large refrigerators, as confirmed by Sugie et al. (2003). According to Davies and Clarke's (1994) model, the less time pressure there is (free Saturdays) and the greater the desire to do a big shopping, the larger the shopping centre chosen.

As shown by Borowska-Stefańska et al. (2022), changes resulting from the Sunday retail restrictions have led to less frequent use of mass transit for transport needs on non-trading Sundays. This changeability is observed to a much lesser extent when other mobility restrictions (i.e., the pandemic situation) were encountered (Borowska-Stefańska *et al.*, 2022). The analysis of the modal division of trips taken on Sundays by 2017 to those shopping facilities that are currently subject to retail restrictions reveals that it does not differ substantially from the current modal division for Sundays – trips by car dominate (70.67%), with a fairly high percentage of trips taken by this mode as a passenger (18.66%).

The above research also found that instead of shopping on Sundays, respondents generally undertook no activity outside home. This partly coincides with the results of the study by Borowska-Stefańska et al. (2020). However, it is evident that each year since the implementation of retail restrictions the residents of Lodz are becoming ever more accustomed to the situation and are choosing to spend Sundays on alternate activities.

7. Conclusions

The 5 patterns identified on the basis of the conducted survey reveal a correlation between respondents' traits (i.e., age and occupation) and transport behaviour (primarily shopping-related). The collected data shows that the Sunday retail restrictions have had a negative impact on both people of working age and those younger respondents who used retail facilities by 2017. Importantly, the respondents in clusters 1, 2, 4, 5 (those who often used to travel to shops before the restrictions were introduced) also declare that they would be eager to shop on that day if possible – in each cluster this percentage amounted to at least 76%. Only those who did not generally shop by 2017 (cluster 3) currently also declare that they would not do so (42.26%), or found it difficult to express a concrete opinion in this regard (10.14%). Age also affects when people do their shopping – older people shop mainly on weekdays (the groups aged 45-64 and 65+). Those aged 13 to 44 and a significant percentage of those aged 30-44 prefer to visit a retail facility on Saturdays. On Sundays, the greatest mobility is demonstrated by people of working age, while the opposite is true those of non-working age (mainly people of pre-working age). The same tendency applies to working days.

Future research could extend the conducted research via the applications of big data, e.g., from intelligent transport systems which offer spatiotemporal information related to journeys taken. However, this alone will not provide answers to the many questions raised by the results of the questionnaire survey.

The analyses of the transport behaviour of Lodz residents could be repeated in the future to monitor the course of change resulting from the act on restricting retail on Sundays. Additionally, these analyses should be supplemented with data on changes in transport behaviour resulting from the COVID-19 pandemic. The implementation of further restrictions leading to the temporary cessation of certain activities (e.g., closing shopping centres) makes certain destinations, normally frequented by residents, disappear from the model that illustrates traffic in the city. The exceptional context of the epidemic also provides an opportunity to anticipate how urban transport systems might react to the systematic depopulation of a number of major metropolitan areas in Poland (Lodz is significantly affected by this phenomenon) and the transfer of some activities (e.g. employment, services and administration) to the Internet.

Literature:

- Barbieri, D. M. *et al.* (2021) 'Impact of COVID-19 pandemic on mobility in ten countries and associated perceived risk for all transport modes', *PLoS ONE*. Public Library of Science, 16(2 February). doi: 10.1371/journal.pone.0245886.
- Bartosiewicz, B. and Pieleśiak, I. (2019) 'Spatial patterns of travel behaviour in Poland', *Travel Behaviour and Society*. Elsevier, 15(January), pp. 113–122. doi: 10.1016/j.tbs.2019.01.004.
- Borkowski, P., Jażdżewska-Gutta, M. and Szmelter-Jarosz, A. (2021) 'Lockdowned: Everyday mobility changes in response to COVID-19', *Journal of Transport Geography*, 90(November 2020). doi: 10.1016/j.jtrangeo.2020.102906.
- Borowska-Stefańska, M. *et al.* (2022) 'Spatiotemporal changeability of the load of the urban road transport system under permanent and short-term legal and administrative retail restrictions', *Sustainability*, 14(9), p. 5137. doi: 10.3390/su14095137.
- Borowska-Stefańska, M., Kowalski, M. and Wiśniewski, S. (2020) 'Changes in urban transport behaviours and spatial mobility resulting from the introduction of statutory Sunday retail restrictions: A case study of Lodz, Poland', *Moravian Geographical Reports*, 28(1), pp. 29–47. doi: 10.2478/mgr-2020-0003.
- Borowska-Stefańska, M., Kowalski, M. and Wiśniewski, S. (2020) 'Changes in urban transport behaviours and spatial mobility resulting from the introduction of statutory Sunday retail restrictions: A case study of Lodz, Poland', *Moravian Geographical Reports*. Sciendo, 28(1), pp. 29–47.
- Buehler, R. *et al.* (2017) 'Reducing car dependence in the heart of Europe: lessons from Germany, Austria, and Switzerland', *Transport Reviews*. Routledge, 37(1), pp. 4–28. doi: 10.1080/01441647.2016.1177799.
- Buehler, R. and Pucher, J. (2021) 'COVID-19 Impacts on Cycling, 2019–2020', *Transport Reviews*. Routledge, pp. 393–400. doi: 10.1080/01441647.2021.1914900.
- Choi, Y. J. and Jeong, J. (2016) 'Effects of the Sunday shopping restriction in Korea', *Contemporary Economic Policy*, 34(1), pp. 203–215. doi: 10.1111/coep.12127.
- Dijkgraaf, E. and Gradus, R. (2006) *Deregulating Sunday Shop Policies*. Available at: <https://econpapers.repec.org/RePEc:tin:wpaper:20060003>.
- Dujava, D. and Kališ, R. (2021) 'How transport policy shapes commuting patterns: The case of the Bratislava sub-urban area', *Case Studies on Transport Policy*. Elsevier Ltd, 9(2), pp. 567–577. doi: 10.1016/j.cstp.2021.02.011.
- Eger, L. *et al.* (2021) 'The effect of COVID-19 on consumer shopping behaviour: Generational cohort perspective', *Journal of Retailing and Consumer Services*, 61(December 2020). doi: 10.1016/j.jretconser.2021.102542.
- Gan, G., Ma, C. and Wu, J. (2020) *Data clustering: theory, algorithms, and applications*. SIAM.
- Garb, Y. (2007) *The impact of retail deconcentration on travel to hypermarkets in Prague*.
- Gębski, Ł. (2021) 'The impact of the crisis triggered by the COVID-19 pandemic and the actions of regulators on the consumer finance market in Poland and other European Union countries', *Risks*. MDPI AG, 9(6). doi: 10.3390/risks9060102.
- Gössling, S. (2020) 'Why cities need to take road space from cars - and how this could be done', *Journal of Urban Design*. Routledge, 25(4), pp. 443–448. doi: 10.1080/13574809.2020.1727318.
- Grunhagen, M., Grove, S. J. and Gentry, J. W. (2000) 'The dynamics of store hour changes and consumption behavior: Results of a longitudinal study of consumer attitudes toward Saturday shopping in Germany', *European Journal of Marketing*, 37((11-12)), pp. 1801–1817.
- GUS (2015) *Badanie pilotażowe zachowań komunikacyjnych ludności w Polsce*.
- Heilig, M. *et al.* (2018) 'Implementation of free-floating and station-based carsharing in an agent-based travel demand model', *Travel Behaviour and Society*. Elsevier Ltd, 12, pp. 151–158. doi: 10.1016/j.tbs.2017.02.002.
- Jaśkiewicz, M. and Besta, T. (2014) 'Heart and mind in public transport: Analysis of motives, satisfaction and psychological correlates of public transportation usage in the Gdańsk-Sopot-Gdynia Tricity Agglomeration in Poland', *Transportation Research Part F: Traffic Psychology and Behaviour*. Elsevier Ltd, 26(PART A), pp. 92–101. doi: 10.1016/j.trf.2014.06.012.
- Kaufman, L. and Rousseeuw, P. J. (2009) *Finding groups in data: an introduction to cluster analysis*. John Wiley & Sons.
- Kowalski, M. and Wiśniewski, S. (2017) 'Dostępność transportowa łódzkich centrów handlowych', pp. 339–357.
- Krizan, F. *et al.* (2018) 'From School Benches Straight to Retirement? Similarities and Differences in the Shopping Behaviour of Teenagers and Seniors in Bratislava, Slovakia', *Moravian Geographical Reports*, 26(3), pp. 199–209. doi: 10.2478/mgr-2018-0016.
- Kunc, J. *et al.* (2016) 'Are there differences in the attractiveness of shopping centres? Experiences from the Czech and Slovak Republics', *Moravian Geographical Reports*. Czech Academy of Sciences, 24(1), pp. 27–41. doi: 10.1515/mgr-2016-0003.
- Maryáš, J. *et al.* (2014) 'Shopping and services related travel in the hinterland of Brno: Changes from the socialist period to the present', *Moravian Geographical Reports*. Czech Academy of Sciences, 22(3), pp. 18–28. doi: 10.2478/mgr-2014-0015.
- McKinney, W. (2010) 'Data Structures for Statistical Computing in Python', *Proceedings of the 9th Python in Science Conference*, 1(Scipy), pp. 56–61. doi: 10.25080/majora-92bf1922-00a.
- Mikołajczyk, J. (2012) *Kreowanie wartości centrum handlowego. Perspektywa interesariuszy*. Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.

- Nemeškal, J., Ouředníček, M. and Pospíšilová, L. (2020) 'Temporality of urban space: daily rhythms of a typical week day in the Prague metropolitan area', *Journal of Maps*. Taylor and Francis Ltd., 16(1), pp. 30–39. doi: 10.1080/17445647.2019.1709577.
- Paradowska, M. (2019) 'The impact of rivalry and excludability on transport choices: A preliminary research', *Ekonomia i Środowisko*. Wydawnictwo Ekonomia i Środowisko, (69), pp. 160–178. doi: 10.34659/2019/2/28.
- Pedregosa, F. et al. (2011) 'Scikit-learn: Machine learning in Python', *the Journal of machine Learning research*. JMLR.org, 12, pp. 2825–2830.
- Pierluigi, P., Paola, P. and Dario, S. (2020) 'Sunday consumer behavior: A case study in retail marketing', *African Journal of Business Management*. Academic Journals, 14(11), pp. 467–477. doi: 10.5897/ajbm2020.9082.
- Plan zrównoważonego rozwoju publicznego transport zbiorowego dla miasta Łodzi do roku 2025* (2018). Łódź.
- Radzimski, A. and Gadziński, J. (2019) 'Travel Behaviour in a Post-Socialist City', *European Spatial Research and Policy*. Sciendo, 26(1), pp. 43–60. doi: 10.18778/1231-1952.26.1.03.
- Raux, C., Ma, T. Y. and Cornelis, E. (2016) 'Variability in daily activity-travel patterns: the case of a one-week travel diary', *European Transport Research Review*. Springer Verlag, 8(4). doi: 10.1007/s12544-016-0213-9.
- Scheiner, J. (2006) • *Travel mode choice-Individualisation-Transport modelling-Longitudinal analysis Does Individualisation of Travel Behaviour Exist? Determinants and Determination of Travel Participation and Mode Choice in West Germany*, ERDE.
- Schlosser, T. et al. (2019) 'Modelling of Capacity and Public Transport Modal Split for New City Centre in Bratislava', in *IOP Conference Series: Materials Science and Engineering*. Institute of Physics Publishing. doi: 10.1088/1757-899X/603/5/052029.
- Shakibaei, S. et al. (2021) 'Impact of the COVID-19 pandemic on travel behavior in Istanbul: A panel data analysis', *Sustainable Cities and Society*, 65(September 2020). doi: 10.1016/j.scs.2020.102619.
- Shamshiripour, A. et al. (2020) 'How is COVID-19 reshaping activity-travel behavior? Evidence from a comprehensive survey in Chicago', *Transportation Research Interdisciplinary Perspectives*. Elsevier Ltd, 7. doi: 10.1016/j.trip.2020.100216.
- Siguaw, J. A. and Simpson, P. M. (1997) 'Effects of religiousness on sunday shopping and outshopping behaviours: A study of shopper attitudes and behaviours in the american south', *International Journal of Phytoremediation*, 21(1), pp. 23–40. doi: 10.1080/095939697343111.
- Sikos, T. and Kovács, C. (2022) 'The competition between discount stores and Coop in Northern Hungary: A case study', *Geographica Pannonica*, 26(4), pp. 373–384. doi: 10.5937/gp26-39642.
- Sikos, T. T. (2019) 'Changes in the retail sector in Budapest, 1989–2017', *Regional Statistics*, 9(1), pp. 135–149. doi: 10.15196/RS090104.
- Silm, S., Ahas, R. and Nuga, M. (2013) 'Gender differences in space-time mobility patterns in a postcommunist city: A case study based on mobile positioning in the suburbs of Tallinn', *Environment and Planning B: Planning and Design*. Pion Limited, 40(5), pp. 814–828. doi: 10.1068/b38068.
- Šimeček, M. et al. (2018) 'Travel behaviour of seniors in Eastern Europe: a comparative study of Brno and Bratislava', *European Transport Research Review*. Springer Verlag, 10(1). doi: 10.1007/s12544-018-0286-8.
- Sugie, Y., Zhang, J. and Fujiwara, A. (2003) 'A weekend shopping activity participation model dependent on weekday shopping behavior', *Journal of Retailing and Consumer Services*, 6(10), pp. 335–343.
- Taczanowski, J. and Kołoś, A. (2020) 'The influence of COVID-19 on regional railway services in Italy and Poland', *Prace Komisji Geografii Komunikacji PTG*. Uniwersytet Jagielloński - Wydawnictwo Uniwersytetu Jagiellońskiego, 23(2), pp. 40–45. doi: 10.4467/2543859xpkg.20.006.12104.
- Thombre, A. and Agarwal, A. (2021) 'A paradigm shift in urban mobility: Policy insights from travel before and after COVID-19 to seize the opportunity', *Transport Policy*. Elsevier Ltd, 110, pp. 335–353. doi: 10.1016/j.tranpol.2021.06.010.
- TomTom Traffic Index* (2020). Available at: https://www.tomtom.com/en_gb/trafficindex/.
- Transport w województwie łódzkim w 2020 r.* (2021). Łódź.
- Trembošová, M. and Jakab, I. (2021) 'Spreading of Food Deserts in Time and Space: The Case of the City of Nitra (Slovakia)', *Sustainability*, 13(13), p. 7138. doi: 10.3390/su13137138.
- Twardzik, M. (2014) 'Typologia i znaczenie centrów handlowych dla miast województwa śląskiego', *Studia Miejskie*. Uniwersytet Opolski, (16), pp. 129–145.
- Wójcik, S. (2019) 'The determinants of travel mode choice: The case of Łódź, Poland', *Bulletin of Geography. Socio-economic Series*. Sciendo, 44(44), pp. 93–101. doi: 10.2478/bog-2019-0018.
- Woods, R. and Masthoff, J. (2017) 'A comparison of car driving, public transport and cycling experiences in three European cities', *Transportation Research Part A: Policy and Practice*. Elsevier Ltd, 103, pp. 211–222. doi: 10.1016/j.tra.2017.06.002.

