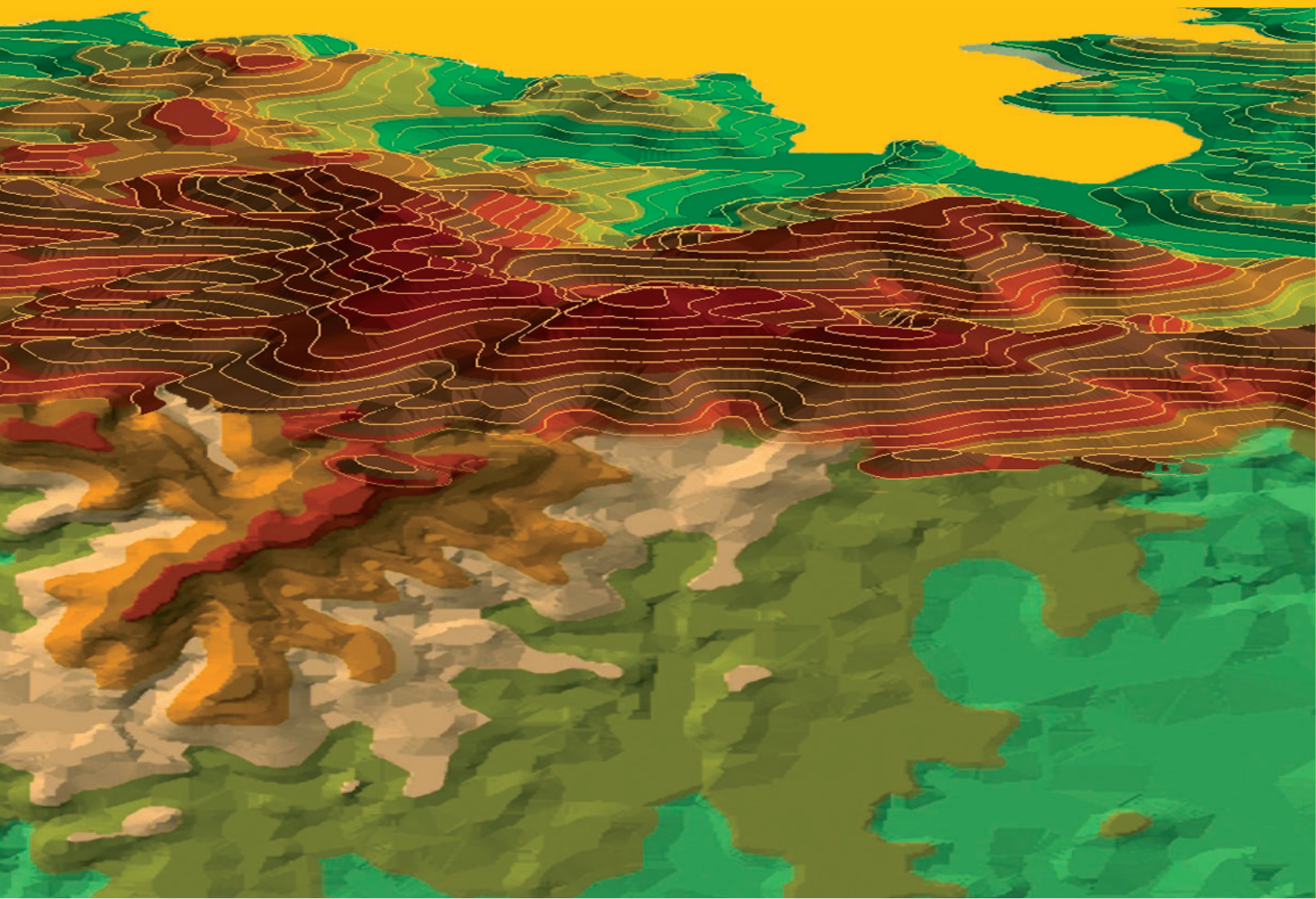


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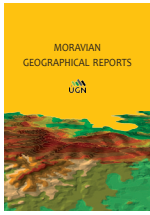
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Decoding escape rooms from a tourism perspective: A global scale analysis

Arsenio VILLAR LAMA ^{a*}, Miguel GARCÍA MARTÍN ^b

Abstract

There has been a spectacular growth in the escape game sector over the past decade. The extraordinary global impact of escape rooms, their implications for tourism, and the limited literature provide grounds for this research. This paper examines such phenomena using an empirical methodology based on a geographic analysis of business repositories and a global survey. Tourism plays a significant role in the escape room industry: approximately one of every three customers is a tourist. Escape roomer-tourists have even been detected: people who essentially plan their trips with the sole intention of playing these games. A significant contrast exists between business-owners and countries, however, as to the role given to foreign customers and the opportunities that all the above implies. Indeed, the connection between escape room narratives and the local culture has been shown to be weak in a majority of cases. Thus, this contribution seeks to feed into an emerging and increasingly relevant debate that has been little addressed in tourism geography: linking experiences, creative economies, authenticity and cultural heritage, etc. – through escape rooms.

Keywords: *escape games, recreation, tourist experience, authenticity, cultural landscape*

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1. Introduction

“In China, people are paying \$13 to be locked in a room and forced to solve puzzles to get out”: this December 2013 headline from The Verge (Jeffries, 2013) described a report on the first escape rooms in Beijing in The Wall Street Journal. Regarded as a descendant of Japanese Takagism¹ in East Asia, this leisure segment is beginning to flourish worldwide and a variety of precursors have been identified (Nicholson, 2015). When this report asked subscribers to comment, they described similar patterns in a variety of cities around the world.

An escape experience is an immersive team-based game, the objective of which is to escape from a room within a given time. The challenge usually involves not just escaping from the room but also a story with a specific goal: finding a treasure, stealing something, finding a key, thwarting a programmed terrorist threat, etc. The room is full of objects and clues that have to be solved. Some elements are accessories and others

are relevant for making progress: keys or data that open safes, briefcases, drawers, cabinets or even doors that allow access to additional unexpected rooms. The environments are varied: a cell, an apartment, a warehouse, a bank, a rail car, an asylum, a laboratory... sometimes a recreation of the past, such as a pirate ship, an Egyptian pyramid, a medieval hall or a Second World War bunker.

The leisure economy is expanding, diversifying and becoming more professional in response to the growing demand for recreation. After commodities and goods and services, experiences – as the fourth stage of Economic Value – have flourished spectacularly: “experiences are not an amorphous construct; it is as real an offering as any service, good, or commodity” (Pine and Gilmore, 1999, p. 98). In this context, and in part due to the rapid development of technologies in everyday life (virtual relations, the digital society, etc.), the experience industry has to all appearances been revamped and reinvigorated by a new generation

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¹ Toshimitsu Takagi is a Japanese multimedia and game developer which created “Crimson Room” in 2004. This and “The Mystery of Time and Space”, developed by Jan Albartus in 2003, are usually considered to be the virtual forerunners of real escape games

of offline entertainment, such as climbing walls, military games (paintball), street gymkhanas and – one of the latest phenomena round the world (Stasiak, 2016) – escape rooms. As an experience product, escape rooms possess the basic ingredients of a structured experience (Ellis et al., 2019): play, immersion, mindfulness, absorption, engagement and quality. Kolar (2017) also identifies novelty and authenticity as basic components of the experience in these escape attractions. Mitás and Bastiaansen (2018) discuss the relevance of novelty – experiencing something new and different than the day to day, believed to be enjoyable – for explaining tourists' positive emotions. In contrast, Wang (1999) draws a distinction between the authenticity of objects, the authenticity of experiences, and existential authenticity. Escape games might be an authentic form of termed constructed experience and could mediate a tourism experience in positive emotions.

Although one precedent can be traced back to the first decade of the 21st century (Nicholson, 2015), the business first emerged in its current format toward the early 2010s and has seen extraordinary growth in recent years. According to Spira (2019), the number of companies in the United States has increased from two dozen facilities in 2014 to 2,300 in 2019. Meanwhile, in Europe, if we take Spain as an example, according to the Escape Room Lover blog in 2019, the business has ballooned 451%, from 150 companies in mid-2016 to 677 in 2019 and 958 in 2021. The rapid development of the offer has been accompanied by the extraordinary popularity of this new form of recreation: escape facilities are ranked among the top “things to do” in the biggest cities around the world in TripAdvisor's What to do indoors? lists. As such, there is a need for a deeper understanding of the phenomenon.

The emerging nature of the sector and its spread around the globe, its implications for tourism, and the limited previous scientific literature all justify the present contribution. This is one of the first papers to systematically examine the geographic features of these attractions, and to contribute to the understanding of escape rooms from the scope of the offer. Specifically, the authors present an analysis of general patterns – dimensions, evolution and location, a deep characterization of the sector and a discussion of its role in contemporary hospitality and tourism. For such purposes, the paper is structured as follows: first, the main concepts and ideas are addressed through a review of the limited literature on escape rooms and their implications for tourism. Second, the sources and methodology are described. Next, the results are presented and discussed. Finally, the conclusions are highlighted.

2. Literature review

Despite their impact in the media, little scientific literature exists today on escape rooms². Most of the contributions are focused on the use of escape experiences for didactic purposes, particularly team building and active learning from Primary School to Higher Education. The growing acceptance of escape rooms as entertainment and the popularity of educational games have led teachers

to repurpose these experiences for the classroom. In this respect, the first studies on the topic have shown a positive impact on content knowledge and collaboration skills. In education, escape challenges have been tested by a wide range of individuals from children (see Nicholson, 2018) to university students, especially in the medical sciences (Kinio et al., 2017), chemistry (Dietrich, 2018) and engineering (Borrego et al., 2017). A few other contributions have drawn attention to such varied fields as librarianship – in order to promote reading, literacy, and search skills (Wise et al., 2018), language learning (Dorado, 2018), and technical writing (Melo and Johnson, 2018).

Despite focusing on the educational field, in his “Peeking behind the locked door”, Nicholson (2015) is the first author to systematise the origins of the sector and to give an approach to the characteristics of the offer, especially in the United States. In this regard, this author includes some questions that have strong links to the goals of the present research, such as perceptions of the market, narratives and local culture.

Escape rooms are one of the latest phenomena in the leisure market. Leisure, recreation and tourism generally are seen as a set of interrelated and overlapping concepts. Following Hall and Page (2014), tourism and recreation are generally regarded as subsets of the wider concept of leisure, and due to this overlap, broader approaches ensure more powerful explanations: “This is because society is not divided into sports players, television viewers, tourists and so on. It is the same people who do all these things” (*ibid.*, p. 8). As a leisure service, in escape rooms – recreational, tourist and work experiences converge. This work assumes these intersections and starts from a holistic conception, but further analyses the implications of escape rooms for tourism.

Research in the social sciences into the impact of escape rooms on leisure is still in its nascent stages and few contributions have been published to date³. Most of these studies have focused on their recreational role, from both the supply and demand perspectives. Stasiak's (2016) and Villar's (2018) works are geographically-driven, describing how the sector spread to Poland and Spain respectively. Stasiak (2016) systematises the origin and structure of these games and also some location patterns at the urban scale in ten Polish cities, while Villar (2018) – in a similar historical overview – surveys Spanish entrepreneurs to give a profile of the offer and initiates what might be called a basic “Geography of Escape Rooms”. These contributions both show the remarkable growth of the sector, its major relationships with recreation, and its special impact on the millennial generation. For their part (demand-led approaches), Kolar (2017), Kolar and Čater (2018), Dilek and Dilek (2018), and Stasiak (2019) analyse users' experiences using ethnography techniques. In these cases, the study area takes a second place and the phenomenon is contextualised within hospitality research as novelty experiences, post-modern tourism and the management of flows. These academic researchers generate a complete discussion of these activities from the perspective of demand, highlighting the way that these attractions provide new,

² A literature search was conducted on Scopus and the Web of Science academic databases. A total of 80 documents were retrieved using the term “escape room” in both cases. A detailed exploration shows a temporal concentration since 2017 (75 entries), with no results prior to 2015. A similar pattern was seen in an examination of Google Scholar, a broader-focus browser, with only 1,880 results (1,430 since 2015).

³ A finer search leads to only 9 papers that analyse escape rooms from social science subject perspectives such as hospitality management, tourism studies and geography.

peak, unique and fun experiences through the challenging social components of gameplay (Kolar, 2017), the importance of theming, narratives and word-of-mouth communication for management purposes (Kolar and Čater, 2018) and, lastly, a comprehensive description of users (motivations, frequency, emotions, etc., see Stasiak, 2019).

These contributions are only partially aware of the implications of this business for tourism: for example, Nagy, Petykó, Diána and Egedy (2018), and Bakhsheshi (2019), have analysed escape rooms as innovative tourist products. The first of these two studies discusses the case of Budapest in the context of creative tourism. The authors underline the innovativeness and creativity of local entrepreneurs as a kind of tipping point for certain destinations, in coherence with the new intangible resources in travel economies such as lifestyles, atmospheres, narratives and media (Richards, 2009). The second study proposes the activity as a novel and memorable experience for tourists. In this sense, we understand that escape rooms are suitable laboratories to study the role of authenticity in leisure industries, as manufactured products linked to residents' and travellers' experiences. The role of the design of spaces in leisure research often focuses on generating places for recreational use, as largely physical places the foundation on which experience is built, designed and valued. The generation of an escape-room tourist destination (e.g. Barcelona) leads to stimulating questions about tourist authenticity (following Rickly and McCabe, 2017): can we truly design spaces for authentic engagement? Is it ever possible to authentically experience places that have been designed?

Multiple theoretical approaches to authenticity have been taken in tourism and leisure studies (Rickly, 2013): from objective views (Lau, 2010), where authenticity is seen as the genuineness of a certain artifact, structure or ritual, measured by experts; to constructivist perspectives that contend that tourists look for symbolic authenticity rather than essentialist properties. These object-based approaches were deconstructed by Wang (1999, p. 358) – as object-oriented perspectives present conflicting points of view regarding tourist motivations and experiences in relation to the epistemological understandings of the object being visited – arguing that “a postmodernist deconstruction of the authenticity of the original implicitly paves the way to defining existential authenticity as an alternative experience.” This existential authenticity ties in with the two dimensions of the studied phenomenon: the intrapersonal dimension implies bodily sensations (Cook, 2010) and/or self-making experiences (Kim and Jamal, 2007), while an interpersonal dimension ties in with a sense of *communitas* (Rickly, 2013). Some authors (Nicholson, 2015; Kolar, 2017; Dilek and Dilek, 2018) have identified escape rooms as flow experiences (Csikszentmihalyi, 1990), in which a group of people plays in a coordinated fashion with the same objective, everyone is fully immersed, and some essential elements of a tourist experience – emotional, learning, practical and transformational – are present (Bakhsheshi, 2019; Bakhsheshi and Ghaziani, 2019).

Finally, apart from the scientific literature, marketing and consulting agencies have used surveys of business owners to develop inventories and technical reports (state of the industry) (Agarwal, 2018; Sofmarr LLC, 2018). Although

they mostly focus their attention on aspects that fall outside the scope of this research project, such as the creation of the game and the business, maintenance and security systems, other features that are more relevant for our topic are included, such as the entrepreneur profile, player demographics and themes. The previous scientific literature and such technical reports are discussed below in concert with the main findings of our investigation.

This phenomenon is thus garnering growing attention both inside and outside the academic world. Nevertheless, there are many focal issues that are still unexplored. In this respect, the implications of escape games for tourism enable us to dig deeper, especially into the relationship between the activity as a tourist offering, on the one hand, and the destination as a well-known, well-represented and symbolised place. In this sense, tourism geography has highlighted the qualities and significance that societies place on their lands, which leads us to a landscape conception of the tourist destination (Cartier, 2005; Crouch, 2013). Escape rooms, especially those that, as will be seen below, are designed to take the city or region in which they are located into consideration, transfer to and confer upon the game plot, the qualities and attributes that most and best characterise the area. This is a mechanism that both qualifies the product and affords it some distinctiveness in a highly competitive market (Pritchard and Morgan, 2001; Truong et al., 2018). In addition, it should not be forgotten that these entrepreneurs can exploit core topics and consolidated tourist routes to make themselves more visible in the complementary tourist market.

3. Data and methods

An exploratory geographical study has been conducted to gain an insight into the escape room sector. A survey was selected as the research method as it has the ability to be administered to every facility in the world quickly and at low cost via the Internet (Solomon, 2001; Gunn, 2002). The first step in such a survey is to define the research universe. The present study is focused on escape facilities and does not include any other agents such as designers, bloggers or demand factors. Identification of the offer allows both the market distribution to be identified and a list of contacts to be obtained for the survey. The primary sources were two company directories: the Escape Room Directory (ERD, 2017) and Escape the RoomZ by Sofmarr LLC (2018).

The challenge of determining the size of the phenomenon at the global scale is complicated due to the poor availability of international directories, their bias toward certain countries and their infrequent updating. Although intermediation websites and escaper blogs have been developed, they are country-based and only list the national offers. The previous research (Stasiak, 2016; Villar, 2018) used ERD to obtain an international perspective, but this directory is no longer updated: the latest version (August 2017) contained over 2,500 registered facilities and 7,000 rooms⁴. A yearbook with a new listing was published in December 2018 by Sofmarr LLC, a company focused on escape room-related information, products and services, according to which about 5,736 enterprises currently operate worldwide. Both indexes were tested at certain locations using national

⁴ As its webmaster explained in a personal communication, it was not possible to achieve perfect coverage in any given place, so this is almost certainly an underestimate of the number of rooms in the world, especially since there were basically no East Asian rooms represented.

directories, Google Maps and TripAdvisor (“Escape Room Barcelona”, “Escape Game Moscow”, “Escape Game Sydney”, etc.). These sources have proved valuable on account of their spatial coverage, although misrepresentations have been detected in certain countries such as Russia, Japan, South Korea and, especially, China. In this regard, there is a noticeable lack of accurate information to obtain an overall picture of the phenomenon in the Chinese market, which is almost certainly the leading market in the world (Nagy et al., 2018). Some corporate organisations put the total number of escape rooms in China at more than 4,000 in 2018 (China EGA, 2020). Nevertheless, this figure contrasts with the scarcity of Chinese companies registered in the many directories that can be consulted, making this obstacle one of the main limitations of our research design. Thus, the main results and conclusions of our work might be extended to most of the world, as revealing a global phenomenon, but all the while bearing in mind this unavoidable under-representation with respect to China.

As these directories only provide the URLs of the facilities, an automated bulk e-mail finder was run using Hunter.io software. A total of 8,468 e-mail addresses were extracted: 2,849 from ERD and 5,619 from Sofmarr LLC. The two lists were combined to ensure the maximum scope of the survey. After this, duplicate rows had been eliminated and a final total of 6,441 e-mail addresses in 117 countries was obtained for use as a contact list.

Once the global offer was quantified and mapped by country, a 20-questions in 3 sections survey was designed:

1. Business and owner profile: year of opening, number and age of business partners, number of employees, franchises, relations with competitors, etc.;
2. Tourism implications: percentage of tourists, number of languages spoken, promotion at hotels and tourist attractions, etc.; and
3. Importance of theme and place: relationship between the room’s theme and the place (city/region), outdoor games offer, location patterns, etc.

A total of 356 responses were obtained from 50 countries and approximately 270 cities. In addition to these numbers, 70 respondents filled out a final open query (Other comments and suggestions) that provided useful qualitative information. Although this sample is statistically significant over our universe of 6,441 escape rooms, the underrepresentation of China in repositories does not allow establishing definitive findings in the matter⁵. A content analysis was carried out for a better understanding of the results. This methodological procedure is useful for reducing all the information provided by respondents to a smaller number of categories, using explicit coding rules and controlled and interpretive deduction through semantic inference (Bardin, 1977; Weber, 1990, Schreier, 2012; Krippendorff, 2013).

There are no records of ER entrants that contain customer data, especially regarding their place of origin. As stated by Nagy et al. (2018), databases allow a demand analysis, and service owners rarely include information about the type of customer, making a fine distinction between locals, travellers and tourists impossible. Our survey is based on the providers’ perceptions (on a scale of 0–10) of the relative proportion of non-locals. This has a bearing on the accuracy of data on the percentage of tourists intended to complement other indexes (number of languages, promotion of tourism

facilities, etc.), to determine the importance of tourism in this type of business. The final open question has also provided us with some further information in this regard, as will be seen below.

The procedure and the subsequent results responded to the following research questions:

- Q1: What are the global numbers and the distribution of this phenomenon?;
- Q2: What are the business models and the entrepreneur profiles?;
- Q3: To what extent is tourism present in this industry? Do managers identify the tourism opportunities of their facilities?; and
- Q4: To what extent are local culture and distinctive heritage incorporated into the design of the game’s storyline? If so, is it possible to align a designed space with an authentic form of tourism experience?

4. Results and discussion

4.1 Global numbers

According to Sofmarr LLC (2018), which is the more accurate and more up-to-date of the two directories, a total of 5,740 facilities are registered in 117 countries. Wójcik and Multan (2020) present a total figure of 8,000 – which has not been rigorously verified – which might cover China and Japan. Apart from with the underestimated Asian market, the phenomenon is clearly located in Europe (2,789) and North America (USA and Canada, 2,426) (see Fig. 1). In Europe, Spain, the United Kingdom, Netherlands, Germany, France, Italy and Poland have more than 200 companies each. By virtue of their clear leading position in the region, these countries are hereafter referred to as the “Big7”. The great expansion in Spain is confirmed: Villar (2018) counted 275 escape rooms in March 2017, whereas today it is the second-largest market in the world. The growth in popularity of the sector in Poland identified by Stasiak (2016) is also validated. Apart from these prevailing areas, Australia, India, Israel, Malaysia, and New Zealand should be highlighted as secondary markets (between 100 and 25 facilities, respectively).

The sector is in its nascent stages in South America with escape rooms currently being opened throughout the entire region. Brazil is the current leading country, but with only 21. Nevertheless, growth is especially intense in major cities (Sao Paulo, Rio de Janeiro, Buenos Aires and Santiago) where – using national directories and Google Maps – new rooms are opening every month and international directories are likely to become obsolete in the immediate future. Similarly, in Africa, the phenomenon has just reached countries such as Egypt, South Africa and Nigeria (between 15 and 5 facilities) and is starting to spread in some cities.

The use of a weighting coefficient shows the relationship between the offer and the local demand and might be useful for estimating the sector’s popularity. A similar index used by Stasiak (2015) for the main Polish cities is given in Figure 1. The ratio is particularly high (more than 8 facilities per million inhabitants) in Europe, where the Netherlands, Finland, Spain, Estonia, and Cyprus stand out. Some other European countries (Greece, Switzerland, Slovenia, Latvia, Poland, amongst others) are on a second

⁵ Our sample has statistical significance at a 95% confidence level and with a 5% error rate.

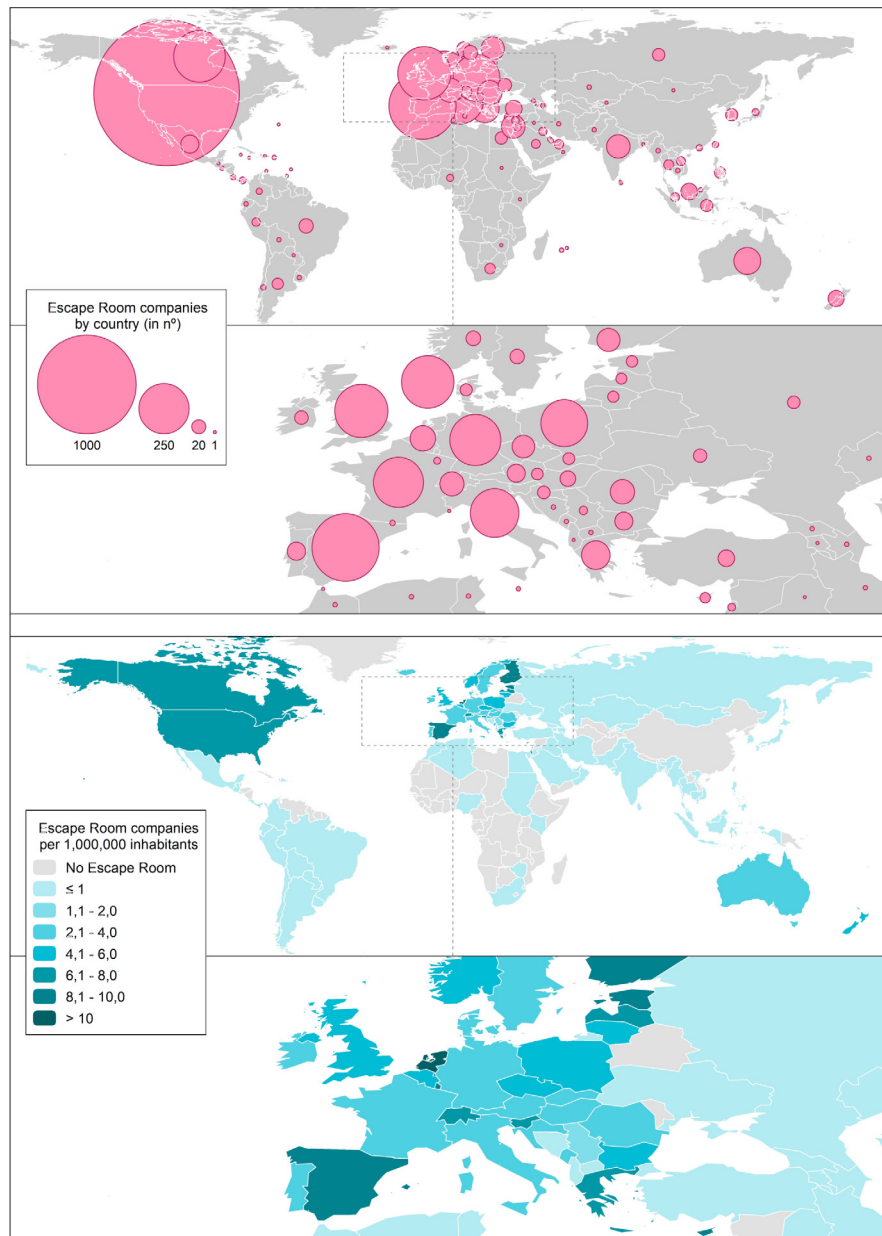


Fig. 1: Global distribution of escape rooms
Source: Prepared by authors from Sofmarr LLC (2018)

tier (5 to 8 companies per million), along with Canada and the United States. Market distribution is uneven and there seems to be no global pattern that explains distribution by country. On a national scale, some authors (Stasiak, 2016; Villar, 2018) have already highlighted prior development in the largest urban areas and the subsequent expansion to small cities, coastal destinations and towns. As a single-use business – the customer is won and lost at the same time – expansion is linked to well-populated and most visited cities, where popularity and novelty among locals and tourists have led businesses to seek promotion. According to Kowalik (2015), these facilities may function well in cities inhabited by at least 100,000 people. Such a study is not within the scope of this paper, but a deeper small-scale analysis might contribute to understanding the geographical drivers of the phenomenon at the regional and national scales. These data are available in Appendix 1.

According to our survey data, this leisure industry boomed around 2016: almost 3 of every 4 respondents (72%) opened their businesses during the 2015–2017 period, with 2016 the

peak year for almost one third of the total sample (Fig. 2). This pattern can be verified in the consulted literature: French and Shaw (2015) describe the explosive growth of the sector worldwide during the 2010–2015 period, from zero at the beginning of 2010 to at least 2,800 in 2015, according to MarketWatch calculations.

Our data reflect the decline in new openings but does not include closures: in line with Spira (2019), 1 every 3 US companies have closed in the 2014–2019 period, with 2018 and 2019 the years with the highest number of closures (86% of total). Some experts predict a reduction in the number of facilities due to the new customer segment ‘drying up’ (Stasiak, 2019). Also, the possible effect of COVID-19 on the leisure and tourism industries in general, and escape rooms, in particular, might reduce the offer – the business contravenes the established principles for tackling the virus as it is fundamentally based on a group of people handling objects in a locked room with no ventilation – or the adaptation of a real game to a virtual setting (Bass, 2020; Meszaros, 2020; Roe, 2020), which can be understood as a return of escape

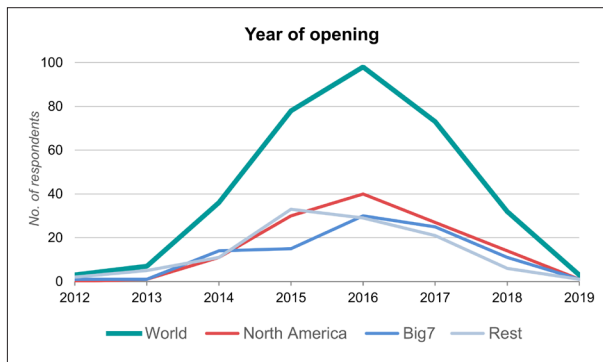


Fig. 2: Number of businesses opening by year
Source: authors' survey and processing

rooms to their digital origins and, in the final instance, a loss of their greatest appeal (handling objects, physical contact, exercise, disconnection from the virtual world, etc.).

4.2 Business and entrepreneur profiles

According to our survey, 72% of the companies are owned by one or two partners. Based on a cross-tabulation, we don't find interregional differences at this regard. As commented by survey respondents – and noted by other authors (Agarwal, 2018; Villar, 2018) – the existence of a family link is very common. For 60% of the respondents, it is their main business, while for 40% it is a complementary activity. The average age of the entrepreneur is 38.1 years. Almost one third of all the entrepreneurs are in their thirties. In the United States, the average age is higher and more broadly distributed among different cohorts. The age of partners and players – see Nicholson (2015) and Agarwal (2018) – leads us to regard escape rooms as an activity strongly linked to the millennial generation.

The sector is primarily based on micro and small enterprises. French and Shaw (2015) underlined the role of smaller businesses, each operating in a single city or region, with some run by enthusiasts who saw the trend taking off and decided to strike out on their own, as noted by one respondent: “Escape games have become my full-time profession. As a backgrounder [sic] I was in training and development for a global research and development pharmaceutical company and also worked in sales leadership. I left the corporate environment to pursue my own company” (respondent No. 178). The number of people hired varies greatly: 11% are self-run, while 56% employ 5 or more people. This pattern is in line with previous research (Agarwal, 2018), which shows that, as escape games continue to grow, they will become a reliable and more recognised source of career opportunities. The cross tabulation shows that this is particularly applicable in North America – where escape rooms have higher employability (71% employ 5 or more) – while in the Big7 countries 53% operate with fewer than 5 people and a significant 14% are personal or family operations. Self-management is especially relevant (25%) in some countries, such as Spain.

Escape rooms are mainly based on an original idea (87%), while franchises represent 13%⁶. Agarwal (2018) and Villar (2018) quantify the weights of dealerships in their respective areas of study at 5% and 19%, while Spira (2019) quantifies it at 28% in United States. Our data show a divergence in this

respect: some countries have a lower incidence of franchises (e.g. Germany, the Netherlands, etc.), while this model presents a greater weight in others (e.g. Greece, Slovenia, Russia, etc.). Qualitative responses state that franchises are becoming more common but there is no statistical evidence, so the current 13% should be compared to similar studies in the future.

According to Agarwal (2018), the marketing channels are mainly online, with advertisements on social networks and search engine optimisation being the most frequent forms. Forming mutually beneficial partnerships with other local businesses such as coffee shops, restaurants or even other escape rooms is relatively common. Our data show that most respondents actually enter into some kind of collaboration with the competition (81%). These working relationships are not exactly inventive, however, consisting of flyers and informal recommendations (60%). In contrast, more elaborated forms of cooperation can be identified, such as escape routes, escape championships, discount cards and others. In line with Pechlaner, Fisher and Hammann (2008), these kinds of synergies are a source of innovation, generate distinctive products in an inter-organisational network process and are especially relevant for expanding this flourishing market at tourist destinations. These collaborative practices also represent a good example of cooperation, understood as behaviours of same-sector companies that generate a network relationship where cooperation and competition coexist and increase mutual shared-market benefits (Kylanen and Mariani, 2012; Chim-Miki and Batista-Canino, 2017), and being extensible (this network) to whole neighbouring tourist destinations (Żemła, 2016). Corporate clients represent a major percentage of the business for many escape rooms (French and Shaw, 2015; Villar, 2018) and fill the rooms on weekdays, when recreation and tourism might otherwise leave them vacant. Entrepreneurs have found unique venues and forms to expand into (French and Shaw, 2015), such as partnerships with movie studios, games on cruise ships (Royal Caribbean), and street escape rooms.

Some opinions show dissatisfaction with the sector boom, partly in line with Nicholson (2015). According to this author, some proprietors, the first to tap into a small market, began to complain about the headlong rush to open other rooms in the same marketplace, charging lower prices and harming the sector. In addition, as “puzzles” are the key to the business, game challenges are not covered by intellectual property standards and accusations of illicit appropriation are common.

4.3 Tourism implications

Based on the methodological premises, tourism appears to play a significant role in the sector: tourists represent 34.8% of the total demand, with national and international visitors constituting 23.2% and 11.6% respectively (see Fig. 3). Despite these data having a fairly high degree of error, other features support the assumption that the number of tourists in the escape room sector is increasing. The scope of the demand shows that the finite nature of the local offer inevitably leads enthusiasts to travel. The offer confirms the relevance of being in a location near a tourist area. Finally, in relation to tourism management, Nagy et al. (2018) highlight the inclusion of escape rooms at great event venues (e.g. the Hungarian Tourism Agency launched a mobile

⁶ Methodologically: It should be taken into account that franchised companies are less able to respond to the survey due to their commitments to their franchisors.

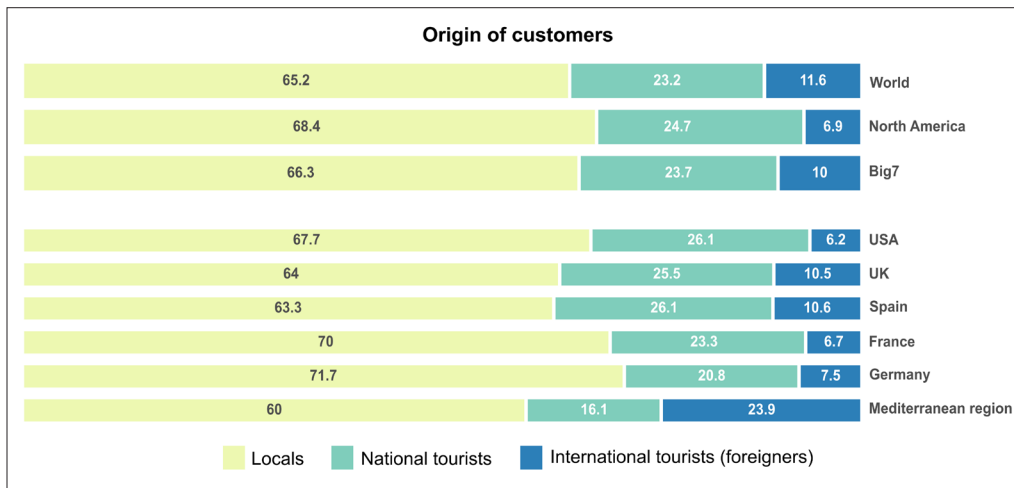


Fig. 3: Tourism implications of escape rooms: place of origin of customers
Source: authors' survey and processing

room at the Sziget Festival) and the organisation of national and international championships (e.g. the Night of Escape Rooms program in Budapest), among others.

According to our tabulation, there is no much difference between the North American and European markets, where tourists represent 31.6% and 33.7% of demand, respectively. Some countries and regions stand out, such as Southern Europe (40%) and particularly Spain (36.7%). The weight of foreign customers is greater than the national market in the former, to the extent that escape rooms are usually focused on travellers at certain frequently visited destinations (e.g. Dubrovnik, Rome, Corfu, etc.). This same pattern is also detected in several North American tourist spots (New Orleans, Palm Springs, Colorado Springs, etc.).

According to our data, three kinds of tourists can be identified:

- i. those that travel for non-escape room-related reasons (cultural, beach, business, visiting the family, etc.) and take in an escape room as an improvised activity;
- ii. those who plan to visit escape rooms on their trips; and
- iii. escape room tourists, or people who essentially plan their trips in order to play these games.

The survey shows that 93% of the offer recognises the existence of this third type, who could be termed escape roomers (travellers whose main motivation is to play escape games). Although the majority of our respondents classify these as rare cases (57.5%), more than one third receive a visit from escape roomers habitually (35.5%) or even weekly (7%). In line with the collected data and other contributions, escape room tourism is spatially conceived as an urban experience or as a road trip. The former is focused on the cities where the offer is broad enough to play multiple games per day. At a national scale, tourists from other parts of Spain make the most of a weekend, a congress or a vacation to play a room. At a higher level, some customers from Germany, Israel or Russia, where the culture of the room escape is well extended, do not hesitate to visit Barcelona to run a marathon of escapes (Picadero Motel, 2016). The latter is based on a road trip: "In the summer of 2018, a group from Chicago drove from there to St. Louis, then Indianapolis, then Louisville. They played over 20 escape games on their trip" (respondent No. 322).

Entrepreneurs are partially aware of the implications of tourism for the business, so they initiate particular actions to attract foreign visitors. These actions are focused on

language ability (website and staff languages) and local promotion (hotels, restaurants and tourist information offices). An important feature of the service for tourism is the proportion of games that can be played in other languages: Websites are not usually translated (54.3%), especially in the USA (97.3%) and the UK (95.7%). This contrasts with Big7 enterprises, where half are translated into at least one other language (in Spain, 3 in every 4 are translated). Regarding staff skills, operators are generally able to host and guide the games in one alternative language (43.0%), and even two (13.8%) or three (8.2%). This is especially prevalent in all countries in Europe where, excluding the UK, 90.8% of companies offer their services in foreign languages.

In connection with visibility in the tourist area, most escape rooms are promoted in the areas around tourist spots and facilities (86.3%). A significant 24% announce themselves at three well-considered sites: accommodation, FandB (Food and Beverage), and tourist information offices. Other responses give additional tourist spots where they advertise, such as tourist attractions, summer camps, music festivals and local stores. Schools, radio stations, and coupon guides are the most preferred sites to attract residents' attention apart from restaurants (visited by both tourists and locals).

Finally, according to the respondent entrepreneurs, the overlapping of the spheres of recreation, tourism and work, inside the rooms has been verified. Thus, the profile is varied: local families ("this game is a great activity for families and sometimes three generations play at the same time": respondent No. 131); mixed groups of locals and tourists ("sometimes we receive groups of students with their pals from abroad": respondent No. 111); work-oriented experiences ("we host corporate colleagues for team-building adventures", respondent No. 266); tourists from other segments ("most of the time it's people that are already around my area for a holiday anyway that book the escape room as one of the activities for their time here": respondent No. 273); and the previously-referred to escape roomers ("I am seeing a burgeoning enthusiast culture both locally, regionally, and nationally ... we have groups that use their vacation to travel around a circuit of cities to play as many escape games as they can along the way": respondent No. 33), among others. Escape-rooming has even been identified as a serious leisure activity: in fact, some enthusiasts in the sector have become professional qualified reviewers or bloggers on forums aimed at such specialised demand.

4.4 Geographic drivers

The relative weight given by an escape room owner to urban location factors is decisive for understanding the extent to which they value the geographic context. When asked about these issues, the highest-rated factors are the price of the premises – leased or owned – and how safe the neighbourhood is (both scored at approximately 4 out of 5). To the contrary, a location in a tourist area, being well-connected by public transit and having other commercial stores nearby receive lower scores (between 3.1 and 3.3 out of 5). There are significant regional differences in this case. For example, public transit is especially underrated in North America, and parking facilities (for private vehicles) receive a higher score. Looking more closely at the national scale, it can be appreciated that it is in the Mediterranean countries – Portugal, Spain, Italy and Greece – where being located in a tourist area, is more appreciated (3.7-3.8 of 5).

Stasiak (2016) compared the geographical distribution of escape rooms in 10 Polish cities. The neighborhoods in and around the old town centres (2-2.5 km from the central point) seemed to be the preferred areas. According to this author, the location factors are the higher influx of both inhabitants and tourists into the centre, accessibility by public transit and the use of representative buildings (capable of offering some kind of atmosphere, with a minor investment). Fourthly, leasing prices received less consideration, as, in Stasiak’s words: “running escape rooms is [...] a very lucrative undertaking” (2016, p. 36). This final factor strongly contrasts with our findings.

On the other hand, Villar (2018) presents some locational drivers and briefly analyses the current distribution of escape games in several Spanish cities. In line with his results, accessibility and leasing price stand out, with proximity to other businesses a less valued factor. This author also remarks that location might be conditioned by the initial investment: “The humblest companies are usually located in less accessible

streets, while franchises and larger projects situate their facilities near avenues as well as pedestrian and tourist areas” (2018, p. 630). In general, the need for premises of a certain size and the limited initial available investment – probably linked to the age of the entrepreneur – drive the activity toward the edges of the historical town centre, where accessibility and leasing prices are moderate. More distant areas offer lower prices and greater opportunities for expansion (new games), but few companies are located on the edges of the city.

The service has also been offered in rural areas: Nagy et al. (2018) report a figure of about one hundred facilities in Hungarian rural settlements despite the low potential demand, with tourism playing a crucial role. This type of escape room could take advantage of unique elements in the countryside. Although it is only an idea put forward in a Seville University Chair ideas contest, a project called Plumbum is based on the recovery of traditional identity industries in Linares (Jaen, Spain), to create a space with business marketing possibilities in the form of a gigantic escape room (See Metropol Parasol, 2020).

4.5 Theme and place

In this paper, special attention has been paid to the link between escape rooms and the places where they are located, whether in the city itself or on a wider regional scale. In this regard, a specific theme – i.e., a plot, narrative contextualisation, even the environment and atmosphere – used as the set and the driver of the game becomes a relevant issue for evaluating the degree to which local identity and a place’s peculiar character influence these kinds of activities.

For this purpose, an appropriate question seeks to establish the thematic offer of our sample. The respondents have provided over 1,000 answers about the different themes proposed in the corresponding rooms and these have been categorised and grouped for better understanding. As can be observed in Figure 4, most of the room themes can

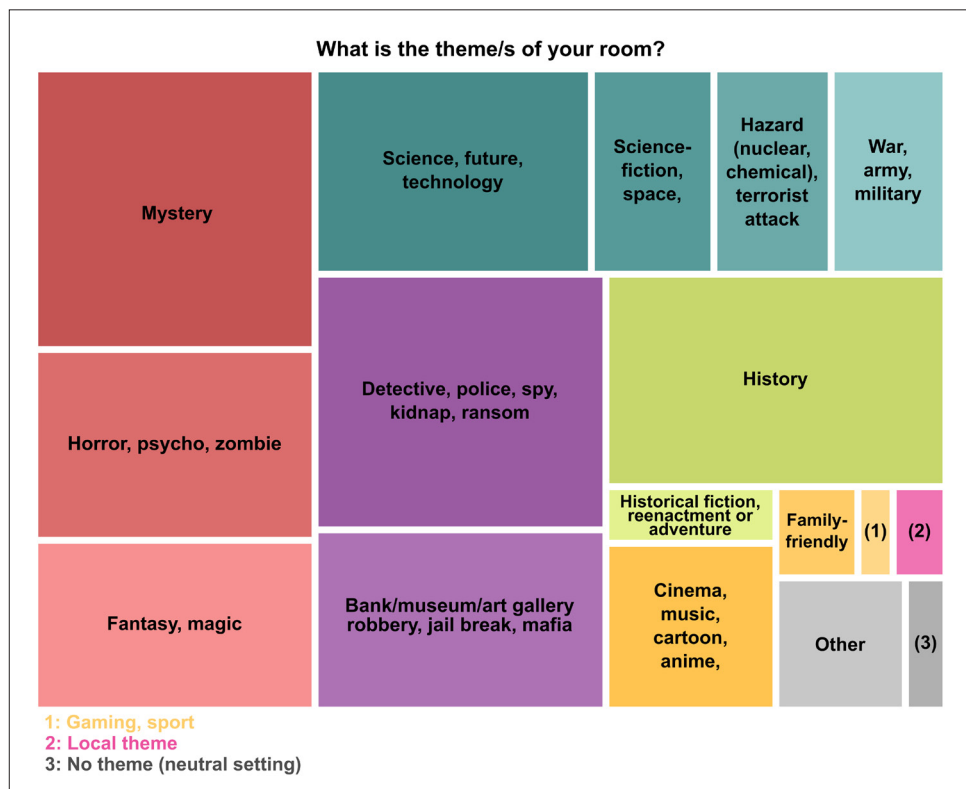


Fig. 4: Themes offered by escape rooms. Source: authors’ survey and processing

be grouped into three main thematic families. The first comprises anything concerning mystery-fantasy-horror and represents almost one-third of the entire sample. The second consists of science and science-fiction arguments, as well as related subjects such as technology, space, nuclear/chemical hazards, terrorist attacks, war and the military, etc. (22% of the sample). The third comprises police and crime topics, including detectives, secret agents, robberies, prisons, the mafia and other similar subjects, and also amounts to almost 22% of all the answers.

Historical motifs also have a less prominent but still significant weight in the survey, as do those inspired by cultural expressions (the cinema, music, literature, etc.). Only a very small percentage of responses, however, took local themes as their inspiration. This does not mean that the previously mentioned themes are not necessarily linked to local attributes or features (such as, for example, solving a robbery at the Louvre museum in Paris). It seems clear, nonetheless, that not many of the survey respondents explicitly see this resource as a potential way to position their business.

For a better understanding of this phenomenon, other questions delved more deeply into the role of local features and attributes. A very explicit question explores the existence of links between the room theme and the city or region. Approximately three out of every four respondents replied negatively. We also proposed a subjective assessment of the relevance of this particular link (to be responded to on a 1 to 5 Likert scale: see Fig. 5). In general, the results point to the same idea: most of the answers show low-medium values with

a mean score of 2.4 out of 5 and a standard deviation of 1.27. These statistics do vary, however, depending on regional and national particularities. Respondents from Canada and the USA are among the owners who place less importance on the theme-place link (score of approximately 2 and a high standard deviation of 1.25). Most of the participants from other countries give very moderate assessments of between 2.2 and 2.5. Only a small number of respondents (from a minority of countries) award a score above the intermediate value of 3, including the Czech Republic (3.13), Bulgaria (3.71) and India (4.5).

In addition, these minority countries show a lower spread of the score, with their standard deviation generally not exceeding a value of 1. The cases of Bulgaria and India are quite relevant, with participants giving a higher relative importance to the theme-place issue, revealing even greater agreement with the statement (standard deviation below 0.9). Consequently, this group of entrepreneurs tends to have a more homogeneous perspective than in other countries such as Canada and the USA, where responses indicate larger discrepancies and differences in this particular business.

Finally, to underline this idea even further, a question was included about live outdoor rooms (street games). A full half of all respondents state that they do not offer any kind of outdoor experience whatsoever. At the other extreme, one in four respondents state that they do. Finally, a further 25% of participants state that they might seriously consider doing so, although they do not currently offer any live outdoor games.

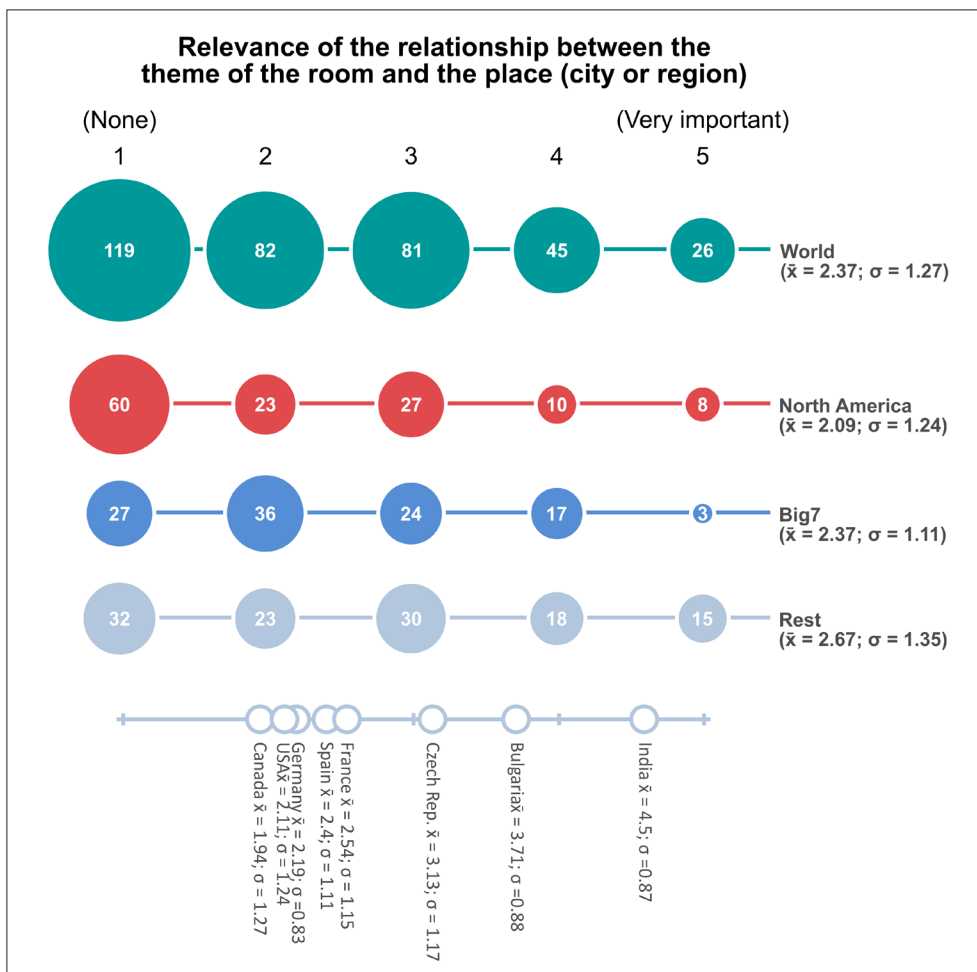


Fig. 5: Relevance of room theme and place (Note: Both the size of the circles and the digit inside represent the number of respondents). Source: authors' survey and processing

An interesting debate about the role of so-called geographic or territorial capital in the design of a localised (i.e. with its roots in a specific geographic space) leisure experience lies behind these responses. As far as activities with a certain tourist focus (and, therefore, also oriented toward a foreign consumer) are concerned, the elements and attributes that characterise the place, whether on a local or regional scale, can be found to form part of the story that underpins the entire tourist experience. Reading these results, however, shows that the tourist relevance of escape rooms as a leisure experience is still in its fledgling stages. In cases where there is a much clearer tourist vocation, the visiting tourist is taken into account much more, but without forgetting that the main demand is still domestic in origin.

There are, therefore, two very distinct models from this point-of-view. The first and more prevalent of the two is characterised by the fact that this is an “atopical” business (i.e. unrelated to place), with arguments that have no links to the territory and with topics that are global, however localised the spaces and times that they refer to (the crypt of the pharaoh, the pirates of the Caribbean, the Wild West, etc.) or ubiquitous (zombies, steampunk, detectives solving a crime, etc.). Be that as it may, these types of escape games correspond to the cultural dynamics of late modernity in the context of global capitalism that Disneyfies leisure experiences (Sorkin, 1992; Beardsworth and Bryman, 1999). Such an intended theming of an escape room responds to a mechanism that attempts to make it distinctive, but much of this attempt trivialises a topic (spaces-times-objects-people) in a context marked by increasingly frequent homogenous and standardised cultural narratives.

The second model, however, takes into account the peculiarities and specificities of place and this connects the leisure supply with the strategies of the tourism industry, in which attributes, authenticity, heritage and local identity form part of the product’s design and storyline. In these cases, the experience might benefit from dual comparative advantages: local consumers can take part in the escape as a social practice rather than identity self-representation, whereas non-local tourists can find in the escape room another tourist offering through which to learn about, explore and actively experience the destination. Some entrepreneurs have understood the opportunities that this business model offers, with local heritage playing a significant role as the main mediator of the gaming experience. This is clear from the testimony of one escape room owner in Norwich (United Kingdom), who expresses it in similar terms:

“At History Mystery, our focus is on interpreting heritage through escape gaming. We work with historic places and museums to develop games that tell real stories from history in the places that they happened. We believe that there is a huge untapped demand for using escape gaming as a way of engaging with other areas of tourism, especially heritage tourism” (respondent No. 4).

Whatever the case, not even this second model is devoid of the risk that this theming process might end up being a simplistic and contrived exercise of autochthonous qualities – which always leads us to the prickly subject of the authenticity of the touristic experience (Cousin, 2011; Piazzoni, 2018; Rickly, 2018).

5. Conclusions and future research

First and foremost, this research project has enabled the mapping and quantification of the global distribution of

escape rooms as a new form of leisure. They first emerged as a leisure product in a small number of cities at the beginning of the 2010s, but their number has grown exponentially over the last few years (2015–2019 period) and spread out from the main urban areas to the rest of the territory in various regions in the world. In this respect, limitations have been observed in escape room repositories (which are used as a data source for this study), especially regarding the limited amount of information about East Asia, which provides an interesting opportunity for the future.

The emergence of this phenomenon could be linked to the value of analogical and off-line experiences in a world that is increasingly virtual – to the point that it could be understood to be a reaction to digital saturation. One key question for the future is to determine whether escape rooms are an ephemeral response or whether they will become a consolidated part of the leisure industry. The business’ main weakness – that it sells a single-use experience: once users have played the game in a given room, they do not become long-term customers – means that they have to reinvent themselves every so often, with the consequent required investment. Bearing in mind the characteristics of the sector – small, flexible businesses led by young entrepreneurs and shaped by demand – the cooptation and idea-sharing strategy and even the swapping of entire games, may be crucial for securing the industry’s medium- and long-term future. The proliferation of new rooms and the lack of administrative control, however, mean that copyrighting is one of the entrepreneurs’ main concerns. It is, therefore, necessary to investigate whether the public apparatus recognises the sector across its entire spectrum (official company directories, registering of patents, social and tourism promotion, etc.) and whether the sector sees this as interference or as an opportunity.

This study has also demonstrated the importance of tourism for the business’ survival. In fact, it has revealed the existence of a new tourist segment, the escape roomers. Within this collective, the influencers stand out. These are people who recount their experiences on their sites and generate a qualified opinion. In this way, some of the demand is turned into an additional actor on the industry’s social map. Escape tourism should, therefore, be acknowledged in destinations’ promotion strategies. In this respect, the analysis of User Generated Content using netnography techniques could help us to understand the relationship between the entrepreneur and the demand in general and the influencers in particular, and its inferences for tourist behaviours.

Escape rooms seem to be aligned with the current discourse on local tourism promotion and management. Several reasons are suggested: first, because the experience has become consolidated as a promotional strategy for destinations; second, because (given their location patterns) they expand and decongest tourist areas; and third, because they shed light on creative tourism, which creates a contact between a local person (gamemaster) and a visitor (player) through the originality of a discourse (topic). With respect to the latter, however, this article reveals the still weak coherence between escape rooms and local culture and their tourist ecosystem. Aligning topics with the local or regional context would mean that entrepreneurs do not have to continue trivialising the destination’s image any longer, and that they can not only generate a discourse connected to what is ‘real’ but are able to reverse its trivialisation and refashion it.

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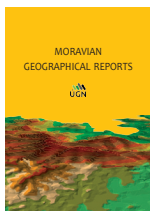
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Country	ER Companies (The Escape Roomz)	Population (thousands) (2018)	IER	Country	ER Companies (The Escape Roomz)	Population (thousands) (2018)	IER
United States	2,155	327,167	6.59	Thailand	10	69,429	0.14
Spain	460	46,724	9.85	United Arab Emirates	9	9,631	0.93
United Kingdom	288	66,489	4.33	Saudi Arabia	8	33,700	0.24
Netherlands	280	17,231	16.25	Singapore	8	5,639	1.42
Canada	271	37,059	7.31	Viet Nam	8	95,540	0.08
Germany	266	82,928	3.21	Kuwait	7	4,137	1.69
France	256	66,987	3.82	Peru	7	31,989	0.22
Italy	241	60,431	3.99	Serbia	7	6,982	1.00
Poland	223	37,979	5.87	Jordan	6	9,956	0.60
Greece	83	10,728	7.74	Lebanon	6	6,849	0.88
Australia	74	24,992	2.96	Japan	5	126,529	0.04
Belgium	65	11,422	5.69	Luxembourg	5	608	8.23
Romania	60	19,474	3.08	Nigeria	5	195,875	0.03
Switzerland	59	8,517	6.93	Panama	5	4,177	1.20
Israel	57	8,884	6.42	Colombia	4	49,649	0.08
India	56	1,352,617	0.04	Hong Kong	4	7,451	0.54
Finland	55	5,518	9.97	Taiwan	4	23,577	0.17
Czech Republic	52	10,626	4.89	Chile	3	18,729	0.16
Portugal	34	10,282	3.31	Costa Rica	3	4,999	0.60
Bulgaria	33	7,024	4.70	Andorra	3	77	38.96
Austria	33	8,847	3.73	Algeria	2	42,228	0.05
Mexico	33	126,191	0.26	Azerbaijan	2	9,942	0.20
Malaysia	28	31,529	0.89	Bahrain	2	1,569	1.27
Turkey	28	82,320	0.34	Bosnia & Herzegovina	2	3,324	0.60
New Zealand	26	4,886	5.32	Bolivia	2	11,353	0.18
Hungary	25	9,769	2.56	Burma	2	53,708	0.04
Norway	22	5,314	4.14	Brunei	2	429	4.66
Brazil	21	209,469	0.10	Cambodia	2	16,250	0.12
Sweden	21	10,183	2.06	Sri Lanka	2	21,670	0.09
Ireland	19	4,854	3.91	Ecuador	2	17,084	0.12
Ukraine	18	44,623	0.40	El Salvador	2	6,421	0.31
Croatia	16	4,089	3.91	Georgia	2	3,731	0.54
Russia	16	144,478	0.11	Iran	2	81,800	0.02
Denmark	15	5,797	2.59	Kazakhstan	2	18,276	0.11
Egypt	15	98,424	0.15	North Macedonia	2	2,083	0.96
South Korea	15	51,635	0.29	Morocco	2	36,029	0.06
Indonesia	15	267,663	0.06	Malta	2	484	4.14
Slovakia	14	5,447	2.57	Montenegro	2	622	3.21
Slovenia	14	2,067	6.77	Pakistan	2	212,215	0.01
Argentina	13	44,495	0.29	Qatar	2	2,782	0.72
Estonia	13	1,321	9.84	Reunion	2	867	2.31
Lithuania	13	2,790	4.66	Puerto Rico	2	3,195	0.63
Philippines	13	106,652	0.12	Tunisia	2	11,565	0.17
Latvia	12	1,927	6.23	Uruguay	2	3,449	0.58
Cyprus	11	1,189	9.25	<i>23 other countries</i>	<i>23</i>	<i>368,925</i>	<i>0.06</i>
South Africa	11	57,780	0.19				

Appendix 1: Global distribution of escape rooms and popularity index (IER)

Source: authors' composition from Sofmarr LLC (2018)



Public transport accessibility to upper secondary schools measured by the potential quotient: The case of Kraków

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Abstract

The spatial differences in public transport accessibility to upper secondary schools are examined in this article, using the potential accessibility model, and based on the example of the city of Kraków. In order to achieve this goal, the potential quotient index has been used, taking into account both the demand for educational services operationalised with the population aged 15–19, and the supply of services depicted by the supply of places for pupils in different types of upper secondary school. A supplementary objective is to present recommendations for transport and educational policy implemented in the city in the context of potential locations of new upper secondary schools based on, among other parameters, the mean centre of the potential accessibility distribution and the potential accessibility dispersion index. We conclude that to better balance access to different types of schools throughout the city in the future, a new location for a general upper secondary school could be considered in the southern or eastern parts of Kraków.

Keywords: Potential accessibility, school accessibility, potential quotient, accessibility dispersion, Kraków, Poland

Article history: Received 25 March 2020, Accepted 30 October 2020, Published 31 March 2021

1. Introduction

Access to services of general interest, including access to educational services at various levels of education, has been an issue analysed by researchers around the world in a variety of contexts. Some authors refer to the concept of social justice which is invoked as a basis for creating broad and equal access to education, including equal access in spatial terms (Cave and Chester, 1981; Pacione, 1989). Spatial variation in the demand for and the supply of education services, measured by the potential model, enables one to produce recommendations concerning possible new locations for schools (Department for Transport, 2005). This is particularly important for upper secondary schools which have neither a local (primary schools) nor regional (universities) catchment area. The catchment area for upper secondary schools is mainly the city itself, possibly extended to its immediate vicinity (Guzik, 2003a; Walaszek, 2016; GUS, 2018).

The relatively small number of accessibility studies concerning access to medium-level education facilities could be the result of scientists showing little interest in the pre-working age group. This group is already independent and does not need to be escorted, but it is still outside

the labour market. At least, in the countries and regions of Central and Eastern Europe, which have similarly shaped population pyramids, there are only a few valuable exceptions in relation to analyses of accessibility to schools (Guzik, 2003a, 2003b; Walaszek, 2006; Biosca, Spiekermann and Stępnia, 2013; Zelinsky and Kubak, 2014; Kučerová, Bláha and Kučera, 2015). There is, then a certain research gap in this field of research in relation to this part of the continent. The result of insufficient accessibility research is that recommendations for school locations at city level are usually implemented in an intuitive way, as proposals by local communities to city authorities demanding the construction of educational facilities. Nevertheless, this is usually related to a lower level of the education system, i.e. primary schools. In the case of upper secondary schools, new school facilities are created for various reasons, including the development of new housing estates, an influx of young migrant families, in particular in Western Europe. In Poland there were educational reforms, after which new upper secondary schools were created in Kraków, the city under examination in this study.

The main goal of the paper is to analyse the spatial differences in public transport accessibility to upper

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secondary schools using the potential accessibility model. In order to achieve this goal, the potential quotient index has been used, taking into account both the demand for educational services operationalised with the population aged 15–19 and the supply of services represented by the supply of places for pupils in different types of upper secondary school in the city of Kraków. A supplementary objective is to present recommendations for the transport and education policy adopted in the city in the context of potential locations for new upper secondary schools based, among other parameters, on the mean centre of the potential accessibility distribution and the potential accessibility dispersion index.

The novelty of this paper lies in the use of the potential quotient index, the mean centre of public transport accessibility distribution and the potential accessibility dispersion index as potential tools for planners concerning decisions on possible locations for new upper secondary schools of a particular type in the city in a period of demographic change.

The paper is made up of six sections. The second section presents a survey of literature on methods of measuring the accessibility of educational services. In the third section we describe our study area. The fourth section is devoted to the detailed methodology we use in the paper. In the fifth section we discuss the results and in the sixth section conclusions are drawn.

2. Methods of measurement of the accessibility of educational services

It is very difficult to identify an approach to accessibility which is the most appropriate from among the range of possibilities available. As Gould (1969, p. 64) indicates: "Accessibility... is a slippery notion... one of those common terms that everyone uses until faced with the problem of defining and measuring it". Despite the lack of a single definition, the concept of accessibility has been developed for many decades, and researchers, depending on the purpose of their projects, have proposed different approaches to it (Geurs and van Wee, 2004). Johnston, Gregory and Smith (1994) formulate the definition of accessibility as "the ease with which people can reach desired activity sites". They also propose three elements that should be included in accessibility analysis. In relation to the topic of this paper, these are: (1) the location of the point from which the accessibility is measured, usually places of residence; (2) the characteristics of the transport system, for example the public transport system; and (3) the location of the activities for which this accessibility is measured, for example secondary schools.

Usually the concept of transport accessibility is used in research and practice to support spatial and transport planning processes by evaluating development strategies at various scales, including Transit Oriented Development scenarios (Geurs, Zondag, de Jong and de Bok, 2010; Litman, 2008; Gulhan, Ceylan, Özuysal and Ceylan, 2013; Qviström, 2015), as well as supporting policies to guarantee high-quality public services (Stepniak, Pritchard, Geurs and Goliszek, 2017; Stepniak and Rosik, 2016). More recent research projects use accessibility in studies of the relationship between transport, social exclusion and other aspects of equity in transport (Tsou, Hung and Chang, 2005; van Wee and Geurs, 2011; Lucas, 2012; Martens, 2012; Pritchard, Moura, Silva and Martinez, 2014; Manaugh,

Badami and El-Geneidy, 2015; Stepniak and Goliszek, 2017). Some authors have also applied the concept of accessibility to express and describe relationships between urban structure and transport behaviour (Scott and Horner, 2008; Szarata, 2013).

On the basis of a literature survey (Geurs and van Eck, 2001), one can identify different groups of methods of accessibility measurement:

1. infrastructure-based accessibility measures, using infrastructure development indicators, such as the quantity and quality of infrastructure;
2. distance-based accessibility measures (travel-cost accessibility), i.e. accessibility measured by the physical, temporal or economic distance to a set of destinations;
3. isochronic-based accessibility measures (cumulative accessibility), i.e. accessibility measured by determining a set of destinations accessible within a specific distance, time, cost or effort;
4. person-based accessibility measures, analysing accessibility at the individual level; and
5. potential-based accessibility measures, which is the most popular method and the one used in this paper.

2.1 Potential accessibility

Modelling of potential accessibility has been well known since the work of Hansen (1959), who was a forerunner in this field and who defined accessibility as the "potential of opportunities for interaction". In general, potential accessibility is measured by the number of activities (opportunities) reachable within a certain distance, time or cost. The closer and greater the opportunity, the more it contributes to accessibility. The potential model is very sensitive to the particular distance decay function that is used (see Stepniak and Rosik, 2018; Rosik, Pomianowski, Komornicki, Goliszek, et al., 2020; and Goliszek, Połom and Duma, 2020).

Potential accessibility is described by the general formula:

$$A_i = \sum_j O_j F(t_{ij}) \quad (1)$$

where A_i = potential accessibility of transport zone i ; O_j = opportunity (attractiveness) of transport zone j ; $F(t_{ij})$ = distance decay function; and t_{ij} = travel time between transport zones i and j .

2.2 Accessibility components

Geurs and Van Wee (2004, p. 128) defined accessibility as "the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)." Therefore, one can select four components affecting the level of accessibility, which are transport, land-use, temporal and individual factors (Geurs and van Eck, 2001; Geurs and van Wee, 2004). Assuming that the attractiveness of the travel destination is measured by the number of places in secondary schools, the four accessibility components have the following characteristics described in the last column in Table 1.

Any changes in the assumptions lying behind the components mentioned in Table 1 can significantly affect the results of accessibility analyses. In the case of the transport component and public transport, one can take into account many factors determining the functioning of public transport – related both to the linear and point infrastructure,

Accessibility component	Characteristics	Access to educational services, in particular upper secondary schools – selected characteristics
Transport	<p>Connected to the transport system, which provides the user with the option of travelling between the origin and the destination using specific means of transport. It can be expressed by the:</p> <p>(1) total travel time (including travel time, waiting time and parking time), cost and effort (e.g. reliability, comfort level, risk of accidents) as elements of the distance decay function;</p> <p>(2) supply of the transport system including infrastructure, frequency, location of stops and tariffs, as well as demand created by the users of individual and public transport.</p>	<p>Public transport as the dominant means of transport.</p> <p>High value assigned to travel time as a nuisance factor by young people. Significantly lower importance of cost (pupils usually use discounted tickets) and comfort.</p> <p>A clear indication of accessibility as one of the most important factors and criteria for selection of the facility.</p>
Land-use	<p>The land use component reflects the land-use system, including the spatial distribution of opportunities (Geurs and van Wee, 2004) and is related both to the supply of opportunities and their location, as well as the demand for these opportunities created in the location of origin (e.g. residential areas). This component can be reflected by juxtaposing supply and demand, then the effects of competition are mapped (van Wee, Hagoort and Annema, 2001).</p>	<p>Accessibility is conditioned by changes in city structure and the demographic development of individual districts.</p> <p>Spatial variation in supply and demand is a prerequisite for the location of potential new facilities.</p>
Temporal	<p>This is related to time constraints, i.e. the level of accessibility depending on the time of day or week, or the time in which users perform certain activities.</p>	<p>Participation in school activities, usually at certain times of the day.</p> <p>A clear morning and afternoon peak.</p>
Individual	<p>Illustrating individual users or groups of people in the context of their needs, abilities and other socio-economic determinants (such as age, income, education level). These features have a significant impact on transport users and their choices (e.g. possession of a car, driving licence, skills and education in finding a school or a job in the vicinity of one's place of residence, etc.).</p>	<p>A clearly defined age of travellers: 15–19 years.</p> <p>Frequent lack of possession of a driving licence, which determines a very large share of the usage of public transport in this age group.</p>

Tab. 1: The four components of accessibility with selected characteristics relating to access to upper secondary schools. Source: authors' conceptualisation

rolling stock and quality features of the transport service. Among all the travel destinations (land-use component) for which accessibility analyses are carried out, the most common are jobs (e.g. Geurs and van Eck, 2001; Cheng and Bartolini, 2013; Östh, Lyhagen and Reggiani, 2016), shopping locations (e.g. Widener, Farber, Neutens and Horner, 2013; Pashkevich and Puławska, 2016; Niedzielski and Kucharski, 2019), health care facilities (e.g. Goddard and Smith, 2001; McGrail, 2012), and other facilities related to leisure or entertainment (Scott and Horner, 2008; Dony, Delmelle and Delmelle, 2015). Some of the accessibility studies also take into account different educational facilities (see Tab. 2).

In general, the concept of the accessibility of education was used in a dynamic way to identify spatial variation in the accessibility of education within the special context of transition in post-socialist countries (Guzik, 2003a, 2003b; Walaszek, 2006; Kučerová, Bláha and Kučera, 2015; Stępnia, Pritchard, Geurs and Goliszek, 2017). Different methods have been applied in determining the accessibility of schools, including competition effects, among them the two-step floating catchment area (hereinafter '2SFCA'), location quotient, and potential quotient. Most of the works emphasise the role of access to schools in making decisions about their choice. Accessibility, understood as proximity to place of residence, is one of most frequently mentioned aspects taken into consideration during the selection of secondary schools (GUS, 2013; Walaszek, 2006). More recent work on educational accessibility also focuses on

equity issues, and combines the spatial pattern of schools together with socio-demographic and economic variables in order to assess ongoing policies considering centralisation or other changes to the educational system (Thelin and Nedomysl, 2015; Gao, He, Liu, Zhang, Wang and Cai, 2016; Lee and Lubinski, 2017; Moreno-Monroy, Lovelace and Ramos, 2018; Ye, Zhu, Yang and Fu, 2018).

2.3 Potential quotient (PQ)

The most general form of the school accessibility model is represented by the potential model with the inclusion of the competitiveness factor. As Geurs and van Eck (2001) point out, the effects of competition on opportunities may be incorporated in an accessibility model by dividing the supply potential by the demand potential. Therefore, the indicator can be interpreted as the distribution of potential for satisfying demands as a function of the intensity of these demands (Czyż, 2002). The PQ is a variable with a continuous spatial distribution (Czyż, 2002), allowing for visual 'smoothing' of differences in the distribution of opportunities between neighbouring regions. PQ solves many problems which arise when the potential measure is employed (e.g. values at the edges of the study area or the level of friction quotient, etc. because in PQ they are being reduced). The indicator is particularly useful for estimating the accessibility of job opportunities (Weibull, 1976) or general practitioners (Knox, 1978). Nevertheless, it can also be used for modelling accessibility to secondary schools

Author(s)	Case study	Type of school	Research goal	Methods
Williams and Wang (2014)	Metropolitan area White flight, Baton Rouge Metropolitan Statistical Area, Louisiana, USA	High schools	Verification of differences in the level of accessibility of high schools in the metropolitan area.	Dynamic analysis using the 2SFCA method
Theelin and Niedomysl (2015)	Halmstad Region, Sweden	Upper secondary schools	Investigation of the factors that affect choices about which school to attend in order to verify policymakers' belief that academic quality is the only factor that influences students' choices.	Empirical survey study, regression analysis
Kučerová, Bláha and Kučera (2015)	Two rural regions (Turnov and Zábřeh districts), Czech Republic	Primary schools	Investigation of the impact of development in the primary school sector in the context of educational policy and management in the Czech Republic.	Catchment area analysis, flow analysis
Gao, He, Liu, Zhang, Wang and Cai (2016)	2873 counties (statistical units), China	Compulsory schools: primary and secondary	Analysis of the inequality of compulsory education from the perspective of imbalanced spatial distribution.	Proximity, cluster analysis, spatial pattern analysis, cold/hot spot analysis
Moreno-Monroy, Lovelace and Ramos (2018)	Sao Paulo Metropolitan region, Brazil	Secondary schools	Investigation of spatial equity in the provision of public schools together with affordable public transport. Assessment of the current policy of centralisation of public secondary education system.	Cumulative opportunities with competition
Guzik (2003a)	Małopolska voivodeship (including its capital Krakow), Poland	Secondary schools	Dynamic analysis of accessibility to secondary schools in Poland and the Małopolska voivodship in the years of 1950–1998. Verification of the impact of accessibility to education facilities on the education level of residents.	Proximity, percentage of population, potential quotient
Walaszek (2006)	Poznan agglomeration, Poland	Primary, secondary and upper secondary schools	Identification of spatial structure and selected elements of the school network in the Poznań agglomeration.	The location quotient was used in order to determine the ratio of demand to supply on the educational market
Ye, Zhu, Yang and Fu (2018)	Guangzhou, China	Secondary schools	Spatial patterns of secondary schools and disparities in school accessibility among different social groups at the neighbourhood level.	2SFCA
Lee and Lubienski (2017)	Chicago, USA	Public primary schools	Answering the research questions: how school closures pursued in 2013, impact on changes to a student's access to schools and how these changes are related to community socio-economic characteristics.	The change in accessibility is compared with density maps
Stępiak, Wiśniewski, Goliśzek and Marcińczak (2017)	Analysis based on address data aggregated to municipalities, Poland	Primary, secondary and upper secondary schools	Identification of the spatial variation in the level of a range of public services, including schools.	2SFCA; spatial concentration of high and low levels of accessibility using Local Statistics, Getis-Ord G

Tab. 2: Review of studies on the accessibility of educational facilities
Source: authors' compilation

(Guzik, 2003a, 2003b). In this case the number of pupils/students produces an educational (supply) potential (E_i) and the number of school-age individuals produces a population (demand) potential (P_i). The form of the equation is as follows:

$$A_i = \frac{D_i F(t_{ii}) + \sum_j^n D_j F(t_{ij})}{O_i F(t_{ii}) + \sum_j^n O_j F(t_{ij})} = \frac{E_i}{P_i} \quad (2)$$

where D_i, D_j = the number of pupils in schools located in the regions i, j ; O_i, O_j = the number of school-age individuals in the regions i, j ; t_{ii} = internal travel time; t_{ij} = travel time between i and j transport zones.

2.4 Potential Accessibility Dispersion (PAD)

The impact on spatial inequality is measured using the Potential Accessibility Dispersion (PAD) index, which takes into account the standard deviation of the potential accessibility values across all transport zones and the mean accessibility level, using the population aged 15–19 as the weighting variable (for details see López, Gutiérrez and Gómez, 2008; Ortega, López and Monzón, 2012; Stepniak and Rosik, 2016). The lower the PAD values, the less polarised is the study area in terms of accessibility distribution.

2.5 Mean centre of potential accessibility distribution

The spatial distribution of potential accessibility also determines the weighted mean centre, which gives interesting information about the location of the centroid point. In general, the weighted mean centre (geographic centre), is a two-dimensional average weighted by a variable and for accessibility it is calculated according to the following formula:

$$\bar{x} = \frac{\sum_{i=1}^n A_i^{(D)} x_i}{\sum_{i=1}^n A_i^{(D)}}; \bar{y} = \frac{\sum_{i=1}^n A_i^{(D)} y_i}{\sum_{i=1}^n A_i^{(D)}} \quad (3)$$

where \bar{x}, \bar{y} = centre (centroid); A_i = accessibility of transport zone i to destination attractiveness D ; x_i, y_i = coordinates of transport zone i ; n = number of transport zones (362).

For this calculation we used the mean centre tool in the QGIS Desktop 3.6.0 application with GRASS 7.6.0.

3. Study area

Krakow is the second largest city in Poland, the capital city of Malopolskie Voivodship, an academic and cultural centre, Poland's largest tourist destination (Więckowski

and Saarinen, 2019) and one of the richer Polish cities. The territorial development of Krakow occurred through the inclusion of neighbouring areas, particularly Nowa Huta, the easternmost district developed to provide housing for a large steel mill built from scratch in 1951. In 1973, the city limits were extended again and rural areas surrounding the city to the east, south and west were incorporated into it. Krakow is divided into 18 districts.

3.1 Some aspects of travel behaviour

For urbanised areas, commuting to schools is identified in a detailed and cyclical manner as part of comprehensive traffic surveys. Commuting to schools (by students) is one of the most important travel motivations in traffic research, usually in second or third place after commuting to work and possibly shopping. This proportion (of all trips) is usually about 12% of all travel (see Tab. 3). The share of public transport in travel related to education is quite variable depending on the city analysed, and in Poland it varies from 35% in Gdansk to as much as 51% in Kraków.

3.2 Land-use component

The number of inhabitants of Kraków has remained at a similar level (around 750,000 inhabitants) for a long time, but changes can be observed between districts. The number of residents registered for permanent residence in the inner-city districts has been decreasing for years: in the Old Town, Krowdrza and Nowa Huta there was a decrease of about 10–15% in the period 2009–2016. These districts are inhabited by an aging population, while young and middle-aged people prefer to live in more modern districts of the city. In Kraków many new housing estates are being built and the largest increase in the number of inhabitants has been seen in the southern (Dębniaki, Swoszowice and Podgórze) and northern areas (Prądnik Biały) of the city.

This work focuses on the distribution of public and non-public upper secondary, following the education system in Poland where upper secondary schools are divided into general upper secondary schools, technical secondary schools, basic vocational schools and other upper secondary schools. In recent years, the number of secondary schools in Kraków has remained at a similar level, with any changes mainly resulting from the reform of the Polish education system. On September 1, 2017, each existing six-year primary school covering grades I–VI became an eight-year primary school covering grades I–VIII, so lower secondary schools, ('gimnazja') ceased to exist, resulting in an increase in the need for places in upper secondary schools, where the number of educational years increased from three to four.

Travel purpose	Gdańsk 2016		Warsaw 2015		Poznań 2013		Krakow 2013	
	(to/from) school	(to/from) university	home-school	school-home	to school	to university	home-education	education-home
Share of education trips	14.40%	11.10%	6.40%	18.20%				
Walking	40.61%	12.53%	32.20%	35.30%	21.20%	5.30%	38.20%	39.30%
Car	13.38%	14.90%	16.00%	13.90%	23.10%	18.10%	8.80%	8.90%
Public transport	35.13%	67.17%	49.20%	48.00%	50.70%	72.40%	51.40%	50.80%
Bicycle	10.80%	5.40%	2.20%	2.60%	2.10%	3.80%	1.10%	0.70%
Other mode	0.08%	0.00%	0.40%	0.20%	3.00%	0.30%	0.50%	0.30%

Tab. 3: Share of travel related to education and mode in selected cities in Poland. Sources: authors' analysis based on KBRs (Kompleksowe Badania Ruchu [Comprehensive Travel Surveys]) from Gdańsk (KBR in Gdańsk, 2016), Warszawa (KBR in Warsaw, 2015), Poznań (KBR in Poznań, 2013), Kraków (KBR in Kraków, 2013)

For the purposes of this study, the number of pupils was aggregated into 362 transport zones. At the end of September 2016, 145 upper secondary schools were identified in Kraków according to data provided by the Board of Education in Kraków (SIO, 2016), with nearly 32 thousand pupils attending them. Young people usually choose general upper secondary schools – in 2016 almost 58% of students took lessons in this type of school. About one third of pupils were taught in technical secondary schools, and about 8% chose basic vocational schools. The upper secondary school system has a moderate degree of centralisation.

Therefore, pupils who do not live within the city are a minority. Data provided by the Central Statistical Office in Poland indicate that pupils of upper secondary schools commuting or temporarily living in Kraków (e.g. in boarding

schools) constitute approximately 10% of upper secondary school attendance (GUS, 2018). In order to simplify the analysis, such students were not taken into account in calculating accessibility levels.

One can observe an uneven spatial distribution of upper secondary schools within the boundaries of the City of Kraków. Most schools are located in the central part of the city and in Nowa Huta. It is clearly visible that the supply of schools is definitely larger on the northern side of the Vistula in comparison with the southern part of the city, where only a few facilities are located. Nevertheless, accessibility to secondary schools depends not only on their distribution, but also on the spatial relations between schools and their pupils' places of residence, as well as the state of the public transport system.

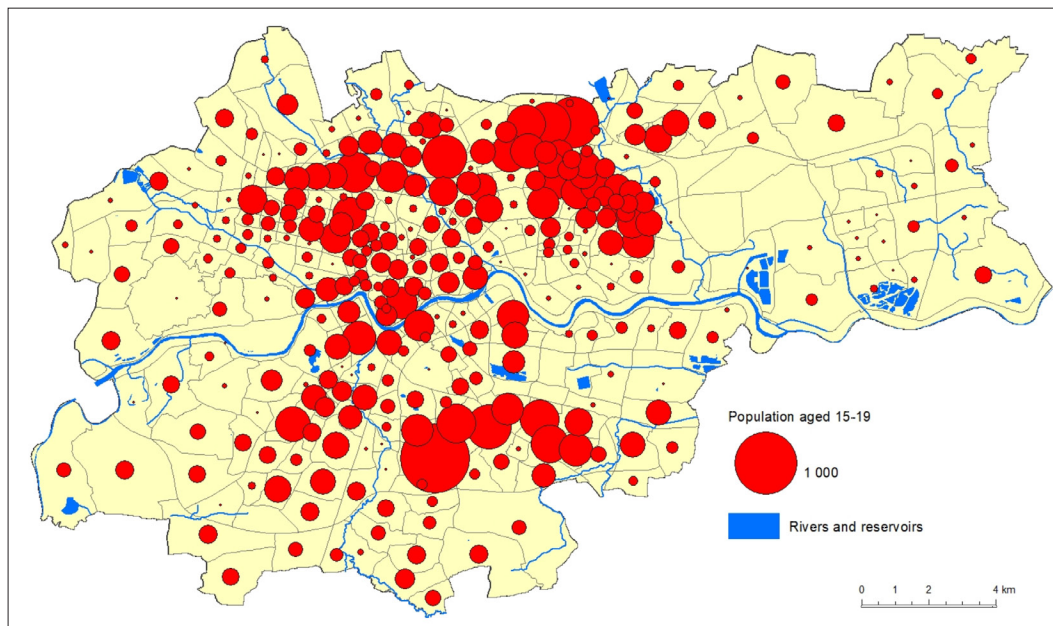


Fig. 1: The number of inhabitants aged 15–19 in 2015

Source: authors' analysis based on demographic data from Imagis. The division into 362 transport zones was based on the existing spatial structure of the city (Szarata, 2014)

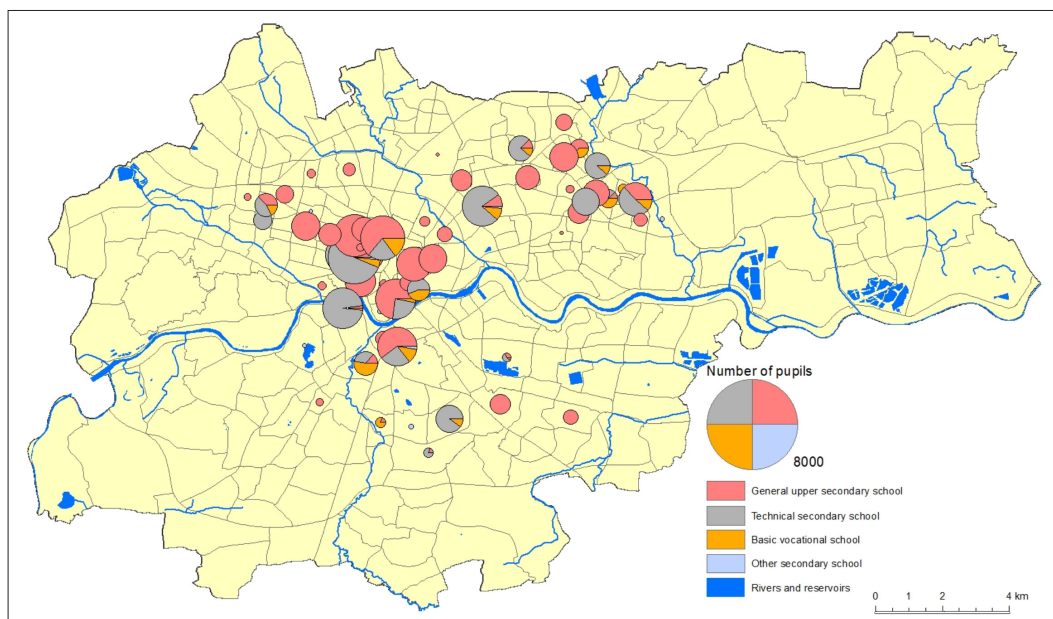


Fig. 2: Distribution of different types of upper secondary school in Kraków (number of pupils in 2016)

Source: authors' analysis based on SIO data as of September 30, 2016

3.3 Public transport system

In Kraków there are 27 tram lines and 161 bus lines (including 72 suburban lines: data for 2017). The total length of tram lines is 353 km and is entirely within the administrative borders of Kraków. The length of bus lines is 2,385 km, of which 1,601 km is within the Krakow City limits. Figure 3 shows the public transport system in Kraków with additional information about areas with access of less than 5 minutes on foot to the nearest bus or tram stop. The areas of high accessibility (5 minutes walking to the stop) are mainly areas with high density buildings. The additional analysis shows that 90% of young residents of Kraków (aged 15–19) have access to a bus stop within 5 minutes on foot.

4. Methods

The level of accessibility can fluctuate greatly throughout the day as a result of congestion or timetables, and a non-linear relationship exists between public transport frequency and losses of precision in measuring accessibility (Stępnia, Pritchard, Geurs and Goliszek, 2019). Therefore, to take into account the temporal dimension, in this paper we use the results of a comprehensive travel survey of Kraków (KBR in Kraków, 2013) in which three main purposes of travel were taken into account: commuting to work, travel to school and other travel. According to the results from KBR in Kraków (2013), 50% of all trips to schools start between 7:00 am and 8:00 am. For this reason, we focus on the morning rush hour and the chosen time at which one gets into public transport, which was used to calculate the level of accessibility, set at 7.00 am resulting in a matrix of travel times between 362 travel zones. For calculations, we use data in the General Transit Feed Specification (GTFS) (see Goliszek, 2021) standard on public transport timetables. We measure accessibility at the centroid of the transport zone. The pedestrian time both to reach the tram or bus stop and to access the internal travel time in formula [2], was determined on the basis of the assumed average speed of access which equals 4.82 km/h.

In order to estimate the distance decay function, we use a sample of 1,471 home-school-home trips carried out by

public transport within the boundaries of Kraków (KBR in Kraków, 2013). The process of estimating distance decay functions has been divided into two stages, using the methodology presented in Salze, Banos, Oppert, Charreire et al. (2011) and Skov-Petersen (2001): (1) matching the type of impedance function; (2) determining the parameters of the adopted function. At the stage of looking for functions, tests were made with non-linear and linear regression models that would best reflect the relationship identified (Tiran, Lakner and Drobne, 2019). In the process of searching for the shape and parameters of the distance decay function, a linear regression model was used, and for this purpose the Statgraphics tool was used. We assumed that the probability of the trip was the dependent variable, and the travel time in minutes was an independent variable. The following formula was determined to be the distance decay power-exponential function (see also Halas and Klapka, 2015):

$$F(t_{ij}) = \exp(-\beta t_{ij}^2) \quad (4)$$

where $F(t_{ij})$ = distance decay function; t_{ij} = travel time (min); β = beta coefficient; $\beta = 0.00122876$.

From the analysis of variance resulting from this analysis, a p-value of less than 0.05 was obtained, which means that there is a statistically significant relationship between the variables (share of travel and travel time) at a confidence level of 95%. A quality assessment of the model was made, resulting in a coefficient of determination $R^2 = 86.79\%$. The same *beta* parameter was used both for population potential, as well as for upper secondary school potential. Moreover, we also used the same distance decay function in calculating the so called self-potential. Following Rich (1978) and Gutiérrez, Condeço-Melhorado, López, Monzón (2011), we assume that when calculating the portion of potential generated internally, the surface of the transport zone is equated to a circle, the average travel distance is half the radius, $0.5\sqrt{\frac{area}{\pi}}$, and the assumed internal travel speed, \bar{v}_i , is 4.82 km/h, which takes into account the pedestrian speed due to the fact that the majority of pupils go to school on foot if located in their own transport zone.

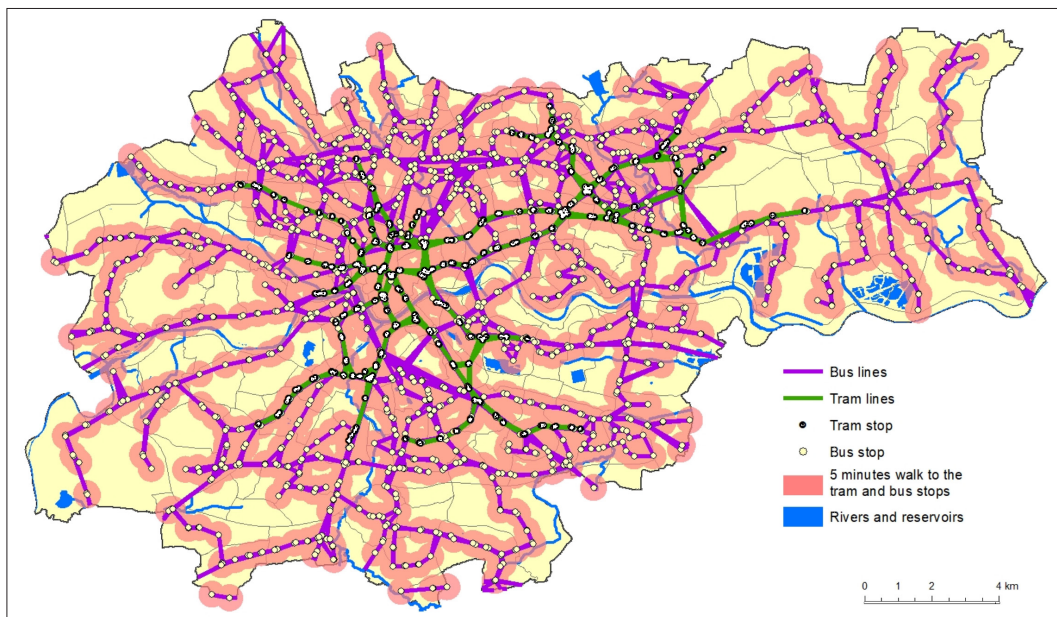


Fig. 3: Kraków public transport system – tram and bus stops within 5 minutes walking time
Source: authors' analysis

The analysis of the accessibility of upper secondary schools was conducted for each of the main types of schools independently (general upper secondary schools, technical secondary schools, basic vocational schools), as well as for all upper secondary schools together. In order to enable comparisons of the spatial differentiation of results, the total sum of results of potential accessibility indicators for the whole city was equated to 1 000 for each accessibility calculation.

A similar procedure was adopted for the potential quotient analysis. For the purposes of comparative analysis, we applied the simplified version of the potential ratio assuming that the total sum of values of both nominator (educational potential) and denominator (population potential) are identical. Then, the potential quotient was calculated for each region independently. The numerical values are multiplied by 100 in the graphics, which means that if the index is higher than 100, then the educational potential exceeds the population potential, and if the index is below 100, then the educational potential is lower.

5. Results

The results presented focus on the spatial aspects of the potential accessibility distribution, with particular attention given to the potential quotient, the mean centre of potential accessibility and potential accessibility dispersion index, concerning both the number of school-age pupils and upper secondary schools.

The spatial distribution of the population aged 15–19 and the pupils in upper secondary schools are generally similar to each other in Kraków. Therefore the potential accessibility pattern also looks similar both for accessibility to the population and accessibility to upper secondary schools. The most accessible areas for pupils are those located in the vicinity of schools, i.e. mainly in the city centre and north-east of the centre, as well as along tram lines and selected high-frequency bus lines.

Nowa Huta and its neighbouring districts, as the area of dominance of heavy industry including the steel industry, are characterised by a relatively higher density of technical

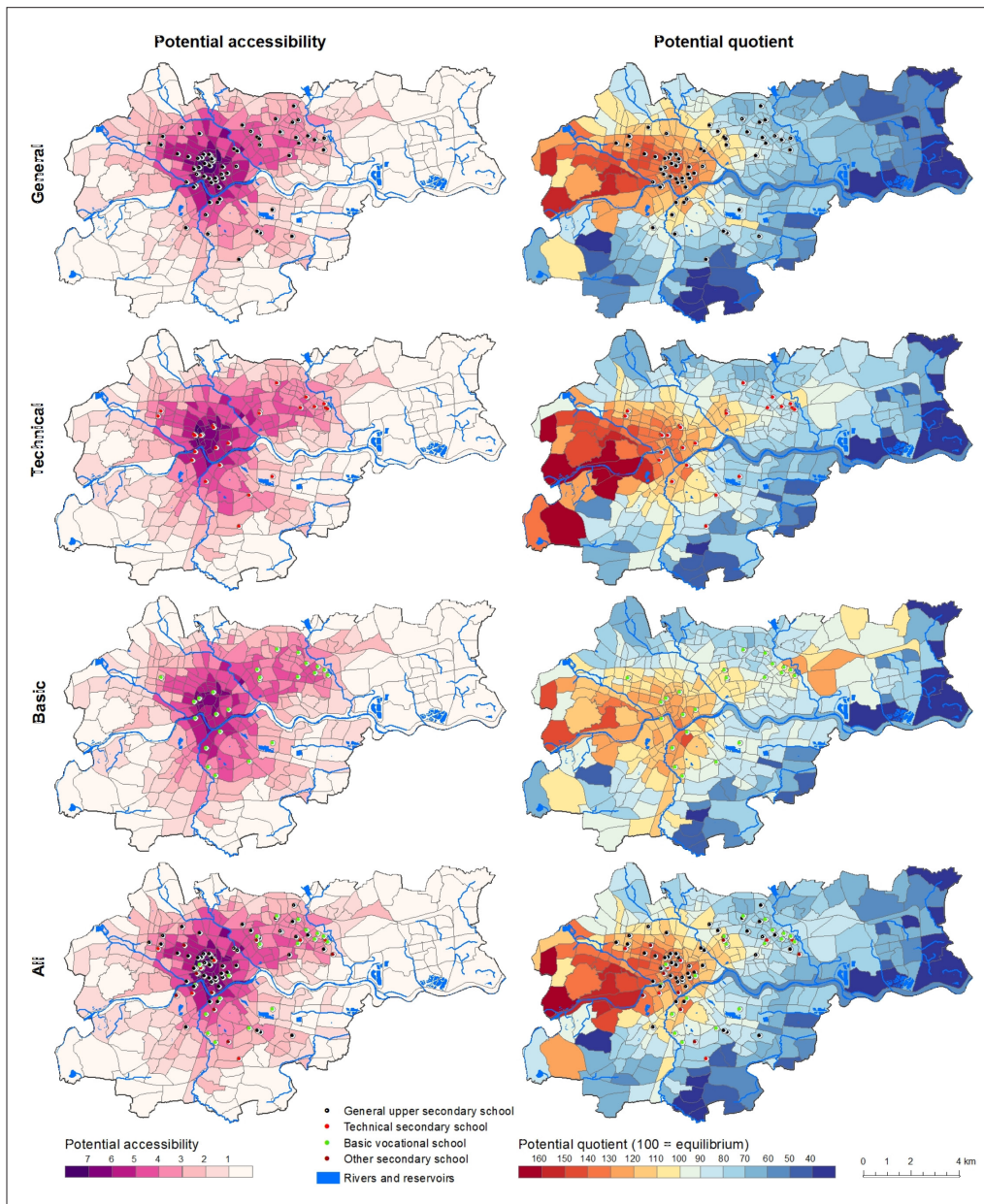


Fig. 4: Potential accessibility of different types of upper secondary school and potential quotient
Source: authors' analysis

secondary schools and, in particular, basic vocational schools. Therefore, pupils inhabiting these areas have relatively better access to the above-mentioned types of schools. The lowest level of accessibility within the boundaries of the city is found in the southern parts of Kraków and in the far eastern parts of Nowa Huta. In the case of Nowa Huta, the situation in this respect was improved by the modernisation of the tram line to Pleszów (Nowa Huta). Further improvement will be possible in the next decade if plans to build a new metro line in Krakow are implemented (east-west connections between Bronowice and Nowa Huta).

At first glance, due to the quite similar distribution pattern of population and education potential accessibility, the mean centres of both indicators are located close to each other (near the Mogilskie roundabout; see Fig. 5). Nevertheless, the results provided by the potential quotient analysis (Fig. 4), show that the surplus of upper secondary school potential over the people aged 14–19 potential is clearly visible in the western part of the city, primarily in the Zwierzyniec district. This result is confirmed by the fact that the weighted mean centre of the potential to upper secondary schools is located a little westward of the population mean. Despite the relatively large number of schools in the north-eastern districts, there are usually less pupils compared with the large upper secondary schools in the city centre. Moreover, the population is more proportionately distributed between these two clusters of upper secondary schools. Thus, the eastern districts can be considered as not sufficiently equipped with secondary schools. This is similar to the southern districts, i.e. Podgórze and Swoszowice, which are rapidly growing in terms of population, and which are also characterised by a surplus of population potential over upper secondary school potential.

In terms of infrastructure investments, especially new tram lines, the city of Krakow has met expectations by launching a new tram line to Płaszów in 2010 (there are advanced plans to extend it up to the S7 eastern ring-road). Because of this investment, young people living in this district have the opportunity to travel rapidly towards the city centre, where the secondary schools are located (Jurkowski and Smolarski, 2018). Currently, the city is also carrying out an investment consisting of the construction

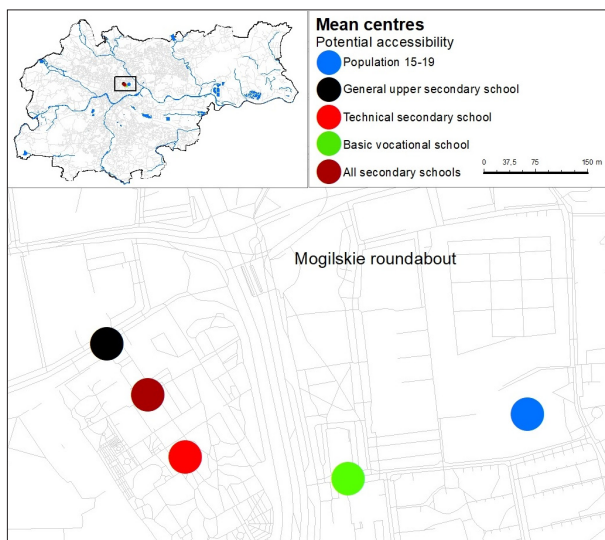


Fig. 5: Mean centres of potential accessibility of the number of school-age individuals and the different types of upper secondary schools
Source: authors' analysis

of a tram line along the Łagiewnicka Route (connecting the housing estates in Kurdwanów with the Zakopiańska route), which will result in the creation of a tram ring in the southern districts of the city. Nevertheless, the location of additional upper secondary schools in the above-mentioned areas will affect the provision of more equal access to education facilities for pupils living in Kraków.

The analysis of the Potential Accessibility Dispersion (PAD) index confirms the above-mentioned results. The spatial inequality is highest for general upper secondary schools (PAD index above 0.7), while technical secondary schools and basic vocational schools seem to be more equally distributed. Nevertheless, the values do not differ a lot when compared with the PAD index for the population aged 15–19, which is an acceptable result from an educational policy point of view (see Tab. 4).

Index	Population aged 15–19	Upper secondary schools			
		General	Technical	Basic	All
PAD index	0.580	0.702	0.659	0.640	0.680

Tab. 4: Potential accessibility dispersion (PAD) index
Source: authors' analysis

6. Conclusions

After commuting to work, commuting to schools is the second most important travel motivation for public transport users within the city. Taking that into account, the relatively small number of studies of the accessibility of schools, in particular those at the medium level of centralisation, i.e. upper secondary schools, is quite surprising.

We conclude that local differences in the level of potential accessibility and potential quotient in the context of secondary schools should become an important premise for making decisions regarding new locations of school facilities. This is particularly important in Poland, and more broadly also in selected countries of Central and Eastern Europe, including the Czech Republic and Slovakia, where in the years to come there will be a slight increase in the group of pupils aged 15–19.

Those cities in which selected peripheral districts had an industrial function in previous decades (as in Nowa Huta in Kraków) may suffer from an unbalanced spatial distribution of different types of schools. Therefore, it is recommended that in the future new schools should not only be located in the context of a new residential area, but also to better balance access to different types of schools throughout the city. It is in this context, that the new location of a general upper secondary school might be considered in the southern or eastern part of Kraków. Nevertheless, the picture of inequality would be a little different if the study also included the suburban zones. Similar research in the future should also take into account the population living in the entire agglomeration outside the city core and the timetables of suburban trains and buses used by pupils in their daily commuting to schools.

Moreover, it is important to consider public transport schedules adapted to the needs of commuting to/from schools in order to increase the level of accessibility (Guzik, 2003a). A fairly large variability in the level of potential quotient

between neighbouring peripheral transport regions was observed in the morning rush hour. Thus, it is important to develop a comprehensive policy that takes into account both the spatial and temporal components of the accessibility of upper secondary schools.

Moreover, there is a need for greater emphasis on the study of the relationships between spatial policy, housing policy and transport policy, both at the city level and in its surroundings. The use of potential accessibility indicators, including also demand and supply conditions, is among the ways to speed up the planning process in the case of the provision of additional secondary schools. The potential quotient method presented can be used for accessibility monitoring and planning. By changing the number of places in schools and using forecasts of the number of lower secondary school graduates, it is possible to simulate changes in accessibility. Interpretation of the results in terms of supply and demand makes it possible to apply this methodology to studies of accessibility to other services, both on a regional, local and intra-city scale (Guzik, 2003b). The proposed method can be used to analyse differences in accessibility to various types of services, not only educational services, but also, for example, to shops, hospitals etc.

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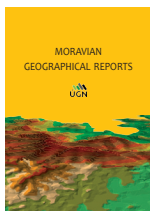
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Measuring the morphology of suburban settlements: Scale-dependent ambiguities of residential density development in the Prague Urban Region

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Abstract

The academic debate on methodological approaches to the measurement of urban sprawl, particularly its most cited dimension, the density of residential settlement, is discussed in this article. The methodology of point pattern analysis, and its benefits in comparison to land-use data analysis, especially for researching the morphology of residential development, is examined. This empirical study was conducted in the hinterland of Prague and is based on point data from 2007, 2010 and 2016. The paper contributes to the scholarly discussion of suburbanisation in Central and Eastern European countries, including the morphology of suburban development. The role of scale is also emphasised, given our observation of two ambiguous means of development, namely spatial dispersion at the regional scale and increasing density at the local scale. The findings support claims regarding the crucial role of micro-scale research in understanding suburban form. The largest Czech suburb of Jesenice serves as a case study, where the morphology of built-up areas is analysed in the local context.

Key words: urban sprawl, suburbanisation, point pattern analysis, morphology, Prague Urban Region, Czech Republic

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1. Introduction

From its early phases during the late 1990s, suburbanisation in Prague's hinterland was described as a potential threat to the natural landscape and social cohesion, which were discussed several decades previously in the Anglo-American literature (e.g. Clawson, 1962; Harvey and Clark, 1965). For example, Sýkora (2002) wrote about the negative social, economic and ecological impacts of post-socialist suburbanisation during the 1990s. The term urban sprawl had been introduced in scientific and media discourse generally as a negative form of suburbanisation, especially with regard to the consumption of agricultural land. Further, the architect Milan Hnilička (2005) used the term *Sídelní kaše* (settlement mash), in a Czech morphological and aesthetic sense and criticised low-density development of new suburban residential and commercial areas in the sprawling post-socialist city.

On the other hand, Ouředníček (2007, 2016) has argued that past suburban development in Central and Eastern European (CEE) countries has specific forms and consequences in comparison to Western countries, and that the typical forms of new housing construction are in-fills and

small spatial extensions of existing settlements. Opinions on the morphology of suburban development differ considerably not only between Western and post-socialist discourses, but also within the literature describing new suburban development in CEE countries (Siedentop and Fina, 2010; Sýkora and Stanilov, 2014; Ewing and Hamidi, 2015; Dinić and Miković, 2016; Mantey and Sudra, 2019).

Many academic researchers have contributed to discussions about the morphological form of suburban development – either on the level of the whole metropolitan area or with respect to the spatial arrangement of individual settlements (municipalities). This paper deals primarily with the local context and morphology of individual suburban settlements. Morphology from our perspective indicates the spatial arrangement of new suburban developments within concrete municipalities. We investigate whether new residential areas are characterised by larger newly built areas, or rather a scattered new construction of several houses within the existing built-up area of a municipality.

The paper is based on an investigation of suburbanisation in Prague and focuses on the main attributes in the development of morphological form of suburban settlements

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within the Prague Urban Region. Its location within the Czech Republic is demonstrated in Figure 1. For the purpose of this work, the suburban zone of Prague is composed of administrative districts: Prague-East and Prague-West. Together with the capital city of Prague, they create the Prague Urban Region, which can be perceived as an area with the most intensive daily contacts of the metropolitan population. The current discussion is mirrored in an extensive literature focused on Prague's suburbanisation as a topical subject. It contains morphology-focused studies, but it is still missing thorough empirical evidence about the general trends in settlement morphology during the transformation era. Thus, the aim of this paper is to measure the most common dimension of urban sprawl, the density of settlement, and its development during approximately the last decade. The main research questions focused on the spatial form of new suburban development and methods for its investigation, and can be formulated as follows:

- What are the main contemporary trends in spatial morphology development on the regional (i.e. in the Prague Urban Region) and local (i.e. in the case study of the largest Czech suburb – Jesenice) spatial levels?; and
- How can we measure settlement density with respect to the specificities of Czech suburbanisation?

The paper incorporates the method of point pattern analysis as an important addition to the analysis of land-use data, which is now dominant in measuring urban sprawl (e.g. Galster, 2001; Song and Knaap, 2004; Siedentop and Fina, 2010; Yue, Liu and Fan, 2013; European Environment Agency, 2016). To demonstrate this methodological approach, the paper focuses on the density of built-up areas, which is the most important dimension of such a multi-dimensional phenomenon as urban sprawl (Torrens and Alberti, 2000; Galster et al., 2001; Reis, Silva and Pinho, 2016).

2. Measuring city expansion

The morphological manifestation of suburbanisation is frequently analysed using the concept of urban sprawl (Cirtautas, 2015; Mantey and Sudra, 2019). It is perceived as the low-density physical pattern of suburban development (European Environmental Agency, 2016), and it is probably the worldwide dominant concept to evaluate the spatial form of urban landscapes, despite the heterogeneity of city models in various contexts. In accord with Galster et al. (2001), we regard urban sprawl as an extremely low-density and low-level product of suburbanisation. Nevertheless, precise definition varies by author and by scale, and the debate over urban sprawl has not resulted in one common sense of the term (Siedentop and Fina, 2010). Galster et al. (2001) define six groups of the meaning of urban sprawl: definition by example; aesthetic judgement; cause of an externality (such as high dependence on the automobile); consequence of an independent variable (e.g. poor planning); pattern of development; and process of city expansion. These various connotations make every empirical analysis more difficult and nearly incomparable with others, because the results are highly sensitive to the definition. Moreover, the same is also true for the definition of suburbs (Forsyth, 2019) or the suburbanisation process in general (Ouředníček, 2007)¹.

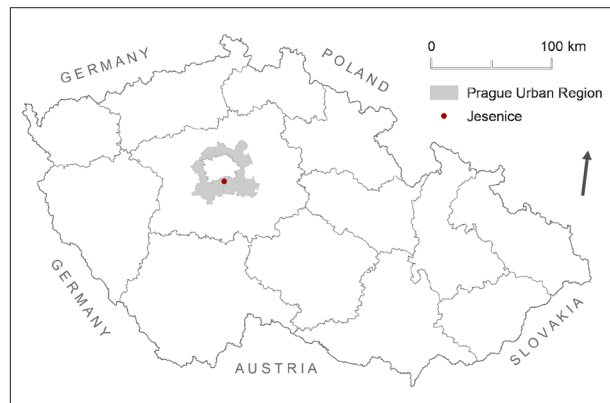


Fig. 1: Location of the Prague Urban Region within the Czech Republic. Source: Arcdata Praha, CZSO (2016), composed by the authors

On the other hand, it is true that at least some agreement does exist: among the common characteristics of urban sprawl one finds extensive urbanisation, low density, single use, fragmentation/scatter or a poor accessibility to selected functions (Reis, Silva and Pinho, 2016).

Empirical attempts of measuring urban sprawl can be found since one of the term's operationalisations in 1997 (Ewing, 1997). Torrens and Alberti (2000) and Galster et al. (2001) were pioneers in this field, stressing the multi-dimensional character of urban sprawl. Nevertheless, there is a lack of consensus about the precise nature of these dimensions. The operationalisation of the urban sprawl theoretical concept has been discussed several times in the context of suburban morphology in CEE cities (Dinić and Miković, 2016; Mantey and Sudra, 2019). Existing reviews of methods (e.g. Schwarz, 2010; Siedentop and Fina, 2010; Ewing and Hamidi, 2015; Reis, Silva and Pinho, 2016) confirm that the density of a built-up area is the most common measurement of urban sprawl.

This paper focuses upon density for at least two other reasons. Firstly, the low density of built-up areas stands as the primary characteristic of suburban form (Sýkora and Stanilov, 2014; Dinić and Miković, 2016), the most frequently used (Siedentop and Fina, 2010; Ewing and Hamidi, 2015), and probably the most noticeable manifestation of suburbanisation for the general public. Hnilička's (2005) critique of urban design within suburbia emphasises such low density. In addition, the one-dimensional conception of urban sprawl, in an earlier stage, was focused on density (Ewing and Hamidi, 2015). This does not mean, however, that this paper attempts to deny more recent multi-dimensional conceptions. The second reason is a subjective preference to focus upon one dimension, as it allows a thorough investigation of that dimension. Finally, density is often discursively associated with quality of life (Eberle, 2005; Dinić and Miković, 2016), a not unimportant factor.

Regardless, in fact, the term density might connote multiple meanings. The literature conceptualises density in two main ways: as a concentration of population, or of buildings (Dinić and Miković, 2016; Mantey and Sudra, 2019). Even though these conceptions are related, they are not interchangeable.

¹ We define (residential) suburbanisation as the relocation of the population from the core city to new housing in the suburban zone (Ouředníček, 2007). Suburb is subsequently a municipality with new housing development and in-migration of new residents from the core city of metropolitan regions. The latest contribution to delimitation of suburban areas in the Czech Republic is available in the article by Ouředníček, Klsák and Špačková (2019).

Hnilička's (2005) review of the architectonic studies concerning population density demonstrates that public transport is too costly in low-density areas. The density, as population per area, however, can hardly be enough to analyse significant parts of the suburbanisation-related issues, such as the consumption of arable land or water retention (Chuman and Romportl, 2008). These issues depend rather upon spatial configuration: the number and the size of newly constructed buildings. There is an important difference between detached single-family houses and apartment houses (de Smet and Teller, 2016). Hence, the population density is not coincident with settlement density, which is the number of buildings per area (e.g. Galster et al., 2001; Song and Knaap, 2007). The choice of an appropriate method must also be made taking account the specific context of CEE cities in the post-socialist era.

The scale choice is not only essential for the spatial resolution of data but also for the loss of information in aggregate data (generalisation) and for spatial non-stationarity. The most common scale for measurement of urban sprawl is at the level of the urban region (e.g. Galster et al., 2001; Tsai, 2005; Yue, Liu and Fan, 2013; Hamidi and Ewing, 2014; Al Mashagbah, 2016; Reis, Silva and Pinho, 2016; Šveda, Madajová and Podolák, 2016). For the land-use data, the spatial resolution of one cell usually corresponds to a city-quarter or a village. For example, Galster et al. (2001) used cells of size 1 square mile ($\approx 2.6 \text{ km}^2$). Further, there are several studies that examine urban sprawl on the level of even states or regions (Sudhira, Ramachandra and Jagadish, 2004; Schwarz, 2010; Siedentop and Fina, 2010) or combine both scales (Hennig et al., 2015; European Environment Agency, 2016). These studies help us to understand better the general tendencies in the development of a settlement system and provide valuable information about the environmental impacts of suburbanisation. Finally, there are a small number of studies of suburban morphology on a local scale (Song and Knaap, 2004; Ouředníček, 2007; Frenkel and Ashkenazi, 2008; Kupková and Ouředníček, 2013; Šveda and Pazúr, 2018). Such investigations on a local scale enable a better distinction between different land-use functions (i.e. commercial and residential development) and offer information about the internal structure of urban areas, which can be quite heterogeneous.

Unfortunately, urban areas are seen sometimes as a kind of black box. Cities around the world hardly grow in the same way. Thus, use of such a black box can be risky because the understanding of the term 'urban area' varies considerably in diverse cultural contexts. Although the origin of 'urban sprawl' measures lies in North America, today the centre of discussion has shifted to Asia (e.g. Sudhira, Ramachandra and Jagadish, 2004; Jiang et al., 2007; Jat, Garg and Khare, 2008; Yue, Liu and Fan, 2013; Al Mashagbah, 2016), where it is extremely relevant for fast-growing cities. In Europe, we can mention the more current work of Hennig et al. (2015), Oueslati, Alvanides and Garrod (2015) or de Smet and Teller (2016). The relevance of the topic in the European context is underlined by the interest of the European Environment Agency (EEA) because urban sprawl is a "major threat to sustainable land use" (EEA, 2016, p. 16). Moreover, the relevance for CEE cities is even higher since suburbanisation is the main process reshaping post-socialist cities during the last decades (Ouředníček, 2007; Sýkora and Stanilov, 2014; Šveda, Madajová and Podolák, 2016).

3. Prague – the expanding post-socialist city

Prague can be seen as a laboratory for post-socialist urban research, where suburbanisation is the key mode of urban growth (Sýkora and Stanilov, 2014). A long tradition of empirical research on urban topics exists in the Czech Republic, including research on suburban development. There are several individual works on this specific topic by geographers (Ouředníček, 2007; Sýkora and Ouředníček, 2007), by architects (Hnilička, 2005) or collective monographies (Sýkora, 2002; Ouředníček, Špačková and Novák, 2013). The early works, in the first two decades of the post-socialist transformation, were inspired by Western concepts. As Ouředníček (2016) states, however, the relevance of these concepts is limited in the Czech Republic (or more widely, post-socialist) settings, especially in the case of the outer zones of metropolitan regions.

Throughout the Czech Republic there is an old settlement system consisting of small villages, whose cores date to the medieval era. Some of the villages were incorporated into the growing industrial and socialist cities during the 20th century, while other more remote villages have become sites of new suburban housing construction. There is still a lack of empirical evidence about morphological characteristics, specifically comparisons between old and new suburban settlements. Nevertheless, the main difference in the morphological form of suburban development between the Czech Republic and North America is that residential greenfield development is very rare (Ouředníček, 2007), as individual projects can mostly be found within existing settlements. Additionally, there are larger housing projects on the edge of existing villages as well. Moreover, the phenomenon of transforming second homes (recreational cottages) into permanent residences is also observed (Vágner, Müller and Fialová, 2011). These houses differ from new construction by morphology on a micro-scale. According to the specificities described above in the Czech literature (e.g. Sýkora, 2002; Hnilička, 2005), urban sprawl is seen as an extreme morphological form of suburban development, which is characterised by a low density of settlement. This general tendency of morphological development in the Prague Urban Region, thus, needs to be discussed.

The phases of suburbanisation in the Prague Urban Region can be detected in Figure 2, which shows the relative number of completed apartments in Prague and its hinterland. As the chart indicates, the process began to intensify from the mid-1990s. The number of completed apartments started to increase at that time. Concerning this new phase, the introduction of mortgages played a key role, as they became available even for middle-income households. It was a period when the first larger commercial projects were finished around Prague. As Figure 2 demonstrates, the peaks in housing construction in the suburban zone were in 2004 and in 2007. Afterwards, the economic crisis slowed growth considerably in the hinterland. The relative number of completed apartments started to converge between Prague and the hinterland, as Prague's housing market recovered sooner after 2010. Housing construction within the suburban zone resumed some growth only after 2014. In sum, the total number of completed apartments reached 51,510 in the hinterland and 137,891 in Prague during the period 1990–2017 (Czech Statistical Office, 2018a).

This increase of housing construction corresponds to the increase in the total number of the suburban zone's population. Since the beginning of the transformation

period in 1990 up to the end of 2017, the total population of the suburban zone increased from 176,000 to 319,000, i.e. an 82 per cent increase (Czech Statistical Office, 2018a). The relation between population growth and built-up areas during the period 1990–2012 is presented in Table 1. While the population increased 1.82 times, the share of residential areas of the total area of Prague's suburban zone increased 1.3 times (Tab. 1). In the same period,

the share of commercial areas increased as much as 2.4 times (Copernicus, 2017). This proportion indicates two tendencies that have shaped the suburban landscape since the 1990s: the intensive development of both residential and commercial areas. The conditions and consequences of both types of suburban development in the Prague Urban Region are more thoroughly described and explained by Sýkora and Ouředníček (2007). Primary factors are described here.

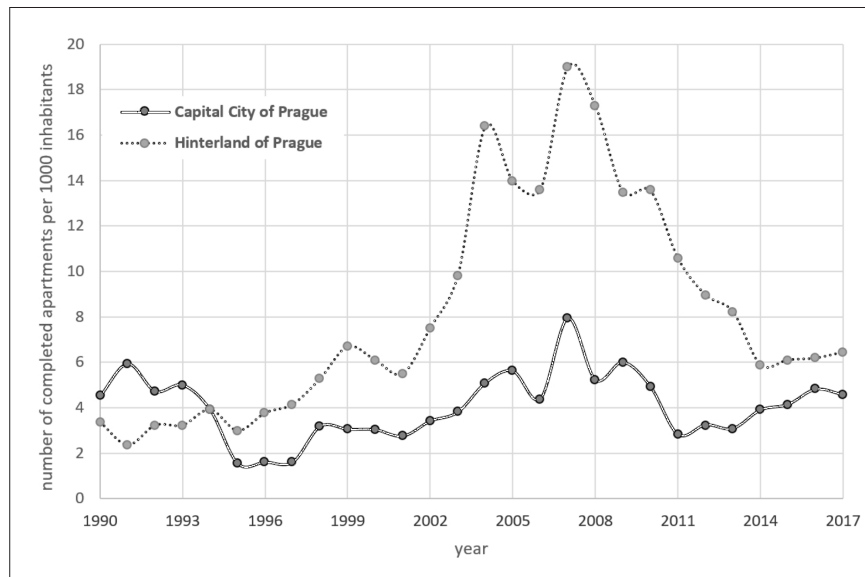


Fig. 2: The development of housing construction in the Prague Urban Region between 1990 and 2017
Source: Czech Statistical Office (2018a), composed by authors

	1990	2000	2006	2012
Residential areas [km ²]	123.50	139.00	152.10	161.60
Change (%)	–	+ 12.60	+ 9.40	+ 6.20
Share on total area (%)	9.24	10.40	11.38	12.18
Commercial areas [km ²]	10.40	15.30	18.10	24.40
Change (%)	–	+ 47.10	+ 18.30	+ 34.80
Share on total area (%)	0.78	1.14	1.36	1.84
Total		1,335.6 km² (100%)		

Tab. 1: The development of the share of built-up areas in Prague's hinterland between 1990 and 2012
Source: Copernicus (2017); Czech Statistical Office (2017); authors' compilation

Firstly, population growth is considerably higher than the growth of residential areas. This disparity, even despite the imprecision of land-use data about residential areas, is a first sign of the growing density of population in suburban settlements. Young couples, who came from Prague and established families in their own house (Ouředníček, 2007; Špačková and Ouředníček, 2012), are the demographic factor leading to such a great increase. The suburban households settled predominantly in single-family, detached houses are consequently larger than those in Prague.

Secondly, the proportion of commercial areas has increased even faster. This growth is especially a focus for landscape ecologists (Chuman and Romportl, 2013). From the social point of view, this growth of commercial areas is important for two reasons: it is an indicator of a complex form of suburbanisation. Such a growth indicates that new residents were followed by more and more opportunities to

work there. Secondly, it is an indicator of change of land-use mix in the suburban landscape. In fact, it is one of the defining dimensions of urban sprawl, as identified by Galster (2001). This land-use mix has influenced the aesthetic of the landscape and it might be a constraint to housing development, as is visible in the case study of Jesenice (see Section 6).

4. Data and methods

The most common way to measure urban sprawl is through the analysis of land-use data. It can be seen on a macro-level (e.g. Galster, 2001; European Environment Agency, 2016), a national level (e.g. Siedentop and Fina, 2010), an agglomeration level (e.g. Yue, Liu and Fan, 2013; Al Mashagbah, 2016) or even on a local level (Song and Knaap, 2004; Kupková and Ouředníček, 2013; Šveda, Madajová and Podolák, 2016). These data are useful

due to their accessibility, but such accessibility is propitious only within a limited spatial resolution. On the contrary, it is very difficult and costly to get processed land-use data at high resolution for individual localities. There are only rare examples of sufficient resolution (e.g. Kupková and Ouředníček, 2013; Šveda, Madajová and Podolák, 2016), but these usually concern a few localities and thus generalisation for the wider settlement system is limited. Therefore, land-use data are practical for describing general tendencies on macro-levels, for exploration of features such as commercial suburbanisation or for landscape ecology evaluations (e.g. Chuman and Romportl, 2013).

In the case of Corine Land Cover (Copernicus, 2017), the built-up area is incorporated into the database only if it exceeds 25 hectares. Hence, this method is obviously not precise enough to evaluate changes that characterise dynamic suburban developments around Prague, for which in-fills within the former built-up areas and small-scale construction sites are typical (Ouředníček, 2007; in Bratislava, see Šveda and Pazúr, 2018). Therefore, this paper uses the method of the Average Nearest Neighbour to measure settlement density and is prepared to demonstrate the potential of point pattern analysis in measuring urban sprawl. The point data originate from the Register of Census Tracts and Buildings (RCTB) provided by the Czech Statistical Office. It is a public database of all residential and commercial buildings, specifically a set of data points in coordinate system S-JTSK. It consists of 129,933 objects in 2016 (compared to 118,724 in 2010 and 102,278 in 2007). Coordinates of every point correspond to the location of one building in the suburban zone of Prague (i.e. the administrative districts of Prague-East and Prague-West). These data have been accessed for years 2007, 2010 and 2016.

To analyse point data, the method of Nearest Neighbour Analysis was applied. It is a transparently interpretable method to investigate the spatial structure of data. This method can be used to investigate data independently of scales (from one settlement up to the city region, or possibly even larger areas). The method assumes a mathematical plane. For each point (or for selected points) of the plane (noted i), the nearest distinct point (noted j) is identified. Thereafter, the Euclidian distance between i and j is

calculated. The numeric value of the resulting coefficient (noted ANN , in metres) is a distance d_{ij} . In fact, this paper uses the method in two versions.

The first method operates with spatial data. The value of each point represents the distance to the nearest point (building) itself and it is used in a map. In order to construct the distribution function (Fig. 3), which is the main analytical figure of this paper, the spatial data were transformed into an aggregate file. The distribution function was chosen to visualise data and their structure. The aggregate of all buildings in Prague's suburban zone was divided into equal intervals according to the numeric value of the Nearest Neighbour statistic and the frequency of occurrence was calculated. Since the discrete data cannot be visualised by a curve, the frequencies were transformed into probabilities. This transformation allows visualisation of data as continuous curves, which are considerably more practical to compare data structures in distinct time periods. Deviations between curves (see Fig. 3) indicate anomalies in morphology at the scale of individual houses, which is the crucial scale in the CEE context.

Secondly, to express the aggregate characteristics of the data set, the arithmetic average is derived. Hence, the mathematical expression of Average Nearest Neighbour, where n is the total number of points in an observed area, is as follows (ArcGIS Pro, 2018):

$$ANN = \frac{\sum_{i=1}^n d_{ij}}{n}$$

The use of this method helps to solve two methodological problems. Firstly, there are several ways to observe settlement density. For example, Galster et al. (2001) or Song and Knaap (2007) see density as the ratio of residential buildings to the built-up area. This way is logical, yet the built-up area can signify many things. The meanings differ considerably with regard to specific methods of delimitation. For example, Czech master plans delimitate the built-up area in a different way than the CORINE database. Hence, the comparison of built-up areas' sizes may be confusing, especially with foreign cities. By contrast, the land-use methods are conducive to international comparison, but they are imprecise because of limited spatial resolution. Point

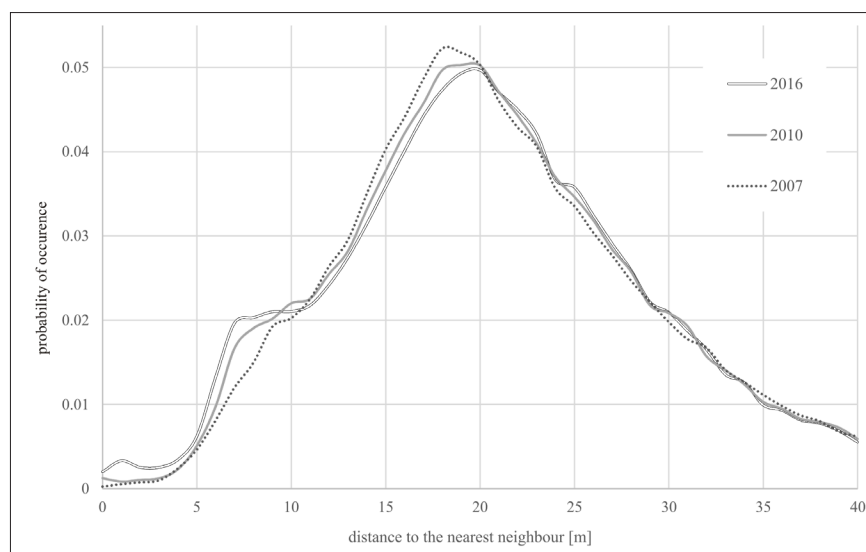


Fig. 3: Probability of distance to the nearest building in the suburban zone of Prague in 2007, 2010 and 2016 (Note: The probabilities of distances greater than 40 metres have not been recorded)
Source: Czech Statistical Office (2007; 2010; 2016)

data analysis is, thus, practical because it is independent of the precise delimitation of ‘the built-up area’. As the density grows, buildings are closer and the average distance to the nearest neighbour decreases.

Secondly, it helps us to focus better on the micro-scale, which is crucial for urban sprawl in post-socialist Prague (Ouředníček, 2007). Using the distribution function for the distance to the nearest neighbour, it is possible to identify anomalies in the morphology of settlement and analyse them in context, because of cartographic visualisation.

5. Development of settlement morphology within the suburban zone of Prague

As it was suggested above, in Figure 2, the population was growing faster than the residential areas until 2012. In fact, this finding was based on land-use data, which gives us a general idea rather than rigorous evidence. Therefore, the point data (from RCTB) are used for more detailed insight, which can demonstrate two periods of suburban housing construction (see Tab. 2). During the first observed period, the population and total number of buildings were growing with approximately the same intensity. Afterwards, between 2010 and 2016, the intensity of population growth was nearly double the intensity of housing construction. This disparity signifies the change in the building occupancy rate from 2.17 to 2.35 persons per building. The real numbers are even higher because, as it was mentioned above, the variable ‘number of buildings’ also includes the non-residential buildings, such as those designated as commercial or public. In sum, the observed tendency is evidence of a successively growing density of settlement, in terms of demographic indicators. As Špačková and Ouředníček (2012) explained, young families in particular move to suburban zones. This explanation does not seem to be enough, however, to explain the dissonance in intensities of population and housing construction growth between the periods 2007–2010 and 2010–2016. We argue that the reason might lie in the considerably changing urbanism of suburban settlements. As the case study of Jesenice municipality will demonstrate, recently there are more constructions of apartment houses than before in suburban municipalities.

Further, Table 2 shows the development of the Average Nearest Neighbour distance. As the population and total number of buildings increase, the average distance to the nearest building decreases. This is partly caused by the construction of larger residential projects with a higher number of apartment houses, which are always close each to other. Secondly, as Ouředníček (2007) states, housing construction in Prague’s hinterland is often characterised

	2007	2010	2016
Population	221,407	257,946	305,374
<i>Change</i>		14.20%	15.50%
Number of buildings	102,728	118,729	129,933
<i>Change</i>		13.50%	8.60%
Average Nearest Neighbour	25.01m	24.28m	23.84m
<i>Change</i>		– 2.90%	– 1.80%

Tab. 2: The development of settlement characteristics in the suburban zone of Prague in 2007, 2010 and 2016
Source: Czech Statistical Office (2007; 2010; 2016), Czech Statistical Office (2017); authors’ calculations

by the development on vacant plots inside the built-up area. There is still a large supply of these plots from the times of fragmented construction (in the early phases of Prague’s suburbanisation during 1990s). From an institutional point of view, the municipalities have already learned how to better regulate housing construction. Then, the increase of the plot prices after 2010 and the general economic crisis forced people to purchase smaller plots for individual construction, or only flats in apartment houses and terraced houses in larger residential projects.

In fact, the general tendencies described above are derived from aggregate data on the scale of the entire suburban zone. Looking closer into the data structure, the observed trend is rather ambiguous. As we see in Figure 3, there are two partial tendencies. Firstly, we can see the increasing share of high-density built-up areas, notably a distance of around seven metres between buildings. This high-density is typical for newly built terraced houses and reconstructions of former recreational cottages, which are gradually transformed into permanent residences (Vágner, Müller and Fialová, 2011). Secondly, there is an opposite phenomenon of increasing lower-density construction. The absolute extreme of distribution function in Figure 3 shifts to higher values – namely from 18 metres in 2007 to 19 metres in 2010 and 20 metres in 2016 (in round numbers). Nevertheless, the share of lower-density built-up areas does not change much. Surprisingly, it generally signifies the enlargement of higher-density areas in the suburban zone of Prague during the last decade.

In sum, the focus on morphological aspects of development in the Prague Urban Region brought new knowledge about contemporary trends of morphological patterns of suburban development. The settlement’s density is growing, the average number of people per building is increasing, and consequently the value of Average Nearest Neighbour distance is successively decreasing. Generally, these three significant findings contradict the idea of a successively sprawling city and the development on a regional scale indicated a clear tendency of growing density. The visualisation of the data’s internal structure, however, revealed ambiguous tendencies. While the mean (Average Nearest Neighbour) is decreasing, the most probable value of Nearest Neighbour (analogy of mode for discrete data) evinces the opposite tendency: a shift to higher values. At the same time, the probability of one specific section grows too. This methodological opportunity helps to avoid false interpretations, which would have been the case if not having these data. The situation on the local level is described in the next section.

6. Suburban morphology in the local context: Jesenice case study

The aim of the case study is to illustrate the previous discussion in practice, rather than serve as an analytical tool. Various meanings and examples of densities were discussed above, and the case study discusses them in the local context. The photographic portfolio (Figs. 6–11 in Appendix) documents several housing types within the municipality of Jesenice. The locations of documented places are indicated in Figures 4 and 5a–d. In addition, the case study attempts to demonstrate the impacts on local milieu and the processes mentioned in the arguments above.

The municipality of Jesenice has been chosen as a case study area. It is a dynamically growing municipality just a few kilometres beyond Prague’s administrative boundaries

(see Fig. 1). It can be considered the largest suburb in the Czech Republic and a frequent representative of suburban development in various case studies (e.g. Hnilička, 2005; Susová, 2008; Špačková, Ouředníček and Susová, 2012). Therefore, we can exploit the cumulative knowledge from previous investigations. It must be mentioned that Jesenice is an extreme example of suburbanisation within the whole country, rather than a typical case. The various types of new suburban development coexist together within the municipality. It concerns residential development (detached houses, terraced houses and apartment houses) and new commercial development (industry, retail, logistical areas), which were developed from the mid-1990s around an older residential core of the town (see Figs. 5a–d).

The physical and social environment of Jesenice was marked by modern suburbanisation from its early phase. Initial suburban development started during the early 1990s at the north-eastern and northern edge of the original settlement. As Susová (2008) points out, the houses of the first suburbanites are classic examples of what can be called (derisively) “entrepreneur’s baroque” (see Appendix – Fig. 9; A in Figs. 4 and 5a). Susová (2008, p. 1) notes that the “(first incomers) have been building their houses on large and isolated plots behind high walls.” This form of development is probably the most striking example of low-density housing construction in the Czech Republic. It is a very rare example of Czech urban sprawl, as the process is known in North America. The size of area affected by this manner of construction, however, is only a few hectares large.

Massive suburbanisation began after 2002, linked to several commercial projects by developer companies. The average tempo of residential growth reached 250 completed apartments per year. Apart from the massive development of single-family detached houses on former agricultural land, new apartments and terraced houses were also built (Susová, 2008). The rapid residential development brought some negative effects to the area, especially the growing demand for social and technical infrastructure, and a huge

increase of transportation and commuting to Prague. The 2011 Strategic Plan of the municipality identified, for example, a deficiency in public facilities and location of these facilities on the edge of the settlement, a lack of public greenery, and a need for additional infrastructure (Město Jesenice, 2011). In addition, the document identifies other impacts that have been described in the literature, such as the poor quality of public spaces or environmental degradation (Hnilička, 2005). It follows from the document that the consequences of the fast growth in the last two decades are problematic, rather than the low-density construction itself. The municipality did not handle the disparity between the number of incomers and their actual needs. After some time, there were not enough free plots inside the settlement for new infrastructure (Město Jesenice, 2011). One exception was the construction of a new elementary school in 2003.

The built-up area and its development are represented in Figure 4. The original village core from 1989 is the old parcellation pattern, situated on the main road to Prague’s south-eastern hinterland, which used to be an imperial road to Vienna (Fig. 4 – marked by the yellow line). This remaining structure is lined by dark points in Figure 5a, which represents the high-density built-up area.

In the town core, there is a mixture of building designs and uses. The ground level of buildings is frequently used for commercial purposes (restaurant, post-office, pharmacy, etc.). The poly-functionality of place makes it the centre of Jesenice (B in Figs. 4 and 5a; Figure 10). The Strategic plan of the town, however, states that residents miss a clear central public space (Město Jesenice, 2011). Furthermore, there are three main areas of new development. First is the cluster of new residential development on the north (C in Figs. 4 and 5c; Fig. 8), where we can find some of the iconic constructions, which were used as an example of urban sprawl by Hnilička (2005) or Ouředníček (2007). Second is the area of rectangular shape with new apartment houses in the west (D in Figs. 4 and 5b; Fig. 7). Finally, the largest area of housing development lies in the east. It consists predominantly of

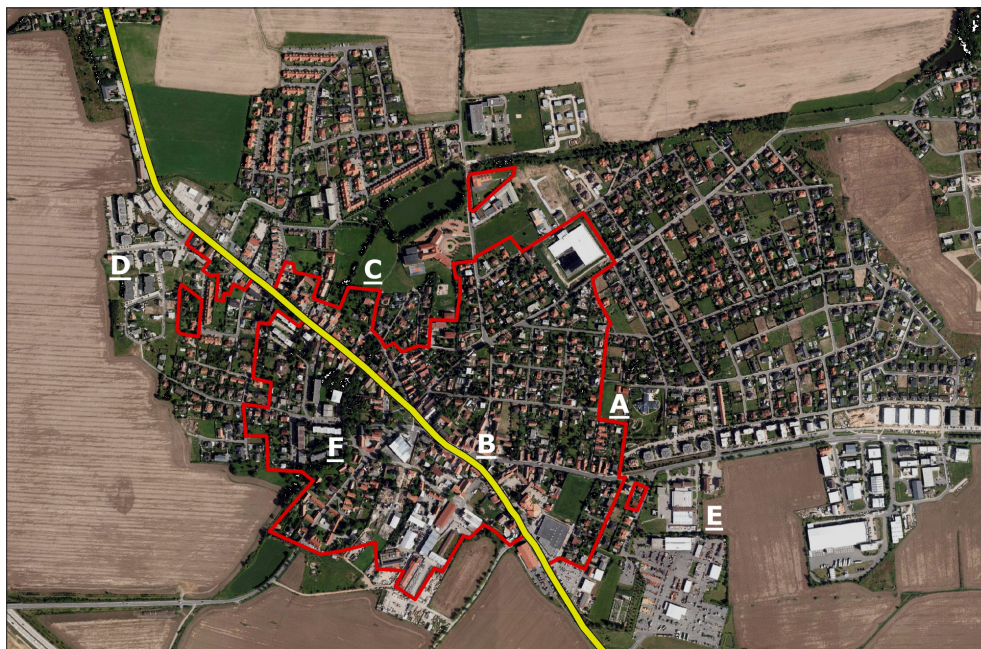


Fig. 4: The extent of the compact built-up area in Jesenice in 1989 and 2018 (Notes: The approximate built-up area from 1989 is marked by a red line, and the former imperial road by the yellow line. The letters A–F refer to the examples of housing patterns in the text and photographic portfolio.)

Sources: Google Earth, MGHO (1989)

detached houses. The south of this area, however, is bordered by strictly commercial constructions (e.g. a retail centre with supermarkets and a small industrial area near the highway – noted as E in Figs. 4 and 5d; Fig. 11).

Similar to the scale of the agglomeration, the quantitative characteristics were measured for Jesenice as well (Figs. 5a–d and Tab. 3). The maps represent settlement density throughout the municipality and indicates where terraced houses and apartment houses are located. Both types are always outside the original core of the town. In that sense, the new constructions are more heterogenous, but neither terraced houses nor apartment houses are homogenous categories of constructions. Terraced houses (e.g. C, see 5c) cover both very dense areas and lower-density constructions. The same is true for apartment houses (e.g. D and F, see 5b). Thus, more than the urbanistic pattern itself, the character of each building is important.

	2007	2010	2016
Number of buildings	672	846	1 005
ANN – core area [m]	24.55	24.17	24.11
ANN – outer areas [m]	28.33	26.10	25.52
ANN – total [m]	26.39	25.28	25.00
ANN – suburban zone of Prague [m]	25.00	24.28	23.84

Tab. 3: Morphological characteristics of built-up areas in Jesenice in comparison to the whole suburban zone of Prague (Note: ANN = Average Nearest Neighbour) Data source: Czech Statistical Office (2007; 2010; 2016); authors' calculations

For example, the houses labelled C (Fig. 8) look more like archetypical single-family detached houses, except the houses are interconnected into a line. Only the apartment houses within the old village achieve the category of the highest density.

Despite the presence of terraced houses, apartment houses and the multifunctional houses along the main road, the dominant type of residential development in Jesenice is the single-family detached house. Paradoxically, the newly built areas are more heterogenous in terms of construction types. This mixture of construction types is in opposition to the common representation of urban sprawl as a large uniform field of detached houses.

Looking further at Figures 5a–d, significant differences between densities are not clearly visible, but Table 3 provides more specific information about the densities within different parts of Jesenice. The density of the built-up area is higher in Jesenice's core than in outer areas during all periods of measurement (2007, 2010 and 2016). As the number of buildings was increasing, the densities of built-up areas were increasing too, but the density increase is not the same over all localities of construction, as can be seen more precisely in Table 3. Between 2007 and 2016, a convergence of the values of densities was observed. The Average Nearest Neighbour value in outer areas decreased by 2.81 metres. By contrast, Average Nearest Neighbour in the core area decreased by only 0.44 metres in the same period. This convergence is caused by filling in the free plots within the existing settlement. In other words, there is a noticeable difference in the number of free plots between the old compact core (which was built before the 1990s) and the newly built areas, which have not yet been fully filled.

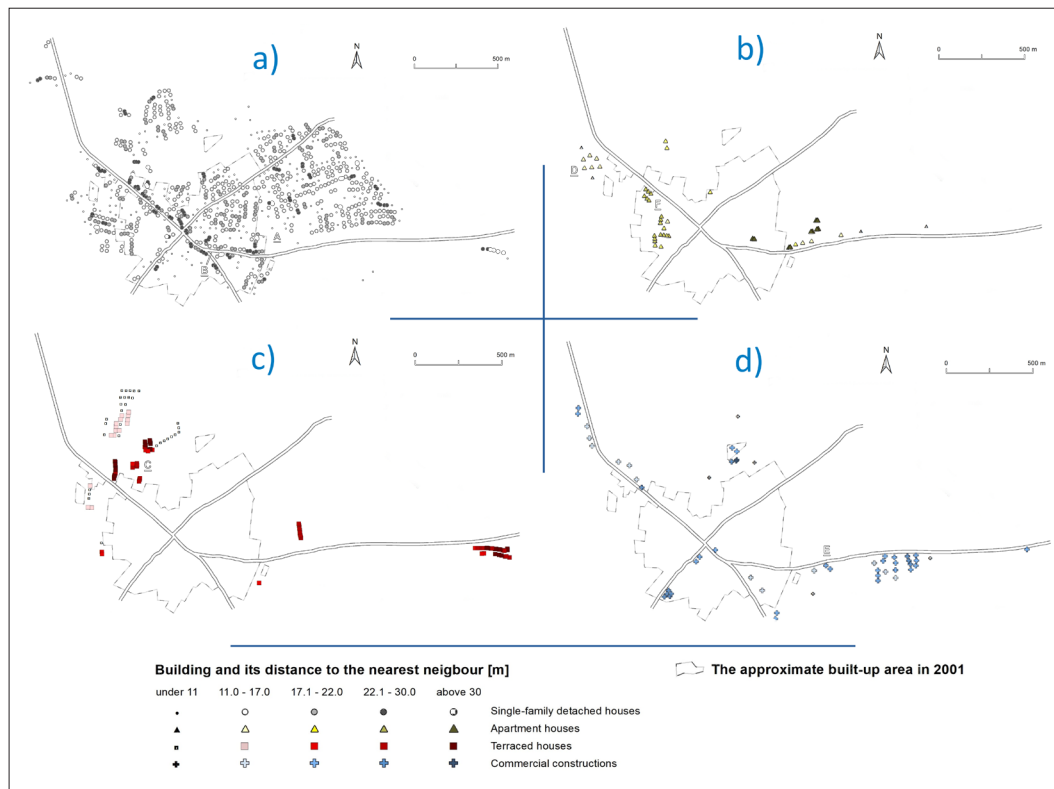


Fig. 5: a) Morphology of settlement in Jesenice by 2016 – single-family detached houses; b) Morphology of settlement in Jesenice by 2016 – apartment houses; c) Morphology of settlement in Jesenice by 2016 – terraced houses; d) Morphology of settlement in Jesenice by 2016 – commercial constructions Source: Czech Statistical Office (2016). Note: Choice of the divisions in the legend is based on the distribution curve from Figure 3

The step-by-step in-filling of free plots inside the former built-up areas of the former village corresponds to Ouředníček's (2007) observation about Czech suburbanisation, which is that it is characterised by very frequent housing construction on free plots within compact settlements. During the first two post-socialist decades, the high demand for suburban housing forced the local councils to delineate new areas for further construction. The new development in suburban municipalities has become, thus, a very serious problem for local politics. The lack of experience with regulations and a non-transparent milieu resulted in the delimitation of large areas for new construction. In the Jesenice case, this oversight in urban planning resulted in the above-mentioned lack of public greenery and public facilities, and a deficiency in social and technical infrastructure. All of this is identified as a weakness in the Strategic plan of the town (Město Jesenice, 2011).

Generally, Jesenice's present is burdened by its past. The development of the municipality is limited by the heritage of the rapid urban sprawl leap-frog development during the first two decades of post-socialist transformation. Ongoing development is realised on both the free plots within the built-up area and on the settlement's outskirts. This course of development rectifies the scattered structure of the built-up area. Furthermore, the appearance of the physical environment is influenced by the development of apartment and terraced houses or by commercial constructions. The preferred form of further development is an ongoing issue in local politics, and the physical environment is highly influential for the local social environment. Jesenice is, thus, an important and frequently analysed lesson about rapid growth and about the heterogenous impacts of such growth.

7. Discussion and conclusions

This paper has discussed the question of measuring urban sprawl in the suburban zone of Prague. At the outset, the concept of urban sprawl was introduced as highly inconsistent. There are several meanings that influenced the subsequent use of methods. The paper has conceptualised Prague as a city with a specific morphology, particularly on a micro-scale. With respect to previous academic literature, the paper has focused on measuring the most common dimension of urban sprawl, density of settlement, and proposed the use of the method of point pattern analysis (Average Nearest Neighbour). By transforming spatial data into an aggregate, the method is able to discern an internal data structure and its change over time. There is further potential in terms of exploring this phenomenon, however, especially in the combination of land-use data and point data. Further, the strength of point data in measuring density was observed. This methodological procedure can be potentially applied and developed in diverse cultural milieus. The combination of land-use data and point data in research suggests a challenge for the revision of past empirical findings. It can contribute to the creation of a basis for the systematic monitoring of urban sprawl generally. As the global discussion over measuring urban sprawl works predominantly on land-use data, a revision of results might enlighten unexpected findings. In the case of the Prague Urban Region, such unexpected ambiguity in development tendencies has been identified.

In the empirical analysis, there were several unanticipated findings about the morphology of Prague's suburbanisation. Firstly, the intensity of housing construction is smaller

than expected in comparison with population growth rates. This means that, with the exception of new residential development, a substantial part of Prague's migration into the hinterland is to existing housing stock, transformed recreational cottages and older houses built during the socialist period or before (see Ouředníček, 2007). Secondly, an increase of residential density is the main tendency in Prague's hinterland. Between 2007, 2010 and 2016 density gradually increased, but this general tendency incorporates two contradictory processes. Extremely dense settlements, such as terraced and apartment houses, are more and more frequent types of housing construction over the past few years. At the same time, the average distance between buildings is, step by step, increasing. In other words, the spatial pattern of housing construction is more polarised. From a methodological perspective, it demonstrates the crucial importance of micro-scale research of suburban settlements.

The case study focused on micro-level morphological patterns in Jesenice. Despite this suburb being an extreme example of suburbanisation in the Czech Republic, the negative impacts of suburbanisation are still far from the alarming experiences found in North American cities. Beside the common negative impacts of low-density construction, the extremely rapid development of the last two decades was identified as a serious problem. Furthermore, the case study sketched how the development in Jesenice follows the Czech forms of construction within or on the edge of existing built-up areas (Ouředníček, 2007). It also showed the variability of new suburban residential construction. Localities with detached houses, terraced houses and apartment houses create differences in residential densities. Only terraced houses and the old core of the former village, however, achieve the highest level of density, while detached houses on the outskirts of the settlement tend toward urban sprawl leap-frog development, with a lot of vacant plots and uncoordinated housing construction. The consumption of agricultural land and fragmentation of the rural landscape are the most problematic consequences of such developments.

To sum up, the density of houses in Jesenice has been increasing over time (Tab. 3) and the value of Average Nearest Neighbour in Jesenice is always considerably higher than the Average Nearest Neighbour measure for the whole suburban zone of Prague. Comparing this value to more conventional methods, the outcomes are similar. Architect Pavel Hnilička (2005) used the method of plane population density on built-up area in his critical book on the form of suburban development in Prague's hinterland. From this point of view, the current extent of built-up area in the whole cadastre of Jesenice u Prahy is 1.91 km² based on data from the masterplan (Město Jesenice, 2006) and orthophotography (SALSC, 2018). In this area, there are 3,970 people registered (Czech Statistical Office, 2018b), representing a population density of about 21 inhabitants per hectare. This roughly corresponds to densities that Hnilička (2005) ascribed to low-density suburban settlements in the Czech Republic but it is still slightly higher than typical suburbs in the USA (Hnilička, 2005).

As was noted at the outset, density is only one of many dimensions of urban sprawl. The example of Jesenice's morphology, however, is in opposition to Eberle's (2005) statement that density is the determinative quantity for quality of living. The qualitative characteristics of buildings, public spaces and the environment as a whole are more

important than density itself. More widely, Kopečná and Špačková (2012) and Špačková, Dvořáková and Tobrmanová (2016) showed that residential stability is an important quality of single-family households, while apartment houses suffer from considerable residential fluctuation and instability. Therefore, physical and morphological aspects should be investigated together with demographic characteristics, social composition and mobility, all of which are crucial factors for understanding new residential suburbanisation (Špačková and Ouředníček, 2012).

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Appendix 1: Housing types within the municipality of Jesenice



Fig. 6: Apartment house from the epoche of socialism (F), core area. The construction belongs to the average category of density (17.1 – 22.0m)
Photo: Jiří-Jakub Zévl, 2019



Fig. 7: Apartment houses from 2000s (D), outer area. The lowest density, ANN above 30m
Photo: Jiří-Jakub Zévl, 2019



Fig. 8: Back-side of terraced houses from the early 2000s (C). They lie in the outer area, just next to the edge of the core area and next to a free plot. This is an extremely dense settlement, ANN below 11m
Photo: Jiří-Jakub Zévl, 2019



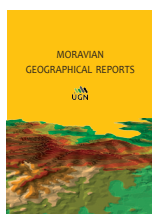
Fig. 9: An example of so-called entrepreneur's baroque in Jesenice municipality (A)
Photo: Martin Ouředníček, 2009



Fig. 10: Central public space of Jesenice municipality (B), core area. The above-average density, ANN 11.1-17.0m
Photo: Jiří-Jakub Zévl, 2019



Fig. 11: Commercial constructions from the 90s in the south of the town (E). The lowest category of density, ANN above 30m
Photo: Jiří-Jakub Zévl, 2019



The role of manufacturing in the development of rural regions: Evidence from a highly industrialised Moravian region

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Abstract

Various types of manufacturing firms located in rural municipalities are identified in this paper, and we determine the intensity of their economic linkages at the local and regional levels. We also examine the factors affecting the intensity of local/regional sourcing and purchasing. Due to the unavailability of detailed economic data at the municipal level, our research draws on a case study of 26 rural manufacturing small/medium-sized enterprises located in the Zlín Region in the eastern part of the Czech Republic. As a highly industrialised region, Zlín should theoretically provide a very favourable environment for the development of local/regional productive linkages of rural manufacturing firms. Several non-parametric tests have been employed to test the effects of firm size, age, industry and location, on the intensity of local and regional purchasing/sourcing. We found the most common firms are those that purchase and sell mostly on a regional (NUTS3) level rather than on the local level. Small firms source and sell more locally than larger firms. Effects of the firm age, industry and location, on the intensity of local/regional sourcing and purchasing were not confirmed.

Keywords: manufacturing, rural regions, local sourcing, backward linkages, forward linkages, Zlín Region, Czech Republic

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1. Introduction

The traditional rural economy has long been associated with primary economic activities, seen predominantly in its production function (Dinis, 2006). Over the last four decades, restructuring (see Woods, 2005) has brought about major economic changes in rural regions, amongst which we can list:

- i. A reduction of the share of agriculture in employment/production as a result of technological innovations and moving towards a rural consumption function (Halfacree, 2006);
- ii. A transition shift of the part of industry and services from urban to rural areas (Keeble and Tyler, 1995; Bosworth and Finke, 2019), resulting in an industrial structure of the rural economy closer to that of cities;
- iii. The decline of part of the manufacturing capacities in traditional rural manufacturing industries (food, textile, glass, wood processing, etc.) associated with shifting employment to technology-intensive industries engaged in manufacturing fields, such as automotive parts or electronics (Fløysand and Sjøholt, 2007); and

- iv. Economic globalisation manifested by, among other factors, changes in the ownership structure of rural manufacturing firms in favour of a growing share of foreign capital.

One of the manifestations of economic globalisation (see e.g. Kalantaridis, 2005; Woods, 2013) in developed countries is the increasing linkages and interdependence of the economies of urban and rural regions (Lichter and Brown, 2011; Mayer et al., 2016; Bosworth and Venhorst, 2018). Paradoxically, however, in many cases, the supplier-customer linkages (hereinafter referred to as “economic linkages”) of manufacturing firms at the local level are weakened: between the urban areas and the rural hinterland, and also between local rural firms mutually (Czarnecki, 2015). The products of local rural entrepreneurs are pushed out of local urban markets by imports from large-scale standardised production.

Rural manufacturing firms, on the other hand, in order to achieve economies of scale, must integrate into global production networks (Coe et al., 2015). They often focus on the production of highly specialised components for

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multinational corporations, usually based in (foreign) metropolitan regions. Rural firms rarely find a sufficiently large market or competent suppliers at the local level (Crone and Watts, 2003).

We focus on Czech rural regions that are highly industrialised (Vaishar and Šťastná, 2019) and export oriented. Intensive local economic relationships of manufacturing firms can be another important source of employment and income (see below). For this reason, we analyse two types of economic linkages that can stimulate the development of rural economies (Courtney et al., 2008): supplier (“backward”) linkages and customer (“forward”) linkages.¹ Our goal is to determine: a) what types of manufacturing firms are developing in Czech rural communities in terms of the geography of economic linkages; b) the intensity of economic linkages at the local/regional level that these manufacturing firms create; and c) what factors influence the intensity of local economic linkages of rural manufacturing firms.

Given the absence of relevant economic data on rural municipalities, we evaluate economic linkages based on a case study of 26 manufacturing firms in rural municipalities of the Zlín Region. Rural municipalities of the Zlín Region have on average the second-highest share of manufacturing industry in employment after the Moravian-Silesian Region (Business Register, 2017). The Zlín Region achieves the highest share of employment in manufacturing industry among all Czech regions. The Zlín countryside is characterised by population continuity, industrial tradition, social capital (Pileček and Jančák, 2010), a high degree of specialisation in the manufacturing of fabricated metal products and technologically related industries, as well as a high density of small-sized manufacturing firms in the above sectors. Because of this, it has, according to the theoretical background (see section 3), very good conditions for the development of intensive economic relationships of manufacturing firms at the local level.

In the following section, we briefly characterise the relationships between local linkages of manufacturing firms and the development of rural regions. In the subsequent section, we discuss the intensity factors of local economic linkages of the manufacturing firms in rural regions, while the fourth section describes specifics of the restructuring of the Czech countryside after 1989. The fifth and sixth sections discuss the distribution and the industrial structure of the manufacturing industry in the Czech Republic and in the Zlín Region. The seventh section presents methods and data sources, followed by a discussion of the empirical results. In the conclusion, we summarise and discuss the main findings.

2. Local economic linkages of manufacturing firms and rural development

The spatial level of economic linkages among firms in the manufacturing industry (hereinafter referred to as manufacturing firms) is crucial for the development of rural regions. According to net income theory (Persky, 1993; Courtney et al., 2008) derived from the original economic base model (see Illeris, 2005, for a summary of the research), regional economic growth is the coefficient of export income

and a regional multiplier, minus the outflow of income from the region due to import (Persky, 1993). Therefore, economic growth not only depends on the inflow of income from other regions due to the export activity of manufacturing industry, agriculture and other “basic” industries (see Illeris, 2005, pp. 448–449), but also on the intensity of local economic linkages and the presence of non-basic industries serving the local market (e.g. consumer services) that prevent income outflow from a particular rural region.

According to the spatial configuration of economic linkages, rural manufacturing firms can be divided into four main types: domestic, dependent, propelling and extravert. The table below (Tab. 1) and the descriptions of individual firm types are based on a simplified adaptation of the Romero and Santos typology (2007) and divide firms by their predominant linkages to local or external suppliers and customers.

Domestic firms are usually small entities that mainly buy and sell at the local level. These entities prevent the outflow of profits from the region (Illeris, 2005) and generate local multipliers, but their overall contribution to regional development is limited due to the absence of strong export linkages. One advantage may be the interconnection of local production systems and a contribution to the formation of a diversified network of suppliers, a source of localisation economies.

Dependent firms buy on the external market and sell on the local market. This increases dependency on external entities and does not create any important multipliers. These firms bring the least benefit to rural economies, especially in low technology-intensive industries. They can contribute to local business productivity, however, through technology transfer, sophisticated components and/or efficient manufacturing processes through business contacts and unintended knowledge spillovers (see Pavlínek and Žižalová, 2016).

Propelling firms that sell to other regions and buy locally provide the strongest impulses for the development of rural economies. Because of their exports, they bring profit to the region, which is multiplied by intensive local supply linkages and the resulting strong local multiplier (Courtney et al., 2008).

Extravert firms buy and sell outside the local market. Although they can contribute with a relatively large profit into rural municipalities because of their exports, a considerable amount will flow out to other localities as a result of weak local economic linkages. This may not only be dis-embedded branch plants of multinational corporations (Sonn and Lee, 2012), but also endogenously formed small-sized firms that extend beyond the local context with their economic linkages (Romero and Santos, 2007).

	Local suppliers	External suppliers
Local customers	Domestic firm	Dependent firm
External customers	Propelling firm	Extravert firm

Tab. 1: Typology of rural manufacturing firms by economic linkages.

Source: Romero and Santos (2007); authors' interpretation

¹ For the overall intensity of these relationships at the local level, we define as the degree of local integration of manufacturing companies. Local relationships are such economic relationships that do not cross the administrative boundaries of the administrative district of the municipality with extended powers. For the purpose of this paper, we define rural municipalities by the population criterion of 3,000, according to the Act on Municipalities No. 128/2000 Coll.

This typology is somewhat simplistic and indicative (Müller and Korsgaard, 2018). In addition to distinguishing between only four idealised firm types, it focuses only on the material linkages of manufacturing firms: it does not include, for example, innovation cooperation, linkages to local institutions, knowledge spillovers, and many other relevant relationships at the local level (Lang et al., 2014). Despite all of these factors, it can be used for the input classification of firms in terms of their potential benefits for the development of rural municipalities. Individual types of firms develop depending on several corporate, sectoral and regional characteristics, which will be discussed in the next section.

3. Factors affecting the intensity of local economic linkages of manufacturing firms in rural regions

Factors affecting the spatial level of supply and customer relationships of manufacturing firms in rural regions can be distinguished into three basic groups: firm, industry, and regional characteristics (see Tab. 2).

The most important firm characteristics affecting the degree of local integration include the size, ownership, and history of a given firm (Courtney et al., 2008). Small firms

generally create more intensive local supply (Courtney and Errington, 2000; Arndt and Sternberg, 2000; Romero and Santos, 2007) and customer linkages (Crone and Watts, 2003), as large firms have found it difficult to find firms at the local level capable of delivering in the required volume, while the local market is not big enough for them. Therefore, with the increasing firm size, the share of extravert firms should grow, while small manufacturing firms are more often either domestic or dependent.

According to some authors (Dobson, 1985; Courtney and Errington, 2000), ownership affects the spatiality of economic linkages. Independent (domestic) firms source more locally than their foreign-owned counterparts that have geographically more extensive networks of contacts. Branch plants of transnational corporations should be generally more extravert than other economic subjects (see Sonn and Lee, 2012). Several other results, however, do not confirm this assertion (Perkmann, 2006; Courtney et al., 2008).

The history of the establishment and development of a firm in a given location affects the scale of supplier and customer linkages in various ways. Mills (2002) documented the negative relationship between the intensity of local linkages and the geographical distance of the firm from the owner's/manager's home. Resident-based firms tend

Factor	Mechanism
Firm	
Size	Small firms are more locally integrated (higher share of domestic and dependent firms), whereas large firms are often extravert, because the rural region does not offer adequate suppliers or a sufficiently large market.
Ownership	Domestic firms create more intensive economic linkages at the local level than international firms that have more contacts in other regions and states. Independent firms are more locally integrated than branches/manufacturing plants of firms based in other regions.
History	“Younger/older”, endogenously established and resident-based firms are, on average, more intensely integrated at the local level due to inertia and/or social embeddedness.
Industry (sector) and product	
Ubiquity	Industries characterised by a large number of small firms scattered, among other things, in rural areas, are characterised by a higher degree of local integration than industries with high levels of size and territorial concentration.
Linkages to rural industries	Industrial firms linked to agriculture, forestry, fishing or other typically rural activities, demonstrate intense local economic linkages.
Technology intensity	Firms in less technologically intensive industries are more closely interconnected with local suppliers/customers that are available in rural areas.
Product standardisation	A higher level of local integration is typical for firms manufacturing non-standardised custom-made products that need intensive personal contacts with customers/suppliers.
Region	
Location	With increasing distance from the city/town, the rate of the local economic integration of rural industrial firms (and the share of domestic firms) increases.
City/region size	Rural industrial firms in the hinterland of large cities are more locally integrated than firms in the hinterland of smaller towns due to the effect of urbanisation economies. With decreasing population size of the municipality, the share of domestic firms should decrease.
Supplier base	Firms in regions specialised in the same/related sectors are more locally integrated than firms in regions with different specialisation.
Firm size structure	Firms in regions with a large number of small/medium-sized enterprises in the given industry benefit more from localisation economies and are more locally integrated than those in regions with the dominant position of a single large corporation.

Tab. 2: Selected factors of the intensity of local economic linkages of industrial firms in rural regions
Sources: Courtney et al., 2008; Courtney and Errington, 2000; Dobson, 1985; Courtney and Errington, 2000; Perkmann, 2006; Akgün et al., 2011; North and Smallbone, 1996; Crone and Watts, 2003; Amin and Malmberg, 1992; Tavares and Young, 2006; Pavlínek and Ženka, 2016; Mitchell, 2005; Meijers and Burger, 2017; Krugman and Venables, 1995; Parr, 2002; Drucker, 2013; Drucker and Feser, 2012; Chinitz, 1961; Romero and Santos, 2007

to purchase more from their vicinity than firms founded by immigrants from urban regions (Akgün et al., 2011; Courtney et al., 2008). The duration of the business activity of the firm in a given location has an ambiguous influence. Some authors document the local focus of the linkages of newly created companies, which subsequently geographically expand the network of supplier-customer linkages (North and Smallbone, 1996). Other studies show the higher intensity of local linkages in “older” firms due to learning effects: the search for and cultivation of relations with local suppliers (Crone and Watts, 2003). Endogenous firms newly established in the region or split off from local firms, should be more closely linked to the local economy than firms created by an enterprise investment from another region or state. This may be due to the inertia and social embeddedness of endogenous firms, as well as the fact that external firms entering the rural region build upon existing supplier-customer relationships with entities outside the rural region (Courtney et al., 2008; Habersetzer, 2017).

Factors at the industry/product level have the least unambiguous impact on the spatial level of supplier-customer linkages of manufacturing firms. Manufacturing industry (especially export-oriented) creates on average weaker supplier and customer relationships at the local and regional level compared to consumer and commercial services (Hirsch-Kreinsen, 2008; Květoň and Šafir, 2019) or the construction industry (Courtney et al., 2008). The main reason is the unavailability of supplies and also insufficient demand for manufacturing products, usually produced in large volumes. In manufacturing, the intensity of local linkages, in general, should be greater in the following sectors (an adaptation of the Crone and Watts, 2003 typology):

- a. “Ubiquitous” sectors characterised by the territorial dispersion of a large number of (often small) firms in rural regions: in the Czech Republic, this is the case, for example, of the manufacturing of fabricated metal products and engineering industries, or the manufacturing of less-complex automotive parts;
- b. Industries linked to rural production activities: e.g. the food-processing industry linked to agriculture or the wood-processing industry linked to forestry;
- c. The production of simpler and less technologically intensive products for which it is realistic to find intermediate product suppliers in rural areas and/or which have a low unit price and thus expensive transport costs over longer distances; and
- d. Custom-made, non-standardised products that require intense personal contacts with suppliers, thus benefiting from the geographical proximity of suppliers (Amin and Malmberg, 1992; Glückler et al., 2020).

On the other side of the spectrum, there is large-scale production of standardised products, and then, on the contrary, the production of highly specialised and sophisticated products in highly globalised sectors such as automotive, electronics, and pharmaceuticals (Tavares and Young, 2006). Such is also the case for material/energy-intensive or other sectors purchasing, in particular, mineral raw materials (Courtney et al., 2008) that are extremely unevenly distributed and may not be available in the given rural region (petrochemical industry – oil; rubber industry – natural rubber; plastics – granulates; production of wire cables – copper): see Pavlínek and Ženka (2016).

The third group of factors are regional characteristics, which include the distance of a rural firm from a nearby city

(‘municipality with extended powers’ – hereinafter ‘MEP’ or regional capital), city size, the industrial specialisation of the rural region, the number and size-structure of firms in the given industry, reflecting the intensity of local competition (Courtney et al., 2008). With an increasing distance of rural communities from urban centres, the intensity of local economic linkages and the share of domestic firms increases (Courtney and Errington, 2000; Mitchell, 2005). On the other hand, intense local linkages can be expected in the hinterland of large cities that can produce higher local multipliers (Persky, 1993), due to agglomeration economies and the positive “effect of borrowed size” in their commuting hinterlands (Courtney et al., 2008; Meijers and Burger, 2017). The large differentiated market creates demand for rural hinterland products, allows for a higher degree of specialisation of supplier firms – hence contributing to the development, productivity and diversity of the local supply base, and thus to the intensity of local supplier linkages (Krugman and Venables, 1995). Sharing local suppliers and intensive local supplier linkages are one of the mechanisms of localisation economies that strengthen the clustering of firms in the locality (Parr, 2002), and stimulates the growth of domestic and propelling firms. The reverse effect also applies, however: territorial concentration and the geographical proximity of a large number of firms may strengthen local supplier linkages between firms in the particular industry (Sohn, 2004).

To achieve local integration, a large number of (small and medium-sized) enterprises in the researched industry is more favourable than one large company. In regions with one large dominant firm, smaller economic entities in the same industry achieve lower localisation economies (sharing of suppliers, skilled labour, knowledge, public assets such as infrastructure, etc.: Parr, 2002) than entities in regions with a less concentrated size structure of enterprises (Drucker, 2013). Large dominant firms are more likely to form linkages at national or (sub)-global levels. Local suppliers prefer large stable contracts with dominant firms and often offer their tailor-made products/services only to these firms, not willing/able to deliver to small local rural firms (Drucker and Feser, 2012). The actual number and size of firms, however, do not mechanically affect the intensity of localisation economies and local economic linkages. The historical continuity of population and economy, institutional thickness, local culture, regional identity, social capital and numerous other factors can play a crucial role in such cases. Important factors of local economic integration include the historical trajectory of the development and specialisation of the regional economy. Rural firms active in the same (or a technologically related) sector in which the particular region has specialised for a long time (Crone and Watts, 2003), may be more closely linked to local firms and markets.

To summarise, the regional historical, cultural, and institutional context has a major impact on the intensity of local economic linkages. For this reason, the following section is devoted to the specifics of restructuring the Czech rural economy with a focus on the Zlín Region.

4. Restructuring of the economy in Czech rural regions –focusing on the Zlín region

In the Czech Republic, the process of restructuring the rural economy started in the early 1990s, that is, with some delay compared to developed Western European countries.

The nature of the process was significantly influenced by the inherited organisational and industrial structure of the rural economy, which, despite a profound transformation in the 1990s, has affected the character of Czech rural industry to this day. Between 1989 and 2000, economically active population in agriculture dropped to one-third (Bičík and Jančák, 2005). An important mechanism for the development of rural industry during the transformation period was the outsourcing of entities from the nationalised unified farmers' cooperatives (collective farms), which, in addition to dominant agricultural production, also dealt in many cases with affiliated industrial production, repair activities, construction work or services (Majerová, 2017; Jančák et al., 2019): these non-agricultural activities accounted for 27% of employment in the agricultural sector (Swinnen et al., 2001).

In parallel, a deindustrialisation process was underway in the 1990s, affecting mainly towns and rural unemployment through the weakening of work commuting more than the loss of jobs directly in the countryside (Jančák et al., 2019). Nevertheless, manufacturing has become a major production sector in most rural regions, including the Zlín region (see Fig. 1). In 2017, the manufacturing industry, in the group of Czech municipalities with fewer than 3,000 residents, accounted for almost one-quarter of the jobs. In the same year, it accounted for 29% of employment in rural municipalities of the Zlín Region², which was the second-highest industrialisation rate in the Czech Republic after the Moravian-Silesian Region (Business Register, 2017).

Rural municipalities in non-metropolitan regions, with large industrial hubs and several peripheral regions mostly in the eastern part of the country (Barbořík, 2019), are mostly specialised in the manufacturing/secondary sector.

Contrarily, the metropolitan hinterlands of Prague, Ostrava, and other regional cities are the least specialised in this type of industry (Fig. 1).

The first decade of the 21st century can be described as a period of reindustrialisation (Koutský, 2011), which had very selective territorial impacts (Hruška and Píša, 2019). Reindustrialisation was mostly driven by economic globalisation, associated with the integration of enterprises into global production networks, and the inflow of foreign direct investment to both existing and newly built production facilities. The inflow of foreign capital in many rural regions compensated for job losses (especially in traditional labour-intensive industries) associated with the deindustrialisation of the 1990s (Hruška and Píša, 2019). Another manifestation (also at the national level) was a shift in industrial structure towards a higher representation of capital-intensive industries and an increasing specialisation in the automotive and supply industries (Toušek and Šerý, 2013). Integration into the automotive production networks has been especially important in the Zlín region, characterised by a relatively high share of traditional (medium-low) tech manufacturing industries and/or links to primary sector activities such as agriculture or forestry (Fig. 2).

Because of the reorientation to the supply for the automotive industry, traditional (medium) low-tech industries in the Zlín Region have survived. Manufacturing of fabricated metal products holds the key economic position (see also Novák and Ježíková, 2016). Wood processing, rubber and plastics, furniture, clothing and, to a lesser extent, the food processing industry, have a higher share of employment compared to other Czech regions (Fig. 2). Intensive local economic linkages in these industries (and to technologically related industries) can be expected.

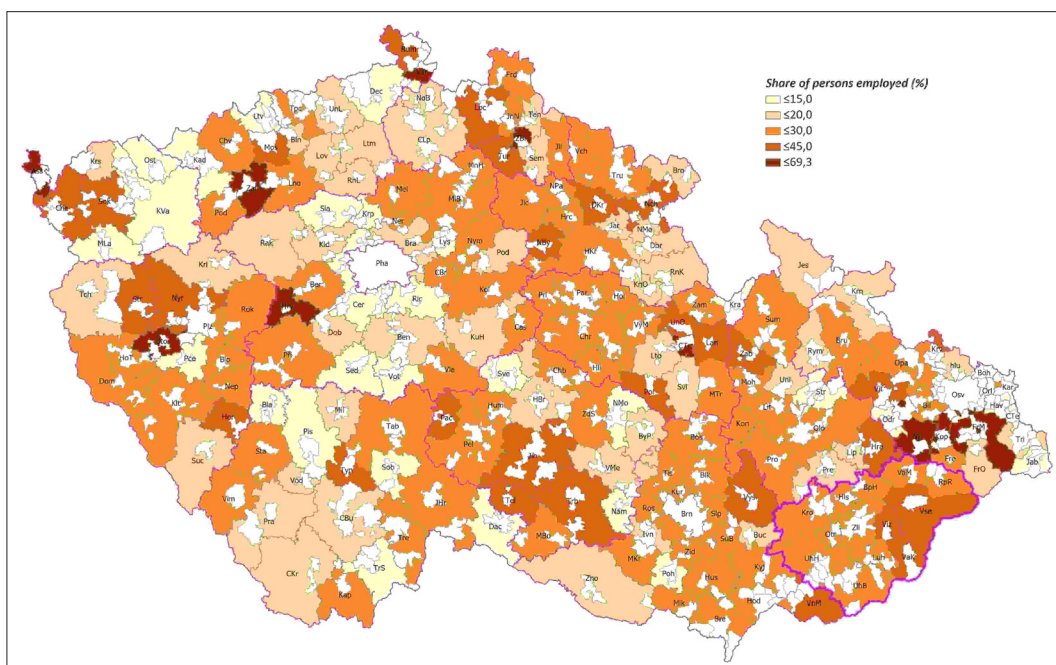


Fig. 1: Proportion of manufacturing industry in the employment rate of rural municipalities in 2017 (aggregated at microregional level: "AD MEP"; administrative districts of the Zlín Region are marked purple)

Source: Ženka and Pavlík, 2019

² At the municipal level, peripheral areas of the Zlín Region are situated in: (1) the southeastern part of the territory close to the border with Slovakia in AD MEP Vsetín, Valašské Klobouky and Uherský Brod (Vaishar and Zapletalová, 2005); (2) the northwestern part of the region, municipalities in AD MEP Uherské Hradiště and Kroměříž (Perlín et al., 2010). At a microregional level, peripheral areas are AD MEP Valašské Klobouky, Luhačovice, Holešov and Bystřice pod Hostýnem (Ženka et al., 2017).

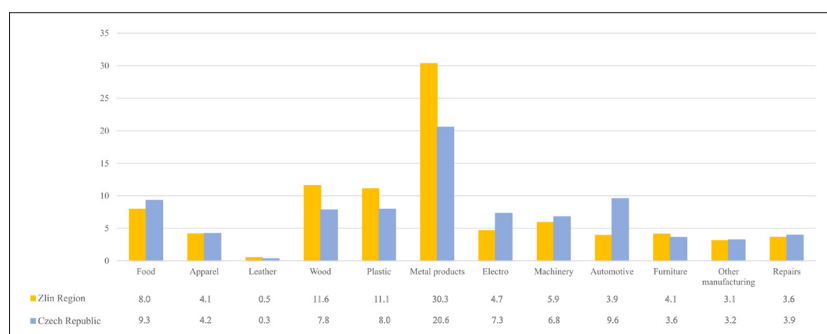


Fig. 2: Employment structure in the manufacturing industry of rural municipalities: comparison of the Czech Republic and the Zlín Region in 2017 (%). Source: Business Register, 2017

Note: Food = 10; Apparel = 14; Leather = 15; Wood = 16; Plastic = 22; Metal products = 25; Electro = 27; Machinery = 28; Automotive = 29; Furniture = 31; Other manufacturing = 32; 33 = Repairs. The NACE rev. 2.0 taxonomy was used, <https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF>

One must also consider, however, that Czech rural and non-metropolitan regions, in general, have been characterised by relatively weak economic linkages at the local level (Ženka et al., 2015). This phenomenon can be explained historically by the interruption of traditions of private businesses and entrepreneurship in rural areas in the socialist era, and by the forced integration of many rural industrial enterprises into large, state-owned, vertically organised industrial companies (Heidenreich, 1994; Slach, 2011). These centrally managed state-owned enterprises were usually based in metropolitan regions, with many subordinate production plants with minimal strategic functions in small and medium-sized towns. The privatisation of such former production and economic units into the hands of Czech or foreign entities, and the restructuring and integration into global production networks of multinational corporations (Pavlínek, 2004), was one of the important mechanisms of rural industry development after 1989. In several Czech regions, however, the pattern of de-regionalised production has been replicated, and new hollow clusters have been developed, this time involving the production plants of multinational corporations (Ženka et al., 2014, 2015). This trend has been less pronounced in the Zlín Region, given its relatively strong path-dependence and long-term continuity in industrial structure and localisation (see Ženka et al., 2017).

The restructuring of industry in rural areas was also influenced by processes of residential and commercial suburbanisation (for more details, see Sýkora and Ouředníček, 2007) and counterurbanisation (for a topical introduction see Keeble and Tyler, 1995; Šimon, 2011; Bosworth, 2019). Commercial suburbanisation/counterurbanisation processes include not only the physical relocation of manufacturing firms from towns to the countryside, but also the establishment of new manufacturing firms in the countryside by ‘urban immigrants’ (North, 1998). Empirical evidence of the nature and intensity of commercial suburbanisation and counterurbanisation in the Czech Republic, in relation to the development of manufacturing industry, is very limited (for initial overviews, see Hruška and Píša, 2019; Píša and Hruška, 2019). The most visible manifestations of such processes include the construction of production halls and logistics centres in urban hinterlands (Hruška, Konečný, 2011), as well as the establishment of industrial zones (Kunc, 2006).

These processes, however, are probably rather driven by the inflow of foreign direct investment rather than by the relocation of industry from urban to rural areas. It can be

assumed that the impact of entrepreneurs moving from towns and cities to the establishment of rural manufacturing firms in the Czech Republic, will be significantly smaller than in Western European countries (e.g. the United Kingdom, the Netherlands), for which relatively extensive empirical evidence of the urban-rural shift process is available (Keeble and Tyler, 1995; Bosworth, 2019). It can also be assumed that the effects of commercial suburbanisation on the development of rural industries in the Zlín Region are limited, considering its relatively low population density and the medium-sized regional capital (80,000 inhabitants in 2020).

Rural areas of the Zlín Region are characterised by a long-term stability in terms of settlement, religiosity, and an overall high intensity of social and cultural capital (Pileček and Jančák, 2010), that might be supportive for the creation of local/regional economic linkages. In terms of its local economic base profile, there is a prevalence of diversified industrial and peripheral regions (Ženka et al., 2017), with only the Otrokovice and Uherský Brod communities as exceptions due to the presence of one large dominant manufacturing firm. All rural regions in the Zlín Region can be defined as industrialised rural localities when using the typology proposed by Hruška and Píša (2019). Most of them demonstrate a relatively good economic performance in the national context (Ženka and Wellisch, 2019), confirming the finding of Bole et al. (2020, p. 23) that small and medium-sized industrial towns/regions are not necessarily disadvantaged concerning their socioeconomic performance.

The current spatial distribution and structure of rural manufacturing in the Zlín region result primarily from the following factors/changes: (1) the development of the shoe manufacturing industry (Baťa Shoe Company) and the path-branching of technology-related industries, especially rubber and later the plastics industries (Bednář, 1970); (2) the state-controlled concentration of the arms industry; (3) the socialist industrialisation following upon the interwar period (see Kunc, 2006), developing, in addition to the above-mentioned sectors, the chemical industry, electrical engineering, aircraft and other industries; and (4) the reorientation of a part of the traditional industries after 1990 to supplies for the automotive industry, and the inflow of foreign direct investment from the production of automotive components (spearheaded by tyre production: see Ženka and Pavlínek, 2013; Blažek and Kuncová, 2011). Industrial development in the Zlín region is characterised by the continuity of several major industries (except for leather products) and diversification into technologically related

industries, rather than by a radical change of industrial structure and any importation of completely new unrelated industries. Therefore, the intensive local and regional economic linkages in traditional manufacturing industries in the Zlín region (mostly in the manufacturing of fabricated metal products) are to be expected.

5. Data and methods

For this paper, municipalities with a population of less than 3,000 are considered rural, therefore we use a descriptive definition based on the Act No. 128/2000 Coll. on Municipalities. The proportion of manufacturing industry in the employment rate (Fig. 2) in rural areas was calculated using data provided by the Business Register (BR, 2017), as the product of the number of firms in the given size category and the mean of the given size category (e.g. employment in 10 firms in the size category of 50–99 employees were estimated as 10×74.5 , i.e. 745 employees). Rural municipalities were spatially aggregated to the level of administrative districts of municipalities with extended powers (AD MEP), excluding municipalities with the population over 3,000 people in the area of the given district) to quantify employment in the manufacturing industry for these territorial units. We decided to include only manufacturing firms (codes 10–33 according to NACE rev. 2.0), which had this type of activity listed as first (in the list of economic activities provided by the Business Register).

Another source of primary data was a semi-structured interview. Between 2016 and 2019, we conducted 26 interviews with business owners or their authorised representatives (names of companies in the text have been changed). When selecting the firms, we opted for the method of deliberate (purposive) sampling. The selection was made in such a way that the addressed firms represented a wide

range of manufacturing industries, but the emphasis was put on a greater representation of firms involved in the manufacturing of fabricated metal products (Fig. 3). The sample is not representative from the statistical point of view, but it reflects industrial and size structure of Czech rural manufacturing and captures the most important types of manufacturing firms located in Czech rural municipalities – see the section 6 and 7. While current sourcing patterns of rural manufacturing firms in other Czech or foreign regions may differ from our sample in the Zlín Region, various sourcing strategies of rural manufacturing firms in relation to their size, industry, mode of entry and growth.

The first part of the interviews was focused on collecting basic information about the surveyed firm: number of employees, main products, date and mode of firm establishment, and the educational structure of employees. The interview was made up of questions to identify key suppliers, customers and competitors, and to estimate the share of local, regional, national/central European, European and global linkages in the total value of purchases and sales. We also inquired about the presence of firms in the same industry in that particular locality, and their possible positive and negative impacts on the local labour market, knowledge dissemination, development of the supplier base and infrastructure. The important parts of the interviews were the respondent's narratives focusing on the establishment and development of the product portfolio, technologies, standards and linkages at various scales. Those mostly unstandardised pieces of information allowed us to understand how various factors affect the spatial nature of production linkages.

We evaluated the collected data using frequency response analysis and content analysis. Because the interviews included also standardised questions and quantitative

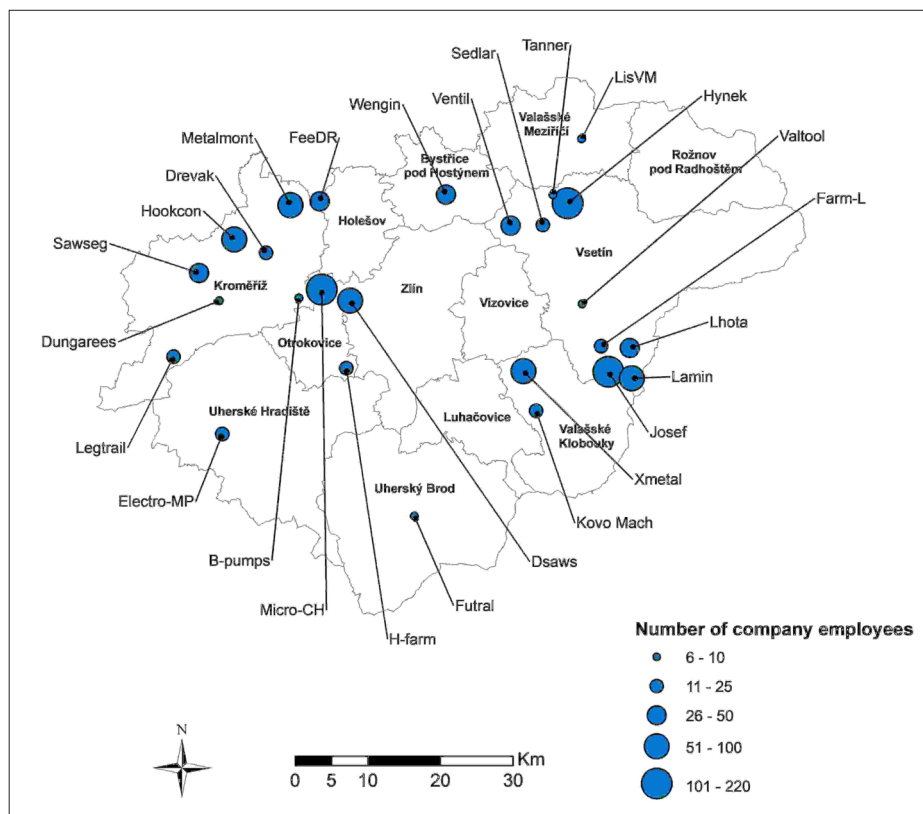


Fig. 3: Localisation of the companies interviewed in the Zlín Region (company names are fictional)
Source: authors' compilation

Variable	Description	Data source
Local/regional supplier/customer (binary)	1: the firm purchases/sells at least 10% of the value of total purchases/sale locally (AD MEP)/regionally (NUTS3); 0: less than 10%	Author survey
Firm size	Number of persons employed in the firm	Business Register 2017
Firm age	Categories according to the period of establishment: 1: 1951–1999; 2: 2000–2019	Author survey
Industry (binary)	Manufacturing of fabricated metal products (1) or other industry (0)	Business Register 2017
Accessibility	Population size of the MEP divided by the mileage from the given firm	CSO 2017; The Time Now
Establishment (binary)	Outsourcing from a local firm in the same/related industry (1) or another way of establishment (0).	Author survey

Tab. 3: Variables and indicators employed in the statistical tests

Source: authors' survey

indicators, we carried out several non-parametric statistical tests of the effect of selected independent variables on the intensity of linkages at the local and regional level (see Tab. 3). Results should be interpreted with caution. Some of them might have failed to reject the null hypothesis due to the small sample size ($N = 26$) and firm heterogeneity (in terms of employment, industry and ownership), not because of the non-existence of the relationships. Simple and robust statistical tests of roughly aggregated data were used only to supplement the qualitative analysis, providing not conclusive but indicative results that might indicate possible avenues of future research.

The intensity of production linkages was evaluated at the following scales:

- Local: inside the administrative district of the municipality with extended powers (AD MEP); divided into local rural (rural municipalities in the AD MEP) and the local city (MEP);
- Regional: linkages in the respective NUTS3 region;
- Central European: Czech Republic, Slovakia, Poland, Austria and Germany;
- European: at least one country outside Central Europe; and
- Global: at least one country outside Europe.

Given that rural manufacturing firms in the sample are generally small in terms of employment, we employed the following definition of small, medium-sized and large enterprises: (i) Large: more than 100 persons employed; (ii) Medium-sized: 20–99 persons employed; and (iii) Small: less than 20 persons employed.

In the next section we present the empirical results of the survey of 26 managers of manufacturing firms in rural areas of the Zlín Region.

6. Results

Of the 26 companies examined, 12 were established in the transformation period in the first half of the 1990s and another 9 in the first decade of the 21st century. Small and medium-sized enterprises prevail as only 3 of the addressed firms employed more than 100 employees (Tab. 4). Almost half of the workers had a secondary education without a secondary school leaving examination; one third had it with this exam. As firms grow in size, the proportion of workers with primary or secondary education without a secondary school leaving exam decreases and the proportion of university graduates increases. Ten firms were engaged in the manufacturing of fabricated metal products, and the remainder (except for one engineering and one chemical enterprise) were in low- and lower-tech industries.

Null hypothesis	Test	p-value
The distribution of Employment is the same across categories of Local-suppliers.	Mann-Whitney U	0.068
The distribution of Employment is the same across categories of Regional-suppliers.	Mann-Whitney U	0.860
The distribution of Employment is the same across categories of Local-customers.	Mann-Whitney U	0.029
The distribution of Employment is the same across categories of Regional-customers.	Mann-Whitney U	0.278
Variables Firm-age and Local-suppliers-binary are statistically independent.	chi-square test	0.320
Variables Firm-age and Local-customers-binary are statistically independent.	chi-square test	0.315
Variables Firm-age and Regional-suppliers-binary are statistically independent.	chi-square test	0.234
Variables Firm-age and Regional-customers-binary are statistically independent.	chi-square test	0.612
The distribution of Accessibility is the same across categories of Regional-suppliers.	Mann-Whitney U	0.020
The distribution of Accessibility is the same across categories of Regional-customers.	Mann-Whitney U	0.138
The distribution of Regional-suppliers-share is the same across categories of Industry.	Mann-Whitney U	0.623
The distribution of Regional-customers-share is the same across categories of Industry.	Mann-Whitney U	0.698
Variables Establishment and Local-suppliers are statistically independent.	chi-square test	0.263
Variables Local-suppliers-binary and Local-customers are statistically independent.	chi-square test	0.191

Tab. 4: Selected results of the statistical tests. Source: authors' calculations

Note: The significance level is 0.05 in all cases. Significant relationships are marked in bold. Results of the tests not listed in Table 4 were not statistically significant

Nearly all firms were established by local entrepreneurs in or near their place of residence, with only one exception of the business shifting from another region (Prague). As we assumed, commercial suburbanisation/counterurbanisation was not an important mechanism of rural manufacturing development in the Zlín Region. A majority of entities were established and developed from local firms operating in the same or technologically related industry before 1989: either by separation of parts of these firms, or by splitting off from associated farmers' cooperative production. Direct links to socialist production are a characteristic for less than one third of companies that use already existing industrial zones or farmers' cooperative areas and have developed by reorganising traditional local industries. 16 respondents stated that their firm was established as "new" in the research locality. In fact, in almost all of these cases, it is possible to trace some type of historical link, for example through the employer's education in a given field or his/her previous employment in a firm operating in the same or a technologically related sector.

Most companies created supplier-customer relationships at multiple scales at the same time and were independent of a single business partner or at the local market only (Tab. 5). They tended to create economic linkages more with the local city than the surrounding rural municipalities. In terms of production volume, purchases and sales at the regional level were the most significant, with a total of 59% of the purchase value and 66% of the sales value being made in the Zlín Region or close to it. Central European purchases were a characteristic for midsize companies (metal working, plastics industry) that purchased material not available locally. The global linkages were rather an exception – only one company (Dungarees) made purchases almost exclusively at the global level.

At the local level, companies generally could not find a sufficiently large market, so the proportion of sales in the local rural hinterland to total sales was very low. The exceptions were companies combining industrial and construction activities: Metalmont specialising in the production of metal structures and construction of prefabricated steel halls or joinery, and the construction company Drevak. The local cities are also not an important market for the products of manufacturing firms. In most cases, firms do not produce final products that could be sold and used in an urban market; their customers are other (industrial) firms, often located outside the region. Again, there are exceptions, such as the Dungarees workwear manufacturer or the toolmaker Valtool with a key customer at the local level: a Japanese company supplying car pyrotechnic airbag initiators.

For most firms, key customers are located in the region, which is again in line with the findings of a previous study on the neighbouring South Moravian Region carried out by Štastná (2011). Customers at the transnational level were identified by 17 (mostly older) companies, which were linked to mainly Central European markets. These were mainly manufacturers of highly specific components for further industrial processing or machining. One example is Ventil supplying among other things fans for the automotive industry and the manufacturer of metal legs for Legtrail trailers. Customers of these companies are dispersed, resulting in supra-regional customer relationships. An interesting example is the Hynek paint shop, where the focus on the (Central) European market is explained by the linkage to major customers – large prestigious multinational corporations in the automotive industry and railway engineering.

The results of statistical tests (see Tab. 4) show that with increasing size of companies the share of local purchases and especially sales decrease. Larger companies at the local level have a hard time finding specialised and competent suppliers capable of complete deliveries in the required volume, as well as finding sales in too small and insufficiently diversified markets. This does not apply, however, to the intensity of economic linkages at the regional level, where we have not found any connection with the number of company employees.

Firm size is not the only factor limiting the share of local sourcing. Even more important is the unavailability of local suppliers that might be caused by various factors. In labour-intensive manufacturing industries, the local suppliers might have been pushed out by imports from lower cost developing countries, so now the firms have to source internationally. This is the case of the workwear producer Dungarees, with cost motivated import of textile fabrics from Pakistan, India and China. Other examples are firms that source mostly materials either from primary industries (agriculture, forestry, mining) or from highly specific suppliers that can be found in few localities around the world. In our survey, the example is FeeDr, producer of feeds for farm animals, who imported specific remixes and minerals from Latin America and China.

Intensive local or regional sourcing is characteristic for endogeneous firms operating in traditional regional industries, such as the Tanner, a producer of leather gloves and saddlery. More importantly, the mode of establishment and development of the firm might be of key importance for current production linkages. Sawseg, a producer of segment saws, has been (together with several other firms) spun off from the local state-owned producer of saws, Pila, that has survived until today. Although Sawseg has been acquired by a multinational company and integrated into its international value chain, the firm has maintained intensive sourcing linkages and collaboration with local successors of the state-owned company Pila. Continuity of traditional regional specialisation and/or diversification into technologically related industries is conducive for the development of local and regional production linkages.

The company age had no statistically significant effect on purchases or sales. The industry sector seems to have almost no statistical effect – on average, firms manufacturing prefabricated metal products did not differ from firms in other industries in terms of the intensity of local purchases and sales. The geographical distance and town size did not affect the intensity of local purchases or sales, but firms near larger cities had stronger linkages to supply firms in the region than firms in peripheral localities. We have not demonstrated a connection between the intensity of local/regional purchases and sales – firms that make significant purchases at the local level do not necessarily need to be linked to local markets in terms of sales and vice versa. Nor did we find any differences in the intensity of local economic linkages between the individual micro-regions of the Zlín Region. Therefore, the firm size structure in MEPs had no measurable impact on local/regional purchases/sales of the analysed rural manufacturing firms: the effect of regional industrial dominance (Drucker and Feser, 2013) was therefore not confirmed.

7. Discussion and conclusions

Summarising the results so far, it can be argued that in rural municipalities of the Zlín Region domestic and propelling firms prevail, while the least represented are dependent firms

Name	Product	Jobs	Backward linkages						Forward linkages						Type of the firm
			LR	LT	RG	CE	EU	GL	LR	LT	RG	CE	EU	GL	
Valtool	metal tools and constructions	10	█	█		█				█	█				domestic
Farm-L	dairy products	17			█					█	█				domestic
B-pumps	pumps	10			█					█	█				domestic
Dungarees	workwear	6									█				dependent
Legtrail	metal components for semi-trailers	15			█						█				propelling
FeeDR	feeds for farm animals	31			█						█				domestic
LisVM	components for pressing machines	9		█											propelling
Josef	meat products	220			█						█				domestic
Lamin	plastic pressings	95			█						█				extravert
Ventil	non-domestic ventilation equipment	40		█							█				propelling
Hynek	coating of metals	200			█						█				extravert
H-farm	pharmaceuticals	13			█						█				propelling
Futral	gun holsters	10		█							█				dependent
Sedlar	saddlery, harness	20			█						█				domestic
Drevak	joinery, construction	13		█											domestic
Kovo Mach	machining	18			█						█				domestic
Metalmont	metal constructions, halls	70									█				domestic
Sawseg	segment saws	41			█						█				propelling
Lhota	meat processing	26													propelling
Tanner	tanning and dressing of leather	7		█							█				propelling
Electro-MP	wiring, lightning conductors	17		█							█				propelling
Hookcon	lifting and handling equipment	80													dependent
Wengin	machining	35		█							█				propelling
Dsaws	saws	80													extravert
Xmetal	machining	55									█				extravert
Micro-CH	plastic microtubes (electronics)	111													extravert

Tab. 5: Firm linkages at local, regional, (Central) European and global level. Source: authors' survey
 Notes: (1) Scales: LR = local-rural hinterland; LT = local-town; RG = NUTS3 region; CE = Central European; EU = European Union; GL = global; (2) Shares in total firm's sourcing/purchasing: 0% (white); 1–9%; 10–49%; 50–89%; 90–100%

selling mainly regionally (see Tab. 5). Dependent firms buy predominantly at the European or global level – due to lower input prices (in agreement with Courtney et al., 2008) and/or the unavailability of components in their home region: see also Pavlínek and Ženka (2016). In the second least numerous group one finds the extravert firms that also do not create any intense local/regional linkages, due to the unavailability of components on-site and insufficient local demand. Most of them are in the position of third-tier suppliers of large industrial corporations in technology-intensive sectors of the manufacturing industry (often related to the automotive industry), located at national or (Central) European level. While rural manufacturing firms in the Zlín Region either supply technologically simple components or focus on highly specific custom-tailored products, their prospects of upgrading towards higher value-added products are usually constrained by their small size, limited localised capabilities (see the discussion by Gwosdz et al., 2020) and resources, rather than by power asymmetries in their respective global production networks.

Despite the existence of these firms, we cannot describe most of the (rural) areas of the Zlín Region as “Satellite Platforms” (Markusen, 1996; Ženka et al., 2017), that is, as clusters of locally dis-embedded firms or plants, usually export-oriented and foreign capital-controlled. Neither can they be labelled as Marshallian Industrial Districts (Markusen, 1996), which are characterised by a dense local network of small locally owned firms interconnected by long-term contracts and capitalising on localisation economies. While there is a relatively high rate of spatial clustering of metal manufacturers in the Zlín Region, mutual economic linkages at the local level are surprisingly weak. According to the results of the interviews, local rural manufacturing firms do not benefit significantly from localisation economies resulting from the geographical proximity of firms in the same industry. Empirical evidence from the highly industrialised Zlín Region thus supports previous assumptions of relatively weak local or regional embeddedness of manufacturing firms in the Czech Republic and other Central European industries, while exceptions exist (see Gwosdz et al., 2020, for an analysis of industrial towns in Poland). Apart from the effects of historically de-regionalised production, rural manufacturing firms in the Zlín region exhibit the relatively low intensity of local sourcing due to their integration into many different global production networks. Their principal customers and suppliers are located elsewhere.

Domestic firms are mainly integrated at the regional level, so from the perspective of rural municipalities, we could consider them as an extravert. Propelling firms that are also third-order suppliers tend to sell at (Central) European level to a large extent for the same reason as extravert firms, as they are often linked to large customers in the Czech Republic or (Central) Europe or produce a highly specific product for which there is not enough demand at the local level. A specific type of propelling firms is entities that buy locally and sell mainly regionally.

The above results are almost the opposite of the empirical findings by Romero and Santos (2007) from the peripheral tertiary Spanish region of Andalusia, with a prevalence of dependent and extravert firms (but they were not just rural firms). Based on this and previous evidence (Ženka et al., 2015, 2017), the Zlín Region can be described as a highly industrialised export periphery, characterised by higher business activity, related diversity and a developed regional

production system. All of that is evident even though export regions, in general, are characterised by a less intensive regional embeddedness of local firms (Květoň and Šafr, 2019). Most of the analysed rural industrial firms made their purchases and sales mainly at the regional level (in agreement with the findings of Slach, 2011 and Šťastná et al., 2011), due to low local demand and lack of relevant suppliers for the production of highly specific products at the local level (Crone and Watts, 2003). We did not identify any monocentric network of economic linkages: rural firms source from various localities in the Zlín Region, not necessarily from the regional capital. Neither did we identify significant supplier/customer linkages of selected rural manufacturing firms to the MEP. This does not mean that economic growth in rural municipalities of the Zlín Region is not driven by the MEP’s demand for industrial goods and services (for the theory: see Bosworth and Venhorst, 2017). The economic linkages of the investigated rural manufacturing firms, however, did not follow necessarily the urban-rural (nodal) pattern of economic linkages.

The sample of 26 manufacturing entities allows for only indicative and preliminary statements about the most important factors of the intensity of corporate purchases/sales at the local/regional level, or a typology of rural manufacturing firms. With a great deal of caution, we can conclude that on average, large corporations buy/sell locally less than small and medium-sized enterprises (see also Crone and Watts, 2003; Courtney et al., 2008; Romero and Santos, 2007). Firms in peripheral and harder-to-access areas purchased less from regional entities (probably because of the focus on highly specific, custom-made products), but they did not significantly differ from firms located near urban areas in terms of the intensity of local supply linkages (contrary to Mitchell, 2005 and Courtney et al., 2008). We failed to demonstrate the effect of other factors at the corporate, sectoral or regional level, such as the age of the firms, the ownership of the firms, the sector/product, the sectoral/size structure of the region, or location. We cannot exclude the possibility, however, that future research into a larger sample of rural industrial firms could reveal the effects of these variables.

This research study has produced some findings that could be used as a base for the formulation of economic and regional policies. It should be considered that for many rural municipalities and regions (not only) in the Czech Republic, the export of industrial products is a key source of income. Thus, local economic linkages can be an important contribution to job creation and added value. Regional and national policymakers, however, often overestimate the benefits for regional development engendered by large foreign-owned industrial firms, which usually have their strongest supply/customer relationships at the (multi-)national level.

Our empirical results have demonstrated a relatively weak link between rural firms and firms in MEPs. Although regional capitals and MEPS retain a key impact on the economic development of their surrounding rural communities, nodal regions are integrated through commutation to work and services much less than the economic linkages between rural and urban industrial firms. Therefore, there is a need to support and develop the production, knowledge and other types of linkages of rural industrial enterprises at the relevant scale levels: regional, national and transnational (North and Smallbone, 2006).

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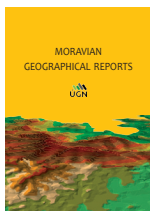
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The role of administrative borders in determining regional identity: The case of Podlasie, Poland

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Abstract

The borders of voivodships in Poland today are not consistent with those of historical regions. The current administrative division is largely based upon imposed boundaries, dividing initial regions. This research topic arises from the dichotomy between the toponymy applied to voivodships because of the administrative reform of 1999 – and the names of historical regions. Implementing such a toponymy, although detached from historical and cultural contexts, has contributed to establishing attachments with current administrative regions, which surpasses identification with historical units. This paper presents the results of empirical research employing a questionnaire survey of the inhabitants of 71 communes (LAU 2 units) in north-eastern Poland. The main objective was to examine the impact of recent administrative reform on territorial identity, with particular emphasis placed on the region of Podlasie. The surveyed communities are to the highest extent attached to national and local levels than to the region, which was only ranked third in the hierarchy of identification with a given area. The regional identity of the population living in north-east Poland is related primarily to the contemporary administrative borders. There are, however, explicit differences in perceptions of the region of Podlasie depending upon respondents' place of residence, which is an indication that relict borders persist in the residents' social consciousness.

Keywords: administrative borders, historical region, territorial identity, place attachment, Podlasie, north-eastern Poland

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1. Introduction

Borders, both constituting barriers and those acting as stimulants, have a multifaceted spatial impact: from economic (border trade, international trade exchange: Komornicki, 2010; Powęska, 2011) and social (e.g. education, demography: Palmowski, 2007; Pászto et al., 2019), to an intangible aspect manifesting itself in forming, within a given territory, a sense of community and belonging to a delimited area. Border changes may modify the strength of attachment to various spatial levels, including regional ones (Weigend, 1950; Erikson, 1974; Huntington, 1998; Rykiel, 2010; Scott, 2018).

In the process of the deinstitutionalisation of “old” regions and institutionalisation of new ones, regional identity may either foster or hinder the mechanism of region-building (Zimmerbauer et al., 2012). Initial territorial identities are often weakened, while new ones are established, bearing different perception of boundaries, values and symbolism. On the other hand, the deinstitutionalisation of regions

can also stimulate a hitherto dormant territorial identity of inhabitants, including their attachment to a delimited area and a region's name (Zimmerbauer et al., 2012). Therefore, the impact of administrative reform often results in increasing and/or altering administrative “regiocentrism” (Matykowski, 2017). All the while, the evolution of state and regional borders is a ‘natural’ phenomenon. Similarly, consciousness of the existence of a common territory associated with a particular area is not a given, once and for all (Rykiel, 1985). Moreover, often borders were established secondary to the spatial development of a given area (subsequent borders: Hartshorne, 1936). They not only divided existing economic systems, but also separated previously formed cultural communities.

The permanence of borders is crucial for the formation of emotional ties with an area once they have been delimited. During the Middle Ages and the First Republic of Poland, as an example, administrative regions were characterised by high border stability (Solarz, 2014). In the case of most

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voivodships¹ (provinces), they did not change for centuries until the partitions at the end of the 18th century. Such durability of borders contributed to the formation of a strong regional identity attributed to communities of ‘small homelands’ (Sobczyński, 1984). Since the time of the partition of the Republic of Poland, state borders and internal administrative divisions of the partitioning powers have shifted numerous times. After World War II, administrative reform in Poland has been carried out on average every 25 years. It is then a relatively short period for a community to develop ties with a given administrative region. At present Poland’s society is comprised of at least three generations growing up in different territorial divisions of 17 (1950–1975), 49 (1975–1998) and 16 voivodships (after 1999).

The essence of the research problem considered here stems from the dichotomy between the names (toponyms) ascribed to voivodships as a result of the administrative reform of 1999, and the names of historical regions (i.e. from the time of the First Republic of Poland). The borders of the new administrative units (see Fig. 1) are characterised by a significant lack of cohesion with the spatial range of the historical regions (Miszczyk, 2003; Zaborowski, 2013). Their toponyms, however, refer to the latter. The borders of current voivodships have been imposed, dividing once coherent regions. On the other hand, there are still relict borders present in general social consciousness, resulting from historical conditions, divisions of former Piast² districts or partitions³. These borders are apparent, for example, in

the diversity of electoral preferences, settlement structure, demographic conditions, land use, cultural landscape, Polish language regionalisms and traditions, etc. (Sadowski, 1997; Barwiński, 2004, 2012; Bański et al., 2012; Ferenc, 2016; Mazur, 2016).

The main aim of this article is to analyse the impact of the last administrative reform (from January 1, 1999) on the regional identity of the inhabitants of north-eastern Poland. Particular emphasis has been placed upon attachment to and perception of Podlasie. A social survey was employed to identify the intensity of respondents’ attachment to different tiers and categories of spatial division, taking into account current and historical boundaries of administrative and physico-geographical units, and to reveal spatial perceptions of Podlasie. The research results are anticipated to determine the strength of regional identity in relation to other spatial levels. The survey that was conducted will also serve to ascertain whether Podlasie operates in respondents’ consciousness as an historical entity (delimited by relict borders) – or merely – an administrative region (i.e. Podlaskie Voivodship) established as a result of the reform in 1999.

2. Theoretical background

2.1 Attachment to territory

Individualised relations with a given territory are presented by both its inhabitants and its researchers. Attitudes towards place are shaped by one’s experience and

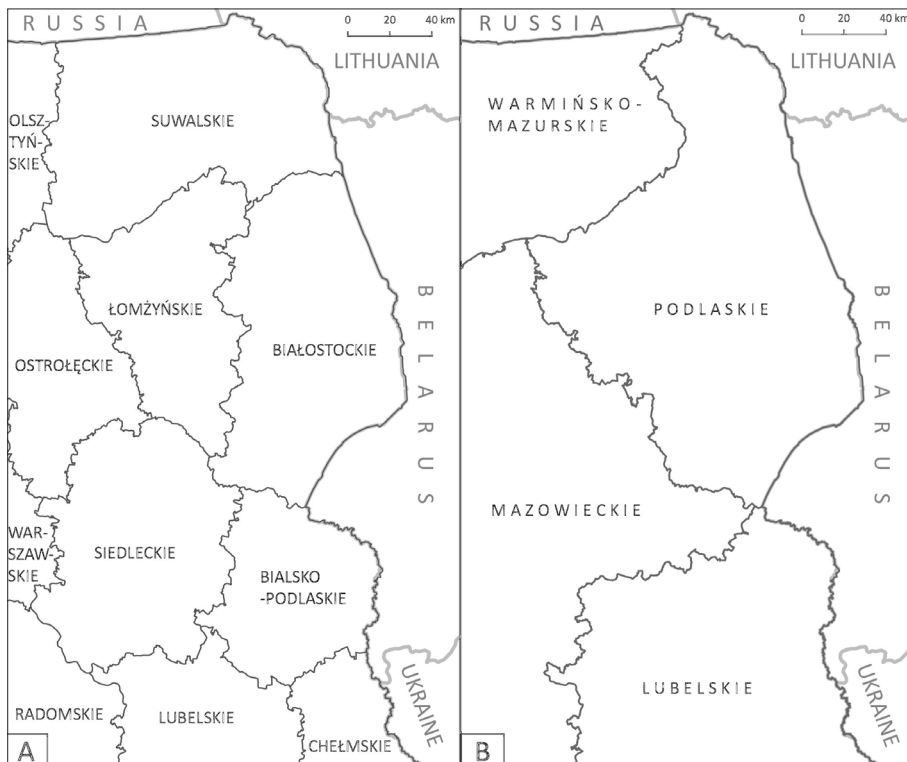


Fig. 1: The voivodships of north-eastern Poland: 1975–1998 (A) and since January 1, 1999 (B)
Source: author’s composition

¹ Voivodship (in Polish: *województwo*) is an administrative region of the highest rank in Poland (NUTS2 region). It corresponds to Italian provinces (*province d’Italia*) or kraje in the Czech Republic.

² The Piast dynasty was the first historical ruling dynasty of Poland. The first documented Polish monarch was Duke Mieszko I (c. 930–992). The Piasts’ royal rule in Poland ended in 1370 with the death of King Casimir III the Great (Kazimierz III Wielki).

³ In 1795, the third and the last of the three 18th-century partitions of Poland, ended the existence of the Polish–Lithuanian Commonwealth. The partitions were conducted by Habsburg Austria, the Kingdom of Prussia and the Russian Empire, which divided up the Commonwealth lands among themselves progressively in the process of territorial seizures and annexation. The sovereign state of Poland was re-established in 1918.

background (Tuan, 1974). A diversified approach towards this issue is evidenced by the variety of terms employed by researchers, such as: territorial identity, territorial consciousness, territorial awareness, place identity, place attachment, sense of place and others (Korpela, 1989; Low, 1992; Paasi, 2003; Pretty et al., 2003; Pollice, 2003). This subject matter has been undertaken by researchers from environmental psychology, sociology, human geography, cultural anthropology and other social sciences.

According to Chojnicki (1996), regional consciousness – as a state of social consciousness determining regional identity – is an inherent element in the spatial and material formation of a region. Such consciousness is constituted by the character and the region's spatial structure, as well as its values and symbolism. An important dimension of a community's self-determination along with the spatial and functional representation of a region, comprises territorial defining in a formal or informal manner (Whebell, 1973). Such process takes place, among others, by naming the region using endoethnonyms – names by which the community determines its territory of residence, or exoethnonyms – terms used by outsiders. Relations between perceiving the region from the “inside” and “outside” have been present in scientific discourse for some time. Paasi (1991) stated that the institutionalisation of regions – the process through which regions come into existence as social, political and economic actors – is composed of both the “identity of a region” (created by outsiders) and “regional identity” (the collective identity of a region's population).

Physical places acquire meaning through personal and group memories, religious and national symbols, as well as by multi-sensorial feelings experienced while being-in-the-place (Patterson, Williams, 2005). In this regard, collective memory is a key factor supporting social identity. It acts as a “material” for the awareness of having a shared past. Collective memory is responsible for transmitting cultural values, including language, groundbreaking events, customs, etc. (Malicki, 2010). Identity built on collective memory is strongly grounded in the past and has greater capacity to outlast territorial changes such as creating a new state or regional borders. This was evidenced by a comparative study of two regions in the Czech Republic by Šerý (2014). The socio-historical development of a region with an uninterrupted continuity results in a greater attachment of residents to the region. Today, regional collective memory also resists changing administrative divisions. Historical and relict borders delineate informal territories, distinguished by their specific cultural landscape (Zarycki, 2018).

Regional identity is a type of spatial identity at a certain scale, often referred to as meso-level. Scale is important in differentiating regional identity from place identity⁴. Even though, in some cases, place identity is employed as a general term for various levels of scale, it is commonly associated with directly perceived space (Pohl, 2004). Research on territorial identity conducted by the Polish scientific community concerning its regional dimension is extensive (Rykiel, 1985; Matykowski, 1996; Szyfer, 1996; Prawelska-Skrzypek, 1996; Schmidt, 1997; Łukowski, 2002; Barwiński, 2004; Rak, 2013; Dziekanowska, 2015; Nowak, 2018). In these studies, a relatively low identification with the regional level in relation to the state or local tiers was often

demonstrated. Poland's historical determinants of the 19th and early 20th century did not favour establishing a sense of regional belonging (Matykowski, 2017). As evidenced by Bialasiewicz (2003), however, Poland currently encounters a revival of sentiments related to historical regions – such as Galicja, a part of the Austro-Hungarian Empire or Upper Silesia, where in the 1990s the Movement for Silesian Autonomy (Ruch Autonomii Śląska) was established (Bialasiewicz, 2002). There has also been a renaissance of regionalism in Kashubia, a region located on the Baltic Sea coast (Mazurek, 2010).

Research pertaining to people's attachment to a region is difficult as the concept of region itself is burdened by an ambiguity of spatial range – being one of the basic categories in the social sciences but at the same time a vaguely defined term, both in conceptual and semantic aspects (Paasi, 2002). As opposed to most other territorial tiers, region is a highly mobile, plural and geographically ambiguous notion rather than a stable ontological category (Antonsich, 2010). The majority of regions have fuzzy borders and diffused identity and thus this place scale is not the most common study object (Lewicka, 2011). Tuan (1975) claims that a direct phenomenological experience converts “abstract spaces” into “meaningful places” and for this reason region “is far too big to be directly experienced by most of its people. Region is primarily a construct of thought” (p. 158). Importantly, current regions are often units that have emerged from the desks of planners or politicians (Paasi, 2003). Comparative international research conducted in this respect by Laczko (2005) has shown that regions are perceived as less important objects of emotional attachment in comparison to other territorial tiers. On the other hand, there are certain regions with strong identification, characterised by a desire for independence (Basque country, Catalonia) or autonomy (Silesia in Poland) (Lewicka, 2011).

2.2 Administrative divisions versus historical regions in Poland

Building regional identity, as well as the spatial and material formation of a region, is closely associated with delimitation of its borders (Matykowski, 2017). This can be based on subjective assumptions and criteria or may result from a spatial unit that is unarguably separated from the environment (Miszczuk, 2003). Administrative regionalisation is therefore an institutionalisation of a natural or artificial (anthropogenic) region. As evidenced by Antonsich (2010), however, an administrative region does not possess a monopoly on the semantics of the spatial unit that it claims to embody, not only in administrative, political or economic terms, but also in identity terms (p. 269).

Territorial division has been regarded as one of the determinants comprising the “administrative power” of the state (Giddens, 1985). Administrative regionalisation is affected by a number of conditions, which include geopolitical location, environmental factors, level of economic development, demographic potential, ethnic and cultural diversity, etc., largely depending on the country under purview. Therefore, there is no universal model for territorial division of the state (Pezzini, 2000). In the (late 16th to late 18th century) times of the First Republic of Poland (Polish-Lithuanian Commonwealth), administrative

⁴ As stated earlier, place identity, place attachment and territorial identity are often used interchangeably in the literature. According to Lewicka (2011), however, place attachment develops relatively quickly, while place identity requires time. In this sense, place, as opposed to space, is considered “meaningful location” (Tuan, 1974).

division was mainly determined by the Catholic Church structures and borders of historical (Piast) regions. In contrast, the period of the People's Republic of Poland (in essence from the end of World War II through to 1989) saw primarily economic concepts of administrative division put into place (Miszczuk, 2003). The era of Poland's post-1989 political transformation thus informed scientists to attend to the need for a new territorial division, underpinned by rational and objective assumptions (Kołodziejcki, 1991; Szczepkowski, 1991).

Regional identity, as a relevant aspect of historical conditioning, was considered an important criterion for the new administrative division. Schattkowsky (1996), Geiss (1996) and Otremba (1997) stressed the importance of historical conditioning in the transformation of Central and Eastern European countries. Poland's latest administrative reform did not take much account of historical conditions, however, as the new voivodships were delimited. A lack of consistency can be observed in the nomenclature of these newly established units, with a mixture of names deriving from historical regions and others referring to capital cities. In no way are the borders of contemporary voivodships consistent with those of historical Polish regions (Miszczuk, 2003; Zaborowski, 2013; Nowak, 2018.). The current administrative division of the country, which in its assumptions adapts Poland to the principles of regionalisation implemented in the European Union, was criticised even before it became applicable in 1999. Shortly after the reform, Bialasiewicz (2002) recognised the disjunction between the administrative Upper Silesia (Śląskie Voivodship) and Upper Silesia, as constituted in socio-spatial consciousness. The recent territorial division deviates from all of the concepts presented by the scientific community (Miszczuk, 2003), which indicates the need to introduce a number of corrections (cf. Zaborowski, 2013).

3. Study area

The research area covers north-eastern Poland. For many centuries it has been the territory where various cultures and political influences clashed. The region of Podlasie encompasses the larger part of the area being examined. Its "cradle" is unanimously considered by researchers to be the middle Bug river basin (Jabłonowski, 1910; Gloger, 1918; Wiśniewski, 1977; Piskozub, 1987). Its historical past contributed to its national, religious, linguistic and, as an outcome, cultural diversity. Currently, it is one of the most diverse regions of Poland in this respect (Barwiński, 2004).

The administrative region called Podlaskie Voivodship⁵ historically existed in two different border variants. The current province is its subsequent, third modification. The first voivodship of Podlasie (also referred to in this paper as historical Podlasie) was established in 1513, and from 1566 to 1795, thus for over 200 years, it had unchanged borders (see Fig. 2). The third partition of Poland in 1795 changed its initial territorial unity. The Bug River, once a regional development axis, has since become a state border and today an administrative one. During the partitions, the second Podlaskie Voivodship was delimited⁶, as a fragment of historical Podlasie region south of the Bug River and

sections of adjacent voivodships from the time of the First Polish Republic (Michaluk, 2013).

In 1999, as an outcome of the administrative reform, Podlaskie Voivodship found itself with changed borders among the newly established regions. Despite its toponym, when delimiting this administrative unit, only the northern part of historical Podlasie was taken into account. Other fragments – located south of the Bug river – are now part of Mazowieckie and Lubelskie Voivodships (Fig. 2). The new Podlaskie Voivodship, on the other hand, includes areas that historically have never belonged to Podlasie. The current administrative division is debatable at the outset on the basis of analysing the names of towns. For instance, Sokołów Podlaski is located in the Mazowieckie Voivodship, while Biała Podlaska or Międzyrzec Podlaski are in the Lubelskie Voivodship.



Fig. 2: Borders of historical and contemporary administrative units in the research area
Source: author's elaboration based on Gloger, 1918; Barwiński, 2004; Żóttowska, 2011

⁵ Podlaskie is an adjectival form of Podlasie in the Polish language. Similarly, other names of voivodships were constructed as an aftermath of administrative reform in Poland: e.g. Mazowieckie Voivodship (adjective of Mazovia, a historical region in central Poland), or Wielkopolskie Voivodship (adjective of Wielkopolska, a historical region in western Poland).

⁶ During the partitions the following administrative regions were established, covering the same area: Department of Siedlce (1810–1815); Podlaskie Voivodship (1816–1837); Governorate of Podlasie (1837–1844); Governorate of Siedlce (1867–1912).

The new image of Podlasie, identified with current Podlaskie Voivodship, has been consolidated in public discourse since 1999. The term Podlasie has become synonymous with the Podlaskie Voivodship in everyday language and the media. Such an approach has also been disseminated by the scientific community (Bałtomiuk, 2003; Bocian, 2003a, 2003b, 2004, 2005, 2008, 2016; Czemieli-Grzybowska, 2006; Proniewski and Niedźwiecki, 2003; Plawgo and Sadowska-Snarska, 2004; Hryniewicz and Potrykowska, 2017). Furthermore, the terms Podlasie and Podlaskie Voivodship are commonly used as synonyms also by the scientific community of Białystok (as the capital city of the new voivodship and located in historical Podlasie). Theoretically, researchers from this academic centre should present a higher consciousness of their region of residence than the general public. This may result, however, not so much from ignorance, but purely the convenience of authors willingly using these terms as synonyms. By deepening research topics of the current Podlaskie Voivodship, scientists are attempting to avoid over-repeating this term. This is due to the pursuit of a 'correct language' style, which requires avoiding repetition in neighbouring sentences. Podlasie has thus become one of the synonyms for the term Podlaskie Voivodship, next to terms such as region or research area.

In brief, the synonymous use of administrative and historical toponyms has greatly contributed to establishing a specific "identity of the region", attributed to territory enclosed by the borders of the Podlaskie Voivodship. This has happened despite the lack of cultural or historical contexts.

4. Research method

The current research project has employed social surveys conducted in 71 communes (LAU 2 units) of the Podlaskie, Mazowieckie, Lubelskie and Warmińsko-Mazurskie Voivodships. The main criterion for the selection of communes was their location (sample design criterion), in relation to:

1. Borders of the Podlaskie Voivodship from the time of the First Polish Republic (1569–1795), the so-called historical Podlasie (30 communes met this criterion);
2. Shared borders of the Department of Siedlce (1810–1815), Podlaskie Voivodship (1816–1837), Governorate of Podlasie (1837–1844) and Siedlce (1867–1912) (20 communes);
3. Borders of the voivodships of north-eastern Poland according to the administrative division of 1975–1998 (within which a researched community potentially identifies with Podlasie) (42 communes); and
4. Borders of the contemporary Podlaskie Voivodship, established in 1999 (26 communes).

Questionnaire surveys were conducted in communes adjacent to the indicated borders of administrative units (see Fig. 3). Pairs of communes on the inside and outside of a given border were selected, assuming their similar number on both sides. An additional criterion was the inclusion of several communes not neighbouring voivodship borders. The purpose of this approach was to analyse the territorial identity of communities living away from the boundaries of administrative regions. The research covered only rural and urban-rural communes assuming the highest share of autochthons with well-established place attachment and rootedness.

Questionnaires were posted to primary and/or junior high schools located in the main towns of a commune. By means of the pupils, surveys were addressed to adult respondents (parents, grandparents and other household members). Such a research method was previously implemented in numerous studies in Poland (e.g. Komornicki et al., 2013; Janc et al., 2019). Pilot studies allowed the selection of the optimal variant for conducting final surveys and the calibration of the research tool. In the period from February 17, 2017 to January 10, 2018, 19,540 questionnaires were sent to 73 schools, resulting in 9,537 received from 71 communes. The return rate was almost 49%. One advantage of this method is the possibility to reach a large number of respondents. On the other hand, the research sample is strongly limited to populations with school-age children, which largely determines the age group of respondents to 30 to 49 years. For a more reliable outcome, weighting was applied to the obtained responses from examined communes, proportionally adapted to its actual demographic structure.

The questionnaire employed closed questions involving Likert-type scales (0 being the minimum: representing no attachment, and 5 the maximum value: highest attachment).

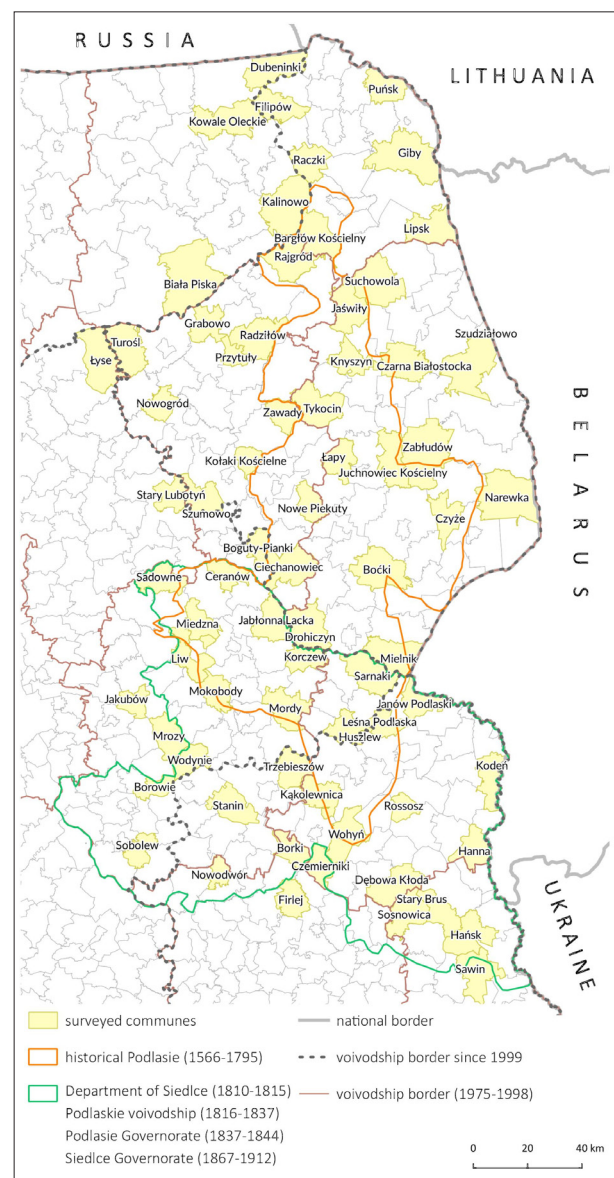


Fig. 3: Surveyed communes in the research area in relation to contemporary and historical borders
Source: author's elaboration of field survey locations

In this way attitudes towards 11 spatial tiers were assessed. These were as follows: Europe, European Union, Poland, Eastern Poland, current voivodship (since 1999), former voivodship (1975–1998), Podlasie, physico-geographical macroregion, district (LAU 1), commune (LAU 2), village/place of residence. Mean values for attachment to spatial levels were then calculated. Analysis was employed to verify the statistical significance of factors potentially determining attachment towards examined spatial tiers. These included the following respondents' characteristics: gender, fact of being born in surveyed commune (Mann–Whitney U tests), age, education level, time of residence (Student's T-tests), occupation, religion and declared nationality (Kruskal–Wallis tests by ranks).

The remaining questions aimed at analysing attachment at the regional level, with special emphasis placed on Podlasie (along with current and former administrative regions) also involved Likert-type scales. The questions were as follows:

- a. Do you live in Podlasie?
- b. Would you like to restore the former voivodship from the years 1975–1998?
- c. Do you consider that Podlaskie Voivodship and Podlasie cover the same area?

These questions employed the Likert ordinal scale. Respondents were given the following options to select: definitely yes; rather yes; rather no; definitely no; difficult to say. Based on the obtained responses, a quantitative interval scale was developed. The results were interpreted as synthetic mean values expressed as a scale of 0 to 100%, where 0 meant that all respondents answered "definitely no" and 100% for all respondents answering "definitely yes" to a given question.

In applying cartographic presentation methods, the research aimed at identifying the spatial structure of survey results. The research was conducted at selected points, thus the added cognitive value of cartographic visualisation is the transformation of quantitative data into a continuous spatial model. For this purpose, a series of isopleth maps was constructed (see Figures 6–8, below), which through interpolation and extrapolation show directions and dynamics of value changes in geographic space. This method allows one to capture the spatial variability of questionnaire findings holistically within the entire research area. On the other hand, exact values of results are retained only at the measurement points – the geographical coordinates of a schools' premises.

A dedicated section in the questionnaire served to examine perception of Podlasie in spatial terms among surveyed residents. For this purpose, respondents were asked the following question:

- d. Where do you think Podlasie is located? Please outline the borders of Podlasie on a schematic map.

A simplified schematic map (see Fig. 9 below) was included, which only provided state borders and the location of 46 towns (LAU 1 and voivodship capitals of north-eastern Poland) for basic reference purposes. The percentage of towns included within the outlined region are presented employing the method of isolines.

5. Results and discussion

The structure of the research sample is definitely dominated by women (70%). The most represented age group of respondents is 30–39 (44%). The share of the 40–

49 age group is also important (38%), while the remaining categories are less numerous: 50–59 (9%), 60 and above (5%) and 18–20 (4%). It is noteworthy that the majority of respondents for most of their conscious lives have lived under the current administrative division (since 1999). Most of them (62%) were born in the commune where the survey was conducted. The others have lived there for 11–20 years (42%), more than 20 years (33%), 6–10 years (16%), 2–5 (6%) and less than 2 years (3%). The religious structure of respondents is characterised by a considerable domination of Roman Catholics (94%). The Orthodox Church followers constituted a small share of population (5%), and only in three of the surveyed communes were in the majority, in the eastern part of the Podlaskie Voivodship (ranging from 54% to 88%). The majority of respondents (91%) identify themselves exclusively with Polish nationality. The remaining most represented nationalities are Lithuanians (77% in case of a single commune by the Polish-Lithuanian border), Belarusians (up to 38% in the Podlaskie Voivodship), and Ukrainians (maximum share of 11% in Lubelskie Voivodship). Particularly in the eastern communes of the research area, the share of respondents not declaring any national affiliation but describing themselves as "locals" was significant (even more than 1/3 of the responses). The percentage of such respondents is the highest in communes with a predominantly Orthodox population, especially in the two oldest age groups (50–59 and over 60).

The hierarchy of respondents' attachments to spatial levels in the research area (Figure 4) is characterised by a number of regularities.

In general, respondents identify themselves most strongly with the national level (Poland). The average value of such indications was 4.6 (on a scale of 0–5). Such strongest attachment to this tier was expected. Although respondents are of diverse ethnic backgrounds they are rooted in a common history. Particularly strong in this regard are socially constructed symbols of group belonging and group identity, evoking strong emotional reactions (Lewicka, 2011). The Kruskal–Wallis test by ranks, moreover, reported statistical significance between declaring Roman Catholicism and attachment to Poland. The next tier with which respondents strongly identify themselves is the broadly defined local level. It consists of a well-founded attachment to the district (mean value of 4.4) but especially the commune and locality of residence (4.5). Gender and village/place of residence are statistically significant: men tend to exhibit a slightly stronger attachment at this level, perhaps because north-east Poland is characterised by a relatively stable socio-historical development with an uninterrupted continuity. There has been no large-scale resettlement after World War II as in western Poland.

Numerous respondents' families have lived in the same villages for generations. Considering that a major proportion of respondents are farmers, they are strongly attached to their land as it is part of their patrimony and heritage. It is noteworthy that the local level is identified to a higher extent in the examined communes of peripheral location than those in the vicinity of the voivodship or subregional centres, where population tends to be more mobile. Peripheral communes are more isolated in spatial terms and local communities are characterised by lower mobility. As observed by Kelly and Hosking (2008), those who spend more time in the place feel more attached. This has been demonstrated here by means of a Student's T-test, as there is a statistically significant association between age of respondents and attachment to

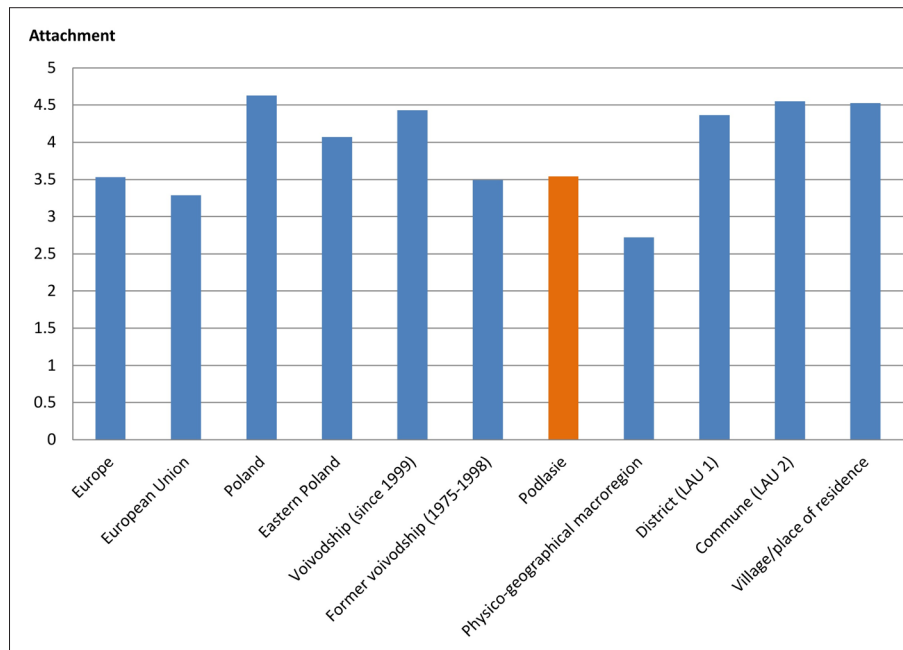


Fig. 4: The hierarchy of respondents' attachment to spatial tiers (mean values) in the research area (0 represents 'no attachment' and 5 'highest attachment'). Source: author's survey

commune (correlation 0.024) and village/place of residents (correlation 0.039). Furthermore, a Kruskal–Wallis test showed that the unemployed (thus potentially spending more time in place of residence) are more attached to a village/place of residence than the population as a whole.

The regional level is the third in this hierarchy of attachment. Respondents most evidently identify themselves with the administrative region established in 1999 (average value of 4.4). The name of the contemporary administrative region is identified more strongly by the respondents as compared to historical regions (3.8). Former voivodships (1975–1998) are characterised by a considerably lower level of identification (3.5), except for respondents inhabiting communes in the vicinity of their prior capitals (Biała Podlaska, Łomża, Siedlce, Suwałki: exceeding 4.0). A student's T-test was employed for verifying whether time of residence affects level of attachment to the spatial tiers under examination. It must be emphasised that only respondents not born in the examined communes were taken into account. In this case, statistical significance is demonstrated, showing a slight negative correlation between time of residence and attachment to the voivodship established in 1999. Thus, the longer one lives (especially in the groups 11–20 and more than 20 years of residence) in this administrative region, the weaker the attachment. This could be explained by the fact that older respondents could be attached to a different region in which they were born and/or a former voivodship (1975–1998). Younger individuals are more rooted in their present administrative region despite a relatively short time of residence.

As observed by Antonsich (2010), regional identity is not always directed to the institutional regional space. A comparative study conducted in Europe showed that inhabitants of Languedoc-Roussillon (southern France) frequently mentioned the South as a crucial identity marker, while respondents of Finland's Pirkanmaa emphasised their belonging to the West. Such identity is constructed out of a social and economic divide and the attributed unevenness of accumulated capital. This seems to be the case of Eastern Poland as being underdeveloped in numerous aspects

compared to other parts of the state and voivodship. Survey results confirmed a strong identification of respondents with the informal region of Eastern Poland showing clear spatial dependencies, gradually intensifying towards the eastern state border. In the case of several communes with peripheral and eastern locations, respondents showed a stronger identification with this informal spatial level than with the institutionalised region (voivodship).

As evidenced by statistical analysis, Eastern Orthodox followers are more attached to Eastern Poland. These respondents also showed the greatest proportion of declaring Belarussian alone or together with Polish identity and/or describing themselves as "locals". In turn, an inverse spatial regularity is characterised by respondents' attachment to supra-state levels – Europe and the European Union. Identification of respondents with these areas is clearly increasing from the east to the west. It is also stronger in communes near larger towns than in peripheries. These communities are characterised by populations that are better educated and feature lower shares of employment in agriculture. Furthermore, there has been demonstrated a statistical significance between declaring atheism and greater attachment to supra-state tiers.

The survey results on the degree of attachment to physico-geographical macroregion is the most polarised spatial level, depending upon examined communes. In addition, the Mann–Whitney U test showed that the fact of being born in an examined commune demonstrated statistical significance only in the case of physico-geographical macroregions. Yet, in general this tier is the last one in the hierarchy of attachment. An interesting pattern was observed among respondents living in the South Podlasie Lowland. The lowest identification with this macroregion is characteristic of its inhabitants living in the Mazowieckie Voivodship, outside the historical Podlasie. Respondents from these communes do not feel attached to a macroregion, whose name suggests relation with Podlasie. The macroregion's toponym may arouse their opposition, as they identify much more strongly with Mazovia and Mazowieckie Voivodships. In the case of other communes located in the eastern part of the

South Podlasie Lowland, which are located in the historical Podlasie, the level of identification with this macroregion is significantly higher. This confirms the high importance of the name assigned to a given area for ultimate perception.

The level of respondents' attachment to the term Podlasie is strongly diversified in spatial terms. Overall, identification with this region obtained an average value of 3.5. It was by far the highest in the communes of the Podlaskie Voivodship, although relatively polarised (ranging from 3.9 to 4.7). In the case of certain communes, respondents showed a comparable level of attachment to Podlasie and the administrative region (Podlaskie Voivodship), but the latter, formalised by voivodship borders, was stronger. Although the borders of the first Podlaskie Voivodship have not existed since 1795 and the Governorate of Siedlce was abolished in 1912, identification of respondents with Podlasie within these historical borders is still relatively high, especially in the former Bialskopodlaskie Voivodship (see Fig. 5).

These observations concern mainly the 60+ age group of the surveyed population. A student's T-test showed that age determines level of attachment to Podlasie in this case, with a slight positive correlation of 0.027. Thus, there is a greater attachment to Podlasie among older respondents within relict borders. Kruskal–Wallis tests demonstrated some statistical significance between identification to Podlasie and occupation. Both farmers and individuals involved in agritourism showed greater attachment to this region. The factor of declared religion also determines such territorial identity: Eastern Orthodox followers are more attached to Podlasie than any other confession. Furthermore, as evidenced by statistical analysis, individuals declaring Belarussian nationality tend to be more attached to Podlasie. The vast majority of them are also Orthodox believers. It is thus difficult to identify one decisive factor in this regard. Respondents living in communes that are located within the boundaries of the historical Podlaskie Voivodship identify themselves to a higher extent with Podlasie than,

for example, with the former voivodships (1975–1998), but evidently less strongly comparing to administrative regions established in 1999. Attachment to Podlasie among respondents residing in the communes of the former Bialskopodlaskie and Siedleckie Voivodships is much higher than in the surveyed communes of Warمیński-Mazurskie Voivodship, which are adjacent to the Podlaskie Voivodship. This is possibly an effect of a historical border between these units, characterised by long durability being a barrier for identifying with Podlasie.

The overriding criterion for respondents' attachment to Podlasie is the location of an examined commune within the borders of contemporary Podlaskie Voivodship and even more so within former Białostockie Voivodship (Figs. 2 and 5, and Tab. 1). The Mann-Whitney U test provided statistical significance between communities located in these administrative regions and identification with Podlasie. In these territorial units, the level of attachment to Podlasie was relatively balanced across all age groups surveyed. This may seem striking, considering that it has been only 20 years since the establishment of this administrative region. The historical criterion, i.e. location in the so-called historical Podlasie, is a secondary feature. A number of communes included in the analysis, which historically did not belong to Podlasie and which are currently located in the Podlaskie Voivodship, present a higher level of respondents' identification with this region compared to the ones which historically belonged to Podlasie but are now located in the Lubelskie and Mazowieckie Voivodships (see Fig. 5).

The role of the administrative region in determining regional identity referring to Podlasie appears to be decisive, but it does not show homogenous spatial intensity (Fig. 6).

Historical borders to some extent still manifest a certain strength of influence, modifying the level and traits of place attachment. The previous Poland's administrative division (1975–1998) persists to affect respondents' relation to the analysed region. Respondents living in the

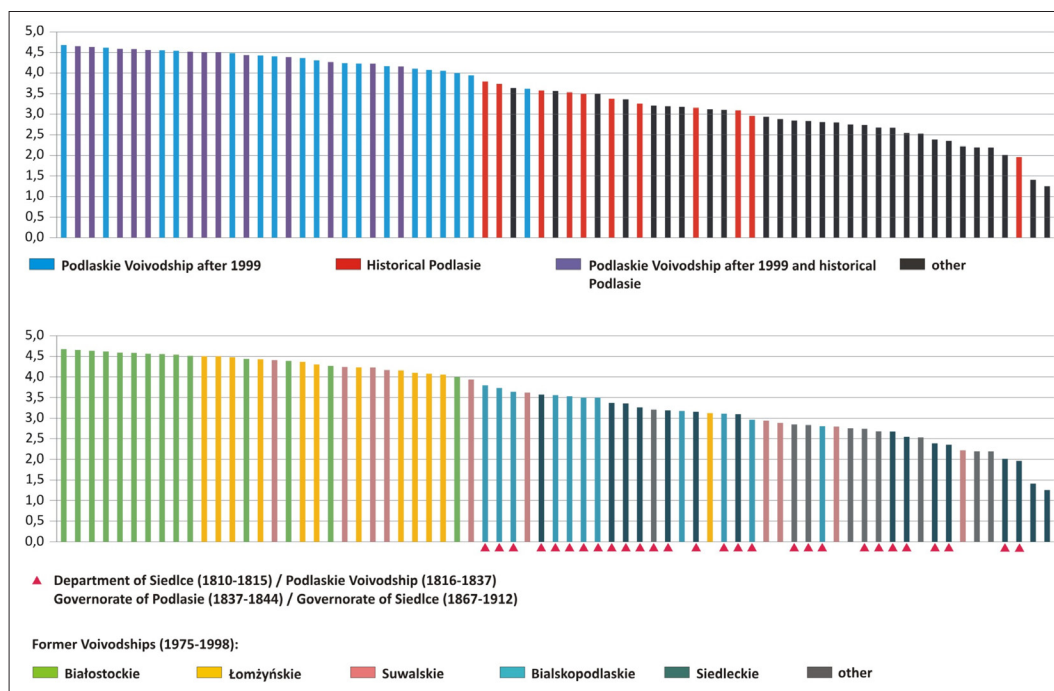


Fig. 5: Level of respondents' identification with Podlasie in the examined communes with respect to contemporary and historical administrative regions (communes were ranked in descending order regarding identification with Podlasie). Source: author's survey

Łomżyńskie Voivodship (1975–1998)										
Averaged percentage of given answers (%)										
Q	Definitely yes	Rather yes	Rather no	Definitely no	Difficult to say	Definitely yes	Rather yes	Rather no	Definitely no	Difficult to say
A	92.6	6.8	0.4	0	0.2	74.2	13.3	4.2	6.8	1.5
B	5.9	5.9	43.9	15.7	28.6	8.6	10.3	43.0	17.4	20.7
C	18.0	46.4	16.2	8.9	10.5	11.3	51.3	15.4	7.0	15.0
Białkopodlaskie Voivodship (1975–1998)										
Averaged percentage of given answers (%)										
Q	Definitely yes	Rather yes	Rather no	Definitely no	Difficult to say	Definitely yes	Rather yes	Rather no	Definitely no	Difficult to say
A	47.0	12.2	9.9	29.3	1.6	34.2	31.1	15.5	16.4	2.8
B	10.9	10.7	40.4	16.6	21.4	8.5	13.6	38.2	17.4	22.3
C	8.5	41.0	21.3	8.9	20.3	4.2	27.5	34.8	16.4	17.1
Podlaskie Voivodship (since 1999)										
Averaged percentage of given answers (%)										
Q	Definitely yes	Rather yes	Rather no	Definitely no	Difficult to say	Definitely yes	Rather yes	Rather no	Definitely no	Difficult to say
A	16.9	18.9	21.5	38.9	3.8	85.3	10.5	1.7	1.7	0.8
B	5.4	10.6	37.8	23.0	23.2	8.7	9.0	42.6	14.9	24.8
C	5.6	32.5	21.8	15.4	24.7	12.9	48.7	15.8	8.6	14.0
Historical Podlasie (1566–795)										
Averaged percentage of given answers (%)										
Q	Definitely yes	Rather yes	Rather no	Definitely no	Difficult to say	Definitely yes	Rather yes	Rather no	Definitely no	Difficult to say
A	63.6	16.9	8.3	9.9	1.3	40.2	15.3	13.6	28.9	2.0
B	6.6	9.3	41.8	16.4	25.9	7.6	9.5	41.0	19.5	22.4
C	11.1	40.0	19.7	14.7	14.5	10.5	37.9	21.6	10.4	19.6

Tab. 1. Averaged percentage of responses (%) to questions (Q) analysing attachment at regional level with respect to current and historical administrative units (Legend: A – Do you live in Podlasie? B – Would you like to restore the former voivodship from the years 1975–1998? C – Do you consider that Podlaskie Voivodship and Podlasie cover the same area?)

Source: author's survey

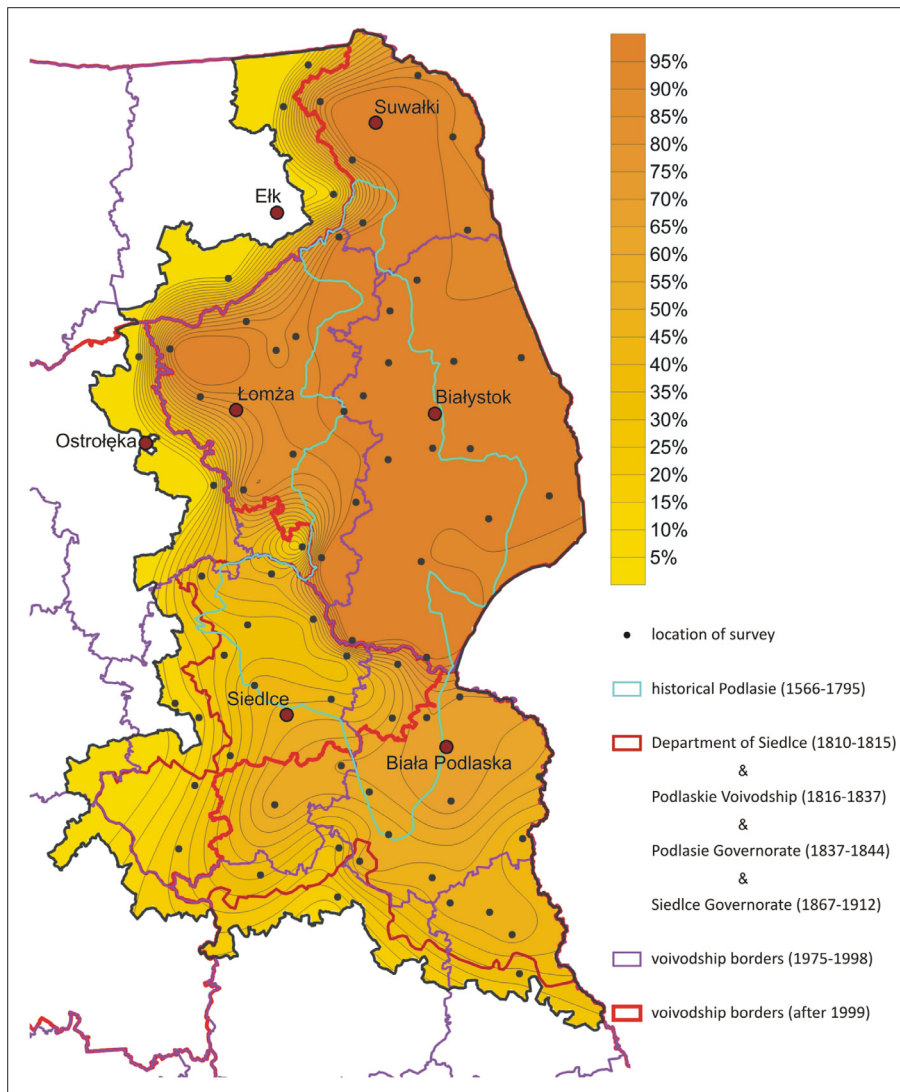


Fig. 6: Synthetic indicator of responses to the question: Do you live in Podlasie? (Question A)
Source: author's elaboration based on his survey

former Białostockie Voivodship feel the strongest bonds with Podlasie. Those inhabiting part of the Podlaskie Voivodship, which used to belong to Suwalskie Voivodship, exhibit weaker attachment to Podlasie. Belonging to a past administrative region is evident as respondents from former Łomżyńskie and Suwalskie Voivodships were characterised by a considerably higher uncertainty in answering the question Do you live in Podlasie?, than those of Białostockie Voivodship. Moreover, about one third of Białkopodlaskie Voivodship's (now part of Lubelskie Voivodship) population are convinced to be living in Podlasie (Tab. 1).

The impact of the last administrative reform on the nature and intensity of the regional identity among surveyed inhabitants is confirmed by their relatively low attachment to former voivodships (from 1975–1998)⁷ (Fig. 7). Inhabitants of the Białostockie Voivodship show the lowest attachment to this administrative region. The city of Białystok has not lost its function as a voivodship capital city as a result of the administrative reform, and its importance has de facto increased since 1999. Białystok also fits into the regional identity of the inhabitants of the former Białostockie Voivodship, whose residents at the

same time identify themselves most strongly with Podlasie. Restoration of the former voivodship would cause Białystok's decline in rank. Overall, in the remaining research area, respondents' attachment to the former voivodships (1975–1998) is relatively low. A significantly higher willingness to restore these administrative regions, however, is noticeable among respondents living in communes located near their capitals (Biła Podlaska, Siedlce, Łomża, Suwałki). The increase of the discussed indicator from the peripheries of former voivodships towards their main cities is evident (Fig. 7).

Such interdependence results from greater attachment among inhabitants of adjacent communes to the former voivodship capital in functional and spatial aspects (education, labour market and related commuting, i.e. factors building attachment). A restoration of former voivodships and their capitals would increase the prestige of the capital city of the region lost in the 1999 administrative reform. The stronger attachment to the former Białkopodlaskie, Łomżyńskie, Siedleckie and Suwalskie Voivodships compared to Białostockie may, to some extent, result from opposition to the name of the present Podlaskie

⁷ Based on analysing obtained answers to the question: Would you like to restore the former voivodship from the years 1975–1998?

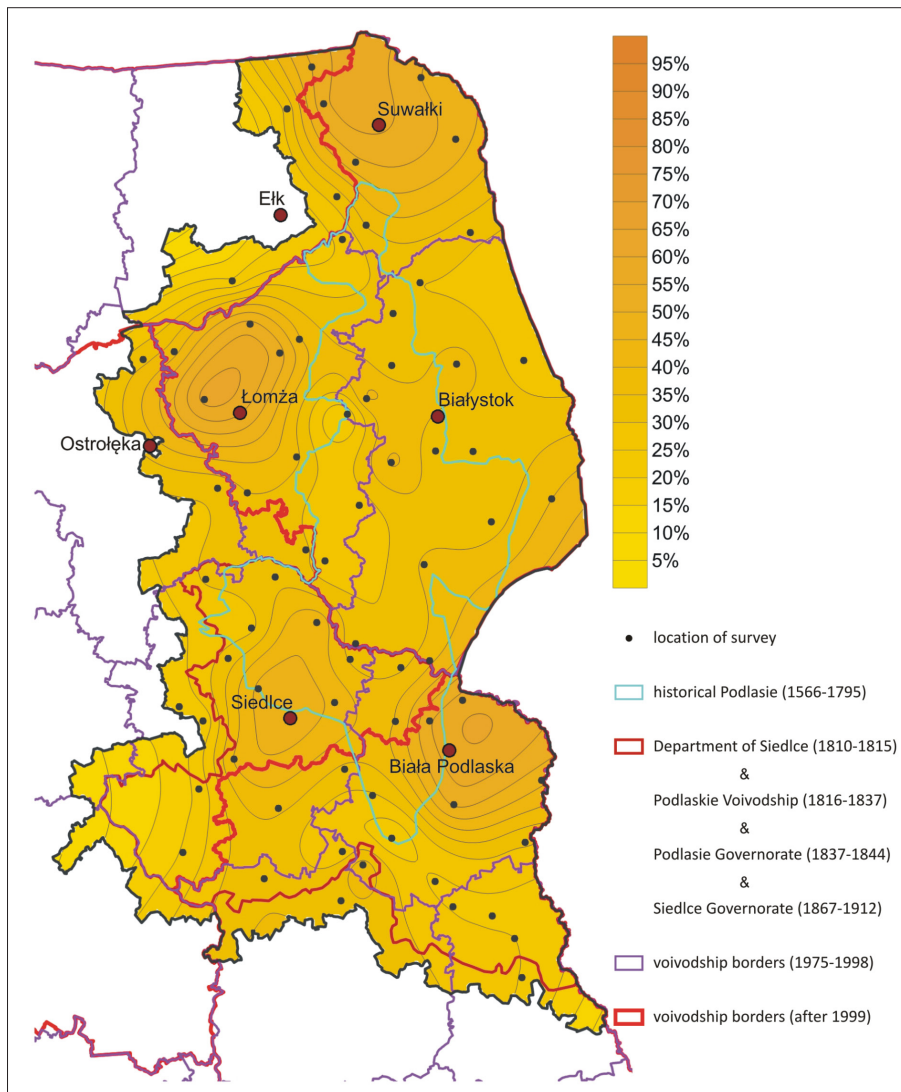


Fig. 7: Synthetic indicator of responses to the question: *Would you like to restore the former voivodship from the years 1975–1998?* (Question B). Source: author's elaboration based on his survey

Voivodship. Inhabitants of communes located in the former Łomżyńskie Voivodship, which belonged to the historical Podlasie region, have significantly lower support for its restoration. They identify themselves more strongly with Podlasie than with the Łomża region. In communes located around the town of Łomża the situation is inverse, some of the respondents do not identify themselves with Podlasie nor Podlaskie Voivodship (these communes were not located in the historical Podlasie), and thus are more attached to former voivodship. Higher values of this indicator, however, may result not so much from respondents' identity colliding with the name and territory of the new administrative units, but from local patriotism or sentiment for the lost voivodship.

Based on this research, one may state that the borders of contemporary Podlaskie Voivodship have exacted a toll upon perceptions of the historical and administrative region⁸. Respondents living in this administrative region – and even more so in Białostockie Voivodship, being its fragment – to the highest extent identify Podlasie and Podlaskie Voivodship

as one area (Tab. 1.) As discussed earlier, these terms function as synonyms – used commonly – not only among the inhabitants of the latter. A similar pattern also applies to other regions, such as the synonymous use of the names Mazowieckie Voivodship and Mazovia, Śląskie Voivodship and Silesia, etc.⁹. The extent of such territorial and semantic perceptions has certainly contributed to confusion when responding to the questionnaire. Synonymous use of the discussed toponyms is reflected in the relatively even intensity of this indicator across the entire study area and inconsiderable (mainly local) spatial polarisation (Fig. 8).

The value of this indicator is lower in the communes which belonged to the historical Podlasie and are currently located in the Lubelskie and Mazowieckie Voivodships (especially in the former Białkopodlaskie Voivodship, Tab. 1). This is a premise to state that respondents living therein identify themselves with Podlasie and not with Podlaskie Voivodship. They therefore distinguish the different meaning of these terms more clearly than the rest of respondents.

⁸ Based on analysing obtained answers to the question: Do you consider that Podlaskie Voivodship and Podlasie cover the same area?

⁹ In these cases, borders of historical and administrative regions are also incoherent as observed in the scientific community (e.g. Białasiewicz, 2002; Miszczyk, 2003; Zaborowski, 2013; Nowak, 2018).

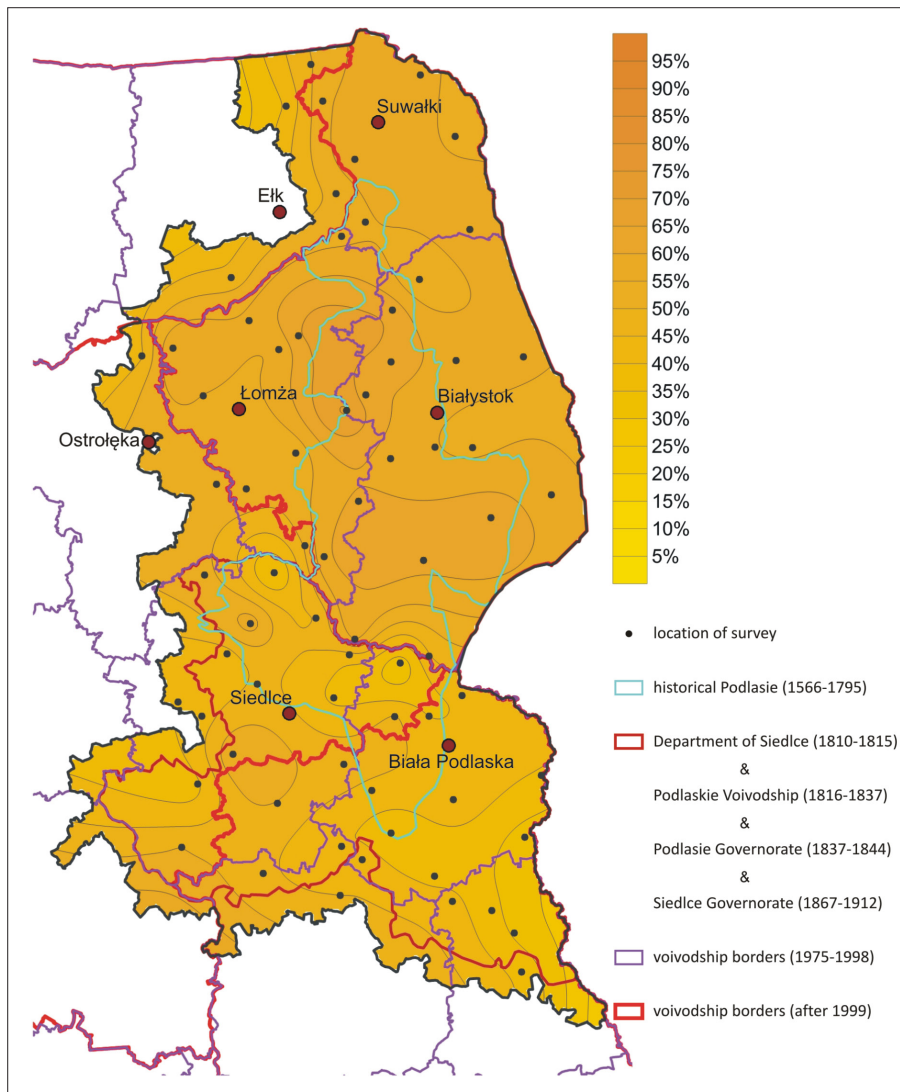


Fig. 8: Synthetic indicator of responses to the question: *Do you consider that Podlaskie Voivodship and Podlasie cover the same area?* (Question C)

Source: author's elaboration based on his survey

For examining their spatial perception of Podlasie, respondents were asked to outline borders of this region on a schematic map (Fig. 9a). The responses that were obtained seem to confirm prior observations that generally Podlasie is perceived as the Podlaskie Voivodship (Fig. 9b). The highest proportions of indications are within the borders of the latter, and especially the former Białostockie Voivodship. Most – above 95% – respondents perceive the city of Białystok to be located in Podlasie.

Despite a largely convergent spatial “picture” of historical and administrative regions, there are however certain exceptions. A significant share of towns considered to be part of Podlasie is located outside Podlaskie Voivodship. This may be caused by either respondents' knowledge concerning the historical borders of Podlasie or by toponyms of reference towns (Biała Podlaska, Radzyń Podlaski, Sokółów Podlaski) suggesting such regional affiliation. The general perception of Podlasie (Fig. 9) to a great extent correlates with the cartographic presentation of respondents' answer to the question: *Do you live in Podlasie?* (Fig. 6). This might suggest that the surveyed population living in historical Podlasie more willingly outlines the region's borders outside the Podlaskie Voivodship, and consider themselves to be living in Podlasie understood as a cultural and not administrative region.

The research conducted in this project has demonstrated that Podlasie is perceived differently depending upon the location in which the survey was taken. The most pronounced variations in comparison to the overall perception of the examined region have been identified between the spatial comprehension of Podlasie among inhabitants of the current Podlaskie Voivodship and former Governorate of Podlasie/Siedlce (Fig. 10). These communities are separated by the border at the Bug River.

The inhabitants of Podlaskie Voivodship tend to associate its borders with Podlasie to a considerably greater extent than all surveyed respondents. The most pronounced differences in this regard concern northern and western parts of the Podlaskie Voivodship, which in historical terms have never belonged to Podlasie. On the other hand, surveyed respondents living in the former Governorate of Podlasie/Siedlce, exhibit opposite spatial dependency compared to the overall “picture” of Podlasie. Figures 10 a) and b) are thus “negatives” of each other. Respondents living in the former Governorate of Podlasie/Siedlce to a significantly lesser extent associate Podlasie with Podlaskie Voivodship, tending to emphasise its borders south of the Bug river, being at the same time their place of residence. This might serve as a premise that they may also feel attached to Podlasie,

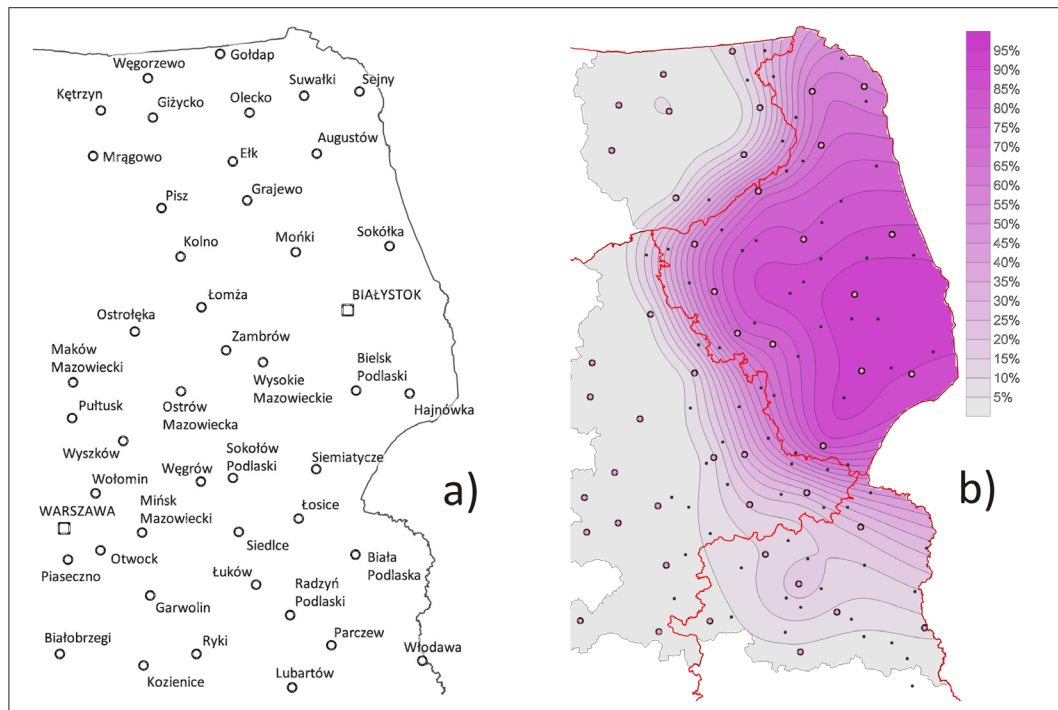


Fig. 9: a) Schematic map of north-eastern Poland; b) Synthetic perception of Podlasie by all respondents: The percentage of towns included in the outlined region used for the question “Where do you think Podlasie is located? Please outline the borders of Podlasie on a schematic map”. Source: author’s elaboration based on his survey

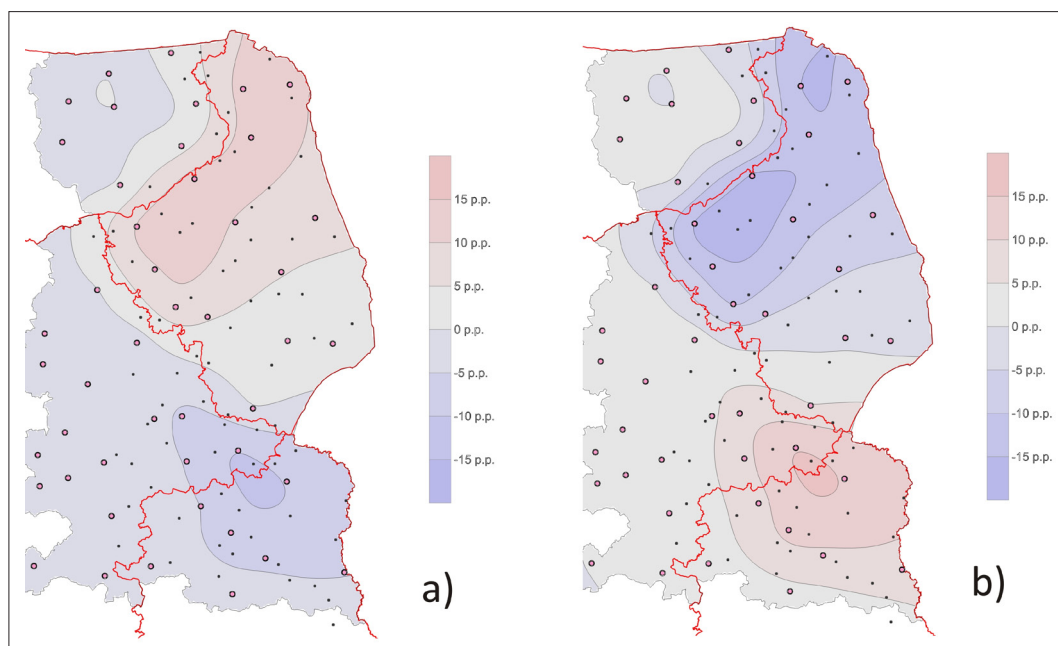


Fig. 10: Differences in the perception of Podlasie by a) inhabitants of the Podlaskie Voivodship (left) and b) inhabitants of former Governorate of Podlasie/Siedlce (right), in relation to all surveyed respondents (%) Source: author’s elaboration based on his survey

however – not perceived as a current administrative region – but a historical and cultural region delimited by relict borders. As already shown (Fig. 8) surveyed inhabitants of the former Governorate of Podlasie/Siedlce – to the least extent – consider that Podlaskie Voivodship and Podlasie cover the same area (see responses to this question for Bialskopodlaskie and Siedleckie Voivodships in Tab. 1) This might also express their opposition towards perceiving Podlasie solely in administrative terms as Podlaskie Voivodship.

The perceived area of Podlasie is relatively broad as the majority of respondents associate its territory with administrative borders and some with a historical region. As observed by Melnychuk and Gnatiuk (2018), the name of the region is a somewhat conservative backbone in reconfiguring perceived regions over time. Naming a clearly delimited region imposes specific spatial perceptions with attributed semantics. Research conducted by Semian (2012) on perceptions of the area of the Bohemian Paradise (Český ráj) corresponds to this statement. In that study, there is no

institutionalised region named that way. As a consequence, the majority of respondents included a relatively small area referring to the Bohemian Paradise on their mental maps. Concurrently, this was the prevailing definition of Bohemian Paradise in the discourse corresponding to a protected landscape area – officially named Bohemian Paradise. Synonymous understanding of the names attributed to administrative and historical regions in the case of Podlasie results in a significant share of respondents who identify Podlasie with the combined area of these two territories.

6. Conclusions

This study has confirmed the complexity of people-place interrelations. Statistical analysis evidenced that factors responsible for shaping attachment to the examined spatial tiers are not obvious. The fact of being born in a given place or having a certain educational level are not decisive for relations with inhabited territory. A declared nationality and religion, as well as age and period of residence, are shown to be most significant. Gender and occupation are secondary factors determining attachment.

The hierarchy of respondents' bonds with a given area proved to be relatively predictable. One may state that there is a clearly stronger identification with the national and local tiers in comparison to the regional rank. A lower attachment to region can be considered a result of unstable administrative borders in Poland, through the prism of which inhabitants primarily perceive the territory of Podlasie. This inquiry has given evidence of a relatively strong attachment related to the informal (sub)region of Eastern Poland, which among certain communities surpassed bonds with administrative units, both current and historical. Hence, governance and the administrative approach towards space are not the only factors determining relations between people and places.

An identification of the respondents with Podlasie in the Podlaskie Voivodship is evident, though not confined to its borders. The greatest attachment in this respect is observed among residents of the former Białostockie Voivodship (1975–1998). Historical conditions exert an observable impact upon relations to Podlasie, and its spatial perception as relict regions show such attachments. One may state that regional collective memory to some extent resists changing administrative borders. Yet, the examined territorial identity is shared with generally stronger bonds with current administrative regions. These findings correspond to research results concerning Podolia, Ukraine (Melnychuk and Gnatiuk, 2018) that the majority of a regions' inhabitants have a "hybrid" territorial identity, combining old and new qualities. The current administrative divides are decisive for perceptions of Podlasie and attachment to this region. Such regional identity is not uniform, however, and especially outside Podlaskie Voivodship it comprises a variety of regional and sub-regional attachments. Despite the specificity of the research area, in consciousness of such a varied community, perception of the region – primarily as an administrative unit – is commonly shared.

The institutionalisation of a region as specified by Paasi (1986, 1991, 1996), concerning the imaginaries and identities of a region's population along with territorial, symbolic, institutional and organisational issues, may contribute to a collective identification process. In the case of this research area, such a process has begun by means of the administrative reform in 1999. Podlasie presently operates in semantic and geographical terms as an administrative region. Statistical analysis has shown that inhabiting Podlaskie Voivodship

strengthens such relations. The historical factor is crucial in this respect, however, as living in the former Białostockie Voivodship determines attachment to Podlasie even more explicitly. One now encounters a similar process as that in the 19th century when the perception of Podlasie was altered due to establishing administrative regions south of the Bug River. Naming the region with a derivative of the word Podlasie fostered establishing specific perceptions and semantics of the territory called Podlasie. By imposing borders of a new region in 1999, such a mechanism has covered northern and western areas of current Podlaskie Voivodship, which historically were not related to Podlasie.

This goes in line with the observation that 'region' is primarily a social construct (Paasi, 2011; Van Langenhove, 2013). Therefore, regional identity should not be understood as a fixed phenomenon, but rather as a continuous process in which space, time, community activity and memory are its fundamental elements (Raffestin, 2003). Apart from these components, a crucial factor contributing to enhanced altering regional identity and a region's perception is the semantics. In social consciousness, not only the names Podlasie and Podlaskie Voivodship became synonyms, but also their symbolism, cultural heritage and borders are to a great extent perceived univocally. But the identity of a historical region has persisted. As stated by Antonsich (2010), if an administrative region may exist in the absence of regional identity, then possibly regional identity can exist in the absence of regional institutions. In the case of Podlasie, a hybrid regional identity has been undoubtedly established pertaining to both administrative and historical regions. Such a combined identity takes diverse proportions, even though attachment to the contemporary voivodship generally prevails.

The semantics of administrative and historical toponyms is crucial in building both the "identity of a region" in public discourse, and the "regional identity" of inhabitants. In such a way, some form of a region's institutionalisation takes place, in which historical borders lose their importance in favour of administrative divides. It is therefore evident that "everyday acts of naming constitute the first step of regional becoming" (Bialasiewicz, 2002, p. 119). This mechanism was recognised by Paasi (1996, p. 35) who stated that naming the region "brings together its historical development, its important events, episodes and memories and joins personal histories of its inhabitants to this collective heritage". Naming the area Podlaskie Voivodship has transferred much of the "old" identity of the region to establish a new regional identity to be found within administrative borders. Attachment to the present region, however, cannot be equated with bonds to the historical Podlasie, built for hundreds of years. Presently, the identity of the region, regional identity and the associated regional history is selective, generalised and reinterpreted for the sake of various – mainly economic – goals (Semian and Nováček, 2017). Attachment to historical regions still persists in the collective memory of the surveyed population. This has been shown in the research area outside the Podlaskie Voivodship, but located in historical Podlasie, thus beyond the impact of administrative or economic factors. Such bonds are evident among the oldest age group (60+) and thus are likely to be displaced over time by attachment to the administrative region, now dominant among the younger population.

With reference to research on the impact of institutionalising new regions (Zimmerbauer et al., 2012) and especially relevant to the issue being examined, amalgamations of regions and its impact on regional

identity (Zimmerbauer and Paasi, 2013), one may draw a general conclusion, that this research has not provided evidence whether regional identity has fostered establishing the new region of Podlasie. In turn, the study has demonstrated a reverse process: the institutionalisation of an administrative region by amalgamation of smaller units has fostered establishing “regional identity”, attributed to Podlasie.

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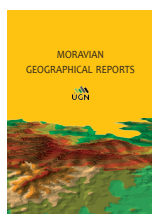
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The dynamics of population distributions in cities based on daily mobile phone operations: A case study of some Moravian cities

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Abstract

Analyses of the changes in the presence of persons in different central and residential parts of urban areas are subject to evaluation in this paper. Case studies of the cities of Brno, Ostrava and Zlín during the day and night are highlighted. Data from a provider of mobile phone services were used for the analyses. It appears that the data can be important for the comparison of different urban structures. The results demonstrate that the organisation of urban structure affects the number of visitors and thus the area attractiveness. It was confirmed that the number of mobile phone users in the city cores is higher than the number of permanent residents. The greatest differences between the day and night in the city cores were found in Brno, a concentric city with the most important central functions among the cities studied. Differences between the day and night in residential areas were not as large as expected. City neighbourhoods in Brno showed some specific rhythmicity.

Keywords: day/night population dynamics, mobile services providers, urban structures, Brno, Ostrava, Zlín, Czech Republic.

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1. Introduction

As a rule, population data have a static character. They are valid at a certain moment in time and usually relate to permanent residents. Although in the last Czech census the concept of usual residence was introduced, most people probably still declared their responses in relation to their permanent residence¹. For larger cities, residents are concentrated normally in residential quarters and suburbs, whereas city cores have lost permanent inhabitants in favour of commercial and office facilities. A significant part of commercial activities has moved from historic centres to shopping malls on the outskirts of cities as well. In general, it can be stated that the greatest changes have been experienced in city centres and some parts of inner cities on the one hand, and in the city outskirts on the other hand (Horská et al., 2002).

It is quite difficult to capture or explain such a situation by using common statistical methods. Understandably, any observation made by humans would be extremely

demanding; hence, other methods are looked for. Using the data about movement of mobile phones by network operators and its application to the territory of cities is one of the options. According to Järv et al. (2018), current models of location-based accessibility are often atemporal in nature. Locations of persons, transport and service supplies may change dramatically within 24 hours. The observation of population changes within a certain territory was introduced by Hägerstrand in the 1960s under the concept of time geography (Brauer and Dimitroff, 2017).

Using statistical data, city cores seem depopulated, whereas suburbs are rapidly growing. The changes were confirmed by Sýkora et al. (2000). It is known, however, that people frequently move across the city territory within a day. It is necessary to add persons who move between the city and its hinterland, students and tourists. It follows that the displacement of people within the city territory can be quite differentiated in the day and in the night, and different from the number of permanent residents. It is extremely

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¹ All persons with addresses registered in the Information System of Population Registration are considered permanent residents. Place of usual residence is defined as the place where a person usually spends his/her daily rest period regardless of temporary absence due to recreation, visits, business trips, stay in a medical facility, etc. and where the person is a member of specific household.

important for urban planning because the infrastructure of all city parts should correspond to the maximum number of people staying in individual parts – not to permanent residents only.

Some parts of the city can be predominantly residential, some are predominantly working quarters and yet other ones can be of mixed nature. Opinions on such a division differ. Some theories prefer a strong functional division of the city; others prefer a mixture of functions. It is said that one-sided profile city parts could be dangerous during the day when they are half-empty (working quarters at night, residential quarters during the day), whereas mixed quarters are relatively safer (Marques et al., 2018).

There are many city structure theories from ancient cities to Thomas More's Utopia. In the last century, town planning was affected by the Athens Charter (1933), for example. Its main idea consisted in the separation of three city functions – residential, industrial, and recreational, which were interconnected by the fourth function – transport. Although the Athens Charter has never been fully implemented, the territorial division of functions exists more or less in each city. Because there are not only one-functional but also multifunctional quarters, however, the situation is more complicated than the Athens Charter presupposed. It follows that monitoring population movement in city areas is meaningful and important.

An attempt on updating the Charter was made in 2003, taking into account new factors such as security, health, innovation, environment, etc. A key factor in our investigation is yet another one – accessibility. The new vision consists of a polycentric structure and connectivity. Population densities change during the day and this represents one of the most important factors in information for its evaluation. ICT technologies represent a suitable tool (Fernandez-Maldonado, 2012).

Identification of regularities in the daily rhythmical changes of population are the subject of evaluation in this paper, using case studies of three Moravian cities. The changes were investigated in relation to the functions of individual city parts. The research was focused on the comparison of cities with similar socio-economic conditions, but with a different historical development of their urban structures. At an application level, the results could be used to design an optimal urban structure in the planning of technical infrastructure, public transport connections, but also for the purposes of personal security or forensic purposes. The paper was created as part of a wider study examining “The impact of urban structure character and location on the sustainable development of the territory.” Various qualitative indicators of sustainable development were monitored in the characteristic urban structure fragments. The number of mobile network users was one of those indicators.

2. Theoretical background

2.1 Rhythmicity of urban spaces

Space and mobility are phenomena interacting in the construction of the contemporary world at and across many geographical scales – including the urban one (Simonsen, 2004). The concept of regular changes in population density in an urban area is based on Lefebvre's theory of rhythm analysis first published in 1992 (Lefebvre, 2004). The substance of the concept consists in

frequency measurement. All interactions between time, place and energy expenditures exhibit a rhythm. It might consist in the repetition of some processes, in interferences of processes and/or in the processes of birth and dying. According to Edensor (2010): “in terms of geography, the rhythm analysis highlights tensions between repetition and innovation, between the need for consistency and the need for disruption”.

The problem of space, time and city based on Lefebvre's theory and its validity for the current century has been discussed for example by Simonsen (2004). Reid-Musson (2017) used Lefebvre's theory to investigate the everyday life of migrant farmers in rural Canada. She states that “rhythms help produce unequal subject positions of migrants in Canada, yet also represent lived uses of space and times which permit transgressions of racial, gender, and class boundaries”. The spatio-temporal relation in human geography, using rhythm theory, was also highlighted by Mels (2004).

Rhythmicity has been changing over time in relation to the development of technologies. In pre-industrial stages, the place of work was more or less the same as the place of residence for the majority of people, who moved for some shopping or religious reasons only. Rhythmicity in the urban territory (which was much smaller than today) occurred only at a lower frequency and at a shorter distance. Originally, also in times of industrialisation, dwelling places of workers used to be built near factories or mines. Such an organisation of the urban territory began to change in the last century when individual functions of the city started to be divided – partly due to environmental reasons. Also, human activities became specialised: besides work and dwelling, new activities started to appear relating to leisure time. Public transport allowed for easier and more frequent movement within the urban territory. Ideas about the division of functions found their expression in the Athens Charter (1933). It evoked frequent rhythmicity across longer distances.

After the Second World War, the division of work and residential places found its expression in suburbanisation, which shifted the rhythms towards the city-hinterland relation – together with the rhythmical relation between first and the second residences. From rural areas, commuting for work brought rhythmical movements to urban territories. Urban rhythmicity, however, was still determined by residence-workplace relations. Industrial areas with thousands or dozens of thousands of employees on the one hand, and large residential areas (represented mostly by prefabricated estates) on the other hand, were the main aims and sources of the movements, which was expressed also in the organisation of municipal transport. A picture of overloaded vehicles of public transport heading from housing estates to industrial zones in the morning and in the opposite direction in the evening, were typical of industrial cities.

The post-productive era and globalisation (understood as a post-socialist era by some authors) brought about another substantial change in rhythmicity. For instance, Muliček and colleagues (2016) analysed daily rhythms in Brno in the light of changes from a productive to a post-productive society using metropolitan transport services, showing a change of hotspots from large industrial plants to hospitals, universities, commercial centres and consumption-oriented places, which are more dispersed across the urban territory. Non-productive functions became not complementary but rather independent. Osman and Muliček (2017) combined

Lefebvre's concept of rhythmicity with Laguerre's concept of chronopolis (2003), reconceptualised on a city-scale level, describing 18 city areas of Brno. Mulíček and Osman (2018) have evaluated urban rhythmicity in relation to shopping activities. The increasing amount and importance of leisure time has also engendered mobility for social life, entertainment, and recreation. Moreover, except for their own city and its hinterland, people travel to a much wider extent. These rhythmical movements have different driving forces, different daily and seasonal courses, and different participants.

Many of these references relate to the methodology itself, however, rather than to the clarification of 'observed facts' and to the identification of possible relations between the movement of persons and the urban structure of cities, a paper by de Nadai et al. (2016) being one of the rare exceptions. Additionally, Louail et al. (2014) showed, using the case of large Spanish cities, how hotspots (points of the high concentration of people) can be delimited, their changes during the day and relations among them. The methodology of these authors resulted in a typology distinguishing between monocentric and polycentric cities. For forensic purposes, Malleson and Andresen (2015) tried to put together the concentration of persons with places of frequent street crimes to estimate the risk of robbery. Similarly, Smith and Hall (2013) observed the circadian rhythms of urban street police in Cardiff. The development of digital technologies allows the use of data of mobile services providers in monitoring population dynamics (Deville et al., 2014; Grauwin et al., 2014; Steenbrugger et al., 2015).

Similar research was realised by Novák and Temelová (2012) in Czech conditions. Their paper combined digital data with interviews aimed at understanding the mechanisms of movements of young people across the city territory. Silm et al. (2013) investigated differences between genders in the daily movement of people in the territory of Tallinn using similarly a combination of mobile phone data and interviews. Šveda and Barlík (2018) used mobile positioning data to investigate daily commuting in the Bratislava metropolitan area with a similar aim, namely, to reveal disproportions between permanent residence and real living. The above-mentioned papers have largely been aimed at the methodological aspect of the identification of daily movement of people across urban areas.

In terms of time, it is possible to investigate daily rhythms (day/night differences), weekly rhythms (weekdays/weekend days), annual rhythms (considering tourist seasons, school years, etc.) or special rhythms which could consider special events. In our research, we focussed on the day/night rhythms. This kind of rhythm is connected mostly with the cycle of <dwelling – working (or education) – daily leisure – dwelling>. Pasqui (2016) characterised the temporary population as "groups of subjects that, temporarily and intermittently, share practices of daily life". Such cycles concern mainly people of productive age and students – although other population groups participate as well. Lager et al. (2016), however, showed that the rhythms of seniors are different. From viewpoint of an individual, however, daily rhythms partly result from a feeling or habit rather than from a rational decision, and in such a way they relate to sociocultural conditions (Neuhaus, 2014).

2.2 Urban structure

The spatio-temporal relations in urban areas relate to the functions of individual urban structures and their localisation within the territory. Individual structural parts change their functions from the source to the target of population movements during the day. The population of a productive city is distributed mainly between residential quarters and industrial areas during the working days. The situation in a post-productive city is more differentiated. The following aspects can play a role: a wider distribution of workplaces within the urban territory; some people working from home; an increasing share of pensioners with a different style of work; the increasing amount and importance of leisure activities; the increasing role of consumption of diverse types; current urbanisation processes, namely suburbanisation and gentrification; and the increasing social differentiation of cities.

In the last few decades, opinions prevailing among urban planners is that an ideal city is a compact city, a city of short distances. This ideal has two characteristics: tightness, the city should be as tight as possible, minimising the occupation of agricultural land and landscape, and a diversity of functions in the territory. Such a structure should be more economical and more sustainable in the long run, as Jacobs (1970) stated years ago. Real urban development, however, does not always correspond to this. On the one hand, a city block is being constructed as an urban manifesto, called "Compact City" (BUS, 2003), and on the other hand, a developer project with detached houses in greenery called "Greene Schanze" is being built right next to it on the same street (two recent realisations in the Vienna district of Floridsdorf, see Matyášová, 2019). One ideal of urban planners is a multifunctional inner city, but people are moving to monofunctional satellites situated beyond the city limits (Hnilička, 2012). Even the socialist panel housing estates do not have to lose their attractiveness (for example, Lesná in Brno: Wittmann, 2017). The decreasing population and the outflow of business activities moving to large shopping areas on the city outskirts increase the risk of a decline of city centres (IPR, 2016; Slach and Nováček, 2017)². There are also expert articles that put the ideal of a compact city into question (Neuman, 2005). In the end, however, people vote on the quality of a city and its parts by their presence (Gehl, 2011). From this point of view, it seems useful to monitor and compare the occurrence and movements of people in different parts of cities and in different types of cities. Large numbers of people in a locality show that the locality is attractive to visitors, as much as the absence of people in a built-up urban area during some parts of the day can be seen as a pathological phenomenon.

Spatio-temporal relations in the studied cities are developing significantly in connection with the transition to a market economy, post-industrial (consumer) society and with the changing conditions of intra-city transport, online work and services. Moreover, the rapidly evolving situation needs to be monitored and generalised at various stages of development. On the other hand, new technologies also allow for a methodological shift. For example, Kubiček et al. (2019) analysed changes in the presence of the population in Brno via mobile phones for the needs of crisis management. Using an example of the five largest Australian cities, Coffee, Lange, and Baker (2016) stated that city cores were rapidly

² The official population census indicates that in the period from 2001–2011, the historic cores of Brno, Ostrava and Zlín lost 8%, 18% and 11% of inhabitants, respectively.

losing population in favour of the fringes in the 1980s. Later, some parts of the inner cities were selectively re-urbanised. Which stage of this process are Moravian cities at? This paper attempts to analyse urban structure optimisation in the contemporary processes of urbanisation.

3. Data and methods

3.1 Cities under investigation

Three cities were selected for our comparative study: the largest Moravian city of Brno, the second largest Moravian city of Ostrava, and the regional city of Zlín (Fig. 1). The analysis was performed for basic settlement units (ZSJ)³, the smallest units for which public data were available. Each unit was assigned a predominant type of urban structure so that it was possible to identify the occurrence of the observed phenomenon in relation to the type of urban structure.⁴



Fig. 1: The location of investigated cities in the Czech Republic

The following types of urban structures were delimited in the cities under investigation:

- Central block (A) – compact historic cores with medieval foundations and the linked-up block structures from the end of the 19th and beginning of the 20th centuries;
- Suburban block (B) – regular block structure outside the city centre, usually realised before the 1950s;
- Unordered urban area (C) – the area of disordered urban structures, consists of a combination of block and free housing structures with buildings of various functions from different times, which could not be classified with the other groups;
- Two-year plan buildings (D) – specific post-war structures from the turn of the 1940s and 1950s, represents a specific type because of the characteristic linear arrangement of apartment buildings;
- Villa quarters (E) – usually detached apartment buildings (villas) in greenery: Baťa houses in Zlín from the period between the wars represent a typical form of such structures;
- Prefab housing estates (F) – housing estates outside the inner city, contain mainly apartment buildings

constructed by using prefabricated technology in the period of socialism from the end of the 1950s to the beginning of the 1990s;

- Family houses (G) – areas of detached houses occupied by family houses from different time periods (mostly from the 19th to the 21st century); and
- Other: public infrastructure – storage, manufacture, services – forests and parks – agricultural land – water areas and streams.

The selected cities represent very different cases. Brno has been growing since the 13th century when individual urban styles and concepts evolved organically and gradually relied on themselves. Ostrava is a rapidly and chaotically growing city, originally based on coal mining and the development of heavy industries. Zlín is a ‘company town’ (Jemelka and Ševeček, 2013) built according to a unified urban plan under the influence of the Athens Charter.

Brno is the second largest city in the Czech Republic and the regional centre of Moravia. It has about 380,681 inhabitants (end of 2018, Czech Statistical Office). The current population, however, can be estimated at more than half a million, including foreigners with long-term residence permits, university students (about 75,000 students, a majority of them coming from other places), commuters, etc. Since the 13th century, the city has been an important centre of commerce, education, culture, and later a node of industries, a transport junction, the seat of administration and justice. The most intensive city structure development is connected with industrialisation in the 19th century, and later with the establishment of Czechoslovakia after 1918 (Kuča, 2000). The socialist period was characterised by the construction of prefabricated residential quarters; the period after 1990 has been affected by suburbanisation, gentrification and reconstruction (Sýkora and Ouředníček, 2007).

Ostrava with the population of 289,100 inhabitants (end of 2018, Czech Statistical Office) was originally twin towns and other settlements in the peripheral location on the Moravian-Silesian border, divided by the Ostravice River into Moravian Ostrava and Silesian Ostrava. The topography at the confluence of four rivers is flat. In 1763, black coal was discovered in the region. In relation to the later industrial revolution, it resulted in a stormy development. The logic of urban fabric formation, however, was different than that of Brno. Individual mines were the main points of activities. They were surrounded by worker colonies, the factories of heavy industry, mine heaps and the related infrastructure. In this way, a mixture of mines, infrastructure, residential areas and other facilities was created. The city experienced heavy environment pollution and in the productive era, Ostrava became “a steel heart of the country”. Mining activities intensified. Industrial development was accompanied by the mass construction of prefabricated housing estates, forming realistic new towns – partly as a substitution for undermined areas. As a result, Ostrava has in fact more city centres – the historical one, which is relatively small,

³ The “basic settlement unit” (in Czech “základní sídelní jednotka” – ZSJ) – is a basic component of residential units defined in the Czech Republic by law in the state statistical office. The unit is smaller than a quarter or district, is clearly delimited in the territory, often represents a block of houses bordered by the surrounding streets, and it is primarily used for the statistical monitoring of socio-economic and territorial-technical phenomena.

⁴ Apart from mobile phone users, we monitor various other social and environmental phenomena in the defined types of urban structures over a long period such as population structure, prices of real estate, air temperatures, etc. (Kopáček and Vaishar, 2020; Wittmann and Kopáček, 2019; Kopáček and Kilnarová, 2018).

and the cores of new quarters. A different social structure was created, characterised by people with low qualifications but high salaries. The city acquired a negative image both in environmental and social terms. It is part of a relatively continuous urban belt stretching into Poland. After 1989, the national economy turned away from heavy industries and coal mining in Ostrava was brought to end in 1994. The city and its surroundings were affected by structural changes. The demographic situation was characterised by emigration to surrounding small towns and villages (Vaishar, 2002). One can speak of a shrinking city (Rumpel and Slach, 2012), but regardless of the decreasing population numbers, the city remains an important regional centre with developing educational and cultural functions.

The post-socialist changes in the inner structure of Brno and Ostrava as examples of second-order cities were described by Bierzyński et al. (2011), including their population development and taking into account the housing market conditions. Zlín with a population of 75,000 inhabitants (end of 2018, Czech Statistical Office) is situated in a narrow valley of the Dřevnice River, dividing the Hostýnské vrchy Hills and the Vizovické vrchy Hills. This geographical situation predetermines the belt-like inner structure of the city. Zlín was a small town until the end of the 19th century. In 1894, Antonín Baťa founded his shoe factory, which became the base for a later expansion to the whole world. Huge development was recorded from the 1920s. The Baťa Company built not only the large factory with its infrastructure, but also a city for about 50,000 inhabitants. A myth came into existence of the living Utopia (Vacková and Galčanová, 2009). The city was an example also for some European urban planners (Abramson, 2009). The factory replaced the main square functioning as a city centre. Quarters of detached houses grew up on the valley slopes, while the valley itself was built with public buildings, a majority of which belonged to or were connected with the Baťa Company. The company was nationalised in 1945 along with key industries. A prefabricated housing estate called Jižní svahy (Southern Slopes) was built for the increasing number of workers. After 1989, the main company collapsed due to unpaid receivables from countries of the former USSR. The city agglomeration is limited by its location in a relatively deep valley. In fact, Zlín forms a belt city with the neighbouring former village of Otrokovice.

All three selected cities are similar in that they are in the same post-socialist socio-political situation and at the same post-industrial stage of their development, they are all regional centres, three of the four largest Moravian cities. What differentiates them, however, is urban structure and arrangement, each one of them representing a different and relatively distinct urban concept. It turned out to be an opportunity to observe how these different physical arrangements affect city life, how they affect the area attractiveness, as measured by the frequency and movement of people. Today, a new option is offered for tracking people in the city – through their mobile phones.

3.2 Database of mobile network operators: A tool for studying urban population movements

The O2 Czech Republic mobile network operator temporarily allowed access to the open data of mobile phones on their website in the form of the API (Application Programming Interface) demo interface (O2, 2018). These data were provided in the beta version and were published every Wednesday, with information about phone traffic from

Monday of the same week. Unfortunately, there were no other weekdays when the data were released in the beta version except for those of Mondays. The mobile network operator uses one of the network base techniques that gathers data as a side effect of the connection of individual phones to the telecommunication network provided by the transmitter tower (BTS) (GSM web, 2018). The phone is usually mostly responding to the transmitter with the strongest signal and can be located by any common signal strength triangulation method in between several transmitters which it is responding to; there are no Call detail records (CDR) data used (Whitehead, 2008). The more transmitters, the more accurate is the user's location. As there are usually more transmitters in the city centres and urban areas, the mobile network operator claims the accuracy of the geospatial position user to be up to 100 metres. In the outskirts of the cities and in rural areas, the accuracy is lower and varies, depending on the density of transmitter towers (Laitinen et al., 2001). The data obtained in this manner are from one mobile network operator and are extrapolated to the whole population. The operator claims that machine-to-machine SIM cards, for example for Internet of Things (IOT) devices, and SIM cards from state institutions are discarded from the data sample (O2, 2018). Those data have been converted by using the common type of triangulation to the system of basic settlement units. The operator does not specify the type of triangulation as it is a subject of competitiveness among various operators.

The data available through the socio demo API were divided into transfer data, showing the number of phone users travelling through the unit in a selected hour of the day, and visitor data, showing the number of phone users staying in the selected unit and hour for more than 30 minutes. The API interface provides separate numbers of male or female users per the selected hour, or a division of users according to age groups defined as 8–18 years, 19–25 years, 26–35 years, 36–55 years and 56+ years in the chosen hour. If the number of phone users (either males or females, or age group as defined in the API) in the selected basic territorial unit is below 100, no data are displayed because of data anonymization, which means that there are no data provided for units with less than ca. 200 users in the given hour (males + females).

The selected data are average values from Mondays in May 2018. They are from the socio demo API containing information about the total number of users who stayed in the units for more than 30 minutes. Those numbers were gathered into a SQL database and converted into a table. Day averages for the period from 06–18 o'clock and night averages for the period from 22–06 o'clock were counted (Horáková, 2018). The outputs can show the density of mobile phone users per 1 ha, which allows for a better comparison among the units of different size.

Mobile phone user data seem to be quite useful for monitoring activities in the basic settlement units (ZSJ). These data cannot be fully associated with a real number of individuals in the urban area but are directly proportional. A higher number of mobile phone users means a higher number of persons in the area and vice versa. The higher number of persons then testifies to the greater attractiveness of the area (Gehl, 2011), because a public urban space without people is not a quality urban space (Jacobs, 1961).

There are some specific characteristics and limitations to expect when working with the beta version data:

- Mobile phone users are aged over 8 years, with an active phone device, who spent more than 30 minutes in a certain basic territorial unit. The number of phone users does not include machine-to-machine or state institution SIM cards. The mobile network operator claims that the data include users from the whole population sample, i.e. all users covered by all mobile network operators and not only by O2 Czech Republic;
- Due to data anonymization, basic territorial units with fewer than 200 users (100 female users + 100 male users) are marked as 0 users. Those units are pictured as 'no information' in images attached to this paper;
- The number of phone users varies within the basic territorial units, the mobile network operator claiming an accuracy of about 100 metres. The boundary lines of basic territorial units and the BTS network do not necessarily match, which means that there are inaccuracies in the triangulation method, especially in rural areas with a lower density of transmission towers. Regardless, daily rhythms of users' movements are still of some significance;
- The mobile network operator provided neither its complex method of data collection, nor the exact type of triangulation due to competitiveness reasons;
- The data represent an ordinary sunny Monday (May, 2018); we are aware that Monday may not be the best characteristic day of the week, unfortunately, there were no other weekday data available in the API beta version; and
- The aim of the paper is to highlight common tendencies of phone users' movements in the urban area. Further research is needed to corroborate the final results of our

study, which would call for greater collaboration on the part of mobile network operators and their willingness to release data from other weekdays to be used for comparison.

4. Results and discussion

4.1 Population distribution changes in Brno, Ostrava and Zlín during the day

In Brno (see Fig. 2), the highest density of mobile phone users per ha can be found in ZSJ units situated in the city core. In these quarters, a peak density occurs at noon. Very high densities are typical also for the inner city, both in areas of lower social level with partly deprived populations and in those of higher social status. Peaks occur in different parts of the day: in the morning or in the afternoon. Areas with the highest density of persons can be found exclusively in compact, multi-functional block structures in the centre and in the inner city of Brno. Cores of prefabricated housing estates on the outskirts of the city are less attractive (see Fig. 2), likely a consequence of the concentric organisation of the city with a dominant centre, and a result of the higher importance and attractiveness of Brno as compared to Ostrava and Zlín.

Similarly, the highest density of mobile phone users in Ostrava (Fig. 3) during the day was observed in the central city parts at noon; in areas with a higher social infrastructure, the highest population density was recorded at 10 a.m., but the density of people was lower than that in Brno, as not all of the mentioned units are of compact block structure. The Fifejdy Hospital is a hospital area, whereas Karolina is a modern shopping mall with quite new apartments. The

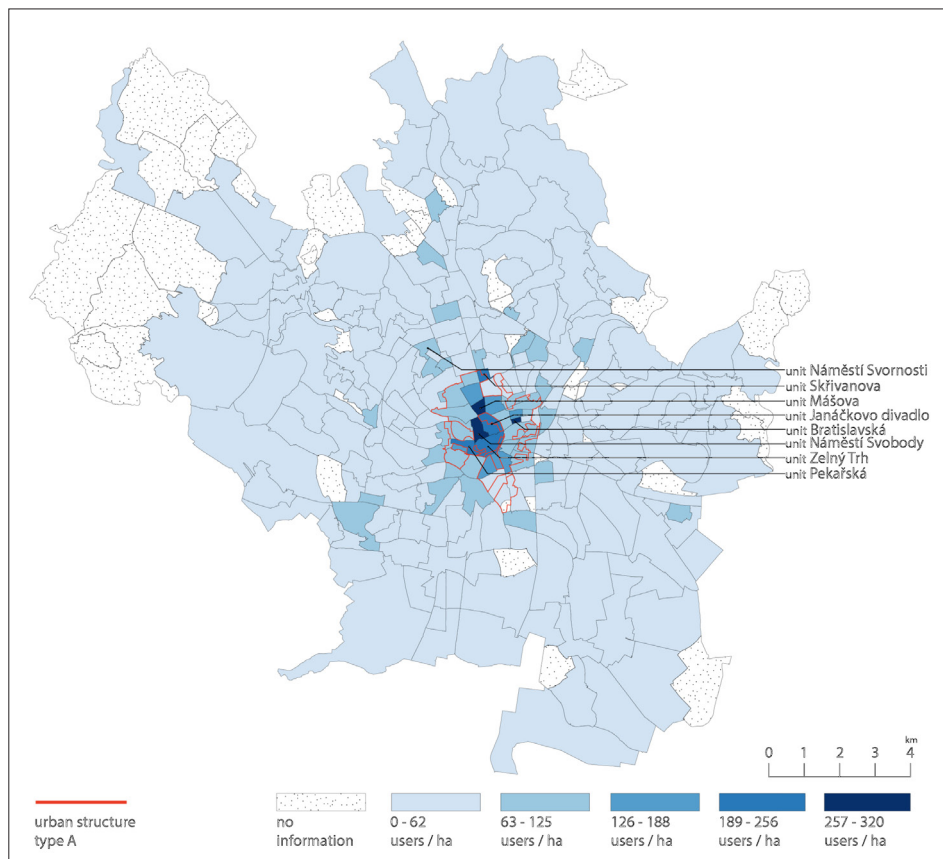


Fig. 2: The attractiveness of individual basic settlement units (ZSJ) in Brno during the day, according to the mobile network operator, May 2018. Source: O2 Czech Republic, authors' elaboration

attractiveness of prefabricated estates is similar to that in Brno; therefore, differences between the central parts and the prefabs are not so distinct.

The lower attractiveness of central parts in Ostrava is conditioned probably by the lower land use intensity (lower buildings, lower density of permanent residents), by the

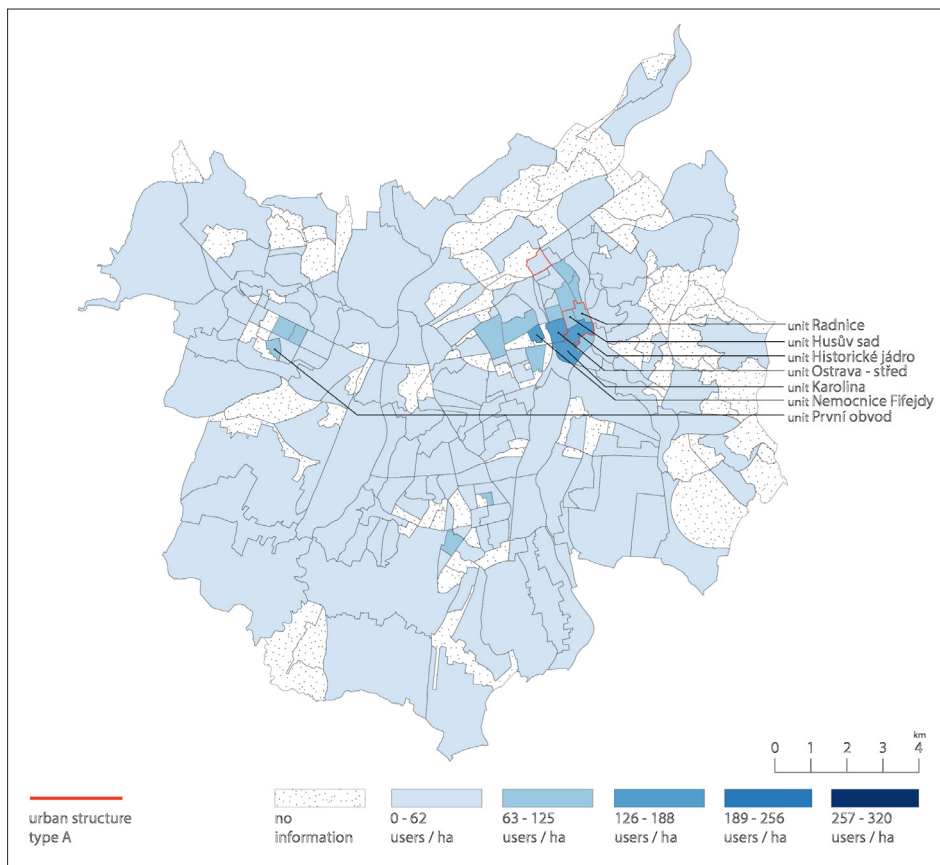


Fig. 3: Attractiveness of individual basic settlement units (ZSJ) in Ostrava during the day according to the mobile network operator, May 2018. Source: O2 Czech Republic, authors' elaboration

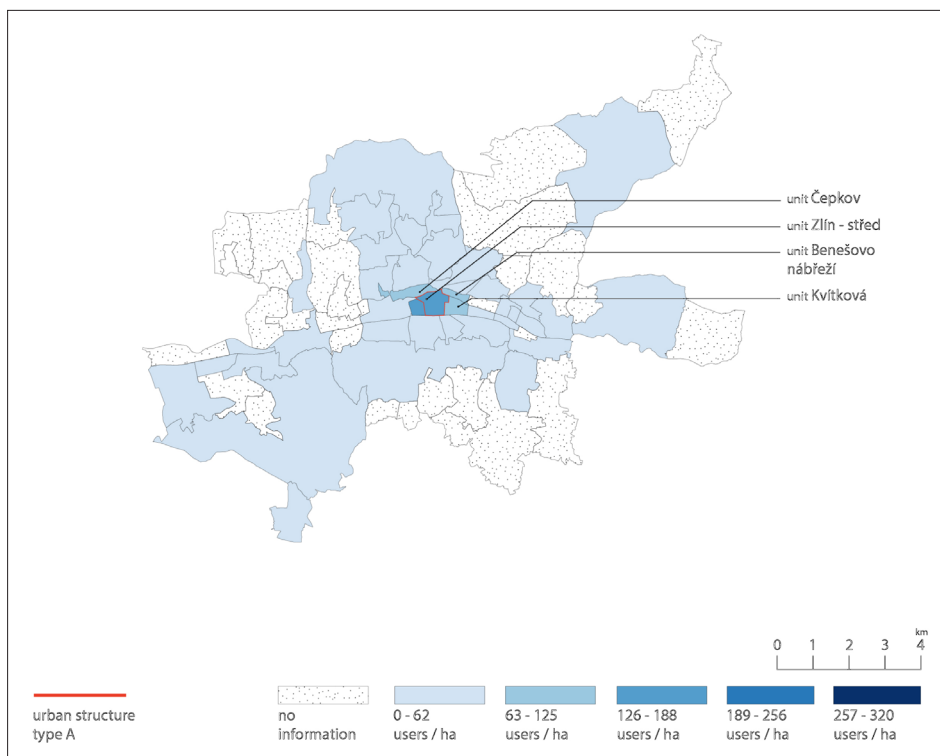


Fig. 4: The attractiveness of individual basic settlement units (ZSJ) in Zlín during the day according to the mobile network operator, May 2018. Source: O2 Czech Republic, authors' elaboration

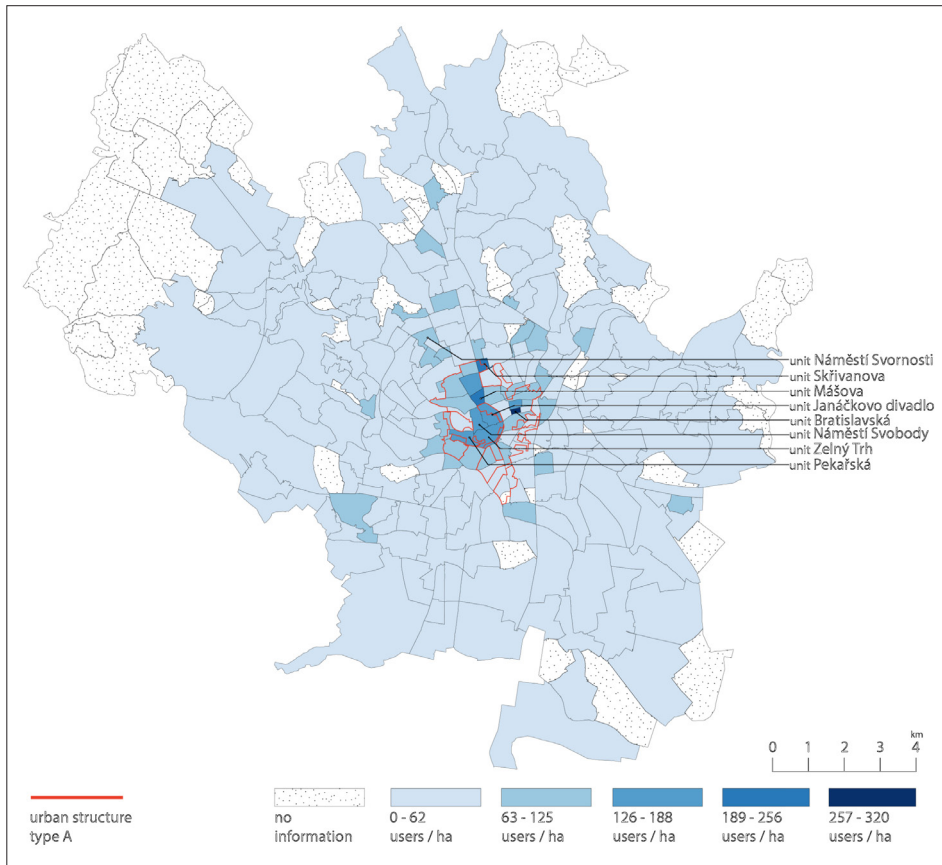


Fig. 5: The attractiveness of individual basic settlement units (ZSJ) in Brno during the night according to the mobile network operator, May 2018. Source: O2 Czech Republic, authors' elaboration

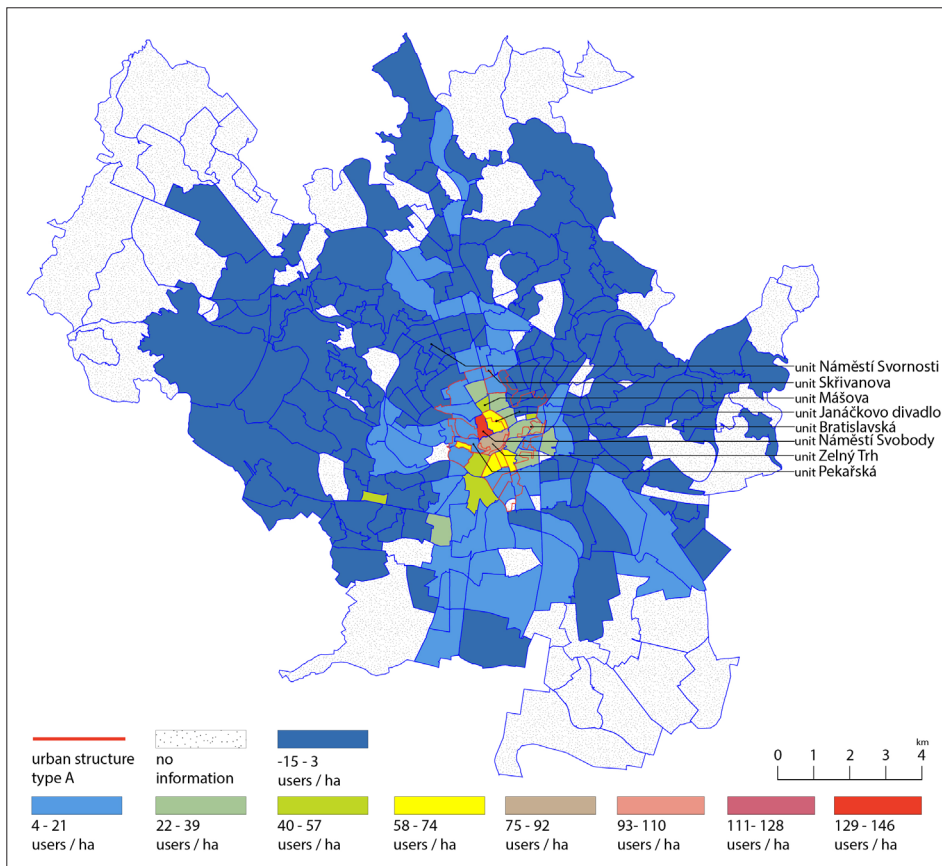


Fig. 6: Differences between the day and night attractiveness of individual basic settlement units (ZSJ) in Brno according to the mobile network operator, May 2018. Source: O2 Czech Republic, authors' elaboration

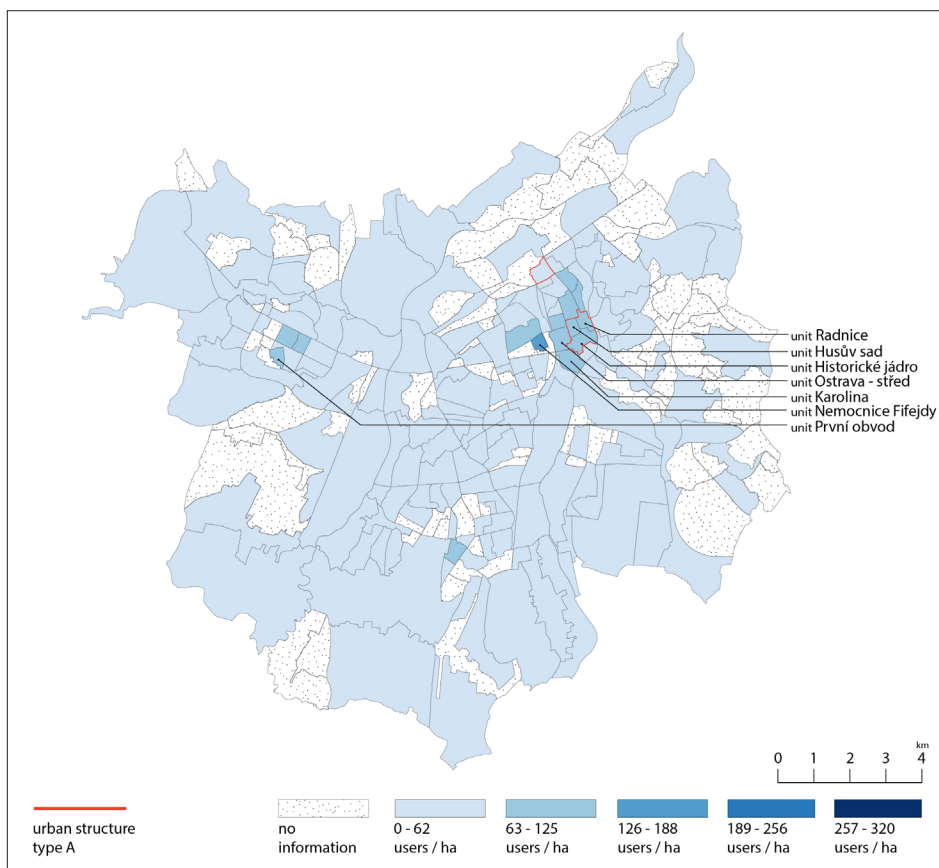


Fig. 7: The attractiveness of individual basic settlement units (ZSJ) in Ostrava during the night according to the mobile network operator; May 2018. Source: O2 Czech Republic, authors' elaboration

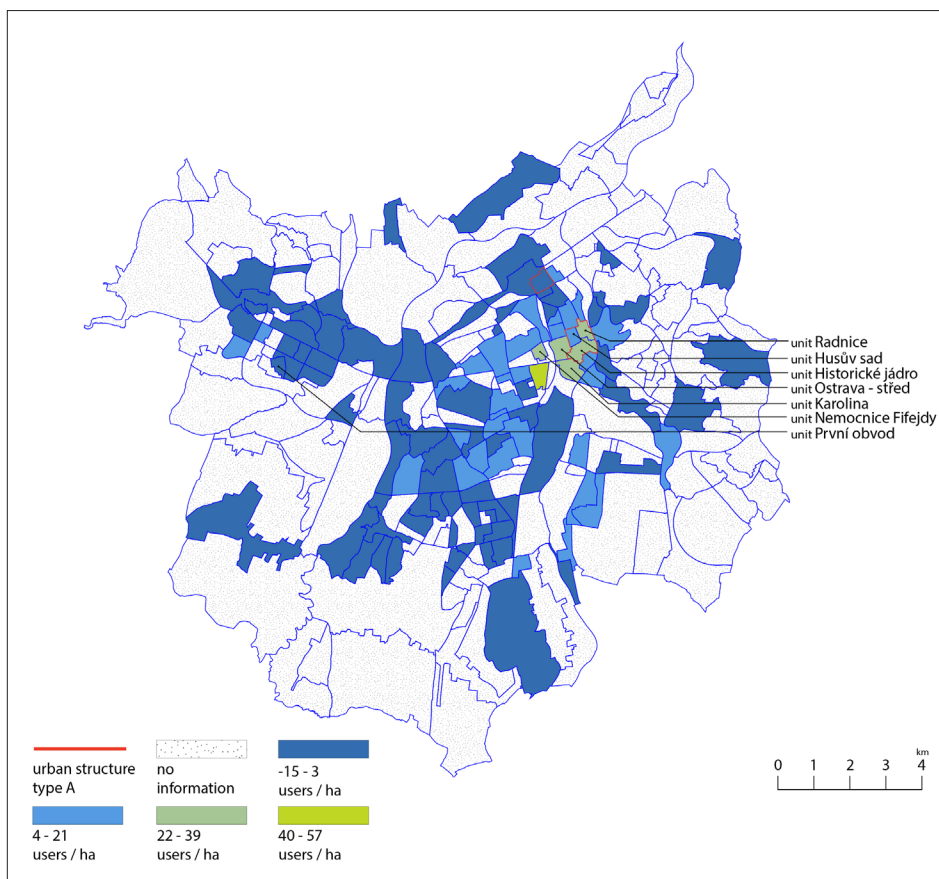


Fig. 8: Difference between the day and night attractiveness of individual basic settlement units (ZSJ) in Ostrava according to the mobile network operator; May 2018. Source: O2 Czech Republic, authors' elaboration

lower importance of the city, and especially by the lower significance of the centre of Moravská Ostrava as a centre of the whole city.

The highest density of mobile phone users during the day in Zlín (see Fig. 4 above) can be seen in central parts and in units immediately surrounding the centre at 2 p.m.,

and in the evening in some inner-city parts. The historical core of old Zlín is not as large as in Brno or in Ostrava, and other parts of the inner city are multifunctional, combining residential and infrastructural functions and residences of various types, originating from different times.

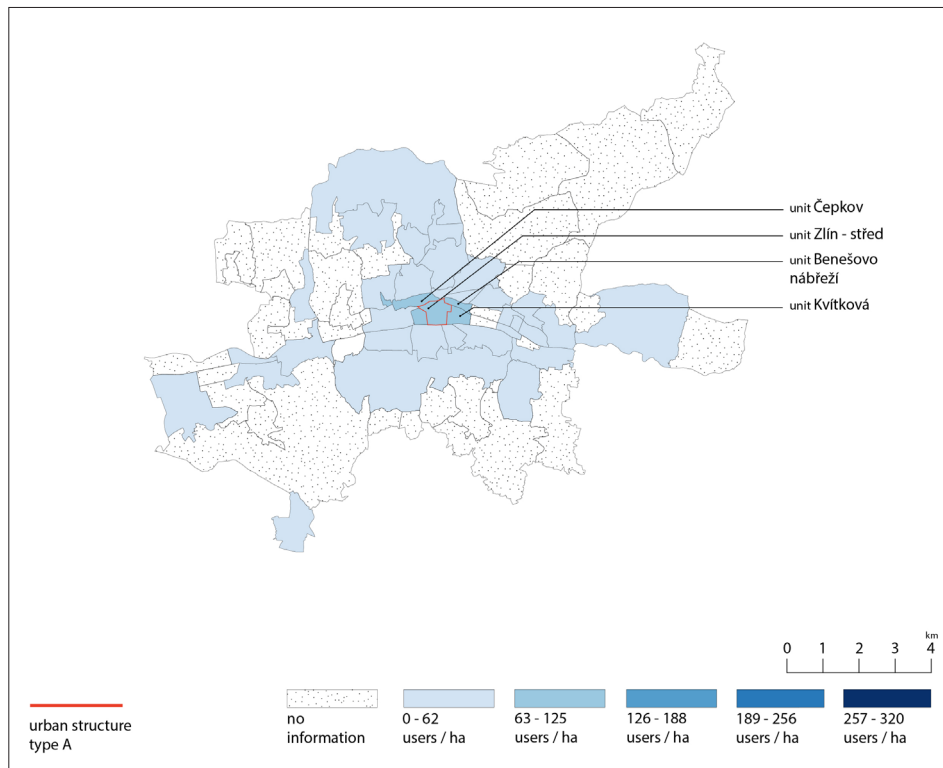


Fig. 9: The attractiveness of individual basic settlement units (ZSJ) in Zlín during the night according to the mobile network operator, May 2018. Source: O2 Czech Republic, authors' elaboration

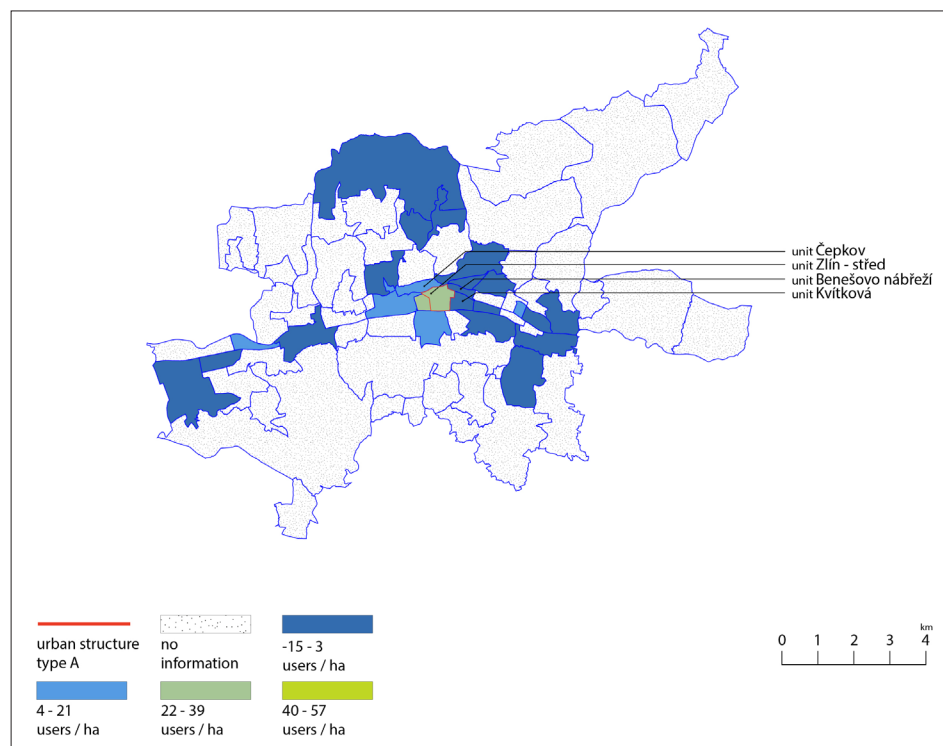


Fig. 10: Differences between the day and night attractiveness of individual basic settlement units (ZSJ) in Zlín according to the mobile network operator, May 2018. Source: O2 Czech Republic, authors' elaboration

4.2 Population distribution changes in Brno, Ostrava and Zlín during the night

The highest density of mobile phone users in Brno at night (see Fig. 5) was observed in fact in the same localities as during the daytime. Of these units, however, the greatest decrease in attending people was found in the most central areas (Fig. 6). Logically, such a decrease should be even more demonstrated in the early morning (4 a.m.). On the contrary, the prefabs on the city outskirts exhibited an increased number of mobile phone users during the night. Nevertheless, this increase was relatively low (on average by 4 users/ha).

The highest density of night mobile phone users per ha in Ostrava (Fig. 7) was shown in the central parts of the city, which also recorded the greatest decrease – similar to Brno. In mono-functional residential areas, the increase was not significant (on average by 1 person/ha; Fig. 8).

The highest density of mobile phone users in Zlín during the night hours was observed in the same areas as during the daytime. Logically, the highest decrease of persons present during the night was found in the city centre (see Fig. 9). In Zlín, the situation at 4 a.m. did not differ from the night average – there are probably much fewer night clubs, shops and restaurants as compared with Brno and Ostrava. In the other central territorial units of mixed residential or non-residential character, the decrease of users did not

occur at night (Fig. 10). Some increase of night-time users (2–8 persons per ha) was found in the mono-functional residential urban structures of all kinds: family houses, villas, apartment buildings. In the largest prefab neighbourhood of Zlín (Jižní svahy – Southern Slopes), however, the operation of mobile phones was identical both during the day and in the night time.

4.3 Changes in mobile phone users in urban structures during the day and night

The above maps (Figs. 1–10) show the numbers of users of mobile networks in basic settlement units of all three cities. Figure 11 presents the continual change in the number of users during the day in the different types of urban structures. The individual diagrams illustrate changes from four o'clock AM to ten o'clock PM, i.e. at the time when the cities live (*x*-axis); in the remaining night hours, the number of users was constant.

Changes in the density of users are not expressed in the number of individuals per hectare but in relative values – in percentage terms (*y*-axis). While the data relating directly to the territorially demarcated units may be inaccurate in the territorial demarcation/geo-location distorted by the transmitters of mobile network operators, relative changes occurring in time do not suffer from such inaccuracies: in these situations, the use of data from mobile network operators appears the most beneficial.

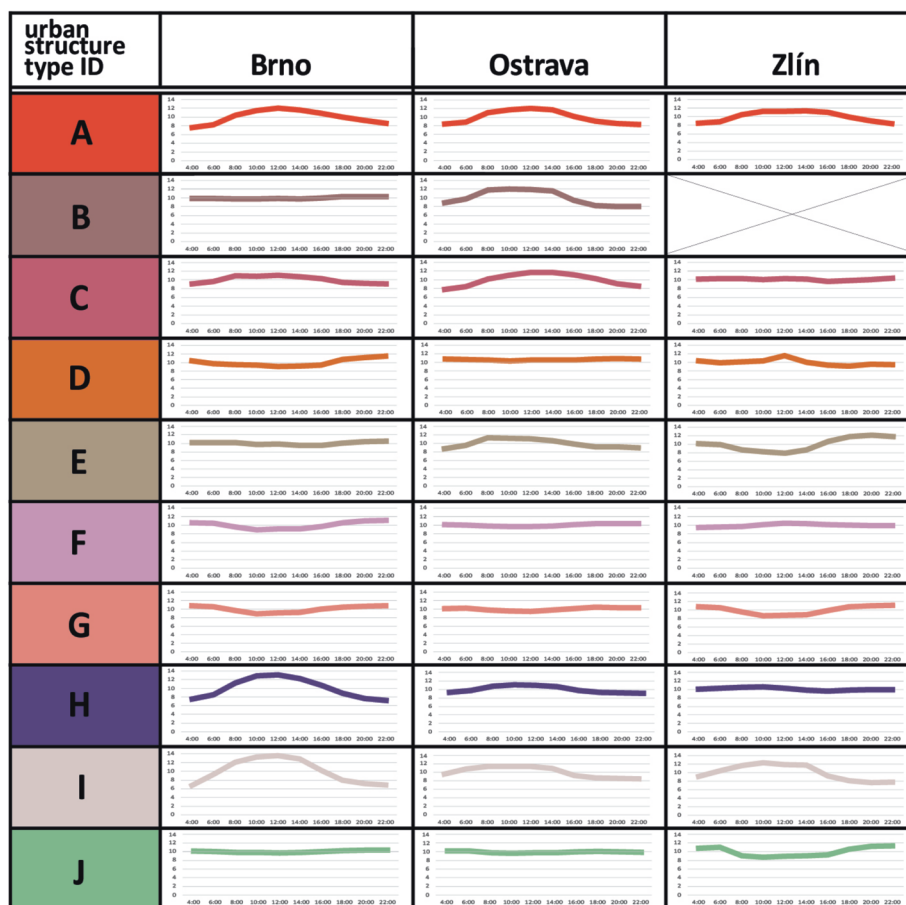


Fig. 11: Changes in the density of mobile phone users in the urban structure types of Brno, Ostrava and Zlín during the day. Source: O2 Czech Republic, authors' elaboration

Legend: Urban structure types: A – central block; B – suburban block; C – unordered urban area; D – two-year plan buildings; E – villa quarters; F – prefab housing estates; G – family houses; H – public infrastructure; I – storage, manufacture, services; J – forests and parks. Note: The data represent all basic settlement units in the investigated cities with the dominant above-shown type of urban structure.

It seems that the change in the density of phone users does not depend so much on spatial aspects of the concrete type of urban structure, but rather on the functional use of the area and whether the function of this area is of housing character or serves visitors. Logically, in practically all cities, the greatest daily fluctuations – daytime increases – are recorded in central areas (A), in areas with civic amenities (H) or manufacturing and administrative complexes with high numbers of employees (I). The studied cities do exhibit, however, some differences in the dynamics of user density change, following from the size and significance of the city and its inner layout. As the largest and most significant city, Brno exhibits the greatest density changes in the city centre and in the areas of manufacturing and civic amenities. Recording smaller daytime increases in the centre, the polycentric Ostrava shows, by contrast to Brno, higher day-time activities in the centres of city districts, which are often comprised of B type block structures. Zlín, with the predominant dwelling character of most structures and a minimal number of external visitors, exhibits the greatest night increases of mobile networks users. A special Zlín peculiarity is the high night activity in suburban woods (J), which is probably caused by inhabitants of summer cottages not returning home for the night. (In this context, it should also be mentioned that the number of users of mobile networks in such areas exceeds the number of inhabitants, according to the census).

Comparing details of the situation in the respective basic settlement units, we found out that considerable differences in the dynamics/rhythmicity of changes in the density of visitors can happen inside a single type of urban structure too. Figures 12–14 show the development of the number of persons, who are present in selected central and residential localities of the surveyed cities during the whole day. The data are related to the number of persons per hectare. In all cases, typical urban structures were chosen, in which houses are organised in more or less regular closed blocks. Figure 12 describes the situation in the poly-functional structures of historical cores; Figure 13 shows the situation in a wider urban centre (in Brno and Ostrava) with constructions from the turn of 18th and 19th centuries; and Figure 14 shows a block structure with the dominating residential function from about the middle of the last century, which can be found in the unbroken urbanised area away from urban centres. The situation represented by the basic urban units of Bratislavská and Hvězdová in Brno (Fig. 13) is atypical, as it has a high share of the Roma population.

The expected decrease of mobile phone users in the central areas at night was confirmed, but the number of users in the central areas of the cities remains surprisingly quite high, also at night. The residential quarters of the cities are not completely depopulated during the daytime either. Some extreme differences can be seen in Brno, where the city core attractiveness during the day is the largest of all studied cities. Such a situation reflects the concentric organisation of the urban structure in Brno, as well as a greater power of this city reaching beyond its regional borders. At the same time, the unattractiveness (depopulation) of residential parts situated on the city outskirts is shown in Figure 14. While the density of mobile phone users in these parts of Brno decreases, in Ostrava the decrease is insignificant and in Zlín it does not occur at all.

The situation in the above-mentioned locality of Bratislavská-Hvězdová with a large share of a culturally different population is interesting (Fig. 13). The

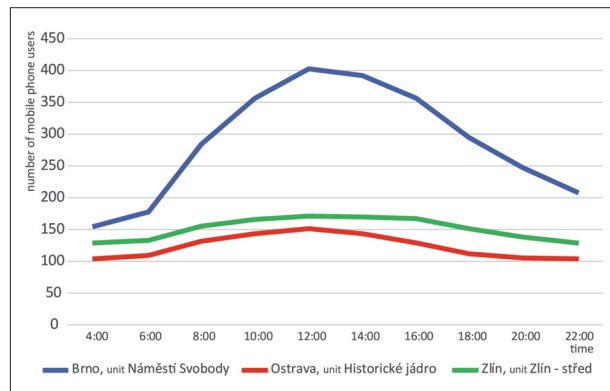


Fig. 12: Development in the density of mobile phone users in the historical cores of Brno, Ostrava and Zlín during the day (Náměstí Svobody Square in Brno, Historical Core in Ostrava, Zlín-Centre)

Source: O2 Czech Republic, authors' elaboration

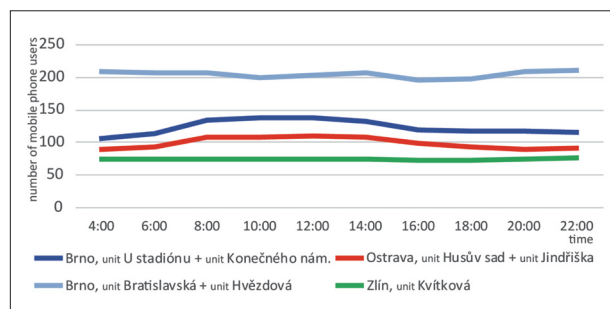


Fig. 13: Development in the density of mobile phone users in the wider centre localities of Brno, Ostrava and Zlín during 24 hours

Source: O2 Czech Republic, authors' elaboration

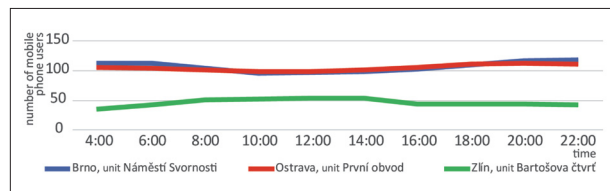


Fig. 14: Development in the density of mobile phone users in the residential localities of Brno, Ostrava and Zlín during 24 hours (Náměstí Svornosti Square in Brno, První obvod District 1 in Ostrava-Poruba, Bartošova čtvrť Quarter in Zlín)

Source: O2 Czech Republic, authors' elaboration

concentration of mobile phones (hence the concentration of people) is very high as compared to other parts of the city, although there are considerably fewer social infrastructure facilities and other central urban functions in this area. In addition, more mobile phone users are recorded there at night than during the day.

The number of phone users present at night in the attractive historical cores and in the quarters inhabited by the Roma population in Brno significantly exceeds the number of permanent residents. Whereas in the case of the historic cores, this phenomenon is likely to indicate flats that are rented for a short-term to tourists or students, in the case of the Bratislavská-Hvězdová locality, there are probably people who have not been registered in the population census (relatives of Roma residents) (see Tab. 1).

The comparison of mobile phone users at four o'clock in the morning also indicates that in the wider urban centre more flats are rented than in the prefabs.

5. Conclusions: Challenges and possibilities of monitoring of users in the urban space

In summary, in all three case study cities, the highest concentrations of mobile network users were recorded in the historic city centres, both during the day and at night. At the same time, however, city centres (excluding mono-functional production, administrative and commercial parks) recorded the largest differences between the numbers of day and night mobile phone users. The historic cores exhibited a high number of users despite a declining number of permanent residents and the outflow of many business activities to new premises on the city outskirts. With the general economic improvement, rising land values and spatial development policies aimed at deconcentration, more people move away from the core areas than move in (Jones, 2000), and similar processes are observed in the largest Moravian cities. It turns out that the picturesque compact and multifunctional structure of the historic core is attractive to visitors by itself, even when the core is relatively small, and central functions are largely concentrated in a new centre outside the original historic core, which is the case of Zlín. Despite this common feature – attractiveness of a compact historic structure – one fundamental difference between the monitored cities was confirmed, which lies in their arrangement. The historic core and the city centre in a concentric layout, such as in Brno, is more important and more attractive to visitors.

The high number of night users of the mobile network in the historic centres of all three cities, even in settlement units with no hotels and night clubs (Tab. 1) is somewhat surprising with respect to an ever-decreasing number of permanent residents in central urban areas – at night, when there are no tourists or employees. This possibly means there is still a relatively large number of statistically not registered residents in the city cores. The observed data say nothing about the social structure of these tenants, i.e. whether they are temporarily accommodated students and young employees or tourists or unregistered members of social/ethnic groups, which could be a sign of the (unwanted)

degradation of the urban structure. As Wittmann and Kopáček (2019) show, however, high prices of real estate in the historic centres of the monitored cities rather suggest a high attractiveness of the studied central localities and that the tenants are relatively wealthy.

With a high share of students and young urban professionals, who are present in the city with the most developed quaternary functions, Brno has a much higher number of temporary residents in comparison with cities that do not have such types of activities. Brno city population is estimated to be about 160,000 persons more than the statistically recorded number of permanent residents (Brno, 2014). This fact was first discovered through the exceeded capacity of the municipal wastewater treatment plant, i.e. not by demographers or statisticians, and it has been confirmed by other technical infrastructures, for example by the number of persons paying for waste disposal.

The above research results lead to the following conclusions. The density of the users of mobile networks, i.e. the number of persons in the area, depends on: [1] city size; [2] on the urban structure and on the relative position of individual functional city areas; [3] on the course of contemporary urban processes such as suburbanisation or gentrification; and [4] on quaternary functions which are mostly post-productive: education, health care, commerce, tourism, and entertainment. Universities, hospitals and commercial centres play the most important role in the daytime rhythm. These aspects discriminate between the three cities under investigation.

Of course, the suitability of the methodology used in this study can be discussed. One of the deficiencies in the open mobile phone data consists in the recorded numbers reduced due to data aggregation and anonymization using 100 users as a limit.

Another problem is the accuracy of up to 100 metres of user signal geo-locations. This could mean that, especially in the city outskirts, phone users can be classified within settlement units different from those they belong to according to the Czech Statistical Office. We agree with the opinion of Soukup (2017), who says that mobile phone data do still have problems with the accuracy of collected user numbers, due to their aggregation to the total number of inhabitants. For such differences, mobile phone data

Locality	Residents per ha (census 2011)	Users of mobile phones per ha at 4 a.m.
Historic Core in Brno	55	142
Historic Core and adjacent parts in Ostrava	85	103
Historic Core in Zlín	68	128
Wider centre in Brno: U stadiónu, Konečného náměstí Sq.	141	111
Wider centre in Brno: Bratislavská and Hvězdová Streets	179	223
Wider centre in Ostrava	132	85
Wider centre in Zlín	89	75
Prefabricated estate Bystrc in Brno	81	12
Prefabricated estate Poruba in Ostrava	108	37
Prefabricated estate Southern Slopes in Zlín	94	13

Tab. 1: Residents versus mobile phone users in some parts of the studied cities during the night

Source: O2 Czech Republic, authors' calculations

Note: Due to a possible discrepancy between the borders of basic settlement units and the areas of telecommunication services, several units were calculated together

should be considered as additional information, where careful calibration and caution in usage are needed. The inaccuracy mainly concerns the absolute number of users in the settlement unit. If we monitor the dynamics, changes in the number of users during a unit of time, however, the data appear to be relevant.

The data from the mobile network operator give a picture of day and night patterns of users' movement within the city, which can be considered in creating a more dynamic picture upon their weekly renewal, than data provided by the Czech Statistical Office. The number of mobile network users seems to be another very useful urban indicator, in addition to population density and stop index or floor area index. Nevertheless, data provided in the open format should be used carefully at least in the format they are published on the O2 API website. There is a huge potential for the use of mobile phone data by city planners after a robust data calibration in the future, and it would be interesting to compare the mobile phone data information with the population Census coming up in 2021.

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Fig. 11: An example of a bilingual board with the name of a village in Polish and Belarusian, Podlaskie Voivodship (Photo: M. Konopski)



Fig. 12: Orthodox church of the Dormition of the Holy Mother of God in Czyże, Podlaskie Voivodship (Photo: M. Konopski)

Illustrations related to the paper by M. Konopski