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TOWARDS A REGIONAL CROSSOVER MODEL? THE ROLES PLAYED BY SPATIAL VICINITY AND CULTURAL PROXIMITY AMONG ETHNIC MINORITIES IN AN EAST-CENTRAL EUROPEAN BORDERLAND

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crossover ethnic model;
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Romania

Abstract: The issue of intercultural negotiation among ethnic minorities in border areas has been widely debated in the social sciences, but the roles played by spatial vicinity and cultural proximity in influencing ethnic membership in borderland areas is still under-researched. This article addresses the role of geographic vicinity among ethnic minorities residing in a border area and the way cultural proximity is involved in this process. The research uses a questionnaire and interviews with a sample of members of ethnic groups (Hungarians, Bulgarians, Serbs and Ukrainians) who live in western Romania (Timiș county). The findings highlight that geographic proximity constitutes a key factor in the manifestation of cultural proximity in the relationship between ethnic minorities and their counterparts in the cross-border region. This process is also shaped by the bilateral relations between the host country and the country of origin of the ethnic group. Concluding the analysis, a crossover ethnic model is proposed.

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Introduction

Previous studies in human geography and more broadly in the social sciences have shown that the process of intercultural negotiation is most active in cross-border spaces (Paasi 1991, Paasi 2003, Paasi 2018, Newman and Paasi 1998). Spatial and cultural proximity to cross-border space typically results in close political, social, and economic relationships between the people on both sides of the border (Scott 2015). Regional identity can influence intercultural negotiation in border areas because this process is based on the sense of belonging to a particular territory that is shared by people, and it is part of their cultural identity (Pohl 2001). Regional identity develops from the individual's personal and group experiences, which are socially mediated and strongly influenced by the historical experience of the place. It encompasses numerous material elements (landscape, specific architecture, material culture) and immaterial aspects (oral tradition, stereotypes, spoken language, music, dance), as well as economic distinctives and the centre-periphery relationship (Paasi 2018). It can bring together human groups who live in delimited political-administrative spaces but have a shared historical experience (Pascaru 2005).

The aim of this study is to identify the reciprocal implications generated by geographical neighbourhood, regional identity, and cultural proximity in the context of relations between ethnic minorities and their countries of origin in the cross-border area in which they live. The theme of relations between minorities and their country of origin is an important topic in the context of the European integration process (Duvold 2015, Scott 2015) and this aspect is manifested in Romania's bilateral relations with neighbouring countries (Deică and Alexandrescu 1999, Ploae 2017). Our research focuses on four major ethnic groups (Hungarians, Bulgarians, Serbs, and Ukrainians) living in the west of Romania and more specifically in Timiș county and it sets out to answer the following research questions: 1) How do the members of ethnic minorities perceive their connection with their country of origin and with their conationals in the cross-border area?; 2) How does the geographical proximity influence the relationship between an ethnic group and its country of origin?; 3) Does cultural proximity based on a common ethnic identity bring people close enough for distance to be of no account, or does physical distance limit contacts between people of the same ethnic identity?

Romanian researchers have studied the intercultural solidarity fuelled by regional identity (Gavreliuc 2003), the cultivation of interculturality in both informal and institutional contexts (Neumann 2012, Para and Moise 2014), the development of cultural, educational, and scientific research activities (Para and Moise 2014), the economic activities (Ploae 2017) and cultural affinities, and the cross-border solidarity of Romania with Serbia and Hungary (Rădoi 2017). However, the impact of geographical and cultural proximity upon ethnic minorities in border areas in Romania is under-researched. Such studies as exist either fall within broader ethnic studies

(Crețan 2006) or they make only a passing reference to work done on cross-border situations (Rădoi 2017).

This paper adds to existing knowledge by highlighting the beneficial influence of interpersonal and group relationships based on spatial and socio-cultural proximity. In addition, it focuses on the twofold perception of the host country and the ethnically related country, and it suggests potential positive implications for higher-level bilateral relations between the involved ethnic groups and their countries of origin.

Spatial vicinity, cultural proximity, and ethnic minorities in cross-border areas

Vicinity (or neighbourhood) and proximity are two almost synonymous concepts. The two terms both express the juxtaposition of two territorial or social entities that have a common reference element. The geographical vicinity of two territories is synonymous with geographical proximity because both concepts spring from the juxtaposition of two spatial units (Erdeli and Ielenicz 1999). Depending on the relationships established between human groups, the neighbourhood may involve relationships of cultural proximity (Unger and Wandersman 1985). In its geographical sense, vicinity implies a dynamic functional relationship between two adjacent territories or states, resulting from the interaction of certain geographical elements and the contiguity of others (Roberto 2018). Turning to the human factor, it is important to note that vicinity creates a special type of relationship based on knowledge and interaction between the concerned groups (Erdeli and Ielenicz 1999).

The term "vicinity" is therefore related to human groups and to the construction of spaces in which they share common values based on interpersonal relationships. The identity and boundaries of these small socio-territorial complexes are conditioned by external factors such as the actions of authorities. The concept of spatial proximity derives from the location of a territory in its immediate vicinity (Roberto 2018). And it constitutes an important geographical factor in the functionality and evolution of territorial systems (Cocean 2002, Neguț 2011).

Cultural proximity refers to people's preference for listening to and even their greater likelihood of accepting messages that are in their mother tongue or messages that come from a culture with which they share common characteristics (Felbermayr and Toubal 2010) or to which they feel close (Straubhaar 2021). Cultural proximity does not always follow geographical proximity. Two geographically adjacent countries can be very different, and their inhabitants manifest a strong perception of otherness, as is the case with the relations between Greece and Turkey. Similarly, two nations that have strong cultural identity ties and have spatial proximity between their territories may not develop relations of cultural proximity. This is the case with Russia and Ukraine

(Grumaz and Rotaru 2015, Plokhy 2017, Tchernoff-Horovitz 2022), the latter of which shares a border with Romania, two countries whose relationships have influenced the working agenda of the European Union and of Romania in terms of foreign policy (European Commission 2023). Although culturally close to Russia, Ukraine has become increasingly distant from it due to the current conflict but it has also become increasingly close to the countries of its western neighbourhood, including Romania.

The country of origin of an ethnicity is an important attribute for that specific ethnicity. For an ethnic group with the status of a minority in another national state, the 'related' country is the one with which they share the same ethnic origin, language, or religion (Sheffer 2006). This phenomenon is evident in the case of countries whose nation has many minorities in other states, such as Hungary and Russia, both of which are known for their active involvement in relationships with the host countries of their ethnically related groups (Duvold 2015).

In the literature devoted to border studies, Balibar (2002, 2009) analyses the typology of contacts between European countries and proposes a crossover model or the theory of crossover ethnic contact specific to the countries on the southeastern flank of Central Europe. The crossover model of political space is specific to the countries in the eastern flank of Central Europe. The definition of political space encompasses the concept of territory approached from a constructivist perspective, as a result of interaction and negotiation between human groups (Painter 2010, Antonsich 2017). In this context, interactions between states and interactions between nations develop in various ways and at different levels, covering a wide range of interests in the political, economic, social, and cultural spheres (Balibar 2009). All these factors have an impact on the complex process of preserving the ethnic identity of minority ethnic communities.

Initially, this model of interaction between countries was applied to the entire European space, where three major open spaces overlap: the Euro-Atlantic space, the Euro-Mediterranean space, and the Euro-Asian space (Balibar 2002). Throughout Europe, especially in the areas of their intersection, between the Baltic Sea and the Mediterranean Sea, there is no homogeneous space, neither in terms of cultural identity nor in terms of political identity.

An ethnic crossover pattern of interaction between neighbouring countries can be observed in the case of minorities whose kin state is a country neighbouring their country of residence. Communication channels are multiple and intertwined with the overlapping folds of relations between those countries. The practice of cross-border relations of communities is synergistic with the cross-border policy of states (Duvold 2015, Ploae 2017).

Additionally, a multi-modal practice may be observed in Romania's relations with the neighbouring countries, relations which have numerous roots and which generate

ramifications across a wide spectrum of the country's social and economic life (Popa 2006a, Ilieș et al. 2010, Damian et al. 2014). The present-day opening towards neighbouring countries and the permeability of state borders evokes cultural solidarities which are rooted in the modern era but also entail risks (Popa 2006b). Additionally, the model of territorial deconstruction which occurs in the social and economic life of cross-border territories, as theorised by Paasi (1991, 2018), can be confirmed from the Banat area.

In Timiș county, and in the Banat region in general, the process of interethnic contacts is complex, and it is made more so by the existence of autochthonous ethnic minorities with a shared historical experience, living in neighbouring countries and separated from their other fellow ethnics in Banat by small distances of under 100 km (Ilieș et al. 2010, Berceanu and Popa 2022). Another factor is that the spatial dynamics of ethnicities in Romania exhibit a decreasing trend for all ethnic groups, with the exception of the Roma, where the trend is an upward one (Rotaru et al. 2023). This same pattern can be clearly seen with the ethnic groups in Timiș county. Moreover, regional identity and a sense of belonging as Banaters are very strong in the study area. Western cultural values are associated with pride, even in sports and other activities (Crețan 2019). However, the migration of Romanians and other ethnic groups from other regions into the Banat region that took place in the communist and post-communist periods has led to a kind of social distancing against the newcomers (O'Brien et al. 2023) and even to patterns of otherness (Crețan et al. 2023).

Similar to Banat, there are many other regions in Europe that have experienced territorial and political divisions as a result of the formation of nation-states or the deconstruction of states due to ethnic territorial partitioning. One such is the case of Cyprus, divided between Greek and Turkish Cypriots for nearly 50 years (Gürdalli and Bulanik 2023). There the two ethnic groups have achieved some local reconciliation by participating in shared cultural events such as the "Buffer Fringe" festival (Gürdalli and Bulanik 2023). Furthermore, economically disadvantaged marginal regions can find opportunities in cross-border cooperation with administrative-territorial units in neighbouring countries, as it is the case for the Gemer Region in Slovakia and the neighbouring Borsod-Abaúj-Zemplén county in Hungary, leading to economic benefits derived from the exploitation of tourist resources (Hutárová et al. 2021). The same pattern can be seen within the DKMT (Danube-Criș-Mureș-Timiș) Euroregion, of which Timiș county is part, where cross-border exchanges have supported the economic development of disadvantaged areas in Romania and Serbia (Ilieș et al. 2010).

Methodology

Study area

Timiș county was part of historical Banat, a province that was divided between

Romania, Serbia, and Hungary at the Paris Peace Conference of 1919. Today, it is part of the Dunăre-Criș-Mureș-Tisa Cross-Border Development Euroregion (Figure 1, DKMT Euroregion 2023). Besides being the westernmost county in Romania, Timiș is also the largest, covering 8,697 km², which represents 3.69% of Romania's total area. To the west, Timiș county shares borders with Hungary and Serbia. The majority of the territory consists of plains and low hills, with elevations of below 300 metres (Munteanu and Munteanu 1998). The extensive plain area provides open access to the west without any physical-geography limitations.

Figure 1. Timiș county as part of historical Banat and of the Danube - Criș - Mureș - Tisa Euroregion
Source: Timár et al. 2008, Esri Romania 2022, DKMT Euroregion 2023, Eurostat 2023

Timiș county and the sample of studied ethnic minorities

In Romania, Timiș county is one of the nine counties that had a minority ethnic population of 10% or over, according to the preliminary data of the 2021 census carried out by the National Institute of Statistics (2022). Further in the analysis, we will be referring mainly to the data of the 2011 population census, since, at the time of writing this paper, local-level data for the 2021 census were not yet available.

In the 2011 census, Timiș county had a minority ethnic population of 12.87%, while in 2021 this represented 11.38% (Figure 2). Between 92% and 95% of localities had at least one resident who declared an ethnicity other than Romanian in the previous censuses

(from 1966 onwards). In the 2011 and 2021 censuses, the most numerous minorities were the Hungarians, Roma, Serbs, Germans, Ukrainians, Bulgarians, and Slovaks. A characteristic of the ethnic minority population is its dispersal throughout the territory, especially evident in the case of the Hungarian ethnicity. The Serbian population is predominantly (88%) concentrated in four localities: Timișoara, Sânnicolau Mare, Sânpetru Mare, and Peciu Nou (including the village of Diniaș), but Serbs have been identified in over 50% of territorial administrative units of Timiș county. Ukrainians are clustered in the southeast of the county, while Bulgarians are concentrated in the northwest.
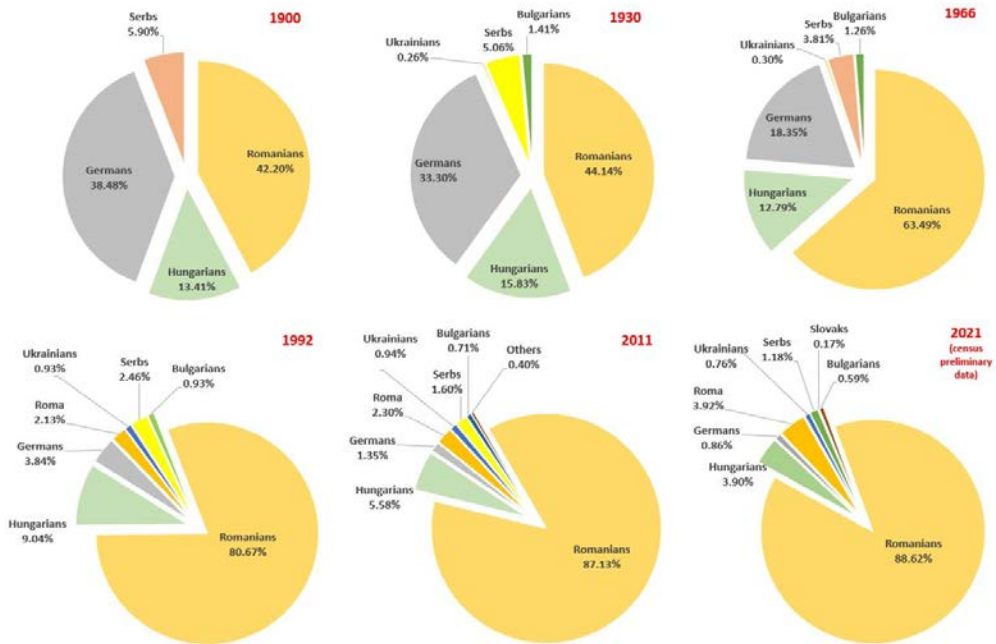
Figure 2. The ethnic structure of the population of Timiș county (selected censuses between 1900 and 2021)
Source: Crețan 1999, Varga 2002, National Institute of Statistics 2022

Timiș county is relevant from the perspective of its ethno-demographic structure and its proximity to Serbia and Hungary. Over 50% of the Serbs and Bulgarians in Romania are located here. Hungarians, however, are the largest ethnic minority in the county (5.58% in the 2011 census and 3.38% in the 2021 census), and Timiș is also home to the fourth largest concentration of Ukrainians in the country (National Institute of Statistics 2022).

Hungary and Serbia border Romania and the territory of Timiș county, where the empirical research was conducted, but they lie partially within Romania's area of cultural proximity. The factors that bring them closer to Romania are related to their common historical experience. After 1918, Romania and Serbia became increasingly

close, initially because both countries were interested in forming a united front against the revisionism promoted by Berlin and Budapest, and then, after 1945, because both countries were part of the same socialist political and economic bloc (Connelly 2020). The post-1990 rapprochement between the two countries was due to shared economic and geopolitical interests (Naumescu 2019). The cultural proximity between Serbs and Romanians was founded on their common belonging to the Orthodox rite of Christianity and because over the centuries of shared history the two peoples had often been in solidarity, or they had common enemies (Cerović 2005, Popoiu 2017). As for Hungary, the sentiment of ethnic otherness is too strong (Cobianu-Băcanu 2007) for cultural proximity to be established, even though the two countries have been part of the same political and territorial ensembles (Warsaw Pact, NATO, EU) for at least 75 years (Naumescu 2019). In addition, the nationalistic discourse of the present Hungarian government can easily provide reasons for Romanians to distance themselves from the neighbouring country (Dâncu 2020).

If we look at the dynamics of the ethno-demographic structure of Timiș county as shown in the censuses, a sharp decrease in the proportion of minorities is evident in the decades after this region became part of Greater Romania in 1918. The main causes identified by historians are the negative population balance, emigration (especially among Germans, who left in great numbers after 1970), and an increase in the proportion of the Romanian population due to inward migration from other counties within the country (Crețan 1999, Bunea 2012).

Research methods

We used a mixed methods approach based on a questionnaire, a semi-structured interview, census statistics and policy papers. Overall, the research followed a paradigm specific to human geography by addressing the territorial dimension of the issue and by investigating its spatial impact and the territorial disparities (Fotheringham 2013).

The field research through the use of questionnaires was aimed at achieving territorial and social representativeness (Fotheringham 2013) and it was carried out chiefly in localities in which the Hungarian, Serbian, Bulgarian, or Ukrainian minority exceeded 20% of the population (Figure 3). This threshold of 20% ethnic minority population out of the total population of a locality was established by the Law 215/2001 and it allows ethnic communities to use their languages in administration, culture, and social life (Romanian Parliament 2007). This category accounts for 73% of all localities where questionnaires were applied, and it covers 79% of the total of 382 administered questionnaires. Four additional localities, in which the ethnic minority populations are significant but their proportion is below 20%, were included: Dumbrăvița for Hungarians, Timișoara and Variaș for Serbs, and Nițchidorf for Ukrainians (Figure 4).
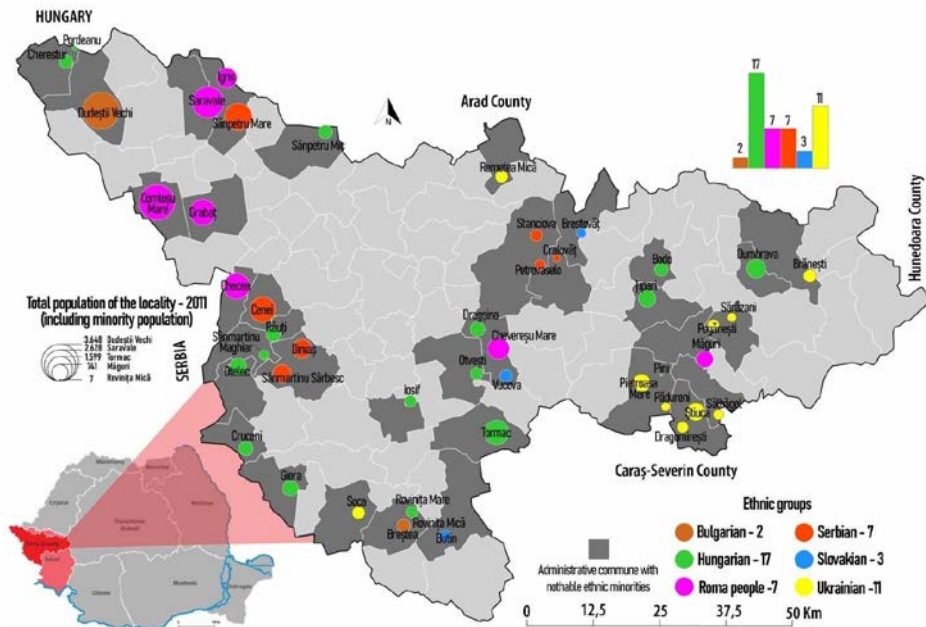
*Figure 3. Local administrative-territorial units in Timiş county, evidencing the settlements where more than 20%
of the population belonged to an ethnic minority in the 2011 population census
Source: Timiş Regional Directorate of Statistics 2023*
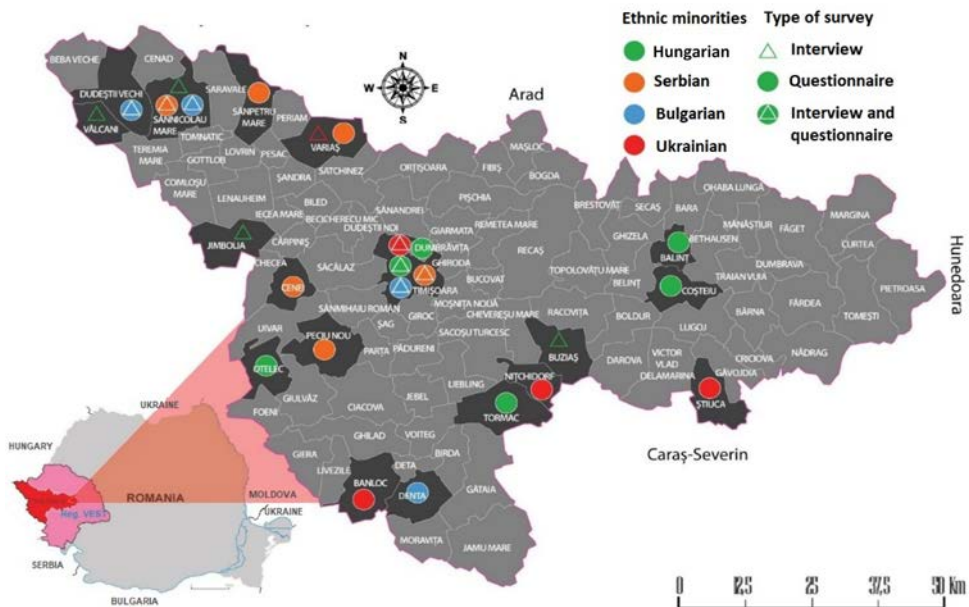
*Figure 4. Localities of Timiş county in which field research was carried out during 2021
Source: Timiş Regional Directorate of Statistics 2023*

The questionnaire, consisting of 41 items (21 closed-ended questions, 15 open-ended questions, and 5 matrix questions), was administered in 2021 through face-to-face contact. Cluster sampling was employed, following the methodology specific to human geography studies (Lorenzi-Cioldi 2007, Bryman 2016, Parfitt 2013). The data analysis from the questionnaires involved sorting, classification, ranking, comparison operations (Parfitt 2013) and sociological analysis. The responses to closed-ended and open-ended questions were categorised, and the frequency of response types was analysed (Chelcea 2004, Lorenzi-Cioldi 2007). Statistical calculations were made, and correlations were established between responses related to the same issues, and the results were compared and then correlated with the other findings identified in the literature (Bryman 2016).

Furthermore, twenty-five interviews were conducted with individuals directly involved in the cultural and social life of the ethnic minorities in Timiş county, including members of the Romanian Parliament, priests, teachers, and local and regional government representatives. Over half of the interviewees were based in the polarising cities of Sânnicolau Mare (32%) and Timișoara (28%).

The interview consisted of ten main open-ended questions, supplemented by follow-up questions. The purpose of the interviews was to identify qualitative aspects of institutionalised relationships between the minorities being studied and their conationals in the cross-border area (Baxter 2021). Responses were analysed to identify the most significant aspects and concrete facts mentioned by the respondents based on their experience (Valentine 2013). These qualitative insights were then compared with the results obtained from the analysis of responses provided through the applied questionnaire by the members of ethnic minorities, following social and geographical methodologies (Agabrian 2004, Davies 2010, Longhurst and Johnston 2023).

The 382 questionnaires and 25 interviews were conducted in the period 2021-2022, across a large area of the territory of Timiş county. Our field research aimed to cover as wide an area as possible within Timiş county and to have a diverse sample in terms of the social roles of the questionnaire and interview respondents.

Additionally, we used statistical data and policy papers provided by relevant ethnic cultural institutions in Timiş county. These obtained data and information were then compared with the findings from the field research (Flowerdew 2013).

For the data interpretation of questionnaires and interviews, a content analysis was used. Three main themes were identified: 1) the perceived distance from the country of origin of the ethnic group; 2) the connections between ethnic minorities and their fellow ethnics in the country of origin; and 3) the cross-border relations with the neighbouring countries.

Results

The perceived distance from the country of origin of the ethnic group

The attachment of respondents to different territorial constructs was measured by each respondent assigning a rating to a series of territorial constructs listed in the questionnaire: their hometown; the current place of residence; Timiș county; Banat region; Romania; the country of their ethnic origin; and the European Union.

From the questionnaire results, it can be observed that ethnic minority respondents have a high attachment to their host country, Romania, but that, overall, this is slightly less strong than their attachment to their country of ethnic origin (Figure 5).
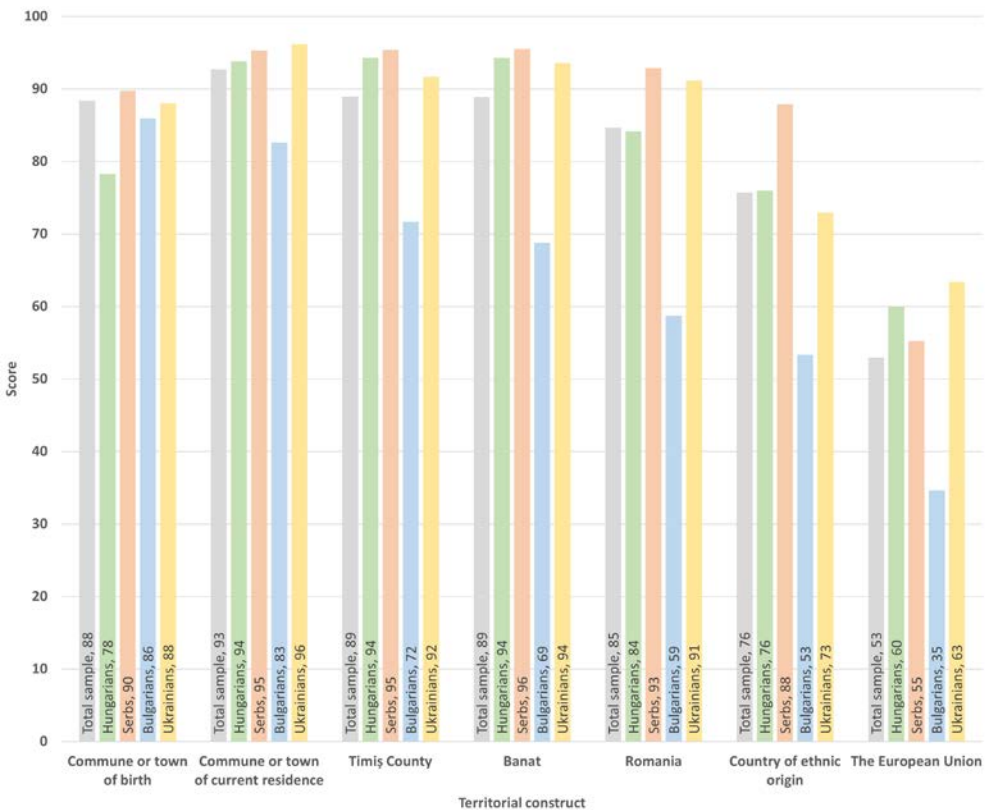
Figure 5. Respondents' attachment to different territorial constructs

In this context, the role of the cultural proximity that our respondents feel towards their country of ethnic origin is clear. It should be noted that in the case of Ukrainians, they can refer to Ukraine as a related country since their proximate origins are not within the territory of Ukraine. The President of the Union of Ukrainians in Romania emphasised this in an interview for our research, stating: "We, Ukrainians in Banat, are neither

settlers nor immigrants. Both in 1906 and in the period after 1960, we moved within the limits of the same country, not from one country to another" (G. H., interview conducted in 2021). It is worth mentioning that Banat and the region of the city of Hust, from where the Ukrainians who settled in the southeastern part of Timiș county in 1906 originated, were both part of the Austro-Hungarian Empire and more specifically of the Hungarian part. Serbs feel the strongest attachment to their country of ethnic origin, but they also rated Romania highly, suggesting cultural affinities with Romanians, with whom they share the Eastern Orthodox Christian religion. In this context, the geographic proximity of the country of ethnic origin clearly did not act as a decisive factor, as Serbs and Hungarians did not assign higher ratings to their countries of origin than Bulgarians, whose country does not border Timiș county and it is over 330 km away.

The contribution of different territorial entities to the organisation of specific cultural activities for ethnic communities is perceived differently by the respondents (Figure 6). Cultural activities are an important component of identity conservation strategy for human communities, and community members attach importance to them (Cobianu-Băcanu 2007).
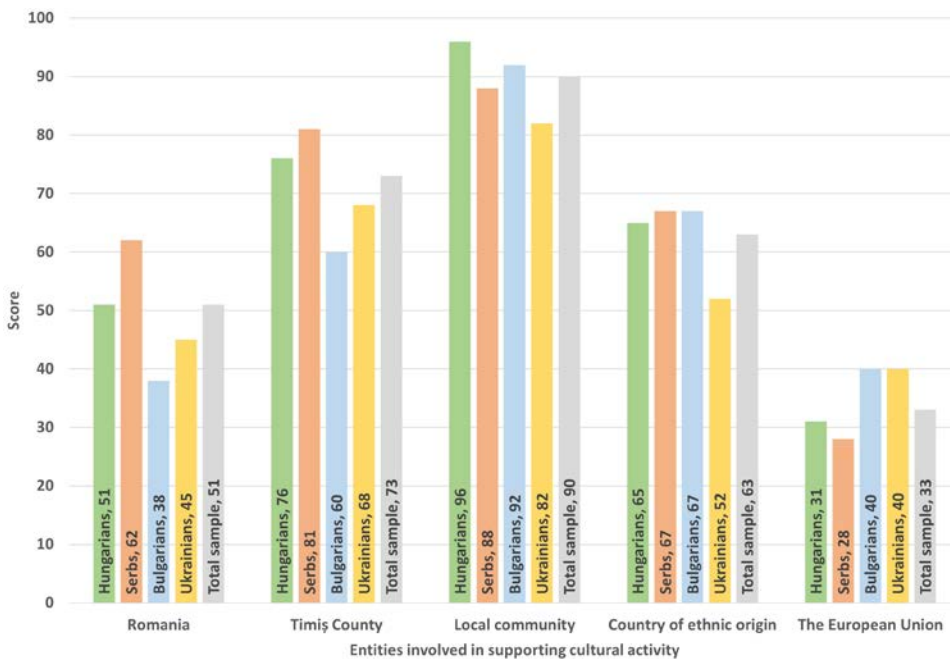
Figure 6. Respondents' perceived involvement in sustaining cultural activities

Among the questionnaire respondents, a majority of over 73% stated that they participated in their ethnic-specific cultural activities, and over 50% stated that these activities were important for the preservation of their ethno-cultural identity. Regarding the personal perception of the roles played by different political-territorial

entities (from the local community to the country of ethnic origin and the European Union) in organising these important activities for them, the score assigned to their country of origin is important. From the analysis of the responses, a higher score was attributed to the involvement of the country of ethnic origin than to that of Romania (perceived through the involvement of the central government in this process). The local community was credited with doing the most, but the European Union also received a fairly high level of trust. Serbian and Hungarian minorities gave more credit than Bulgarians and Ukrainians to their related country than to the host country.

Connections between ethnic minorities and fellow ethnics in the country of origin

We were also interested in understanding the existence of constant and long-term contacts between the respondents and their fellow citizens in other spaces, located at different levels of the regional and cross-border territorial hierarchy (Figure 7). From the analysis of the responses, it is evident that the closest connections are established with the compatriots in the same county, immediately followed by connections with the compatriots from the country of ethnic origin. Here, a distinction could be observed: Serbs and Hungarians declared connections with the compatriots from the country of ethnic origin, located in their immediate proximity, in proportions of over 77% and over 84%, respectively, while the Ukrainians and Bulgarians reported the same connections in proportions of only 44% and 46%, respectively.
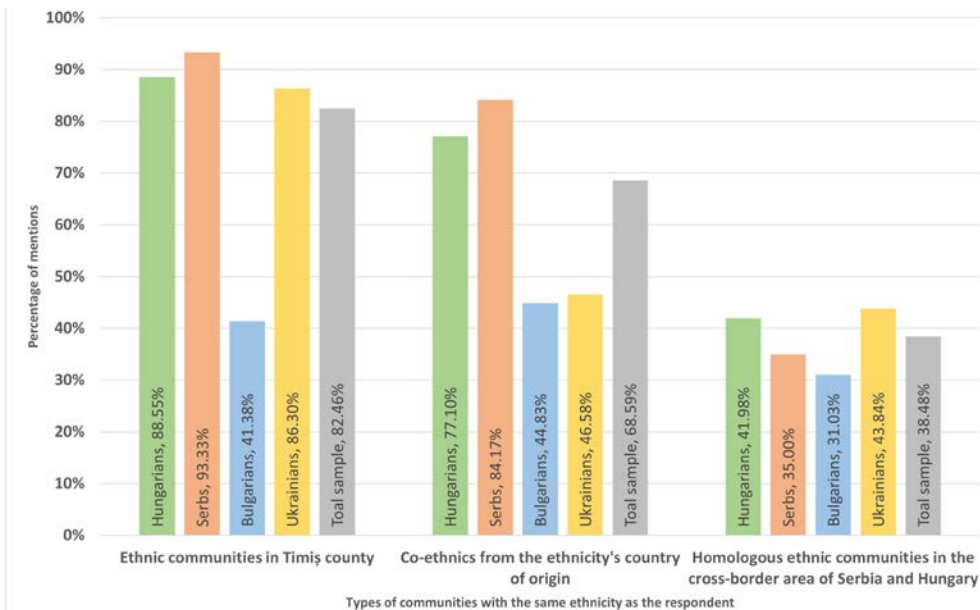
Figure 7. The existence of constant and lasting links between the members of ethnic minority communities in Timiş county and their co-ethnics at different levels of territoriality

Hungarians significantly declared, in a proportion of over 41%, that they also maintained connections with their fellow ethnics in Serbia, located in the cross-border area that overlaps with the historical territory of Banat. Serbs also maintained contacts with their counterparts in Hungary, living less than 100 km from the respondents' place of residence, but to a lesser extent, only 35%. The response from the Ukrainians was surprising in this context, being at over 43% (the highest score). This response cannot be explained by a historical tradition but rather by the cultural proximity facilitated by a common mother tongue. Information supplied by the Union of Ukrainians in Romania reveals the existence of an identity conservation strategy that includes reciprocal visits between the members of Ukrainian communities on both sides of the border, as well as the role of long-distance communication tools that bring together people who speak the same language but have the status of members of an ethnic minority in different countries. The lowest frequency of contacts was observed among the Catholic Bulgarians. This result is related to the small size of the Catholic Bulgarian communities in Serbia, with fewer than 500 members.

The frequency of visits to the country of ethnic origin reflects a strong influence from the proximity factor. In the "monthly" and "3-6 times a year" categories of visit frequency, the highest proportion of positive responses came from Hungarian and Serbian respondents (Figure 8).
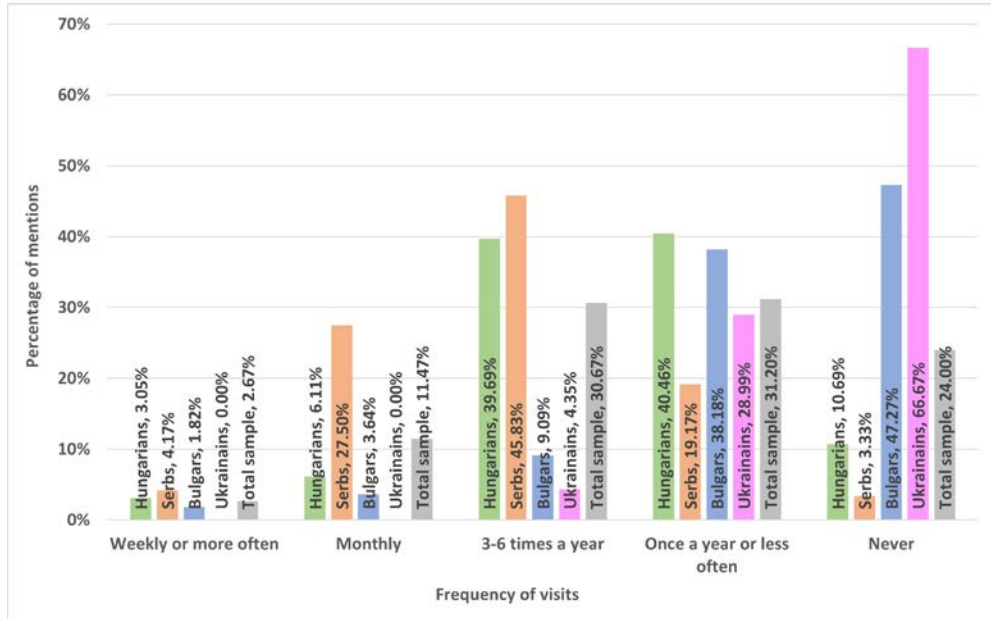
Figure 8. Frequency of visits to the country of origin of the ethnic group in the total sample

Nearly a quarter (24%) of the respondents have never visited their country of ethnic origin. Within this category, the majority are Ukrainians, followed by Bulgarians.

The similar indicator, but on age groups, reveals other disparities (Figure 9). Among the studied ethnic minorities, the most active in visiting the country of ethnic origin at least 3 times a year were the individuals aged 30-64. With the exception of Hungarians, among all other respondents, the majority of individuals who have never been to their country of ethnic origin are also in the 30-64 economically active age group.
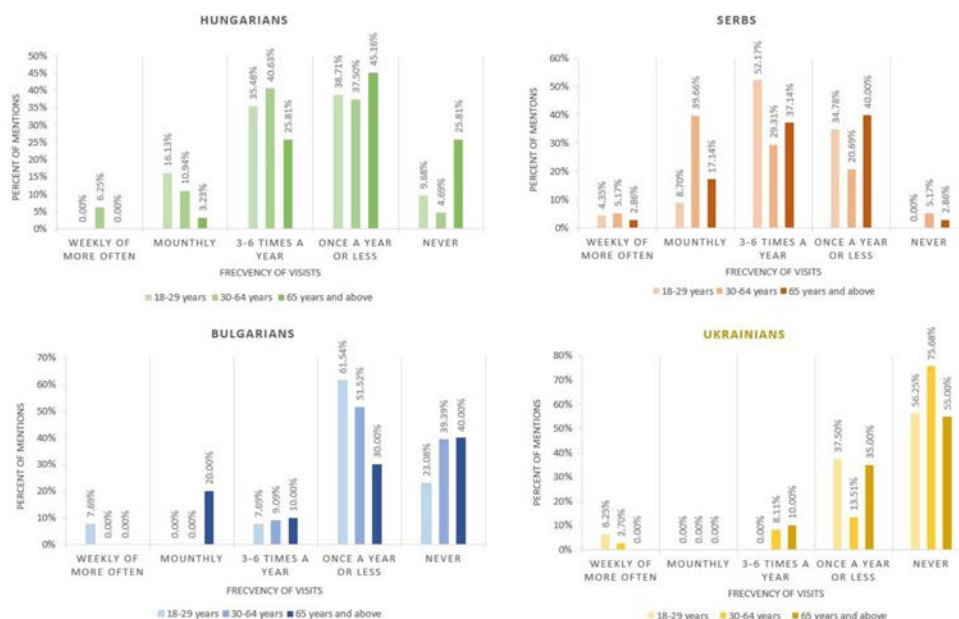
Figure 9. Frequency of visits to the country of origin of the ethnic group, by age group

The connections between the members of ethnic minorities in Timiș county and their fellow ethnics in the country of origin of their ethnicity are very frequent. Our study also investigated people's motivation for cultivating constant and long-lasting contacts (Figure 10). The analysis carried out on the entire sample reveals the predominance of contacts based on social relationships or friendship (over 59%) and those motivated by the need for communication in the interests of the preservation of cultural identity (over 53%). Disparities may be observed between the minorities studied in the category of "friendship", with Bulgarians invoking this motive to a lesser extent. Similarly, they mentioned family relationships much less frequently than other minorities. However, this difference is compensated for by those Bulgarians who are motivated to preserve their language and traditions.

In the relations between the members of ethnic minority communities in Timiș county and their fellow ethnics from the transborder space of Serbia and Hungary, the motivations are the same, but they take on different proportions. For example, Serbs have the lowest kinship relations, Bulgarians the lowest social relations, and

Hungarians the lowest economic relations. In contrast, cultural relations are well represented in each ethnic minority. These disparities are related to the representative-ness of the respective ethnic communities, as minorities in the cross-border space of Serbia and Hungary.
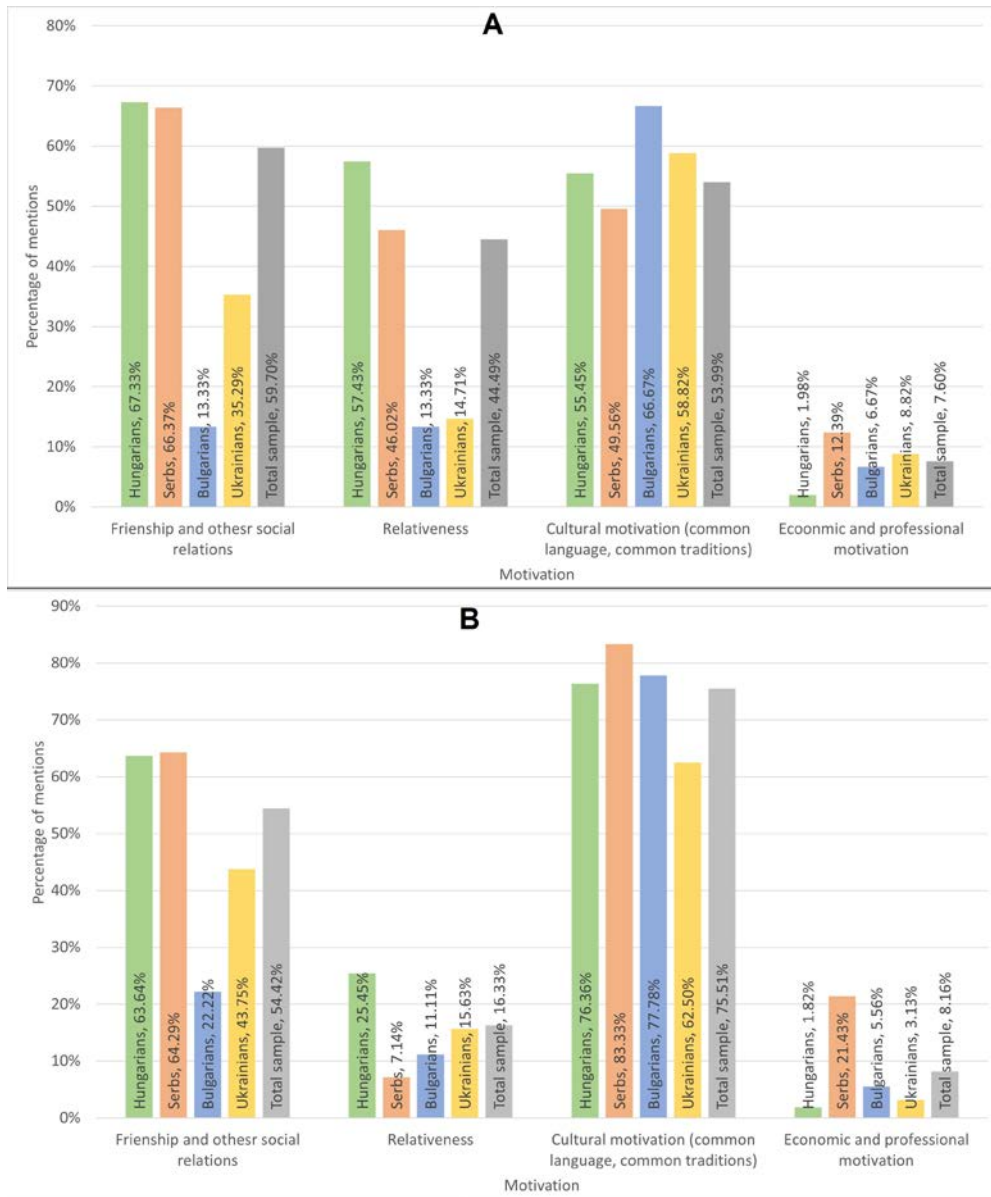
Figure 10. Relations between the members of ethnic minority communities in Timiș county and their fellow ethnics from the country of origin of the ethnicity (A),
and from the transborder space of Serbia and Hungary (B), grouped by areas of interest

On the other hand, the respondents were asked whether they consider the possibility of migrating in the future to the country with which they consider themselves ethnically related. Individuals who stated that they had considered the possibility of emigrating to their country of ethnic origin made up a low percentage (less than 20%) of the total sample. This intention was expressed even by the Ukrainians, whose related country is located at the greatest distance and it has the lowest level of relations with Romania when compared to Serbia, Hungary, and Bulgaria. It is worth mentioning that the survey was conducted in 2021, before the outbreak of the war, so that responses cannot have been influenced by it.

If we analyse the responses represented separately, based on the respondents' educational level, disparities emerge. While differences also exist in the analysis of this indicator across age groups, it is evident that individuals in the 65 and above age group will exhibit the lowest intention to emigrate, due to age-related factors. For all but one of the ethnicities, the proportion of those who have considered emigrating to their ethnic-related country increases in line with the educational level. It is worth mentioning that all those individuals who reported graduating higher education in their ethnic-related country also stated that they had completed their education there. This could be acting as an influencing factor in the analysis. The Serbs constitute an exception, but the difference between the responses received from high school graduates of this ethnicity and those received from college graduates is less than 2%, a percentage that falls within the margin of statistical error for any study of this type (Lorenzi-Cioldi 2007, Parfitt 2013).

Cross-border relations with neighbouring countries

In terms of cross-border relationship with Serbia, a wide range of connections can be observed, forming a complex system of relations between the two countries; these relations are influenced by their shared historical experience and common Orthodox Christian religion (Glenny 2012, Novák 2020), as well as by the bilateral treaties and the cross-border movement of people (Aelenei 2018). In addition, the relations since 1990 have been influenced by European and NATO politics. In this context, the establishment of the DKMT Euroregion in 1997 has stimulated closer bilateral ties in various fields (Crețan 2006), and cross-border development projects have brought numerous economic and social benefits to both countries. The NATO intervention of April-June 1999 in the region generated reactions from the Serbian community in Romania, as reflected in the interviews. A representative of the Serbian community in Timiș county, a writer and publicist, stated: "Romania did not support the Orthodox Easter peace ceasefire (supported by Greece, a NATO member). Romania opened up its airspace for NATO aircrafts to use it for bombing raids, while Hungary and Bulgaria did not" (D. B., interview conducted in November 2020). But the European integration process of Romania has had a positive impact on the Serbian community, as they also have cross-border projects.

As it is clear from our analysis of the interviews, cross-border relations between Romania and Hungary have been active and marked by numerous twists and turns, starting with the delineation of the border between the two countries after the World War I. A central theme in the dialogue has been the existence of the Hungarian minority in Romania and the preservation of its ethno-cultural identity (Novák 2020). The integration of both countries into the European Union (Hungary in 2004, and Romania in 2007), accompanied by the implementation of cross-border cooperation projects, has played a role in this process. The interviews reveal a positive perception of the effects of the European integration process on the social and cultural life of the Hungarian minority in Timiș county.

The relations between Romania and Bulgaria have developed in a positive evolution since the World War II (Aelenei 2018, Connelly 2020). As with Hungary, the collapse of the communist regime in December 1989 and the process of integration into NATO and the EU have played a positive role in strengthening the relations between the two countries. But, the cross-border projects with European funding have had a much smaller impact on Timiș county, as their area of implementation is in southern Romania.

The importance of the relations between Romania and Bulgaria was also revealed by the responses given in the interviews with individuals directly involved in the cultural life of the community. The Bulgarian respondents stated in the questionnaire survey that they maintain constant relationships with their counterparts in their country of origin up to a proportion of 25.86%, while with counterparts from Serbia and Hungary up to a proportion of 31.03%. The main cause of this behaviour, in contrast to the case of Serbs, lies in their cultural identity itself. In Serbia, there are Catholic Bulgarians who originated from the settlement of the population from Dudeștii Vechi in the 19th century (Vasilcin 2013). On the other hand, the distance from the country of origin, as well as the different religious identity and tradition of the last three centuries have kept them at a distance from them.

The frequency of visits to the country of origin of the Bulgarian ethnicity is significantly lower than that of Hungarian and Serbian respondents, due to the distance of over 330 km (the distance between Timișoara and the Calafat border crossing) to get there. Two Bulgarian respondents stated that they visit their country of origin weekly because they engage in economic activities that require such travel. Also, 20% of respondents over the age of 65 make monthly visits. The majority of the respondents visit the country of origin of their ethnicity once a year or less frequently. The highest proportion of respondents who have never visited Bulgaria is found among those over 30 years old. Some of them, pensioners, do not have the necessary financial means for such travel. Young people aged 18-30 and adults under 65 visit Bulgaria at least once in high proportions (over 50%), as they are attracted by the tourist facilities in this country. In addition to good prices in tourism, another attractive factor is their ethno-cultural affiliation.

Among the questionnaire respondents, only a percentage of 5.17% have pursued study programs in their country of origin, but over 65% know people who have done so in the recent past. Additionally, 27% know people who have attended school in their country of origin, and they have lived there.

In the case of Bulgarians in Timiș county, the fact that their country of origin does not directly border Timiș county, and it is at a significant distance from their place of residence, has negatively influenced the frequency of contacts. Additionally, cultural proximity is manifested only in the context of linguistic identity, as the culture of Catholic Bulgarians has an original character, with its own writing system and a different historical experience over the last three centuries (Markov 2012, Markov 2013, Bogdanov and Szőke 2019).

The relationship between Romania and Ukraine, as neighbouring countries, began in the immediate period following the Declaration of Independence in 1991. Romania's relations with Ukraine were driven, on one hand, by the existence of a substantial Romanian minority in Ukraine, coupled with the presence of a Ukrainian minority in Romania (Călian 2017), and on the other hand, by the European Union's Neighbour-hood Policy (Longinidis 2016).

The bilateral relations between Romania and Ukraine, as neighbouring countries, have effects on the social imaginary of the Ukrainian communities in Timiș county. One of the interview respondents from the locality of Știuca emphasised that an intensification of the relations between Romania and Ukraine would be beneficial for preserving the ethnic identity of the minority to which they belong. The President of the Union of Ukrainians in Romania, Timiș branch, stated that although Ukraine is far away, an improvement in the relations with this country would have a positive effect on the Ukrainian minority and on the relations between Romanians and Ukrainians as ethnic groups.

The strong attachment to the local and regional geographical horizon was emphasised by the respondents through the high scores given to these territorial constructs. From the analysis of the responses to the question: "From which one do you feel closer to?", two categories of territorial constructs emerge in terms of the respondents' declared attachment: the local community, Timiș county, Banat, Romania, and the country of ethnic origin – with high and close scores – followed by the European Union at a considerable distance.

The analysis of *the motivation for maintaining connections between the members of ethnic minority communities* in Timiș county and their compatriots in the cross-border areas of Serbia and Hungary (the historical Banat region) reveals a statistically similar distribution of responses to the same theme studied in the context of maintaining connections within minority groups and compatriots in the country of ethnic origin. However, the motivation for Serbs to maintain connections with their counterparts in

Hungary, and for Hungarians to maintain connections with their counterparts in Serbia, is primarily based on the preservation of ethnic identity, especially through the use of their common mother tongue. In both cases, the economic and professional motivation was mentioned by a minority of respondents. The occurrence of these responses, however, demonstrates that cultural proximity is directly involved in economic exchanges. In practice, people who speak the same language seek each other out and they meet across borders to engage in economic or professional activities. This result supports the hypothesis stated in other research papers that cultural proximity has a positive impact on economic exchanges (Ploae 2017, Rădoi 2017, Crețan 2019, Rotaru et al. 2023).

Direct relationship with the country of origin of the ethnic groups was visible to all analysed ethnic groups. After 1989, the possibility of collaboration with cultural actors from Serbia emerged, as one interviewee stated: *"Initially, it was more difficult, but in the past two decades, folk groups have increasingly relied exclusively on choreographers from Serbia to stage dance routines. The grants provided by Serbia (...) seriously affect perhaps the most important field for preserving the Serbian minority's identity in Romania: the preservation, conservation, promotion, and development of Serbian traditions"* (M. L., Serbian folklorist, and former deputy of the Serbian minority in the Romanian Parliament).

The relations between Romania and Hungary have a visibly favourable impact on preserving the identity of the Hungarian community, for example, schools in Timiș county are twinned with schools in Hungary. On this, one Hungarian interviewee stated: *"(…) so, our students participate in visits, school camps, excursions to Hungary, and they become aware of Hungarian cultural values, getting to know the achievements of the Hungarian people. The sense of belonging to the same culture, the same values, plays an important role in preserving the Hungarian identity in a globally interconnected world"* (K. F., school inspector).

It is obvious that the Hungarians have educational, cultural, and recreational activities in the community, together with social assistance, organised and announced through phone calls and social media networks.

In terms of Bulgarians relations to Bulgaria, a Bulgarian consulate has been opened in Timișoara, and this is of real importance because through this consulate Bulgarian citizens can ask for the honorary consul's help in various situations where a translation is needed in their discussions with the Romanian authorities: *"(…) through the help of this consulate, efforts are being made to establish a Bulgarian language lecturership at the West University of Timișoara"* (B. P., teacher from Dudeștii Vechi). Also, another Bulgarian interviewee added: *"In the first 10 years following the 1989 Revolution, many Bulgarians from Banat went to Bulgaria to see the places where their ancestors came from and the villages that were established when our people returned to Bulgaria after being liberated from the Turks"* (K. C., historian, and teacher in Dudeștii Vechi).

Ukrainian interviewees consider that the relationship between Romania and Ukraine does not have a direct impact on their community in the area of Banat. One Ukrainian interviewee considers: *"I strongly believe that implementing joint Romanian-Ukrainian projects would be useful because they would develop stronger feelings of belonging to the Ukrainian ethnicity, especially if these projects were cultural, related to tradition, customs, and mutual understanding"* (B. N., professor, interview conducted in 2022).

Results on the implications of the European integration process towards the cultural development of ethnic groups in the cross-border area reveal different aspects for the analysed ethnicities. Serbian and Ukrainian interviewees were more reluctant on the EU integration impacts for their ethnicity: *"Personally, I don't see any concrete effect due to this European integration process. I could be wrong, but I think it's more about bilateral connections and understanding. The exception being the IPA Cross-Border Program"* (M. L., Serbian folklorist, former deputy of the Serbian minority in the Romanian Parliament). Also: "The European Union does not have a direct involvement in the life of the Ukrainian minority in Romania. Maramureș and Suceava counties have economic benefits, and the Ukrainians there are supported in their cultural activities" (G. H., President of the Union of Ukrainians in Romania, interview conducted in 2021).

On the other hand, some of Hungarian and Bulgarian interviewees see the EU integration as having many advantages for the Hungarians and Bulgarians in the Timiș county: *"The integration process helps more in the relationship between the Romanians from the community and those abroad, as well as between the Hungarians abroad and those in our community. There are families living in Hungary and commuting to Romania for work. Also, many residents in our county have bought vacation homes in Hungary, both ethnic Hungarians and Romanians"* (D. Z., project manager and local project promoter in the public administration of Sânnicolau Mare, interview conducted in 2021). Additionally: *"The European integration process has had a positive role within the Bulgarian community in the area and, of course, in the relations between Romanians and Bulgarians. Excursions have been organised where mixed teams of Romanians and Banat Bulgarians have participated in tournaments organised in Bulgaria"* (B. P., teacher from Dudeștii Vechi, interview conducted in 2021).

To sum up, the direct relationship with the country of origin of the ethnic groups is an important issue and it does not depend so much on the spatial proximity, while the EU integration process has a lower impact on the studied ethnicities whose home countries are not in the EU (i.e., the Serbs and the Ukrainians).

The analysis of the responses given by the respondents to questionnaires and interviews also reveals our findings to the three questions stipulated in the introduction of this study. On the one hand, responding to the first question, we observe a high degree of closeness between the studied ethnic minorities with respect to the related country and with the co-ethnics in the cross-border territory of Timiș county.

On the other hand, for the second question of this paper, we noticed that the Serbs and Hungarians are much closer to their ethnic country of origin than the Bulgarians and Ukrainians, and this is also perceived in supporting cultural activities that help preserve their ethnic identity. No big differences were identified between Serbs and Hungarians, respectively Bulgarians and Ukrainians, in the frequency of contacts with their compatriots from the cross-border area of Timiș county (western historical Banat). This means that if the dialogue partners are in the same region or in a neighbouring area, the intensity of the dialog between them is little influenced by their ethnic identity.

Finally, for the third question of this study, our response is that cultural proximity based on ethnic identity is not strong enough to keep people in contact, as Ukrainians and Bulgarians have had a much weaker connection with the country of origin of the ethnicity. This reality is revealed by the frequency of visits and the frequency of interpersonal contacts with the co-ethnics from their countries of origin.

Discussion

The construction of a potential crossover ethnic model

The analysis of interactions between the ethnic minorities in Timiș county, on the one hand, and their counterparts in the home country and the cross-border areas of Serbia and Hungary, on the other hand, could be seen according to the following conceptual framework. In the relationship between the studied ethnic minorities and their compatriots in the neighbouring country and the cross-border area (Serbia and Hungary), several factors come into play. The primary factor is the geographic proximity, followed by the regional identity (manifested in the relationship with the compatriots from Banat region), and the complex of subsequent bilateral relations influenced by Romania's cross-border policies in the context of European integration.

The conceptual framework aims to analyse and understand the multifaceted dynamics of interactions, considering the geographical, historical, cultural, and political dimensions. It recognizes the importance of geographic proximity as a facilitator of connections and exchanges, allowing for regular contact and a sense of shared regional identity. Additionally, the framework acknowledges the impact of Romania's cross-border policies, influenced by its European integration process, on fostering bilateral relations and facilitating interactions between ethnic minority communities and their compatriots.

By examining these interconnections within the proposed conceptual framework, a comprehensive analysis can be conducted to better understand the dynamics and implications of interactions between the ethnic minorities in Timiș county and their compatriots in the home country and the cross-border areas of Serbia and Hungary.

In the context of the identified crossover connections in Romania's relations with the neighbouring countries (which are kin countries for the ethnic minorities in the studied region), several levels or layers can be mentioned: the level of interactions between the individuals; the level of interactions between human groups; the level of interactions between administrative units (implemented within cross-border cooperation Euro-regions); the level of bilateral relations between countries; and the level of relations within the European Union. At this level, it should be noted that Romania is a co-member of the EU together with Hungary and Bulgaria, and it develops relations with Ukraine and Serbia within the partnerships that these countries have with the EU. Manifestations and implications of these multi-layered relations have been identified, with varying intensities, in the responses obtained from the questionnaires and interviews.

In the case of Romania's western border, especially in the sector that borders Timiş county, crossover interactions consist of political, economic, social, and cultural links that act synergistically (Ploae 2017, Rădoi 2017), and correlate with the social imaginary of the populations on both sides of the border (Decoville and Durand 2019).

People who belong politically to a certain state may belong culturally to another state or another politico-territorial construct. Hungarians, through their cultural model and historical evolution, belong to the Western world or the Euro-Atlantic space. Bulgarians and Serbs belong to the Euro-Mediterranean space through their cultural heritage of Eastern Orthodox Christianity, of Byzantine origin. Ukrainians are Eastern Slavs, a periphery of the Euro-Asian space, but they have been influenced by the Western political space. This comment refers to the political identity assumed by the respective ethnic groups' home countries or the nation-state representative of the respective ethnicity (the case of Ukrainians). Cultural proximity, manifested in the relationship between minority ethnic groups in Timiş county, brings minority ethnic groups closer to their kin country.

Active factors include regional identity and geographical proximity. The intensity of relationships with fellow ethnic people from the ethnic group's country of origin is much higher for Serbs and Hungarians compared to Bulgarians and Ukrainians. Analysing the relationships that Ukrainians and Bulgarians have with their counterparts in the transborder area overlapping with the historical Banat, it is observed that they feel more attached to Banat than to their kin country. The proportion of respondents who maintain contacts with their compatriots from Serbia and Hungary (where their counterparts are also ethnic minorities) differs by a few percentage points. The factor that brings them closer is the common ethnic identity and social relationships. The same statistical distribution of motivations for maintaining contacts is also observed in the case of relations with compatriots from the kin country. Significant differences are only observed among the Serbs and Hungarians. It was

noticed that for them, social relationships are more important than the common cultural identity in the case of relations with the compatriots from the kin country.

Regarding the implications of geographical vicinity and cultural proximity on the connection between ethnic minorities and their counterparts from the kin country and the transborder area, the information obtained through interviews indicates that the geographical proximity of the two countries has an impact on the community under study, but this impact is weaker due to the distance of Timiș county from the kin country of the ethnicity. Additionally, cultural proximity, although manifested through awareness of the common language and customs, is weakened by the distance factor and the fact that Ukrainians in Romania do not have direct experience with Ukraine, and their community does not even have origins there.

It is observed that the share of Ukrainian respondents who maintain relationships with Ukrainians from their ethnic homeland and feel close to them is almost double compared to Bulgarian respondents. The cause can be found in the intensified cultural activities of the past decade, which have connected the Ukrainians in Romania with their counterparts in Ukraine. Additionally, the internet greatly facilitates long-distance communication between compatriots.

The frequency of visits by the Ukrainians to their ethnic homeland is much lower compared to Hungarian, Serbian, and even Bulgarian respondents. The distance from Timiș county to the nearest border crossing point with Ukraine (at Halmeu) is over 335 km. It is worth mentioning that most of the Ukrainian respondents were born in Suceava and Maramureș counties, where there are border crossing points. In this context, distance plays a key role, but the visits to their ethnic homeland are not the most important factor in preserving the ethno-cultural identity.

The motivation for maintaining constant and long-lasting connections with the compatriots from the country of origin of the ethnic group is also predominantly linked to linguistic affinities, ethnic origin, common customs, and traditions. In second place there are social friendships that have been established between Ukrainians in Timiș county and those in Ukraine. The percentage is higher than in the case of Bulgarians but lower than in the case of Serbs, indicating that the distance from the country of origin (which is approximately equal) is an important factor in cultivating these kinds of relationships but not a decisive one. It is worth mentioning that a majority of respondents who maintain relationships with compatriots from Ukraine are originally from northern Romania, meaning from the neighbouring border communes. Other respondents also mentioned family relations in this context correlated with their place of origin and that they know compatriots who have emigrated from Romania to Ukraine. However, only few Ukrainians stated that they would like to emigrate to their country of ethnic origin, mostly based on cultural affinities.

Takeaway for practice

Geographical proximity and regional (cultural) identity viewed as active factors in this analysis can be used as bases for collaboration between the administrative units at local and regional level within development projects. The preservation of the common cultural heritage, resulting from the shared historical experience, generates solidarity between people and between communities. Spatial and cultural proximity could be a starting point in the application of cross-border development plans, as it has been seen to act as a strong pro-active factor in people-to-people communication. All this will strengthen the cooperation between Romania and the neighbouring countries, with positive effects in the economic and social development of the south-eastern flank of the European Union.

Conclusions

The spatial proximity of Romania, Serbia, and Hungary has resulted in the construction of a complex system of bilateral relations between these countries, which has been accompanied in the post-communist time by institutional relations between the communities and the administrative units located on both sides of the border. If the geographical proximity has also facilitated the movement of people between these countries, the cultural proximity in Timiș county is derived mainly from the ethnic identity (through the mother tongue) and the regional identity (derived from a common historical experience).

This study examined the implications that geographical proximity can have on the manifestation of cultural proximity and it demonstrated that there are strong implications of geographical proximity in the manifestation of cultural proximity. However, cultural proximity also motivates people to maintain contacts with their counterparts in a neighbouring country or in the country of their ethnic origin. The theoretical implications of these findings include the geographical interpretation of the manifestation of cultural proximity, bringing to the attention of researchers another field of investigation. Cultural proximity is not sufficient to bring ethnic minorities closer to their kin country. Even though previous studies have demonstrated the importance of cultural proximity in the economic and social life, especially in interpersonal communication, the reception of media messages and in economic relations, geographical proximity intervenes as an important factor in this process.

The responses to the first research question in our study, which related to how members of ethnic minorities perceive their connection with their country of origin and with their conationals in the cross-border area, show that the members of our selected ethnic groups perceive these links as strong ones. The respondents feel close to their country of ethnic origin and they cultivate frequent and long-term relationships with their conationals, which arise from a range of motivations.

In terms of the second research question, regarding how geographical proximity influences the relationship between an ethnic group and its country of origin, we found that the geographical proximity of the home country does influence the relationship between the home country and the ethnic minorities living in a different state. Our research reveals that the frequency of visits and the numbers of long-term stable contacts are significantly higher in the case of Serbs and Hungarians of Timiș county. Furthermore, social, and economic relationships are more common among these two groups, and an intention to re-emigrate to the ethnic group's home country is mentioned more frequently.

The third research question was intended to help us understand whether cultural proximity based on a common ethnic identity keeps people close enough for distance to be of no account, or whether physical distance limits the contacts between people of the same ethnic identity. We highlight the finding that cultural proximity based on ethnic identity is not strong enough to keep people in contact. The responses show that the Ukrainians and Bulgarians resident in Romania have a much weaker connection to their countries of ethnic origin than the Serbs and Hungarians, judging by the lower frequency of visits and interpersonal contacts with the co-ethnics in those countries. Speaking the same language is not sufficient to make people feel close. If the distance between them is substantial and they do not see or visit each other regularly, the strength of the connection between them weakens. The cultural link invoked by most social scientists as a key factor in communion between people living a long way apart is less important than territoriality.

In the future, the epistemic framework that led to the realisation of this study could be tested in other territorial contexts. For example, in Dobrogea there is a significant Ukrainian minority too. Conducting a field study could reveal the extent to which their ethno-linguistic identity influences their connections with their ethnic fellows in Ukraine, to which they do not feel a regional attachment, but more of a spatial proximity. Additionally, such a study could shed light on whether Romanian-Ukrainian cross-border projects and the ongoing war in the neighbouring country have an influence on this process. Also, other similar studies could be made in different other European regions in order to see if geographical vicinity and cultural proximity behave the same or they are different than in our study.

Acknowledgements

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WHERE THE NORTH-SOUTH GAP IN HUMAN CAPITAL BEGINS: AN ANALYSIS OF EDUCATIONAL OUTCOMES ACROSS THE ITALIAN REGIONS

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Abstract: Promoting education is a priority for most of the world's governments, but, in some cases, beneficial access to school curricula and student achievement is influenced by the socioeconomic background. We investigate the influence of many aspects of the Italian socioeconomic background on school achievement, specifically on mathematical capabilities, at two school levels (primary and secondary) by using regional data over the period 2013-2019. Italy is a country with a solid scholastic tradition that, especially in the past, had a strong imprint mainly of humanistic and social culture. Investments are currently being made in human capital (HC), particularly in the scientific, mathematical and computer fields; however, the results vary according to region. The results show that in the central-northern regions, a virtuous circle of HC enrichment can be triggered, while in the southern regions, economic support is necessary. In addition, we observe that a sort of family safety net (a form of social capital) could play a positive role in sustaining the students' learning efforts in the southern area. It seems that the different support for school education that underlies the Italian "North-South problem" is one of the causes of the gap in the local levels of HC development.

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Introduction

The development of human capital (HC) is both a policy objective and a strategic resource that goes beyond the economic contribution that it generates, since it creates many direct and indirect effects (Guisan and Neira 2006, Ogundari and Awokuse 2018, Rahim et al. 2021). Among the effects of education, researchers include developing capabilities for improving individuals' living conditions and decreasing the risk of poverty (Lanzi 2007, Duarte et al. 2018), reducing inequalities (Lee and Lee 2018) by influencing the wage structure and the economic returns to education (Goldin and Katz 2007), having better health and lifespans (Raghupathi and Raghupathi 2020), and the ability to take care of others (Boyle et al. 2006, Sonego et al. 2013). The positive outcomes are related to the adequate growth of HC based on quality education, which is the 4th goal of the 2030 Agenda for Sustainable Development Goals by the United Nations (2015).

The basis of adequate HC is commonly traced back to school education (Becker 1994), although positive experiences and academic success derive both from student characteristics (Day et al. 2018) and from the influence of the environment in which they live (Berkowitz et al. 2017, Osman et al. 2021).

In this study, we consider the different elements that influence the student performance at regional (aggregate) level and we examine them in the Italian context. We investigate the main factors that influence achievements at various school levels, and we consider the two macro areas of the Centre-North and the South separately. We explore whether there may be local characteristics that explain the early potential stages of dualism in educational pathways, reinforcing, in turn, a de facto territorial dualism, which we may assume is the beginning of the HC gap. We must consider that early-stage efforts related to education are a key policy aspect since they condition HC development (Yamauchi and Liu 2013).

Our research starts from the observation of the empirical evidence from the reports of the Italian National Institute for the Evaluation of the Education and Training System (INVALSI 2013-2019) which show a growing, observable, gap in the polarisation of test scores with the increase in school levels (i.e., scores progressively higher in the northern regions and lower in the southern regions). In our analysis, we did not include the years of the COVID-19 pandemic, which impacted the educational pathways, and it made school performance abnormal due to limitations and new forms of teaching (Tejedor et al. 2020).

In fact, Italy may represent an anomalous and controversial case study, in part due to the substantial divergence in educational outcomes between the "richest" and "poorest" areas of the country, similarly to what happens for the economic development paths of the two areas (Capello 2016). Italy's "North-South divide" is characterised by numerous

socioeconomic gaps (Odoardi and Muratore 2018), which are connected to an evident gap in educational terms, despite the centralised school system (Ballarino et al. 2014). In particular, the North-South dualism in HC has been noted since the unification of the country in 1861 (Felice 2012) and it can be observed more recently from the school results (OECD 2019) up to the research activity (Abramo et al. 2016) and labour productivity (Gitto and Mancuso 2015). It is possible that the issues underlying the uneven economic development among central-northern and southern regions are also connected to issues that undermine the formation of HC that begins with school education.

To answer our main research question, we need to examine three issues. First, we analyse the factors influencing school performance (observed through test scores in mathematics) in the Italian regions. Second, we compare a school level with homogeneous results among regions in test scores with another in which the gap widens to observe the differences in causes. Third, we search for the disparities between the Centre-North and the South.

In this framework, Italy represents an interesting field of inquiry for analysing the critical issues that affect education: (i) Italy is the eighth economy in the world (according to the 2019 GDP levels, from World Bank data), but its productive structures of technological and HC intensity do not represent the typical high-tech economy, being characterised by a large population of micro and small firms, scarce investment in innovation, widespread low-skilled and labour-intensive sectors (Dell'Agostino and Nenci 2018, Brunetti et al. 2022). On the other hand, the investment in education and training, as well as the average levels of education achieved, are below that of the EU and OECD countries (European Commission 2019); (ii) Italy offers the opportunity to consider two macro-areas with divergent development paths and different levels of HC, i.e., the Centre-North and the South (Ballatore and Mariani 2019); (iii) The social/cultural consideration of education also differs between macro-areas. For example, despite national (INVALSI data) and international surveys (PISA data, OECD 2019) showing dualism in the educational performance, on average, grading in the South is more "generous" compared to performances that are worse than in the North (Argentin and Triventi 2015); (iv) Overall socioeconomic conditions (including school facilities) are also strongly at a disadvantage in the South and they could influence the educational path of children and subsequent inequalities (Ballarino et al. 2014). For example, southern students are more prone to interrupt studies after compulsory school, with rates up to 20% in some regions, on ISTAT data, representing the percentage of the population aged 18-24 with at most the middle-school certificate, who has not completed a professional training course recognized by the region for more than 2 years and who does not attend school courses or participate in training. Following secondary school, many continue their university career in the central-northern regions, as they attribute a greater value to university degrees in these regions (an interregional brain-drain, Ciriaci 2010).

A particular focus of our analysis is on the representation of the economic and cultural characteristics at regional level, i.e., the socioeconomic status (SES) that affects the education achievements of young Italians (Brunello and Checchi 2005). We include macro data representing the average characteristics of households. The effect of SES starts with the economic possibility of investing in education (Liu et al. 2020), almost describing a real "transfer of human capital" between generations (Becker and Tomes 1979, Tomes 1981); the creation of a home environment favourable to school education (Tramonte and Willms 2010); and the possible support for the continuation of advanced studies (Gorard 2010, Alfieri et al. 2015).

In the context of the many studies on the relationship between SES and school performance, considering the effects on subsequent school levels (Li and Qiu 2018) and on mathematics (Wu and Tian 2008), we propose a double comparison. The first comparison is between classes and the second one is between geographic areas, searching for the causes of the divergence in school test scores.

In this respect, INVALSI (2013-2019) offers an aggregation framework to measure various aspects of learning among the Italian students. In this article, we report data related to mathematics learning carried out from 2013 to 2019 at regional level. Specifically, we consider the outcomes of INVALSI sample classes of 5th grade (final class of the primary school) and 10th grade (the class that concludes compulsory education). We focus on students' mathematical skills because they are associated with the reasoning ability and they appear universal for the continuation of formal schooling (Pagani et al. 2017, Xu and Dadgar 2018). Achievement in mathematics also gives high satisfaction to parents (Chen and Feng 2013) and, thus, the subject may possibly be more influenced by parental interest in the children's education.

Factors affecting student achievements

Considerable debate exists among researchers about the direction and causes of changes in student achievement (Ramirez et al. 2006). In general, key factors that impact the students' learning are found in external and political environments, where countries make a variety of choices about education reflecting both national objectives (e.g., increasing the proportion of graduates) and the availability of resources and infrastructure (e.g., teacher salaries, working time, teacher training, OECD 2022). Therefore, the sociopolitical culture (including economic, political, social, and religious aspects) of each country tends to shape the education system according to its needs and it can encourage specific learning practices (Rubenstein 2006). Among them, the nature of school culture makes a significant contribution to students' academic achievement (Maslowski 2001, Melesse and Molla 2018). The absence of a healthy school culture, including teaching aids and peer cooperation, and the lack of effective methods of studying, in fact, could affect students' achievement (MacNeil et al. 2009).

Students' school performance is also associated with the quality of the school management, the teachers' commitment, and the motivation of students (Hoy and Miskel 2013, Ferrer et al. 2022). For example, it has been proven that when teachers support children from families with low levels of social capital, their scholastic performance increases both in reading and in maths (Rose et al. 2013).

Moreover, numerous aspects concerning the background of individuals influence academic performance. Many studies have emphasised the relationship between family background and education (Wu et al. 2015, Li and Qiu 2018); in this framework, parental SES is recognized for its major role across countries (White 1982, Sirin 2005, Chmielewski 2019). SES, mainly through the education level and income of parents, influences the beliefs and behaviours of parents and it affects the children's performance (Davis-Kean 2005). It has been observed that the role of parental education starts early, already influencing the choice of the study pathway and children's cognitions, thus, demonstrating the interconnection of the lives of parents and children (Astone and McLanahan 1991, Hortaçsu 1995, Vergolini and Vlach 2017). For example, Dickson et al. (2016) found a direct and continued positive effect of parents' educational attainment on children's outcomes throughout the school career in the UK. Saw (2016) observes in Malaysia a strong relationship between the students' maths and science achievements and the parents who have postsecondary degrees. Following Landeras's (2009) model of education, Kuehn and Landeras (2014) observe that the students' marginal productivity of effort depends on their family background. More specifically, among students aged 12 to 15, a higher parental education is associated with more time spent on homework (Kuehn and Landeras 2014).

In early school grades, the high SES should have a positive influence on students' performance. Financial resources at the household level acquire a major role in subsequent school years, e.g., by equipping students to remain involved in the educational process that interests them or provides some educational opportunities that otherwise would not be accessible (Thomson et al. 1994, Teachman 2008). Indeed, family wealth influences the chances of completing studies and the opportunities to receive a better education and to get a better job, even in rather egalitarian societies (Chesters 2019). Following Kao and Tienda (1998) and MacLeod (2018), adolescents from less advantaged socioeconomic families rarely have high educational ambitions when parental income is scarce or in the case of education's diminishing returns due to their discrimination in labour markets. In the same way, parental beliefs about the children's academic performance change according to their economic status: parents in more advantaged households are very realistic about the educational outcomes of their children compared to the optimistic attitude of less affluent parents (DeBacker and Routon 2017).

Many other aspects of family behaviour, structure and social relations play a role. For example, social mobility matters, and this aspect influences teenagers in adapting their academic choices (Mocca et al. 2019). Some studies also underline that students from high-SES families tend to build social networks with classmates of similar status and they take advantage of them to learn more than other students (Crosnoe 2004). Students in marginalised populations, instead, often have negative interactions with their classmates, increasing the likelihood of poor scholastic skills (Ream 2003). Positive classmates' family factors and home education resources are correlated with a better student reading performance in 33 countries (Chiu and Chow 2015). Parental attitudes are bound to their attitudes of their children, while an increase in parents' social activities leads to children with low educational progress (Zunich 1966, Hoard and Shepard 2005, Oncu and Unluer 2012), which is particularly true in the case of mothers (Fagan and Barnett 2003).

The home environment is another factor linked to academic achievement. For instance, reading at home with parents provides a stimulating literacy environment that is positively linked to the children's academic achievement (Keith et al. 1993). Moreover, parental affective support and communication have a strong influence on student outcomes (Deslandes et al. 1998, Davalos et al. 2005). Among a variety of home background factors, the family structure can have repercussions on the students' performance (Coleman 1988), as in the case of residential mobility, for which the transfers (negatively) affect the school results with an effect that can last over time (Voight et al. 2012). For example, Astone and McLanahan (1994) found that children from single-parent families are more exposed to school mobility risking lower educational attainment; and students from single-parent and stepparent families run a higher risk of low school performance. For disrupted families, any move is linked to an adverse school life, while children who have changed school several times are not significantly damaged if they live with both biological parents (Tucker et al. 1998).

The spacing of children and the size of the family are positively and negatively related to the scholastic outcomes, respectively (Steelman et al. 2002). The students' achievement is even influenced by the order of birth in the family (i.e., older siblings are likely to obtain more schooling, Kim 2020) and the sibship size (although the dilution of resources in families with a few children, compared to one child, should not create problems, Lao and Lin 2022). In higher socioeconomic strata, students who are early siblings perform better than last-born siblings (Glass et al. 1974, Bu 2016). The same occurs in poor and rural contexts, where the economic and educational conditions of families are low, as Effiong and Igiri (2015) confirm that the significant effect of birth order on academic achievement in basic science. Possible explanations lie in the dilution of parental time and other family resources (Blake 1981) and in the interactions between the siblings and their parents (Zajonc and Sulloway 2007), even if the time that parents devote to looking after their children seems positively connected

to the level of education (Gimenez-Nadal and Molina 2013). However, the effects of birth order on intelligence seem to be limited in larger families (Sulloway 2007).

Methodology

To examine whether and to what extent socioeconomic local features influence the mathematical scores obtained by different categories of students, we estimate the following equation:

$$
\begin{aligned}
lnMATHS_{it} = {} & \beta_1 HC_{it-1} + \beta_2 lnGDP_{it-1} + \beta_3 POVERTY_{it-1} + \beta_4 SC_{it-1} \\
& + \beta_5 CRIME_{it-1} + \beta_6 CHILD_{it-1} + \beta_7 YOUNG_{it-1} + \beta_8 DENS_{it-1} \\
& + \mu_i + \tau_t + \varepsilon_{it}
\end{aligned} \quad (1)
$$

in which the dependent variable is the INVALSI score in mathematics (at two school levels, $MATHS5$ and $MATHS10$); HC and GDP represent the SES in the average endowment of HC and income (which on average are the characteristics of families in each region, Goldhaber and Brewer 1997). The other regressors represent known factors that influence the school results, as presented below. Data refer to the 21 Italian regions and autonomous provinces (i) for the period (t) 2013-2019. The regression (1) includes a full set of time dummies, τ_t, which represent time-specific factors that can affect the dependent variable $MATHS$, and the regional time-invariant characteristics, μ_i, while $\varepsilon_{i,t}$ is the idiosyncratic error term.

In our case, the endogeneity due to reverse causality is related to the fact that mathematical scores influence the HC value, since mathematical skills could be considered one of the components of HC estimation (Goldsmith et al. 1997). For this reason, to consider this endogeneity issue, we adopt an instrumental variable approach—a two-stage least squares (2SLS) procedure—aimed at obtaining the exogenous variation in individuals aged 25-64 with tertiary education by means of two external instruments. We consider that cultural capital, observed through cultural consumption, has been shown to be a useful resource for fostering tertiary training, as proven by Crociata et al. (2020). In line with this study, we consider two types of cultural consumption at regional level, i.e., the percentage of children aged 6+ who at least once in the last year visited an archaeological site and went to the cinema (on the respective population, ISTAT data).

However, it is necessary to demonstrate the instruments' relevance and orthogonality to the error terms in Equation (1). First, to verify the relevance of the instruments, we implemented the underidentification test. This is a Lagrange multiplier (LM) test that allows to evaluate if the correlation between the excluded instruments and endogenous variables is high enough and, thus, that the excluded instruments are "relevant". However, in the presence of heteroskedasticity, as in our case where the standard errors are clustered by region, we had to look at the LM and Wald versions of the Kleibergen

and Paap (2006) rk statistics instead of Anderson LM and Cragg–Donald Wald statistics. By looking at the results of the several tests performed, it is possible to confirm that the models are correctly identified, as the null hypothesis seems to be rejected. Second, since the model is overidentified and the standard errors are robust to heteroskedasticity, we tested the validity of our instruments by relying on Hansen's (1982) J test, which is confirmed by the fact that the null hypothesis cannot be rejected at 10%.

Data: A look at the Italian school system, student assessment and the INVALSI tests

The Italian education system is open and mandatory to all resident children aged between six and sixteen. Nevertheless, from the age of three, resident children can start attending nursery school. Basic education is divided into three levels: primary school, middle school, and high school.

Drawing on international verification tests (OECD-PISA, IEA-TIMMS, IEA-PIRLS), INVALSI verifies two explicit aspects of learning: (i) strictly numerical, comparing educational syllabus of Italian schools with national guidelines, as well as with European and international curricula; and (ii) methodological, referring to a standardised and systematic learning approach usually adopted by advanced economic countries. In wider terms, INVALSI depicts rich assets between psychometrics and didactics for analysing basic disciplinary skills in mathematics and Italian language (English language skills are also recently tested).

Our approach is based on a seven-year (2013-2019) dataset that includes two classes. To detect fraudulent and cheating behaviours and to obtain a greater guaranteed reliability of the collected data (Quintano et al. 2009), we selected only sample classes, where it is mandatory that an external observer to be included (we therefore excluded the second primary class because the students are not completely autonomous in completing the tests). The INVALSI (2013-2019) reports allow us to include annual data and to make comparisons between students of different ages.

Following a large literature on school/student grades and mathematical aptitudes (Floyd et al. 2003, Fuchs et al. 2006, Saß et al. 2017), we selected mathematical literacy as the Science, Technology, Engineering, and Mathematics (STEM) of students' performance. Mathematical literacy is an individual's ability to formulate, employ, and interpret mathematics in broader contexts. INVALSI tasks are based upon reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena (OECD 2013).

Control variables: Some causes of students' school performance

In our analysis, we included a set of independent variables that control for some of the main factors that affect school performance (Table 1).

Table 1. Variables definitions and sources

	Variables	Definition	Source
1	MATHS5	Average score in mathematics from Italian students in primary school, class 5th	INVALSI
2	MATHS10	Average score in mathematics from Italian students in high school, class 10th	INVALSI
3	HC	Population aged 25-64 with tertiary education over total population (%)	EUROSTAT
4	GDP	Gross Domestic Product *per capita* at the 2015 values	ISTAT
5	POVERTY	People at risk of poverty rate (%)	EUROSTAT
6	SC	Percentage of people aged 14+ who believe that most people are trustworthy out of total people aged 14+ (%)	ISTAT
7	CRIME	Number of robberies per 1,000 inhabitants	ISTAT
8	CHILD	Couples with single child over total couples (%)	ISTAT
9	YOUNG	Share of individuals aged 0-15 over total population (%)	ISTAT
10	DENS	Population per square kilometre	EUROSTAT

First, the effect of SES was observed through the level of the HC of the population (proxied by the share of the adult population with advanced education) and the average income (proxied by the gross domestic product *per capita*, see GDP). These variables can approximate the average SES of families, which role is the main determinant of children's school performance, and this is confirmed for the Italian case (Odoardi 2020). We considered two known features: (1) the educational level of parents affects their children's learning; and (2) family income plays a major role in HC formation (Li and Qiu 2018, Cai and Wu 2019, Husain et al. 2019).

Second, we considered the risk of poverty rate (POVERTY) because deprivation in children is a major cause of poor school performance (Hegedus 2018), and this is a significant concern also observed in highly developed countries (Hirn et al. 2018).

Third, we included a measure of social capital (SC, proxied by the level of trust) since such intangible capital, through the relationships and the structure present in a society is a recognized factor that influences the students' performances (Plagens 2011). Social capital can be considered useful in school success through networking and bridging opportunities (Allan and Catts 2014).

Fourth, we included a measure of crime (CRIME, proxied by the ratio of robberies on the population) since the negative relationship between the spread of crime and school performance is known (Boxer et al. 2020), and evidence exists on the specific relationship with the INVALSI results in southern Italy (Cavalieri et al. 2021). A violent community environment appears to have a negative impact on school achievement (Gershenson and Tekin 2018), and Burdick-Will (2013) shows that school violent crime

in Chicago Public High schools had a negative effect on maths standardised test scores. Also, Torrats-Espinosa (2020) observes that in the same U.S. school districts, children who start at a school system with a low violent crime rate score higher than children from the same district but who entered the school system when there was a higher violent crime rate.

Fifth, we considered three demographic aspects. The first is related to the composition of families, including the percentage of those with an only child (CHILD) who should have greater expectations and commitment to their children's school performance (Tsui and Rich 2002, Yamamoto and Holloway 2010). The second, related to the age structure of the society, is the percentage of people under the age of 15 (YOUNG). This represents a control on demography that influences, for example, the demand for education and the age of lecturers and researchers in higher education (Willekens 2008). The third is population density (DENS), since human capital-related aspects could benefit from the agglomeration economies that are presumably present in the most populated areas (Thisse 2018).

We present the summary statistics for Italy and the two macro-areas in Table 2. The average values highlight the differences in terms of academic results alongside the more evident ones in the field of average education (HC) and economic well-being (GDP, POVERTY).

Table 2. Summary statistics

Variable	Area	Obs.	Mean	Std. Dev.	Min	Max
	Italy	147	201.224	6.289	181	220
MATHS5	Centre-North	91	203.670	3.455	194	213
	South	56	197.250	7.714	181	220
	Italy	147	201.250	11.938	174	229
MATHS10	Centre-North	91	208.659	7.587	190	229
	South	56	189.214	6.768	174	203
	Italy	147	17.869	2.820	13.1	26.1
HC	Centre-North	91	19.235	2.405	14.8	26.1
	South	56	15.650	1.882	13.1	20.5
	Italy	147	27451.27	7817.32	15844.48	45875.21
GDP	Centre-North	91	32532.17	5169.05	23366.85	45875.21
	South	56	19194.82	2525.26	15844.48	24338.45
	Italy	147	19.097	10.216	5.4	42.3
POVERTY	Centre-North	91	12.111	3.466	5.4	21.8
	South	56	30.45	6.738	18.7	42.3
	Italy	147	22.187	5.635	11.8	41.7
SC	Centre-North	91	24.923	5.161	17.8	41.7
	South	56	17.741	2.866	11.8	23.5

Variable	Area	Obs.	Mean	Std. Dev.	Min	Max
	Italy	147	0.957	0.711	0.1	4.4
CRIME	Centre-North	91	0.969	0.491	0.1	2
	South	56	0.937	0.973	0.2	4.4
	Italy	147	47.413	5.670	35.7	57.8
CHILD	Centre-North	91	50.280	4.709	36.9	57.8
	South	56	42.753	3.654	35.7	53.1
	Italy	147	0.133	0.012	0.111	0.163
YOUNG	Centre-North	91	0.134	0.011	0.111	0.163
	South	56	0.132	0.012	0.112	0.159
	Italy	147	181.213	113.785	38.6	439.2
DENS	Centre-North	91	193.602	111.075	38.6	439.2
	South	56	161.080	116.246	55.7	438

Source: Authors' elaborations on EUROSTAT and ISTAT data

Figure 1 illustrates the "polarisation" of school result performance (MATHS5 and MATHS10); at the lowest level, (a) shows "outlier" cases in the South, while the advanced level (b) shows high values in the northern area only.
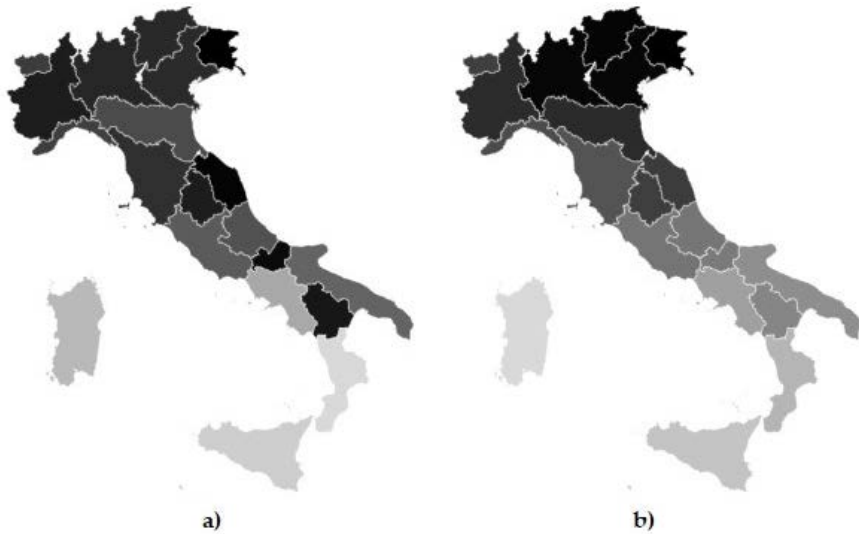
Figure 1. Average values (2013–2019) of levels in maths results at grades 5 (a) and 10 (b) (darker colours correspond to higher values). Source: Authors' elaborations on INVALSI data

Results

We present the results on the two levels of test scores in mathematics according to the INVALSI data for the students of all regions (Italy), Centre-North and South. Fixed-effects two-stage least squares (FE 2SLS) models are considered.

The support of widespread advanced HC has no statistical significance (Table 3) for the lowest educational level analysed (corresponding to 11-year-old children of the final class of primary education), probably because even a relatively low parental education, on average, may be sufficient at this level (Smits and Hoşgör 2006). Furthermore, the effect of HC could be mediated by a sort of individual compensation effect between the continuous improvement of school quality and the role of parental education, as historically observed in Italy (Brunello and Checchi 2005).

Table 3. Maths grade 5 results for Italy and the two macro-areas (2013-2019)

Dependent variable	Italy	Centre-North	South
	MATHS5 (1)	*MATHS5 (2)*	*MATHS5 (3)*
HC_{t-1}	-0.0009	0.0024	0.0105
	(0.0045)	(0.0074)	(0.0147)
GDP_{t-1}	0.2706**	0.1903	0.5203***
	(0.1153)	(0.1379)	(0.185)
$POVERTY_{t-1}$	-0.0016*	-0.0014**	-0.001
	(0.0009)	(0.0007)	(0.0015)
SC_{t-1}	-0.0004	-0.0003	0.0002
	(0.0006)	(0.0006)	(0.0017)
$CRIME_{t-1}$	0.0031	0.0116	-0.0172
	(0.0079)	(0.0116)	(0.0252)
$CHILD_{t-1}$	0.0004	0.0005	-0.0026
	(0.0007)	(0.0006)	(0.0033)
$YOUNG_{t-1}$	1.1797	3.0672	4.0898
	(1.7167)	(3.1413)	(4.6041)
$DENS_{t-1}$	-0.0001	-0.0001	0.0006
	(0.0005)	(0.0005)	(0.0012)
N*T	147	91	56
N	21	13	8
Time effects	YES	YES	YES
Provincial effects	YES	YES	YES
Under-identification test (*p-value*)	16.422 (0.000)	4.671 (0.097)	6.604 (0.037)
Hansen's J Test	0.787	0.992	0.917

Note: *statistically significant at the 10% level; **statistically significant at the 5% level; and ***statistically significant at the 1% level. Standard errors clustered by provinces are given in parentheses. All models are fixed-effect two-stage least squares estimates where HC is treated as an endogenous variable and instrumented with two external instruments (two proxies of cultural capital: % of people aged 6+ who at least once in the last year visited an archaeological site and went to cinema). The control variables are assumed to be exogenous.

In contrast, the economic aspect has a significant influence at this schooling level (Peraita and Pastor 2000), since income has an observed role in affecting the specific case of mathematics test scores (Conwell 2021), as observed particularly for the

southern area. In general, this latter effect could derive from the better conditions of life, health and opportunities that increase for children as family income increases, as it is extensively observed in the literature (Weinberg 2001, Akee et al. 2010, Reinhold and Jürges 2012).

In Maths grade 5, we notice a first North-South difference. In the South, a better average economic condition positively influences school performance (i.e., the geographic area where family support is most needed in the face of scarcity of external services and aid), while only the extreme condition (connected to poverty) has an effect, obviously with the opposite sign, in the wealthiest area (Centre-North).

The other control variables have no effect on the academic performance in elementary school.

Table 4 shows the result for the highest educational level (approximately 15-year-olds in the second year of high school, the last year of compulsory education). These results show evidence of the dualism between the two Italian macro-areas in terms of the SES effects. In the South, the level of average income continues to be an important aspect influencing education performance, as it is the case for the lower level. In the Centre-North, the mechanism hypothesised for HC is observed, and the increase in the level of education of the adult population plays a role in assisting children in improving school results.

Table 4. Maths grade 10 results for Italy and the two macro-areas (2013-2019)

Dependent variable	Italy	Centre-North	South
	MATHS10 (1)	*MATHS10 (2)*	*MATHS10 (3)*
HC_{t-1}	0.0140***	0.0354*	0.0138
	(0.0054)	(0.0212)	(0.0122)
GDP_{t-1}	-0.0085	-0.3564	0.3239**
	(0.1428)	(0.3734)	(0.1492)
$POVERTY_{t-1}$	-0.0030***	-0.0039**	-0.0009
	(0.0009)	(0.0016)	(0.0014)
SC_{t-1}	0.0006	0.0013	0.0022**
	(0.0006)	(0.0016)	(0.001)
$CRIME_{t-1}$	-0.0185*	0.0117	-0.0344**
	(0.0101)	(0.0288)	(0.0173)
$CHILD_{t-1}$	0.0012	0.0016	0.0032
	(0.001)	(0.0017)	(0.0023)
$YOUNG_{t-1}$	5.1953***	13.5491	6.5298**
	(1.8886)	(8.5829)	(3.2906)
$DENS_{t-1}$	-0.0007	-0.0018	0.0022***
	(0.0005)	(0.0012)	(0.0008)

Dependent variable	Italy	Centre-North	South
	MATHS10 (1)	*MATHS10 (2)*	*MATHS10 (3)*
N*T	147	91	56
N	21	13	8
Time effects	YES	YES	YES
Provincial effects	YES	YES	YES
Under-identification test (*p-value*)	16.422 (0.000)	4.671 (0.097)	6.604 (0.037)
Hansen's J Test	0.724	0.757	0.632

*Note: *statistically significant at the 10% level; **statistically significant at the 5% level; and ***statistically significant at the 1% level. Standard errors clustered by provinces are given in parentheses. All models are fixed-effect two-stage least squares estimates where HC is treated as an endogenous variable and instrumented with two external instruments (two proxies of cultural capital: % of people aged 6+ who at least once in the last year visited an archaeological site and went to cinema). The control variables are assumed to be exogenous.*

On the one hand, the effect observed for the South could be linked to close family ties (Fukuyama 1995) that suggest a high level of support from parents for their children (e.g., by paying private lessons). On the other hand, the highest level of graduates in the Centre-North would trigger virtuous circles toward the education of children, and in general, more virtuous aspects in the education framework, from enrolment rates to the risk of dropout, up to labour opportunities (Contini et al. 2018). In fact, when considering advanced education, the effect of parental HC should be predominant on financial constraints (Edwards and Pasquale 2003, Li 2007), also considering the absence of tuition fees in Italy.

The role of the family, or the extended family group typical of the South, could also explain the negative effect of POVERTY only in the Centre-North. For example, the relationship between poverty and PISA scores in mathematics is demonstrated in Italy (Daniele 2021). Family ties would counteract the difficulties in studies due to deprivation (e.g., reducing health-related behaviour with an influence on test scores, Gunter and Daly 2013) through the support that would come from the extended family network and that would be weaker in the Centre-North. This result, in which the role of supportive kinship networks is supposed, could also explain the unexpected positive effect of social capital only in the area where it is relatively scarcer, i.e., the South. In our analysis by area, it could acquire relevance precisely by having the effect of decreasing the social inequalities that would affect the children of the economically and culturally disadvantaged social classes (Cemalcilar and Gökşen 2014) that are more widespread in the southern regions.

The effect of CRIME is observed only in the South, confirming the role of some types of criminal activities as a known deterrent to HC formation, for example, by discouraging investment in education (Coniglio et al. 2010). In the same area, the demographic control of the composition of the population (YOUNG) could be influenced by the negative effect of the demographic shock on labour market

opportunities (Biagi and Lucifora 2008) for young people approaching the job market, which probably tends to reinforce the effort in education. Finally, the positive effect of population density on school grades in the South can be considered a positive aspect of the economies of agglomerations that could support the (insufficient) role of local HC.

Discussion

In this article, we observe that the mechanism that should link SES and school performance is recognized, although it works through different channels in the wealthy Centre-North and in the less developed South. In this first area, the level of advanced education of the adult population has a positive influence on the students' secondary school performance. This mechanism, however, does not work in the less "endowed" regions in terms of HC, the South.

In the southern regions of Italy, financial resources are instead important in contributing to higher student achievement. This confirms that economic conditions matter for educational outcomes, particularly in mathematics, in relatively low-income contexts (Okpala et al. 2001).

In this framework, an expression of regional dualism seems evident: the North retains the characteristic of creating virtuous circles of HC reinforcement, while in the South, the economic condition plays the major role in supporting children's education. These differences show the restriction on the desirable convergence of HC levels between the two areas since the average income in the South is approximately 60% of that in the Centre-North (on ISTAT data). Nevertheless, limits on educational convergence lie in the risk of persistence of the education weaknesses present in disadvantaged social groups that are prevalent in the South, thus adding intraregional inequalities (Contini et al. 2018) to the inequalities between regions. In fact, the lack of convergence would add to a difficult intergenerational social mobility, being the schooling systems essential for promoting equality of opportunities (Ammermueller 2013).

The present article is an original exploratory study that investigates school performance through the educational attainment of students, considering the regional dualism that influences and is influenced by these outcomes. An evident limit in our analysis lies in the possibility of integrating microdata into our dataset that would better explain the role of the SES, particularly regarding the economic status. Furthermore, our results connected to social capital pose a possible development of future research, which should consider the effects of both bridging and bonding social capital.

Conclusions

What supports students in their scholastic performance? The answer is that supports vary locally and have different effects. We have observed how the North-South gap in

education that exists in secondary school levels is due to differences in the level and type of support needed to be successful in studies, such as the economic condition or the average level of education in the region. But these differences can create a serious problem, to the detriment of the poorest area, given the local heterogeneity present in many countries such as Italy. This is an evident limit to the development of national HC – in a typical case of North-South divide – with consequences for the country's economic development.

A possible strategy to counteract the divergence may lie in a different type of support suggested by our findings. We hypothesise that the support of a specific type of social capital whose social group is halfway between the family and the whole community could potentially limit the malaise due to the condition of economic deprivation. Social capital and interpersonal relationships can be useful precisely for targeted help and to alleviate the conditions of poverty (Méreiné Berki et al. 2017). In our study, we can assume some kind of support from the family, or extended family, which is more present in the southern regions (and it is stronger in beyond the parent-child relationship, Micheli 2012) which are less endowed with "formal" social capital. This could be linked to the strong Italian tradition of attention to childcare with the almost exclusive support of the family (Del Valle et al. 2013), worsened in the 2007-2008 crisis and the austerity measures that followed to the detriment of household resources (León and Pavolini 2014), combined with the traditional strong family ties in the South, even as a type of kinship network (Costabile and Coco 2017).

In synthesis, this would suggest that in the relatively poorer areas, this presumed "extended family network" is able to avoid the inconveniences of poverty for children (as an extreme condition) and it would directly benefit from improved economic conditions. The first results imply that the North-South dualism itself affects the support for students (in fact, it is self-fuelling), and that other resources can support the most vulnerable among the vulnerable.

Our findings suggest some changes and areas of intervention. The first change should concern public intervention and support. We show that the gap in terms of HC between North and South begins during compulsory education and that the support that families on average could afford is not homogeneous. The goal of reducing the gap by strengthening the southern area could therefore start by supporting the finances of the poorest families and by improving the delicate interventions in the field of social welfare (Rontos et al. 2021), as, for example, it is expected from the post-COVID-19 EU Recovery Fund. The latter seems to be an opportunity and a fundamental turning point in the period of the post-COVID emergency (Luo 2022).

Second, a different consideration of the social capital available in the South should be developed, with reference to the support for students and their education. There are many criticisms and revisions of Banfield and Putnam's research (Tarrow 1996, Macry

1997, Huysseune 2020). Our results suggest that the form of present social networks, although they may be imperfect for economic development, as suggested by the literature, can at least support a part of the fragile population (young people) in the less resilient context of Italy. The role of the parental and kinship networks in the South has developed due to historical circumstances (Macry 1997) and it could be exploited to support intergenerational ties (e.g., the known "family welfare" that supports young people leaving the family nest) as a continuous economic support while on the educational path (even before the expensive tertiary education).

Third, it is possible that some adjustments are needed in the school system. We must emphasise the meaning of our dependent variables. Investment in STEM education is a primary goal for many governments (Johnson 2012) because of the benefits that it represents in shaping the development of future HC. Battistin and Meroni (2016) observed that lengthened instruction time in contexts with low socioeconomic backgrounds has a positive effect on mathematics skills. This suggests that there is room for improvement where it is most needed. In fact, numerous studies have examined school dropout after compulsory school or noncontinuation to university studies, especially in the South (for which the income and parents' educational level are relevant aspects, Aina 2013). The focus of policy actions should be moved to the lower levels of education to prevent early dropout and to possibly apply support toward those students most at risk, i.e., those who cannot benefit from the support (mainly economic) of the family network. This approach should be implemented to avoid further deterioration in the southern school system that shows, in some cases, lower educational attainment than the rest of the country and it may even tend to worsen the situation of the already disadvantaged students (Agasisti et al. 2017).

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CLUSTERING AND MULTINOMIAL LOGIT ANALYSIS OF FACTORS INFLUENCING HOUSEHOLD RESIDENTIAL LOCATION CHOICE IN THE WASHINGTON METROPOLITAN AREA

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Abstract: The vast range of location alternatives and the preference heterogeneity have made it challenging to model, analyse, and predict the location choice process. In this study, we propose a two-step analytical model to focus on lowering the magnitude of these choices. The Transportation Planning Board's 2007-2008 household survey was used in the Washington metropolitan area, consisting of 3722 Traffic Analysis Zones (TAZ). First, location choice alternatives were clustered based on TAZs into homogeneous groups. These TAZs were categorised based on accessibility to public transport, population density, and employment density. Then, the Multinomial Logit (MNL) model was employed to allow the interpretation of the relationship between the clustered areas and the socio-economic characteristics. Four clustering algorithms were compared in terms of efficiency, and the mini-batch k-means performed the best based on the silhouette coefficient. Overall, households tend to prefer suburban areas as household size and the number of owned vehicles increase. Urban areas were selected with an increase in income, number of household workers, number of unemployed looking for a job, number of part-time employees, number of retirees, and the presence of university students. This paper contributes to the current trend of using unsupervised algorithms in the urban planning literature.

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Introduction

Transportation and the built environment are directly and bilaterally associated (Schwanen and Mokhtarian 2007). Land use patterns and availability of transportation facilities create mobility, and transportation as the primary mobility source can lead to land-use transformation. The residence of households directly impacts their travel behaviour and daily activities (Næss et al. 2018). Various criteria can influence location choices, such as density, accessibility, and distance to public transportation (Cox and Hurtubia 2022).

One of the challenges among most of the studies conducted in this field is the vast number of residence alternatives (Heldt et al. 2014, Zolfaghari 2013). Based on the size of the choice span, household options can range from hundreds to hundreds of thousands. Neighbourhoods, traffic analysis zones, parcels, and buildings are a few examples of different choice scales for Residential Location Choice (RLC) models. Such humongous choice sets make it challenging for urban planners to model and analyse residential location choices. Some studies were based on the property of an alternative or on selecting random subsets of all available options (Lee and Waddell 2010). Another substitute solution is dividing a city into contrasting subregions, then modelling and analysing the output (Bagley and Mokhtarian 1999). Clustering can group the wide range of alternatives into small categories and thus address the ample choice availability (Saxena et al. 2017). With clustering, urban and transportation planners' modelling and interpretation can be facilitated.

Discrete choice models, especially the Multinomial Logit (MNL), have been utilised to model and analyse the factors influencing RLC. MNL model does not provide accurate results considering the unobserved preference heterogeneity solely. The Mixed Logit Model (MXL) with random parameters or Latent Class Analysis (LCA) has been used to resolve preference heterogeneity problems (Habib and Miller 2009, Liao et al. 2015, Lee et al. 2019). This paper identifies and analyses household features and socio-economic factors affecting RLC and it aims to cluster alternatives into homogeneous differential groups.

In previous studies, the dominant factors affecting RLC have been studied in four general categories: (1) residence characteristics (Lee et al. 2019); (2) residence vicinity (Cao 2008); (3) lifestyle and attitude criteria (Smith and Olaru 2013); and (4) socioeconomic features (Gurrutxaga 2023). The extensive list of available choices and preferences heterogeneity are the main challenges in estimating residential household demand. In this section, some related works in this field are reviewed and sequenced from 1959 to 2019.

After World War II, as income and household size increased, households' preferences changed in favour of living in low-density neighbourhoods. The impact of household

characteristics, such as economic, social, and demographic factors, outweighed transportation and public service issues (Weisbrod et al. 1980). RLC modelling was first proposed by McFadden (1978), who introduced an MNL for this purpose. In the proposed model, the consumer was assumed to select the most desirable alternative while examining the features of the available location options. The influential parts of RLC were divided into two classes: (1) features related to the house itself; and (2) features regarding the house vicinity, such as accessibility to public services. The vast availability of available locations was a challenge in modelling location choice.

Hansen (1959) introduced public services availability and the potential productivity of land use based on residential land-use models. Results suggested that as accessibility and mobility expand, the region's growth potential increases consequently. With further distance from the urban area due to fewer job opportunities and higher transportation costs, the land value decreases, and peripheral areas are less attractive for households (Alonso 1964).

Household characteristics, lifestyle, and attitudes toward residence choice can be analysed using the binary logit model, considering household characteristics in central and suburban areas. Attitudinal criteria such as transportation pricing policies and lifestyle criteria, such as participation in cultural events, differ significantly in central and suburban residents, and residence choice using the features observed at the individual level causes errors. It should be done more significantly (Bagley and Mokhtarian 1999). On the one hand, socio-economic factors play a pivotal role in relocation; for example, a shift in the number of people or a change in a household occupation creates a powerful incentive to relocate (Clark and Davies Withers 1999). On the other hand, travel time and commuting expenses impel households to relocate (Van Ommeren et al. 1999).

The nested logit model is another method to identify and analyse the factors influencing RLC. Using the nested logit model, Kim et al. (2005) assessed the impact of transportation and amenities in the UK Oxford area on the location decision-making process. The results showed that a combination of factors such as shorter travel time, lower transportation costs, lower density, and higher school quality determines the preference of individuals in RLC. Travel time, housing rent, household income, and neighbourhood conditions such as air pollution, crime, and distance to school are the most influential variables in modelling RLC (Molugaram and Rao 2005).

Many aspects of RLC cannot be explained by modelling with observed variables. Combining socio-economic factors as observed variables and lifestyle as an unobserved variable makes it possible to identify RLC preferences more insightfully. In this regard, based on lifestyle and employment of the latent class model, Levine and Frank (2007) categorised the city into three homogeneous groups, including city dwellers, suburb dwellers, and public transportation users, and they identified the

impact of socio-economic variables in each category.

Population and employment density are the main variables for separating neighbourhoods, and household income is the pivotal factor in RLC (Bhat and Guo 2007). Heterogeneity in data is one of the many formidable challenges in estimating housing demand. An MXL framework can be used to minimise the unobserved heterogeneity in RLC preferences; as the house unit price rises, the possibility of choosing that alternative decreases, regardless of the household income (Habib and Miller 2009). Marcucci et al. (2011) used the MXL and the MNL to perform an analysis and comparison to highlight the role of every household member in RLC, finding that the wife, adolescents, and the husband are respectively the most influential in the household preference on residence selection. Adolescents are more sensitive to accessibility, noise, and losing their current position.

The set of household choices based on the average commuting distance could create an accurate selection set and lead to a more efficient model without bias (Rashidi et al. 2012). More accurate results are typically attained by classifying choices into homogeneous subsets and by applying the LCA (Liao et al. 2015). Likewise, Ardeshiri and Vij (2019) employed the LCA to label households as six classes based on different preferences, residence characteristics, and household characteristics. They found that high-income immigrants and white families live more in the suburbs, and suburban households depend more on private cars.

To address the problem of choice vastness observed in previous studies, and consequently the modelling complications, the present study aims to develop a cluster-based multinomial logit model to limit the number of choices available and to provide interpretability at the TAZ scale. The results of the model are expected to allow the analysis of similar TAZ, even though they might be scattered in the studied area, and to scrutinise how the socioeconomic features of the household impact their choice to live in a TAZ. In order to achieve this aim, first, the location preferences were clustered based on the zonal percent-walk-to-transit (PWT), population density, and employment density into homogeneous groups; next, the MNL was employed to interpret the results. The results of this model can be used as a tool in urban planning, specifically for the classic problem of location choice.

Methodology

Data

The household data used for modelling is the transportation planning board transportation survey (TPB) 2007-2008. The Transportation Planning Board conducts periodic surveys in the Washington metropolitan area to collect data on demographic information and travel behaviour. This area encompasses Washington DC and several

US states, including Virginia, Maryland, and West Virginia encoded at the TAZ level. The survey data includes more than 11,000 household records, 25,000 individual records, 16,000 vehicle records, and 130,000 travel records. The data was pre-processed to extract the features for the modelling. Then each feature was scaled in the range of 0 to 1. Table 1 shows a description of the features used for this study.

Table 1. Household feature description

Variable	Description
hhsiz	Household size
hhwrk	Number of workers
hhveh	Number of vehicles
incom	Low<= 50000 $
	Mid 50000 $ 100000$
	High >= 100000 $
bikes	Number of bikes
has_wk_at_home	The household has people working at home (if any = 1 else =0)
n_retired	Number of retirees (numeric value)
unempl_look_job	Number of unemployed people looking for a job (numeric value)
has_uni_stu	The family has at least one university student (if any = 1 else =0)
n_part_time_worker	Number of part-time employees (numeric value)

TAZ Feature Data

There are a total of 3722 TAZs in the Washington metropolitan area. Table 2 shows the TAZ features considered for clustering in this study, including access to public transportation, total population, total employment, population density, employment density, and employment numbers concerning job categories.

Table 2. TAZ features considered for clustering

Variable	Description
MTLRTSHR	The zonal percent walk to transit (PWT) within a short (0.5 mile) walk of Metrorail or LRT service
MTLRTLNG	The zonal percent walk to transit (PWT) within a long (1.0 mile) walk of Metrorail or LRT service
ALLPKSHR	The zonal percent walk to transit (PWT) within a short (0.5 mile) walk of any transit service (including Metrorail and LRT) in the AM peak period
ALLPKLNG	The zonal percent walk to transit (PWT) within a long (1 mile) walk of any transit service (including Metrorail and LRT) in the AM peak period
ALLOPSHR	The zonal percent walk to transit (PWT) within a short (0.5 mile) walk of any transit service (including Metrorail and LRT) in the off-peak period
ALLOPLNG	The zonal percent walk to transit (PWT) within a long (1 mile) walk of any transit service (including Metrorail and LRT) in the off-peak period
Popden	Population density
Empden	Employment density

Analysis framework

The methodology of this analysis is a combination of unsupervised machine learning methods and discrete choice models (Figure 1). The entire Washington metropolitan area consists of 3722 TAZs. Once TAZs were clustered based on accessibility to public transportation, population densities, and employment densities, each sample's corresponding cluster coupled with demographic features were fed into MNL to allow the interpretation of the reasons for the households' choices.
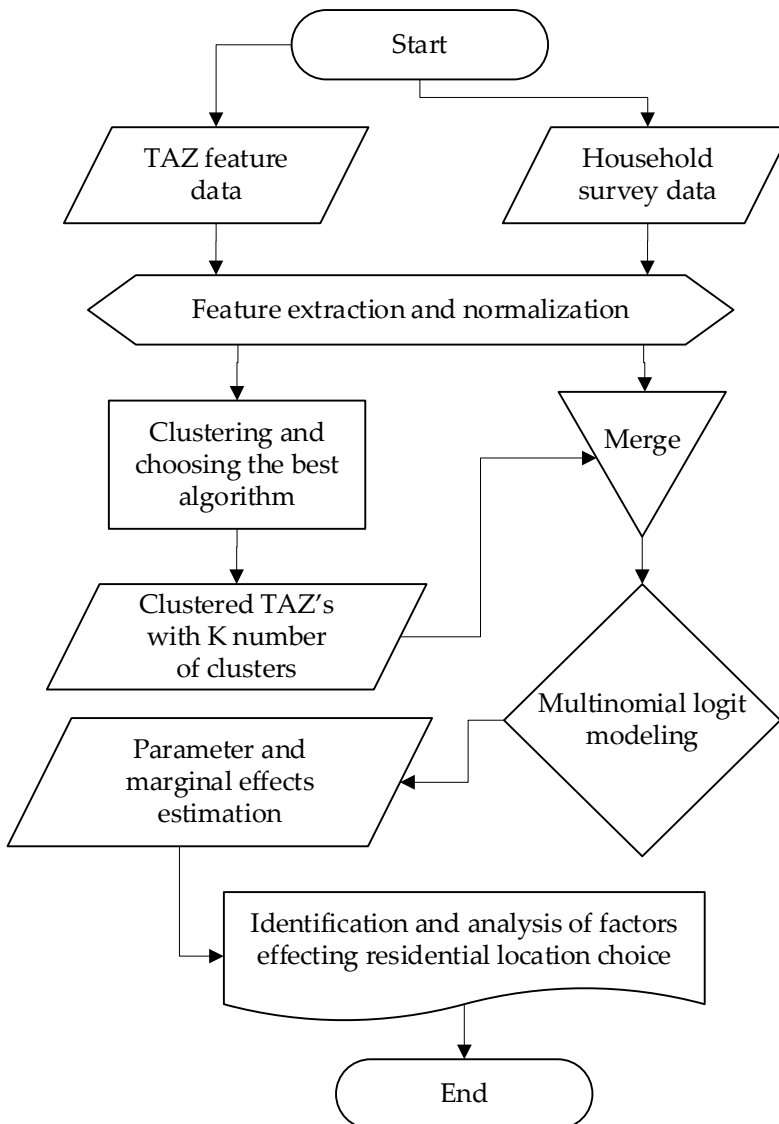
Figure 1. Analysis framework

Clustering

Clustering is an unsupervised learning method that identifies natural clusters in multidimensional data into a chosen number of categories, where samples within each group (cluster) are akin compared to other groups (Jain et al. 1999). With the aid of clustering algorithms, a handful of TAZ clusters with the most similar features can be achieved instead of dealing with thousands of alternatives (in this study, traffic analysis zones). TAZs can be distinguished based on accessibility, land use, employment density, or other features. TAZs were clustered based on the zonal PWT, population density, and employment density. Similarities and distinguishing differences in these features were discovered by comparing the results of clusters. Data visualisation and numerical observation of statistical descriptions made the cluster comparison possible.

The TAZ data was clustered using four clustering algorithms. The algorithms employed and compared in this paper comprise Birch (Zhang et al. 1996), Agglomerative (Ackermann et al. 2014), Spectral (Ng et al. 2001), and mini-batch K-means (Sculley 2010). The K-means algorithm tends to be the most popular clustering algorithm. The objective of k-means optimization is to find the set of C of cluster centres $\in R^m$, given $|C| = k$ to minimise a set of X of examples by the objective function:

$$\sum_{x \in X} \|f(C, x) - x\|^2 \tag{1}$$

where $f(C, x)$ is the function to return the nearest cluster centroid $c \in C$ to x using Euclidean distance (Sculley 2010).

After clustering with different algorithms, the optimised number of clusters was found, along with the best-performing algorithm. The silhouette coefficient was used as the evaluation metric to make this possible (Rousseeuw 1987). The silhouette coefficient is calculated from:

$$Silhouette\ Score = \frac{(b(i) - a(i))}{max(a(i), b(i))} \tag{2}$$

where here $b(i)$ is the minimum distance between recognized data patterns i from the selected features and patterns in all the other dissimilar clusters not containing pattern i, and $a(i)$ is the mean distance between the data pattern and every other pattern in the same cluster (Zhou and Gao 2014). The best value for the silhouette coefficient is 1, and the worst is -1. If one is obtained for this coefficient, clusters are distinctly separated, while when this coefficient is 0, clusters are indistinguishable, or the distance between clusters is insignificant. If this coefficient is -1, it can be concluded that the clusters are wrongly determined.

Multinomial Logit Model

Based on discrete choice modelling, households choose the alternative with the highest utility. In the MNL, alternative utility is defined as a function of the factors influencing RLC. This model suits the situation where the purpose is to predict the residence location of households concerning the factors affecting it. The utility of the household RLC is defined as:

$$U_{ij} = \beta X_{ij} + \varepsilon_{ij} \tag{3}$$

where the utility function U_{ij} is created for the respondent i who selects alternative j. β is the coefficient of the descriptive variable and ε_{ij} is the unobserved error term of the utility function. The probability that the respondent i selects alternative j is defined with the following function:

$$P_{ij} = \frac{exp\, exp\left(\beta X_{ij}\right)}{\sum_{i=1}^{j}\; exp\, exp\left(\beta X_{ij}\right)} \tag{4}$$

The use of multinomial logit in our study has one limitation. The alternatives of the model are selected by a clustering algorithm, and because the clustering algorithms are expected to work based on the similarity of features, this may create some uncertainty about how the identified groups relate to socioeconomic features in the results of the multinomial logit. To minimise this issue, we used a range of clustering algorithms and evaluation criteria to choose the best possible clustering model in the process.

Results

Clustering Comparison

Figure 2 compares the silhouette coefficient from the four clustering algorithms and four choices for the number of clusters (two to five). The mini-batch K-means algorithm had the highest silhouette coefficient value in all cluster numbers except for three, where it performed only better than the agglomerative algorithm. In dividing TAZs into three clusters, Spectral had the highest silhouette coefficient. The agglomerative algorithm showed the worst performance, and its silhouette coefficients were minimal for all numbers of clusters. Finally, the Birch algorithm had a moderate performance compared to other algorithms.

The two clusters and mini-batch K-means algorithm had the most differentiation and the most significant silhouette coefficient. Therefore, they were used for the final modelling.
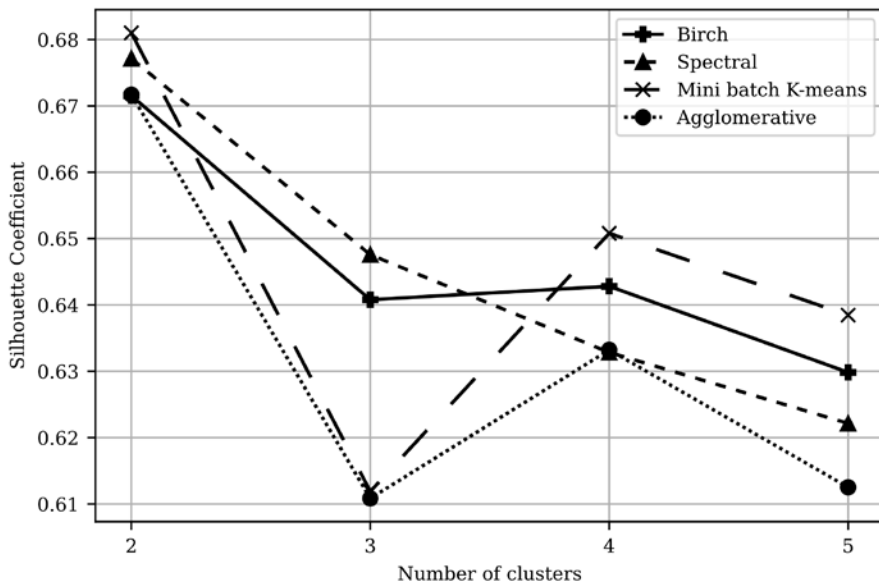
Figure 2. Performance comparison of different clustering algorithms

Analysis of the Clusters

The characteristics of each cluster were discovered by data visualisation and statistical description. Employment-related parameters and population density were compared and discussed.

Accessibility to public transport in cluster 2 is much easier than it is in cluster 1. To illustrate this, Figure 3 compares the two clusters for a public transport accessibility parameter. Cluster 1 (58.03% of the TAZs) includes peripheral and less developed areas, whereas cluster 2 (41.97% of the TAZs) covers more central and developed areas. Access to public transport in cluster 1 is less than in cluster 2. In addition to the example parameter, a similar difference was observed in other parameters related to public transport accessibility.

Comparing the values in Table 3, it is noticeable that the mean of total employment in cluster 1 is close to half of the mean for the same feature in cluster 2. Population and employment in TAZs of cluster 2 are by a substantial amount more densely distributed.

The difference between clusters is also comparable, pondering the redundancy of each employment category. It is assumed that industrial jobs are located in the suburbs, and office employment lies closer to or in the urban area. The average industrial employment in cluster 1 is higher than in cluster 2, and office employment in cluster 1 is much lower than in cluster 2. Given that these variables were not considered in the clustering process, this confirms cluster 1 as the suburbs and cluster 2 as the urban areas.
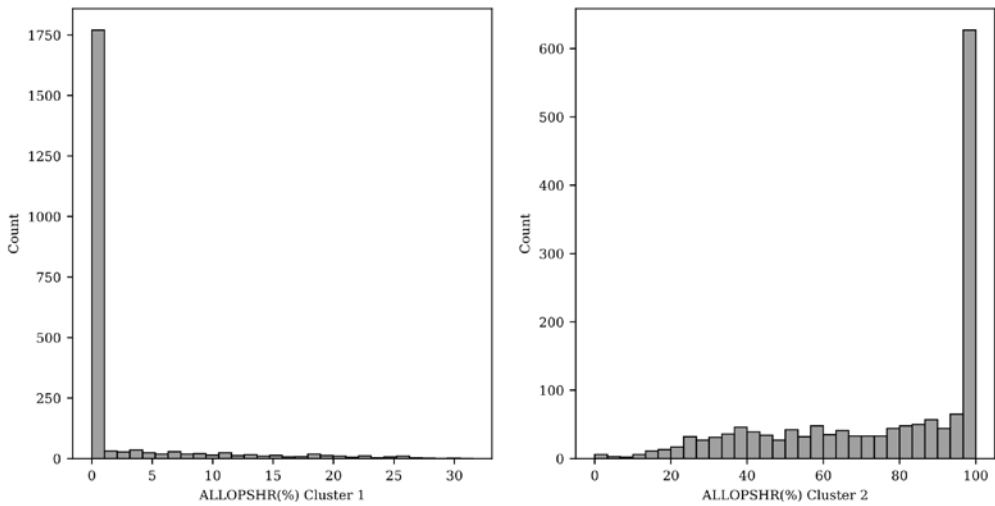
Figure 3. Comparing value counts of ALLOPSHR (the zonal percent walk to transit – PWT within a short, 0.5 mile, walk of any transit service in the off-peak period) for the 2 clusters

Table 3. The statistical description of employment and population characteristics in clusters

	Cluster 1			Cluster 2		
	mean	Std.	max	mean	Std.	max
Total Employment (Person)	788.72	1902.36	42638	1343.339	2508.41	22290
Industrial Employment (Person)	161.49	541.19	14111	127.2644	334.5192	4103
Retail Employment (Person)	148.41	360.02	4695	220.6159	411.3774	4873
Office Employment (Person)	306.71	936.8	20298	725.6876	1903.869	17639
Other Employment (Person)	172.1	517.02	14110	269.7714	782.4411	18097
Population Density	1.5169	2.7899	55.869	6.65616	8.48945	77.5862
Employment Density	1.189308	4.913772	135.2821	11.2768	36.2743	413.754

Multinomial Logit Analysis

As mentioned in the previous sections, cluster 1 is for households with low access to public transportation and living in suburban areas. In this cluster, the positive sign of coefficient β for household size, and the number of vehicles, indicates a positive effect, while the negative sign of coefficient β for other variables indicates their negative impact on selecting this cluster. The results for cluster 1 are reported in Table 4.

The same signs of upper and lower coefficient intervals and the t-test value for all variables, except for the number of household bicycles and the presence of a family member working at home, show the significance of the variables. The parameter of descriptive variables can only express its positive or negative impact on the likelihood

of choosing an alternative. Therefore, the marginal effects analysis is required to analyse the variables affecting RLC.

Table 4. Estimation of MNL for cluster 1 (base cluster = cluster 2)

Variable Name	Coefficient	Std. Err.	t	95% Conf.	
hhsiz *Interval*	0.4462516	0.0939333	4.75	0.2621457	**0.6303574**
hhwrk	-0.5651202	0.0965597	-5.85	-0.7543737	**-0.3758666**
hhveh	0.941377	0.0307236	30.64	0.8811598	**1.001594**
bikes	-0.0236511	0.0169711	-1.39	-0.0569138	**0.0096116**
n_part_time_worker	-0.2546975	0.0908127	-2.80	-0.4326871	**-0.0767079**
n_retired	-0.0974938	0.0457508	-2.13	-0.1871638	**-0.0078238**
income_1	0.5707335	0.0764166	7.47	0.4209598	**0.7205072**
income_2	0.4671024	0.0656184	7.12	0.3384927	**0.595712**
income_3	0.3262629	0.0657375	4.96	0.1974198	**0.455106**
unempl_look_job	-0.4567923	0.1218809	-3.75	-0.6956744	**-0.2179101**
has_uni_stu	-0.8604996	0.1292721	-6.66	-1.113868	**-0.607131**
has_wk_at_home	-0.0436464	0.0698691	-0.62	-0.1805873	**0.0932945**
ASC	-2.140847	0.0897519	-23.85	-2.316758	**-1.964937**

Marginal Effects Analysis

The descriptive variables of the utility function were estimated. The marginal effects were calculated in percentages to determine how much the probability of selecting each group differs with one more unit of another variable. Table 5 shows the average marginal effects for cluster 1 (households in the suburbs with low access to public transportation). Adding one person or vehicle to the household, choosing cluster 1 increases by 11% and 23%, respectively. A decrease in income increases the likelihood of selecting suburban areas. Adding a vehicle to the household is the most influential factor in choosing a suburban residence.

Cluster 2 embodies households with better access to public transportation. The marginal effects of cluster 2 variables, such as household size, number of vehicles, and household income, are identical to cluster 1 with only the opposite sign.

With the addition of an employed member or a member who has a part-time job to the household, the probability of selecting the urban area increases by 14% and 6%, respectively. Moreover, adding an unemployed member looking for a job to the household increases the likelihood of choosing the urban area.

The presence of students in the household has the most significant impact (21%) on choosing the urban area. The presence of retirees in the household effectively increases the probability of choosing cluster 2 (2%). The number of bicycles and the number of members working at home have no effect on RLC in the studied case.

Table 5. The average marginal effects for cluster 1

Variable Name	dy/dx	Std. Err.	t	95% Conf. Interval	
hhsiz	0.1108379	0.0233306	4.75	0.0651107	**0.1565651**
hhwrk	-0.1403619	0.0239849	-5.85	-0.1873714	**-0.0933524**
hhveh	0.2338148	0.0076564	30.54	0.2188086	**0.2488211**
bikes	-0.0058743	0.0042152	-1.39	-0.0141359	**0.0023872**
n_part_time_worker	-0.0632606	0.0225558	-2.80	-0.1074691	**-0.0190521**
n_retired	-0.024215	0.0113643	-2.13	-0.0464886	**-0.0019415**
income_1	0.1417561	0.0189868	7.47	0.1045426	**0.1789696**
income_2	0.1160167	0.0163015	7.12	0.0840664	**0.1479671**
income_3	0.0810357	0.0163288	4.96	0.0490319	**0.1130394**
unempl_look_job	-0.1134559	0.0302713	-3.75	-0.1727866	**-0.0541253**
has_uni_stu	-0.2137269	0.0321071	-6.66	-0.2766557	**-0.1507981**
has_wk_at_home	-0.0108407	0.0173538	-0.62	-0.0448536	**0.0231722**

Discussion

This study aimed to tackle the issue of having too many location choices in previous research, which made modelling complicated. To do this, we developed a cluster-based multinomial logit model that limits the number of choices available and it provides interpretability at the TAZ scale in the Washington metropolitan area. The model's results are expected to allow for the analysis of similar TAZ, even if they are scattered in the studied area, and to examine how household socioeconomic features affect their choice to live in a TAZ. The knowledge of location choice preferences can be a decisive factor in the development of an area, as policymakers and urban planners need to know why socioeconomic groups choose their residence location in order to be able to allocate local and government funding to the building of areas as they find appropriate. Thus, the results of this study can play an important role in the process of urban planning.

The availability of vehicles for households and the lack of dependence on public transportation can influence RLC, meaning that residents buy cars to be able to live in the suburbs. With a rise in the number of owned vehicles, households are more likely to choose a location far from the urban area; and previous studies reached the same conclusion (Schwanen and Mokhtarian 2007, Cao 2008, Ardeshiri and Vij 2019). From the coefficients related to household size and vehicles, it can be deduced that cluster 1 belongs to households far from the urban area with little access to public transportation. The coefficient related to the household size and the number of household vehicles in this cluster is positive. That is, increasing the size of the family and the number of vehicles positively affects the likelihood of choosing cluster 1. The increase in the number of household members also seems to be a factor in the increased

number of vehicles in the household. It can be inferred that as the household size and the number of owned vehicles increase, selecting cluster 2 is less likely.

Income is one of the most critical factors affecting RLC in this study and it has always been a key factor (Weisbrod et al. 1980, Molugaram and Rao 2005). Income coefficients indicate that households choose to move to the urban area as income increases.

The RLC of workers depends mainly on their job location (Clark and Davies Withers 1999, Van Ommeren et al. 1999, Liao et al. 2015, Lee et al. 2019). The number of household workers and the number of people with part-time jobs are among the most critical descriptive variables in RLC. This may be because household workers prefer more affordable travel costs and lower commuting time and distance.

University students choose residences that offer less travel time and expenses because universities are typically located in urban areas. This study, like previous studies, considers travel time and cost as influential factors in choosing a residence (Guo and Bhat 2002, Kim et al. 2005). This result might be due to the educated people's tendency to move from the suburbs to urban areas over time. The same results were found in Costa and Kahn (2000). However, some studies have shown that people with low education tend to live in urban areas (Cao 2008).

The unemployed household members looking for a job probably are more considerate about their transportation expenses due to the absence of income. They are likely to prefer to live in the urban area since there are ample affordable public transportation facilities in developed areas. These people are probably more in need and deprived. Thus, they can benefit from affordable public transportation, accessible market, and amenities.

The marginal effects for the number of retirees in the household show that with the presence of a retiree in the household, the probability of choosing the urban area with better accessibility increases. This could be because retirees are likely to have mobility and physical challenges due to senescence, making them prefer to be closer to amenities such as leisure and shopping centres.

Despite our efforts to conduct solid research, we should acknowledge several limitations. Although the use of clustering algorithms solves the problem of a large number of alternatives, there is no approach to evaluate the accuracy of clustered results. The clustering algorithm groups unlabelled data based on similarity criteria without any prior baseline, so no comparison can be made to determine precision. Future work could experiment with some labelled data and compare the results of this model against some baseline truth. Additionally, the data used in this study belong to an old survey as we did not have access to newer data. The same model should be implemented on more recent data to discover the preference changes in the area.

Conclusions

This study examined the role and effects of factors influencing RLC in the Washington metropolitan area. Households choose their residence location based on environmental criteria such as density, accessibility, and proximity to public transportation. One of the issues that researchers have faced since the beginning of RLC studies is the wide range of possible alternatives for RLC and the heterogeneity in the preferences of households. Discrete choice modelling and reliable estimations are infeasible in the presence of such an extensive number of alternatives. Clustering was performed based on location attribute data, including 3722 traffic analysis zones in the Transportation Board Planning Survey 2007-2008, splitting the data into two distinct categories: central areas of the city with high accessibility to public transport, and suburban areas with low accessibility to public transport. Then, the MNL model was employed to analyse the features that influenced RLC.

The results showed a greater tendency to choose suburban areas with increasing household size and the number of owned vehicles. A growth in income, the number of household workers, the number of unemployed looking for a job, the number of part-time employees, the number of retirees, and the presence of university students leads to a greater desire to choose urban areas.

Since the influential factors in choosing RLC depend on the research case, and since there was a challenge with accessing newly collected data, it is necessary to be careful in generalising the results obtained from this study. Future research could do a more concrete analysis of the factors influencing RLC using a more comprehensive and up-to-date dataset. It is also possible to conduct the clustering of traffic analysis zones based on criteria not considered in this study, such as the area of various land use types, quality and number of educational centres, land value, and level of service.

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DEMOGRAPHIC AND PHYSICAL ASPECTS OF GENTRIFICATION IN RELATION TO RESILIENCE OF LOCALITIES: CASE STUDY OF THE RENOVATED DISTRICT IN THE CITY OF PRAGUE

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Keywords:

residential gentrification; commercial gentrification; city resilience; Prague

Abstract: Gentrification is a complex process taking place in major cities around the world. This process varies from city to city and it is influenced by the specific conditions of each country. Both positive and negative impacts of gentrification can affect a city's resilience. The aim of this paper is to assess and verify how residential and commercial gentrification is taking place in two selected locations of the municipal district Holešovice in the City of Prague. Both locations are attractive due to their proximity to the city centre. The paper focuses on two aspects of gentrification, i.e., the outcomes of demographic changes and its physical dimension, assessed by the visual complexity of building appearance. The results show the relationship and temporal continuity of residential and commercial gentrification. With its findings, the paper contributes to the knowledge base of urban studies following the identified growing need for commercial facilities in urban districts as a result of demographic changes.

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Introduction

Gentrification is a process that is taking place with varying degrees of intensity in all major cities around the world. In post-socialist countries it began to develop more significantly after 1990 (Kubeš and Kovács 2020). This is also certainly related to the delay in research on this process, and its implications for the urban environment in these countries, compared to Western countries. In the second decade of the new millennium, a turbulent socio-economic development affected property prices and the costs associated with them. This development also had a significant impact in Czechia, especially in its capital city of Prague. In 2020, in Prague, rental prices were the second highest in the capitals of post-socialist countries after Warsaw in Poland (Delloite 2021). Gentrification is a process that can influence housing price increases and it can lead to (or be a consequence of) the renovation of previously neglected urban areas (Hamnett 1991, Zuk et al. 2018). Thus, the perceived positive benefits of gentrification on the economic resilience of urban locations is evident in the academic literature (Atkinson 2004, Lester and Hartley 2014), but its impact on social resilience is highly contested (Sýkora 2010, Watt 2013).

Generally, papers on gentrification focus on case studies of different cities or districts, and more often on residential gentrification (Temelová and Novák 2007, Kairjaka 2019) than on commercial gentrification (Williams and Needham 2016, Sakızlıoğlu and Lees 2020). Alternatively, there have been studies with a focus on the combination of commercial and residential gentrification (Butler and Lees 2006), and associated economic and social impacts (Centre for Urban Studies 1964, Smith 1979, Lees 2003, Chapple and Zuk 2016, Waley 2016, De Boeck and Ryckewaert 2020). This study presents research findings on both types of gentrification, simultaneously.

The analysis focuses on the gentrification of Prague, which has been studied by both Czech (Temelová and Novák 2007, Sýkora 2010, Ouředníček and Temelová 2009, Zdráhalová 2014, Sýkora and Špačková 2022) and foreign scholars (Verwaaijen 2013, Kährik et al. 2015, Kairjaka 2019). The research focus is on two sites in the renovation of the formerly industrial neighbourhood of Holešovice (Prague 7 Municipal District), which are attractive due to their proximity to the centre of Prague, historical development, and transport accessibility. There are similar districts to Holešovice in other cities, such as Praga Północ district in Warsaw (Dudek-Mańkowska and Iwańczak 2018), Āgenskalns district in Riga (Kairjaka 2019), Prenzlauer Berg in the eastern part of Berlin (Siemer and Matthews-Hunter 2017), or North Tallinn in Tallinn (Kährik et al. 2015).

The aim of this paper is to assess and verify how residential and commercial gentrification is taking place in two selected locations of the municipal district Holešovice in the City of Prague. The process of gentrification is a complex spatial phenomenon. This paper focuses only on two aspects of gentrification, i.e. outcomes of demographic changes and its physical dimension, assessed by the visual complexity of

building appearance. Demographic data and empirical research, aimed at assessing the physical condition of buildings according to the methodology of Temelová and Novák (2007), are used to assess residential gentrification. According to the literature review (Zukin et al. 2009, Williams and Needham 2016, Pastak et al. 2019), and considering Czech conditions, a categorisation of commercial facilities (commercial facilities in line or in contradiction with commercial gentrification) is created, to assess commercial gentrification. In relation to these contexts and the basic traits of gentrification, the following two research questions were formulated: (1) To what extent are the elements of residential gentrification reflected in the form of selected urban sites?; (2) What are the interrelationships between residential and commercial gentrification?

The paper is structured as follows. The literature review covers the theoretical departures of gentrification, also in relation to urban resilience, and then briefly summarises gentrification in post-socialist countries. The following section characterises the study area: the urban district and the two selected sites. The methodology describes the procedure for assessing gentrification processes in the selected sites, which is then followed by the results section, the discussion of the findings, and the conclusions.

Gentrification in terms of its genesis and perception by scholars

The term gentrification was first used by the Centre for Urban Studies (1964), which defined gentrification as a process of moving members of the upper social classes from the countryside to the big cities. Hamnett (1991) extended this view to the movement of middle or even upper-class residents to urban centres, with new residents replacing some of the original residents. In that, the housing stock is being upgraded according to the requirements of the new residents. However, in the past, Smith (1979) pointed out that gentrification is determined by emerging investment opportunities in urban centres, rather than by the influx of new residents. In this sense, it is a combination of social, physical, and economic changes, which according to Sýkora (1993) support the process of gentrification, especially in the central parts of large cities which have deteriorated but for certain reasons still hold an attractive housing stock.

In the 1970s, efforts to understand why gentrification was occurring began to emerge. The demand theory suggests that gentrification is influenced by the changes in consumer preferences driven by lifestyle changes (Ley 1980, Short 1989, Hamnet 1991, Sýkora 1993, Zuk et al. 2018). A major pillar of the supply theory in explaining the causes of gentrification is the difference between the level of potential land rent from the best possible use of a property and the level of rent from the current use (Smith 1979, Lester and Hartley 2014, Bernt 2016). Bernt (2016) pointed out that both theories of gentrification are extremely useful, as gentrification can be seen as linking the consequences of the rent gap and the changes in the lifestyles of young people.

Ley (1980) pointed to the emergence of a new social class (young intellectuals, professionals, civil servants, or technicians) with a new lifestyle that is characterised by cultural and ethnic pluralism. Short (1989) deepened the characteristics of new residents in general, as being young, single, childless, university-educated people who have high incomes and are focused on work, living, and entertainment in the city centre. Lester and Hartley (2014) confirmed the influx of middle-class residents into urban areas that were once home to low-income populations, and they perceived this process as contentious and highly controversial. Also, according to Ha and Kwon (2017), on the example of regeneration programs in Seoul, housing prospects of low-income residents have worsened and gentrification contributed to residential polarisation by income, education, household composition, and tenure type.

Holm et al. (2015) identified that development in the information technology sector, with high-paying jobs, has also contributed to gentrification. A new group of gentrifiers, super-wealthy professionals from the global finance and corporate service industries, was identified in the early 21st century by Lees (2003) in New York, and by Butler and Lees (2006) in London.

In addition to residential gentrification, commercial gentrification also needs to be addressed. Kubeš (2017) defines it as a change in the supply of goods and services to accommodate new residents. Pastak et al. (2019) define commercial gentrification as the gradual loss of local, traditional businesses and the rise of specific types of shops and businesses that replace them, while changing the influence and mutual relations of entrepreneurs. Williams and Needham (2016) point to the displacement of original small businesses in the face of changing the consumer preferences and rising rents. Meltzer (2016) also notes that changes in the residents in the context of residential gentrification can bring new services and access to a wider range of basic goods, which do not serve the original residents. This confirms Zukin et al. (2009) finding that certain new types of shops, restaurants or cafes emerge to serve the needs of new residents; these new commercial facilities also serve a social function and they represent a certain form of cultural capital.

Pastak et al. (2019) note that commercial gentrification is the result of intentional and unintentional decisions and actions by individual entrepreneurs and public authorities, all influenced by local and global market forces. Chapple et al. (2019) add that the mechanisms of commercial gentrification are market driven but they can also be triggered by public investment that affects the availability or attractiveness of a district.

Gentrification impacts on the resilience of urban localities

A number of different spatial processes take place in cities that influence their attractiveness and, at the same time, their long-term ability to withstand various external pressures. For this reason, public authorities seek to support elements of

strategic decision-making or spatial development planning that aim to improve the conditions for the functioning of the socio-economic structure of cities. This often involves various types of public investment, either to improve the provision of public services (e.g. health, education, and culture) or to improve the business environment in order to maintain a diversified economic structure. These activities by public authorities can be seen as a targeted effort to support the resilience of cities to potential external pressures. According to Pělucha and Kasabov (2020), in regional studies, resilience is precisely understood as a broader normative concept that refers to the long-term ability of communities/localities to withstand various external shocks or spatial processes or trends in a stable manner. As Shamsuddin (2020) points out, there are different definitions of urban resilience; the term is ambiguous and different people, groups, communities and disciplines can work with it in different forms and with a particular approach to understanding. Lang (2012: 8) perceives "urban socio-economic resilience as being linked to those properties of the system that maintain the success and continuous existence of the system". Meerow et al. (2016) define urban resilience as an ability to maintain or rapidly restore necessary functions in the face of disruption, to adapt to change, and to transform the systems to enable adaptation. According to Bautista-Puig et al. (2022), resilience can be understood as the ability to cope with uncertainties, and to continue development while maintaining functions.

Thus, gentrification is a process of changes (Pělucha and Kasabov 2020) which requires adaptation and, as Atkinson (2004) points out, it has both positive and negative impacts. These are mainly the revitalisation and modernisation of urban centres, some economic and transport savings, and the creation of new and better-quality jobs. Lester and Hartley (2014) also report positive impacts on the total number and quality of jobs. Zuk et al. (2018) stated that the new residents themselves are also contributing to the modernisation of the district, aiming to improve the physical environment around their new homes, and often getting involved in the district.

Among the negative impacts of gentrification, Atkinson (2004) identifies social polarisation and the emergence of conflicts between original and new residents, rapid increases in rent prices, and displacement of original residents. Watt (2013) and Zuk et al. (2018) described the growth of rent prices that cause displacement in these localities. Wachsmuth and Weisler (2018) and Kairjaka (2019) link the rapid rise in rental prices to short-term rentals for tourists. Sýkora (2010) pointed out that these factors can lead to social polarisation or even residential segregation. Other authors also warn of negative impacts on the relations between the majority society and the minorities (Lancione 2017, Méreiné-Berki et al. 2021, Crețan et al. 2022), which fundamentally affects the stability and resilience of urban localities.

Commercial gentrification can be perceived as a problem by the original residents. As noted by Chapple et al. (2019), commercial gentrification means the influx of new businesses that, on the one hand, displace the original shops due to higher rents, but

on the other hand, new cafes, trendy boutiques or gourmet restaurants appear; this changes the district for better or for worse. Le Grand (2023) points out that the displacement of original establishments due to commercial gentrification leads to the symbolic displacement of an original culture of the locality. According to Jeong et al. (2015), the current trend of commercial gentrification and its impact on long-term residents can lead to social exclusion and further gentrification.

The form of gentrification changes over time, and this is reflected in changes in the resilience conditions of the relevant urban areas. According to Lees et al. (2016), contemporary gentrification, in addition to the revitalisation of old houses in the working-class districts, also involves the construction of new infrastructures, houses, or even entire districts that are characterised by ostentatious consumption by the wealthy gentrifiers. In this context, gentrification can be seen as a process affecting or changing the appearance of urban districts. This is particularly the case where new construction or changes in the use of vacant land occur in response to the demands of gentrified residents (Zukin et al. 2009, Kubeš 2017, Carmona et al. 2019).

Gentrification in the post-socialist countries of Central and Eastern Europe

Cities in post-socialist countries are strongly influenced by developments during the socialist period (Stanilov 2007, Ilchenko and Dushkova 2018, Manahasa and Manahasa 2022). Kubes (2017) found that gentrification in the post-socialist countries of Central Europe only started to manifest itself significantly after 2005. Grabkowska (2015) stated that the accession of post-socialist states to the European Union in 2004 contributed greatly to the development of inner-city revitalisation. According to Sýkora and Bouzarovski (2012), the urban environment of post-communist cities has been adapting and reshaping itself to new conditions; post-communist urban spaces are being reorganised, involving the restructuring of existing urban areas and the creation of new ones, leading to a qualitatively better urban environment. Gentile et al. (2015) emphasised that privatisation and restitution processes influence the development of gentrification. The importance of property rights transformations is also highlighted by Chelcea et al. (2015). Kovács et al. (2013) and Gentile et al. (2015) report that, unlike in Western countries, the displacement of indigenous peoples occurs to a small extent.

According to Jakóbczyk-Gryszkiewicz et al. (2017), Central East European (CEE) countries can only present the initial phase of the gentrification process. Bernt et al. (2015) mentioned that the differences between CEE countries and individual cities are widening, due to different "starting" conditions and different speeds of transformation, which have led to the uneven development of gentrification. Kubeš and Kovács (2020) created a typology of gentrification in CEE countries: early-stage gentrification driven by transitory urbanites (typical for cities with universities); classic gentrification; and super-gentrification; and also specific forms of gentrification (marginal gentrification; controlled soft gentrification; organised gentrification with the displacement of low-

income residents; tele-gentrification). Nevertheless, Porębska et al. (2021) use the example of Kraków to show that some districts in historic centres can skip the gentrification phase.

Gentrification is a process in large cities to which the capital of Czechia undoubtedly belongs. The question is where, and to what extent, gentrification is manifested in the territory of Prague, and how it affects the functioning of these capital city districts. The gentrification of Prague has been addressed by a number of scholars (Temelová and Novák 2007, Sýkora 2010, Verwaaijen 2013, Zdráhalová 2014, Kährik et al. 2015, Kairjaka 2019, Sýkora and Špačková 2022). According to Kairjaka (2019), who compared residential gentrification in the Holešovice District in Prague and the Āgenskalns district in Riga, the future development of the residential gentrification process in both districts is somewhat unclear. The present study, conducted in 2021, focused on assessing gentrification using demographic data and, in particular, on empirical research that was aimed at assessing the physical condition of residential buildings, and the presence of commercial gentrification objects in two specific locations in Holešovice. In contrast to Sýkora and Špačková (2022), who examined the local context of social changes associated with gentrification in this district, the present study does not focus on the social impacts.

Methodology

Study area

The Prague 7 district is applicable for gentrification research mainly due to its location, its historical development, and the attractiveness of its territory. It is a district directly adjacent to the historical core of Prague (Figure 1), and whose development is noticeably influenced by its industrial past. Prague 7 is characterised by older residential development, but over the last fifteen years there are significant features of gradual revitalisation and modernisation of the physical environment. Holešovice, like Karlín in Prague 8 district (Ilík and Ouředníček 2007), was affected by the flood in 2002. According to Sýkora and Špačková (2022), the subsequent need for reconstruction contributed to the overall physical modernization of this district. Holešovice is, therefore, a district that has its own unique atmosphere, as it combines elements of original architecture with those of modern architecture.

According to MČ Praha 7 (2016), the cadastral area of Prague 7 is currently 7.09 km²; it is therefore a medium-sized urban district. The core of Prague 7 is Holešovice, representing 66% of the Prague 7 area, and about 85% of all its inhabitants. The cadastral area of Bubeneč (about a half of the Bubeneč cadastral area) makes up 32% of the Prague 7 district, but only 15% of the population of Prague 7 lives there. A large part of Bubeneč is covered by the Stromovka Park. The Prague 7 district also extends into the cadastral area of Libeň (about 2% of the Libeň cadastral area). This small part

of Libeň is industrial in nature and there is no registered population.
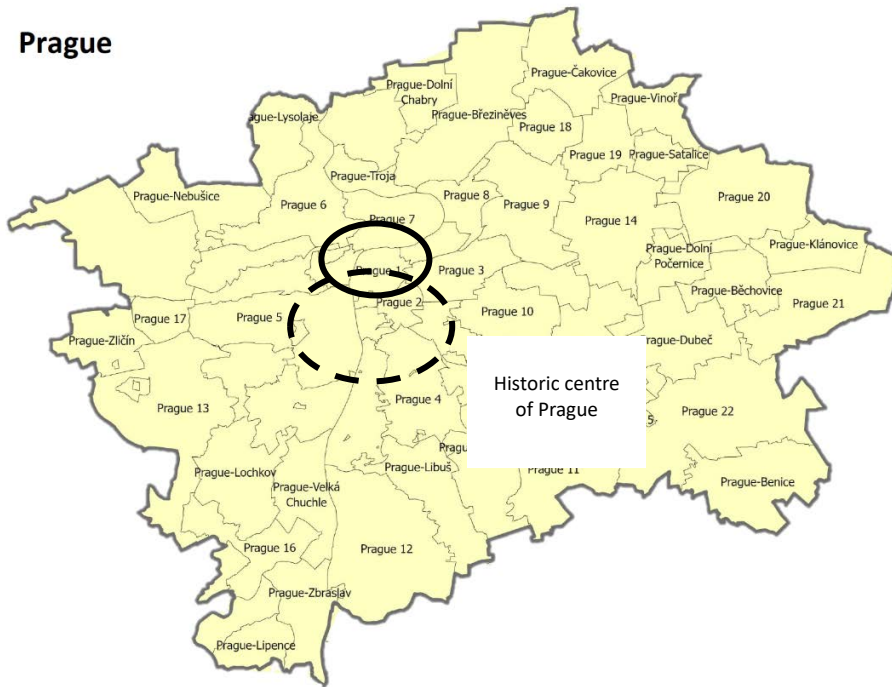
Figure 1. Location of Prague 7 district in the capital of Prague, near to the historical city centre
Source: ČSÚ (2005)

The Prague 7 district has some features that make it an attractive district for potential gentrifiers: proximity to the city centre and very good transport links to the city centre and other districts, as well as a wide range of leisure activities that match the lifestyle of gentrifiers. Within Holešovice, two sites were selected for detailed research: the Dělnická site and Horáková site (Figure 2).

The Dělnická site was chosen primarily because of its historical development, and it can be described as a more residential location. In the 19th century, the construction of houses and dormitories for the workers gradually began to take place here. Therefore, historically, this site is a working-class urban area (Sýkora and Špačková 2022), and it has also been industrial, but the decline of industry has resulted in environmental degradation, triggering the need for revitalisation and investment. The research area of the Dělnická site is bounded to the north by U Průhonu Street, to the east by Bubenské Riverbank and Sanderova Street, to the south by Jateční Street and, to the west by Argentinská Street. A total of 322 buildings were included in the empirical research.

The Horáková site has more of a commercial focus, and it had a different historical development. Significant development of construction only started here at the beginning

of the 20th century, with rather more representative buildings for the upper classes. The Horáková site has good prerequisites for the gentrification because of its location between two attractive large city parks (Stromovka and Letenské sady). The nearby Strossmayer Square, where a total of 10 tram lines cross, is considered as the centre of Holešovice. Good transport connectivity with the rest of the city improves the conditions of gentrification. To the empirical research, the Horáková site was bounded to the north by Veletržní Street, to the east by Dukelských hrdinů Street, to the south by Kostelní Street, and to the west by Nad Štolou Street. A total of 428 buildings were included in this research.
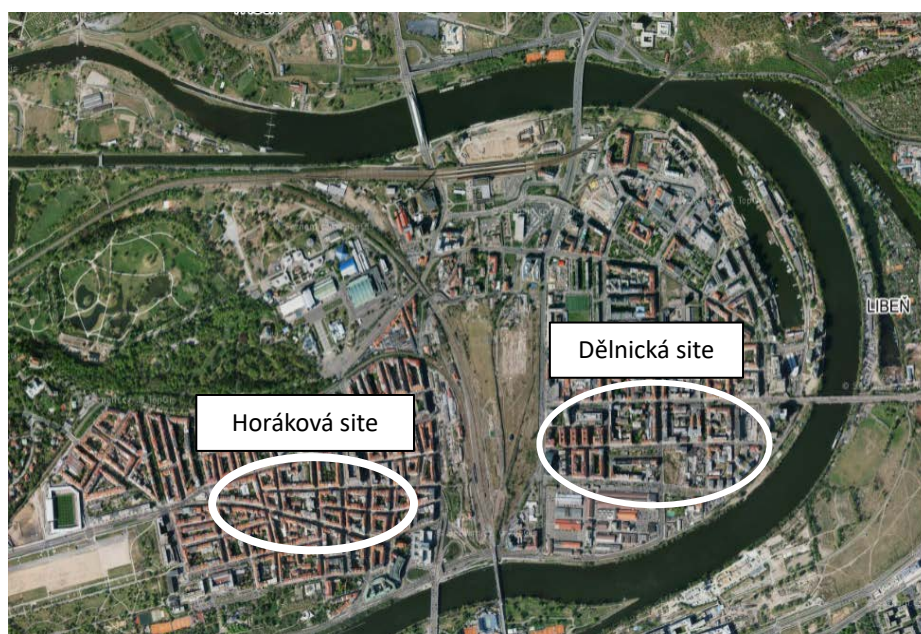
Figure 2. Location of the two selected sites in Prague 7 district. Source: mapy.cz

Procedure for assessing gentrification

The process of residential gentrification in the study area was evaluated in two dimensions: (1) demographic; and in terms of (2) the physical condition of the buildings (Figure 3). The process of commercial gentrification was assessed by the categorisation of commercial facilities. The empirical research was carried out in June 2021.

The authors are aware of certain limitations of conducted research because, as stated in the methodology, the focus of this study is based only on two aspects of gentrification, i.e. the demographic analysis, and the physical aspects. Even though gentrification is a complex process, its theoretical foundations and knowledge base can be expanded by these approaches based on partial analyses.
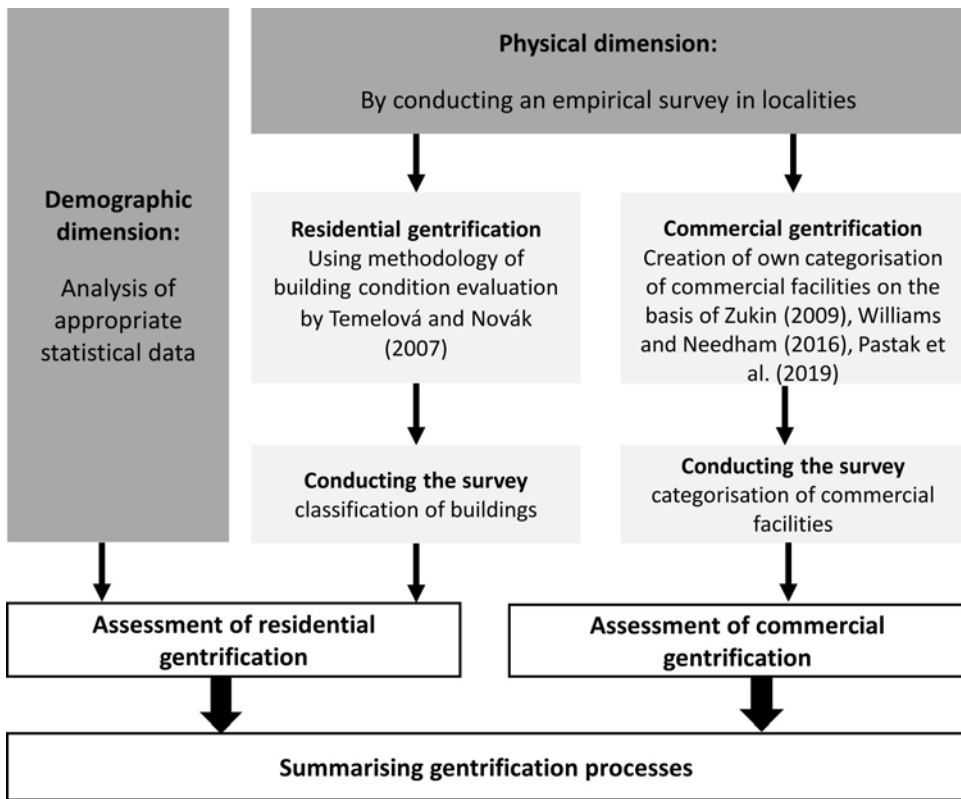
Figure 3. Methodological procedure

Assessing the demographic dimension of gentrification

The demographic dimension of residential change was assessed based on statistical data from the Czech Statistical Office (ČSÚ). All data were monitored for the entire Prague 7 district, and some data are also presented for individual cadastral areas. The monitored indicators (Table 1) were selected in order to be able to assess the changes.

Table 1. Selected indicators

Indicator	Time period	Territorial level
Population development	2001-2021	Prague 7 district
Natural and migration change	2001-2021	Prague 7 district
Average age of inhabitants	2000-2021	Capital of Prague, Prague 7 district
Age structure of population (by 5-year age groups)	2001, 2011, 2021	Capital of Prague, Prague 7 district
Educational structure	2001, 2011, 2021	Capital of Prague, Prague 7 district
Marital status of inhabitants	2001, 2011 and 2021	Capital of Prague, Prague 7 district

Assessing residential gentrification

The assessment of residential gentrification, or the physical condition of the buildings, was carried out using the methodology of a case study of Smíchov (Prague 5 district) (Temelová and Novák 2007). This methodology was used as the basis for the empirical research presented in this paper, which focuses on assessing the visual complexity of building appearance. Subsequently, the buildings were then divided into seven categories, in accordance with the aforementioned methodology by Temelová and Novák (2007) (Table 2).

Table 2. Methodology for assessing the physical condition of buildings

Categorisation of the physical condition of buildings
Buildings in construction
New buildings
Fully renovated buildings
Partly renovated buildings
Buildings in reconstruction
Buildings in satisfactory condition
Neglected buildings

The authors are aware that the process of gentrification is not necessarily connected with painting new facades or renovations, when, for example, it can be very tempting for creative workers to move to urban post-industrial locations and use their skills to improve the organisation of space. The methodology created by Temelová and Novák (2007) places explicit emphasis on the assessment of the physical condition of buildings, which well describes the process of gentrification in the conditions of Prague's urban districts. The external visual aspects of the buildings were judged by the condition of the facade, windows, and doors. The category 'buildings in construction' included buildings that were being built on sites where no building was previously located, or where the original building had been demolished. The category 'new buildings' included buildings that were constructed after 2000. Data on these buildings were collected from the websites of the Prague 7 district, and from the websites of developers. The category 'fully renovated buildings' included buildings that showed signs of renovation (bright, non-faded plaster, new windows, and doors). 'Partly renovated buildings' were the buildings that met at least two of these characteristics.

The category 'buildings in reconstruction renovation' included buildings that were undergoing construction works (in June 2021). These buildings were usually surrounded by scaffolding, and they showed other signs of ongoing construction work. 'Buildings in satisfactory condition' were buildings which did not show signs of

renovation (i.e., old windows and doors, and faded or scratched plaster), but which had a preserved appearance. The category 'neglected buildings' included buildings in disrepair, which were characterised by a significantly damaged facade and decayed, or even broken, windows and doors.

For a better visual idea of the condition of the buildings and their assessment, photos of specific buildings according to the categorisation of their physical condition were added to Annex 1 (Figures 8-13).

Assessing commercial gentrification

Commercial gentrification was assessed in both selected locations. The assessment was conducted through our own empirical research. Only those commercial facilities that were related to the gentrification process (i.e. in-line with it or in conflict with it) were examined. Shops and services that were neutral to gentrification are not concerned here. The categorisation of commercial facilities is inspired by scholars who have researched commercial gentrification (Zukin et al. 2009, Williams and Needham 2016, Pastak et al. 2019), while additionally considering the Czech conditions (Table 3).

Table 3. Categorisation of commercial facilities

Commercial facilities	
In line with gentrification	In contradiction to gentrification
Modern (high class) restaurants, stylish cafes, and wine bars	Lower category pubs, restaurants and cafeterias, gambling bars/halls, and nightclubs
Boutiques with luxury goods	Second-hand shops, charity shops, junk shops
Stores of supermarket chains, organic food and health food stores, stores with exotic goods	Convenience stores, grocery, clothing, and shoe shops (i.e., out-of-chain outlets)

Results

Demographic dimension of gentrification

According to the data of the Czech Statistical Office (ČSÚ 2022a), the total number of inhabitants of the Prague 7 district increased by 2,644 persons, i.e., by 6.1%, in the period of 2001-2021 and it was positive, mainly due to migration (Table 4). Compared to other districts of the inner city, this is an above-average increase in population. In the districts of Prague 1, Prague 2, and Prague 4, there was a decrease in population, and in the districts of Prague 3 and 10, the increase was only about 1.3%.

In the Prague 7 district, between the 2011 and 2021 censuses, the share of the 25-39 age group, that can be considered representative for gentrifiers, decreased by 1.4%.

However, the share of this age group in Prague 7 (30.8%) is still above the Prague average (24.7%). In the period of 2001-2021, the average age of Prague 7 inhabitants decreased by 2.4 years, up to 40.5 years, which is below the average of the capital city of Prague (42.3 years, 41.3 in 2001) (ČSÚ 2022a). And, according to Kährik et al. (2015), it may be a sign of the rejuvenation process of this district.

Table 4. Basic data about the Capital of Prague and Prague 7 (2011 and 2021 censuses)

Indicator	Capital of Prague		Prague 7	
	2011	**2021**	**2011**	**2021**
Total population	1,268,796	1,301,432	41,129	45,910
Share of age group 25-39 (in %)	28.1	24.7	32.2	30.8
Average age (years)	41.2	42.3	41.5	40.5
Share of university educated (in % of population 15+)	23.6	33.7	25.4	41.2
Share of single persons (in %)	42.2	47.7	46.3	54.2

The basic characteristics of gentrifiers can include high levels of education (Short 1989, Davidson and Lees 2005). In Czechia, this is an indicator collected and published by the census. Between 2001 (ČSÚ 2001) and 2011 (ČSÚ 2011), the proportion of persons with a university degree in Prague 7 district increased by 9.8% (to 25.4 %). The results of the 2021 census (ČSÚ 2022b) show a further increase in the proportion of university graduates, reaching 41.2% (the Prague average is 33.7%). Another characteristic of gentrifiers is the marital status. In 2011, the proportion of single persons was 46.3% compared to 35.8% in 2001. In 2021, this proportion reached 54.2% (ČSÚ 2022b), which confirms the increase of singles in the Prague 7 district (the Capital of Prague share is 47.7%). Thus, it can be concluded that the statistical data indicate an ongoing gentrification in Prague 7 district.

Physical dimension of gentrification

A significant change that is occurring in gentrifying neighbourhoods is the revitalisation of the physical environment. The following Table 5 indicates the age of the housing stock as of the 2011 census.

Data from the 2021 census are not compatible with the data of the 2011 census, as they include both construction and reconstruction. Therefore, they are listed in a separate Table 6 in accordance with the data of the 2021 census (ČSÚ 2022b). So, there are differences in terms of the structure of housing construction/renovation when comparing Prague 7 with the capital. While 68.8% of the houses in Prague 7 were built before 1945, the figure for Prague as a whole is only 35.4%. The structure of house owners in Prague 7 and a comparison with the capital city, according to the 2021 census (ČSÚ 2022b), are shown in Table 7.

Table 5. Periods of housing construction in the Prague 7 district

Period	Family houses	Apartment houses	Other buildings	Total
Before 1919	41	552	15	608
1920-1970	84	666	11	761
1971-1980	14	9	0	23
1981-1990	11	11	4	26
1991-2000	25	46	12	83
2001-2011	30	73	6	109

Table 6. Houses according to the period of construction or renovation

Territory	Houses total	of which according to the period of construction or renovation*								
		1919 and earlier	1920-1945	1946-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2015	2016 and later
Capital of Prague	108146	10246	26976	13619	10444	8795	9890	14586	4451	5169
in %		9.5	24.9	12.6	9.7	8.1	9.1	13.5	4.1	4.8
Prague 7 district	1897	615	691	87	26	27	92	175	29	49
in %		32.4	36.4	4.6	1.4	1.4	4.8	9.2	1.5	2.6

*It does not include houses with an undetermined period of construction or renovation

Table 7. The structure of house owners (2021)

Territory	Total houses	Of which by house owner (%)					
		Natural persons	Municipality/state	Residential cooperatives	Other legal person	Homeowners' partnerships	Combination of owners
Capital of Prague	108146	67.7	1.2	2.8	6.7	20.5	0.5
Prague 7 district	1897	36.5	1.2	5.1	13.5	42.2	0.8

The structure of house owners in Prague 7 is different from the ownership structure in the capital, mainly due to a significantly higher share of homeowners' partnerships and a lower share of natural persons. According to Němec (2014), Prague 7 district had one of the most fragmented ownership structures of the housing stock compared to other municipal districts. As noted by Krijnen (2018), it can be a barrier for the development of gentrification.

In the context of flat ownership, it should be noted that in the early 1990s, approximately 8,000 flats were entrusted to the ownership of Prague 7 district (MČ Praha 7 2016). Gradually, a significant number of them were privatised. The privatisation process was completed in 2010 and then the district owned only 631 flats (MČ Praha 7 2016). According to the results of the 2021 census (ČSÚ 2022b), Prague 7 district, with 44.6%, has the fourth highest share of rental housing after Prague 2, with 60.5%, Prague 1, with 50.5%, and Prague 3, with 47.2%; in the capital of Prague, the share of rental housing is 32%.

Between the 2011 and 2021 censuses, the number of persons per household in Prague fell from 2.2 to 2.0. In Prague 7, it was from 2.1 to 1.9. In both censuses, Prague 7 shows a high proportion of single person households, 41.6% in 2011, and even 49.9% in 2021.

Gentrification in the Dělnická site

Residential gentrification

From Dělnická Street northwards, the number of buildings that have been fully reconstructed (i.e., new facade, replacement of windows and doors) significantly prevails (Figure 4). South of Dělnická Street, the majority of buildings are partially renovated (i.e., replacement of windows) or in satisfactory condition.

Figure 4. Classification of buildings according to categories, based on their physical condition (Dělnická site)

In terms of residential gentrification, several new apartment buildings have been built on this site since 2000. These projects were located mainly along the left bank of the Vltava River, in the Bubenské riverbank and the Holešovický port. In Na Maninách Street, the development project "Vltava viewpoint" was completed in 2016 (Zipreality 2016). In V Háji Street, a development project "Residence above the Vltava river" was completed in 2018, and there are luxury apartments with a view of the Vltava River (Central Group 2018). Another development project named "Smart Living", on the corner of Na Maninách and Jankovcova Streets, was completed in 2019 (NMN Byty 2021). In all cases, these are modern apartments of a higher standard.

In the Dělnická site, there are also three buildings that are classified as "in construction" (as of June 2021). A new apartment building project with several luxury apartments is being completed at the corner of Komunardů and Přístavní Streets. Originally, there were two apartment buildings on this site which were destroyed by the aforementioned 2002 flood (Sebre 2021). Another residential development project is "Byty Dělnická", for the construction of 32 environmentally and energy friendly apartments, with non-residential premises on the ground floor (Byty Dělnická 2021). On this site, there are only a few neglected buildings. Buildings in very poor condition are located mainly in Tusarova Street and its surroundings. These are buildings with significantly disturbed external visual aspects, especially with a much scratched facade, rotten or broken windows and doors, and, in many cases, these buildings have sprayed coatings.

At the Dělnická site, fully and partially reconstructed buildings predominate. After 2000, several new residential buildings with modern apartments were built in the south-west area of this site. Only a few neglected buildings are in evidence; they are located in the south-east part of this site, especially in Tusarova Street. It can be concluded that newly built shops or modern offices are positively evaluated by the local residents and gentrifiers with regard to the overall development of Dělnická site. A similar conclusion was reached by Verwaaijen (2013) on the example of another part of Prague.

Commercial gentrification

Within the Dělnická site, 75 commercial facilities were included in the empirical research, of which 32 facilities were assessed as being in contradiction with gentrification, and 43 facilities as being in line with gentrification (Figure 5). The highest concentration of commercial facilities can be observed in Komunardů Street. The commercial facilities in line with gentrification include mainly modern restaurants, stylish cafés, and wine bars. There are many restaurants focusing on international cuisine, and among them Asian cuisine is predominant. Their concentration shows a certain characteristic of gentrification. At this site, there is also a significant presence of chain stores, and there is only one health food store. Again, this can be a sign of ongoing gentrification.
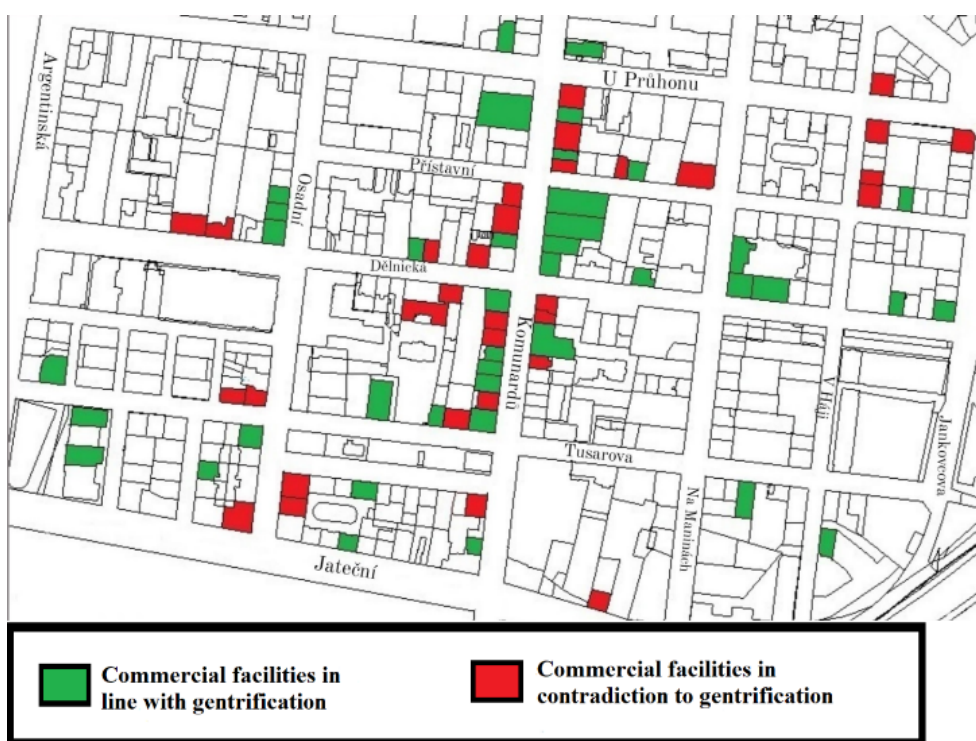
Figure 5. Classification of commercial facilities (Dělnická site)

Most commercial facilities in contradiction with gentrification belong to the category of lower category pubs, restaurants, cafeterias, gambling halls, and nightclubs. At this site, there are also several junk shops, second-hand shops, and charity shops, as well as several groceries, convenience stores, and fashion shops not belonging to any chain.

Gentrification at the Horáková site

Residential gentrification

The majority of houses in the Horáková site predominate in the "in satisfactory condition" category (Figure 6). These are old houses in good condition and showing no signs of reconstruction. The second most represented category is partly renovated buildings. There are only a few fully renovated buildings at this site, mainly in Jirečkova, Dobrovského, and U Letenského sadu streets. Compared to the Dělnická site, the Horáková site has more buildings in a neglected condition, which are distributed relatively evenly within the area of the site. There is only one new building in the Horáková site, the Stromovka Shopping Centre, which was built in 2019 in Veletržní Street, and it is not intended for housing (Centrum Stromovka 2021).

Figure 6. Classification of buildings according to categories, based on their physical condition (Horáková site)

Commercial gentrification

Within the Horáková site, 127 commercial facilities were included in the empirical research, of which 51 were assessed as commercial facilities in contradiction with gentrification, and 76 as commercial establishments in line with gentrification (Figure 7).

At the Horáková site, most of the commercial facilities are in Milady Horákové Street. The map shows quite clearly that commercial facilities which are predominant here are in line with gentrification. Most of these facilities are, as with the Dělnická site, modern restaurants, stylish cafes, and wine bars. There are several shops with luxury goods (designer fashion shops). At this site, there are also several chain stores, health food and exotic goods stores. Overall, it is possible to perceive them as possessing certain characteristics of commercial gentrification.

Commercial facilities in contradiction with gentrification include mainly lower category pubs, restaurants, cafeterias, gambling halls, and nightclubs. There are two commercial facilities in the category of second-hand shops and junk shops. A large part of commercial facilities in contradiction with gentrification are also food and fashion shops not belonging to a chain.
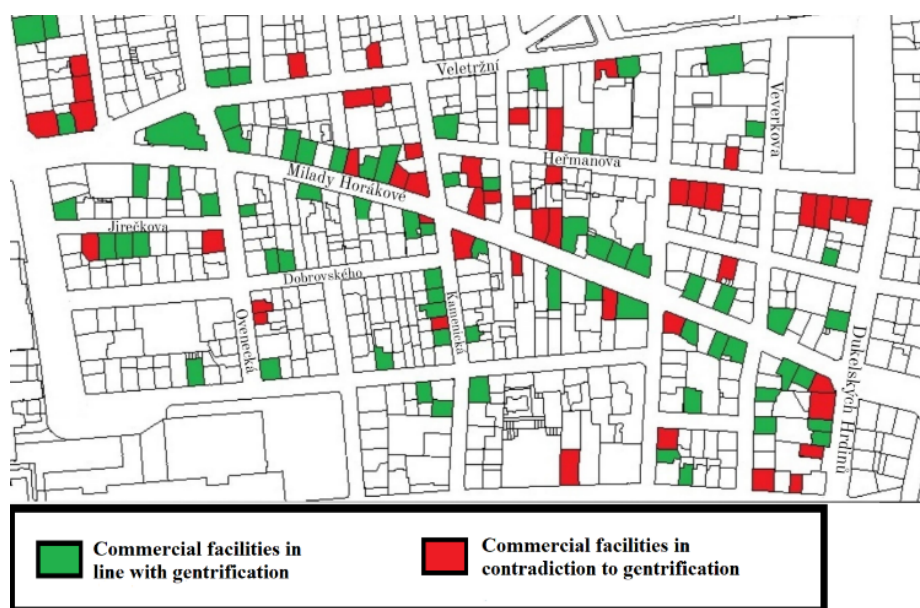
Figure 7. Classification of commercial facilities (Horáková site)

Summary and comparison of results

This section focuses on the results, their comparison, and the linking of data analysis and empirical research findings with theoretical departures from gentrification and its partial aspects. The significance of the selected sites of Prague in this study relates to the unprecedented socio-economic developments affecting property prices and the costs associated with them. While in the 1990s the property market was frozen through rent regulation, after the end of key transformational steps in the economy, property prices and rents began to rise dramatically. According to a study by Delloite (2021), rental prices were the second highest in the capitals of post-socialist countries after Warsaw in Poland, and property prices were around 130% of the Czech average. In this regard, the development of the real estate market was significant precisely in the urban districts near the city centre. This study includes this type of urban district.

Demographic aspect of gentrification in relation to resilience of urban localities

As demographic data shows, the population of the Prague 7 district is growing in comparison with the population of other districts that belong to the wider centre of the capital city of Prague. While the population of Prague as a whole is ageing, the average age of the inhabitants of Prague 7 is decreasing which means that the district is rejuvenating. This along with the increasing proportion of university educated residents suggests a gentrification process (Ley 1980, Lester and Hartley 2014, Ha and Kwon 2017). In this context, some authors (Atkinson 2004, Sýkora 2010) point to a

possible polarisation of district populations, but this cannot be proven on the basis of statistical data, nor can the negative impact on minority-majority relations be reported (Lancione 2017). Similarly, the displacement of old residents cannot be demonstrated by general demographic statistical data. Sýkora and Špačková (2022), however, point to the possibility of involuntary emigration, especially in gentrified areas. In their study (also focusing on the Holešovice district in Prague), a perceived 'neighbourhood-not-for-us' effect was identified in a group of old residents. The main reason for this effect is the changes associated with commercial gentrification. All these issues do not contribute to the social stability and resilience of an urban district.

Physical aspect of gentrification in relation to resilience of urban localities

In the empirical research of the two sites in terms of residential gentrification, 750 buildings were assessed (Table 8). According to the Prague 7 district data, in 2011 there were 1,800 buildings in this district (MČ Praha 7 2016). Assuming that the number of buildings has not changed, the empirical research at the two selected sites covered approximately 42% of all buildings of Prague 7 district.

Table 8. Summary of the empirical survey on residential gentrification

Buildings	Dělnická site		Horáková site	
	Number	%	Number	%
In construction	4	1.2	0	0
In reconstruction	3	0.9	3	0.7
Fully renovated	110	**34.2**	23	5.4
New	12	3.7	1	0.2
Partly renovated	99	30.7	116	27.1
In satisfactory condition	85	26.4	253	**59.1**
Neglected	9	2.8	32	7.5
Total	**322**	**100**	**428**	**100**

The first group of findings includes the physical aspect of residential gentrification in relation to the resilience of urban localities. There are significant differences between the two studied sites. At the Horáková site, the category of buildings in satisfactory condition is the most represented (about 59%), followed by the category of partly renovated buildings (27.1%), by a large margin. The representation of other categories is significantly lower. In contrast, in the Dělnická site, the highest share is achieved by renovated buildings with 34.2%, followed by partly renovated buildings (30.7%), and buildings in satisfactory condition (26.4%). At the Dělnická site, there are also more new buildings, and more buildings in construction, because of new development

projects. Regarding the category of neglected buildings, it reaches 7.5% at the Horáková site, while only 2.8% at the Dělnická site.

According to the literature review, an increase in the number of buildings in the following categories can be considered as a sign of gentrification: in construction; in reconstruction; new buildings; fully and partly renovated buildings (Temelová and Novák 2007). Conversely, neglected buildings may indicate that gentrification is not occurring at a given location. The category of buildings in a satisfactory condition is the least indicative of possible gentrification, as the term 'satisfactory condition' does not require financial resources, which are among the characteristics of gentrification. Based on the above, it can be concluded that the Dělnická site is experiencing an influx of financial resources and revitalisation of the physical environment, which are characteristics of residential gentrification (Hamnet 1991, Atkinson 2004). The situation at the Horáková site is more static, in that the housing stock is not being significantly renewed; this is rather contrary to the process of residential gentrification.

The second group of findings covers the physical aspect of commercial gentrification in relation to the resilience of urban localities (Table 9). Most commercial facilities in line with commercial gentrification at both sites are modern restaurants, stylish cafés, and wine bars (74% in the Dělnická site, and 71% at the Horáková site). The share of chain stores is 5% higher in the Dělnická site (16% compared to 11% at the Horáková site). But, at the Horáková site, the share of shops offering exotic goods is significantly higher (8% compared to 2% at the Dělnická site).

Table 9. Summary of the empirical survey on commercial gentrification

Commercial facilities	Dělnická site		Horáková site	
	Number	%	Number	%
In line with gentrification	43	57.3	76	59.8
In contradiction with gentrification	32	42.7	51	40.2

In terms of commercial facilities in contradiction with commercial gentrification, the majority is made up by lower category pubs, restaurants, cafeterias, casinos and nightclubs, in both sites. In the Dělnická site, this is 53% and, in the Horáková site, 71% of the total number of facilities is in contradiction with commercial gentrification. There is also a difference in the representation of junk shops and second-hand shops. At the Dělnická site, they account for 19% of the total number of facilities in contradiction with gentrification, while at the Horáková site they represent only 4%. The share of non-chain stores is similar at both sites; 28% at the Dělnická site, and 25% at the Horáková site, of the total number of facilities in contradiction with commercial gentrification.

Based on the categorisation of commercial facilities, it can be summarised that at both sites (more so at the Horáková site), commercial facilities in line with commercial gentrification slightly prevail over those in contradiction with it. Both sites show certain, but not unambiguous, features of ongoing commercial gentrification. The Horáková site can be described as more commercial due to its character, although the results of the commercial gentrification assessment are not significantly different from the Dělnická site. This means that there is not a significant pressure from gentrifiers to develop services and commercial facilities typical for them (Zukin et al. 2009, Bernt 2016). It is probably connected to the weaker residential gentrification at this site, which does not produce strong groups of gentrifiers.

Assuming that resilience is understood as an adaptation process, in line with Pělucha and Kasabov (2020), the results of the study show that in the case of the influence of gentrification, its residential part is particularly significant. In addition, both localities are gradually adapting to the needs of gentrifiers through the creation of new shops and services according to their requirements (i.e., characteristics of commercial gentrification). This creates conditions for diversifying the economic structure of the cities and their neighbourhoods and it strengthens the aspects of resilience as an adaptation process to ongoing external and internal changes.

Discussion

The process of gentrification in post-socialist CEE countries is delayed and influenced by country-specific conditions (Sýkora and Bouzarovski 2012, Jakóbczyk-Gryszkiewicz et al. 2017), and gentrification is often linked to inner-city revitalisation (Grabkowska 2015).

This paper, using the example of the two sites in Holešovice, in the wider centre of the capital city of Prague, confirms the specificity of the conditions of post-socialist countries and a certain delay and slowness of this process. The Prague 7 district is characterised by proximity to the city centre, its good transport connections to the city centre and other districts, a wide range of leisure activities etc.; this positively influences the attractiveness of this district for potential gentrifiers.

The characteristics of the district population and their evolution as monitored by statistical data suggest the process of gentrification (Short 1989, Lees 2003, Holm et al. 2015). These are mainly indicators of a decrease in the average age, an increasing share of university-educated residents compared to Prague, an above-average share of the 25-39 age group and single residents. On the one hand, this can be assessed positively in terms of the resilience of urban localities, as new residents contribute to the modernisation of the district, to economic and transport savings, while improving the physical environment, and together with the creation of quality jobs (Atkinson 2004, Zuk et al. 2018). On the other hand, in terms of social stability and resilience, the increases in property prices and rents can lead to the displacement of original residents,

to social polarisation and an increasing risk of conflicts between the original and the new residents; this weakens urban resilience especially from a social perspective.

The results of the presented empirical research in the two selected sites show their difference and they confirm the interdependence of residential and commercial gentrification. New residents, the gentrifiers, create pressure for change or the creation of new commercial establishments, especially in the Dělnicka site. This finding is fully consistent with the conclusions reached by Zukin et al. (2009) and Kubeš (2017). However, these changes may not be well perceived by the old residents, both in terms of prices and in terms of preference for other types of facilities in relation to their different lifestyles (Zukin et al. 2009, Williams and Needham 2016). Le Grand (2023) points to the symbolic change in the original culture of the urban site as a result of commercial gentrification. This is also confirmed by Sýkora and Špačková (2022) in their study of Holešovice, where some of old residents do not take these changes well; this is reflected in their feelings that the neighbourhood is no longer for them. This situation can lead to social polarisation and even to segregation (Sýkora 2010), which weakens the social stability and resilience of the urban locality.

The basic assumption of this research was a comparable intensity of the gentrification process within one urban district (Holešovice). The empirical verification showed that more pronounced signs of gentrification can be identified in the Dělnická site. However, this finding is limited by the narrower scope of the research, which included two aspects associated with gentrification. In a way, the obtained results indicate the processes taking place in the selected urban sites. If resilience is perceived in its economic and social dimensions (Lang 2012), then the processes taking place in these two sites can contribute to the development of economic activities and thus to the economic dimension of resilience. However, the social resilience of these two sites is controversial (Sýkora and Špačková 2022). In this context, it is essential that cities, when making decisions about public investments, consider the fact that the activities in question may trigger processes of commercial and residential gentrification. These are mainly investments that increase the accessibility or attractiveness of the respective districts (Chapple et al. 2019), which clearly affects the socio-economic structure in the future, including the structure of the inhabitants of individual districts. The consequences are then long term, and policy-making by regional or local authorities needs to address these problems or to balance them with potential positive effects, i.e. diversification of the economic structure versus social problems associated with conflicts between new and old residents. The long-term resilience of cities is conditioned by a wide range of processes, including the gentrification discussed here. From this point of view, it is necessary to take these potential aspects into account in the strategic and territorial planning of cities.

Based on the literature review and the results of the empirical analysis, policy-making measures can be formulated for the CEE countries. Urban development policy needs

to take into account demographic changes, which may be reflected in issues related to minorities, social polarisation and segregation. The physical aspects of the impacts of residential and commercial gentrification (the appearance of buildings) should be taken into account analytically in the preparation of strategic spatial and socio-economic development plans. These aspects indicate the potential and limits of specific urban neighbourhoods. The identified problem areas need to be adequately reflected. It is also necessary to identify appropriate steps to address the situation to ensure the stability and resilience of urban localities.

This study focused only on the physical aspects of gentrification and the examination of relevant statistical data. A certain limitation of this paper is that all possible aspects related to gentrification (e.g., social) were not reflected, but this was not the ambition of the research presented in this paper. For the academic discussion on gentrification, it is possible to use these two perspectives, knowing that there are, however, other aspects and approaches to addressing or analysing this topic. The paper can contribute to the broader academic debate on the factors influencing gentrification in the context of sustainability and resilience of urban locations in ongoing spatial processes.

Conclusions

The aim of this paper was to evaluate and to verify, based on statistical data and empirical research, how residential and commercial gentrification is taking place in two selected sites located in close proximity to the city centre (Prague – Holešovice). The authors used statistical data to assess residential gentrification and they followed the methodology of Temelová and Novák (2007) to assess the visual complexity of building appearance. To assess commercial gentrification, the authors developed their own methodology for categorising commercial facilities. This paper contributes to the body of literature by linking the physical examination of residential and commercial gentrification, and it confirms the strength and importance of their interrelationships.

The main empirical results show that the urban part with residential elements (i.e., the Dělnická site) logically shows a stronger residential gentrification in the long term. There is a revitalisation of the housing stock and the associated influx of financial resources. This residential gentrification is then followed by the development of facilities characteristic of commercial gentrification that responds to the needs of the new residents. The transition to commercial gentrification is, therefore, gradual and intertwined with residential gentrification. Facilities that are not sought by gentrifiers continue to remain in the area (approximately 43% of commercial facilities).

The urban part with a more commercial character (i.e., the Horáková site) does not show significantly different characteristics of commercial gentrification compared to the Dělnická site. At the Horáková site, residential gentrification is slower and therefore it does not form a strong group of gentrifiers creating pressure for the development of

relevant services, shops and other facilities.

Improving the physical condition of buildings (i.e. the visual attractiveness of the site), attracting new higher income groups and developing new commercial facilities can help to diversify the neighbourhood economy. This improves the attractiveness of districts and the development opportunities. These processes are also accompanied by negative processes related to the financial capacity of original residents who cannot afford to operate in the environment of new prices for rents, goods and services. The resilience of cities is thus directly affected by the processes of gentrification, but in different, contradictory and often confused directions. From this point of view, there is a clear challenge for public authorities to strategically consider the potential direct and indirect impacts when making decisions on public investments that subsequently affect the overall environment of urban districts.

The process of gentrification in Prague, as in other similar cities in post-socialist countries, is influenced by the peculiarities of the structure of housing ownership (Chelcea et al. 2015). However, this structure is gradually changing, and, in the future, it can be expected to be more pronounced in the context of the residential gentrification in close proximity to the city centre and also in the context of rising property prices (Delloite 2021). On the one hand, the findings of this study, based on an assessment of the demographic and physical dimensions of gentrification, highlighting that residential gentrification is followed by the development of commercial gentrification that is forced by population change (young, wealthy people), confirm previous knowledge in the field of gentrification. On the other hand, the study clearly demonstrates that gentrification processes are ongoing in Prague, although their pace may vary from one district to another, depending on their specifics. Finally, the results suggest that gentrification, like other urban processes, needs to be studied in all its aspects over the long term, and across various disciplines (Wolman et al. 2022).

Acknowledgements

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Annex 1

Figure 8. Building in reconstruction, Na Maninách Street (2021-05-06)

Figure 9. New building, Na Maninách Street (2021-05-06)

Figure 10. Fully renovated building, Delnická_Street (2021-06-14)

Figure 11. Partly renovated building, Kamenická Street (2021-05-10)

Figure 12. Building in satisfactory condition, Dukelských hrdinů Street (2021-06-14)

Figure 13. Neglected building, Tusarova Street (2021-05-06)

ASSESSING THE IMPACT OF PUBLIC INFRASTRUCTURE ON NEIGHBOURHOOD LIVEABILITY IN CYBERJAYA, MALAYSIA: A GLOBAL TECHNOLOGICAL HUB

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Keywords:

public infrastructure; technology hub; internationa community; quality neighbourhood design; neighbourhood liveability

Abstract: The phenomenon of rapid urbanisation that has occurred since the 1950s has presented opportunities for growth and innovation in cities, primarily through the utilisation of urban agglomerations and economies of scale. Urban areas encounter diverse obstacles that restrict their ability to provide services to inhabitants and hinder the achievement of a sustainable urban future for the residents. This research examines the issue of urban functional weakness, with a specific emphasis on the emergence of a global technology hub such as Cyberjaya, Malaysia. This study analyses the relocation behaviours of the residents, with a focus on the international community, and it identifies the inadequate public infrastructure as the primary factor contributing to liveability issues within the urban area. This study employs a mixed-methods approach, utilising both quantitative data collection and in-depth interviews, to support its findings. This study examines the impact of social variables and public infrastructure on neighbourhood liveability and design quality. The findings suggest that social variables play a significant role in neighbourhood liveability, while public infrastructure has a positive effect on both liveability and design quality.

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Introduction

Rapid urbanisation has caused problems for urban planning and design because cities lack the dynamism, efficiency, and ability to meet citizen needs and to provide comfort, safety, and welfare. Cities have become prisons, harming psychology, emotions, morals, and core human values (Zhang et al. 2019). Urban planners worry about the steep deterioration in urban living standards (Pacione 2003) while residents' needs must be considered to make cities habitable as understanding citizens' needs helps development succeed (Elliott 2008). Resident satisfaction is complex and impacted by both objective and subjective aspects, and urban and municipal services affect inhabitants' satisfaction and opinions in relation to temporal-spatial, social, economic, cultural, and physical factors (Bernhard et al. 2018). Close community interactions improve the inhabitants' happiness with the neighbourhood and services, so, while modern cities have better sanitation (sewage, garbage collection, and infrastructure) and services (police stations, fire stations, and health), the residents feel less connected to the neighbourhood and the local community (Dassopoulos et al. 2012).

Previous studies found that tangible elements improve resident satisfaction and quality of life the most (Smith et al. 1997). This study shows that residents' environmental impressions matter more. According to Holbert et al. (2021), neighbourhood satisfaction, which is correlated with urban liveability, is influenced more by social factors than physical ones. But, as public infrastructure is lacking in new communities, the human life cycle requires infrastructure planning and design. De Guimarães et al. (2020) describe infrastructure as a combination of facilities and services provided by the government, designers, and planners to cities and their residents so that they may use all areas of the city. However, the lack of attention to public infrastructures related to sociological and psychological understanding of the complex individual and social needs of contemporary humans for their neighbourhood appears to be the greatest obstacle in relation to contemporary space design (Dantas et al. 2021).

Public infrastructure (hard and soft infrastructure) in neighbourhood areas is generally used to improve urban liveability (Yeon et al. 2018, Ngeow 2021). However, research on how high-quality public infrastructure in residential neighbourhoods affects the viability and happiness of international Cyberjaya inhabitants is lacking, especially from the perspective of less-habitable societies (Zheng et al. 2020, Mirzahossein and Mohghaddam 2021). To address these concerns, this article examines the Cyberjaya neighbourhood liveability and the public infrastructure provision determinants.

Public infrastructure

The quality of public infrastructure increases the quality of life (Yhee et al. 2021). Transportation, communication, sewage, water, and power are all considered

"infrastructure" (Sobnath et al. 2020). These systems boost city capacity and liveability so that, for liveability, sustainability, safety, and quality of life, all cities need an infrastructure foundation (McShane and Coffey 2022). A study found that public infrastructure supports a city's long-term population as it improves city life (Layton and Latham 2022).

To address urbanisation, public policy and society need smart city initiatives (Shehab et al. 2022). Smart technology is part of sustainability, resilience, and liveability to build future cities (Kutty et al. 2022). Soft infrastructure — arts, cultural institutions, public space, and amenities — is considered important for economic growth and creativity, and the internet of things and ICT are among the components of required urban architecture and planning (Cities Alliance 2019). Figure 1 depicts the conceptual framework for the interaction of hard and soft connectedness and the network infrastructure needed to construct urban systems, and it also improved the public infrastructure needed by Cyberjaya neighbourhoods to promote liveability.
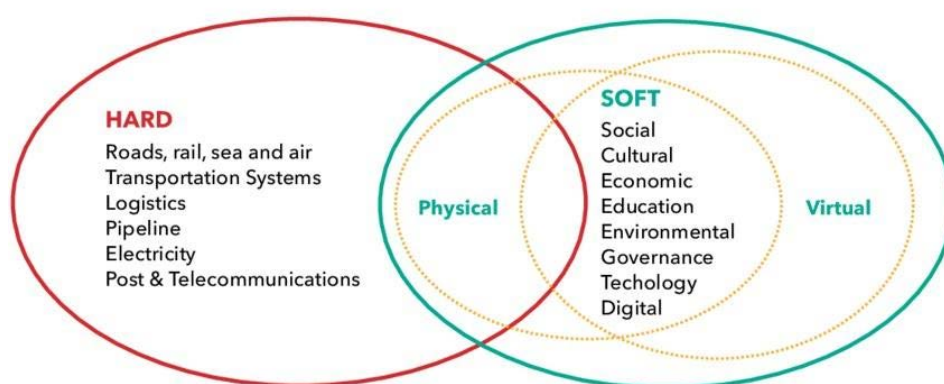
Figure 1. Framework of the interrelationship between hard and soft connectivity and network infrastructure
Source: Cities Alliance (2019)

On the one hand, hard connectivity consists primarily of physical connections: networks of transportation, communication, and utility services that link communities (Cities Alliance 2019). On the other hand, a variety of other political, economic, social, and cultural factors determine the characteristics of hard connections (Cities Alliance 2019). Also, a soft connection is characterised by both virtual and physical characteristics, while virtual features manifest themselves in a variety of ways, including transfers or transactions of intangible capital, ideas, information, and data, as well as knowledge exchanges between governments, organisations, and communities, and the relationship is technological rather than physical (Cities Alliance 2019). Also, online education, blogging, and social media are greatly increasing access to and the breadth and depth of vital information, knowledge, and experience for human capital development, social development, and local economic growth (Cities Alliance 2019).

Cyberjaya, a technology hub, requires the presence of both soft and hard infrastructure for its sustenance. Inequity in fair distribution arises from an imbalance between these two groups. International citizens express dissatisfaction with smart city living based on their subjective opinions. Cyberjaya, a technology hub located on the outskirts of Kuala Lumpur, was originally a large expanse of land covered in natural vegetation before undergoing urban development.

The concept of developing a smart centre with an emphasis on economic growth is aligned with the fundamental principles of smart city models and it reflects the neoliberal ideology. Ortiz-Báez et al. (2022) argue that land use changes in urban areas are indicative of the influence of neoliberalism on urbanisation. The conversion of natural land, including green areas and agricultural land, to urban expansion on the outskirts of cities can have notable impacts on the quality of urban life. Over time, these changes can impact the environmental, economic, and social policies of the city, potentially leading to shifts in political positions regarding future city plans. One important aspect that has been noted is the necessity of urban development towards the suburbs in order to establish adequate infrastructure and to prevent the emergence of low-quality living conditions and welfare deprivation in these areas. Physical and social infrastructures play a crucial role in the growth of urbanisation by supporting sociological approaches. Urban transportation infrastructures have significantly influenced land use patterns by facilitating the concentration of construction activities along major arterial routes connecting cities. However, it is crucial to ensure that these connections are designed in a manner that minimises the fragmentation of urban development. Disruption in the context of urban expansion can lead to the proliferation of low-quality settlements in suburban areas. The limited functionality of urban infrastructure has implications for the quality of life and well-being of the residents, as well as the long-term growth and sustainability of urban areas (Borsdorf 2003, Ortiz-Báez et al. 2022).

In addition to public amenities, a pleasant view, and quality schools are factors that contribute to the desirability of a neighbourhood. The quality of a neighbourhood is determined by various factors, including the presence of facilities and other contextual factors (Li et al. 2019, Kim et al. 2020). Kerimoglu and Ekinci (2021) argue that urban innovation on both regional and global scales can be facilitated by technological and economic advancements, as well as the availability of adequate social and physical infrastructure. In prosperous and liveable innovative global cities, a diverse range of public urban infrastructures contributes to their complex and well-maintained infrastructural structure. The infrastructures considered in this study encompass high-tech exports, patent counts, and the number of entrepreneurs. Additionally, the social and physical environment is considered, which includes the number of libraries, art galleries, festivals, opera houses, green buildings, and foreign visitors (Koçer and Karakayaci 2018).

Infrastructure is a collection of social, economic, and physical services that improve the quality of life and well-being of governments, businesses, and community members (Nesticò and Russo 2022). Planners and developers are focusing on city infrastructure to improve services and to make cities more enticing to live in. The city's neighbourhoods have many public facilities. These urban districts are linked to the neighbouring neighbourhoods and they serve as hubs for human interaction due to their evident character. According to government studies and publications (Yusof and Van Loon 2012, Salman 2018, Nakano and Washizu 2021), cities need well-designed public infrastructure. Prioritising high-quality infrastructure and services increases neighbourhood liveability and city improvement. Excellent infrastructure design allows people to improve their communication and social lives. Public infrastructure affects cities' functions, social structures, identities, and liveability (Carmona 2021, Jabareen and Eizenberg 2021).

Cyberjaya's inclusion in the category of innovative cities positions it as a brand city (Kavaratzis and Hatch 2013). The theory of Ortiz-Báez et al. (2022) posits that land use change influences urban expansion policies. Another influential factor in the transformation of city expansion is known as city branding. The alteration of urban development patterns and city design policies can lead to issues including even the absence of a distinct urban identity at both regional and global levels. In this sense, Vesalon and Crețan (2019) proposed that the integration of urban policies and economic interests is a significant factor affecting cities in Central and Eastern Europe. In contrast, the development plan for Cyberjaya city in Asia has prioritised an economic approach to this integration. However, urban life in suburban neighbourhoods lacks a distinct identity (Ortiz-Báez et al. 2022).

Design criteria for Global Technology Hubs

Innovation should drive smart city investment (Ajala 2018). However, a city is a human-inhabited area with a variety of services and economic activities. Cities, unlike towns and villages, are heavily populated metropolises with several roles. Urbanisation worldwide has raised demand for city infrastructure and services and its survival depends on meeting this demand. Bibri and Krogstie (2017) identified six smart city features – intelligent economics, mobility, environment, governance, people, and life are covered. They are the city features that smart initiatives affect to achieve smart city goals of sustainability, efficiency, and good quality of life (Albino et al. 2015).

A technology hub is a city that prioritises economic development, environmental stewardship, quality of life, and natural resource management, with ICT at its centre – and cities, in general, must evolve into intelligent, dynamic infrastructures that serve citizens while meeting all energy efficiency and sustainability criteria (Pellicer et al. 2017). This research is crucial to evaluating how neighbourhood smartening affects

quality of life. The analysis must identify which intelligence components satisfy foreign citizens as the city becomes more liveable and business friendly. Vesalon and Crețan (2019) found that the proximity of developed cities to transportation corridors plays a crucial role in fostering regional business connections. Cities that serve as growth poles, offering abundant business opportunities, can attract immigrants and investments, thereby improving the overall liveability of the city.

Cyberjaya has emerged as a prominent technology hub in Malaysia, fostering the exchange of knowledge and fostering innovative creativity (Vesalon and Crețan 2019, O'Brien et al. 2023). Technology and innovation are significant factors in shaping city branding, while multiculturalism also plays a crucial role in this phenomenon. Rotaru et al. (2023) argue that ethnic polarisation and fractionalisation significantly influence regional ethnic connectivity and diversity. These factors can have detrimental effects on various socio-economic outcomes, including economic development, social trust, and democracy. And the presence of innovation and multiculturalism in a city contributes to its involvement in the regional competition.

Quality neighbourhood design and its liveability

According to this hypothesis, the quality of a living space is a major factor in human life and enjoyment (Jones et al. 2019, Lam 2021). Neighbourhood quality is closely related to location satisfaction and attachment (Poortinga et al. 2017). Lewicka (2011) has elaborated on the concept of sense of place, which has garnered attention across multiple disciplines such as psychology, sociology, human geography, and economics. It is evident that individuals' emotional connection to their environment influences their sense of place and attachment to it, ultimately impacting their overall satisfaction with residing in that specific location (Lewicka 2011). Also, the physical environment and individual experiences establish a connection between the individuals and a particular place.

Cervero (2009) identifies the liveability concept as a highly effective characteristic of quality neighbourhood design. The ongoing debate within urban studies and the existing literature revolves around the significance of liveability as a key aspect of urban planning and design. Its importance lies in its ability to enhance quality of life by impacting lifestyle, health, sustainability, and power dynamics (Dsouza et al. 2023). But many studies define liveability differently, as ecology, geography, sociology, and urban planning all discuss liveability (Norouzian-Maleki et al. 2015, Paul and Sen 2020). Heylen (2006) defines liveability as how people view the environment. Also, the location, culture, and circumstances of a city affect its liveability (Lutz et al. 2021).

Liveability includes four components that affect environmental and place quality (Leby and Hashim 2010). Functionality and a safer environment are linked to social issues. However, liveability is linked to quality of life and place. The quality of the

neighbourhood is directly affecting the liveability of the area. So, numerous researchers have dedicated their efforts to assessing the quality of life by examining the quality of residential environments. McCrea et al. (2005) found that the primary concerns of younger residents in their research were regional services, including health and education, as well as the cost of living. On the one hand, the studies conducted by Mittal et al. (2020), and by Emami and Sadeghlou (2021) found that neighbourhood satisfaction was most accurately predicted by assessments of social interactions, neighbourhood crime, and public facilities such as parks and libraries. On the other hand, housing satisfaction was primarily predicted by the age of the home and homeownership (Davoodi and Dağli 2019).

The standard concept of livability emphasises physical, functional, social, and safety aspects (Mouratidis 2020). Hoogerbrugge and Burger (2018) said that the social dimension of liveability includes all aspects of community, life, and social interaction. That is why one of the most crucial aspects of liveability is neighbourly interaction. According to Paasch (2015), a liveable smart city can find interactions between people from different backgrounds, and it should be receptive to people with different life perspectives. Thus, city architects and designers should offer income-based housing to accommodate diverse populations (Castells 2020). Also, residential neighbourhood architecture, public infrastructure, and services affect liveability. So, the social, physical, and environmental infrastructure of a neighbourhood determine its liveability (Figure 2).
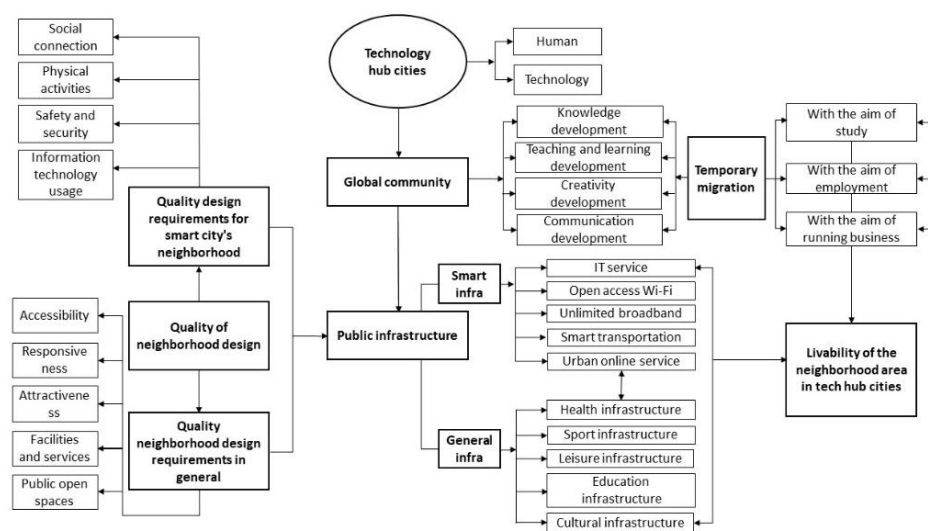

Figure 2. Theoretical framework of the analysis

Recent research has introduced the concept of liveability as a potential solution to address the challenges faced by smart cities in Asia. Randhawa and Kumar (2017)

argue that the holistic development of urban cities can be achieved by focusing on the economy, environment, and quality of life. This approach aims to make cities more liveable. However, both international ranking organisations and Indian standards share a similar perspective when evaluating urban liveability. India's emphasis solely on the physical dimensions has led to inadequacies in the provision of consumer and goods services. In the global context, international liveability tools aim to establish safe, healthy, economically prosperous, and environmentally vibrant cities for their residents. However, in the regional Asian context, these tools primarily focus on providing basic essential infrastructures in urban areas, with the expectation of achieving similar outcomes as the global standards. In a study conducted by Iyanda et al. (2018) on urban liveability in Malaysian cities, the authors examined the influential factors, and they identified the most significant indicator that enhances the residents' empowerment, so, urban liveability is influenced by factors such as environmental safety, urban facilities, and housing unit characteristics. This research employs a multidimensional concept to improve neighbourhood liveability in an urban setting, and it focuses on integrating smart city standards in an Asian tech hub.

Migration and its effect on international residents' life

Relocating to "global cities" with advanced service sectors, large economies, international hubs, political and cultural impact, is growing. These cities now have over one-third of migrant populations, and the Urban Future Agenda provides urban authorities with long-term solutions to related infrastructure and service issues. Affordable and social housing, quality education and health services, robust and congestion-free roads, transit infrastructure, easy access to essential utilities, and community cohesion are among these problems (O'Brien et al. 2023).

Although numerous migrants settle in cities, city migration data is scarce, and urban centres must address the migrants' urgent needs and assimilation issues. The growing migrant population requires metropolitan areas to provide vital infrastructure and services. As economic and social hubs, Asian cities are growing rapidly. Urbanisation has boosted regional productivity, but it also presents considerable obstacles, so that urbanisation may not benefit all city dwellers. Urban centres are expected to expand, but their full potential may not be realised due to poor coordination between spatial and economic planning, a lack of affordable housing, the marginalisation of disadvantaged and vulnerable populations, high air and water pollution, inadequate climate change mitigation, and urban infrastructure deficiencies. The international migration policy shows that the states struggle to regulate migratory movements. So, the gap between policy and practice has shown that certain states, despite their restrictive language and public posturing, have large migrant populations and that migration controls often fail. As a young technology centre in Southeast Asia, Cyberjaya meets all the above issues, according to Angelidou (2017a, 2017b).

Methodology

The objective of this study is to investigate the perspectives of international residents regarding the adequacy of public infrastructure provision in Cyberjaya and its impact on the liveability of neighbourhood areas in Cyberjaya. The study will specifically focus on the planning and design of high-quality soft and hard infrastructure that enhances physical spaces and facilities.

This investigation employed a quantitative approach as its primary research methodology. Following this, the study employed solely a qualitative approach to corroborate the quantitatively derived data and to enhance the data's credibility. The selection of the methodology was appropriate as it pertains to an investigation that examines the impact of autonomous factors such as social, physical, and environmental infrastructures on the dependent variable of neighbourhood liveability. Employing a statistical approach is deemed more efficacious in addressing the research objectives. Partly, this is due to the fact that anticipated results can be quantitatively estimated by utilising characteristics obtained from the pre-existing research in the literature. The independent variables were derived from distinct categories of characteristics that relate to social, physical, and environmental factors. The tripartite fundamental classifications of standards are subsequently partitioned into a secondary inventory of particular elements that enhance the comprehensive calibre of neighbourhood configuration.

Study area

The government first introduced the plan to develop Cyberjaya into the Malaysia Super Corridor in 1996 (Salman 2018). Cyberjaya in Selangor, Malaysia, is becoming a prominent global technology city. Its success relies on effectively implementing the Global Tech Hub (GTH) Blueprint. This blueprint aims to create a thriving environment for technology entrepreneurs, multinational corporations, and small-to-medium-sized enterprises (SMEs). Additionally, it seeks to provide access to top-notch human resources and infrastructure.

The demography of the study area highlights the growing global population in this new urban development in Kuala Lumpur's suburbs and their connection to Cyberjaya's pioneers (Figure 3). Technology workers, professors, and residents have steadily grown the urban area. The city lies 40 kilometres south of Kuala Lumpur and it covers 2,800 hectares, consisting mostly of undeveloped land.

An analysis of public infrastructure development in relation to community age and service quality, as judged by the international residents, resulted in selecting three residential areas in several parts of the city. This approach does not involve a comparative methodology. There exist specific localities that exhibit a greater degree of

desirability among the inhabitants, resulting in a heightened need for residential accommodations.

Figure 3. Case study location. Source: Sepang Action Plan (2025)

Data collection

The design step of this research recommended a quantitative approach using a questionnaire. Based on the demographics, a representative sample of residents from each neighbourhood was selected to complete the survey online or on paper. The survey's first segment examined the participants' demographics, and a total of 330 people took the survey – 110 respondents represented each neighbourhood; however, there is no reason to compare these three neighbourhoods.

According to Khorrami et al. (2021), liveability is a multidimensional and hierarchical concept that consists of various criteria and sub-criteria, and it can be evaluated in different ways. This study also includes an in-depth interview which was conducted to confirm the quantitative technique section's conclusions. In this sense, 15 interviewees from local governments associated with the Ministry of Housing and Urban Development and public-sector business organisations were chosen. City authorities and government officials were asked 10 open-ended questions about Cyberjaya's public infrastructure and services. 15 meetings with Sepang city officials and professionals were scheduled. In general, the independent variables of this research were categorised into three categories of general social, physical, and environmental infrastructures, and all the subgroups of the variables of each group were evaluated both through the survey as well as through the in-depth interviews.

Analytical method

According to the proposed method of this research, as well as the steps of data collection, and also following Zhao et al. (2019) that employed a quantitative method supported by a qualitative method in their research to find the correlated relationship between the residents' quality of life in the countryside and the urban infrastructure provision, the main analysis method of this study is the statistical analysis method in the first phase of data analysis. Considering that the main research method is a quantitative one and that a large amount of data has been obtained during the data collection stage, the best method for data analysis is to use a precise statistical and numerical method. A statistical analysis using the SPSS software was proposed and implemented in order to examine the data generated from the quantitative method of this research. Afterwards, the information gathered through in-depth interviews was analysed using the standard content analysis method. With the help of a content analysis approach, the information from the interviews was assessed and categorised.

The first stage of data analysis is concerned with the examination of pre-processed data from the quantitative phase. The residents who participated in the survey included students, employees of various enterprises, proprietors of their own businesses, as well as housewives (Table 1).

Table 1. Demographic characteristics of the statistical sample

	Valid	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Gender	Female	139	42.1	42.1	42.1
	Male	191	57.9	57.9	100.0
	Total	330	100.0	100.0	
Age	19-23 years old	88	26.7	26.7	26.7
	24-28 years old	117	35.5	35.5	62.1
	29-33 years old	100	30.3	30.3	92.4
	34-39 years old	25	7.6	7.6	100.0
	Total	330	100.0	100.0	
Education	High school	19	5.8	5.8	5.8
	Bachelor's degree	128	38.8	38.8	44.5
	Master's degree	146	44.2	44.2	88.8
	PhD or higher	37	11.2	11.2	100.0
	Total	330	100.0	100.0	
Employment	Employed Full-Time	82	24.8	24.8	24.8
	Employed Half-Time	23	7.0	7.0	31.8
	Seeking opportunities	51	15.5	15.5	47.3
	Just study	174	52.7	52.7	100.0
	Total	330	100.0	100.0	

Source: Cyberjaya neighbourhood areas survey

Results

Public infrastructures needed by the residents of a neighbourhood

Table 2 extensively evaluates the details of the infrastructure and public services required by the city in residential neighbourhoods from the resident's point of view and then it prioritises them according to their relevance in terms of ratings and their significance has been established. Totally 29 infrastructures were the most commonalities among the residents, which should be considered in the design of neighbourhood areas. The method of calculating the scores given to each variable was inverse. And, according to the obtained averages, the first 10 significant rankings were explained as an example. Hence, the most important public infrastructures in the neighbourhood area of cities, based on the international residents' perceptions, are: welfare infrastructure; transportation infrastructure; housing infrastructure; economy and finance infrastructure; safety and security infrastructure (including security teams, police, fire department, emergency services); governance; administrative and urban management infrastructure; food, restaurant, and food delivery infrastructure;

commercial and business infrastructure; soft infrastructure (ICT, IT, internet connection, digital technology and telecommunication); and education infrastructure.

Table 2. The most important public infrastructure in the neighbourhood areas of the city

Row	Public infrastructure and services	Rank	Mean	Std. deviation	5	4	3	2	1
1	Welfare infrastructure	25	1/00	0/00	330		0	0	0
2	Housing infrastructure	25	1/00	0/00	330		0	0	0
3	Education infrastructure	16.5	1/12	0/320	292	38	0	0	0
4	Food, restaurant, food delivery infrastructure	19	1/09	0/288	300	30	0	0	0
5	Commercial and business infrastructure	19	1/09	0/288	300	30	0	0	0
6	Transportation infrastructure	25	1/00	0/00	330	0	0	0	0
7	Soft infrastructure (ICT, IT, internet connection, digital technology and telecommunication)	16/5	1/12	0/330	289	41	0	0	0
8	Safety and security infrastructure (including security teams, police, fire department, emergency services)	21/5	1/06	0/244	309	21	0	0	0
9	Governance, administrative and urban management infrastructure	21/5	1/06	0/244	309	21	0	0	0
10	Economy and finance infrastructure	25	1/00	0/00	330	0	0	0	0

Source: Cyberjaya neighbourhood areas survey

According to the respondents' ratings of the variables, it can be stated that they carefully picked the requirements for their new living environment in Cyberjaya as a technology centre. Residents rely on services in this category of welfare because they are identified as one of their key requirements in the residential neighbourhood. Following that, consideration was given to transportation services. As previously mentioned, a large percentage of survey respondents indicated dissatisfaction with the existing level of transportation services, while providing convenient and easily accessible transportation for residents was one of the indicators of the world's smart cities. Communication services were listed third on the list of required infrastructure requirements for residential neighbourhoods. In terms of social life, the urge to engage with other neighbourhood or city residents is crucial for both city residents' mental health and the environment's liveliness.

Influential public infrastructure on urban neighbourhood liveability

Table 3 mentions the infrastructure and public services that impacted neighbourhood liveability. Residents could list any infrastructure or services they desire in response to the open-ended question. Following data collection, the frequency of similar responses was used to code this section. It was then compared to the data collected during the

literature review section to create a set of critical public infrastructures. This set was analysed, prioritised, and evaluated using SPSS software. The neighbourhoods' infrastructures were evaluated, and the residents ranked them according to the importance of the service from their perspective. Additionally, the prioritisation method was used in this section to determine the most critical services, reflecting the impact of public infrastructures on neighbourhoods from the perspective of residents. The following are the respondents' top priorities. The scoring system was switched around. The residents assigned a value between one and five points to each variable. A score of 1 indicates the greatest importance, while a score of 5 indicates the least importance. As a result, the lower the mean column value, the more statistically significant the variable is.

Table 3. Influential public infrastructure on neighbourhood liveability

Row	Influential public infrastructure on neigh-bourhood liveability	Rank	Mean	Std. deviation	5	4	3	2	1
1	Public transportation services	27	1/00	0/00	330	0	0	0	0
2	Public security	27	1/00	0/00	330	0	0	0	0
3	Public open spaces	27	1/00	0/00	330		0	0	0
4	Food services	25	1/09	0/288	300	30	0	0	0
5	Education and learning services	23/5	1/12	0/320	292	38	0	0	0
6	Internet and online services	23/5	1/12	0/330	289	41	0	0	0
7	Affordable housing	22	1/15	0/356	281	49	0	0	0
8	Leisure facilities	20	1/17	0/379	273	57	0	0	0
9	Walkability, sidewalks and cycling paths	20	1/17	0/379	273	57	0	0	0
10	Nightlife facilities and services	17	1/19	0/394	267	63	0	0	0
11	Multipurpose design and flexible buildings	17	1/19	0/394	267	63	0	0	0

Source: Cyberjaya neighbourhood areas survey and in-depth interview

Therefore, public transportation services and public security have the highest and most significant priority. Following them, public security, public open spaces, food services, education and learning services, internet and online services, affordable housing, leisure facilities, walkability, sidewalks and cycling paths, nightlife facilities and services, and multipurpose design and flexible buildings received the highest rank based on the frequency of choice by the neighbourhood residents. According to the residents' prioritisation of the indicators affecting the liveability of a residential neighbourhood, it can be concluded that their perception has been towards having a

quality life with various amenities in a neighbourhood. International residents taking part in the survey may not have a complete definition of a smart city's main infrastructure and its design criteria, but the way they prioritise effective infrastructure on neighbourhood liveability is such that they are aware of the differences between a city with a standard design and a city with the title of a technology hub.

Importance of public infrastructure and services related to city intelligence

On a scale of one to ten, the respondents were asked to rank the relevance of infrastructures connected to the city's intelligence in the questionnaire's third section (Table 4). The T-test has been used to rank the most important urban intelligence elements.

Table 4. Public infrastructure and services related to city intelligence

One-Sample Statistics T Test						
Row	Public Infrastructure	N	Mean	Std. deviation	Std. Error Mean	T
1	New digital infrastructure; e-services	328	4.9878	.10992	.00607	327.506
2	Creation of innovation; knowledge	330	4.9848	.12234	.00673	294.722
3	Better education; skills building	329	4.9878	.13470	.00743	267.675
4	Better public transportation	330	4.9788	.16403	.00903	219.152
5	Economic growth	329	4.9635	.25640	.01414	138.907
6	News skills for the citizens	328	4.9360	.25734	.01421	136.247
7	Increase of security	329	4.9027	.29677	.01636	116.294
8	Protection of the environment	327	4.9083	.29953	.01656	115.206
9	Cleaner energy	330	4.9000	.30046	.01654	114.876
10	Protection of natural resources	327	4.8991	.30168	.01668	113.833

Source: Cyberjaya neighbourhood areas survey and in-depth interview

According to the analysis, it can be concluded that the respondents believe that with the implementation of the smart city, the city's management will be improved significantly. In conclusion, the respondents largely agreed on the variable choice (better education and skill development) and the design of a smart city, and these variables have a critical effect on the intelligence of the neighbourhood area. Out of the twenty-six public infrastructures participating in this test, ten of them are very critical for the smartening of the neighbourhood. These ten infrastructures in their order of importance are: new digital infrastructure, e-services; creation of innovation, knowledge; better education, skills building; better public transportation; economic growth; new skills for the citizens; increase of security; protection of the environment; cleaner energy; and protection of natural resources. Nevertheless, the residents

mentioned that social infrastructures are more important for improving the liveability of their neighbourhoods, and the smart infrastructure that makes life easier for them can also be of high importance because the goal of choosing a city or neighbourhood for international residents is to experience a better quality of life.

Table 5 shows the effect of each of the variables on enhancing the liveability of Cyberjaya neighbourhoods, which are prioritised from the most effective to the least effective based on the effectiveness coefficient. The findings obtained from the regression test are important in order to prioritise the influence of the independent variables on neighbourhood liveability. Ranking them based on the degree of impact that they have on neighbourhood liveability can help create a better understanding of their importance in quality neighbourhood design.

Table 5. Coefficients for independent variables in the regression model
(subscales of social, physical, environmental aspects)

	Model	Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	1.444	1.173		1.231	.219
	Social relationship	-.079	.119	-.053	-.668	.504
	Safety	.005	.079	.004	.063	.949
	Education	-.074	.300	-.015	-.246	.806
	Health	-.002	.055	-.002	-.034	.973
1	International relationship and culture	.101	.074	.105	1.365	.173
	Welfare facilities	.061	.189	.026	.322	.748
	Equity in services	.170	.067	.187	2.533	.012
	Vitality of the place	-.066	.095	-.049	-.696	.487
	Public spaces	.023	.063	.026	.365	.716
	Technology and smartness in design	.100	.100	.075	1.004	.316
	(Constant)	1.025	.523		1.962	.051
	Accessibility	.264	.082	.189	3.228	.001
	Affordability	.004	.083	.003	.044	.965
	Connectivity	.076	.051	.082	1.491	.137
2	Mobility	.026	.077	.019	.335	.738
	Beautification	.087	.078	.065	1.121	.263
	Walkability	.050	.055	.053	.908	.365
	Flexibility of design	-.090	.035	-.144	-2.545	.011
	(Constant)	1.970	.430		4.579	.000
3	Climate design	-.017	.041	-.025	-.423	.673
	Clean and renewable energy	-.008	.085	-.007	-.099	.921
	Environmentally friendly design	.106	.079	.084	1.333	.183

Source: Cyberjaya neighbourhood areas survey and in-depth interview

Discussion

The study of smart city liveability, particularly in Indian and Malaysian cities, has gained attention in recent years (Bunnell 2015, Macke et al. 2018, Yap 2021). Most studies suggest that the effectiveness of smart cities relies on the presence of information and communication technology (ICT) infrastructure. Additional factors that contribute to a city being considered smart include human capital and education, social and relational capital, and the environmental concern. These factors are recognised as important drivers of urban expansion. Most experts agree that human involvement and effective communication are essential for the success of a smart city in terms of liveability and vitality.

Technology hub towns prioritise two essential elements: hard and soft infrastructure. The term "hard" in the context of urban infrastructure generally pertains to the physical construction of the city. In addition to the physical aspects, the development of a city necessitates the establishment of soft infrastructure, encompassing the human and social sectors. Smart cities, knowledge capitals, and technological centres are subcategories of contemporary intellectual cities that prioritise knowledge availability, communication quality, and social infrastructure provision for their residents and users (Caragliu et al. 2011, Angelidou 2017a, Angelidou 2017b). The focus of their interest extends beyond the ICT infrastructure to encompass the significant contributions of individuals and education in urban development. The primary objective of technology hub cities is to educate the residents, thereby cultivating a skilled workforce that can contribute to the city's economy and overall success (Berry and Glaeser 2005, Glaeser and Berry 2006). The presence of comprehensive neighbourhood infrastructure improves the connectivity, aesthetics, and overall quality of life in an area (Aldegheishem 2023).

The results of the analysis revealed a significant association between the public social infrastructure and neighbourhood liveability. The provision of public infrastructure can have a positive impact on the quality of life. As a result, the improvement of public infrastructure in Cyberjaya is expected to contribute to the enhancement of liveability, which in turn may lead to an increase in satisfaction levels among the international community residing in the area. The analysis of the sampled population indicates that the utilisation of social infrastructure is a key determinant in fostering a sense of vibrancy within individuals. So, the establishment of a scenario that fosters a sense of interconnectedness among individuals, their surroundings, and the communal amenities contributes to their contentment with residing in a superior locality.

Based on the study findings, it can be concluded that Tamarind Square stands out as the most vibrant locality owing to its diverse range of amenities, recreational facilities, entertainment options, and public transportation links that effectively interconnect the

urban fabric. However, it is imperative to acknowledge the crucial role played by the physical and environmental infrastructures in this regard, which cannot be discounted. After analysing the factors that have a significant impact on the liveability of a city, it can be inferred that an equitable allocation of public infrastructure is imperative for all neighbourhoods (Carballo et al. 2022) within the city. According to Gómez-Varo et al. (2022), this is crucial for sustaining the liveability of the city, as the availability of public spaces and opportunities for social interaction can contribute to the vitality of the city and its neighbourhoods. This is particularly important in a multicultural city that accommodates diverse populations with varying backgrounds (Alizadeh and Sharifi 2023, Karmaker et al. 2023).

According to the theory of neighbourhood design quality (Mumford 1989, Richards et al. 2014, Mkandawire et al. 2018), the quality of a neighbourhood is influenced by three key variables, namely social, physical, and environmental factors (Siordia and Saenz 2013, Ribeiro 2018). The study centred on the pivotal function of public infrastructure in augmenting the quality of life in residential areas.

The present research confirms the findings of prior studies that have established a positive correlation between the standard of public infrastructure provision and the quality and liveability of the neighbourhood (Li et al. 2019, Kim et al. 2020). The results of the study suggest that the liveability of Cyberjaya's neighbourhoods is suboptimal. After conducting thorough investigations, it has been concluded that the problem of neighbourhood liveability is closely linked to the absence of crucial public infrastructure that is necessary for neighbourhoods to fulfil the expectations of their residents (Xiao et al. 2023). The proliferation of neighbourhood issues has resulted in a decrease in demand for residential properties, leading to a lack of vitality in the urban environment and a perceived sense of stagnation (Konduri and Lee 2023). Therefore, in order to enhance the habitability of urban regions, it is imperative to effectively cater to the public infrastructure requirements of the locality.

The provision of amenities and services in specific neighbourhoods has a positive impact on the satisfaction of residents and it promotes their retention in those areas especially in the Asian developing cities context (Zhang et al. 2022). Numerous scholarly articles have been published regarding this topic, including those by Costamagna et al. (2019) and Kasim et al. (2020). Therefore, it offers a firmly established theoretical and practical structure. The use of this tool has the potential to aid urban designers, specialists, and authorities in making informed decisions regarding future actions aimed at enhancing urban areas.

The study conducted an analysis of the social, physical, and environmental dimensions in order to enhance the scientific and practical frameworks of future projects. This was done to better understand the implications of the study's results and their contributions to theoretical and practical frameworks. It is noteworthy that the outcomes of this

study were solely derived from the perspectives of the expatriate inhabitants of Cyberjaya. These viewpoints were further authenticated by means of discussions with regional officials and specialists. It is important to note that the responses gathered are exclusive to individuals who are international residents and that they are influenced by their perceptions, emotions, and personal subjective connections with their surroundings. Additionally, the needs of an international migrant differ from those of a native individual, resulting in distinct expectations of a location (Chen et al. 2022). The results of this study may vary significantly if the survey were conducted through random sampling or by selecting individuals from the local population as participants. This study focused on the international residents of Cyberjaya, as it is a technology hub that initially attracted foreign investors and later developed into an educational centre with notable institutions catering to international students.

The previous research on urban planning has not adequately addressed the matter of ensuring a high quality of life for non-native residents (Valero-Escandell et al. 2023). However, it is important to note that a smart city's definition includes a focus on its human dimension (Allam et al. 2022), which necessitates special attention to the needs of all residents. The research did not centre on smart city designs. Instead, it aimed to assess the readiness of Cyberjaya, in light of its characteristics and global introduction, to cater to the needs of its residents who have migrated to the Asian tech hub city (Yasin et al. 2022).

The study's results suggest that nine specific types of public infrastructure have a significant impact on improving the liveability of a neighbourhood. The public infrastructure comprises various services and facilities such as social relationship and communication infrastructure, public safety infrastructure, education infrastructure, public health and healthcare services, international relationship and culture, welfare facility infrastructure, equity in service provision, vitality of the place, public spaces, technology, and smart infrastructures and services.

The research data collected in different conditions and according to the method used in this study may have limitations that will eventually cause the results to have a percentage of error. The data collection period of this research coincided with the peak of the restrictions of the first phase of the pandemic, and for this reason, it was not easy to access the statistical community selected to participate in the survey. On the one hand, numerous questionnaires were completed and sent back by the online response system, as a result, there was a possibility that due to the limited physical presence of the surveyor, the participants did not give complete and decisive answers to some questions, and this is while the mental conditions of participants were also considered due to long-term quarantines and nationwide lockdown which made them more isolated and disconnected from the social life (Tran et al. 2020). On the other hand, in the conducted interviews, due to the limited time of the interview and the observance of social distance, as well as the limitation of the interviewed city officials in providing

detailed information on future urban planning, it was not possible to access detailed data. However, the review of existing government documents and blueprints has greatly contributed to the collection of qualitative data. As a result, the generalisation of the results of this research as a comprehensive framework in the implementation of new urban neighbourhood design policies or practical implementation has limitations because different neighbourhoods of a city also have differences in conditions and characters (Málovics et al. 2019), but still, the problem of the liveability of residential neighbourhoods of Cyberjaya has shown many similarities.

Among the other limitations of generalising the research results to urban studies on a general scale, we can mention the special branding of Cyberjaya as a technology centre because the residents and users of such cities have different perceptions and expectations of the standards and quality of urban life, which is different from the quality of life in other cities. Finally, this research has come to a conclusion by emphasising the public social, physical, and environmental infrastructures and their impact on urban liveability with a focus on neighbourhood areas, while the effects of other groups of infrastructures, especially economic infrastructures, should be studied because only in this case an excellent theoretical and practical framework can be presented to deal with the problem of the liveability of smart and sometimes neoliberal cities and their neighbourhood areas where the human capital of the cities live.

Conclusions

Rapid urbanisation, privatisation of public spaces, and technocratic infrastructure planning in Asia has led to urban sprawl, socio-economic segregation, and failure to meet the residents' needs. Public infrastructure, both hard and soft, can improve urban liveability. However, there is a lack of information on the influence of quality public infrastructure on the liveability of residential areas and the urban satisfaction among international residents in smart cities.

The Asian Development Bank predicts that developing Asia and the Pacific will require over \$22.6 trillion in hard infrastructure by 2030, with much of this required in urban areas. The level of investment required in soft infrastructure remains unknown. Governments and policymakers must prioritise connectivity and achieve the optimal balance of hard and soft infrastructure. Developing connectivity indexes can help identify the most effective mix for economic and social development. However, the focus on local economy and welfare services is crucial for city liveability and dynamism in Southeast Asia (Arfanuzzaman and Dahiya 2019, Le and Nicolaisen 2021).

First and foremost, this study investigates the liveability of neighbourhoods in Cyberjaya, Malaysia's IT super corridor. It fills the gap between smart city liveability and the critical need of urban infrastructures. The study systematically unpacks how multiple infrastructures shape the liveability of urban neighbourhoods, revealing that

social factors affect liveability the most, whereas environmental elements impact it the least. Social factors include equity in services, international relationships and culture, technology and smart design, public spaces and welfare facilities, safety, social relationships, place vitality, and health.

Developing liveable, and equitable cities is a major policy aim especially in the regional context for the Asian cities development (Kamiński 2023, Quang Giai and Kim Hai 2023, Susantono et al. 2023). However, liveability criteria are broad, emphasising different dimensions. Secondly, this study develops a novel data-driven approach by directly surveying the perception of urban international residents, alongside satisfaction with key social-physical-environmental infrastructure urban correlates to indicate liveability criteria and influential priorities. According to Brown et al. (2023), the importance of paying attention to social and cultural communication and collective decision-making on a larger scale than the regional scale has been pointed out and its importance has been examined in the position of global cities.

Additionally, the study highlights the importance of providing soft public infrastructure in residential neighbourhoods, which is crucial to urban neighbour-hoods' liveability and citizens' satisfaction. It also highlights the need for a practical framework for future designs focusing on the human dimension of cities and their expectations of global cities design standards. This approach can enhance the liveability situation in smart cities in regional scale, particularly in Southeast Asia and Pacific countries. According to Chen (2023), some Asian cities are evaluated as smart but with a lower subjective well-being and while technical products are playing the main role in the smart city, the quality of the urban infrastructure is more vital for increasing the resident's well-being. Finally, the study has several advantages for policy making, such as showing how diverse infrastructures affect the urban neighbourhood liveability, and as providing a practical framework for future designs focusing on the human dimension of cities. Future studies should test this approach in other cities to highlight their needs and to prove its efficacy in new cities especially in the Southeast Asia developing countries.

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MOBILITY AS CENTRAL ELEMENT IN THE COVID-19 PANDEMIC: FROM ACCELERATION TO CONTAINMENT. EXPERIENCE AND LESSONS FROM GALICIA (SPAIN)

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Abstract: The COVID-19 pandemic developed in a context of hypermobility. International globalised financial capitalism has been consolidated at the beginning of the 21st century and it has resulted in an unprecedented increase in mobility. In Galicia (an autonomous region located in the northwest of Spain), as in many other Spanish, European and world territories, mobility restrictions were carried out according to different criteria. Here we will be concerned with showing the effectiveness of the different measures taken by the national and regional governments, linked to mobility and pandemic management. To achieve this objective, in addition to the official reports from the competent authorities, we use detailed data on the number and addresses of those infected during the first wave. We have this information because we were selected by the Government of Galicia to carry out a study on the territorial behaviour of the pandemic in Galicia.

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Introduction

The current COVID-19 pandemic has been raging for more than three years now, and it has completely transformed the world we live in. The emergence of an unknown and highly contagious coronavirus in late 2019 in the Chinese city of Wuhan and its rapid spread across the globe has led to what it is just one more episode in the long list of plagues and pandemics that humanity has suffered throughout its history (Agamben et al. 2020).

Indeed, although there were sufficient indications in the scientific community to suggest that such a pandemic might occur, the COVID-19 pandemic can be described as a true "black swan". In the social sciences, this terminology refers to an unexpected phenomenon, of large dimensions and negative consequences, which affects the territory and society in a dramatic way (Yarovaya et al. 2022).

In any case, the COVID-19 pandemic has had its precursors – viral epidemics that had more limited effects in space and time. Perhaps the best known was SARS, which had been confined a few years earlier to Southeast Asia, but which had already put the World Health Organisation on alert because of the major consequences that it could have had for the entire planet. Another of the epidemics with great media repercussions in recent years was Ebola, which at the time, aroused great concern throughout the world, although its scope was practically confined to Africa. In any case, it cannot be said that there have been no precedents in the near future (Pigott et al. 2014, Diamond 2019).

If we take a longer view, we must bear in mind that pandemics have always existed. The history of mankind is the struggle to overcome the natural dangers to which the species is exposed. Extraordinary advances in medicine and health research have brought us to a situation where it seems difficult to compare any of the mediaeval plagues that struck Europe with the COVID-19 pandemic. And yet, while there are important differences, there are also great similarities.

Despite great advances in health care, human beings are still exposed to infectious diseases that are transmitted through the air, via airborne particles, from person to person. Nevertheless, the reading of Boccaccio's "The Decameron", written in the 14th century and set in the midst of a plague epidemic in modern-day Italy, is highly topical (Boccaccio 2001). As in Boccaccio's book (2001), the pandemic due to an unknown virus spread amidst the fear of most of the population, the anguish and panic of some, leaving behind a trail of death and destruction. It is curious that in Europe Northern Italy was one of the places most affected by the pandemic, where the images of the overflowing funeral services in the city of Bergamo in the face of the avalanche of the dead became sadly familiar to us (Bernucci et al. 2020).

But while there are similarities between the Middle Ages and the 21st century, it is no less true that there are clear differences, with both positive and negative connotations. On the positive side, we must take into account the great organisational and technical capacity of today's modern societies, which are able to quickly dictate measures, protocols and legislation to try to control the pandemic. Likewise, the speed with which effective vaccines against the coronavirus became available has been fundamental in the fight against the pandemic and in the global strategy to return to normality as quickly as possible.

Among the differential elements with a negative character, one is particularly relevant: the high mobility of the citizens of the countries of the global North. Indeed, the spread of the current coronavirus has occurred at enormous speed precisely because we live in a hyper-mobile world, accustomed to constant, frequent and continuous population movements. This hypermobility is one of the defining characteristics of global north societies, and it can be observed across all scales of geographical analysis (Cohen and Gössling 2005).

We are not only talking about forced mobility on a daily basis or in metropolitan environments; we are referring to mobility on a regional, supra-regional and supra-state level. These continuous mobilities imply constant and continuous population movements between regions, countries and continents, for many different reasons. At the global level, the rapid spread of the virus between Asia and Europe is explained by the existence of a world system with a very high level of integration thanks to the omnipresent and frequent air connections (Gross et al. 2020). In a context of "Jumbo Geography", as Rimmer (1988) put it, the entire planet is interconnected as never before, due to globalisation.

It is a characteristic of our times, therefore, this constant hyperconnection between people living in very distant territories, and the so-called "urban archipelagos" (Romero 2004, Stavrides 2013). Paradoxically, two metropolitan areas located on different continents may be more integrated than one of these metropolitan areas with the surrounding rural spaces. This leapfrog urbanisation and this privileged connectivity between large urban archipelagos explains the initial difficulty in controlling the spread of an airborne virus (Flandoli et al. 2021).

From a geographical point of view, what is therefore characteristic of this pandemic in relation to previous pandemics? Undoubtedly, it has been the great speed at which the virus has spread and affected the entire planet in record time, as never seen before. The speed at which the pandemic has spread and the great disruption it has caused in the economic system and in the living habits of societies accustomed to compulsive mobility characterise this 21st century pandemic, and therefore make it interesting to study it from the perspective of the new paradigm of mobility (Sheller and Urry 2006).

This paper is structured as follows: first, after the introduction and the presentation of the objectives, we will present a theoretical framework on the implications between mobility and the COVID-19 pandemic. Indeed, mobility was one of the great catalysts for the spread of the pandemic, but also one of the main instruments to contain it and to try to stop it. Subsequently, the methods and materials used are presented. It is important to highlight that official data provided by the regional government of Galicia in the framework of a research project obtained in a competitive call for proposals were used. Thirdly, the study area is presented. Fourth, we analyse the main spatial characteristics of the first wave of the pandemic. Fifth, we finally look at mobility during that time and we analyse its territorial significance. Finally, we present the main conclusions of our analysis.

Mobility and the COVID-19 pandemic

From a theoretical point of view, this article agrees with the postulates of the New Mobility Paradigm, enunciated by Sheller and Urry (2006) who are the architects of the formalisation of a new point of view for understanding the social sciences, which gives mobility a central role. In contrast to the classical approaches where analyses adopted an eminently static perspective, the role of movement, change and interaction as constitutive elements of the contemporary world is now highlighted (Pazos Otón 2022).

It is not just that mobility is one of the foundations of the current globalisation process, but that it plays a fundamental role in explaining how the individual and society experience space and territory. In the case of the pandemic and the rapid spread of infection, it is precisely the dependence on mobility at all scales of analysis that explains the rapid evolution of the pandemic (Cartenì et al. 2020). Mobility is therefore a key component in the study of the COVID-19 pandemic, as it was in other recent pandemics such as avian influenza or SARS.

In recent years, few words have been gaining as much prominence in the scientific literature related to the territory as the word mobility. In parallel, its use by the general public has become widespread at great speed. Where before we talked about transportation, now we talk about mobility. The previous traffic police officers are now mobility agents. Ministerial transport departments now include the word mobility. This emergence of the concept is related to the crisis of the large infrastructure model, the awareness of the threat of climate and global change and the progressive importance that the individual and his personal variables take on when explaining his movements.

Until the appearance of the Covid-19 pandemic, the progressive and increasing mobility of people seemed to have no limits. Everything was moving faster and faster. It was as if there were no limit to the increase in trips, their duration and their frequency. In this first major pandemic of the 21st century, mobility appeared as one of the great explanatory agents for the rapid spread of the virus throughout the planet.

The globalisation of the economy, the constitution of the planet as a set of urban archipelagos and the growing interrelationships of territories justified the unprecedented global mobility, in which air transport played a fundamental role.

With the outbreak of the pandemic, throughout 2020 and 2021, mobility became a key component in the fight against the expansion of the pandemic. What had accelerated its expansion now became the best tool to content it. For many months there were home confinements decreed by governments and mobility limitations were put in place depending on the problems of certain territories and certain social groups. The promotion of mobility containment by public powers had its counterpart in the extraordinary development of the application of technology to labour and social relations (Pazos Otón 2022).

The exit from the pandemic throughout the years 2022 and 2023 was progressive and it was accompanied by a growing desire for mobility on the part of the citizens. Isolated and confined to their homes for many months, citizens made use of their freedom of movement as soon as possible. There was an explosion of mobility for work reasons but, above all, for leisure reasons. After the initial months of the end of the pandemic, governments greatly relaxed the restrictions and barrier measures (progressive elimination of masks) until they declared the end of the pandemic as such.

In this context, the population's tendency to move more and more has increased. Contrary to what was prophesied (the pandemic was going to be an opportunity to reinvent ourselves and to stop being so mobile, to decrease), the experience of mobility restriction caused what is called "revenge tourism". This is, in short, a substantial increase in the voluntary mobility of the population, without serious energy or climatic circumstances acting as a brake on the trend.

Be that as it may, in times of pandemic, a series of measures were implemented to try to contain the expansion of the virus, the main agent of which was mobility (Pazos Otón 2022). In Spain, as in other countries as well, extraordinary legislative measures were decreed that annulled one of the basic rights of the citizens – free movement throughout the national territory. The State of Alarm decree of March 2020 was first renewed within 15 days in the Madrid Parliament, and subsequently a continuous state of alarm was decreed from October 25, 2020 to May 9, 2021.

Secondly, the assumption that the evolution of the pandemic would adapt positive cycles to negative ones (the so-called "waves") was associated with the existence of more or less important mobility restrictions. The relaxation of mobility restrictions during the Christmas period of 2020 caused a significant wave of infections in January and February. The greater the mobility, the greater the incidence of infections. The decision to allow mobility during the Christmas period was criticised and it pointed out as one of the causes of the so-called "fourth wave".

Thirdly, a series of fundamental measures were generalised, such as the obligation to maintain one and a half metres of social distance from non-cohabitants. Likewise, it was considered that there should be no type of restriction in the domestic sphere. The generalisation of the mask and the social distance between people were implemented as a confirmation that what was pertinent was to reduce the mobility and interaction of the population.

Fourth, teleworking was promoted to the extent possible, in order to reduce the daily forced mobility of workers. The pandemic meant the explosion of a growing trend, which had been practised in a timely manner and with uneven implementation throughout the world. The generalisation of teleworking has had a clearer consequence of the need for its regulation from a legal point of view. In fact, a law was passed regulating remote work (Agencia Estatal Boletín Oficial del Estado 2021).

Finally, there have been others that were variable and mobile, and that were adapted to the specific circumstances of the evolution of the pandemic. Basically, they were confinement measures (personal), business closure and perimeter (or confinement of different administrative and territorial units). They consisted of restricting mobility and they were popularly known as "closures". Its application also varied depending on different factors (on age groups, on time slots, on the type of activity, on the structures of the premises, on territorial units). There can be multiple cases, from the perimeter closure of a municipality (Igualada, Catalonia, in March 2020, was the first), to an autonomous community or even by health areas. Different levels (1, 2, 3) were also used to restrict mobility between health areas that are in different phases (Galicia in the first quarter of 2021).

In any case, mobility has at all times been a central element in the COVID-19 pandemic, first as an accelerator of the transmission of the virus and, later, as a central element in the containment policies and fight against its spread.

This study contributes to inform the debate on the management response to a pandemic. Specifically, it aims to develop a territorial analysis methodology to identify the geographical behaviour of the coronavirus pandemic in Galicia and, to a greater extent, the influence it had on human mobility (Aràndiga et al. 2020).

Methodology

Study area

Galicia is located in the northwest of Spain. It covers an area of almost 30,000 square kilometres and it has a population of 2.7 million inhabitants. The population density is 91.4 persons per square kilometre. Administratively, the region is divided into 313 municipalities distributed over 4 provinces (Figure 1). The population is concentrated

in the two westernmost provinces, reaching average densities of over 140.9 inhabitants per square kilometre in A Coruña, and 209.7 in Pontevedra (INE 2021).
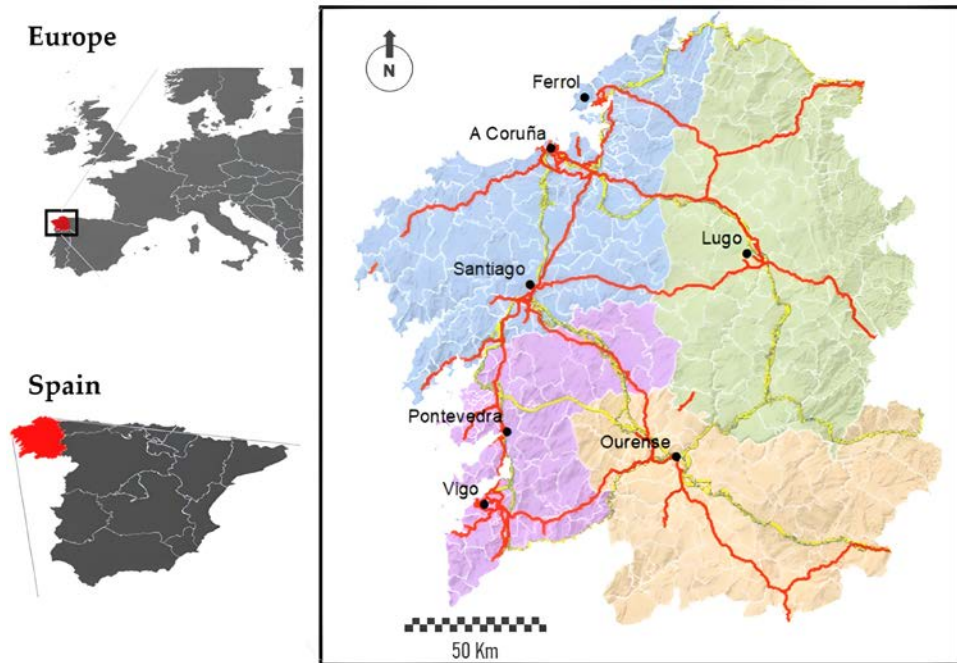

Figure 1. Location and characterisation of the Galician region

In coloured background, distribution of provinces (second-level administrations) and municipalities (third-level administrations). The most populated cities and industrial hubs of each province appear highlighted in bold. Red lines represent the major road infrastructures, i.e., motorways in red and railways in yellow.

Increasing levels of urbanisation have occurred since the 1960s and rural depopulation has contributed to a spatial concentration in some areas within this region. Today, most of the population, economic activity and political power are concentrated in a very small number of cities (Lois and Pino 2015). The most important ones are located along the Atlantic Axis, structured by the AP-9 motorway that crosses the region from north to south. This axis links the cities of Ferrol, A Coruña, Santiago, Pontevedra and Vigo within this region. The largest cities are Vigo and A Coruña, which each have around 300,000 inhabitants. Situated outside this axis, we find two important cities: Lugo and Ourense. These constitute the main centres of economic activity in their respective provinces and both have populations of around 100,000 people.

The region presents a dual population pattern. On the one hand, the main cities account for around 80% of the population and 75% of the regional GDP (Pazos Otón 2003, Lois-González 2004, Lois and Pino 2015), while a vast area is rural and it shows declining

populations. This general pattern is evident at provincial level, with the two western provinces having a greater economic diversity and a higher proportion of the population. In this demographic duality, a very dynamic coast contrasts with a depressed interior region. Of course, the reality is more complex, with some emerging exceptions in certain coastal sectors, such as the Costa da Morte, where population dynamics have been clearly regressive in recent decades.

This territorial structure determines mobility patterns. At the regional level, commuting flows to the main cities and surrounding areas predominate. Internally, a significant number of head cities form the backbone of most of the non-urban territory. These cities are nodes that, despite typically having low populations, function as child-sized cities for vast rural areas (Balsa-Barreiro et al. 2021). Most mobility flows in these predominantly rural areas cover large distances compared to urban areas. In any case, in order to understand the particularity of Galicia's territorial structure and its relationship with population mobility, four fundamental issues need to be taken into account:

a) The population in Galicia has internalised the habit of daily mobility. They have done so in order to continue living in rural areas, and they need to move every day in order to live in today's modern society of advanced services. There are many people who have to travel every day to county seats, towns or cities and they still live in the countryside. They value the quality of life that exists in the countryside, and that is why they want to continue living there. For this reason, in many families in rural Galicia it is very normal to have 2 or even 3 cars. People in rural areas assume that they have to have a car to live in the 21st century, and this means that the rate of motorisation in rural municipalities (less than 10,000 inhabitants) is much higher than in the rest of Spain.

b) The dispersion of the population and the specificity of the settlement system in Galicia means that public and collective transport in general is scarce and not very operational. If we add to this the high levels of motorisation and the availability of 2-3 cars per family unit in rural areas, we can understand that in the middle of the pandemic most of the journeys were made by private car, in an individual bubble in many cases that nullified the risk of contagion during journeys. Unlike in large cities or even in medium-sized and smaller cities that are more dispersed territorially, in Galicia, the high use of cars was fundamental for the low diffusion of the virus in comparison with other territories.

c) The population of Galicia lives in more than 31,000 singular population entities, which represents more than half of the population of Spain as a whole. This explains why they live in very scattered population conditions. Precisely the great distance between population centres in Galicia was a key factor in the pandemic, as it minimised interaction. There are still many population centres, but with a dispersed population structure. In other words, there are many villages, but these villages are not compact. In recent decades, the number of single-family houses around the roads has increased

enormously, and these houses have an adjoining space. Except in the compact cities, in general there is a lot of residential space available in Galicia. In rural Galicia there are few possibilities to interact with neighbours nearby, and in any case these interactions take place in the open air. In many villages there is no longer even a bar or café. There are no places for socialising as there may be in other regions.

d) In Galicia there is a strong link with the rural and agricultural, and livestock areas. Unlike in other parts of Spain, in Galician cities practically everyone maintains strong affective and effective ties with the countryside. In a region that was urbanised very late, the first and, above all, the second generation of urbanites is very numerous. In many cases, they are children of the baby boom who return to their family homes as soon as they have the chance, on holidays, etc. In many cases, they return to homes where their elders live, but in other cases they build new homes. These are second homes to which they try to return whenever they can. Particularly interesting in this respect is the behaviour of people who have emigrated from Galicia, who, even if they live in a large European city, aspire to move to the house they built with all their life savings in a rural Galician village when they retire.

Analysis dataset

This dataset contains information related to all individual cases reported during the first wave of the pandemic, which runs from 1 March to 15 July 2020. This information was officially transmitted to us by the Galician Health Service (SERGAS 2020), the health authority of the region. This was possible because the Galician Innovation Agency (GAIN) of the Xunta de Galicia offered an urgent competitive public call during the month of March 2020, to the entire scientific community (public and private), to propose solutions to "fight" against COVID-19. The project "Risk mapping of COVID-19 in urban and rural areas of Galicia" was selected, the purpose of which was to produce a series of territorial analysis reports on the pandemic and to provide them to SERGAS (2020). This project is the basis for this article. Therefore, these data were transmitted to us by SERGAS (2020) after signing a confidentiality agreement.

The dataset, initially of 11,070 records, includes data related to each patient, such as main data, place of residence and physical address, and some relevant time data that allow checking a complete disease follow-up for each reported case (i.e. admission/death at home/hospital). Knowing that most mobility was restricted during the confinement, case and outbreak tracing may be limited spatiotemporally because health authorities recorded data related to the first symptoms and test results. The official address of each reported case allows us to obtain a very accurate graph of the actual spatial behaviour of the virus.

The raw dataset was initially checked for inconsistencies. The dataset was prepared and cleaned by removing duplicates. We also removed all false positives, as well as all cases

without any address that was untraceable. In summary, 581 records were eliminated. After that, we standardised the formats for the remaining records. All the survey and cartographic representations were done with ESRI technology (mainly ArcGIS Pro and ArcGIS Online). Finally, a complete dataset consisting of 10,583 records was correctly geolocated on a map (Miramontes Carballada and Balsa-Barreiro 2021a).

In any case, we want to emphasise that in this work the objective is not to value the cartography carried out on the territorial behaviour of the pandemic (Guallart Moreno 2020, Sancho Comíns and Olcina Cantos 2021). Nor to carry out a new innovative treatment of this data. But, from its purification and its most basic representation, we aim to detect the influence that people's mobility has had within the pandemic. In this work we intend to link the knowledge on its territorial behaviour and distribution (Carballosa et al. 2021, Cruz Villalón et al. 2021, Miramontes Carballada and Balsa-Barreiro 2021b, Carballosa et al. 2022, Miramontes Carballada and Lois Gonzalez 2022).

Spatial behavioural data

We focus on the first wave, which is unadulterated, contrasted and highly detailed data. We analysed and mapped the data associated with COVID-19 in this Spanish region. Our data contain individual and accurate information on each infected person, including their physical address. These data allow for a very accurate and detailed estimation of the actual spread of the virus in this territory. This information was provided to understand the spatial dynamics and impact of the pandemic, in order to predict its future behaviour and to be able to anticipate and to adapt the appropriate decisions at any given moment.

In fact, our maps were used as a fundamental tool for monitoring the pandemic and for evaluating the subsequent measures, allowing us to identify the spatial patterns of the virus. To this end, we developed several strategies for visualising and mapping the data. This time, we give more importance to population mobility variables and their relationship with the distribution of infected people.

The way in which the information is represented should serve as a basis for the integration of multidisciplinary work teams, not only medical but also from other disciplines, most of which do not have experience in cartographic visualisation. In fact, maps similar to those presented in this work served the purpose of advising the competent authorities responsible for the management of the pandemic in this part of Spain (Andrés López et al. 2021, Carballosa et al. 2021, Cruz Villalón et al. 2021, Lois-González et al. 2021, Carballosa et al. 2022).

Mobility data

However, in this paper, we go even further and, in order to show an analysis of the

spatio-temporal evolution of both virus incidence and human mobility flows during the first wave of the COVID-19 outbreak in Galicia, we also use data on human mobility.

Anonymised mobile data was provided by INE (2021). With this data, it is possible to extract the physical location of mobile users of the three most important operators in Spain. The geographical location of each user can be accurately estimated by deducing the antennas from which their mobile phone receives a signal. This dataset includes the location of more than 80% of the mobile phones that are distributed throughout the region.

The time frame of the data ranges from 15 March to 16 June 2020, which basically corresponds to the first wave of the COVID-19 pandemic. Mobility data are estimated for certain common days according to the methodology proposed by INE (2021). These days correspond to periods of normal educational and work activity, which are part of a week without any intervening holidays that might affect mobility. In all cases, we selected data from the second week of each month. For a broader perspective on this dataset, we included mobility data for November 2019, before the outbreak of the virus (INE 2021).

These data are spatially aggregated, fully respecting user privacy. The data are aggregated and represented on the basis of mobility areas, a particular spatial unit established by INE (2021). Mobility areas are defined on the basis of the administrative division of municipalities, although they have some differences. They are arbitrary areas whose size depends on functional aspects related to mobility and population. The division into mobility areas tries to reflect a more homogeneous distribution of the territory according to population aspects. The borders between these mobility areas mostly respect the original distribution of the municipalities, but they always group together areas with a population between 5,000 and 50,000 inhabitants (INE 2021).

In this paper, we selected the following information from the dataset: resident population; number of people staying in their residence; number of people leaving their residence; and areas of mobility to which they moved and/or they came. It is thus clear that one of the potentials of this work is the two databases used to analyse and to map the COVID-19 pandemic and the population.

The main mobility dynamics have changed dramatically since the emergence of COVID-19 in mid-March 2020. In Spain, national authorities implemented nationwide measures to control the virus. On 14 March, they adopted a hard lockdown with strict mobility restrictions and stay-at-home orders for all. Work activity was reduced to very few essential activities related to human care and the purchase of primary commodities. Between 30 March and 9 April, only essential workers were able to travel to work. Galicia was the first region to ease mobility restrictions and to return to pseudo-normality. This was done in four different phases. On 4 May, some businesses

and activities, mostly outdoors, were authorised. Two weeks later, restaurants and some shops could open, but with partial capacity restrictions. Human mobility was limited within each province. On 15 June, the region began a "new normal" with no restrictions on mobility.

We will now present the main quantitative and qualitative features of the pandemic in Galicia, with special attention to its territorial consequences, in order to understand the relationship between the behaviour of the virus and the main characteristics of the Galician territory and its population.

Results

In order to better understand the territorial impact of the pandemic in Galicia, we divided the analysis, and therefore this section, into four subsections. We begin with a brief overview of the case of Spain as a whole. Galicia is a territorial administration with competences in health (among others such as education, justice, etc.), and territorial characteristics that are different from those of the other autonomous communities in Spain (there are 17 autonomous communities in total) (Méndez 2020, Cruz Villalón et al. 2021).

Next, we will focus on the specific case of Galicia and on two differentiating territorial processes: the relationship of urban spaces with the pandemic and a study on a larger scale such as the 313 municipalities into which Galicia is divided, which can be classified as an analysis on a local scale.

Impact in Spain

The first case of COVID-19 in Spain was reported on 31 January 2020 in La Gomera, in the Canary archipelago (Monastiri et al. 2021). A few days later, on 9 February, a second positive case was detected in Palma de Mallorca. The first cases reported on the mainland were recorded in the last week of February in Madrid, Catalonia, the Basque Country and Valencia. All these cases were initially imported from other countries, although EU transmission within the country was already evident in early March. At the time, the national authorities declared the containment (on 14th March) while Spain had 6,332 cases and 193 deaths. The containment decreed by the central government lasted 49 days, followed by a period of 40 days in which restrictions were progressively lifted until the end of the first wave at the end of June. The balance of this first wave was, as of 21 June, of 246,504 cases and 28,313 deaths at the national level, although the actual figures were predictably much higher. According to data published by Instituto de Salud Carlos III (2020), the actual number of COVID-19 deaths could be one third higher than reported (Romero 2020). The results of the first national seroprevalence study estimated that only 5% of Spaniards had been infected with the virus during the first wave (Pollán et al. 2020), although showing great geographical variability, with a

higher prevalence observed in the Madrid area (>10%) and much lower in coastal areas (<3%) (Oliver et al. 2020, Sierra Moros et al. 2021).

Impact in Galicia

In the case of Galicia, the first official positive report for COVID-19 was made on 4 March and it corresponded to a case imported from Madrid. Between the time this case was reported and the containment decree implemented by the central government, only ten days elapsed during which the virus circulated freely. Most of the cases reported during this period correspond mainly to imported cases from primary foci of infection and cases of community transmission within household circles, as well as dependents.

In Galicia, the first wave left a total of 10,489 cases and 619 deaths. The seroprevalence study carried out during the first wave estimated that only 1.15% of the population had been infected, making it one of the least affected regions in Spain (Carballosa et al. 2021, Miramontes Carballada and Balsa-Barreiro 2021b). Comparatively, the fatality rate in Galicia was much lower than in the rest of Spain. On 30 June 2020, Galicia accounted for 4.2% of cases and 2.2% of deaths nationally, a percentage considerably lower than its demographic weight (5.7%). The cumulative number of cases per 100,000 inhabitants was 388.2, while the number of deaths was 22.9. The fatality rate was 5.9 deaths per 100 reported cases. A comparative analysis between the incidence of the virus in Galicia and Spain is shown in Figure 2.

The incidence of the pandemic was lower in Galicia than in the rest of Spain. This could be related to the special characteristics of the Galician settlement system. As argued in the main characteristics of population and mobility in Galicia, the Galician countryside is made up of a large cloud of villages with a high degree of dispersion and territorial overlap. The distance between them and the small number of inhabitants in each of these settlements means that there is less interaction between people than in other Spanish regions. Furthermore, in a large part of Galicia, these singular population centres are characterised by an internal structure that is not very compact. In the Galician countryside it is common to find single-family dwellings with adjoining areas for agricultural and livestock work. Thus, each individual dwelling usually has a plot of land surrounding the house and there is no continuity of construction between different family units. In times of pandemic, this resulted in less interaction between people from different family units, which undoubtedly contributed to a lesser extent of contagion.

Similarly, it is important to note that the degree of compliance with the guidelines, both mandatory and non-mandatory, provided by the health authorities in Galicia was very high, and higher than in other regions. The percentage of refuseniks and non-vaccinators was lower. This fact has logically helped to keep the volume of infection low. We believe that the degree of resilience of the Galician population is higher, and

the capacity to withstand isolation is also higher than in other parts of Spain (Carballosa et al. 2021, Miramontes Carballada and Balsa-Barreiro 2021b).
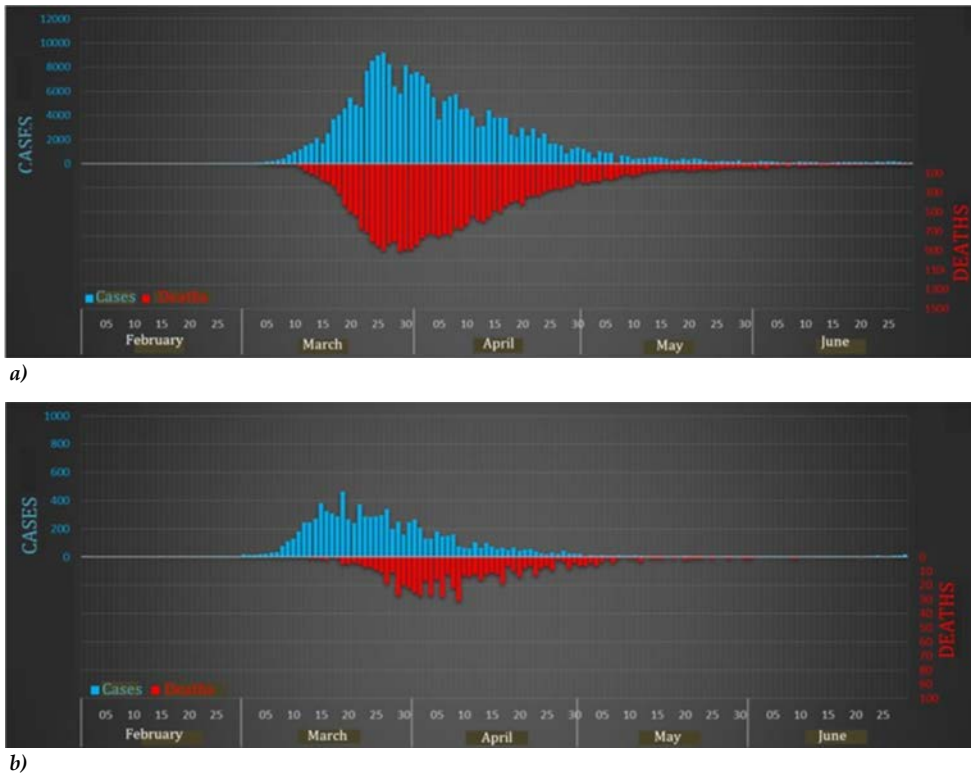

a)

b)

Figure 2. Incidence of COVID-19 in (a) Spain, and (b) Galicia during the first pandemic wave
Source: Centro Nacional de Epidemiología (2020)

Finally, it should be borne in mind that during the confinement and throughout the pandemic, many of the family homes in "la aldea" (as the traditional family home is called in Galicia, where several generations can still live together) or second homes became main homes. The ability to telecommute and the possibility of commuting a certain number of days to work were key factors in explaining this process. The choice was made to convert "village" housing or secondary residences into primary residences, and many people were provided with internet access in them, when before the pandemic they did not have it. Once again, the Galician particularity of the strong link with the land and the rural environment meant an important economic and social capital in reserve that implied a better situation a priori than in other territories to face the challenges of the pandemic (Miramontes Carballada and Balsa-Barreiro 2021b).

The analysed data indicate that the spread of the coronavirus is mainly associated with urbanisation. Most of the COVID-19 cases were concentrated in more urban Galicia. One out of two cases was registered in one of the seven main cities. Most were

concentrated along the Atlantic Urban Axis, which links five of the seven main cities. In fact, these five cities alone accounted for 36.9% of the cases. Outside this axis, the municipality of Ourense accounted for almost 10% of all cases, which in some way confirms the existence of a second axis of spread of the virus over the territory. As for urban municipalities, Lugo and Ferrol were the least affected with only 3.4% and 2% of cases respectively (Figure 3). It clearly shows a high incidence axis (N-S) in the westernmost sector of the region, and a secondary axis with a SE-NW direction, with less continuity, which would link the urban region of Ourense with the Atlantic Urban Axis. In general, the western and southern sectors of the region show much higher incidence patterns than the rest.
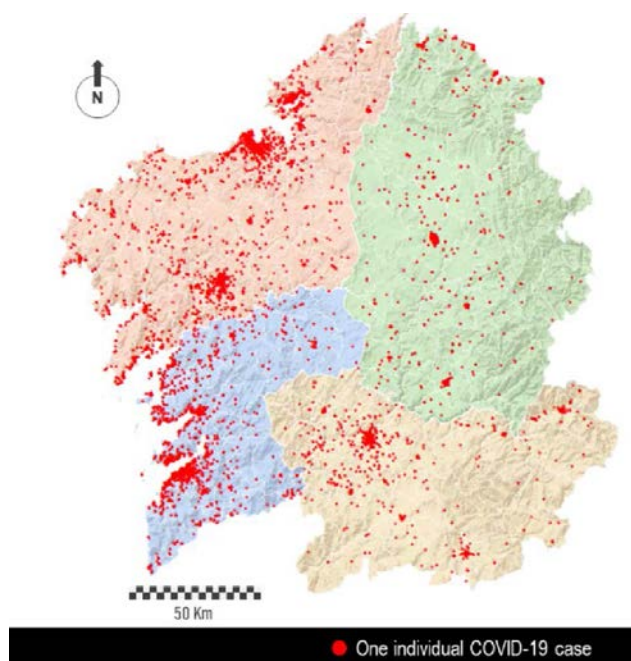

Figure 3. Territorial incidence of COVID-19 during the first pandemic wave
Representation of each of the registered cases by nodes. Each node corresponds to an officially reported case.
The geolocation of cases is based on the residence of the infected person. Source: SERGAS (2020)

As it can be seen in the map, the first thing that stands out is the absence of red dots in certain areas, which correspond to mountain areas. Particularly noteworthy are the Central Massif of Ourense and the Eastern Sierras of Galicia, as well as the lands of the Galician Ridge. On the other hand, the point cloud is denser in the surroundings of the main cities, and clearly outlines the Atlantic Urban Axis, which extends from Ferrol towards the Portuguese border. The correlation between the degree of urbanisation and the structure of settlements can be seen very clearly in the surroundings of the city of Ourense, southwest of the capital, where we find high population densities. In contrast to Ourense, the other provincial capital of inland Lugo, where there has been

practically no peripheral spread of urbanisation, the area is much more compact.

If we now look at the second map, drawn up with the heat islands, we can see perfectly well what we have just indicated, as well as the importance of the layout of communication routes in general and of the Atlantic Urban Axis, structured by the AP-9, in particular.

Results by municipality

Aggregating data by municipality allows for a clearer picture of actual incidence. Figure 4 shows how the impact is concentrated in the most important cities, but also in a number of adjacent municipalities. These municipalities concentrate most of the industrial and logistic activity in cities and a very important part of the residential land for many citizens who commute daily to work in the nearest cities. These are areas with great economic diversity and high levels of human mobility, being the origin and destination of a large number of daily commutes (Pazos-Otón et al. 2015, Miramontes Carballada and Balsa-Barreiro 2021b, Varela Cornado and Pazos Otón 2022).
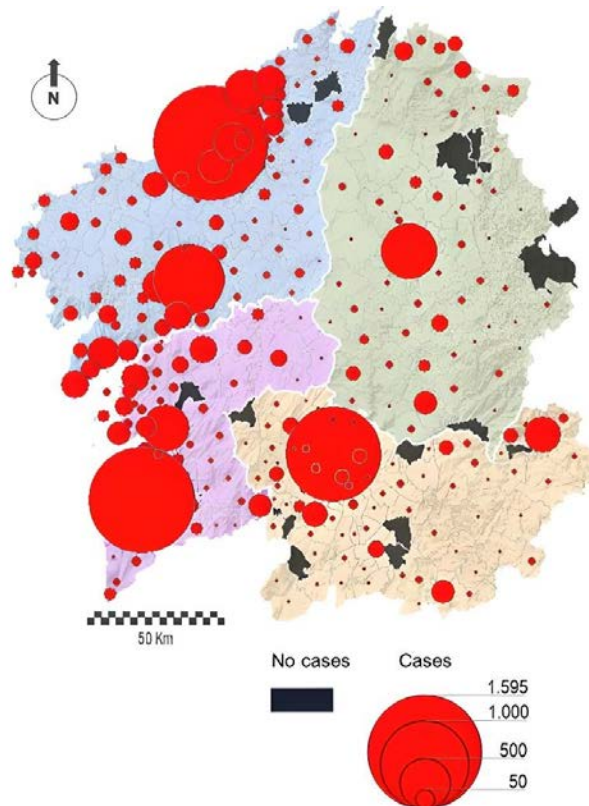

Figure 4. Territorial incidence of COVID-19 during the first pandemic wave.
Total number of cases at the municipal level. Source: SERGAS (2020)

In addition, the group of municipalities shaded in black are particularly significant, as they correspond to those municipalities in which no cases were recorded during the first wave. Most of these municipalities are located in mountain and high mountain areas, where the dispersion of the population centres is greater, as well as the absolute population itself and the population densities are among the lowest in Galicia. It is also interesting to note that many of those in the first quartile correspond to mid-mountain areas, with low population densities. These are the municipalities located on the border of the provinces of A Coruña and Lugo, mainly belonging to the mountainous area known as the Galician Ridge. This incidence per 100,000 inhabitants shows a much more heterogeneous territorial pattern, especially in the case of the province of Ourense, where many of the municipalities with higher and lower relative incidence are located.

The idea that COVID-19 was a pathology closely linked to the urbanisation process is confirmed if we take into account that the two municipalities with the highest cumulative incidence during the first wave are the two most populated. A Coruña concentrates 14.7% of the total cases and a cumulative incidence of 649.1 cases per 100,000 inhabitants. Vigo concentrates 12.1% of the cases and a cumulative incidence of 444.5 cases per 100,000 inhabitants. In Vigo, the spread of the virus extends throughout the entire urban area (Figure 5).
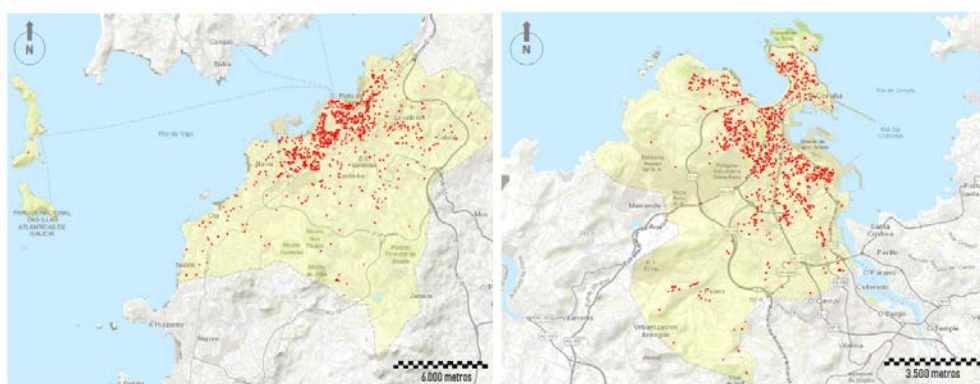

Figure 5. Cases of COVID-19 registered in the two most populated municipalities in Galicia
a) Vigo, b) A Coruña. Each reported case is represented by a red dot
Source: SERGAS (2020)

These two cities also correspond to the two main health areas of Galicia, and they have the most complete hospital, medical and care facilities in the region. However, the large number of cases registered in the two main cities of the Galician urban system meant that the emergency hospital care units reached some of the highest saturation levels in Galicia.

On the other hand, in the case of Vigo, it is interesting to note that the spread of the pandemic is much lower in the periurban areas than in the central city. The high

population density in the periurban areas surrounding the urban agglomeration is one of the most significant characteristics of Vigo. In all Galician cities it is a notable phenomenon, but it is in Vigo where we find a more important rururbano, with more than 70,000 inhabitants. This type of settlement is a hybrid between urban and rural spaces. The dwellings are located very close to the central city of Vigo, but their characteristics are more reminiscent of rural spaces. In most cases, the dwellings are single-family homes with adjacent agricultural or livestock plots. Evidently, this minimises population interactions, which reduces exposure to contagion.

For future work, it would be interesting to relate the level of e-commerce use in times of pandemic to the level of urbanisation. Given that urban areas have a higher penetration of broadband and greater use of the internet, it seems logical that they would have made greater use of e-commerce to stock up on basic (and secondary) products during the hardest moments of confinement. Similarly, urban spaces are characterised by a younger demographic structure, another variable that correlates positively with the use of the internet and e-commerce in particular.

From a territorial perspective, the highest virus rates were concentrated around major cities with high population densities. In addition, these same suburban areas are home to most of the industrial and logistical poles. These are areas with a relevant economic diversity and high levels of human mobility, being the origin and destination of a large number of daily commutes. Figure 6 shows the change in mobility due to the impact of the virus and the implementation of restrictions by the central government. It can be seen that many of the patterns of the spread of the virus partially correspond to the predominant direction of presented mobility flows.

The summary of these mobility datasets corroborates to the fact that the largest reduction in mobility occurred in April 2020. According to origin and destination flows, the number of flows and total distance travelled decreased by around 55 per cent and 60 per cent, respectively, in April 2020 compared to November 2019. The recovery was very slight in May, and even in June, while mobility was still about 25 per cent lower than in November 2019. In terms of the average distance travelled per trip, it can be seen how this fell considerably from 7.8 km to 7 km on average at the most severe time.

The mobility maps based on origins and destinations actually show this drop in absolute mobility flows from November 2019 to March 2022, and a recovery is also observed in the third moment – June 2020. Between the first and second moment, not only the weakening of flows is striking, but also the reduction of arcs and linked nodes. Topologically, the network is simpler.

One could say that there is a shift from a classical "network" model of relationship to a more "Christallerian" model, based on the primacy of central places, which regain their nodal character by eliminating non-relevant displacements.
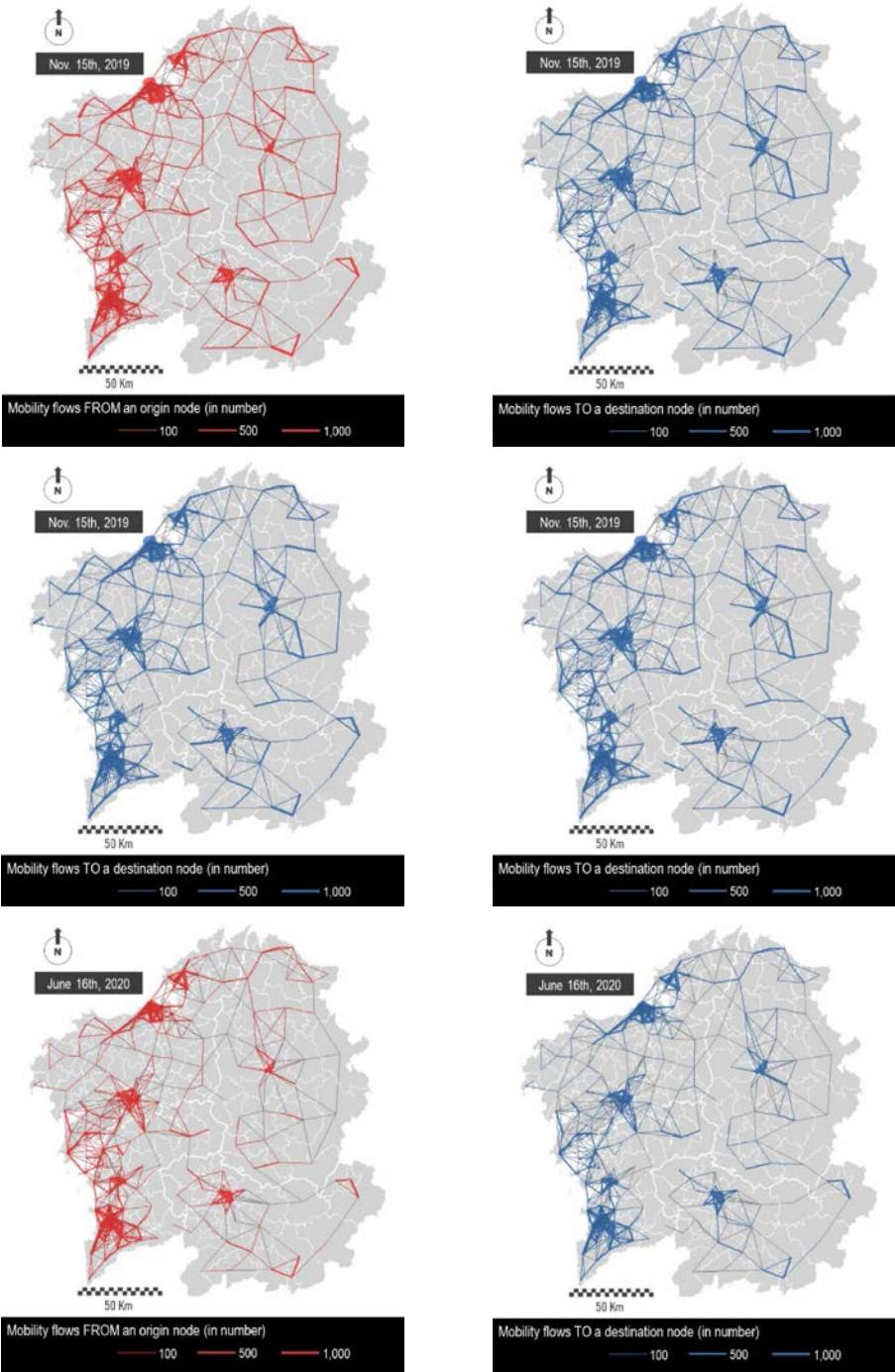
Figure 6. Mobility flows during the COVID-19 pandemic. In red, the flows are represented considering an area of origin mobility. In blue, the flows are represented considering a destination mobility area .
Source: INE (2021)

In other words, in a normal situation, the reasons for movement increase, leading not only to more mobility, but also to a diversification of origins and destinations. Confinement, and the mobility restrictions that it brought with it, implied a simplification of main mobility patterns, which can be seen in the mapping presented here.

Discussion

The emergence of the COVID-19 pandemic in 2020 required the forced adoption of non-pharmaceutical interventions and other measures by the national authorities. Similarly to other pandemics in the past, these mainly focused on social distancing and major constraints to human mobility. In this paper, we analyse the relationship between human mobility and the spread of COVID-19 during the first wave (March to June 2020) in the region of Galicia. For this purpose, we use detailed data on all reported infections and mobile phone data (Miramontes Carballada and Balsa-Barreiro 2021a).

The results show a clear correlation between the reduced mobility and the reduced transmission over time. On a larger scale, territorial complexity and regional specificities explain differences in virus transmission, but also uneven mobility rates across the region. Ideally, policy makers and health authorities should design interventions and responses to the current COVID-19 pandemic, or any other potential future infectious disease, according to the particularities and the geographical complexity of each region (Flandoli et al. 2021).

Mobility restrictions should be based on territorial characteristics and take into account the territorial heterogeneity at different scales. The authors would encourage a better communication between different levels of governments and authorities, as well as the free availability of detailed data that could help achieve the most optimal responses, which in turn would result in better management for society as a whole (Desjardins et al. 2020, Dong et al. 2020, De Cos Guerra et al. 2021). Future studies should focus on disentangling the correlation between human mobility and the spread of the virus at any spatial scale and attempt to resolve the territorial complexity and intrinsic mechanisms behind it.

Conclusions

In mid-March 2020 in Spain, the national authorities declared a State of Alarm, a constitutional mechanism allowing for the concentration of powers in the executive, in order to take swift action to tackle the spread of the coronavirus. The State of Alarm was subsequently renewed periodically by the Congress of Deputies. On 14 March, a house lockdown with strict mobility restrictions was decreed. Work activity was reduced to very few essential activities related to human care and the purchase of

primary commodities. Between 30 March and 9 April, only essential workers were allowed to travel for work. Most businesses related to non-essential activities, as well as cultural and religious facilities, were closed.

As discussed in the previous chapter, Galicia was the first Spanish region to ease mobility restrictions and return to pseudo-normality. This was done in four different phases. On 4 May, some businesses and activities were authorised, mostly outdoors. Two weeks later, restaurants and some shops could be opened, but with some partial restrictions on capacity. Human mobility was limited in each province. On 15 June, the region began a "new normal" with no restrictions on mobility.

In this context, the first cases of the virus detected in Galicia were imported from other regions of Spain, especially Madrid, which was initially the main focus of infection. Transmission flows were determined by land transport routes and the radial design of infrastructures with Madrid (Balsa-Barreiro et al. 2019). The significant difference in the levels of virus incidence in the two eastern provinces, which have similar demographic structures, could be explained by this radial road design and the relationship of the provincial capitals with the Atlantic Urban Axis, being much more intense in the Ourense-Vigo axis.

As the virus circulates within the system, internal mobility flows and territorial structure are determinant for understanding the actual spread of the virus. The temporal analysis of human mobility allows us to verify the dynamic correlation between the virus and its territorial impact.

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Aims & Scope

Urban and regional questions are crucial in understanding the present territorial conditions. From the World Bank's 'rediscovery' in its 2009 Report of the potential of cities in encouraging economic growth, to the multiple ways in which cities are being drawn into the processes of neoliberalism, to the dynamic growth of cities in the developing countries in Asia far out stripping the scale of cities in the older urbanized nations – everywhere there are signs of a rapidly changing urban condition. The same is true for the regions where 'old questions' of regional economic disparity and uneven development are being given a new twist as economic globalization impacts the national and local arenas.

JURA, the Journal of Urban and Regional Analysis, working as an Open-access journal (with two issues/year, in **April and in October** - starting with 2023; previously annually publishing in June and in December, for the period 2009-2019), was launched as a response to the exciting world of urban and regional research emerging in reaction to these changes happening in the real world.

JURA represents the initiative of the Interdisciplinary Center for Advanced Research on Territorial Dynamics (CICADIT) at the University of Bucharest working in collaboration with Ronan Paddison at the University of Glasgow, for the period 2009-2020. Starting with 2021, JURA is also supported by the Professional Association of Romanian Geographers (APGR). While the intention is that articles published by JURA will draw on examples throughout the world, particular emphasis will be given to urban and regional change as it is being experienced in Eastern Europe.

Transitional economies, and urban and regional shifts in the region since the end of the socialist regimes have been profound. The socialist regime had its particular effects on the regional economy and the cities, linked with structures that, in many ways, were very different from the trends apparent in Western Europe in the post-World War II period. Since 1990, change has been swift, challenging our theoretical understanding of the processes; for example, it is plausible to transport theories of contemporary urban change under neoliberalism developed in the advanced economies to the transitional economy. The legacy of the socialist regime, its imprint on the city physically and socially, provides further reason to suppose that urban (and regional) development in transitional economies is distinctive. These differences re-emphasise a consistent axiom underpinning the study of cities and regions: that if it is possible to point to broad theories that apply across different regions of the world, they often need to be modified taking into consideration the local conditions.

Though JURA is primarily concerned with looking at urban and regional change in the transitional East European economies, case studies exploring similar problems but in other parts of the world are certainly parts of the journal's agenda. The remit of the journal is emphatically interdisciplinary. The analysis of the urban and regional conditions needs to be interdisciplinary. Urban and regional researchers usually tend to belong to a discipline reflecting their training whether as sociologists, geographers, urban planners or any number of subjects concerned with the study of space and place. Our training very often endorses an appreciation of how other disciplines explore the city and the region. For the journal, the acknowledgement of the many disciplines that are concerned with understanding cities and regions will be indicated by the different disciplinary backgrounds reflected in the published papers. Articles will be published by geographers, sociologists, urban planners, economists, political scientists, to mention just a few of the scholars involved in the urban and regional study.