Chapter 20
Metropolitan Spatial Reconfiguration and the Mobility Transition: Sustainability Challenges in the Fragmented City

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Abstract Within the context of the European Commission's Sustainable and Smart Mobility Strategy for a transition to a green, smart, and affordable transport system, local governments of large cities have implemented private vehicle restriction policies. However, do these policies come into conflict with current metropolitan suburbanisation spatial trends? (i.e. the fact that a growing share of the urban population is residing in increasingly large and fragmented metropolitan peripheries). First, this text reflects on the reasons for the spatial reconfiguration of urban and metropolitan areas; the consequences of these changes on daily mobility; and the design of European and local policies for the transition to sustainable mobility, which—this is our hypothesis—can collide with the present population and residential mobility trends in urban cores and their peripheries. This hypothesis is verified in the second part of the chapter, taking the region of Madrid as a case study. Results show that population suburbanisation trends in the last decades have led to an increase in daily mobility, and particularly, in the use of private vehicles, despite policies hampering their use and promoting public transport.

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20.1 Introduction

The aim of this chapter is to analyse the apparent contradiction between, on the one hand, the political interventions that local governments have planned and implemented seeking a transition towards more sustainable mobility—for instance, encouraging the use of public transport and of the so-called 'active mobility' (walking, cycling, etc.)—and, on the other hand, population and migration trends observed in urban/metropolitan areas over the last decades. The initial idea is that the spatial reconfiguration of large metropolitan areas is currently determined by the diversification of mobility and migration flows, leading to an increasingly fragmented city from the social, economic, and demographic perspective. Focusing on population, residential mobility towards urban cores, and other phenomena such as gentrification, touristification, and the replacement of the native population by foreign immigrants, have increased in the last decades. However, the magnitude of these centripetal flows is still smaller than that of those towards the suburban peripheries, where medium- and low-density urban sprawl grows. These centrifugal flows, known as decentralisation or suburbanisation, are mainly residential in nature and driven by families (adults and their children) who seek housing that meets their economic, environmental, or status expectations. The initial hypothesis is that suburbanisation trends—which potentially imply an increase in the number of movements, the time spent in them, and the distance travelled, and also a greater use of cars—counterbalance policies for a transition to a more sustainable mobility. In fact, this may lead to their failure, at least in suburban peripheries. Thus, we believe that urban population change and residential mobility trends should be taken into account when elaborating local mobility plans. This would enable to predict how metropolitan spatial reconfiguration will condition daily mobility and the use of different means of transport in the near future. This chapter shows the challenge of implementing the transition to sustainable mobility in a specific metropolitan reality, that of post-Fordist neoliberal capitalism, which is increasingly spatially diversified and fragmented. This is done by using the metropolitan region of Madrid as a case study, and by analysing its demographic (population growth in the urban core and the peripheral areas) and daily mobility data.

20.2 Urban Spatial Reconfiguration and Its Impacts on Mobility in a European Framework to Combat Climate Change

20.2.1 Mobility as a Determinant of Urban Growth and Its Spatial Differentiation

Studies on the spatial structure of urban areas from the point of view of the population's demographic and social characteristics have a long tradition in urban geography and sociology. Whilst the sociological tradition originates in the Chicago School (Burgess, Park, McKenzie, etc.), geodemographic studies have been influenced by the stages of urban development model developed by Hall, Berry, Champion, Fielding, Klaassen, Van den Berg, and others. In short, the model intends to explain the population growth of urban cores and peripheries in four stages—urbanisation, suburbanisation, counterurbanisation (or deurbanisation), and reurbanisation, that repeat in a cyclical way. This mechanistic model, still being used as a classificatory framework for present urban areas (Wolff 2018), has been criticised by several authors, as it often does not fit into empirical evidence. For instance, as the model does not incorporate contextual economic factors—which would for instance explain the existence of shrinking cities (Bagchi-Sen et al. 2020; Haase et al. 2021)—the model cannot shed light on why diverse urban areas of the same country can be at different stages of the cycle. In addition, the fact that several urban areas have suburbanised whilst their urban cores have continued to grow also shows the limits of a model that treats cities as closed systems, and does not consider the increasing role of external migration in the growth of urban cores and peripheries.

However, the role of mobility in its different forms—not only international migration but also internal migration, intra-metropolitan residential mobility, and daily trips—is increasingly relevant. Indeed, so is its impact on the growth, and the spatial differentiation of urban areas (Gil-Alonso et al. 2021), and on the demographic and the socio-economic characteristics of their population (Rees and Sander 2019). Thus, a proper understanding of the changes in the spatial structure of urban areas and of their social and economic consequences, requires an analysis of spatial mobility, distinguishing the different flows that compose it. For example, foreign immigrants tend to settle in urban cores alongside the 'creative class' (Florida 2017). By contrast, young families prefer to move to suburban peripheries (Rérat 2020), forming large low-density neighbourhoods (Garcia-Coll and López-Villanueva 2018) with distinctive demographic, sociological, or political features (Dioni 2021).

20.2.2   Structural and Temporal Factors of Mobilities in Urban Areas

Mobility patterns—and thus population growth and decline in (and within) urban areas—cannot be explained by a closed cyclical urbanisation model, but by a series of internal and external factors acting on them and making sense of who moves and who does not. Some of these factors are temporary whilst others are structural, such as a population's composition by age and sex and the type of households they form. These characteristics influence residential moves related to biographical events, that is, life-course transitions (Clark 2016; McCollum et al. 2020). Household and family transformations associated with the Second Demographic Transition model also entail an increase in residential moves deriving from changes in living arrangements (Mikolai and Kulu 2020). This could lead to the hypothesis that residential mobility has increased worldwide, in comparison to former decades. However, this is not true for all types of mobility or for all geographical contexts (Shuttleworth et al. 2021). In some developed countries, mobility rates are currently lower than in previous decades (Champion and Gordon 2021). In Spain—as in southern and eastern Europe—residential mobility levels are lower than in northern and western Europe (Rowe et al. 2019) and continued to decline further during the recession years (Bayona and Pujadas 2020). This was the consequence of fewer foreign immigrants—who move more frequently than Spanish people—arriving in Spain, and of fewer young natives leaving their parental homes and starting new families. Even though the first cause has been reversed in the post-crisis period, the second has not, because smaller cohorts have reached the age of leaving parents' households.

Amongst the temporary factors, phases in the economic cycle influence urban growth and decline in multiple ways: directly, by affecting both migration and natural growth—through fertility changes—and indirectly, by their impact on the labour and housing markets.

The labour market and, more specifically, the impact of economic cycles on labour insertion levels of both Spanish workers and foreign immigrants has influenced the spatial distribution of urban population through diverse types of mobility. International migration was the main cause of urban population growth during the economic expansion years (since the mid-1990s to 2007) and was one of the main factors in population redistribution within urban areas (Otero-Enríquez et al. 2019). Some of the immigrants left during the economic crisis (2008–2014), but inflows have resumed in the post-crisis period (2015–2019). Changes introduced by the COVID-19 pandemic and the extent to which previous international flows will recover remain to be seen. This will depend on Spain's capacity to generate employment and attract population (Esteve et al. 2021). In labour markets described as 'dual'—using Piore's (1979) words—foreigner flows will very probably recover, especially in the case of Spain, where most foreign immigrants work in occupational niches within low added value economic sectors (Moreno-Colom and López-Roldán 2018).

The relationship between economic cycles, the labour market, and mobility within urban areas—intra-metropolitan flows—and its spatial consequences, seems to be

even more complex, as it is influenced by local factors. In general terms, suburbanisation is the dominant process during economic expansion phases, whilst recentralisation was relatively more common during the last economic crisis period. This latter phenomenon could be explained by the fact that peripheries had higher unemployment levels than metropolitan cores, as industrial employment and construction were more important in the former (Rodríguez and Pozo 2019). Additionally, the stock of rental housing is larger in urban cores and these areas also have denser public transport networks. As suburbanisation reduced during the economic crisis, differences in growth between urban cores and peripheries also did so (López-Villanueva and Pujadas 2015). The post-crisis has also influenced migration flows, though in the opposite direction, by leading intra-metropolitan mobility to increase and, as consequence, to an upsurge in suburbanisation. However, given the extent of population ageing and fertility decline, this new periphery growth period is not expected to be as strong as that before 2008. In fact, urban cores have continued to attract certain types of population during the post-crisis period (Gil-Alonso et al. 2021).

The housing market is also influenced by the moment in the economic cycle, and by other institutional mechanisms such as access to mortgages and public policies regarding housing (López-Colás et al. 2021). In Spain, some specific groups, such as young people and immigrants, find it particularly difficult to access housing. Their problems have worsened in the post-crisis period, because housing purchase and rental prices have increased, especially in large cities, because of financial globalisation. Instead of satisfying a basic need, housing has become an attractive investment for small investors and especially for large funds (Méndez 2021), intensifying gentrification in some neighbourhoods of large cities (Alexandri and Janoschka 2020). Tourist pressure or 'touristification' is another factor to be considered (Cócola-Gant and López-Gay 2020): it is the reason why part of the housing stock is no longer used for residential purposes but for tourism demands, consequently reducing the housing supply and increasing its prices. All these processes related to housing affordability have increased residential mobility and displaced residents with less purchasing power from urban cores, particularly from those neighbourhoods most affected by gentrification, to the periphery. Therefore, residential mobility has been acting as a way to relocate people by social class, income, or educational level (López-Gay 2018).

20.2.3 Diversified Daily Mobility in Increasingly Fragmented Cities

The suburbanisation of low-income groups—which some authors call the 'suburbanisation of poverty' (Hochstenbach and Musterd 2021; Porcel and Antón, 2020; Bailey and Minton 2018)—partly explains the renewed immigrant and native suburbanisation flows in the post-crisis period. Simultaneously, another form of precarious housing, that of sublet rooms, has gained force in urban cores and the first

metropolitan rings (Orozco et al. 2022). As these authors claim, it is the only way for the most precarious groups, particularly foreign immigrants, to access housing. This confirms that rather than a suburbanisation of poverty or a simplistic dichotomy between affluent urban cores and deprived peripheries, there would be a 'fragmentation of poverty'. In other words, vulnerable areas and also those occupied by high-income groups are growing both in urban cores and peripheries, in contiguous and even overlapping areas.

These complex socio-residential patterns, within this growing inequality context (Piketty 2019), respond to what authors such as Florida (2017) call a 'new urban crisis'. Indeed, residential mobility plays an essential but extremely complex role in the social reconfiguration of metropolitan spatial interactions, generating new 'fragmented' areas (Borsdorf and Hidalgo 2009). However, socio-spatial fragmentation—with growing segregation, polarisation, and the creation of new vulnerable areas—is not the only form of urban fragmentation in the twenty-first century. It is also occurring for environmental reasons, as in the case of the 'return to the countryside', observed during the COVID-19 pandemic. In 2020, urban areas lost population and some rural ones gained it. More specifically, those municipalities close to (or well connected to) urban areas, and those that had many secondary homes having become the main place of residence, were those that benefited the most (González-Leonardo et al. 2022). Leaving the temporary nature of this counterurbanisation caused by the COVID-19 pandemic aside, a prediction can be made. Due to teleworking and the improvement of transport infrastructures, metropolitan areas will extend increasingly further away from the core city, so that the transitional spaces between what is considered urban or rural will be increasingly blurred and fragmented.

Simultaneously, demographic fragmentation, because of the diversification of population and household structures, is also occurring and generating spatial impacts. For instance, gentrified urban cores are being able to attract youth and young adults. In the coming years, working-class neighbourhoods built in the 1960s and 1970s will be rejuvenated, as its population, which is becoming increasingly elderly, will gradually be replaced by a younger one, mainly international immigrants. Similarly, many low-density suburban housing developments, where young families settled a few decades ago, will also be affected by ageing in the future.

Finally, an economic fragmentation is also taking place and is introducing spatial changes in production, distribution, and consumption, which the COVID-19 pandemic has intensified. Yet, the impact of the skyrocketing growth of e-commerce (that has increased the areas devoted to logistics) and of the expansion of teleworking on urban spaces is difficult to predict. The tendency of shops in the centre of large cities to specialise may intensify, ensuring their survival, but, at the same time, the crisis of retail shops in non-central neighbourhoods and of suburban shopping malls will deepen (Guimarães 2019; Townsend et al. 2017). These spatial consequences could affect both commuting and daily trips to consumption and leisure centres. In sum, urban reconfiguration for environmental, demographic, social or economic reasons will change daily mobility and the way modes of transport are used, although these impacts will vary by sex, age, place of residence (in the core city or in any of the peripheral rings), and social class.

20.2.4 *Local Policies Promoting the Transition to an Urban Sustainable Mobility*

Within the global climate change context, large cities have been promoting policies to protect the environment and reduce greenhouse gas emissions, for several decades. Policies are mainly based on reducing the number and the use of cars, as urban transport accounts for 40% of total road transport in the EU, and their emissions are now higher than in 1990. Moreover, the pollution it generates is believed to be responsible for around 400,000 premature deaths in Europe per year (Bernardo et al. 2020). These local and metropolitan policies accelerated when the Sustainable and Intelligent Mobility Strategy was launched by the European Commission (2020), with the aim to make modes of transport more sustainable, whilst improving the health of the population. This strategy is part of the European Green Deal that aims to achieve an ecologically and socially just transformation towards a climate-neutral development model (net-zero target) by 2050 (European Commission 2019).

Within this policy framework, and the context set by COVID-19 pandemic, which has reduced mobility and introduced major changes in the use of urban transport, European cities have accelerated policy actions to reduce air pollution and congestion levels. This has been done along three axes:

a) the promotion of the use of public transport, car sharing, and micro-mobility (bicycles, motorised, or electric scooters), better adapted to short-distance daily trips (Gragera 2021);

b) 'tactical urbanism' or the intervention on the physical urban space by the reduction of private vehicle lanes, the extension of bus lanes and those for the exclusive use of bicycles and skates, the enlargement of pavements or the creation of pedestrian streets, thus implementing the so-called 'low traffic neighbourhoods' (Leach 2021). These are areas that reduce car traffic by restricting circulation (through speed limits, changes in the direction of traffic, or road closure to private vehicle, amongst other measures); and

c) the implementation of traffic restrictions by the prohibition of polluting vehicles in urban cores. In this sense, Madrid is one of the more than 300 European cities that has opted to ban the circulation of the oldest and most polluting vehicles by implementing the Madrid Central Low Emission Zone (LEZ) in 2018. The new municipal government has renamed this LEZ as *Zona de Bajas Emisiones de Especial Protección* (ZBEDEP according to its acronym in Spanish) *Distrito Centro* (Ayuntamiento de Madrid 2022) or, Low Emission Zone of Special Protection, Central District, in English. This LEZ is like the one implemented in Barcelona on 1 January 2020, called ZBE-*Rondes*. Though LEZs have shown to be effective in combating pollution, only tolls on vehicles entering the city—a mechanism implemented in several European cities such as London, Stockholm, or Milan—reduce congestion (Simeonova et al. 2019; Gibson et al. 2015). In fact, whilst LEZs reduce traffic in urban cores, they increase congestion in the surrounding areas.

This text aims to be a useful exercise to develop public policies such as those mentioned above, intending to diminish pollution in cities by reducing the use of cars. However, we believe that they may miss their target if they do not consider population and spatial trends in urban reconfiguration, as we underline in the following section using the case study of the metropolitan region of Madrid.

20.3   The Case Study of the Region of Madrid

20.3.1   Definition of the Study Area and Data Sources Used

This chapter uses the metropolitan region of Madrid as a case study. There are several ways of defining its boundaries. One is the 'Functional Urban Area' (FUA) delimitation used in the *Indicadores urbanos* (urban indicators) published by the Spanish National Statistics Institute (INE). However, it does not provide up-to-date data on journeys and modes of transport. Therefore, we chose to use the population and transport data published by the Community of Madrid's Household Mobility Survey (*Encuesta Domiciliaria de Movilidad*, EDM) in its 1996, 2004, and 2018 editions. The survey covers the entire Autonomous Community of Madrid (CAM), made up of 179 municipalities. It is very similar, from the spatial and demographic point of view, to the Madrid FUA—though the FUA includes some municipalities in the bordering provinces of Toledo, Avila, and Guadalajara, and excludes others in the northern, eastern, and western parts of the CAM—for this reason, the CAM is used here as the equivalent of the metropolitan region of Madrid.

The main advantage of this source is that it publishes population and transport data for four transport rings. Population data come from the 1996, 2004, and 2017 *Padrón continuo* (continuous local register), which provides official annual population data for each municipality. As for those on movements and modes of transport, they proceed from EDM surveys, which in the case of the 2018 one was done to 10,000 households or 50,000 people. All this information allows us to analyse changes in both variables for the central city (the municipality of Madrid) and its periphery (178 municipalities). In fact, the city of Madrid is divided into two rings: *Madrid Almendra* (Madrid core districts) and *Madrid Periferia* (rest of the city districts). The first, with 981,000 inhabitants in 2017, covers Madrid's most central districts, inside the M-30 ring road. As for *Madrid Periferia*, it includes the districts within the municipality of Madrid but outside the M-30, so it is located around the city core, and had 2,201,937 dwellers in 2017. Those municipalities belonging to the periphery of Madrid are also divided into two rings: the *Corona Metropolitana* (inner ring) and the *Corona Regional* (outer ring). The first, which is made up of the 49 most densely populated municipalities located closest to the city of Madrid, forming its inner ring, had 2,847,633 residents in 2017. Concerning the *Corona Regional*, which consists of the remaining 129 municipalities of the CAM, creates a less densely populated
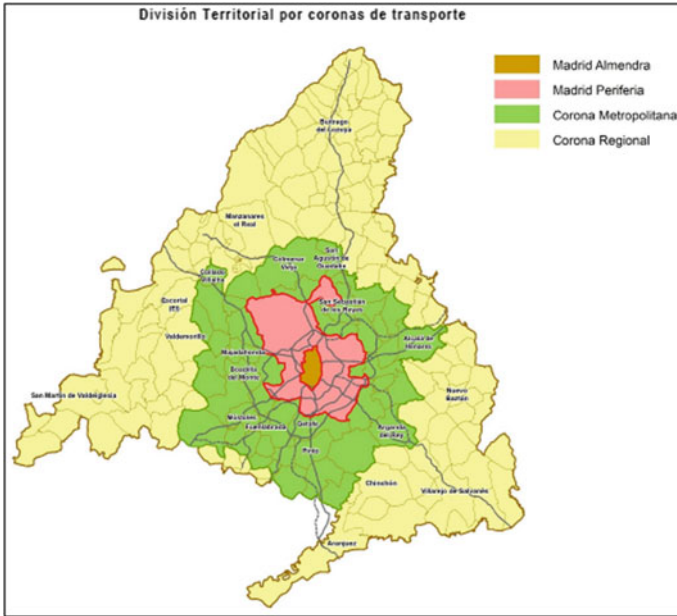
Fig. 20.1 Map showing the four metropolitan rings in the Community of Madrid, used by the EMD surveys in 1996, 2004, and 2018 (*Source* CRTM (2019), p. 3)

outer ring of municipalities situated further away from the core city, with 476,570 inhabitants in 2017 (Fig. 20.1).

20.3.2   Population Changes: The Growing Suburbanisation of Madrid's Population

Table 20.1 shows that suburbanisation grew throughout all the periods analysed. The population of periphery rings increased, and particularly that of the municipalities situated furthest away from the city, which almost doubled their residents between 1996 and 2017. In fact, the further out a municipality was situated, the more it grew.

Similarly, inside the city of Madrid, the population of the districts situated outside the M-30 grew more than core city ones, which lost population between 2004 and 2017 (population data published in the 2018 EDM correspond to the *Padrón* as of 1 January 2017). Therefore, in 2017, 7.3% of the population lived in the *Corona Regional* or outer ring, which means a significant increase with respect 1996, when less than 5% of the population resided there. In 2017, the highest share corresponded to the *Corona Metropolitana* or inner ring, as almost 44% of the population of the Community of Madrid lived in it, compared to 38% in 1996. As a result, the population of the city of Madrid represented less than half of the total of that of

Table 20.1 Absolute and relative (%) population by residential rings in the Community of Madrid, 1996, 2004, and 2017

Ring of Residence	Population 2017	% Population 2017	Population 2004	% Population 2004	Population 1996	% Population 1996	Population change (%) 1996–2004	Population change (%) 2004–2018
Madrid core districts	981.044	15,1	1.018.732	17,5	915.318	18,2	11,3	-3,7
Rest of the city districts	2.201.937	33,8	2.116.513	36,3	1.951.532	38,9	8,5	4,0
Inner ring	2.847.633	43,8	2.348.884	40,3	1.913.804	38,1	22,7	21,2
Outer ring	476.570	7,3	342.143	5,9	241.635	4,8	41,6	39,3
Community of Madrid	**6.507.184**	**100**	**5.826.272**	**100**	**5.022.289**	**100**	**16,0**	**11,7**

Source CRTM (2019, Table 3 and Charts 1 and 2, p. 10) and CRTM (2005, Table 11, p. 15)

the CAM (48.9% in 2017), whilst in 2016 it constituted well above half of it, i.e. 57.1%. In fact, this was so despite the arrival of a significant number of international immigrants to the urban core and the municipalities closest to Madrid. Yet, they were not able to compensate for the outflow of Spanish-born inhabitants who moved from the central areas to the peripheral municipalities (Gil-Alonso et al. 2021). The impact of this increasing suburbanisation on the daily mobility of the Community of Madrid's inhabitants, and their use of different modes of transport, will be analysed in the following section.

20.3.3 Daily Mobility Trends: The Increasingly Dominant Use of Private Vehicle

According to the 2018 EDM, the inhabitants of Madrid have made an average of 2.44 trips per person per day, diminishing by one-tenth those of 2004. In fact, there are hardly any differences between residential rings (Table 20.2). As for the number of journeys per household, a growing centre-periphery gradient can be observed, as households are larger in the periphery (where families with children have settled) than in the core city, where there are more one-person and single-parent households.

Concerning the mode of transport, active mobility users (those travelling on foot or by bike, the latter being included in the category 'other') stand out in the city of Madrid, and especially in the core districts. There, 40% of all trips were made on foot, and almost 5% by other means of transport (Table 20.3). By contrast, cars were dominant in the inner and outer ring. In the city of Madrid, more people used public transport than cars though in the outer districts of the city (outside the M-30) both

Table 20.2 Population, daily trips, and number of daily trips per person and per household, by residential rings, in the Community of Madrid, 2018

Ring of Residence	Population	Number of journeys	Number of journeys / person	Number of journeys / household
Madrid core districts	981.044	2.402.684	2,45	5,22
Rest of the city districts	2.201.937	5.325.948	2,42	5,84
Inner ring	2.847.633	6.957.688	2,44	6,75
Outer ring	476.570	1.160.947	2,44	6,83
Community of Madrid 2018	**6.507.184**	**15.847.266**	**2,44**	**6,16**
Community of Madrid 2004	**5.782.072**	**15.173.407**	**2,55**	**7,18**

Source CRTM (2019, Table 3 and Chart 19, p. 20 and 22) and CRTM (2005, Table 18, p. 20)

Table 20.3 Distribution of daily trips by residential rings and by mode of transport in the Community of Madrid in 2018, comparing the total regional shares to those of 1996 and 2004

Ring of Residence	On foot	Public transport	Private vehicle	Others	Total
Madrid core districts	40,0	34,8	20,3	4,9	100,0
Rest of the city districts	32,2	32,8	32,4	2,6	100,0
Inner ring	34,0	16,4	47,7	1,9	100,0
Outer ring	29,6	10,8	56,2	3,4	100,0
Community of Madrid 2018	**34,0**	**24,3**	**39,0**	**2,7**	100,0
Community of Madrid 2004	**31,0**	**32,0**	**34,0**	**3,0**	100,0
Community of Madrid 1996	**37,0**	**32,0**	**28,0**	**3,0**	100,0

Source CRTM (2019, Table 4 and Chart 26, p. 30)

modes of transport were used similarly. From a time perspective, the proportion of trips made by public transport has decreased since 1996, whilst the use of cars and walking has increased significantly since 2004.

Comparing the Community of Madrid and the Metropolitan Area of Barcelona (Gil-Alonso et al. 2022), it is worth noting that active mobility was more frequently used in Barcelona (representing around 50% of all trips). In Madrid, it only accounted for just over a third of all moves. Daily trips by public transport represented around a quarter of the total in both metropolitan areas, though they became slightly less important compared to previous years. As for those by car, they grew more than those by sustainable means of transport, accounting for almost 40% of the trips in the Madrid region, but only a quarter in the Catalan metropolis.

20.3.4 Characterisation of the Different Types of Mobility: Seeking Why the Use of Public Transport Diminishes

In Madrid, walking was especially popular amongst retired people, women, children, and teenagers (i.e. students). The latter three have also been the main users of public transport, whilst adult men (aged 30–59 years), particularly workers, are those that mainly use private vehicles (Table 20.4).

As a consequence of an increase in commuting because of the post-crisis economic recovery, the percentage of car users has risen. In fact, despite the diminution of the ratio of jobs per inhabitant from the centre to the periphery (0.96 in the core and only 0.27 in the outer ring), employments have tended to centrifuge, in the last decades. Whereas the core districts concentrated almost 40% of jobs in 1996, this percentage has dropped to less than 30% in 2018. By contrast, it has risen from 29 to 35%, in the inner ring, in the same dates (Table 20.5). Therefore, suburbanisation and gradual population ageing (fewer young people and concentration of baby boomers at adult ages), together with economic recovery (more commuting), and a growth of jobs in

Table 20.4 Daily trips by sex, age, and occupation, and their distribution by mode of transport in the Community of Madrid, 2018

Ring of Residence	On foot	Public transport	Private vehicle	Others	Total
Male	31	21	44	4	100
Female	36	27	35	2	100
4–13	51	8	38	3	100
14–17	44	29	22	5	100
18–21	24	57	17	2	100
22–29	20	43	34	3	100
30–39	26	23	48	3	100
40–49	25	19	53	3	100
50–59	28	24	45	3	100
60–64	40	22	36	2	100
65–74	49	25	25	1	100
> 74	58	25	14	3	100
Worker	20	26	51	3	100
Unemployed	47	18	33	2	100
Student	42	26	29	3	100
Retired	51	23	24	2	100
Ohers	52	15	32	1	100
Community of Madrid 2018	**34**	**24**	**39**	**3**	100

Source CRTM (2019, Charts 29, 30, and 31, p. 32 and 33)

peripheral municipalities, have led to an increase in the use of private vehicles and a diminution in that of public transport in the Community of Madrid.

Why does the use of public transport diminish because of population and economic suburbanisation? Peripheral areas are generally less densely populated (Garcia-Coll and López-Villanueva 2018), so the distance travelled between the place of residence and work/study grows as the distance to the central city also does. Indeed, the average distance of each trip, or of the set of trips made by an average person, triples between those living in core districts and those doing it in the outer ring (Table 20.6). In fact, because of the lower density, the accessibility and efficiency of public transport diminishes as distance from the core districts increases. Thus, this should also result in an increase in the average time travelled. However, this is not so (Table 20.7). The average daily travel time was 29 min in 2018, only two more minutes than in 1996. When all the trips made by one person per day are added (on average, about 2.4 trips per day) the figure rises to 69 min. Surprisingly, these times are similar regardless of the area of the Community of Madrid where people live, and this is also the case for walking and car trips. The only visible difference is their duration by public transport, which increases as the distance does when the trip to be done is short. Therefore, in the municipality of Madrid, people choose to walk when the

Table 20.5 Population and job distribution by residential rings in the Community of Madrid, 1996, 2004, and 2018

Ring	% Population 2018	Distribution (%) of jobs 2018	Jobs / inhabitant ratio 2018	Distribution (%) of jobs 2004	Jobs / inhabitant ratio 2004	Distribution (%) of jobs 1996	Jobs / inhabitant ratio 1996
Madrid core districts	15	29	0,96	34,7	0,94	38,7	0,75
Rest of the city districts	34	30	0,47	29,5	0,39	28,7	0,26
Inner ring	44	35	0,43	32,4	0,38	29,1	0,27
Outer ring	7	4	0,27	3,4	0,27	3,5	0,26
Community of Madrid	**100**	**98***	**0,52**	**100**	**0,47**	**100**	**0,35**

Source CRTM (2019, Charts 1, 6, 9, 10, and 11, p. 10, 13 and 15) and CRTM (2005, Chart 12 and Table 16, p. 19)
* *Note* 2% of employees working outside the CAM are not counted

trip to be done is short, whilst in the two peripheral rings, they opt for the car when it takes longer.

In sum, the growing number of people (many of whom are working-age adults who move for work-related reasons, i.e. commuters) living in peripheral suburban municipalities—where public transport is no longer competitive, as it involves longer journeys—helps to explain the growth in the use of private vehicles in the Community of Madrid in the analysed period. This translates into an increase in the number of vehicles per capita and per household, both in the inner and outer rings, whilst in peripheral districts of the city of Madrid they have increased more slowly. Finally,

Table 20.6 Mean distance travelled by ring and mode of transport in the Community of Madrid, 2004 and 2018

Ring of Residence	Mean distance travelled (in km) 2018					2004
	Daily distance travelled by persons travelling	On foot	Public transport	Private vehicle	Mean distance of each journey	Mean distance of each journey
Madrid core districts	11,1	0,8	4,7	8,7	4,6	5,6
Rest of the city districts	13,8	0,7	5,9	7,8	5,2	6,6
Inner ring	19,6	0,7	12,9	9,4	8,0	10,2
Outer ring	30,2	0,6	24,6	13,2	13,7	18,5
Community of Madrid	**17,1**	**0,7**	**8,2**	**9,3**	**6,7**	**8,8**

Source CRTM (2019, Table 9 and Chart 44, p. 56 and 57)

Table 20.7 Mean duration of the trip by ring and mode of transport in the Community of Madrid, 1996, 2004, and 2018

Ring of Residence	Average time (in minutes) 2018					2004	1996
	Daily time travelled by persons travelling	On foot	Public transport	Private vehicle	Mean duration of each journey	Mean duration of each journey	Mean duration of each journey
Madrid core districts	69	19	31	26	28	28	26
Rest of the city districts	72	18	36	23	29	30	29
Inner ring	67	17	46	22	28	27	26
Outer ring	70	15	57	24	29	28	23
Community of Madrid	**69**	**17**	**38**	**23**	**29**	**28**	**27**

Source CRTM (2019, Table 10, p. 58)

Table 20.8 Motorisation rate (vehicles per 1,000 inhabitants) and Motorisation index (number of vehicles per household) by residential rings in the Community of Madrid, 1996, 2004 and 2018

Ring of Residence	Motorisation rate 2018	% Households without private vehicle 2018	Motorisation index / household 2018	Motorisation index / household 2004	Motorisation index / household 1996
Madrid core districts	356	37,6	0,76	0,72	0,75
Rest of the city districts	388	30,0	0,94	0,90	0,87
Inner ring	472	16,9	1,28	1,13	1,10
Outer ring	506	12,0	1,41	1,09	0,97
Community of Madrid	**429**	**24,8**	**1,08**	**0,97**	**0,93**

Source CRTM (2019, Charts 13 and 14 and Table 2, p. 16 and 17) and CRTM (2005, Chart 10, p. 18)

in central core ones, where public transport is more efficient and more widely used, the motorisation rate remains stagnant in the period analysed (Table 20.8).

In other words, policies to reduce the use of private vehicles have had some success in the city of Madrid, where there is a significant use of public transport and active mobility, and where the rate of motorisation has not increased. However, this has not been the case in metropolitan periphery municipalities, where the use of private vehicles has increased significantly. As it has been argued, in the inner ring, cars are used for almost half of all daily trips, whilst in the outer ring this percentage rises to more than half of all of them (Table 20.3). Thus, the more population lives in the periphery, the higher the use of private vehicles and the lower that of public transport and active mobility—though their use has also increased in absolute numbers since 2004, that of cars has increased even more.

20.4 Discussion and Conclusion

The case study research, which analyses the relationship between recent spatial population trends in the metropolitan region of Madrid and their effects on daily mobility, confirms the initial hypothesis. Indeed, population suburbanisation trends in the last decades have led to an increase in daily mobility, and particularly, in the use of private vehicles. This same trend has been observed in other Spanish cities, both in the post-economic crisis and the post-COVID periods—these last years, the fear of contagion has delayed the recovery in the use of public transport (Greenpeace 2021). Although the European Commission's Sustainable and Smart Mobility Strategy stimulates policies that discourage the use of private vehicles and promote public transport, there would be several reasons for this increased use of cars.

The first is changes in population structure, in which there is a decreasing number of young people—the main users of public transport—and a concentration of baby boomers at adult ages, where the use of private vehicles reaches its maximum. The second is the growing relevance of commuting because of the post-crisis economic recovery as mobility by labour reasons involves a greater use of cars than daily trips for other reasons. This trend was later accentuated by the COVID-19 pandemic, when mobility restrictions reduced congestion and therefore shortened commuting times, encouraging a greater use of private transport instead of the metro, buses or trains. The third reason, and we consider it as the most important, is the increasing percentage of population living in Madrid's peripheries—most of them, working-age adults and their descendants. A growing suburban population implies an increase in both the distance travelled and in car use, to reduce the time that travelling by public transport would involve.

Obviously, there are differences between the city of Madrid—where there is a very significant use of public transport and active mobility—and the suburban municipalities, where car use predominates. The slow transition to sustainable forms of mobility in both the Madrid's core and the rest of the municipality must be considered a success. However, this tendency is counterbalanced by what occurs in the inner and outer rings, where an increasing proportion of the population of the Community of Madrid lives. This result, applicable to Barcelona (IERMB 2020; Gil-Alonso et al. 2022) and other large cities, shows that interventions to reduce car use in large cities can be affected by the socio-demographic and residential trends observed at the metropolitan level, which seem to favour the use of cars over that of public transport or active mobility. Therefore, policies must be planned beyond the strict municipal boundary of the core city and be extended to the metropolitan level, in which environmental and transport planning policies develop by definition.

The measures that have been implemented so far to reduce road traffic and reclaim public space for citizens have strengthened the transition to low-carbon mobility in many European cities. However, they have also widened the so-called 'mobility divide' or the mobility gap between social groups (García Lamarca et al. 2020). For instance, the implementation of the LEZ in Madrid and Barcelona—and of entry tolls in other European cities—has negatively affected the mobility of the most vulnerable population. Whilst middle- and high-income commuters, who own newer and less polluting cars, have been able to continue commuting by private car after the low emission zone came into force, low-income commuters find it more difficult to do so, unless they renew their vehicle.

The relationship between the demographic and the socio-economic characteristics of the population, mobility and urban inequality has even more angles. Indeed, the latter not only involves an unequal access to housing but a growing uneven accessibility to teleworking and an increasing diversity of modes of transport. Green gentrification (Triguero-Mas 2021; Frago and Graziano 2021) makes it possible for a significant proportion of gentrifiers to commute on foot, by bike, or scooter. By contrast, the ban on polluting cars from the city is increasing the use of public transport—and travel time—by lower-income groups. This mobility divide widened even more during the first COVID-19 lockdown. Workers in essential sectors—in jobs

that are not compatible with teleworking—continued to commute, with the risk of catching the coronavirus both at the workplace and on public transport (Checa et al. 2020). At the same time, teleworking in higher value-added jobs—such as those in ICT-intensive sectors—increased dramatically (Florida et al. 2021). In sum, the results have shown that it is impossible to separate mobility, environment, and equity when designing policies for the transition to sustainable mobility. Therefore, their implementation should not only be based on environmental criteria, but also on social ones.

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