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NEW URBAN MOBILITY STRATEGIES AFTER THE COVID-19 PANDEMIC

Individual Sustainable transport as solution to mobility crisis

Thesis supervisor: Prof. Luca Studer

Thesis of

Domenico Suraci Matr. 919906

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Content index

Index of Figures

CHAPTER I INTRODUCTION

The Covid-19 pandemic had, among the countless and tragic effects, that of putting a crisis on the entire urban transport system of cities, showing how this is a strategic need, which must be satisfied for the very survival of cities.

The new conditions forced a change in the strategy with which the problem had been solved up to now. Generally, the answer was the same, albeit with different tactical variations depending on the context: the increase in the offer of individual mobility, and in particular the sustainable one.

However, the crisis did not represent a point of discontinuity as much as a point of ascending inflection: it did not generate any real news, it was a catalyst for phenomena already underway. In fact, the measures implemented almost entirely derive from proposals already presented or even approved for the next decade.

The attempt, common all over the world, to use the response to the health crisis as a tool to change mobility within the city once it is over, is evident.

The tragic evolution of the epidemic into a global pandemic has forced a large number of cities to take action, offering a vast case study. The intent of this thesis is to investigate the measures taken in the various cities of the world with regard to urban mobility and evaluate which have been the most effective, verifying their effects in both the short and long term.

1.1 Events

Evaluating the evolution of the epidemic is the first and fundamental step in understanding the problem. Mobility restrictions are in fact a direct consequence of the violence with which the virus has struck. The key milestones in the contexts analysed in this work [1] [2] [3] are therefore reported below, while the detailed statistics of each individual country are available in the annexes:

- 31 December 2019: the World Health Organization is informed by the Chinese authorities of a series of cases similar to pneumonia in the city of Wuhan;
- January 22, 2020: the Chinese government quarantines the city of Wuhan;
- February 2020: SARS-COV-2 cases and deaths multiply outside China;
- March-April 2020: most countries apply severe travel restriction measures;
- May-August 2020: containment measures seem to have worked and in many countries the situation returns to close to normal;
- September 2020-April 2021: the virus spreads again and new travel limitation measures are implemented.

It is noted that the pandemic has not affected the whole world univocally, but with different timing according to the epidemic zones [4] and with different effects depending on the characteristics of the populations and health systems.

The response of the states was also different. Some, such as South Korea, Japan and initially Germany, managed to contain the infection through tracking and live an almost normal situation. Instead, most have had to make very severe, if initially reluctant, mobility restrictions. Still others have decided to live with the virus by imposing very mild limitations [3].

1.2 The problem of public transport

The main effect of the epidemic on urban mobility was the collapse of public transport [5], both from the point of view of supply and from the point of view of demand. In fact, three phenomena went to compete.

The most obvious is the drastic decrease in the number of trips, due to the suspension of many work activities, smart working, the closure of schools and many non-essential services. The decrease was around 90% compared to the average of the movements of previous years in the most stringent lockdown moments and then stood at around 40% less when the activities were able to reopen.

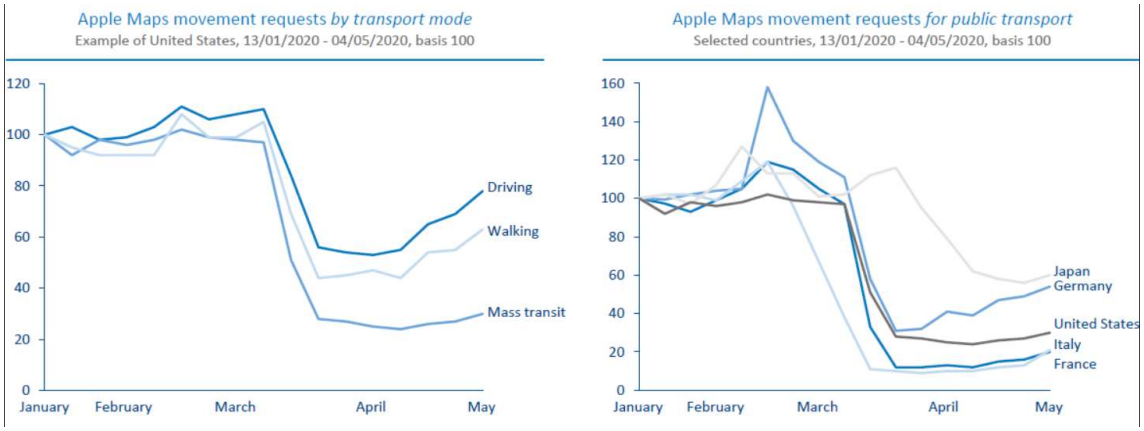


Figure 1 Decline in mobility in European countries during the first phase of the pandemic [6]

Then there was the need to reduce the maximum capacity of the means of transport - generally by 50% compared to the normal situation - to ensure distancing.

Finally, there has been a general change in the choice of moving users towards individual mobility for fear of contagion on public transport, regardless of the safety levels declared by the health and transport authorities.

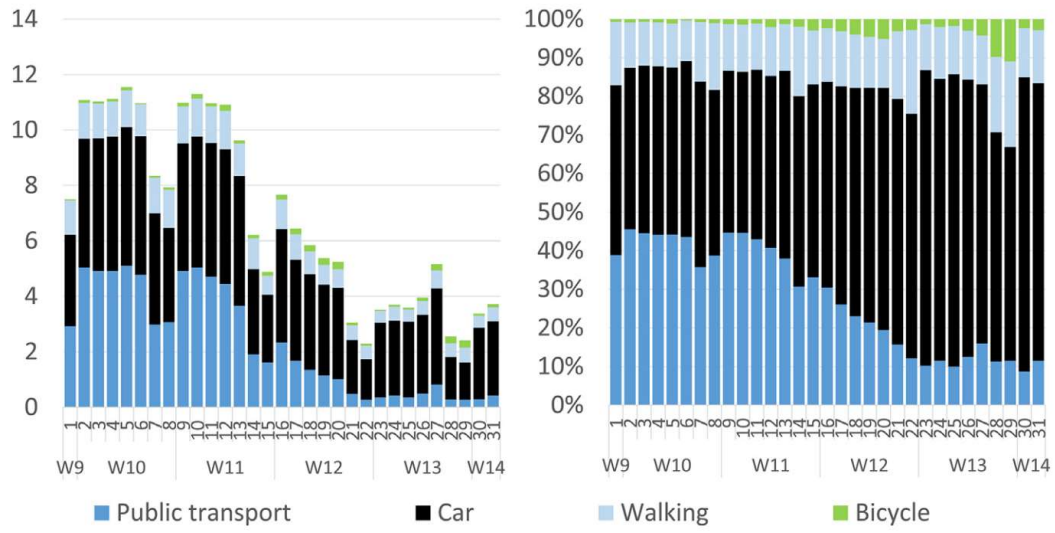


Fig. 2. Daily average trips by mode of transport and modal share by day in March 2020.

Figure 2 Change in the modal split in Budapest: there is an increase in individual transport, especially motorized transport [7]

The problem on the part of the planner is therefore to be able to guarantee a safe service from a health point of view and as efficient as possible. The greatest criticality is found during peak hours, which are those of maximum overcrowding of vehicles. We have tried to solve the problem in two ways.

On the one hand, the offer has increased through the enhancement of the service compared to normal during peak hours. However, this path has proved to be complex: the recruitment and training of new staff, the purchase of new vehicles and the upgrading of lines often already at maximum capacity require costs and timing that cannot be reconciled with the emergency nature of an epidemic. In this way, private companies were used, which provided their own means to strengthen the network. However, the serious problem of lack of knowledge of this alternative on the part of users has been highlighted, which has largely continued to use the means they previously used [8].

On the other hand, an attempt was made to spread the demand in order to flatten the rush hour, especially the morning one which is the most loaded. The hourly flow was therefore completely rethought, staggering the openings and entrances of schools, services and companies. In particular, the focus was on dividing the opening of schools into two time

slots. However, it was not sufficient: the peak in demand was found outside the half hour before the two school entrance hours because the entrance to offices, shops and companies was not staggered [8]. In fact, this operation turned out to be very complicated. Often it took months just to start negotiations for an agreement with the interested parties [9] and in the few places where it was reached it was often not respected.

From the experience gained, we can therefore see three ways to follow to be ready in the event of a new epidemic.

First, the preparation of a pandemic plan that brings together companies, public bodies, social partners and citizens on how to stagger the entrances, so that in the event of an emergency, immediate action can be taken with the participation of all.

We can then think of staggering the entrances not in two but in three bands, anticipating the entry of half of the students in high schools and universities, which are the ones who use public transport the most. In this way, a band that is soft outside the emergency would be used. In this way, the opening hours of companies, shops and services could be left almost unchanged with a consequent greater collaboration on the part of these.

Finally, it is necessary to effectively communicate the enhancement of the service so that users are aware of the options available to them. The dissemination of information must not only be carried out by the public service, but also by companies, schools and trade associations before and especially during the emergency.

A final note should be made regarding the use of public transport itself during an epidemic. Sars-Cov-2 has among its greatest dangers a high contagiousness, which increases even more with the variants that have spread in 2021. However, in the future we may have to deal with epidemics that have a high level of contagiousness at point of not being able to guarantee health safety on vehicles [10]. To cope with an emergency of this gravity, an adequate mobility plan must therefore be developed, which takes into account the inevitable and even more radical changes in people's lives and which is focused on individual travel, the only ones that can be safely practiced in this situation.

For these reasons, the work of the thesis focused on individual mobility, in particular the soft one, which turned out to be the most effective and the only possible response in the case of more serious epidemics than that caused by SARS-CoV-2.

CHAPTER

II WORK PROCESS

During this work we proceeded according to three distinct and successive phases, which were repeated schematically to be able to go through the same logical procedure from identifying what was happening and why up to the attempt to find the most effective interventions for each context.

The first step was the research, initiated by newspapers and online sites and then deepened on the websites of local administrations, on which cities have taken steps to change mobility and what were the reasons behind these decisions.

Similarities were then sought between the cities studied to go in search of which were, within similar contexts, the most effective measures.

Finally, data on changes in mobility were analysed to assess the effects of the measures introduced.

2.1 Search for measures

As already mentioned, the actions of the city administrations have been mainly directed in the direction of increasing the supply of transport for safe alternatives from a health point of view. This concentrated the measures in three main fields of action.

The most widespread measure was the construction of new cycle paths, in different positions and with different objectives, as will be explored in the next chapters. However, what unites this type of infrastructure is their "pop-up" nature: due to the emergency context it was necessary for them to be built in a very short time. Pop-up infrastructures, with their cheapness and ease of implementation, have been considered the most natural solution.

Pedestrian and cycling mobility were then favoured to the detriment of motorized mobility. New limited traffic areas and pedestrian zones were therefore introduced, maximum speed limits were lowered, crossing traffic in residential areas was prohibited, sidewalks were widened and the green time at traffic lights was increased. pedestrians.

The last field of action may be counterintuitive with respect to what has been said, because at the same time the cities have also eliminated the restrictions and tolls on the passage of cars in some ZTLs and allowed the free parking of vehicles where before it was paid. However, these measures, even if diametrically opposed to those described above, are part of the attempt to increase the offer of individual transport. This direction has been taken by a very small number of cities and it has been announced that they will be cancelled with the end of the emergency, while it has almost always been decided to increase and finalize the infrastructures and measures regarding sustainable mobility.

Once the measures were identified, the reasons for which they were adopted were sought. Three main selection criteria have been identified.

The most obvious but also the most important was the level of contagion in the city and country in question: the harder the epidemic hit, the more mobility changed [11]. In fact, the cities of countries such as South Korea and Japan, similar to those of the major European countries, have adopted infinitely less travel restriction measures because they have managed to almost completely control the spread of the virus.

Secondly, the morphology of the cities (population, density, infrastructure, economy, history) and the modal split of movements before to the epidemic were decisive in the choice.

Finally, it was decided to carry out projects that were under development or already planned for the future. This point is essential to understand the tactics of local administrations: to respond to the changing needs of mobility in the immediate future by implementing those measures that were designed to solve existing problems and which will recur in the future when the emergency is over.

2.2 Classification of cities

Once the measures taken by each city were catalogued, criteria were sought to find points of contact between them, in order to subsequently verify which measures were effective in certain contexts and which were not.

Population, infrastructure, previous modal split and service levels were taken into consideration. The sources from which they were searched are the national statistical institutes of the respective countries and the mobility studies of the local and national transport departments. For the modal split, it was decided instead to use a database provided by the European Platform on Mobility Management, [12] so that in this phase of comparison, data collected in the same way were used. The modal splits were all subsequently checked on the sites of the respective transport departments and were all consistent with the platform data. American cities, which were not present in the database and for which data from the transport departments and those from the Deloitte Insights website, were used as an exception [13].

However, no similarities were found when evaluating each of the parameters individually. Mobility is in fact such a complex and integrated system that it does not allow one to be decisive compared to the others outside the pandemic context.

It was therefore necessary to make an overall assessment, which would go to evaluate the urban transport system and the cities. This has brought to light how the most similar cities in terms of morphology, citizens' habits, infrastructures and problems are found within the same state or a common cultural region.

The same similarity was found, in the measures that were introduced, despite the absence of central national directives that would guide the choices.

Therefore the "national" criterion is the one chosen to analyse the interventions before and the effects after.

2.3 Data analysis

The data analysis was the longest and most complex part for many factors.

The first difficulty was encountered in their own research. First, because they are scarce: almost none of the cities that have adopted the measures have been able to measure their effectiveness in a capillary manner, a fundamental condition for understanding what worked and what didn't within the same context. In addition, the work of aggregation was also complex: the data are calculated with different criteria, refer to different periods and are represented differently.

The help that can come from the giants of "big tech" must be used with great caution. In fact, the data made available show many shortcomings: they are almost never available for the years preceding the pandemic, they do not present all the most significant transport alternatives and they are almost never data of actual movements but data on internet searches on how to reach certain locations and surveys with a non-representative statistical sample. Given all these highly uncertain factors, these data are taken into consideration only to signal trends when there are variations with very significant orders of magnitude.

A happy exception is the Strava Metro app, which has made a dashboard available online [14] with data shared by users anonymously. They are trusted by the United States Centers for Disease Control and Prevention, which conducted a study [15] showing the strong correlation between the location of people using the App to track their movements and the location of commuters on bicycles and feet in the total population. The active commuting rate in each area of a city according to the census is therefore similar to the active commuting rate in the same area among Strava users. Their reliability is also evidenced by the consistency with the results of statistical studies and with the counting of steps, where these are available. It was therefore decided to refer to this database in the absence of "real" data.

Another problem that makes it difficult to make a comparison is the general decrease in mobility compared to the standard situation, oscillating on average between a minimum

of 40% and a maximum of 90% in the most severe lockdown period. It is therefore not possible to reason in absolute terms but only in percentage terms.

The evaluation of the "time" of the virus was also complex: the pandemic affected different states and geographic areas in different ways, with a different perception by the population of the seriousness of the situation even for comparable levels of contagion. The only period in which the pandemic situation would have allowed a confrontation would have been the summer, when in Europe it seemed that the virus had stopped. However, even in this circumstance, the sharp decline in mobility prevents us from making adequately precise comparisons.

Finally, the last and perhaps most significant difficulty was caused by the change in the process of choosing the mode of transport. The user is considered a rational decision maker who seeks to maximize his utility (or in other words to minimize the generalized cost) which he evaluates through a series of attributes [16]. In the presence of such a contagious epidemic, the attribute of health safety, previously so obvious that it was not considered, assumes a predominant importance over all the others. The demand for individual transport increases very strongly and another element of uncertainty is generated when analysing the data. The conditions of choice during the emergency are therefore radically different from the normal ones, which are those for which the measures introduced were designed: particular attention must be paid to the difference between the response to the same interventions depending on whether one is inside or outside the pandemic, without making a single assessment.

For all these reasons, the exact effectiveness outside the pandemic context of the measures taken can only be verified when the epidemic ends. For now, trends can be underlined, taking advantage of those moments in which the contagion was low and those changes that were too sensitive to be considered momentary.

CHAPTER

III STUDY CASES

Going into the specifics of the issues dealt with so far, we report the analyses and the effects that have been identified.

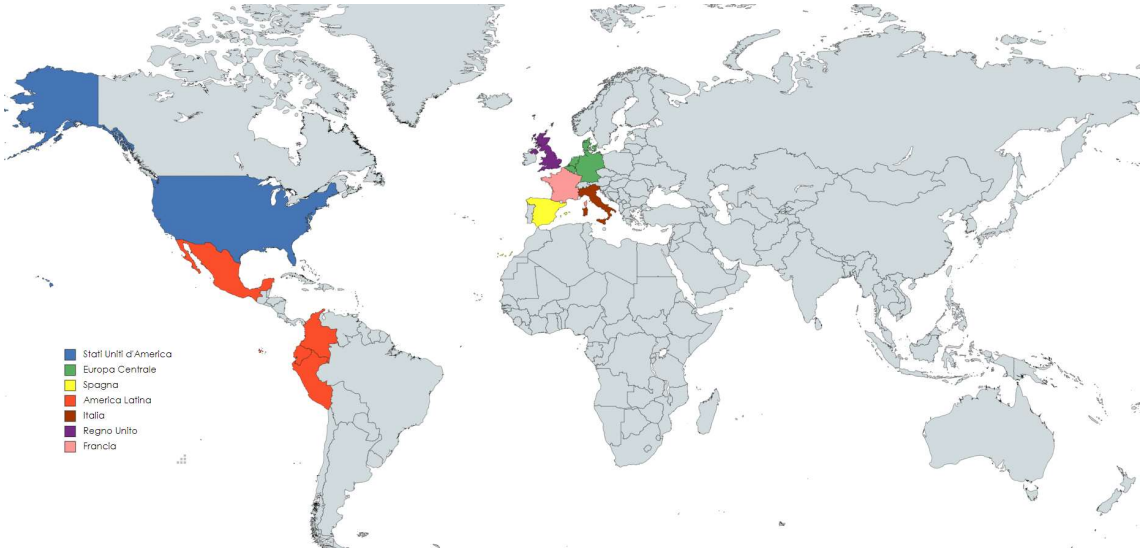


Figure 3 Map with study contexts

The contexts reported - France, Spain, United Kingdom, Latin America, United States and Northern Europe and Italy - are those that were considered most interesting. Others have been omitted for various reasons: for China, insufficient elements have been found to make a description; Irish cities basically behaved like the English ones.

In reporting the cases studied, it was decided to follow the workflow described above. The context was described for each, briefly with regard to the spread of the epidemic and more in depth with regard to the characteristics and modal split of the cities. The measures taken and the reasons that led to their realization were then analysed, focusing on the topography of the various interventions, considered a key element for a complete understanding. The construction techniques were among the most varied and we focused

on the most interesting ones. Finally, changes in mobility were analysed, again in relation to the evolution of the epidemic and the consequent confinement measures.

3.1 France

3.1.1 Context description

French cities have very similar morphological characteristics: a very high density, a small surface area, a low population within the municipal boundaries and a metropolitan area extremely connected to the city.

	Inhabitants	Surface (km²)	Density (ab/km^2)
Paris	2206488	105	20934
Lyon	513275	48	10722
Toulouse	471941	118	3989
Lille	232741	35	6682

Figure 4 Morphological characteristics of the major French cities that have implemented measures [17]

Studying the modal breakdown in these cities, you can see how motorized mobility preponderant, pedestrian mobility widespread and public transport is not widely used and bikes are practically absent.

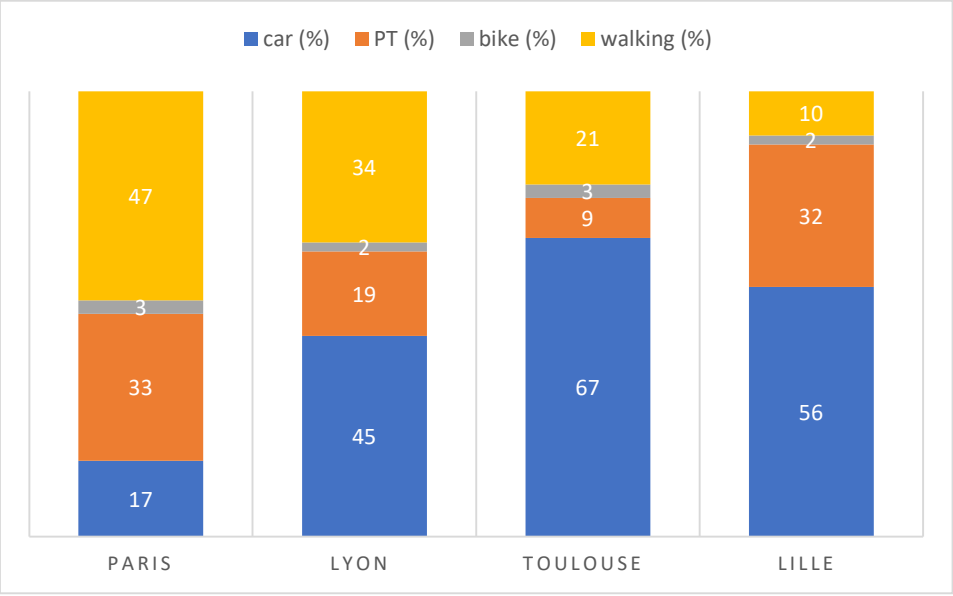


Figure 5 Modal split of major French cities that have implemented measures [12]

For very small cities it is understandable that public transport is not so effective for getting around the municipality due to the short distances, which do not reconcile with waiting times at stops and the routes followed which are not the shortest.

It is not immediately clear why the car is so disproportionately preferred to the bike, despite the short distances to be covered, the habit of gentle mobility evidenced by the widespread pedestrian mobility and a network of cycle lanes that are often very extensive.

To understand the phenomenon, the state of the cycle paths was checked using Google Maps [18]. We have seen how they are very unsafe from an accidental point of view because they are not protected, with little space available and with the presence of large vehicles in the adjacent lanes. The space dedicated to the lane is extremely narrow and the carriageway is practically never separated. As evidence of this, France is the second country (after Italy) in Europe for the number of deaths compared to kilometres travelled [19].

Figure 6 Example of the cycling network in Lille. The accident risk due to the limited space and proximity of vehicles is very high

3.1.2 Measures taken

Given that there is a modal split so pushed towards motorized transport and given that one of the fundamental problems created by the crisis was that of having to prevent the majority of users from choosing this, the main address of French cities is was to focus almost exclusively on the construction of pop-up cycle paths (with the exception of Lyon which has also taken other measures).

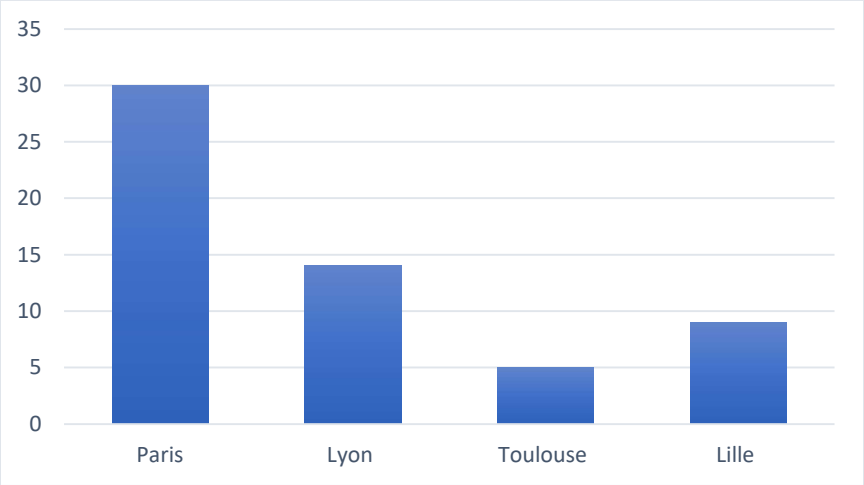


Figure 7 Length of cycle paths (km) built by major French cities [20]

Studying the topography of the cities to evaluate the position of the cycle paths, it was seen that the choice of the route almost always fell along the lines of the main surface public transport.

Figure 8 Example of evolution of the cycle lane and bus line in Lyon

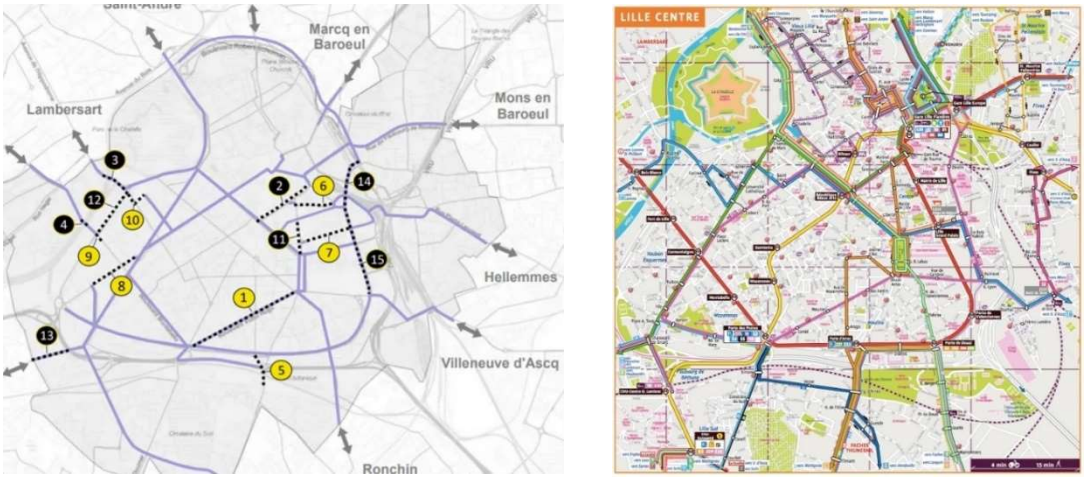


Figure 9 Comparison between the cycle paths built in Lille and the lines of surface public transport

In fact, it was decided to create lanes dedicated exclusively to bicycles and public transport, to obtain a double advantage. First of all, that of increasing safety against accidents, which was the fundamental choice factor for not choosing the bike. Secondly, with the creation of dedicated lanes, the commercial speed of public transport has been increased, making them more efficient.

The exception is Paris. It is in fact a city that from a morphological point of view presents all the characteristics that had been previously described, but in an even more evident way. In addition, it has a gentle mobility inside it that already counts half of the movements and a very poor motorized mobility.

The differences are in the political will to make as many trips as possible in the city sustainable and in the strong relationship between the large and highly populated metropolitan area. Therefore, the measures taken in the area of the municipality, similar to those in other cities, have been joined by cycle paths connecting with Île-de-France.

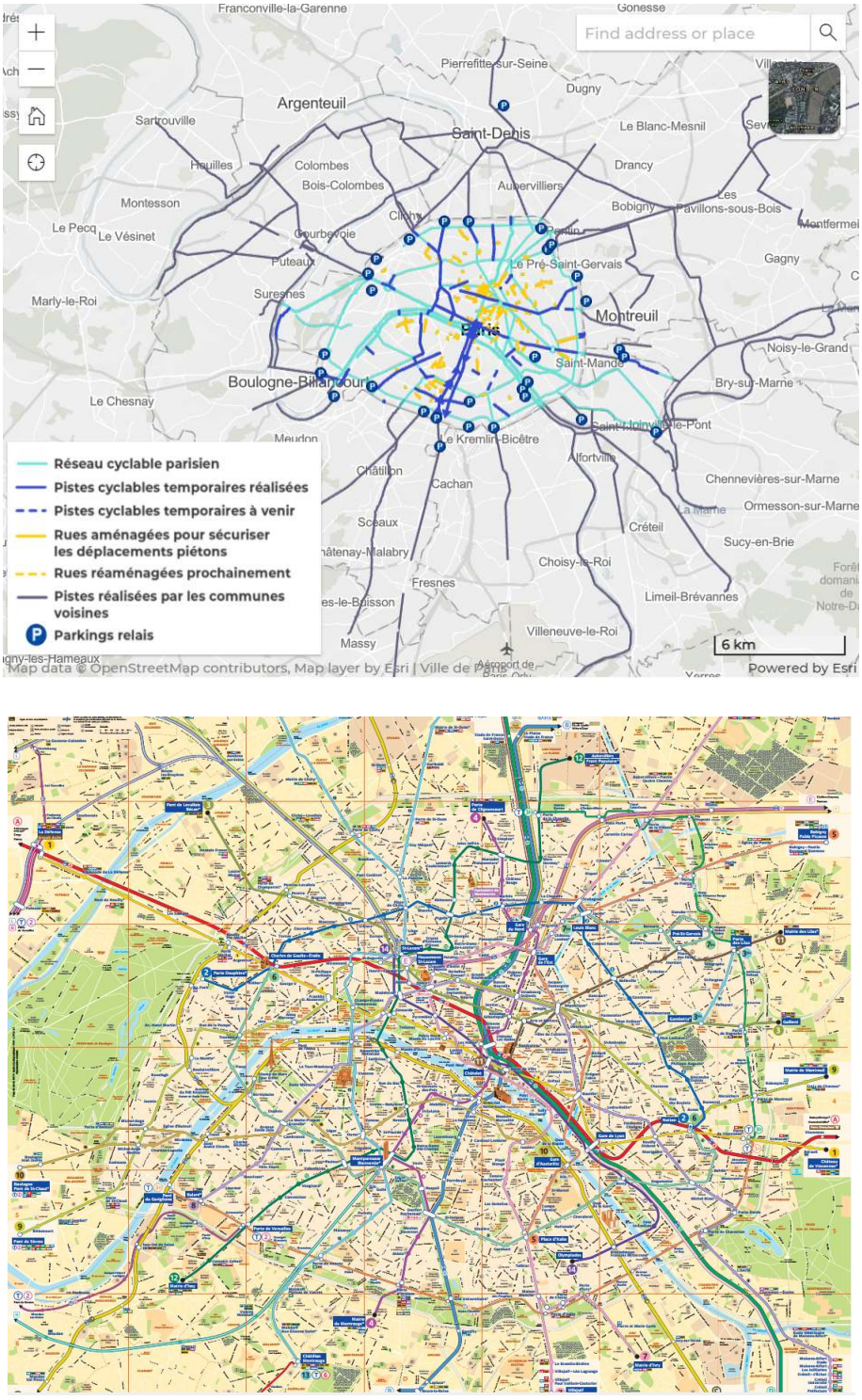


Figure 10 Comparison between the cycle paths built in Paris [21] and the main lines of public transport. It is noted that for the metropolitan area the lines of force of the subways are followed

3.1.3 Analysis of the results

Nelle città dove si sono realizzate le misure descritte l'aumento dei ciclisti è stato estremamente significativo. Il paragone è stato fatto tra i dati relativi all'estate del 2019 e quella del 2020, che essendo il periodo più vicino alla normalità risulta anche quello più rappresentativo.

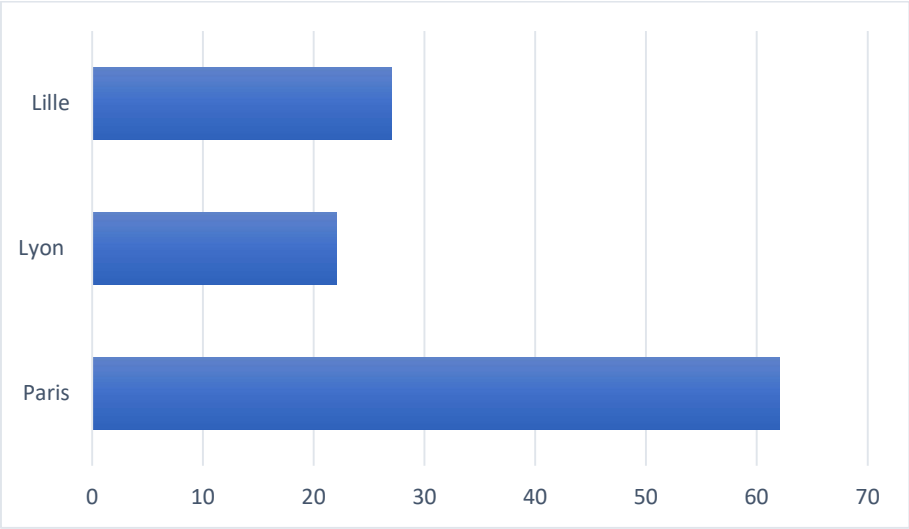


Figure 11 Increase in cycling in the French cities where they were built

The data, calculated from the Vélo & Territoires association, a group of French local administrations aimed at promoting the use of bicycles, are very positive. It can be seen that generally cycling between the end of the lock-down and October 2020 increased, compared to the same period in 2019, by about a quarter in the cities that were analysed, with Paris still presenting a figure. more positive, equal to 62%, testifying to having chosen the correct approach for its particularities. The city of Toulouse is not present in the study and therefore the data is not reported. However, the counts carried out indicate a significant increase [23].

The study also reports separately the movements during and after the block, which are absolutely comparable: the use of the bike is kept high even after the end of the period of the movement restriction.

However, the association also monitored other cities, where no significant interventions were made in favour of sustainable mobility as in those treated.

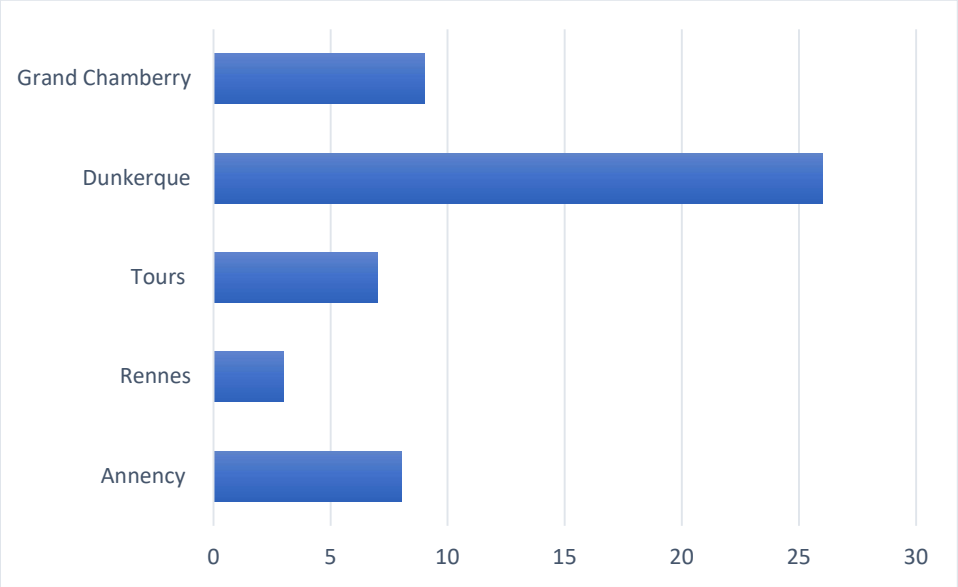


Figure 12 Increase in cycling in French cities where no cycle paths have been built [22]

The increase is not negligible, but it is significantly lower than the cities that have introduced measures. Therefore, direct evidence of their effectiveness is obtained: once it was protected, users perceived the alternative as safe and the number of cyclists immediately increased even compared to a period in which the total number of all journeys was greater.

An exception is the city of Dunkerque, which has seen an increase comparable to that of the cities where cycle paths have been built. The reason is believed to be that the whole city became a "zone 30" for cars in 2018. In this case, therefore, the conditions for cycling were already favourable. The epidemic only acted as a trigger.

The last result that we want to discuss concerns the user relationship with the infrastructure. It has in fact been noted that the overlap of cycle paths on the route of public transport allows users to have an immediate perception and knowledge of this transport alternative starting from the knowledge of the bus network. This passage is very evident when looking at the data on the searches of the routes made available by Apple, which show that in the French cities that have chosen this approach there has been a

dizzying increase in research concerning public transport [6]. Being aware of the development of the network can be decisive both in the long term and when you are in full emergency and you need to quickly change behaviour.

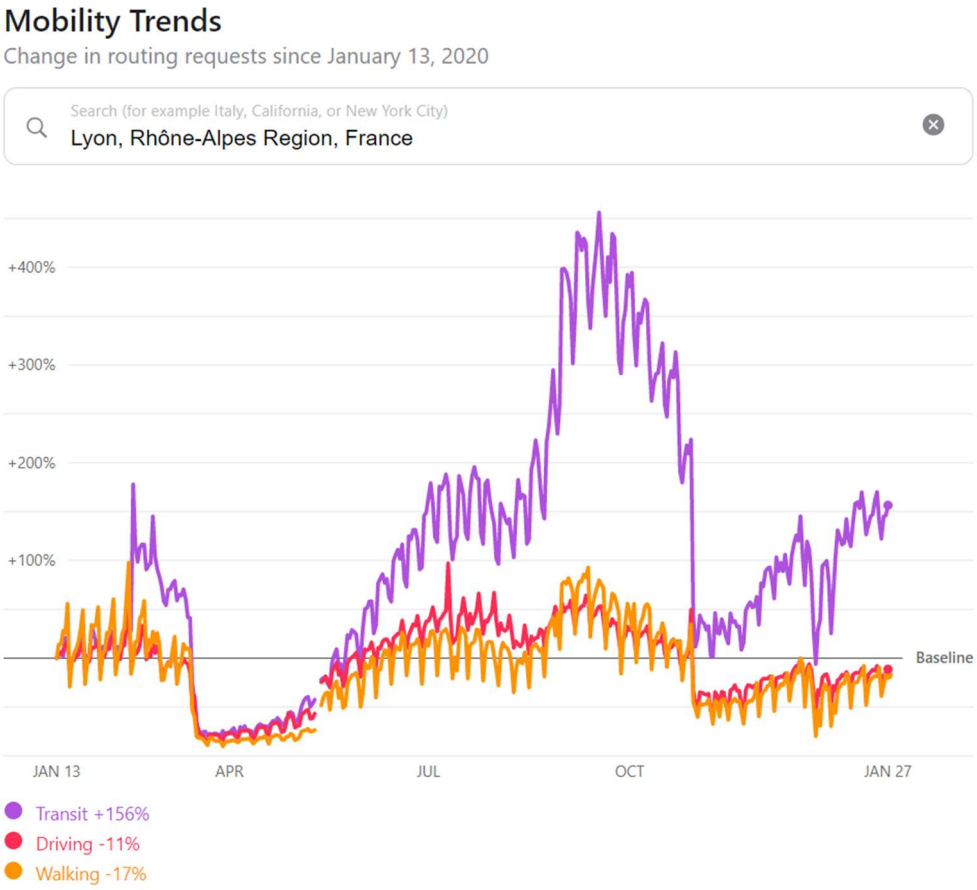


Figure 13 Number of requests for directions on Apple Maps in 2020 [6]. The trend is comparable to that of the other cities where cycle paths have been built

3.2 Spain

3.2.1 Context description

With the Spanish cities it is known how the context with which we are dealing is completely different from the French one.

First of all, due to the morphological diversity of the cities, which have very different characteristics from each other.

	Inhabitants	Surface (km²)	Density (ab/km^2)
Madrid	3223334	604	5334
Barcelona	1636762	101	16157
Seville	688711	140	5899
Valencia	794288	135	4898
Bilbao	346843	41	8406

Figure 14 The most populous and representative cities in Spain are shown in terms of autonomy and geographical distribution [24]

But above all for the different habits of Spanish citizens move, which leads to a modal split with a unique peculiarity at the level of the largest European countries.

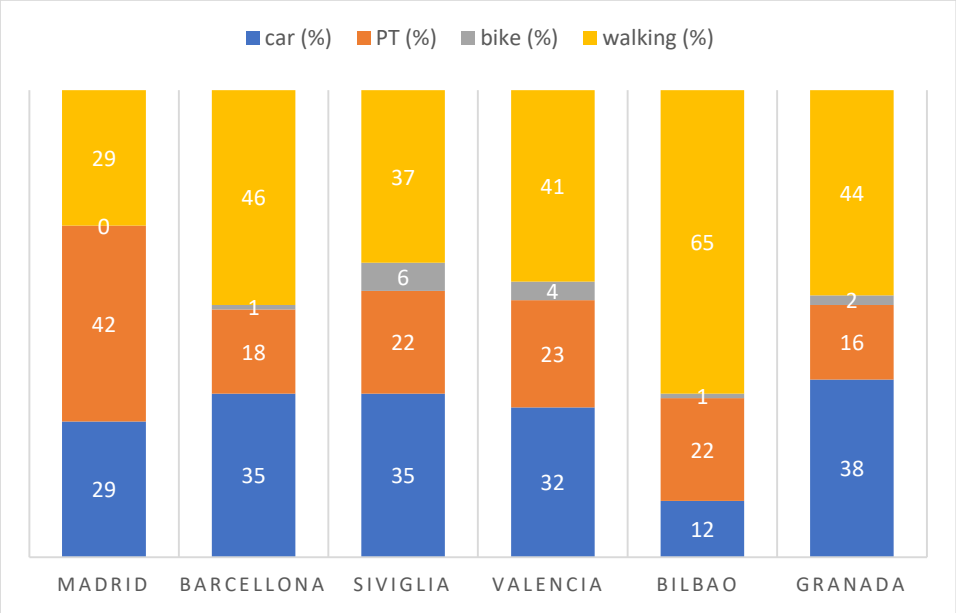
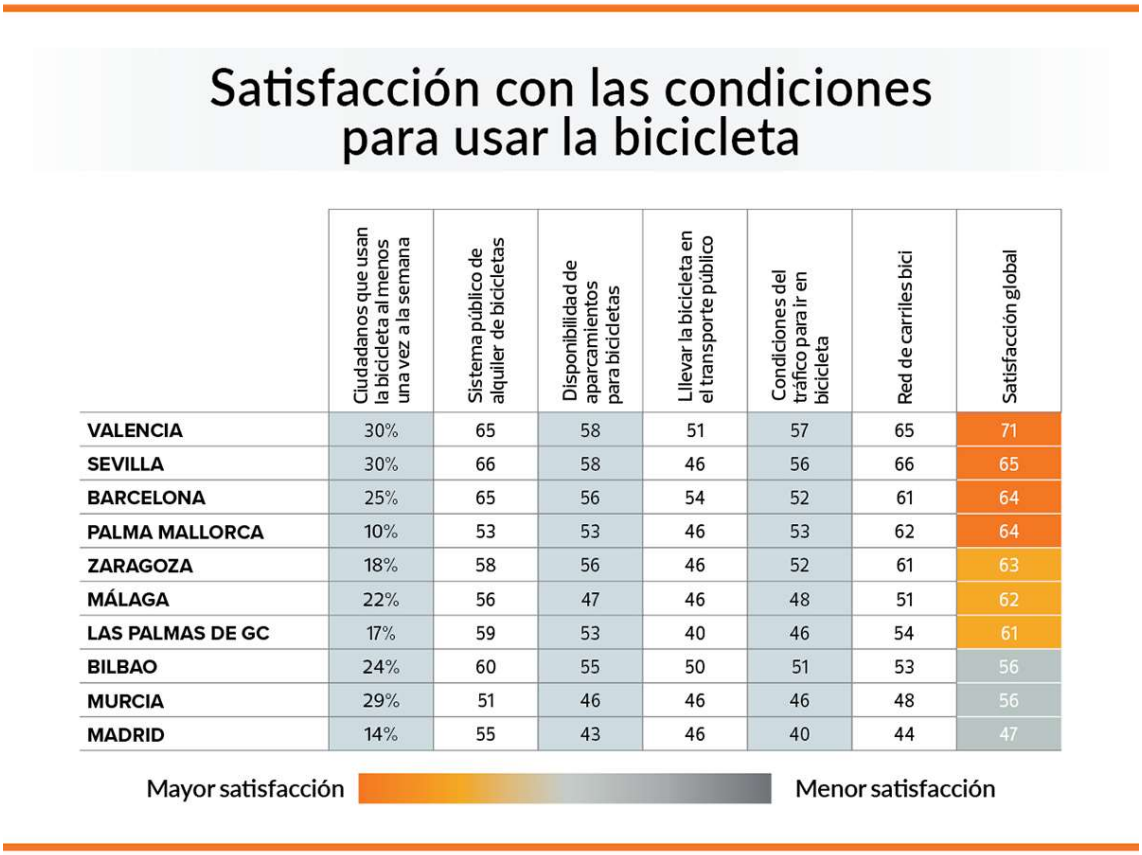


Figure 15 Modal share of the Spanish cities described [12]

The sweet mode is clearly in the majority and local public transport is used by a significant but not high number of users. The comparison with cities morphologically similar to French cities such as Seville, A Coruña and Bilbao even more highlights the difference in transport choices between Spanish and French citizens. However, there is a common point: the bicycle alternative is almost always ignored, even in the presence of excellent cycling infrastructures such as, for example, in Valencia, Seville, Zaragoza and Barcelona, while the movements are mostly on foot.

This is testified by a survey conducted by the Spanish consumer association OCU [25], which shows that satisfaction with cycle paths in Spanish cities is high, but this does not mean that cycling is perceived as a real alternative.



Satisfacción con las condiciones para usar la bicicleta

	Ciudadanos que usan la bicicleta al menos una vez a la semana	Sistema público de alquiler de bicicletas	Disponibilidad de aparcamientos para bicicletas	Llevar la bicicleta en el transporte público	Condiciones del tráfico para ir en bicicleta	Red de carriles bici	Satisfacción global
VALENCIA	30%	65	58	51	57	65	71
SEVILLA	30%	66	58	46	56	66	65
BARCELONA	25%	65	56	54	52	61	64
PALMA MALLORCA	10%	53	53	46	53	62	64
ZARAGOZA	18%	58	56	46	52	61	63
MÁLAGA	22%	56	47	46	48	51	62
LAS PALMAS DE GC	17%	59	53	40	46	54	61
BILBAO	24%	60	55	50	51	53	56
MURCIA	29%	51	46	46	46	48	56
MADRID	14%	55	43	46	40	44	47

Mayor satisfacción — Menor satisfacción

Figure 16 Results of the survey on satisfaction with the cycling infrastructure in your city

3.2.2 Measures taken

The response to the pandemic crisis took into account the habits of Spanish citizens. Bike paths, modalities integration policies and ZTL have been created in very few cities, because it was not believed that they could intercept individual motorized and collective mobility.

Instead, we preferred to focus on public transport given that, with these surrounding conditions, they were the mode most in crisis.

The main measures were therefore the creation of new transport lines and the strengthening of existing ones during rush hour [26] [27] [28]. However, they remained largely on paper for most of 2020 due to the time factor.

First of all, because the drastic decline in the first months of the lockdown - which, as in all of Europe, has decreased mobility by up to 90% - has made the existing network sufficient for such low demand. Subsequently, due to the general reduction in mobility and the choice of other methods considered safer, the LPT in Spain suffered a decrease of around 50% throughout Spain. It was therefore not necessary to have an immediate response and perhaps it would not even have been possible, given some technical times that cannot be eliminated such as those for the production and purchase of the vehicles themselves or the increase in personnel.

The choice was therefore obvious: to change the mode almost only in the long term, relying on the compensation capacity granted by the general decline in mobility and the widespread habit of walking.

The exception to this pattern of behaviour is Barcelona. Contrary to the rest of Spain, despite starting from a very similar modal split and morphology (except for the very high density), the city has decided to implement a dense network of 70 km cycle paths, of which 20 built in 2020, which they expand an already dense network of over 300 km.

3.2.3 Analysis of the results

The evaluation of the effects cannot therefore be made at this time, the answer was only thought of in the long term. When the epidemic is over, a very useful tool will be given by the monitoring of the Istituto National de Estatistica [29], which has published the number of public transport passengers in major cities every month since 2016.

On the other hand, some considerations can be made regarding Barcelona. The Strava Metro app [14] reports an 84% increase in cycling mobility between June 2019 and the same month of 2020. We therefore arrive at considerations similar to those of France: in case of need, the population quickly change mode of transport as long as this is actually valid, especially from a safety point of view. This worked however in an emergency phase. However, such an impressive network could risk going back to being unused when the epidemic is over if we consider the very small number of kilometres of routes that are effectively protected.

3.3 United Kingdom

3.3.1 Context description

The morphological similarities between the cities of the United Kingdom are very evident, with the exception of London due to its much larger size.

	Inhabitants	Surface (km²)	Density (ab/km^2)
London	8961989	1572	5700
Liverpool	578324	112	5170
Manchester	547627	115	4735
Birmingham	1111300	268	4150
Glasgow	621020	175	3538

Figure 17 Morphological characteristics of the main cities of the United Kingdom [30]

In fact, there are consistent populations but not very high, small size and high density.

Going to evaluate the modal split, we can see how also from this point of view the similarity is very strong.

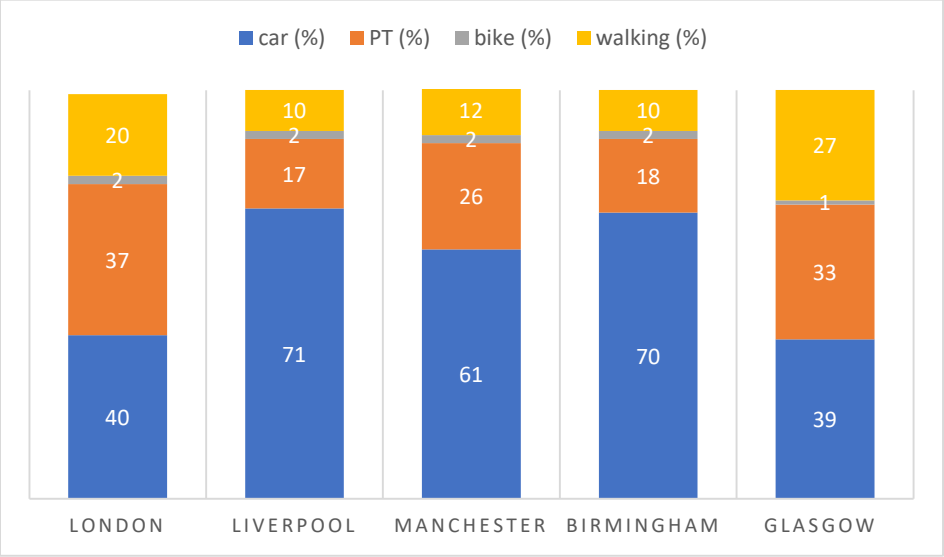


Figure 18 Modal split in major UK cities [12]

Motorized mobility is clearly the majority choice, especially to the detriment of the individual sustainable mode, while public transport, where present, is also widely used.

These alternatives, the two that have been most affected by the epidemic, alone represent between 75% and 90% of the entire mobility. There is a minority of travel on foot, while those by bike are practically absent.

The risk that the mobility system could collapse due to the pandemic was therefore very high.

3.3.2 Measures taken

Local administrations were aware of the initial situation and, in fact, many quickly approved a series of strategic plans, often already under study, to make a real mobility revolution [31] [32] [33] [34]. These plans are not particularly innovative, but they take as a model the initiatives that have been implemented in other European cities over the decades.

These are historic centers made pedestrianized, preferential lanes for buses, parking lots for modal interchange: a sort of recovery of lost time.

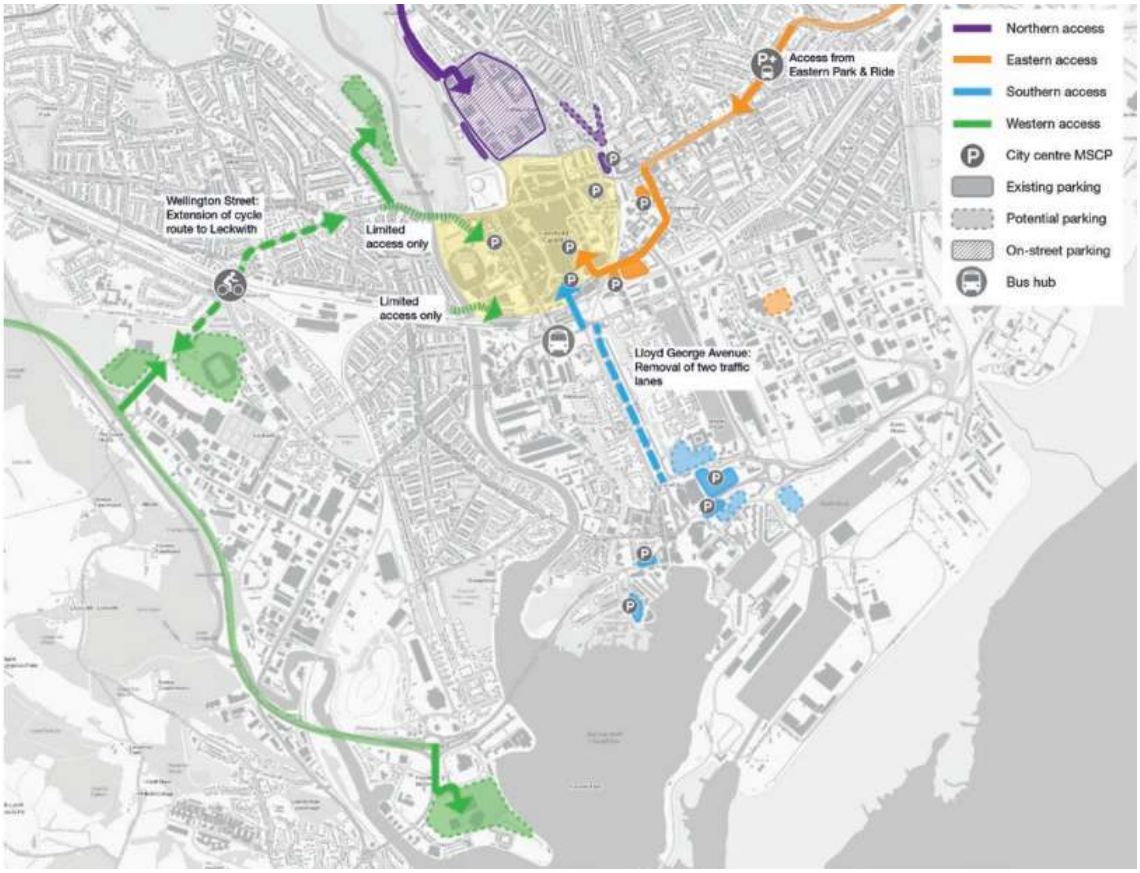


Figure 19 Location of the interventions of the Cardiff Strategic Plan, which highlights the accesses dedicated to non-motorized mobility, interchange parking lots and pedestrianization [33]

However, these measures take time to fund and implement and their effects will be seen in the coming years. To respond to the emergency, it was decided to focus on providing alternatives to road traffic, which, as mentioned, was both the preferred means of

transport for most of the inhabitants and the one to which users of the other alternatives would most likely turn. health security.

The decision was therefore to focus on “pop up” cycle paths, as in France, whose cities have characteristics very similar to those of the United Kingdom (small surface and high density). However, if in the first case we have seen very intricate routes, which often followed the trajectory of public transport and focused especially on the densest areas of the city, here instead we focused on the routes that lead from the suburban areas to the town center.

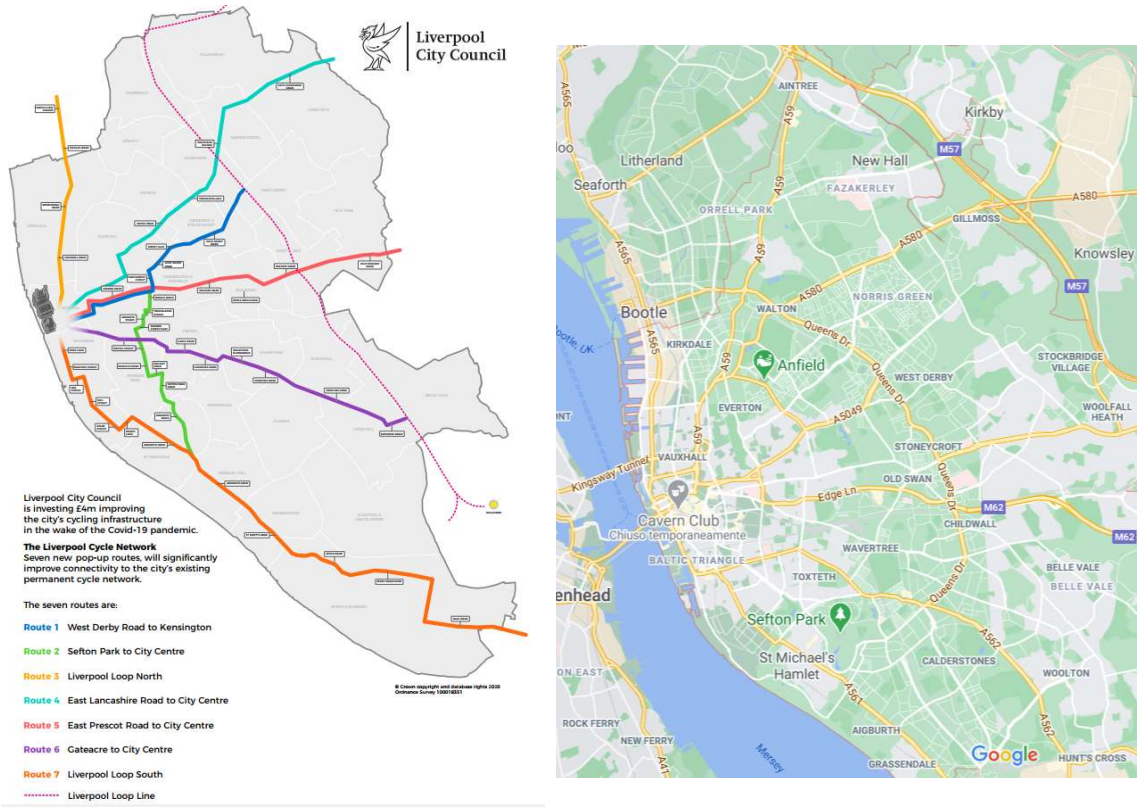


Figure 20 Topographical comparison between the pop-up cycle lanes introduced in Liverpool [56] and the main thoroughfares of the city [18]

We note the great importance of the interventions, which have gone to cover tens of km in many cities. Many cities in the United Kingdom update on the initiatives they are carrying out and it has been verified through the internet (social networks, blogs, Google Maps) that the number of interventions has been impressive. Unfortunately, in many cases no information is available on how many km were already built. For cities such as Liverpool, Birmingham, Manchester and Glasgow, interventions of the order of tens of kilometres have already been carried out. However, updated maps are available online,

which are reported in the annexes and in the bibliography. London, on the other hand, stated that it had built 25 km of cycle paths [20], but the figure has not been updated for several months and therefore it cannot be said what the actual extension of the new cycle network is.

Evaluating these installations from a constructive point of view, it can be seen how in some cases the space was obtained by dedicating one of the lanes of the high-speed arteries and building alongside the most evident protections (such as, for example, the New Jersey) given the high speeds and high traffic volumes characteristic of this type of road.

Figure 21 Example of a cycle path created from a main artery in Liverpool

In other cases, on the other hand, an existing network of cycle paths has been worked on and which, despite the scarce use of bicycles, has found itself very extensive in many cities. The interventions focused on increasing protection, in this case with cones or poles

since in most cases the site was promiscuous or adjacent with the lanes dedicated to the machines.

Figure 22 Example of protection of an existing cycle lane in Birmingham

On the other hand, almost no interventions have been carried out to favour pedestrian or integrated mobility. It is therefore likely that we did not want to focus on neighbourhood trips but on commuting for work and education, which are clearly in the majority: before the pandemic they represented 58% of total trips and 85% were carried out or with a motorized vehicle. or by public transport [35].

3.3.3 Analysis of the results

Unlike France, where a study was carried out with actual counts and calibrations that also consider climatic conditions and restrictions, the data with which the evaluations were carried out in this chapter come, as in the case of Barcelona, from the Strava app. Metro [14]. Although they are not a real statistical study, for the reasons already mentioned above they are considered reliable.

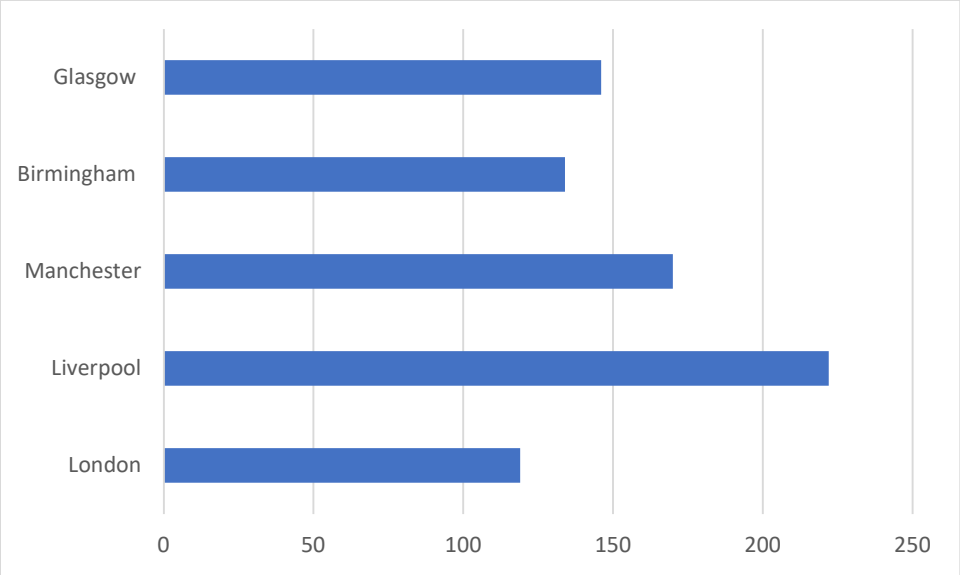


Figure 23 Percentage increase in cycling in major British cities

The results are extremely positive. In May 2020, when the lockdown was eased and the situation returned to a situation close to normal, the number of bike trips at least doubled compared to May 2019 in all the cities where the measures were taken.

The increase in cyclists has been so encouraging that the administrations have decided to pursue these initiatives by making permanent the cycle paths already built in a "pop up" way and building many more. Plans for the creation of networks of 100 and 150 km respectively have already been approved for Liverpool and Manchester.

3.4 Latin America

3.4.1 Context description

The great metropolises of Central and South America are a very interesting case. It was decided to analyse Mexico City, Bogota and Lima for the enormous similarity in many characteristics.

You immediately notice it when you evaluate the morphology of the cities, which have absolutely comparable surfaces, inhabitants and densities.

	Inhabitants	Surface (km²)	Density (ab/km²)
Bogotà	8080734	1775	4553
Lima	9822514	2672	3675
Mexico City	8918653	1485	6005

Figure 24 Morphological characteristics of Bogota, Lima and Mexico City [36]

The movements then, even if they present some differences, have in common the poor use of motorized private vehicles and the great importance of local public transport, which assumes impressive dimensions for Mexico City, where, moreover, soft mobility is practically non-existent.

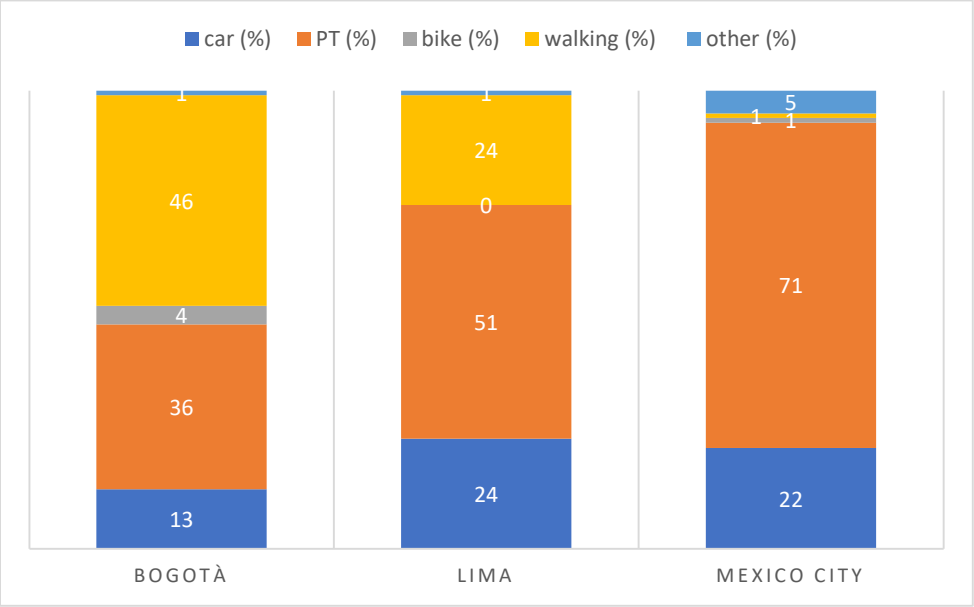


Figure 25 Modal split of Bogota, Lima and Mexico City [13]

The system can therefore easily go into crisis when the capacity of public transport is drastically reduced and motorized mobility is not yet a viable alternative for a large part of the population, who travels only on foot or by public transport.

These metropolises are also united by a very rapid economic, urban and population development. The inhabitants increase by the hundreds of thousands every year and have a median age between 26 and 28 years [37], while European cities have a population that is now stable and significantly older. Furthermore, the sharp economic rise is spreading greater well-being among the population.

The difference with respect to the European contexts analysed so far is clear. In fact, if from a morphological point of view these cities are very similar to the great European capitals, as far as development, economy and anthropological characteristics are concerned, we fully realize that we are in another continent.

All these dynamics are at the heart of the studies of the respective transport departments. As shown by the Ministry of Transport of Peru on the city of Lima [38], a general increase in mobility is expected in the coming decades and a shift in choice towards individual motorized vehicles. This requires huge investments in new infrastructures, dedicated to both collective and individual transport, which are often already planned or under construction but still take years to complete.

It is in this situation that the coronavirus epidemic has entered, which has seriously affected these countries.

3.4.2 Measures taken

The solution identified was, once again, the construction of pop-up cycle paths.

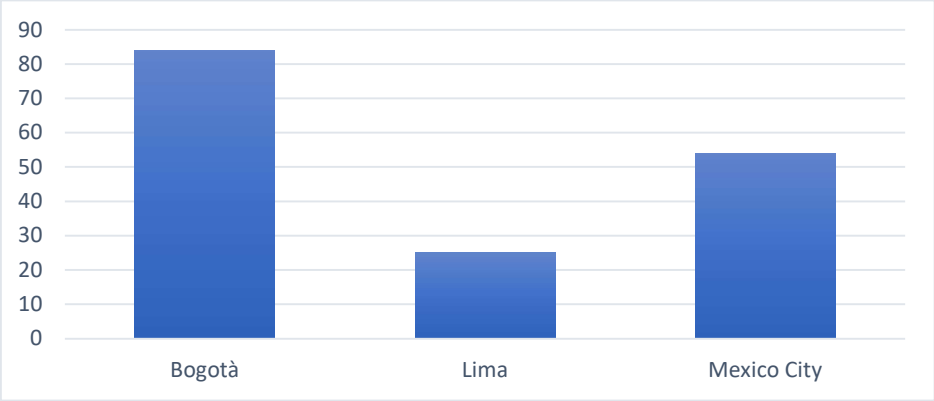


Figure 26 Extension of cycle paths built in Bogota [38], Lima [39] and Mexico City [40]

The purpose is twofold: to create mobility alternatives not only in order to distribute the movements in a more balanced way both in this emergency phase and in the future, but to be able to intercept the new demand, creating real lines of force. In fact, it is precisely along the routes of the main public transport and those planned for the future that they have been built.

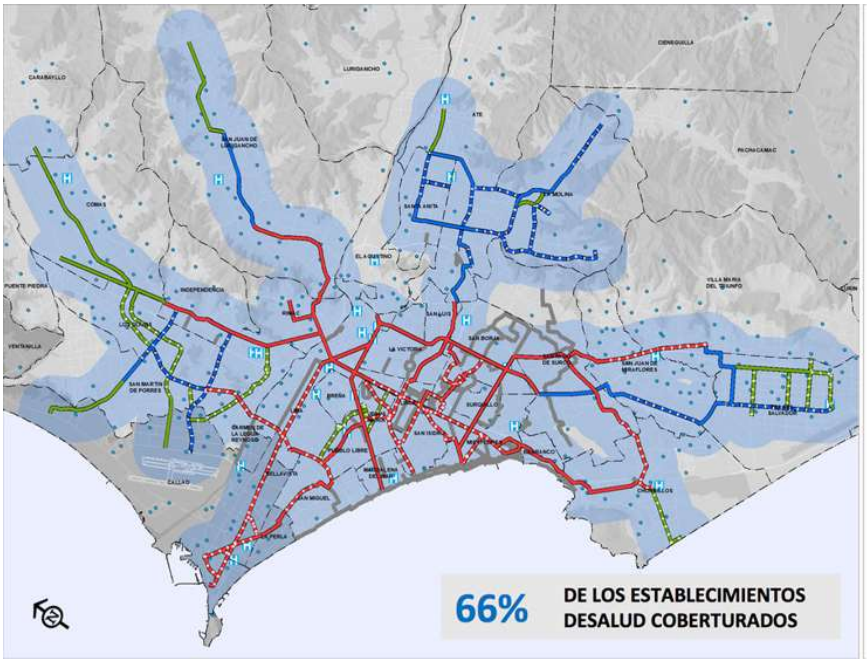


Figure 27 Map of the cycle network announced for 2020 in Lima [41]

Figure 28 Map of the future metro network of lima, of which only the green line exists for now

While for Lima it was a big news, for Bogota and Mexico City it was the thickening of an already considerable network (the networks were respectively 550 km for Bogota and 170 km for Mexico City). For this reason, the Lima plan expects to overcome the 200 km of new network by 2021. The topography of the interventions will cover even very long journeys, ranging from one end of a large metropolis to another. Imagining making a round trip to the centre, it is a question of cycling for 40 km every day.

This alternative would not be feasible in an older context such as the European one discussed so far. On the other hand, it is possible in such young contexts, where 50% of the mobility is made up of people under the age of 30, physically capable of making this effort every day.

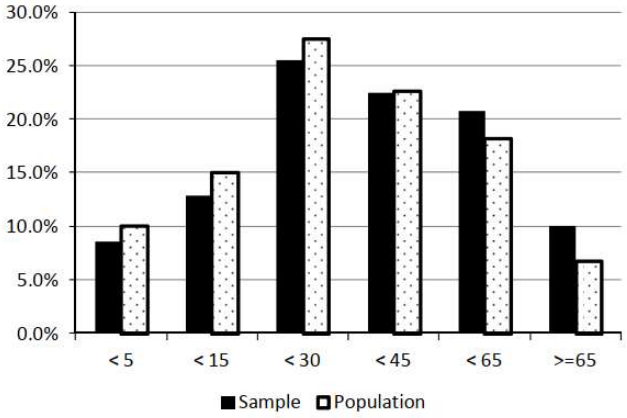


Figure 29 Transfers in the city of Lima divided by age groups [42]

In some cases, it was also proceeded in a rather hasty manner from an infrastructural point of view, with obvious security risks.

Figure 30 Pop up bike path in Bogota. The segregation is carried out with simple cones and without horizontal signs

However, there is another fundamental reason why, even before the epidemic, the cycle network in all these areas is expanding: all these cities are located in areas with very high seismic danger. In the event of a very violent earthquake, traditional transport infrastructures are no longer usable: the roads are not passable because they are full of debris and other vehicles, blackouts blow up traffic lights and subways.

As shown in the days following the violent earthquake that hit Mexico City on September 19, 2017, a capillary cycle network allows you to arrive safely in all parts of the city, even in the early stages of the emergency, bringing basic necessities and medicines while everyone the other vehicles are still unable to circulate [43].

The large networks are being created will allow cities to respond more quickly and effectively to the problems caused by any new tremors of great magnitude.

3.4.3 Analysis of the results

The evaluation of the results deserves some reflection. Also in this case, no in-depth statistical studies are available, but only the data of the counts released by the transport departments of the cities. Then, these are published with reference to different periods and situations, so it was preferred not to aggregate them and to treat the three cities separately.

For Bogota, the results have been impressive. Although the overall number of bicycle trips has decreased (due to the general reduction in mobility), the percentage of bicycle trips in 2020 has more than doubled compared to 2019, reaching an overall 13% [44]. The results are also very positive in Mexico City: bicycle trips increased by 221% [45] between March and December of 2020.

However, no official data on Lima is available. There are polls and counts on some private organizations bike lanes, but they are too limited and imprecise to be considered statistically significant. The data published by Google through user surveys of the Moovit app are certainly more reliable [46]. The data are fairly consistent with each other and show an increase in bicycle travel in the order of magnitude of Mexico City and Bogota, albeit to a slightly lesser extent. Again, more in-depth studies will be required to accurately assess the extent of the phenomenon.

As in the rest of the world, given the success of the initiatives, the administrations have decided to finalize the measures already taken and to increase the cycling infrastructure even more.

3.5 United States of America

3.5.1 Context description

The United States is probably the most difficult country to analyse

If all the other states have had a more or less consistent response over time in measures to combat the spread of the virus, a decisive factor in this analysis, the relationship of the United States with the emergency has been very oscillating between wanting to ignore the epidemic and being forced into very severe lockdowns once the infected had reached unsustainable levels.

The extension of the country, comparable to that of the whole of Europe, has seen a different evolution of the epidemic within the various federated states to the point that while some areas of the country are in the midst of the problem, others had very low levels of contagion.

However, even in the presence of such great differences, the measures to allow mobility to be possible have been the same across the country. In fact, there is a characteristic that the mobility of all US cities has in common: the enormous use of cars, which in many cities reaches a percentage of use of more than 90% of total journeys [13]. From this also derives the distribution of spaces in the streets, almost entirely dedicated to the car. Consequently, public transport, with the partial exception of New York, is very much in the minority.

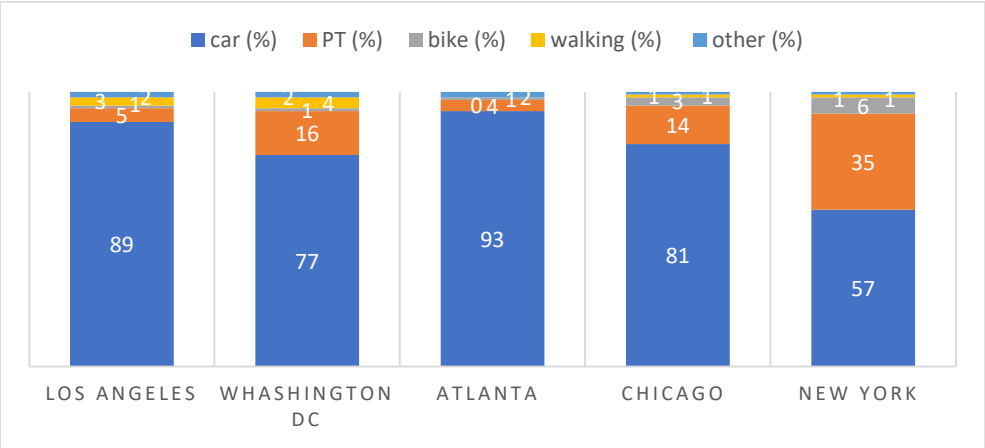


Figure 31 Modal split in major US cities

3.5.2 Measures taken

The counter actions taken derive strongly from the situation described.

In this case, too, they concentrated on encouraging gentle mobility, but in completely original ways. In fact, it was decided to take up space along the roads and dedicate it to micro-mobility, with two main methods.

The most similar was that of "shared streets", which are "zones 30", therefore roads with a low speed limit to allow weak users to use that same space more safely.

The other and more particular was the creation of "open streets", which prohibit the passage of motorized vehicles on the entire route in the main streets and on halfway in residential areas, in order to still allow the use of vehicles by residents. In addition to encouraging gentle mobility, we also wanted to make more space available to people during the most severe lockdown periods to stay outdoors.

The topographical distribution of the interventions is also very similar in the cities, which turns out to be very uneven, without a continuity such as to allow movements even of medium distance using them.

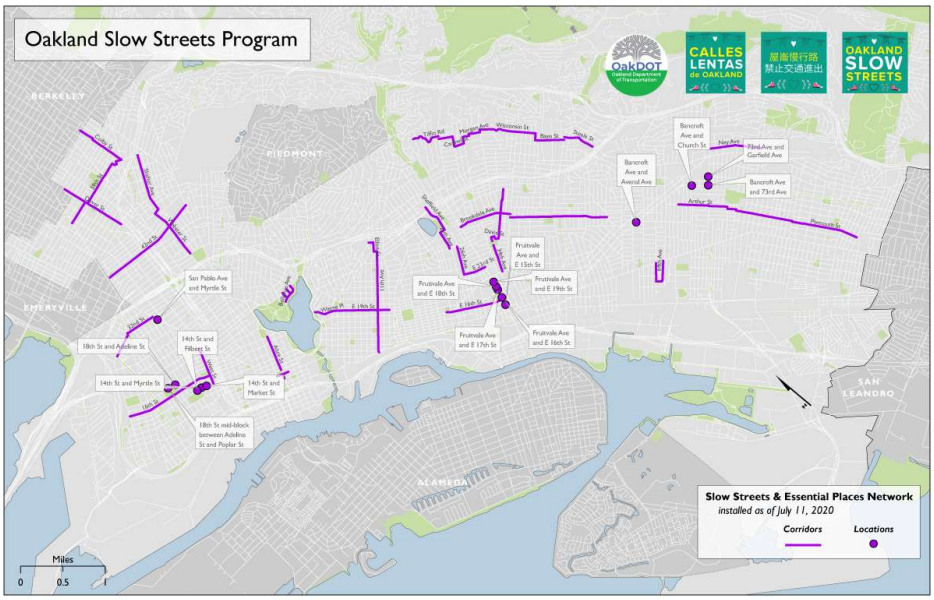


Figure 32 Map of Open Streets in Oakland, California [47]

Also in this case the nature of the infrastructures is pop-up, both to implement the measures quickly and because in many cases it has been chosen to keep the ban on vehicles only during the day.

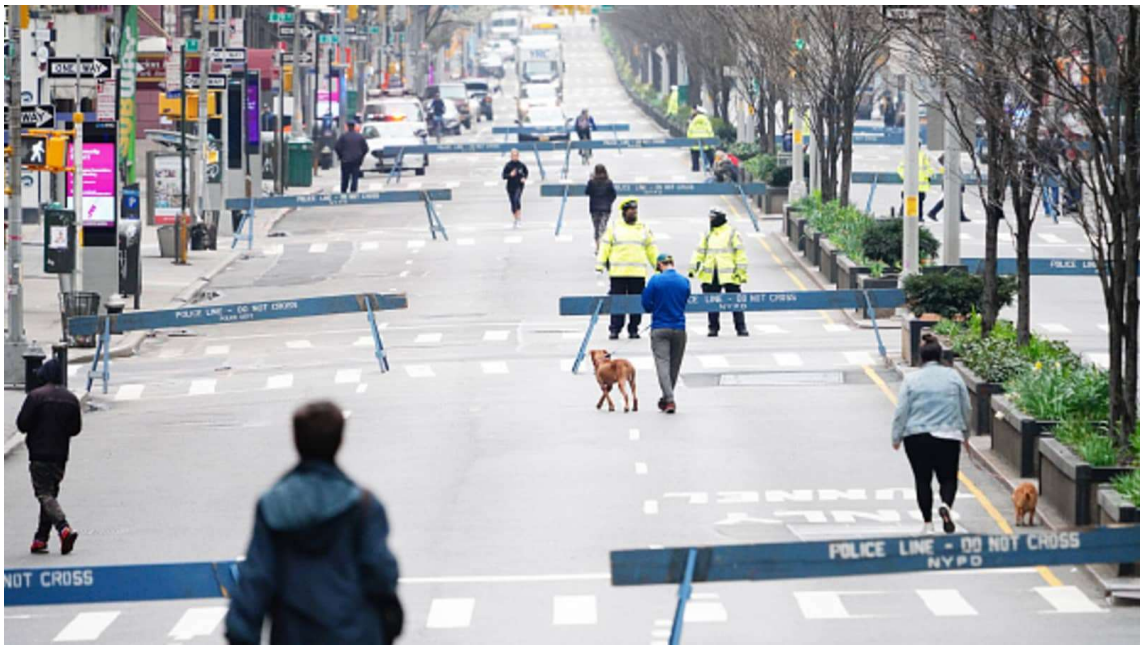


Figure 33 Open street in New York

Other measures have also been taken, such as widening the sidewalks, always in a pop-up manner,

In some cities, such as Oakland, a digital platform has also been set up where users themselves can express their feedback on the infrastructure and also leave suggestions.

3.5.3 Analysis of the results

Many difficulties have also been encountered with regard to the study of the results. In fact, as in all the other contexts analysed except the French one, there is no real statistical study that observes the change in mobility that took place in 2020 with all the necessary tools.

It is also noted that there is no direct correlation between the increase in bicycle use and the interventions prepared and that the trend in bicycle use is in any case very fluctuating, although generally increased.

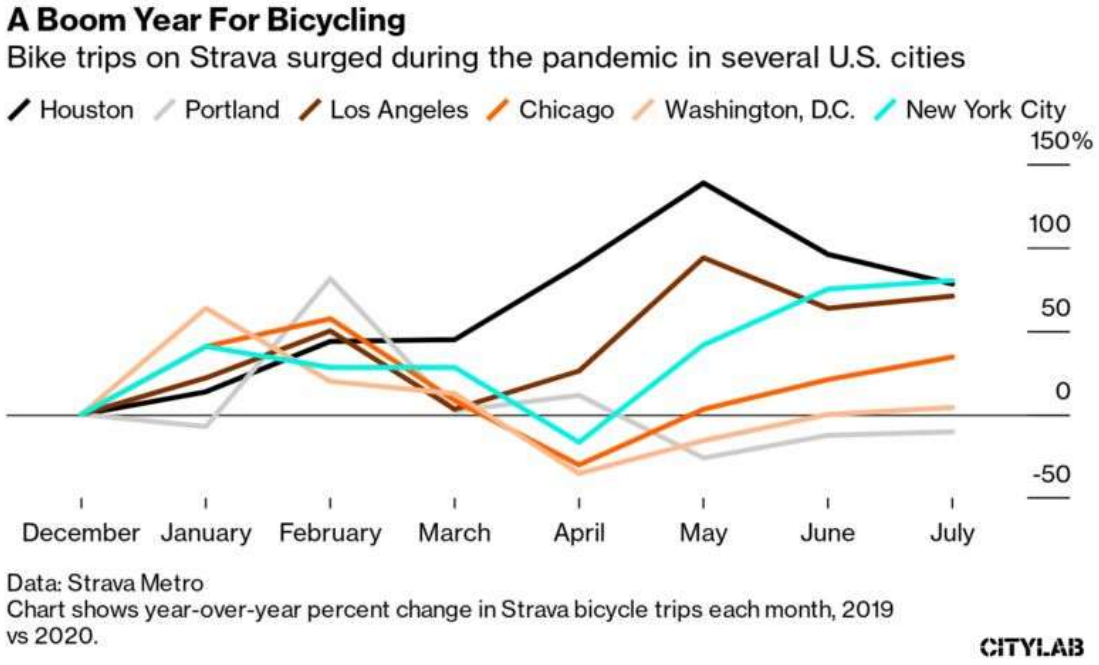


Figure 34 Bike travel trend according to Strava metro data in some of the main cities of the United States compared to 2019 [48]

Other cases, such as those in Philadelphia, show how the existence of protected cycle paths has meant that the number of bike trips has on average more than tripled compared to the same period in 2019 without any measures being implemented. It is therefore not possible to define to what extent the increase in bicycle travel reported by Strava Metro in all US cities is due to the measures actually taken or the change of modality carried out by citizens regardless.

The general lack of organicity then reinforces the feeling that while elsewhere individual sustainable mobility has proved to be a useful tactic in the emergency and projected into the future, in the United States a direction has been chosen that would facilitate immediate micro-mobility without however wanting to change the situation. previous once the emergency is over.

It is therefore believed that the particularity of the US case is such that it is not possible to fully assess what happened until the end of the epidemic, when the response of citizens and administrations can be verified.

3.6 Central Europe

It was decided to consider Germany, Belgium and the Netherlands together. It can in fact be seen how, with the exceptions of Berlin and Brussels, which will be discussed later, the cities of these nations have reacted in the same way despite the fact that the impact of the epidemic in terms of time and violence was completely different.

The measures to combat the epidemic at the state level have therefore been diversified and have had a different impact on mobility. In particular, while for almost all of 2020 Germany managed to have a much more efficient control of infections and consequently implemented very mild restrictions, the other nations were forced to impose much stricter lockdowns with obvious greater repercussions on mobility. . But even the cities themselves are different in morphological characteristics.

Despite these substantial differences, the answer has almost always been the same. not to intervene completely or to do it in a very mild manner.

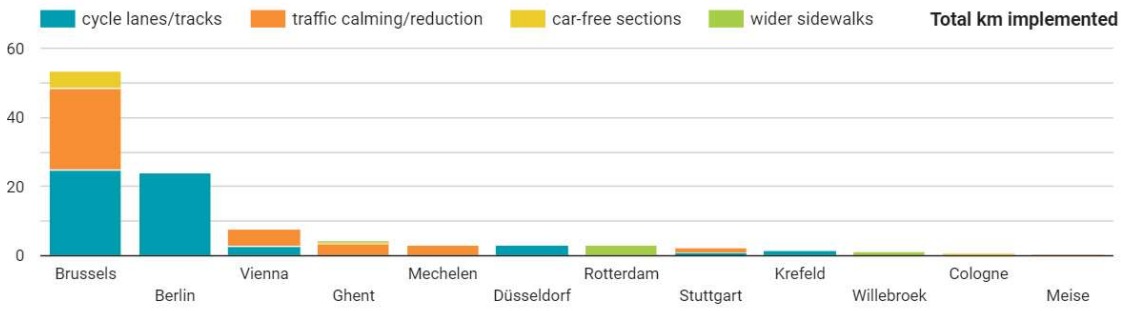


Figure 35 ECF ranking of northern European cities that introduced the most km of mobility changes in 2020 [20]

This is understandable in Germany, where until December 2020 the contagion situation has changed mobility to a much lesser extent. On the other hand, it is very surprising in other countries, which despite having been hit so hard have chosen to go in the opposite direction from the rest of the major European countries, despite the fact that the data on the reduction of mobility are similar to those of other countries.

The reason was identified in the transport infrastructures of these cities and modal split. In fact, it can be seen that these are very similar to each other.

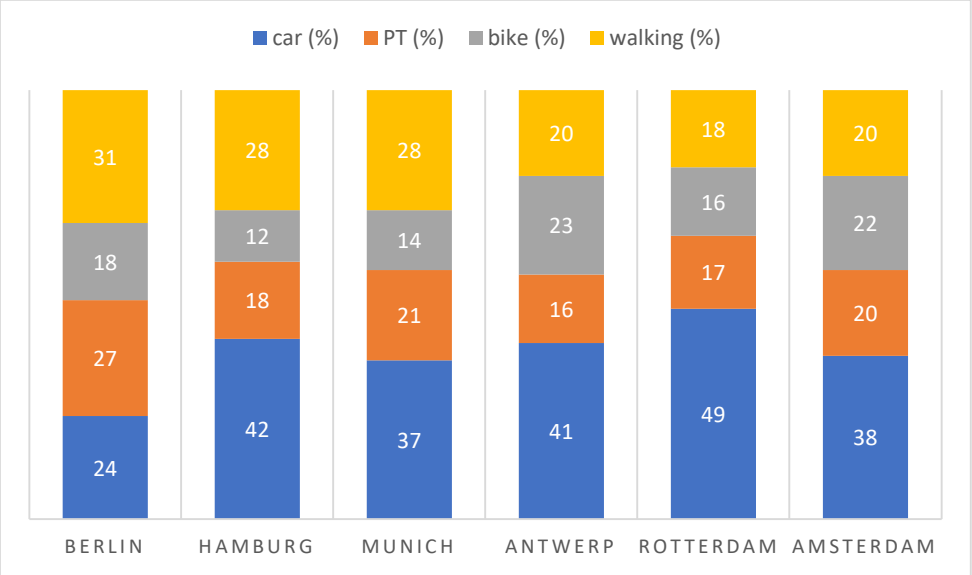


Figure 36 Modal split of central Europe cities

The analysis of the modal split in the cities considered in the tables, among the most important of the nations considered, highlights two factors. The first and most evident is that non-motorized mobility represents the minority of trips. The second is that among the other types of movements considered (by bike, on foot or by public transport) there is not one predominant.

Even before the emergency, the mobility system offered real alternatives - and perceived as such - to public transport and the car and for this reason it did not go into crisis. The dynamics, very similar to the Spanish one, allowed that compensation to be activated within it that was not possible elsewhere.

In this context, two exceptions were found, which it was decided to analyze separately.

3.6.1 Berlin

The capital of Germany has in fact built 25 km of pop-up cycle paths [20] to respond to the emergency. However, the need to implement these measures was not so stringent, as evidenced by the modal split of the city's movements, which shows how individual sustainable mobility is more important than in the major German cities. What drove the administration was the political motivation to increase the percentage of green travel in the city.

The reason why we chose to deal with this case, however, is the constructive one: the city of Berlin was the first to choose an original solution for the construction of cycle paths which was then replicated in many other cities.

The cycle path was built directly on the road, dedicating to it the space previously intended for parking, which are moved to the left instead of the outermost lane dedicated to the passage of cars.

Figure 37 Berlin pop-up cycle path, with protection provided by both delineators and the row of parked cars shifted to the left

The idea in its simplicity is very effective because it requires very few constructive interventions, is quick to implement, keeps the number of parking spaces unchanged and above all offers real protection for weak users. For this reason many other cities have decided to take this model project for the construction of their own pop-up tracks.

3.6.2 Bruxelles

Analysing the modal split of the Belgian capital, the motivation for such a strong response is immediately evident, which led to the construction of 25 km of pop-up cycle paths and the creation of 25 km of limited traffic roads and another 5 km of car-free zone [20]. In fact, it is noted that before the crisis in the metropolitan area of the city only 5% of journeys were of a gentle type, while 47% are individual motorized vehicles and 48% take place on public transport [12]. The system is therefore extremely unbalanced precisely towards those alternatives that proved, for the reasons already discussed, to be the most problematic during the epidemic.

The results of such a substantial action were evident. According to data from Brussels Mobilité [49], the number of cyclists in 2020 increased by 64% compared to 2019, a very high growth, which is even more surprising taking into account the general decrease in the number of trips. The number of car trips decreased by 20%, again compared to 2019, but it is not possible to calculate how much is due to the measures to discourage the use of cars and how much is due to the reduction in the number of trips. It would also be very interesting to evaluate the change in the number of walking trips, but the organization does not report this data in the study and it was not possible to find it from other sources.

The initiative of the city, however, did not stop only in the short term: a strategic plan was also approved and financed [50] which aims to revolutionize the entire mobility by 2030, starting from the initiatives already undertaken in 2020, with the evident purpose of favouring individual sustainable mobility to give breath to other modes of transport, now saturated. The plan has an overall view of the entire transport system and plans to discourage the use of the car - reducing the maximum speed to 30 km / h on all roads except those of flow and prohibiting the passage of non-residents in residential areas - and favour alternative mobility - both by pushing on multimodality in the streets in the

neighborhood streets and by creating cycle paths in a protected area that have preferential mechanisms at the intersections on the scheme of a urban light rail.

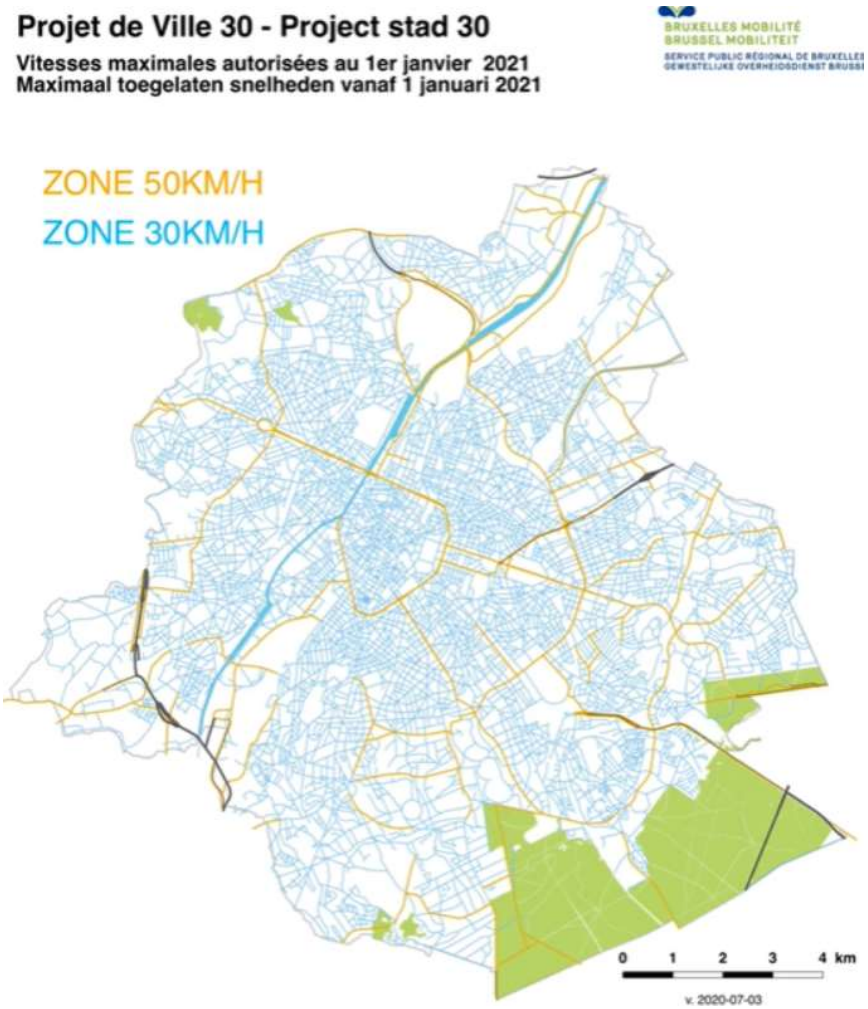


Figure 38 Map of the 30 zones of the city of Brussels from 1/1/2021 [50]

The first results have already been published [51]. In January 2021, the average speed of car journeys decreased by 9%, but journey times did not increase. There are therefore grounds for saying that this solution may be the key to allowing the integration of the various mobilities.

3.7 Italy

In Italy almost all cities are transported mainly by motorized vehicle or through collective transport, with the consequence of being particularly sensitive to the problems generated by the epidemic.

As regards Italy, it was not possible to identify an organic context within which to include the measures introduced. Each city has found its own way, with interventions similar to those that have been treated so far: construction of cycle paths, pedestrianization, experimentation of 30 zones.

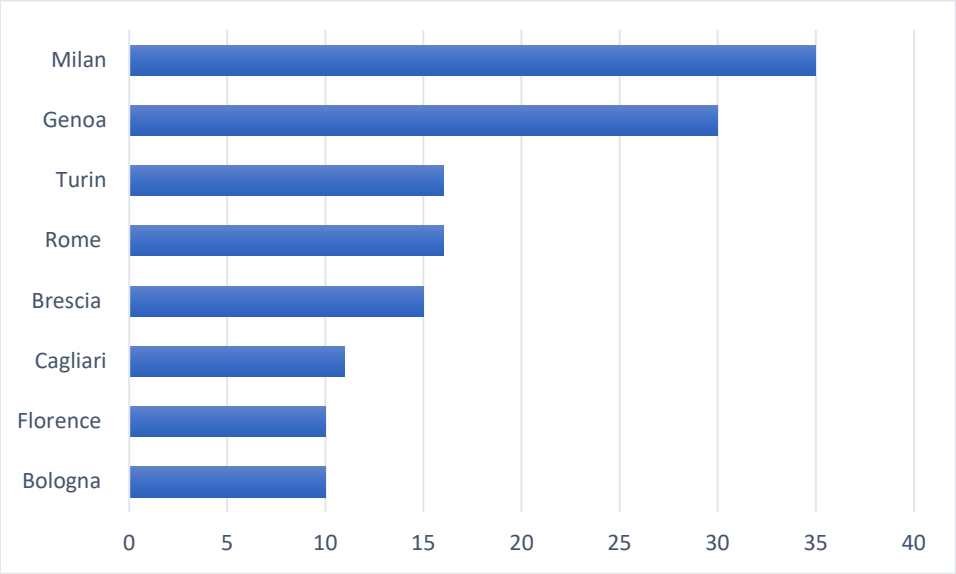


Figure 39 Italian cities with more km of cycle paths built [52]

There are no data or studies on pedestrian mobility as in other countries. Unfortunately, there are also none on cycle mobility in individual cities, apart from single counts on lines made by private associations, which show a net increase in passages [53]. Even if they cannot be considered appropriate for a definitive evaluation because they are not carried out with the capillarity and for the necessary period, they can be considered as indicators of a trend. However, the figure is confirmed at a national level: there is an increase in the use of bicycles in 2020 of 27% [52], higher than that recorded in other European countries. However, it is not possible to consider how much is due to the pandemic and

how long it will continue in the periods without restrictions on travel and the contagion period is over.

In Italy, too, they operated according to the scheme of tactical urbanism in order to act quickly and economically. However, in most cases it was only intervened with horizontal signs by creating dedicated lanes, without going to protect users with one of the many solutions that have been highlighted so far. This aspect is particularly critical from a safety point of view for all the reasons that have been dealt with up to now.

Figure 40 Example unprotected cycle path built in Milan

CHAPTER IV CONCLUSIONS

The Covid-19 pandemic has hit the whole world hard, albeit at different times and in different ways. In the field of study of this thesis, it has been noted how many cities have reacted, but according to their respective possibilities and needs.

The available data are not abundant, and largely focus on cycling, almost completely neglecting walking. However, it can be said that all measures have worked, often beyond the best expectations. They worked both in the most emergency period and when the lockdown was eased. The citizens' response was immediate and continued over time. It can therefore be said that the strategy implemented by all cities, of exploiting the response to the epidemic to solve the mobility problems prior to it, has been a success.

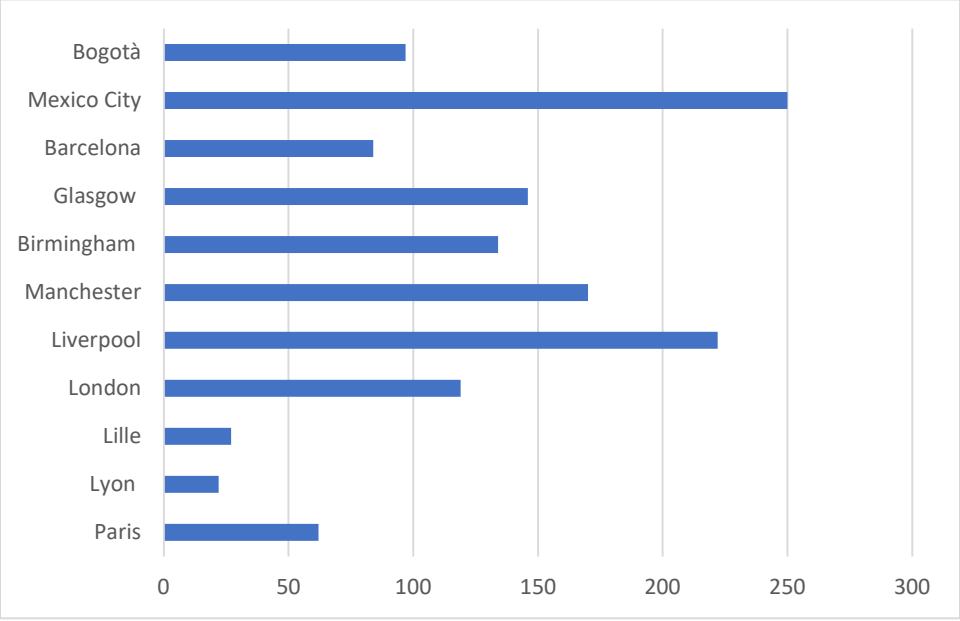


Figure 41 Some of the cities that have most experienced an increase in cycling mobility

The full assessment of how mobility has changed will only be possible when the virus is eradicated and the health situation is back to normal, but the numbers available so far show that sustainable mobility has taken a leap forward decades.

4.1 A diversified transport system

An element of strong reflection is given by the importance of having a diversified mobility system so that the emergency response is effective. In fact, the best response occurred in Spain and Central Europe, that is, in those contexts where transport choices were more evenly distributed between motorized transport, cycling, walking and public transport. In fact, it was not necessary to build new infrastructures or upgrade existing ones, because in the absence of saturated alternatives, the system has an internal compensation capacity that is automatically activated with the different choices of citizens, allowing the emergency to be overcome without serious problems. Proof of this is the fact that in cities that did not present this balance, citizens began to change modes of transport before the measures discussed during the thesis were implemented, automatically recognizing in the movement a strategic need.

In planning urban mobility, public transport has probably been taken too much into consideration, which has always proved insufficient despite continuous improvements. Individual soft mobility is therefore inserted as an alternative to partially satisfy the demand for transport and as a need to avoid that the transport system is too fragile because focused solely on a solution.

In the future, however, the same mistake must not be made, by neglecting collective transport in favour of individual transport: in order that urban transport to be efficient in periods of normality and ready to change in an emergency, it must be diversified and balanced.

4.2 Example for the future

As the epidemic has affected the whole world, a huge number of cities have found themselves facing the same problems. The contexts dealt with here were the most disparate, from medium-sized European cities to megalopolises in South America. The construction methods were the most diverse and original, even when it was a question of similar measures. The requests for transport that were wanted to be satisfied were different, from that of the neighbourhood to the commuters of medium-long distance.

We have seen that there are no universal solutions. Each city has an articulated, integrated and detailed mobility system to such an extent that a schematic and functional answer cannot be found for each case. It is up to the planner's experience to be thoroughly familiar with the mobility of the city and to take appropriate measures. One of the reasons for the success of the measures was precisely to have implemented measures that had already been planned and therefore were already inserted in the city context.

Therefore, those who want to intervene in a similar way in the future will have to go and see what has been done in the same context in which they are operating. As shown throughout this work, the greatest similarities in context, morphology, mobility problems and citizen habits are found in the national context. Looking at the nearby cities and copying what has been done and has proved successful (obviously adapting it to the case) is probably the best way to follow for all those cities that have not used the months of confinement to solve their previous mobility problems.

The cases studied in this work, starting from the huge global mobility laboratory that was created with the epidemic, can precisely provide guidelines precisely because this is the approach we wanted to give.

4.3 The trigger problem

However, for the cities that want to take this path in the future, there is a big pitfall: the emergency context that triggered the explosion of individual sustainable mobility in 2020 and 2021 will be lacking (hopefully).

The situation is very similar to that of the 1973 energy crisis in Amsterdam [54]. The city had congestion and security problems that it had not been able to solve for years despite being more than evident and much debated. Protected bicycle and cycle paths allowed mobility in emergencies and, when oil prices were lowered, they continued to be a very popular transport alternative.

Referring to the present, the case of Dunkerque is emblematic: having established the "30 zones" throughout the city has not increased cycling mobility for two years. During the epidemic, on the other hand, research on health safety increased bicycle trips, which however did not decrease when infections drastically decreased.

To change mobility with existences comparable to those measured during the epidemic, another push will therefore be needed, which represents a strong discontinuity. A solution could be represented by large economic incentives that make the use of bicycles, electric scooters and mobility in general extremely advantageous for an initial period compared to other alternatives, going into direct competition with the mode that is most unbalanced. in the respective context. For example, in a city where the car is the most used vehicle, a bike sharing service could be provided at a very low cost.

The investment can be expensive, but still limited in time. As demonstrated by both crises, oil and health, the problem of users about soft mobility is mainly of a prejudicial nature. When it is possible to make this alternative perceive as real, users continue to benefit from it extensively even when the conditions that led them to change have ceased to exist.

4.4 Tactical Urbanism

A decisive factor for the success of all these experiences was the pop-up form with which they were implemented, which fall within the concept of tactical urbanism.

This form of planning has in fact the best features to respond to the emergency according to the will of the administrations. Building the infrastructures in a flexible, rapid and economical way was fundamental in the initial phase, when an immediate solution had to be found to the new mobility needs. Furthermore, in the long run it is a low-cost form of experimentation that lends itself easily to improvements and can be made permanent later. Administrations can thus decide to invest the much larger sums necessary for permanent infrastructures when they are now sure of their necessity and effectiveness [55].

Further help to the planner is given by the spread of digitization: the immediacy with which each user, thanks to digital devises, can report defects on special portals allows to immediately highlight many critical issues, which precisely with pop-up infrastructures can be resolved quickly simply.

The opportunities provided by tactical urbanism are therefore very vast and it is likely that this way of thinking and acting will be increasingly widespread in the future.

4.5 Accidental safety

The analysis of the measures introduced allows to find a common denominator which, as evidenced in practically all the cases handled, was decisive: the accidental safety of the movement. In fact, if health safety was the decisive factor in the change of modality during the epidemic, the lack of intrinsic safety in the promiscuity of soft and motorized mobility was the basis of the lack of attention that users reserved for it.

Accidental safety was sought through two different principles, depending on the types of movements that were wanted to be protected.

For short trips, the solution identified was the integration of spaces. Since micro mobility is not by its nature ductable no dedicated infrastructures have been built, but the existing spaces have been redistributed and weak users have been protected with restrictions on circulation. It is in this direction that initiatives such as the widening of sidewalks, shared streets with speed limitations and filtering of users who can travel the streets have gone. They are therefore measures that have been introduced in residential districts and historic centres.

However, to make long journeys safe, integration does not work. Segregation was required through the construction of infrastructures dedicated to soft mobility, practically everywhere in the pop-up form. In fact, the demand they must serve is very high and develops right on the road axes with the highest and busiest speeds, making the mixed location impracticable.

The construction of cycle paths in South America deserves a separate comment: having a transport infrastructure available even in the case of catastrophic earthquakes that, unfortunately, periodically hit that part of the world, proves to be decisive in an urban environment to allow rescue in first few hours after the shock.

4.6 Developments of the thesis

The work described here can be a starting point for deepening the topics covered. Three fields of interest are identified.

The first is the refining of the work itself when more statistical studies on soft mobility will be carried out during the epidemic and when, hopefully soon, the pandemic will be over and the long-term effects of the measures introduced can be assessed. In particular, the major limitation of the work done is the lack of data regarding the pedestrian mode. Helping the development of this modality was certainly not the first goal of the administrations, probably trusting that the change would happen automatically. This is probably why we have not even focused on monitoring the phenomenon.

The second concerns the safety of the measures introduced. We must go and study how mortality and accident rates changed during the epidemic to resolve any problems not identified by the designers as soon as possible. In general, it has been seen that in 2020 they have increased considerably compared to 2019. However, it is not yet possible to make an accurate study of the problem. First of all, because the data on the increase in soft mobility are still partial and therefore no comparison can be made between the increase in users and that of accidents. Secondly, because the measures introduced, even if they share the same aims, have such a constructive variety that they cannot be schematized. Therefore, a dedicated study is needed, which analyses what happened on a case-by-case basis, highlighting critical situations.

Finally, it is considered necessary to study a remodelling of the models that represent the transport supply and demand system of a city. The epidemic highlighted how the classic service level attributes with which the generalized cost of the trip and the usefulness perceived by the user are defined (monetary cost, duration - and uncertainty of duration - of the trip, travel comfort, risk of accident), take on considerably less weight during an epidemic. The health risk, which until now had not been considered among the attributes, in this situation becomes a fundamental parameter that probably assumes the greatest weight of all. In particular, it would be interesting to highlight the difference between the level of health service actually offered by collective transport and the perceived level of users. For example, the authorities have established thresholds for the capacity of the

vehicles below which it is believed there is safety from contagion. But public transport almost never reached the capacity limit that had been declared, because users still considered them dangerous.

4.6 Future prospects

The Covid-19 epidemic has highlighted many of the critical issues in the world we live in. In response, it took a step forward whose changes could completely revolutionize even the cities in which we live, and consequently urban mobility.

Smart working will be increasingly widespread and will radically change the demand for mobility, especially commuting. The increase in individual sustainable mobility will make cities less polluted and more liveable. The vision of a "city of 15 minutes", where most of the services can be reached by micro-mobility within a quarter of an hour, would be a real revolution in the urbanization model that has developed since the end of the Second World War until now, with drastic changes for the entire mobility system.

The transport planner must therefore be able to encourage and accompany all these phenomena. The experience accumulated in all cities in this 2020 could be decisive in ensuring that these steps forward are taken.

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