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# Urban mobility and COVID-19: will public transport be able to accommodate the demand? An analysis for the city of Barcelona

## The impact of COVID-19 on mobility

Mobility data confirm that the population confinement measures taken to reduce the spread of COVID-19 have been highly effective. No matter what data source you use, the conclusion is the same: every region saw a dramatic drop in the number of journeys made after 13 March. This decline intensified after the entry into force of the Royal Decree of 29 March that further restricted travel related to non-essential activities, and today's values remain lower than normal. The National Statistics Institute (INE) offers mobility information based on mobile phone data with respect to normal circumstances, broken down into very small territorial areas[1]. According to figures provided by this source for the whole of Spain, journeys made by people outside their area of residence during working hours stood at 30% of normal levels at the end of March, a figure that had recovered to around 48% by 11 May.

The changes varied depending on the reason for travelling and the mode of transport used. Data offered by Google are particularly interesting, since they allow a distinction to be made between the different reasons for travelling[2]. For the whole of Catalonia, work-related travel stood at around 33% of normal values after the state of alarm was declared and fell to 23% between 30 March and 9 April, when only activities classified as essential were allowed. In the first week of May, work-related trips had recovered to 40% of normal values. The reduction in mobility for non-work reasons has been much sharper. School and university closures put an end to all study-related trips. Likewise, there were virtually no trips related to leisure and other personal reasons, although levels recovered after early May to reach 25% of normal values.

The information provided by ATM (Barcelona Metropolitan Transport Authority) and Barcelona City Council makes it possible to analyse, for the study area, the differential impact of the confinement measures on private and public transport. Graph 1 illustrates the percentage of demand, on working days, for each mode of transport compared to normal circumstances on a similar day in 2019[3]. First, there has been a sharper drop in the use of public transport. On average, the use of public transport during the entire confinement period has remained below 10% of normal levels, while the use of private transport stood at 30%. More importantly, the recovery of work-related travel has been absorbed primarily by private transport. According to data available for mid-May, private transport on access roads to Barcelona and within the city stood at 44% with respect to 2019 levels, while the figure for the ring roads rose to 52%. By contrast, public transport figures were barely 14% of the usual values. The different modes of public transport present similar behaviour. The figures show that a fear of contagion has impacted user confidence in public transport and made it essential to design measures to help boost trust.

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## Public transport occupancy levels under different scenarios

Given the mobility patterns seen over the last two months, there is no doubt that the pandemic will have an impact on transport in urban areas, at least in the short and medium term. More structural behavioural changes are difficult to predict right now; it will be necessary to wait and see how the spread of the disease evolves in the future. In any case, as the de-escalation process advances, people's mobility needs will increase, thus making it essential to seek out an appropriate solution to ensure that transport does not stand in the way of an already difficult economic recovery process.

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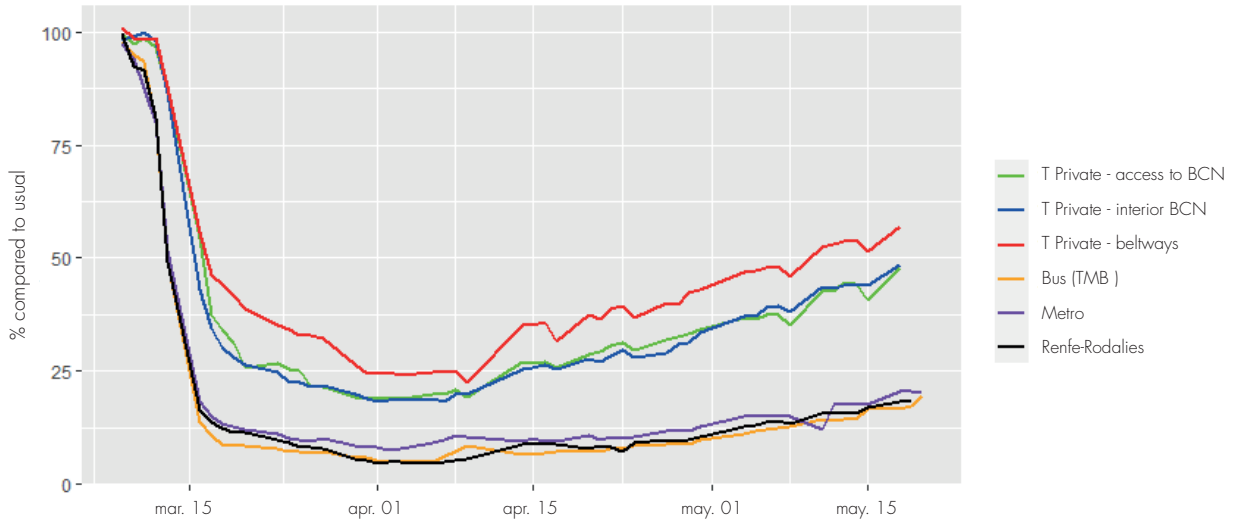
Public transport faces the challenge of continuing to guarantee this mobility. From the outset, user confidence must be restored through measures to reduce the risk of contagion. These measures include introducing distancing conditions inside vehicles to achieve lower occupancy levels. This, however, reduces the effective capacity of the public transport system and

[1] National Statistics Institute (INE): https://www.ine.es/covid/covid_movilidad.htm

[2] Google LLC "Google COVID-19 Community Mobility Reports": https://www.google.com/covid19/mobility/ [last accessed: 19/05/2020]

[3] ATM (Barcelona Metropolitan Transport Authority): https://www.atm.cat/web/ca/covid19.php?expandpanel=oferta-demanda; Barcelona City Council, Municipal Data Office: https://dades.ajuntament.barcelona.cat/seguiment-covid19-bcn/ [last accessed: 19/05/2020]

Figure 1. Transport trend in Barcelona. Working days




Source: ATM and Barcelona City Council

raises the question of whether it will be feasible to meet demand in the new scenario without causing saturation.

Next, we analyse the level of demand that public transport in Barcelona will be able to accommodate without causing saturation if the new distancing parameters are implemented. Our approach to answering this question uses data on the distribution of demand on Barcelona's municipal transport network between buses and underground transport. These data are taken from the latest available working day mobility survey (EMEF, 2018)[4] and some descriptive variables relating to the supply of Transports Metropolitans de Barcelona (TMB) for underground transport and buses[5]. It is important to note that this aggregate approach can obscure widely varying situations on different lines or on specific sections of the network that cannot be identified in this work. This would require access to disaggregated data relating to the occupancy of buses and underground transport at different times of day, on different sections of the network and according to the reason for the trip, information that is not publicly available.

According to the EMEF, on a working day in 2018, there were 2,480,094 trips made on public transport that originated and/or ended in the city of Barcelona; 40.8% of these trips used underground transport, 30% used buses and the remaining 29.2% used other modes (e.g. FGC, Renfe and tram). This figure includes residents of the city and the rest of the Barcelona Metropolitan Region, but excludes tourists and residents from outside the Barcelona Metropolitan Region. Fifty-five percent of public transport trips were obligatory in nature (study or work reasons, including return journeys) and 45% related to personal reasons (leisure, shopping, personal dealings, etc.). Obligatory trips were split 84%-16% between work and study reasons.

Based on the average values of traffic speed and capacity of TMB vehicles and train coaches in rush hour conditions, we have calculated the average vehicle occupancy level during peak-demand periods. As mentioned above, this average value may obscure a high variability between different points of the network, but it serves as a reference to estimate the network's capacity to operate without saturation in different scenarios.

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For the purposes of calculating the change in the effective capacity of the system and its impact on occupancy levels, we assumed a reduction in the capacity of buses in accordance with the provisions of order TMA/384/2020 (50% of seats and two people per square metre). If we accept a value of 30 passengers with respect to the average of 85 seats

[4] The latest data available from the EMEF relating to Barcelona are from 2018 (https://www.atm.cat/web/ca/observatori/enquestes-de-mobilitat.php), while the data on TMB and underground networks can be found at: https://www.tmb.cat/documents/20182/94438/Dades+viatgers+bus+metro+2020_CA_EN/

[5] TMB is the main public transport operator in Barcelona and the Barcelona Metropolitan Region. It manages the underground transport and urban bus networks.

**The scenarios show that only very severe reductions in the number of passengers travelling on public transport would allow the capacity requirements to be fulfilled.**

in normal situations as valid, the reduction amounts to 65%. If the same value is applied to the underground network, the effective capacity of the entire public transport network is reduced to just over a third of normal values[6].

It is clear from these values that, if demand does not change with respect to pre-crisis values, the situation will clearly be unsustainable, since occupancy levels at peak times would be multiplied by 2.85. Questions arise, therefore, about how the system would perform with respect to occupancy levels in different demand evolution scenarios.

Public transport demand varies depending on different factors. On the one hand, trip generation depends primarily on the need to travel. Furthermore, modal shift phenomena may occur if alternative modes (travelling by car, by bike or on foot, for example) are perceived by users to be more appealing in light of the current circumstances. With the information currently available, it is not possible to determine the importance of each of these factors separately; however, we can conclude that the combined effect of all factors will be a reduction in the demand for public transport during peak-demand periods. The calculations of the different scenarios are based on assumptions about the decline in overall demand for public transport for all the reasons mentioned.

Table 1 summarizes the results of three simulations concerning the reduction in transport demand for different reasons.

The first scenario involves a 42% reduction in work-related trips on public transport compared to the pre-crisis situation. The continuation of teleworking would account for 20%, in line with the findings of a recent study by IVIE[7], which used data from Randstad and found that 22% of the working population has access to this option. The effect of job losses, which current estimates put at around 7%, are added to this value, which is considered a maximum. Moreover, there would be a modal shift towards private transport and active travel. Although there is insufficient information to quantify this phenomenon, we would hazard a guess that it would lead to a 15% reduction in public transport demand, which is consistent with the trend observed over the last two months. In addition, the scenario assumes that study-related trips would reduce by 50% due to the distancing measures proposed for schools and universities. Lastly, personal travel will continue to be affected by people's lack of confidence in public transport. We have assumed, therefore, a 30% reduction in these trips. Thus, in this scenario, demand for the public transport system as a whole would stand at 62% of normal 2019 values; therefore, peak-hour occupancy levels would multiply by 1.79 given the new distancing parameters. It is clear that the sustainability of the system could not be guaranteed in this scenario.

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[6] In the case of the London underground, Transport for London has announced that the capacity will be cut to 15% of normal levels.

[7] F. Pérez and E. Benages, Restringir la movilidad para combatir el Covid-19 y recuperar la actividad económica, COVID-19: IvieExpress, IVIE, 9 April 2020: https://www.ivie.es/wp-content/uploads/2020/04/04.-Restringir-la-movilidad-para-combatir-el-COVID-19-y-recuperar-la-actividad-econ%C3%B3mica.pdf

Table 1. Scenarios of mobility changes by trip reason with respect to their usual values and impact on public transport occupancy level (bus and metro)

| | Reason for trip | | | | | |
|---|---|---|---|---|---|---|
| Scenario | Work | Study | Personal | Total demand | Capacity of the system | Occupancy level |
| 1 | 58% | 50% | 70% | 62% | 35% | x1,79 |
| 2 | 58% | 50% | 9% | 35% | 35% | x1,00 |
| 3 | 32% | 28% | 39% | 35% | 35% | x1.00 |

One of the consequences of the spread of COVID-19 will be changes in mobility in urban areas. Firstly, individual preferences have shifted towards less mobility due to a loss of confidence in commuting, especially on public transport. Secondly, control of the epidemic requires that restrictions be implemented with respect to the level of public transport use, thereby significantly reducing the system's capacity to absorb mobility flows.

In the second scenario, we consider what level of reduction in personal travel on public transport would make the capacity reduction sustainable, without modifying obligatory journeys beyond the reduction anticipated in the first scenario. The result is shown in the second row of Table 1, and indicates that personal travel would have to decrease by 91%, down to just 9% of normal levels. In other words, virtually all journeys by public transport for non-obligatory reasons would have to be eliminated. However, since personal travel is not concentrated at peak periods, such measures would not be expected to prevent saturation of the system during peak-demand periods.

Given the challenges identified, the third scenario considers that demand on all grounds would decrease by the same level as the first scenario, in the proportion required to maintain occupancy levels. The results show that demand would have to fall by around 70% in obligatory travel and 60% in personal travel.

It is important to note that the above calculations are based on a set of assumptions and the absence of information regarding the hourly distribution of demand related to different reasons, and do not take account of demand from tourists and residents from outside the Barcelona Metropolitan Region. Moreover, it must be stressed that these are average values for the whole network, which may obscure widely varying situations at different points on the network. One of the major problems with managing public transport networks is that different locations are affected by very varied congestion conditions simultaneously; this situation is expected to be exacerbated by the reduction in the effective capacity of vehicles.

## Concluding remarks

One of the consequences of the spread of COVID-19 will be changes in mobility in urban areas. Firstly, individual preferences have shifted towards less mobility due to a loss of confidence in commuting, especially on public transport. Secondly, control of the epidemic requires that restrictions be implemented with respect to the level of public transport use, thereby significantly reducing the system's capacity to absorb mobility flows.

If we accept that public transport remains essential to guaranteeing sustainable mobility in urban areas, measures will be required to strengthen it and optimize its capacity. These scenarios show that only very severe reductions in the number of passengers travelling on public transport would allow the capacity requirements to be fulfilled. Active travel (i.e. on foot and by bike) can help reduce demand, but it can hardly replace public transport to the extent necessary to avoid saturating the system under the new distancing conditions. Therefore, in the short and medium term, teleworking should continue where possible and travel for personal reasons must be reduced. In addition, it is essential that trips are distributed more evenly throughout the day. Traffic peaks in the morning and, to a lesser extent, in the afternoon, are caused by work- and study-related journeys. For these measures to take effect, it is essential that companies, education centres, public services and other labour market stakeholders get involved in the process. In the medium and long term, investments in public transport, which are designed to make the system more efficient and sustainable with a view to benefiting society, cannot be brushed aside.

**Javier Asensio and Anna Matas**