

# 213 Sustainable and inclusive digital mobility services in times of Covid: a case study of Barcelona

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## Abstract

In the transport and mobility sector, developments such digitalisation, smart applications, local-based digital services, are radically altering mobility patterns, offering a whole range of mobility innovations that meet the fast-changing lifestyles of Europeans. Nonetheless, while transport public services and products become more interactive and are increasingly offered solely online, different societal groups do not fully benefit from these new opportunities offered by digitalization. In fact, the lack of a proper digital literacy can lead to situations of exclusions from many transport services and facilities, as most of them move online or integrate digital elements. The most vulnerable people experiencing mobility exclusion are mainly linked to situations of multiple social disadvantages related to physical impairment, material deprivation (low income, migrants), cultural issues (ethnic minority background), and demographic variables (elderly). National legislation addressed to ensure access to essential mobility services and products has often a limited reach, since technological advances are faster and permeating the mobility ecosystem. Therefore, the design of inclusive mobility solutions has a key role in maximising social inclusion and improve the user experience.

The research presented is part of the DIGNITY project – Digital Transport in and for Society (<https://www.dignity-project.eu/>) – a research European H2020 initiative, aims at promoting a sustainable, integrated and user-friendly digital travel eco-system, which improves accessibility and social inclusion, travel experience and the daily life of all citizens. This, in turn, will foster the use of public transport system, helping the transition towards more sustainable mobility solutions. The project approach combines analysis with concrete actions to make digital mobility services inclusive over the long term, connecting users' needs and requirements with the provision of mobility services.

The key challenges addressed in the project are: i) understanding how the needs and characteristics of all end-users are considered in the design of digital mobility solutions and ii) supporting policymakers to plan long-term strategies to reduce the digital gap in transport innovations, considering vulnerable groups and gender issues.

Four case studies (pilots) have been selected in five EU partners countries – Spain, Italy, Belgium, the Netherlands and Germany – based on their ambitions for working towards inclusive sustainable mobility solutions (<https://www.dignity-project.eu/pilots/>). This contribution specifically addresses the case study based in Barcelona, one of the leading cities undergoing a smart city transformation. The propensity to use digital transport information and services in the Barcelona Metropolitan Area (BMA) has been assessed through a quantitative survey. The results discuss the habits of Barcelona citizens in current local mobility characterised by Covid-19 pandemics, as well as the need of promoting more inclusive digital solutions, specifically in public transport.

**Keywords:** Mobility, Social inclusion, Inclusive digital solutions, Sustainable mobility

## Introduction

Digital transformation has a great impact on the daily lives of people. Public products and services are becoming more interactive and are being increasingly offered online. Nevertheless, some groups in society do not fully benefit from the opportunities of digitization (Groth, 2019; Loos et al., 2020), (for instance, women, people who are older or have functional impairments, low education, low income, as well as short-term migrants and ethnic minorities) and are more likely to be excluded from many services and facilities (Durand and Zijlstra, 2020).

Furthermore, the last technological advances in the transport and mobility sector, such as digitalization, availability of smart applications, and local digital services are radically altering mobility patterns and offer a range of mobility innovations that respond to rapid changes in lifestyles. New mobility concepts include a wide variety of elements, such as novel products, data-based processes, and services inspired by new transport dynamics e.g., Mobility as a Service (MaaS) or on-demand public transport, as well as new business models. However, many services are offered currently as an "online" mode or incorporate digital elements, and the lack of adequate digital literacy or of specific competencies/skills can be expected to generate situations of exclusion. This may exacerbate the conventional structural disadvantages due to the emergence of new systems and modes of transport that are not accessible to people with low digital sovereignty. This digital divide in mobility mainly affects citizens at risk of exclusion and encompasses different social dimensions which often accentuate situations of poverty and social injustice, such as: gender, poverty, low education level, age, reduced mobility, migrant status, ethnic minorities, etc. Until now, technology has not yet contributed to universal access and most of the new transportation technologies have more greatly benefited a specific demographic: urban, young, tech-savvy, and usually well-off (Vandycke, 2018).

Therefore, commuting and mobility produces new challenges for the political agendas and the development of the public and private sectors, with a strong presence of information and communication technologies. In this context, there are synergies appearing that can produce social exclusion in the field of mobility and the use of new technologies. Different studies are examining the digital divide and transport poverty in greater depth (Kuttler and Moraglio, 2020). Nevertheless, the growing relationship between mobility and the use of new technologies, as well as the tendencies of governments and companies to move towards digitization, require further studies relating the two concepts and give a precise overview of social exclusion and situations of inequality that are being generated in this area.

## The opportunity of the DIGNITY project

Digital mobility services should be based on and promote inclusivity, taking into account the attitudes, skills and capabilities of users that might not fully benefit from mobility digital services. Understanding the aspects related to the integration of inclusiveness in digital mobility services is one of the research objectives of the DIGNITY project (DIGital traNsport In and for society, 2020, <https://www.dignity-project.eu/>) a European initiative funded as part of the European Union's Horizon 2020 research and innovation programme. The overarching objective of DIGNITY is to foster a sustainable, integrated, and user-friendly digital travel ecosystem that improves accessibility, social inclusion, travel experiences, and daily life of all inhabitants. DIGNITY aims to contribute to the development of a transport system that is inclusive, digital, and interconnected, and that meets the needs of all residents. The project has fourteen partners from six European countries and selected four pilot studies in five EU partners' countries (Spain, Italy, Belgium, the Netherlands, and Germany) for their innovative proposals in sustainable and inclusive mobility solutions.

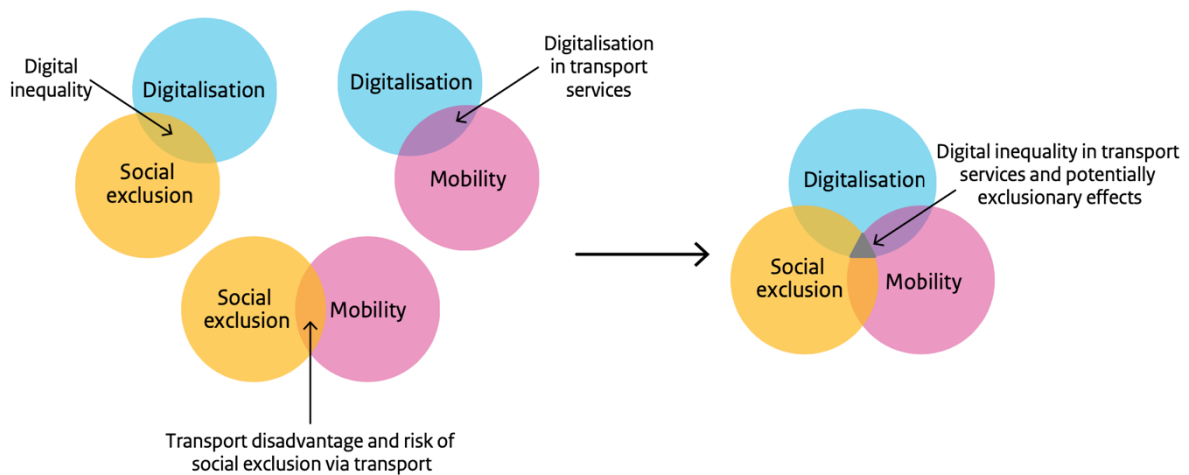
The project thoroughly examines the digital mobility ecosystem to understand the full range of factors that could lead to disparities in the adoption of digitized solutions for different user groups in Europe. Its aim is to propose solutions for an inclusive digital transport system that takes into account the needs and characteristics of all sectors of society, with particular attention to digitally excluded groups. The idea is to support public and private mobility providers in their conception of general digital products or services, to make these accessible and usable by the largest possible number of people, regardless of their income, location, social or health situation, or age. The challenges of digitisation are analysed from the perspective of users and suppliers, through a new approach that connects users' experiences with the available products and services, while analysing how transport policies and strategies can support a more inclusive digital transition. Four case studies on implementing inclusive mobility solutions have been selected as pilot projects, based on their ambition of working towards these types of solutions: Ancona (Italy); Barcelona (Spain); Flanders (Belgium), and Tilburg (the Netherlands).

This paper is specifically based on the case study of the Barcelona Metropolitan Area (BMA). The objectives are to: i) characterize the context of digital exclusion with respect to mobility in the BMA, and ii) to understand the patterns of use of digital technologies by residents for their daily mobility. The research work is partially based on a Master's Thesis conducted by one of the authors of this article (Wybraniec, 2021), under the direction of the first and the last author.

## Methods

The research applied a mixed-method approach, combining a literature review and a quantitative survey data analysis. The review of literature has been carried out by investigating challenges and trends in the context of sustainable mobility, with special focus on the new digital services, inclusive design and related problematic of digital exclusion (Hoeke et al. 2020) and mobility poverty (Kuttler and Moraglio, 2020). It was found that the great part of the research done till now in those matters has been focused on each of the topics separately and there is still lack of literature addressing digital gap in mobility in particular. As a result, the literature review has allowed to identify the most adequate scheme for analysis of the survey data and interpret them properly thanks to the previous contextualisation of the main concepts relevant in the studied domain.

A scheme marked out in Durand & Zijlstra (2020) has been used as a framework for understanding the digital gap related to the new mobility services in the context of the BMA. The three principal areas of the analysis are digitalisation, social exclusion and mobility, along with the intersections between each of them. As shown in Figure 1, the target and core focus of this study is the central point formed by an interconnection of those main topics, namely digital inequality in transport services and its potentially exclusionary effects. Applying this approach is considered well-founded and reasonable as a great part of the past studies are mainly focused on one of those realms individually and there is still lack of scrutiny that would integrate the aforementioned themes. In addition, previous research has tended to focus on singular aspects of digital mobility exclusion, such as specific determinants that may cause and exacerbate mobility-related disadvantages of a particular vulnerable group. In contrast, this work takes a wider perspective by analysing those three interrelated areas and looking at a range of factors across the population as a whole. What is more, the fact that people at risk of exclusion typically belong to more than one specific group has to be taken into account. Therefore, it enables to consider digital exclusion and mobility poverty as a complex, interrelated and multi-layered phenomena, which requires in-depth research in order to be able to understand the nuances affecting it.



**Figure 1. Project scheme/framework. Source: adapted from Durand & Zijlstra, 2020.**

## User survey in the Barcelona Metropolitan Area

The user survey used in this study forms part of the work done within the DIGNITY project (DIGNITY, 2020). The survey aims at improving the understanding of the patterns of use of digital technologies among the resident population in the BMA. The survey was conducted in Barcelona and other pilot cities. In the BMA, the fieldwork of collecting interviews was entrusted to the GESOP (Gabinet d'Estudis Socials i Opinió Pública - Cabinet of Social Studies and Public Opinion), an independent market and opinion research institute from Barcelona, who carried out a population-representative survey (n=601) conducted at the end of 2020. The survey questionnaire was adapted from a previous questionnaire examining digital exclusion (Goodman-Deane et al., 2020). It contains 96-questions/variables, divided into eight parts, each of which addresses specific issues related to; users' access to and use of digital technology, their digital capabilities, attitudes towards technology, current use of and attitudes to digital transport services and limitations in their regular mobility. Specifically, the survey objectives are to:

- measure level of accessibility and use of different technologies;
- measure use of digital mobility services;
- analyse characteristics that affect how a person interacts with the technologies;
- analyse daily mobility habits and its changes due to the pandemic.

Apart from that, this study provides an additional insight about the impact of the COVID-19 pandemic on the mobility patterns of the BMA residents and public opinion regarding measures for future urban planning.

The work presented here is mainly focused on specific topics of the survey:

- Technology access and use: related to the access to and frequency of use of different devices;

- Technology for public transport: addresses issues related to the use of digital public transport services;
- Demographics: describes characteristics of the population (e.g., social, educational, residential, etc.);
- Questions about daily mobility.

Although two subsamples were defined (one for the city of Barcelona, and the other for the remaining metropolitan area), this article only presents grouped data. Interviews were stratified by district, and the potential interviewees were selected randomly after taking into account quotas of gender, age, nationality and type of place of residence.

## Results and Discussion

The results of the survey highlight interesting characteristics in the use of digital technologies and services related to mobility, as well as the main limitations and concerns of the main groups analysed in the BMA. The next paragraphs provide analysis based on the quantitative data gathered through the questionnaire and outline general gaps and trends among the studied population.

### Digital inequality

First of the analysed intersection is the digital inequality, which comes as an effect of digitalisation processes and could aggravate already existent social exclusion. This creates disadvantages for vulnerable groups which cannot take advantage out of new technological solutions in daily life because of lack of access and/or skills to use the ICTs.

According to the results, in the context of the metropolitan area of Barcelona, the Internet is the most accessible technology, with almost 93% of the population connected. This confirms the results presented in a recent report of Barcelona City Council (Ajuntament de Barcelona, 2020). This set the digital divide in Barcelona of about 7% of the population. If we extrapolate this percentage to the total of about 3,3 million of residents living in the BMA (Ajuntament de Barcelona, n.d), we will get more than 200.000 people without access to the digital world and, consequently, without the possibility to benefit from the digital mobility services.

Subsequently, the categories of Smartphone (85.2%) and Computer (77.4%) are reported to be available among the citizens, which is compatible with the current trends observed in the society. Finally, less than 50% of the interviewees (45.9%) answered that has access to the tablet, which demonstrates that use of these kind of devices is not that popular in comparison to those mentioned earlier.

Moreover, analysing the differences in the access to the different technologies among different socioeconomic groups, factors such as age and education level are the ones that, in general, influence the level of population access to the ICTs. In fact, the

younger and the better educated, have better access to all kind of the analysed technologies, apart from the tablet, which is the most popular among the middle-aged group. Finally, results show non-significant differences in the level of access to technologies between males and females.

It should be noted that the access to the different technologies does not mean that people use them on a daily basis and/or without any limitations. There are numerous factors influencing the appropriate use of digital solutions resulting in different use patterns among the population.

Taking into account that the Internet and smartphone are accessible to more than 85% of the BMA population, and that in order to use new digital mobility products and/or services it is usually required the use of a smartphone to access the Internet, survey results on the frequency of technology use point out that:

- Internet: 84% of people uses the Internet every day or almost every day. 6.2% uses it at least once a week and 2,8% never uses it.
- Smartphone: 84,9% uses a smartphone every day or almost every day. Just 1% uses it at least once a week and the 12,3% never uses it.
- Accessing the Internet on a smartphone: the data proves that the uptake in that case is less frequent, with about 80% of people using it every day or almost every day. What is more, 3.8% of the interviewees answered that they used it at least once a week and 13.6% that they have never done it. This proves that on a daily basis, about 1 out of 5 individuals doesn't use a smartphone to access the Internet, for example to rent an on-street bike or check an alternative route for a journey while being on the move. This gap puts in question inclusiveness of the current transport services, and marks the needs of future work, especially thinking about future multimodal mobility.

## **Digitalisation in transport services**

The second intersection to be analysed is the digitalisation in transport services. As mentioned before, the new digital mobility services usually require the use of a smartphone with access to the Internet. Therefore, this section considers it the most relevant in the context of digital mobility services use, as well as the attitudes towards technologies and the uptake of innovative digital solutions in mobility.

Another important factor in the uptake of the new mobility solutions are the attitude and capabilities of users for whom they are designed. Although some groups have access to technologies and use them regularly, a large part of them is not aware about availability of new mobility products, feel insecure while using them, and/or experience limitations while planning (before the trip) and during the journey, related for example to the handling capacity of electronic devices.



The results highlight that big part of the population could be exposed to difficulties while using innovative digital solutions in transport or trying benefit from new mobility services. Specifically, regarding the confidence to plan successfully an unfamiliar, local public transport journey using the Internet or an app on a smartphone, results show differences among different target groups:

- Gender: higher percentage of men answered that they are highly confident to plan such a trip (67.7%) comparing to women (60.9%). Besides, only 8.3% of men reported feeling low confident in contrast to higher proportion of women (19.6%). This point out that gender gap should be considered when it comes to attitudes towards use of the technologies in mobility. However, this doesn't mean that women have fewer digital skills.
- Age groups (16-29; 30-64; 65 and more): there is a higher distrust among older people in the use of digital services for trip planning; 40% of older people feel insecure about planning a trip on public transport using the Internet or an application on a smartphone, and only about one out of them feel very secure about that. On the contrary, less than 1% of the people aged 16-29% and just 8,4% aged 30-64 feel insecure planning a trip using the internet.
- Education level (low; medium; high): about 25% of people with lower, 14.4% with medium and only 4.4% with high level of education answered that they have low confidence when planning a trip using a smartphone. On the contrary, the highest level of confidence was observed in the case of people with high educational attainment levels (80,9%), followed by 65.1% of those with medium and 44.9% with low attainment levels.

Again, the observed tendencies are similar to the ones outlined in the previous paragraphs; feminine gender, older age and low education level are risk factors for digital exclusion, here, influencing the proper uptake of new mobility solutions.

Regarding the use of digital transport services, the survey results revealed that, in general, new digital solutions are still little used. The highest percentages are reported for digitally booked taxi services and digital payment for parking, although still much lower than 25% even considering longer period of time than 3 months before carrying out the interviews. Furthermore, the use of carpooling, car sharing or on-street scooter/motorbike hire services is very low, which shows that these new forms of shared transport remain unpopular among the general population.

## **Transport disadvantage and risk of social exclusion via transport**

Lastly, the third intersection within the marked methodology will be analysed, focused on transport disadvantage and risk of social exclusion via transport. In this section, the main means of transport used by the population in their regular mobility will be studied and comparison between the target groups will be made. Afterwards, the main motives

for regular travel (work, studies, leisure etc.) among general population, as well as within various groups will be analysed.

The three main means of transport indicated by the respondents as primarily used for their daily displacements are active mobility, public transport and private vehicle. Overall, active mobility, which include walking, riding a bicycle, scooter or other low-speed transportation mode, is the most popular mean of transport for the daily displacements of the BMA residents (52.2%). Secondly, up to 30% uses public transport as the main mode for the daily displacements. Finally, about 18% of the population moves in private vehicle to reach their daily destinations. Similar results, were obtained in the EMEF 2019 (IERMB, 2020) – the reference report regarding regular mobility conducted annually in the BMA. However, changes provoked by the pandemic should be taken into account while analysing this distribution.

Splitting general results by target groups offers interesting results. Specifically:

- Gender: the difference in active mobility is not significant (52.2% of women and 51.4% of men). In the case of public transport, 35.3% of women and 22.9% of men make use of it, while men use more often private vehicles (10.9% of women and 25.3% of men) in their daily journeys. These results prove that gender gap in mobility still exists in the BMA, especially regarding private mobility use, a fact reported also in other recent studies (Cubells, 2020). These differences are also consequence of the social roles and distinct mobility patterns of both genders. In fact, women's daily mobility is usually more complex, diverse and sustainable since they tend to look for a workplace closer to home in order to be able to undertake home responsibilities (Ortiz, 2019).
- Age groups (16-29; 30-64; 65 and more): older people tend to move around actively (76.3%), and primarily by foot, much more often than the ones aged 30-64 (45.5%) and 16-29 (44.5%). Furthermore, public transport is the first choice to commute for 42.7% of younger people, followed by the middle aged (30.3%) and the elderly (16.3%). Finally, data show that people aged 30-64 are principal users of private vehicle (23.9%), while only 12.9% of young people and 5.9% of the older ones use this mode of transport on a daily basis.
- Education level (low; medium; high): active means of transport are used in large part by people with lower attainment levels (60.5%), followed by the individuals with high (54.9%) and medium (42.6%) education levels. Public transport use, instead, is more common by those with medium education levels (34%), while less people with high (27.2%) and low (27%) education levels reported that they use this mode of transport. Finally, 23% of the interviewed with medium attainment levels answered that they commute in private vehicle, followed by 18% of individuals with high and 11.4% with low education levels.

Finally, the interviewees had to answer to the question: thinking about your regular travel within this region, to what extent do you feel limited in your travel by the following aspects? The concept of “limitation” in this question is defined as ‘wanting to travel more but feeling unable to’.

Regarding perceived limitations in regular mobility, safety of transport services and cost of the travel are indicated as the most significant limitations, respectively with 44,7% and 43,2. Next, limited availability of transport services and limited availability of infrastructure are the motives that limit users to some extent up to 39% and 33% respectively. Overall, the lack of digital skills required for planning travel, as well as during trip are not indicated as one of the most significant limitations (about 20%). Finally, difficulties using the available transport due to special needs or disabilities were indicated as the reason that limits the least part of the respondents (up to 16%).

### **COVID-19 Impact, public opinion**

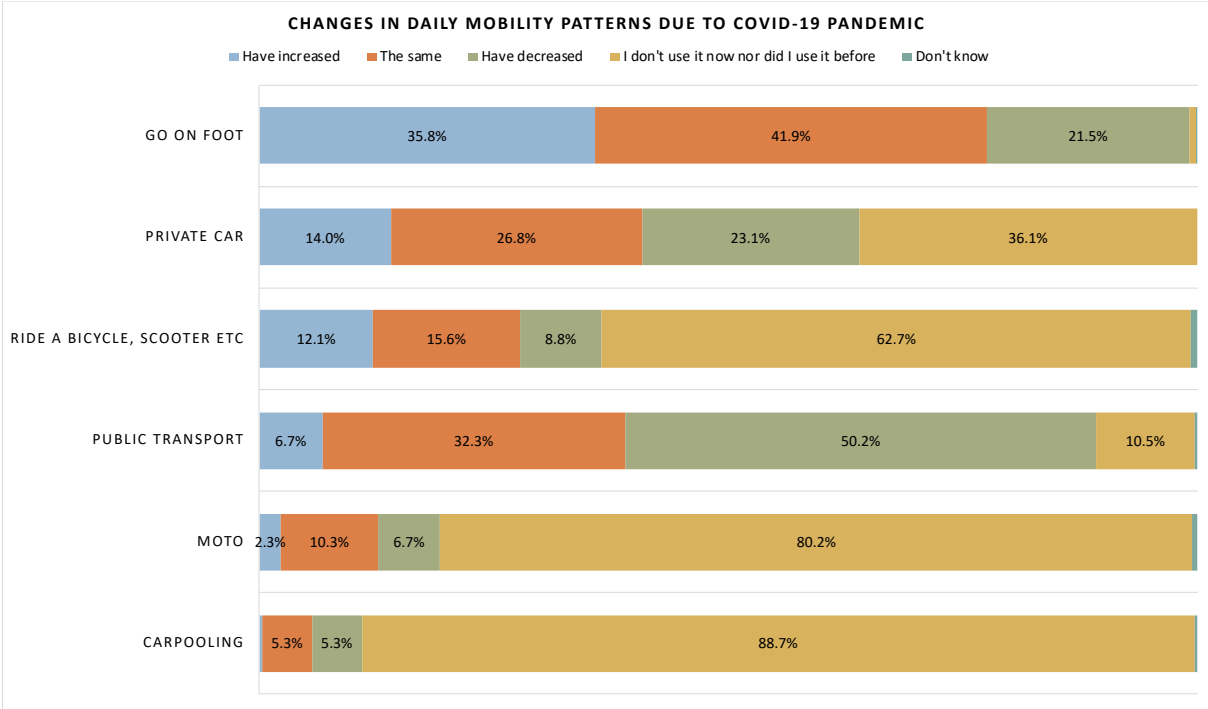
Adding to the already present issues in urban mobility and its diverse users’ needs, the COVID-19 pandemic has brought new challenges for future-proofing urban mobility planning. Post-lockdown studies, for instance the one issued by EIT Urban Mobility (2021), report on the main trends: changes in mobility demand, shift in user requirements, and decreases in investments in mobility. However, questions still remain on how the pandemic has impacted the users’ attitudes per se, and to what extent the observed changes in mobility demand will continue after this crisis. This paragraph will present the survey results regarding the changes of users’ daily mobility patterns, as well as public opinions on the importance of promoting some selected actions for future mobility in the Barcelona metropolitan area.

The questionnaire results reveal that, due to the pandemic, a great number of the population increased their use of active mobility modes, and especially walking, which is good news in regard to future sustainable mobility within more liveable cities. However, some interviewees reported switching to private vehicle use. The most worrying fact is that around half of the respondents decreased their use of public transport. Furthermore, those changes in daily mobility varied depending on the age group and/or education level: in general, the well-off, better educated, and younger groups could afford to change to alternative modes of transport, while some less-advantaged individuals were forced to maintain or even increase use of some transport modes (such as public transport) despite concerns related to social distancing or risk of contagion.

New digital mobility services include carpooling, which aims to be an alternative for private car use and an option for integration into public transport. However, the results show that the great majority did not use, or decreased their use of those digital solutions due to the pandemic crisis. This demonstrates that reduced use of public

transport and lack of alternatives could lead to changes towards private transport use and further aggravate the negative effects related to this mode.

Specifically, the results (Figure 2) show that, due to the pandemic, 41.1% of the people resident in the metropolitan area of Barcelona increased their active mobility modes, with 35.8% walking more and 12.1% more frequently riding a bicycle, scooter or other low-speed transportation mode. Conversely, 14% of respondents increased their use of a private car. Moreover, over half (50.2%) of the respondents have decreased their use of public transport. Notably, these changes differed amongst people within different socioeconomic groups.

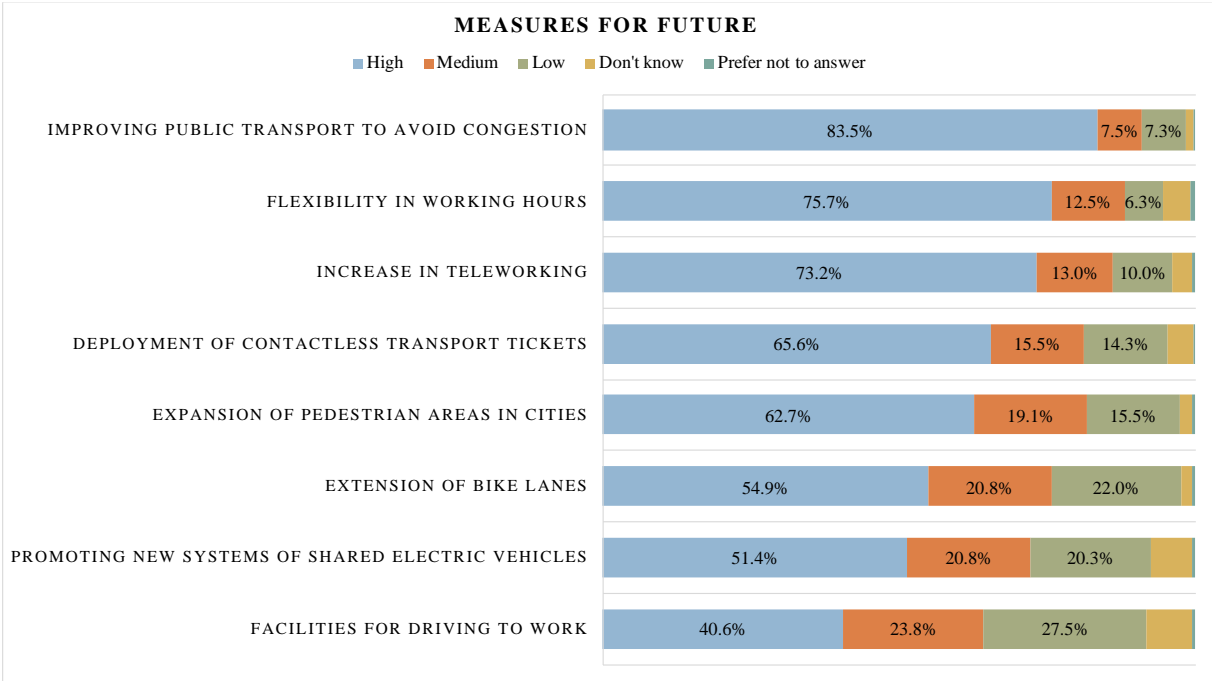


**Figure 2. Changes in daily mobility patterns due to the COVID-19 pandemic. [n = 601, error margin ±4%, significance level = 95%] Source: own elaboration.**

The survey also collected information about the importance that the interviewees assigned to the promotion of different actions for the future, taking into account the crisis of COVID-19. An increase in the provision of public transport to avoid congestion stands out amongst the measures indicated as the most important. This is mainly related to perceived safety at the health level and concerns about the risk of contagion; these are important issues from now on in the context of public transport that have to be addressed with adequate measures, in order to regain the trust and reliability of this fundamental public service, which is essential for a sustainable urban ecosystem. Other future actions indicated as highly relevant were those addressing working conditions: specifically, the flexibility of working hours and an increase of teleworking. Less importance was assigned to measures such as the expansion of bike lanes or the promotion of new shared electric vehicle systems. Finally, the measure with the lowest perceived importance is the ease of driving to work by car.

These insights are very relevant for the post-pandemic life, as they can help authorities to make appropriate decisions on the way to recovery and to transition towards future sustainable mobility. However, the remaining question is how those perceptions will evolve in the longer-term, and to what extent they will shape our future cities.

Regarding the importance that the interviewees assigned to the promotion of different actions in the future (Figure 3), the post-COVID measure highlighted as the one most needed was an increase in the provision of public transport to avoid congestion (83.5%). Other measures considered as highly important were related with working conditions—specifically, the importance of having flexibility of working hours (75.7%) and increased teleworking (73.2%). The promotion of the implementation of contactless transport tickets or the expansion of pedestrian areas were also considered important for the future of cities, with percentages above 60%. The expansion of bike lanes (54%) and the promotion of new shared electric vehicle systems (51.4%) were also considered important, while less importance was given to the ease of driving to work by car (40.4%).



**Figure 3. Measures for future. [n = 601, error margin ±4%, significance level = 95%]  
Source: own elaboration.**

This case study gives a first overview of the changes in daily mobility of citizens of BMA during the pandemic. Public attitudes towards different actions give context-based insights to address future mobility policies for a sustainable transport ecosystem. The study provides interesting insights for policy-makers and transport operators with respect to what measures are considered important by the metropolitan population—valuable information for designing citizen-focused, future-proof urban mobility systems and crucial for sound strategic planning of transport policies.

The case study confirms the information reported in other works regarding changes in mobility demand, and especially, the strong decrease in public transport use. One lesson to be learned that should be highlighted is that shifts in regular travel during the pandemic did not affect all collectives equally and could have aggravated the already existent transport disadvantages amongst different socioeconomic groups.

Interestingly, the feedback regarding the importance of promotion of different actions in the future shows that the great majority of respondents indicated that an increase in the provision of public transport to avoid congestion was important. This proves that, despite the strong decline in mass transit during the COVID-19 crisis, the citizens consider this mode of transport as valid, as long as its high level of safety, good quality, and good provision are guaranteed. Moreover, measures enhancing working conditions were considered more important than those related to promotion of new shared mobilities or contactless ticketing.

## Conclusions

The project results allow a better understanding of factors leading to the existing digital gap between mobility service provision and uptake, by different users' groups, within the current digital travel ecosystem.

The literature review pointed out that the great part of the research done until now regarding the matters in question has been focused on each of the topics separately and there is scarce literature addressing digital divide in mobility in particular.

Furthermore, the analysis of the qualitative information from the user survey confirmed the problem of potential exclusion related to the mobility in the BMA. The identification of several digital gaps proves that there are large parts of population that cannot access the digital world or lack required knowledge and skills and, consequently, they are not able to take advantage of novel transport services. Consequently, very low levels of digital mobility services' uptake were observed which proves that solutions such as carpooling, carsharing etc. are accessible mainly for small part of the society; usually younger, tech-savvy and well-off individuals. Therefore, in the process of urban mobility planning and design of digital services, it is important to take into account that, apart from access to the technology, provision of appropriate mobility options and awareness of their availability, the final user needs confidence and digital skills in order to make proper use of them. It should be taken into account that there are diverse individuals with different needs, patterns of use and attitudes towards digital technologies in mobility. Hence, adaptable solutions, as well as non-digital and low-tech alternatives are needed that would meet specific person's requirements and make mobility ecosystem more inclusive and sustainable.

Furthermore, main groups at risk of digital mobility exclusion have been identified. In the context of the BMA, older people and people with low level of education have been

found to be the most affected groups with regard the access to the ICTs and their use, and consequently, the changes that may result from the development of new modes of transport. In addition to that, gender may be an aggravating factor for digital mobility exclusion since women indicated feeling less confident in using technology, and they tend to use more sustainable modes of transport, which is linked with the social roles and distinct mobility patterns of both genders.

On that account, a better understanding of the relationships among digitalisation in transport services, digital inequality and mobility poverty is required in order to address the exclusion situations that different vulnerable groups might experience. The identified gaps affect the groups that could be the main beneficiaries of new innovative products/services such as transport on demand or shared mobility. However, these solutions are not accessible to vulnerable persons or in excluded areas, but are mostly addressed to general public with digital skills and available in urban areas with a wide range of mobility. Without adequate measures to make new digital means of transport accessible to greater parts of the population exposed to transport related disadvantages and/or mobility poverty and to empower the most vulnerable, new technological solutions will continue to increase the digital dichotomy between sustainable mobility and social inclusion.

In addition, urban mobility needs adequate actions for future, taking into account its current challenges, as well as the COVID-19 pandemic impact. In this sense, it will be important to address certain aspects, such as improvement of public transport, with particular attention to categories such as women and older persons, who represent a significant percentage of users. Regaining the trust and reliability of this fundamental public service is essential for a sustainable urban ecosystem since reduced use of public transport and lack of alternatives could lead to changes towards private transport use and further aggravate the negative effects of externalities related to this mode. Other important measure for future is the promotion of working conditions that recognize the flexibility of working hours and the possibility of working remotely. These factors will in turn lead to important changes in the design of services to be offered and in the conditions of provision of the public transport service.

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