



COVID-19 and public transport demand trends in Sicily: analyzing external factors and governmental recommendations

Socrates Basbas^{1*}, Tiziana Campisi^{2*}, Georgios Georgiadis³,
Muhammad Ahmad Al-Rashid⁴, Giovanni Tesoriere²

¹*School of Rural & Surveying Engineering, Faculty of Engineering, Aristotle University of Thessaloniki, GR-54124, Thessaloniki, Greece*

²*University of Enna Kore, Faculty of Engineering and Architecture, Cittadella Universitaria, Enna 94100, Italy*

³*School of Civil Engineering, Faculty of Engineering, Aristotle University of Thessaloniki, GR-54124, Thessaloniki, Greece*

⁴*Department of City and Regional Planning, School of Architecture and Planning, University of Management and Technology, Lahore 54770, Pakistan*

Abstract

The year 2020 has brought changes in transport services and travel demand globally due to restrictions related to the spread of the COVID-19 pandemic, especially in public transport. The present work focuses on Sicily (Southern Italy). Through the elaboration and administration of an online questionnaire, a sample of 700 regular public transport users was characterized from a socio-demographic point of view, identifying their travel habits, and their opinion on governmental and public transport company initiatives. Eight (8) national government strategies were evaluated on a Likert scale, and ten (10) pandemic mitigation factors were assessed in different phases of the pandemic, highlighting which of these factors were most preferred by the sample on a hierarchical scale. The results lay the groundwork for identifying critical challenges when dealing with such severely restricted mobility conditions and suggesting improvements for public transport agencies and local authorities.

Keywords: COVID-19; mode choice; sustainable mobility; travel demand; travel behavior; public transport; Italy

1. Introduction

Travel behavior and mode choice preferences have been transformed significantly compared to the pre-pandemic period. This happened mainly because of restrictions imposed by the authorities and the fear of contagion among individuals. The most numerous trips were related to necessities such as shopping or buying medicine (Abdullah, Dias, Muley, & Shahin, 2020). The preventive self-isolation, teleworking, and closures of certain activities have reduced the trips related to home-work and home-

* Corresponding author: Tiziana Campisi (tiziana.campisi@unikore.it)

* Corresponding author: Socrates Basbas(smpasmpa@auth.gr)

school purposes. People preferred to travel short distances to shop or go for a short walk or bicycle ride while maintaining social distancing (De Vos, 2020). Besides, an increase in the use of private cars and active modes of transport and a decrease in the use of public transport and related means (e.g., taxis) for primary travel purposes was observed in the post lockdown period, indicating that people tend to use safer modes of transport (in terms of infection) during pandemics (Borkowski, Jażdżewska-Gutta, & Szmelter-Jarosz, 2021).

Notably, the obligation of maintaining a one-meter distance between individuals has been implemented in several countries. Numerous researchers across the world have analyzed the COVID-19 restrictions in the transport domain. For instance, Zhang, Hayashi, and Frank (2021) identified the geographical differences in modal shifts concerning active transport and car dependency. Previous research results have shown an increase in infections as many people not respecting the distance (Pan et al., 2020). A stated preference survey was designed and implemented in the Chicago metropolitan area to investigate the travel behavior, habits, and perceptions of individuals before and during the pandemic and their future expectations. Analysis of the data revealed significant changes in several aspects of people's travel behavior (Shamshiripour, Rahimi, Shabanpour, & Mohammadian, 2020).

Moreover, a survey conducted in the United States found that the pandemic has made personal and private transportation more attractive (Francois & Moe, 2020). Out of 4,600 users surveyed, nearly two-thirds of people who drove their car to work before the pandemic say they are more willing to use their vehicle than other modes of transport, while only 4% said they would have been less inclined to use their car. Nearly three in five motorcyclists and more than two in five motorcyclists and cyclists say they will be more willing to commute those ways when they get back to work. (Francois & Moe, 2020), conducted a survey in Moscow and utilized cluster analysis to identify different classes of people who preferred to use the private car rather than public transport. They further studied the factors characterizing the necessary passenger and environmental factors, including the impact of the COVID-19 pandemic. Their results showed that it is essential to differentiate social and marketing programs to promote public transport competitiveness to change the behavior of the demand for transport.

Considering the European context, a study conducted in the city of Gdansk (Poland) showed that almost all respondents had given up or limited public transport use and nearly 75% of them expected to return to it once the epidemic situation had settled down (Przybylowski, Stelmak, & Suchanek, 2021). Similarly, due to conditions dictated by governmental actions and transport mode choice, lifestyle changes were analyzed by disseminating several surveys in the European and non-European contexts (World Health Organization, 2021). The analyses revealed that our society was not well prepared for the current pandemic, reaffirming the importance of risk communication. Moslem et al. (2020) focused on two large cities in Sicily (Italy) and showed an increasing tendency of the population to want to walk and not use public transport, especially for short distances (<1km), underlining that they are better able to maintain social distancing. A change in the motivation to travel was also recorded during the March-April 2020 periods of confinement. The researchers further found that the social distancing led to a substantial decrease in the use of some forms of mobility, such as public transport, and a significant pollution reduction. Another study conducted in Sicily, in 6 cities, showed differences in mode choice among gender groups and highlighted a positive opinion on micro-mobility means during post lockdown period (Campisi et al., 2020).

Regardless of the emerging research on the COVID-19 impact on travel behavior, there is still little understanding of how governmental measures shaped public transport demand trends during the various phases of the pandemic. Thus, this study aims to fill this knowledge gap by analyzing survey data from a sample of public transport users in one of the Italian regions, which was severely affected by the pandemic and at the same time is not characterized by recent infrastructure development.

1.1. Italian Public transport demand trend after lockdown

In Italy, which was the first European country to be critically affected by COVID-19, there was a significant reduction in vehicular traffic (up to 80%) in March-April 2020, i.e., during the lockdown. Vehicular traffic demand underwent a slight increase during the summer and, in particular, in July 2020 due to the relaxation of mobility restrictions (Ministero della Salute, 2021). The Institute of Training and Research for Transport (2021) highlighted a significant decrease in the rate of citizens' mobility immediately after the issuing of the national ministerial decree DPCM11/03/2020).

Two months after the end of the lockdown (July 2020) in Italy, around 40% fewer trips by public transport were recorded compared to the period before the pandemic, while private car trips resumed with a small reduction of about 10-20% in some regions (Ministry of Sustainable Infrastructure and Mobility, 2021). These reductions probably occurred due to teleworking but also due to other factors such as lower mobility needs. The Italian national data provided by ISTAT (2019) showed that before the pandemic and specifically in 2019, about 13 million people/year used public transport (including bus, tram, metro, train). Moreover, 24.6% of the population, aged 14 and over, used public transport daily and the same percentage of people used it at least a few times during a typical week. These data also highlighted that the Italian public transport service was mainly used in the metropolitan areas and Central and North-West regions. National statistical data, before the pandemic, estimated the following distributions of frequent users of public transport over 18 years old, as shown in Figure 1, with male (left) and female (right) distributions. The distribution is quite varied according to age but quite similar when referring to gender.

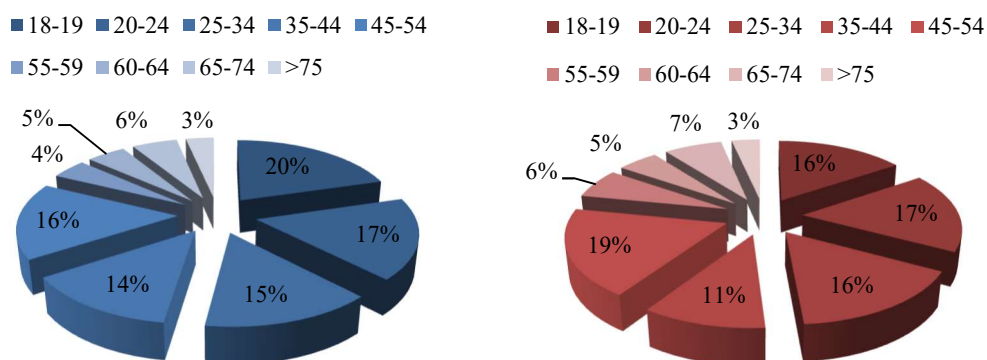


Figure 1. Italian Public transport users' distribution against their gender (male-left and female-right) and age.

Source: (ISTAT, 2019)

As shown in Figure 2, the national statistics also reveal the factors that characterize public transport choice over the age of 18s. It can be seen that the choice depends mainly on the presence of seats on-board and the speed of the journey (ISTAT, 2019).

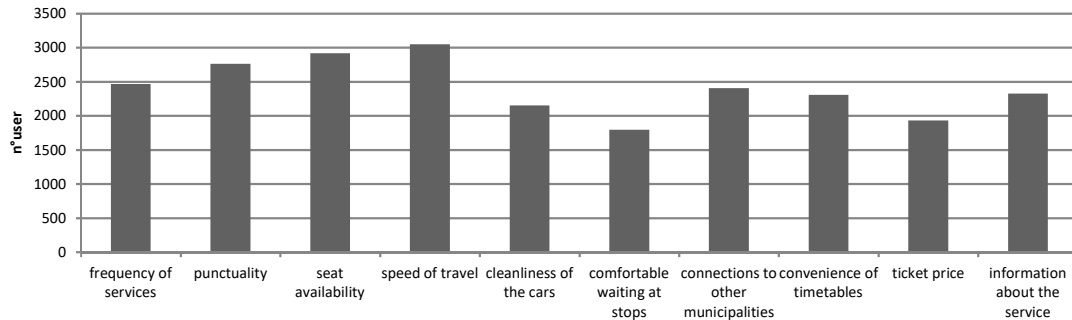


Figure 2. Factors that influence the public transport choice in Italy

Source: (ISTAT, 2019)

The COVID-19 pandemic began in March 2020 in Italy and has spread with different implications, considering the following periods: (1) Lockdown period (March-May 2020); (2) Post-lockdown period (May-September 2020); and (3) Phase 2 period (September-December 2020). The latter period was extended until the discovery and first administration of the COVID-19 vaccine. From January 2021 onwards, phase 3 is defined, following the previous one, during which the reabsorption of cyclical effects gave way to non-reversible structural transformations. Mobility habits have changed as travelers have generally avoided public transport, used bicycles more frequently, and prefer to walk for short distances. The national trends on public transport use are shown in Figure 3, where the specific variations observed in some of the major Italian cities are compared as representative of the different regions and in particular with reference to Milan for Lombardy (northern Italy), Rome for Lazio (central Italy), and Palermo and Trapani for Sicily (southern Italy).

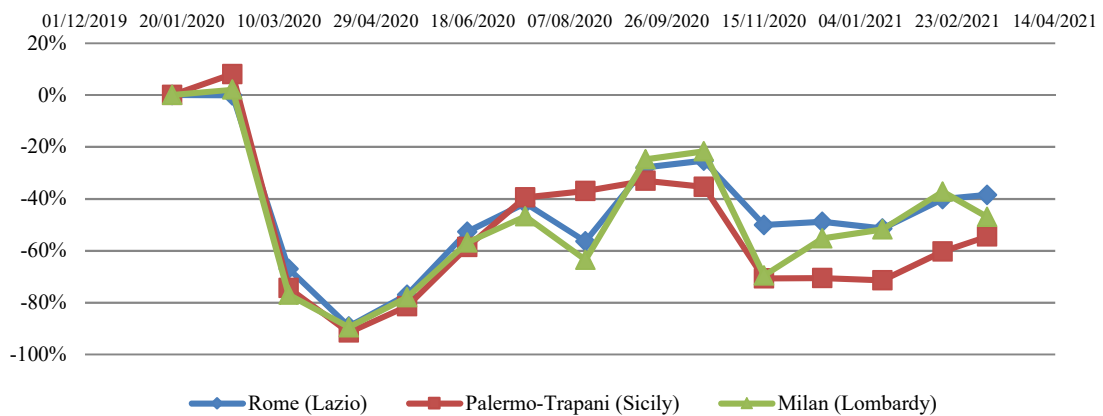


Figure 3. Public transport demand trends in different regions of Italy during the various pandemic periods

Source:(<https://moovitapp.com/>)

1.2. The development of mitigation strategies for public transport

Government restrictions and company-led actions to reduce the contagion have primarily decreased vehicle capacity to reduce crowding and facilitate physical distance. However, this action cannot be the only one but must be accompanied by transport planning strategies that can fill the gaps in public transport services (Coppola & De Fabiis, 2021). Strategies include proactively supporting new transport strategies and promoting cycling and walking, reducing high-risk scenarios, or not encouraging a return to the private car for longer urban distances (Brooks, Tingay, & Varney, 2020). It has also been observed that short-haul trips (within 1 km) such as those within the neighborhood have increased as local grocery stores avoid contact with the supermarket crowds and offer shorter queues to enter (Carteni, Di Francesco, & Martino, 2020). Simultaneously, the growth of e-commerce has been observed, which has reduced trips for home shopping (Alaimo, Fiore, & Galati, 2020).

Local administrators and service companies are searching when the demand for mobility will return to the same level as before the pandemic and whether this level will be higher or lower. Another critical issue under consideration is the role of public transport and shared mobility in the future (Shokouhyar, Shokoohyar, Sobhani, & Gorizi, 2021). Thus, it is useful to investigate the population and make it an active participant in questionnaires and political choices to understand transport demand trends better. Among the most widespread European strategies there were those to protect the design and restoration of cycling and walking infrastructures and incentives for micro-mobility acquisition. By expanding pedestrian and cycling infrastructure and making roads safer for people cycling and walking, cities can reduce crowding on public transport (Megahed & Ghoneim, 2020).

Public transport companies have implemented several strategies to be able to attract users again. An alternative approach has been given by extending the ticket's duration to allow passengers to wait for less crowded services, as cities like Montevideo have done (Massobrio & Nesmachnow, 2020). Compliance with the reduced number of passengers on board was encouraged by the spread of teleworking, making it possible to diversify the offices' working hours, considerably reducing the number of users during peak hours. For example, in the United States, a survey indicates that nearly 20% of financial managers plan to permanently keep remote jobs for at least 20% of their workforce (PwC, 2021). Other strategies have been implemented considering the infrastructures. Considering the waiting areas, some cities such as London have imposed the physical distance to bus stops and stations by scoring points of 2 meters for waiting-passengers and have also promoted the widening of physical space (Vickerman, 2021). On-board public transport, a series of measures and devices have been introduced to reduce contact between personnel and passengers for personnel safety and services operation. To this end, cities allow passengers to get on and off from all gates, install plexiglass screens, request cashless transactions, or perform free services to reduce the risk of passing tickets. Cities can also set up COVID-19 monitoring systems, such as Bogotá, which allows public transport personnel and passengers to report potential symptoms of COVID-19 in bus drivers and other personnel (Dueñas, Campi, & Olmos, 2020, Honey-Rosés et al., 2020).

Several strategies have also been implemented to clean and disinfect vehicles and stations. The frequency of disinfection services may need to be increased as more people return to using public transport. Removal of items from buses most susceptible to virus contamination, such as carpets and seat covers, facilitates disinfection. The introduction

of hand washing and disinfection facilities will reduce the risk of transmission and improve passenger confidence in their safety. Similarly, personal protective equipment such as masks has reduced aerosols dispersion into the environment by increasing people's protection using FFP2 masks (Edwards et al., 2021). All Italian regions and European countries have made masks mandatory on public transport, with significant fines for non-compliance. Cities may also consider installing contact-tracking technology on public transport to help manage the virus.

Shanghai and Nanjing, for example, have placed QR codes on buses and subways, which passengers scan with their cell phones to help identify and notify people who have been exposed to COVID-19 (Wong, 2020).

2. Data collection and analysis

The present work focuses on evaluating results obtained by disseminating a questionnaire survey on an online platform (www-googleform.it). The survey was forwarded via the leading social media (such as Facebook and Whatsapp) by forwarding the reference link. This dissemination method was chosen for the simplicity of data acquisition considering a random sampling within a specific class of users, namely Sicilian travelers who frequently travel for home-work purposes. A total of 700 participants responded to the questionnaire. The methodology adopted for data acquisition is called CAWI (Computer Assisted Web Interviewing), based on completing a web-based questionnaire provided through a link, panel, or website. It is considered the most cost-effective way to survey general populations, and it has been the easiest way to avoid possible contact with users and therefore avoid contagion risks. Particular care was taken in the design of the 3-section questionnaire as the quality of the data collected is directly proportional to the quality of the questionnaire itself. The completion of the questionnaire had an average duration of 15 minutes. Although this methodology is not particularly easy to acquire certain population groups, the present work considered a sample of under 60 years of age who habitually use multimedia tools and social channels. The data were collected during November-December 2020, i.e., during the Phase 2 period of the pandemic. Table 1 shows that the variables in section 1 of the questionnaire were the single response.

Table 1. Socio-demographic data

		variables	possible reply
Section 1	q1.1	Gender	M; F
	q1.2	Age	18-30; >31
	q1.3	Residential Area	metropolis; city; town; other
	q1.4	Educational Level	bachelor; master; Ph.D.; other
	q1.5	Employment	freelancer; employee; other
	q1.6	Worker And Commuter	Yes; No
	q1.7	Car Ownership	yes, and I drive it; yes, I have, but I don't drive it; no, I have not a driving license

While the data in section 2 were rated on a Likert scale from 1 (completely disagree) to 5 (completely agree). Section 3, on the other hand, examined on a hierarchical scale the three factors that reduced the use of PT. In particular, section 2 considered the top eight (8) national governmental restrictions from March 2020 onwards across the country like describe in Table 2 below:

Table 2. Judgment on implemented government recommendations

		Investigated recommendation
Section 2	q 2.1	Inhibition of PT use in case of suspected symptoms of COVID-19
	q 2.2	Purchase tickets electronically, online, or via an app, whenever possible
	q2.3	Use of dedicated routes and signposting in the external terminal area
	q2.4	Use of dedicated accesses and respect for on-board spacing
	q2.5	Limitation of seats on-board
	q 2.6	Avoid approaching or asking the driver for information
	q 2.7	During the trip, frequently sanitize your hands and avoid touching your face
	q2.8	Use the IMMUNI app to control the spread of the virus

Section 3 considered ten (10) actions developed by regional public transport companies following the principles and national legislation against the spread of COVID-19. The variables that were measured are listed in Table 3.

Table 3. Factors that reduced propensity to use PT

Section 3.	q3.1	Non-respect of % people on board
	q3.2	Incorrect or reduced sanitation
	q3.3	Reduced frequency of service
	q3.4	Likelihood of increased spread of the virus and contagion
	q3.5	Information provided by newspapers, TV, and social networks
	q3.6	Reduction in the use of coins and paper tickets in favor of prepaid cards and electronic tickets
	q3.7	Problems with the correct information or lack of information on PT
	q3.8	Restrictions provided by the company on the service in general
	q3.9	Differentiated working hours and agile working
	q3.10	Other

3. Results

The sample examined was made up of 700 respondents who daily use public transport buses to travel from home to work (commuting). Considering their gender, 56% are women, while the remainder is men. The age groups all made up of adults showed a higher percentage of young people aged between 26-30 years. A small proportion of over 40s responded. This distribution reflects the degree of digitization of the users interviewed. Figure 4 shows the main work-related characteristics, i.e., location in the same city of residence or elsewhere, type of work performed, and salary.

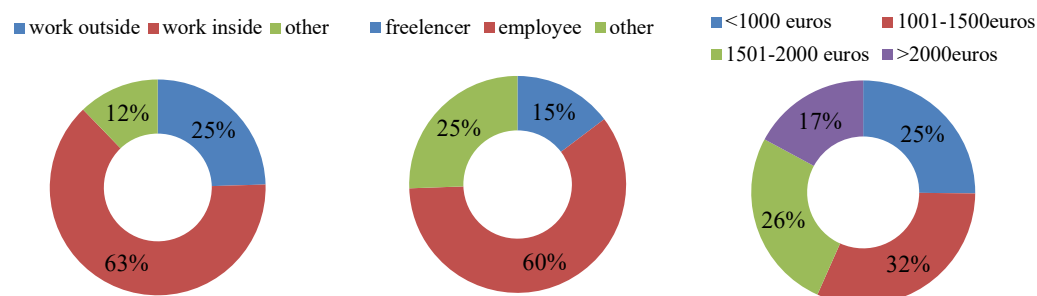


Figure 4. A trend on the commuting destination, type of work, and monthly salary
Source: authors survey

About 34% of the sample lives in city areas with populations between 100 thousand and 50 thousand inhabitants (Ragusa, Syracuse, Trapani, and Caltanissetta). In comparison, 28% of the sample lives in small towns with less than 50 thousand inhabitants (such as Enna and Agrigento). Similar figures apply for those who live in metropolises (such as Palermo, Catania, and Messina) and small villages or areas with weak transport demand (Figure 6). Over 90% of the sample owns a car and drives it.

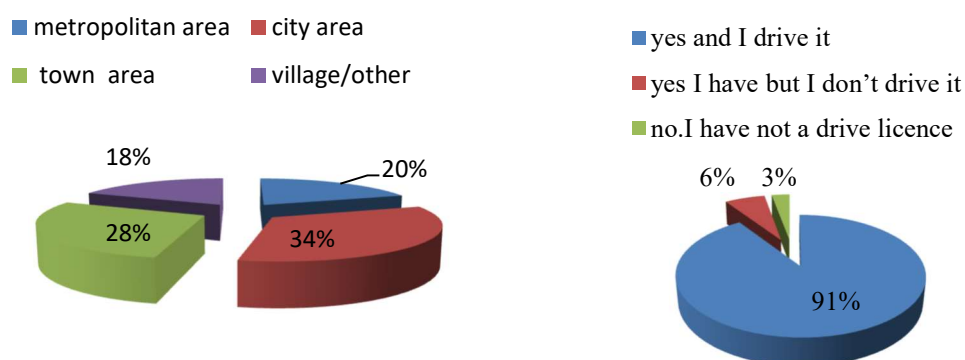


Figure 5. Residential area distribution (left) and car ownership distribution (right).
Source: authors survey

3.1 Results about judgment on implemented government recommendations

In synergy with the Transport Ministry, the national Government has issued guidelines to avoid possible COVID-19 infections. Several general measures for the containment of COVID19 infection were dictated and promoted. Besides, eight recommendations for all users of public transport services were issued for the public transport sector. They are concerned with both service and user behavior and the use of technology. The Italian Government has promoted a series of initiatives, including disseminating an application for smartphones and tablets to geolocate the presence of positive persons. This application is called IMMUNI (<https://www.immuni.italia.it/>) and has allowed tracking in both open and indoor areas by transferring certain data via Bluetooth. The Government has also encouraged the spread of electronic ticketing and promoted all those actions on-board and in the waiting areas to enforce social distancing. For example, the use of dedicated routes and signs in the area outside the terminal, the use of dedicated accesses, and respect for the spaces on-board, limiting the number of seats on-board. Finally, users on board were asked to avoid approaching or asking the driver for information.

Section 2 has the following question for the eight recommendations: "How well do you agree with the implementation of the following recommendations?" Considering a Likert scale from 1 (completely disagree) to 5 (completely agree), it was possible to obtain the trend shown in Figure 6.

This rating scale was used for the second section of the questionnaire to determine the opinions of users. Survey participants read a pre-filled statement and use a multi-level scale to indicate how strongly they agree or disagree with the statement submitted to them.

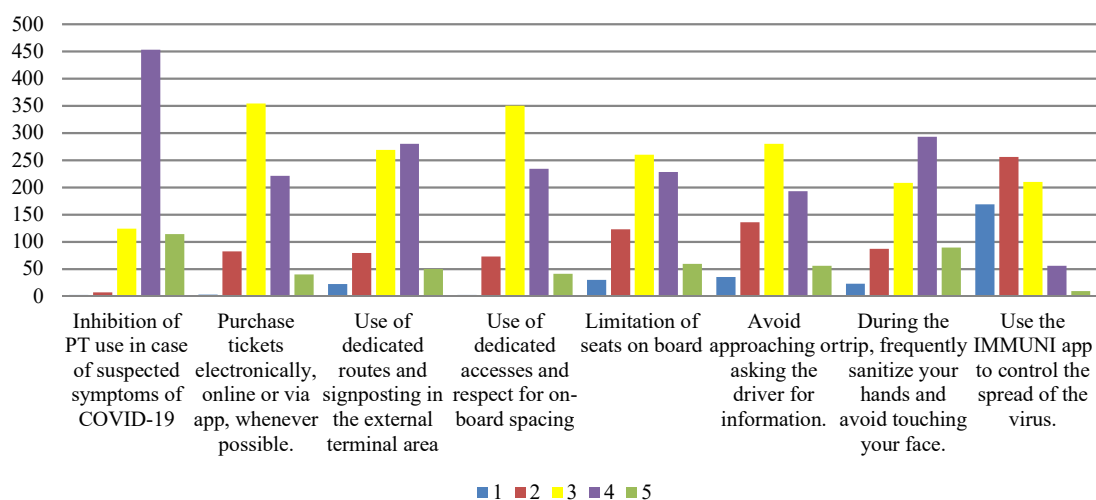


Figure 6. Evaluation of national (Italian) recommendations when using public transport during COVID-19 pandemic periods.

Source: authors survey

Many of the governmental recommendations analyzed have been implemented in other European and non-European countries. Electronic ticketing is now widespread in many Italian cities regarding regional public transport while still struggling to spread within urban transport, especially in Sicily.

Concerning the use of the IMMUNI app, a national strategy providing notification of exposure was considered by the Italian Government, implemented by the Special Commissioner for the COVID-19 emergency (Presidency of the Council of Ministers), in collaboration with the Ministry of Health and the Ministry for Technological Innovation and Digitisation. It only uses public infrastructures located within national borders. This App has been installed by less than 10% of the population on average with higher results and 15% in the city of Bolzano instead of only 5.4% in the Sicily Region,

Section 3.2 Results about factors that reduced propensity to use PT

The sample of users surveyed finally answered the last section concerning the definition on a hierarchical scale of the first three factors that discouraged public transport use. The factors were selected through a preliminary online survey that selected ten disincentive factors, some of which related to the recommendations discussed above.

They were marked with a letter of the alphabet as follows :

A = non-respect of the percentage of people on board

B = incorrect or reduced sanitation of vehicles, passenger cabins, and stop/station facilities

C = reduced frequency of service

D = likelihood of a greater spread of the virus and infection in an enclosed or poorly ventilated place such as a bus

E = influence caused by the media(negative information about contagion provided by newspapers, TV, and social networks)

F = reduction in the use of coins and paper tickets in favor of prepaid cards and electronic tickets

G = problems with information availability and correctness on public transport

H = Restrictions provided by the public transport company on the service in general
 I = Differentiated working hours and teleworking
 L = Other

Users reported the first three most important factors, in their opinion, in a hierarchical order from 1 to 3. Figure 7 shows that during the two phases examined. The first main factor was marked with the letter C (reduced frequency of service), with almost similar distributions.

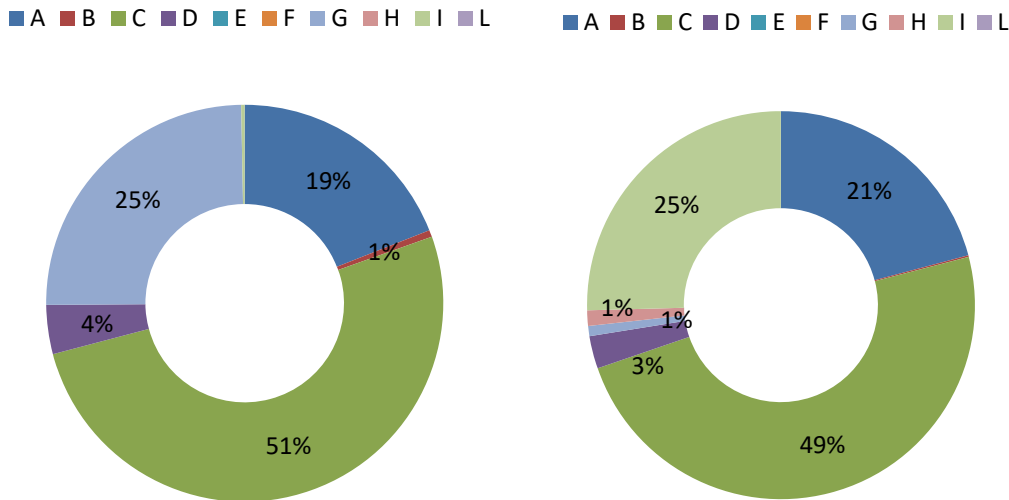


Figure 7. The first most important factor that reduced the public transport demand in Sicily post lockdown (left) and during Phase 2 (right)
 Source: authors survey

Factors A and G (during post lockdown) and factors A and I (during Phase II) also have high percentages. A decisive role in the reduced use of public transport in the post-lockdown phase was both the non-compliance with the percentage of people on-board (often due to the absence of controllers on-board) but also the news from the mass media negatively influenced people to go out and use public transport generating an increased state of concern.

During the second phase, teleworking played a decisive role. On the one hand, it allowed people to work from home without having to travel, but on the other hand, it changed the working hours in the office. It also meant that workplaces were less easily accessible by bus, as there was no bus service every 30 minutes.

As far as the second predominant factor is concerned, Figure 8 shows a higher percentage of respondents who selected the D factor (likelihood of increased spread of the virus and contagion) and an almost similar distribution between the two periods.

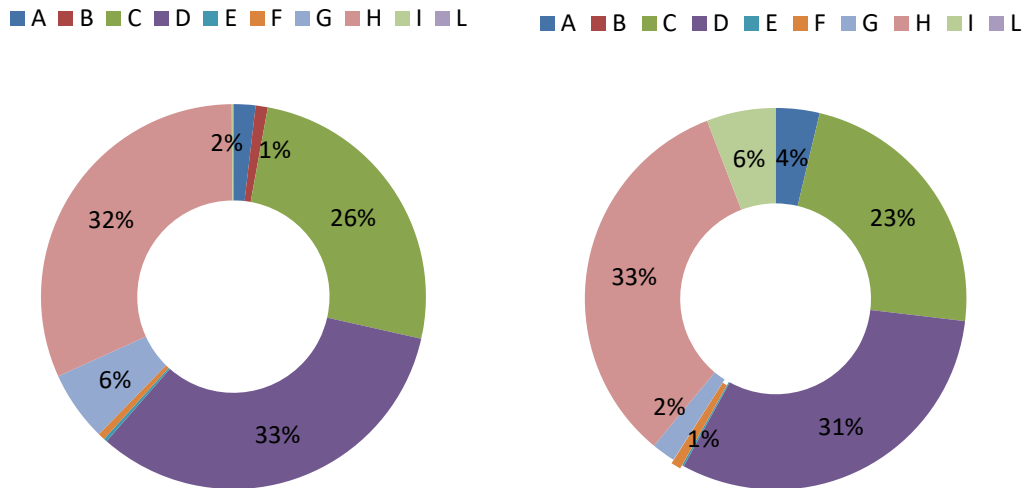


Figure 8 The second most important factor that reduced the PT demand in Sicily post lockdown (left) and during Phase 2 (right)
Source: authors survey

A similar percentage was recorded for factors A and C in the post-lockdown phase and factors D and C in the second phase. It confirms that reduced service and a greater chance of infection in an enclosed location have reduced the propensity to use buses.

Considering the third place, Figure 9, finally, shows the diversification of factors during the two periods, and in particular, a choice of the factor G and a similar value for the factor D. In contrast, in the second pandemic phase, there is a predominance linked to the letter D and followed by the letter C.

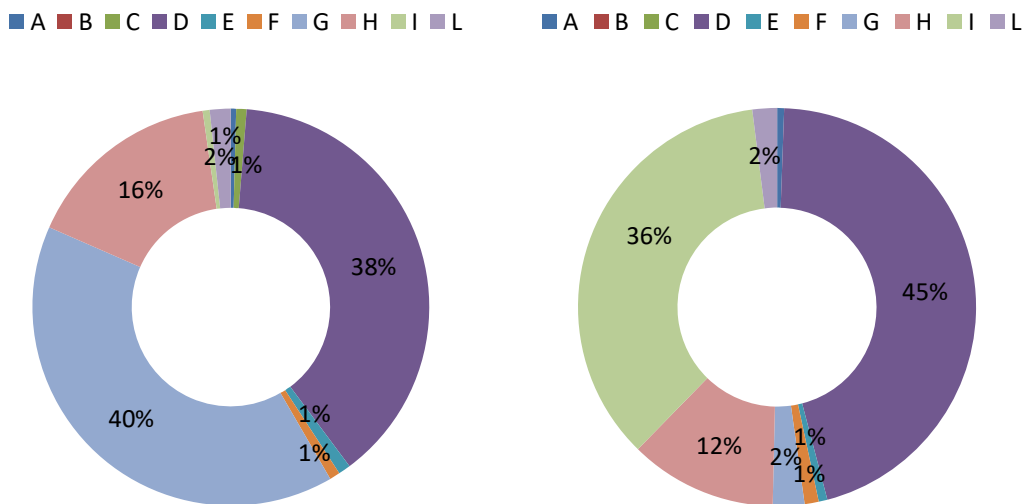


Figure 9. The third most important factors that reduced the PT demand in Sicily post lockdown (left) and during Phase 2 (right)
Source: authors survey

Poor information, often not in real-time provided by websites and box offices about the trips reduced the propensity in the post lockdown phase together with factors D and H related to having to use an indoor environment and general restrictions provided by the different travel companies (e.g., compulsory online booking difficult for people who do not usually use technology). Finally, in the second phase, the greatest response was obtained for factor D with a percentage comparable to factor I. It confirmed that teleworking reduced both the propensity (being able or having to stay at home) and the possibility of reaching workplaces at different times from the pre-pandemic period.

Some studies of primary travel have found that respondents placed high importance on infection-related factors. For example, passengers wearing masks, social distance, cleanliness, and concern about infection, etc. When choosing a travel mode during COVID-19 placing less importance on time savings, convenience, and cost under normal circumstances. The present work shows that for home-work travel purposes, potential infection and reduced service are among the factors that most reduced demand for transport.

Public transport rides decreased during the early stages of the pandemic mainly due to government restrictions, i.e., suspension of services and people's infection concerns. However, public transport will continue to be a societal necessity even though many studies will have to be conducted on possible on-board contagions.

4. Discussion and conclusion

Among the recommendations provided by the Government, the results obtained from this research showed that some preventive measures were highly favorable. For instance, the inhibition of people with suspicious symptoms, frequent sanitation of vehicles and people, on-board and before boarding.

The choice of public transport as a mode of transport fell sharply in the post-lockdown phase and during the second phase of the pandemic, and among the main factors that reduced users' propensity to use it were both the reduced service provided by transport companies and a greater fear of being infected on-board vehicles. The constant negative news in the mass media also increased this reluctance to use public transport, as did the disruption of working hours and places brought about by teleworking.

In order to avoid the collapse of the public transport system, it is necessary to ensure integration between the different modes of transport and, at the same time, to systematically raise awareness among citizens and - through optimal infrastructure planning - create incentives for them to prefer public transportation to individual transport. It is useful to prioritize using easy-to-use digital tools (e-ticketing, MaaS etc.) by transport users while ensuring that services are accessible to all stakeholders, including digitally impaired users.

The top-down approach can be useful and critical, and urgent by introducing innovative solutions in transport management and organization and good spatial planning, facilitating the integration of public and individual transport, which cannot be eliminated but can certainly be reduced to the minimum necessary. Similarly, organization, planning, analyses, and diagnoses should be based on up-to-date data from the mobility flow monitoring systems of sustainable urban mobility plans. Moreover, to achieve the decarbonization objectives, cities, and metropolitan areas will need clear political decisions and the appropriate financial resources to implement them, including those provided by cohesion policy funds and other funding instruments.

Local and regional authorities are committed to ensuring public transport efficiency and promoting its spatial, organizational, and pricing integration. It is imperative in metropolitan areas, capital regions, and larger conurbations, where commuting makes it necessary to link the many urban, suburban, and local transport modes with each other and the national transport network. In this context, it is also essential to emphasize the importance of ensuring the accessibility of cities from rural areas: even today, in some countries such as Poland, these areas are too often excluded from connections.

The development of a sustainable urban mobility plan makes it possible to design an optimal model for a mobility system that integrates a standard pricing system, with clear synergies between the many public transport operators active in the same metropolitan area, and also facilitates access to public transport stops, for example through ITS systems.

Unfortunately, the COVID-19 pandemic has imposed on citizens the obvious and unforeseen need to minimize their daily mobility needs. It is mainly due to the expansion of teleworking, the introduction by the individual Member States of measures limiting people's activities in public spaces, and the decreasing perception of safety among public transport users.

One response to these trends could be to pursue the urban model of the '15-minute city', i.e., cities where different actions and services can be performed within each neighborhood. It requires local and regional authorities to incur additional costs for preventing health risks in public transport vehicles to contain the loss of revenue resulting from their reduced use. Help for the public transport situation could also come from an effective information campaign to promote a reduction in car travel and, in many cases, commuting by individuals.

The new integrated public transport strategy will need to include Europe-wide standards for preventing and detecting specific threats, including pandemics, and practices to ensure the safe movement of people should such threats occur. The analysis carried out on users who habitually use public transport for home-work motivation could extract relevant and easily interpretable clusters. Such classifications may be useful for different applications. In fact, they can:

- help transport operators to understand the demand of their customers better and to propose incentives, services, and targeted tools accordingly, especially after the pandemic;
- create a more in-depth knowledge of the transport demand of each region allows on the one hand to implement democratic planning activities with the direct interaction of the population to the strategic choices of the Administrations and the service companies;
- mitigate negative impacts due to the reduction of transport demand by assessing the criticalities caused by both the implementation of the national regulation and external or service-related factors;
- improve the city's perspective; this can also help to redesign and improve existing transport policies.

The spatial position as a residential area of the different passenger types is therefore of great interest.

References

- Abdullah, M., Dias, C., Muley, D., & Shahin, M. (2020). Exploring the impacts of COVID-19 on travel behavior and mode preferences. *Transportation Research Interdisciplinary Perspectives*, 8, 100255. doi:10.1016/j.trip.2020.100255
- Alaimo, L. S., Fiore, M., & Galati, A. (2020). How the Covid-19 Pandemic Is Changing Online Food Shopping Human Behaviour in Italy. *Sustainability*, 12(22), 9594. Retrieved from <https://www.mdpi.com/2071-1050/12/22/9594>
- Borkowski, P., Jażdżewska-Gutta, M., & Szmelter-Jarosz, A. (2021). Lockdowned: Everyday mobility changes in response to COVID-19. *Journal of Transport Geography*, 90, 102906. doi:10.1016/j.jtrangeo.2020.102906
- Brooks, J. H. M., Tingay, R., & Varney, J. (2020). Social distancing and COVID-19: an unprecedented active transport public health opportunity. *British Journal of Sports Medicine*, bjsports-2020-102856. doi:10.1136/bjsports-2020-102856
- Budd, L., & Ison, S. (2020). Responsible Transport: A post-COVID agenda for transport policy and practice. *Transportation Research Interdisciplinary Perspectives*, 6, 100151. doi:10.1016/j.trip.2020.100151
- Campisi, T., Basbas, S., Skoufas, A., Akgün, N., Ticali, D., & Tesoriere, G. (2020). The Impact of COVID-19 Pandemic on the Resilience of Sustainable Mobility in Sicily. *Sustainability*, 12(21), 8829. doi:10.3390/su12218829
- Carteni, A., Di Francesco, L., & Martino, M. (2020). How mobility habits influenced the spread of the COVID-19 pandemic: Results from the Italian case study. *Science of The Total Environment*, 741, 140489. doi:<https://doi.org/10.1016/j.scitotenv.2020.140489>
- Coppola, P., & De Fabiis, F. (2021). Impacts of interpersonal distancing on-board trains during the COVID-19 emergency. *European Transport Research Review*, 13(1), 13. doi:10.1186/s12544-021-00474-6
- De Vos, J. (2020). The effect of COVID-19 and subsequent social distancing on travel behavior. *Transportation Research Interdisciplinary Perspectives*, 5, 100121. doi:10.1016/j.trip.2020.100121
- Dueñas, M., Campi, M., & Olmos, L. (2020). Changes in mobility and socioeconomic conditions in Bogotá city during the COVID-19 outbreak. *arXiv preprint arXiv:2008.11850*.
- Edwards, N. J., Widrick, R., Wilmes, J., Breisch, B., Gerschefske, M., Sullivan, J., . . . Espinoza-Calvio, A. (2021). Reducing COVID-19 Airborne Transmission Risks on Public Transportation Buses: An Empirical Study on Aerosol Dispersion and Control. *medRxiv*, 2021.2002.2025.21252220. doi:10.1101/2021.02.25.21252220
- Francois, A., & Moe, K. (2020). US Mass Transit Faces Daunting Challenge to Win Back Riders. *Oliver Wyman Forum*. Retrieved from <https://www.oliverwymanforum.com/mobility/2020/jun/us-mass-transit-faces-daunting-challenge-to-win-back-riders.html>
- Institute of Training and Research for Transport, I. (2021). Audimob category archive. Retrieved from <https://www.isfort.it/category/news/ricerca/audimob/>
- ISTAT, S. (2019). Censimento popolazione istat; 2019. In.
- Massobrio, R., & Nesmachnow, S. (2020). Urban Mobility Data Analysis for Public Transportation Systems: A Case Study in Montevideo, Uruguay. *Applied Sciences*, 10(16), 5400. doi:10.3390/app10165400

- Megahed, N. A., & Ghoneim, E. M. (2020). Antivirus-built environment: Lessons learned from Covid-19 pandemic. *Sustainable Cities and Society*, *61*, 102350. doi:<https://doi.org/10.1016/j.scs.2020.102350>
- Meier, K., Glatz, T., Guijt, M. C., Piccininni, M., Van Der Meulen, M., Atmar, K., . . . Zamanipoor Najafabadi, A. H. (2020). Public perspectives on protective measures during the COVID-19 pandemic in the Netherlands, Germany and Italy: A survey study. *PloS one*, *15*(8), e0236917. doi:10.1371/journal.pone.0236917
- Ministero della Salute, M. (2021). Nuovo coronavirus - Aggiornamento dati. Retrieved from <http://www.salute.gov.it/portale/nuovocoronavirus/homeNuovoCoronavirus.jsp>
- Ministry of Sustainable Infrastructure and Mobility, M. (2021). Observatory on mobility trends during the Covid-19 health emergency. Retrieved from <https://mit.gov.it/comunicazione/news/covid-19-trasporti-tpl/osservatorio-sulle-tendenze-di-mobilita-durante>
- Moslem, S., Campisi, T., Szmelter-Jarosz, A., Duleba, S., Nahiduzzaman, K. M., & Tesoriere, G. (2020). Best–Worst Method for Modelling Mobility Choice after COVID-19: Evidence from Italy. *Sustainability*, *12*(17), 6824. doi:10.3390/su12176824
- Pan, Y., Darzi, A., Kabiri, A., Zhao, G., Luo, W., Xiong, C., & Zhang, L. (2020). Quantifying human mobility behaviour changes during the COVID-19 outbreak in the United States. *Scientific Reports*, *10*(1), 20742. doi:10.1038/s41598-020-77751-2
- Przybylowski, A., Stelmak, S., & Suchanek, M. (2021). Mobility Behaviour in View of the Impact of the COVID-19 Pandemic—Public Transport Users in Gdansk Case Study. *Sustainability*, *13*(1), 364. doi:10.3390/su13010364
- PwC. (2021). *Business needs a tighter strategy for remote work*. Retrieved from <https://www.pwc.com/us/en/library/covid-19/us-remote-work-survey.html>
- Shamshiripour, A., Rahimi, E., Shabanpour, R., & Mohammadian, A. (2020). How is COVID-19 reshaping activity-travel behavior? Evidence from a comprehensive survey in Chicago. *Transportation Research Interdisciplinary Perspectives*, *7*, 100216. doi:10.1016/j.trip.2020.100216
- Shokouhyar, S., Shokoohyar, S., Sobhani, A., & Gorizi, A. J. (2021). Shared mobility in post-COVID era: New challenges and opportunities. *Sustainable Cities and Society*, *67*, 102714. doi:10.1016/j.scs.2021.102714
- Vickerman, R. (2021). Will Covid-19 put the public back in public transport? A UK perspective. *Transport Policy*, *103*, 95-102. doi:<https://doi.org/10.1016/j.tranpol.2021.01.005>
- Wong, Y. (2020). To limit coronavirus risks on public transport, here's what we can learn from efforts overseas. *The Conversation*.
- World Health Organization, W. (2021). COVID-19 Weekly Epidemiological Update, 7 February 2021.
- Zhang, J., Hayashi, Y., & Frank, L. D. (2021). COVID-19 and transport: Findings from a world-wide expert survey. *Transport Policy*, *103*, 68-85. doi:10.1016/j.tranpol.2021.01.011