

Standard Cost of Local Public Transport in the Post-COVID-19 Era: The Italian Case

G. Acampa[1(✉)], M. Grasso[1], C. M. Parisi[1], D. Ticali[1], and A. Severino[2]

[1] Faculty of Engineering and Architecture, University "Kore" of Enna, 94100 Enna, Italy
{giovanna.acampa,mariolina.grasso,dario.ticali}@unikore.it
[2] Civil Engineering and Architecture Department, University of Catania, 9531 Catania, Italy
alessandro.severino@unict.it

Abstract. Local Public Transport (LPT) plays a key role in the economic system of any country. The Covid-19 outbreak and subsequent lockdowns led to an unprecedented economic crisis in this sector. Governments had to block all unnecessary travel and keep only essential services moving, reducing public transport services (air, train, bus, metro, etc.) by more than 90%. Despite the economic aids provided by Governments, many LPT companies are facing a crisis that they are unlikely to be able to overcome. This for two reasons: skepticism of passengers in the use of public transport, and therefore reduced revenue from ticket sales, and additional costs for the vehicles' sanitization Focusing on the Italian case, and especially on Sicily, the paper aims to analyze the standard costs of the LPT road service and assess the cost increase in which companies have to incur in order to meet the guidelines imposed by Government and encourage citizens to use public transport. The paper relies on the results of a direct investigation on clients' attitudes through a questionnaire submitted to a population travelling to and from the city of Enna in the centre of Sicily.

Keywords: COVID-19 · Local public transport · Standard cost · Sustainable mobility

1 Introduction

In the last decades, the rapid growth of population and its concentration in urban areas forced a quick and continuous evolution towards sustainable urban mobility. To date, mass public transport is the only suitable solution to meet the needs of large-scale urban mobility for short and medium distance travel. According to the latest UITP report (2018), mass public transport serve more than 53 billion passenger all over the world (with an 19% increase as compared to 2012) [1]. This has had positive effects on public and private investment aimed at increasing the level of service provided.

Due to the Covid-19 outbreak, mass public transport witnessed a steep fall in users. The close proximity among passengers turns the transmission of pathogens much more likely, and public transport has become the catalyst for the COVID outbreak [2, 3].

This phenomenon forced Governments all over the world to reduce and limit the operating efficiency of passenger transport and ensure minimum level of service by

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keeping LPT only partially operating. In the first three months (from February to April 2020) the actions taken to curb the pandemia inevitably caused an economic and social crisis. Over four billion people worldwide lived in lockdown for months and the limited travel had a drastic impact on the public transport system: a significant decrease in revenues (in some cities by more than 90% less), an increase in the costs of disinfection activities and the implementation of containment measures (such as social distancing) aimed at reducing the risk of virus transmission [4]. In addition, users prefer to use the private vehicle to avoid contact with other.

The steep decrease in the use of public transport has led not only to increased use of private vehicles but also sustainable transport means (bicycles, electric micro-mobility, car sharing, etc.) [5, 6]. Having more private cars on the road certainly brought negative impacts in terms of environmental pollution, public land occupation, traffic congestion, longer travel time [7], stress for travellers and dissatisfaction of citizens [8]. On the other hand, the increase in the use of sustainable means of transport such as bicycles and electric micro-mobility drastically reduced pollution in urban areas.

In any case, the pandemia lead to the financial collapse of local public transport companies. Most commuter rail, subways, and bus hubs reported significant declines because many people avoided and are still avoiding public transportation both for fear of contagion and compliance with advisory and precautionary measures [9]. The result is an inevitable deterioration of providential services (reduction in the number of daily rides and increase in ticket prices), which may push users to prefer private to public transport. Therefore, fewer passengers translate into less money for transportation agencies and the slowdown of economic activity in large cities.

Many governments adopted specific economic support measures for the Covid-19 emergency, both for service operators and users, but it is often insufficient.

In Italy, the Legislative Decree no. 34 of May the 19th 2020 [10] provided for an initial allocation of 500 million euros for the year 2020 as a compensation for the reduction in passenger tariff revenues in the period from 23 February 2020 to 31 December 2020.

This research aims to analyse the impact of such measures once addressed the cost structure and allocation of economic resources for local public transport (LPT) by analysing the standard costs of local public transport taking into account three factors: the commercial speed (VC) of the vehicles, the amount of service offered (Km) ("bus-km service" or "seat-km service"), and the degree renewal of the fleet (Akm).

Some researchers worked on the cost structure of LPT companies focusing on the estimation of variable and total costs [11–15]. Others suggested to rely on demand indicators such as passenger-travel or passenger-kilometre and supply indicators such as vehicle-kilometre or place-kilometre [16]. Many researchers also discussed the effect of economies of scale and population density on LPT costs [12, 13, 17, 18].

Between 2014 and 2016, Avenali et al. [19, 20] carried out a research leading to the adoption in Italy of the Ministerial Decree no.157 of 28 March 2018 [21]. According their studies, commercial speed is the most important cost factor, while economies of scale have little influence and are limited to small groups of services. The results show a strong correlation between investments in the bus fleet and the costs incurred in providing the service [22]. On the basis of these studies, this paper aims to provide an overview of how standard costs have changed in the post-COVID 19 era.

The results highlight the need to reassess the allocation of economic resources to local public transport companies following the provisions of decrees such as the Italian Prime Ministerial Decree of 26 April 2020 [23] the opportunity to balance the higher costs incurred by transport companies.

2 Mobility During the COVID 19 Outbreak: Public Transport Trend – The Italian Case

The COVID 19 health emergency and the measures taken to contain the pandemia had a significant impact on the entire transport and mobility system. In Italy, two Prime Ministerial Decrees issued on March the 9th 2020 [24] banned all forms of people gathering in public or open places and suspended all non-essential commercial and catering activities, allowing mobility only for proven work needs, cases of clear necessity or travel for health reasons. In the weeks following the publication of the Decrees by the Italian Government these restrictive measures generally defined by the term "lockdown", were adopted by most European countries. Google and Moovit insight made available reports showing the impact of these restrictions imposed on the mobility system. The pre-emergency and post-emergency data were compared, taking as a baseline the start date of the survey, January the 13th 2020, until March the 1th 2021 (when this study was completed). These reports are updated daily both by Google and Moovit[1]. Google made available reports showing the evolution trend towards shops, restaurants, bars, museums, places for the purchase of essential goods, parks, means of transport, workplaces and places of residence. The analyses provided by Moovit, taking the data by Google analysis, revealed the percentage of change in demand for public transport worldwide.

For this paper, we referred to reports on the main European countries affected by the pandemia: Italy, Spain, France and Germany focusing on public road transport data. The reference period for all data analysed is from January the 13th 2020 (start date of the survey) to March the 1th 2021 (last update).

The data provided by Google highlighted the percentage change in the attendance of most popular spots for daily life, grouped in venues for retail and free time (shops, restaurants, bars, museums), for the purchase of essential goods (groceries, pharmacies), parks, transport vehicles, workplaces and residence (apartments, houses etc.). The data collected by country gives an idea of the impact of the pandemia on both the demand for non-systematic mobility (e.g. attendance in bars, restaurants, museums, shops) and systematic mobility (e.g. attendance in workplaces). A location attendance is quantified by counting users who have logged into their Google account, saved their location history and activated the "Location Reporting" function. The visitors' attendance distribution is calculated on the basis of the number of visits and the length of stay; then, the median value is taken as a daily measure of visits. With this data, it was possible to calculate the overall average variation of the displacements (Table 1).

We focused especially on the mobility trend towards public transport spots (bus stations, trains, airports, etc.). In Italy, as well as in Spain, France and Germany travels

[1] This application is based on the official information delivered by local administrations and public transport operators to users in order to offer the best available route of LTP in real time.

Table 1. Mobility trend according to Google.

Country	Retail and free time (bar, restaurant etc.)	Grocery and pharmacy	Parks	Public transport stations	Work places	Residence
Spain	−34%	2%	−8%	−26%	−20%	7%
Italy	−29%	1%	9%	−35%	−24%	9%
France	−34%	1%	34%	−28%	−31%	10%
Germany	−38%	0%	62%	−32%	−24%	10%

to public transport spots fell by 30% compared to the baseline [25]. Looking at the Google data, it can also be seen that the decrease in the trend of mobility towards public transport spots almost overlaps the decrease in travel to workplaces. It suggests that travel on public transport is mainly due to work needs; thus smart-working at home can only negatively impact on LPTs. As mentioned before Moovit insight analyze Google's data referring to public transport. In particular, Fig. 1 shows a comparison between the aforementioned Country within the time laps considered (January 13th 2020 to March 1th 2021) and the public transport mobility trends.

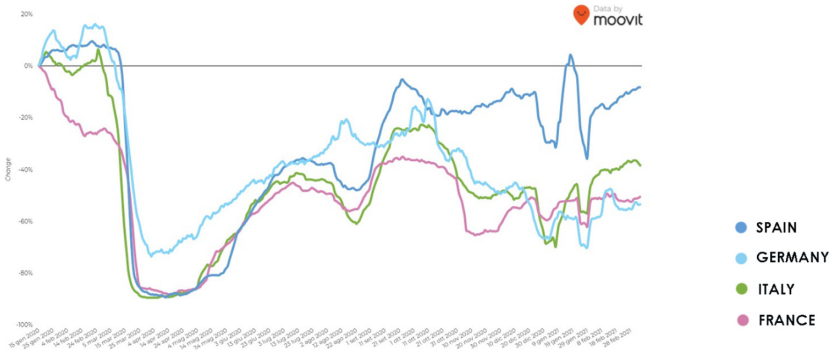

Fig. 1. Moovit public transport report during Covid 19[2]

Among all the Country took under exam there is a homogeneous trend and all the mobility trends referring to public transport are under the baseline starting from the first days of March 2020 when the pandemic began.

[2] Source: www.moovit.com

3 Materials and Methods

3.1 Local Public Transport (LPT)

Local public transport (LPT) plays a key role in urban and suburban mobility and had significant impacts in terms of development and competitiveness of the entire national economy. Like other local public services, it contributes significantly to improving citizens' quality of life [26].

In the main EU countries, mobility produces more than twice as much income as in Italy (e.g. Germany reaches a value of € 28.1 billion). The effect is a quality offer that attracts increasing volumes of traffic. The level of infrastructure and the efficiency of the service are the elements that make the difference to achieve a competitive offer. In fact, the higher the levels of efficiency, the more local public transport is able to take away parts of demand from private transport and provide added value to the community.

3.2 Standard Cost for LPT According to Italian Law

According to the fiscal federalism approach, standard cost is a benchmark adopted by Governments to allocate economic resources to Regions. In Italy, the law on fiscal federalism no.42 of 2009 [27] sets the historical cost criterion (based on the expenditure incurred in the previous year) to quantify the economic resources to be allocated to local authorities for the provision of essential services.

Needs and standard costs are the only reference criteria to balance and review local and regional authorities' expenditure, as each authority is to receive resources matching with its needs. Resources are assessed on the basis of objective parameters and no longer in relation to past expenditure. Operators thus have an incentive to promote their efficiency, in accordance with the yardstick competition principle [28]. The authorities shall grant economic resources on the basis of the costs that an operator faces to provide an efficient service.

Standard costs are set not only for the management of public transport companies, but also for the management of many other areas of civil engineering, such as transport infrastructure [29] and wastewater treatment infrastructure [30].

As far as LPT is concerned, the use of the standard cost was implemented by the Stability Law of 2014, which called the Ministry of Transport to define (with uniform criteria at national level) the standard costs of the local and regional public transport services (LPT) and the criteria to update and implement them. In addition, the law specified that the standard cost should take into account the *"context factors"* (e.g. commercial speed, economies of scale, production technology, modernisation of rolling stock and a reasonable profit margin for the transport carrier).

The first national law that introduced in Italy the definition of standard cost (Law no. 151/1981[3]) established the National Transport Fund. It defined the standard cost as "*Economic cost of services with reference to criteria and parameters of strict and efficient management, divided by categories and modes of transport and taking into account,*

[3] Law no. 151 of 10 April 1981: Framework law for the ordering, restructuring and strengthening of local public transport.

through comparative analysis, the quality of the service offered and the environmental conditions in which it is carried out"[4].

Another important law in this context is the Decree no. 50 of March the 24th 2017 that contains the following principles:

- call for tenders for all local and regional transport services, including rail services;
- exceeding the 35% threshold for the share of operating costs to be covered by revenues;
- introduction of the mandatory separation of the management function from the regulatory, guidance and control function of regional and local public transport services.

In summary, there are two important legislative provisions: putting aside the criterion of "historical cost" as a parameter for the distribution of public economic resources from the State to the Regions (and from the latter to local authorities and businesses) and the call for tendering procedures to increase the competition in the offer of services. The standard cost therefore has a dual function: on the one hand, it allows a better allocation of available public resources and, on the other, it encourages an increase in the efficiency of the system through the optimization of internal management costs.

Standard Cost Model

The Ministerial Decree no.157 of 28 March 2018 ("*Definition of standard costs of local and regional public transport services and criteria for updating and application*") completed the complex regulatory process regarding standard costs in the public transport sector.

The Ministerial Decree defines the standard cost according to a function that takes into account different production technologies (buses, tramways, subways, regional railways), demand conditions (metropolitan areas and areas with weak demand), commercial speed, modernisation of rolling stock and reasonable profit margins.

Regarding road transport service, the calculation takes into account the qualitative and quantitative characteristics of the service and explains the variability of costs through a top-down approach.

According to the regulations, the standard cost depends on the commercial speed (VC) of the vehicles, the amount of service offered (Km) ("bus-km service" or "seat-km service"), and the degree renewal of the fleet (Akm).

$$CS = f(VC; Km; Akm) \tag{1}$$

Where:

- *VC* is the commercial speed (km/h)
- *Km* is millions of bus-kilometres
- *Akm* is the degree of renewal of the fleet (€/km).

[4] In this law, rail services were excluded from the fund.

3.3 The Management Cost of LPT During the COVID-19 Outbreak

The Guidelines for the information of users of public transport have been subject to numerous changes during the issuance of the various Prime Ministerial Decrees containing urgent measures to deal with the epidemiological emergency from COVID-19 (frequency in October became fortnightly!), in order to adapt them to the evolution of the pandemic scenario.

Thus, from their first edition (Prime Ministerial Decree of April the 14th 2020 with the Annex No. 9) to the current version (Prime Ministerial Decree of March the 2nd 2021 with the Annex No. 14), the national legislator has varied, according to need or strategic choice, certain parameters, such as, but not limited to, the crowding index of the specific public means of transport, alongside refinements of the text and/or correction of material errors, in accordance also with the impact that the recovery of economic activities foreseen in phase 2 and above all schooling in attendance could determine, and in fact has determined, on the local transport system. And, specifically, starting from the Prime Ministerial Decree of August the 7th 2020, it has also entered into the merit of some types of public transport, such as dedicated school transport.

For local public road transport, the contagion curbing measures include:

Daily disinfection of public transport and sanitisation in relation to specific company realities.

- Separation of the driver's seat from the passengers;
- Separation of the entry and exit of passengers using the central and back doors and in respect of appropriate waiting times in order to avoid contact between those who get off and those who get on;
- Suspension of the sale and control of tickets on board;
- Checking the correct use of personal protective equipment (masks and gloves);
- Installation of hydroalcoholic dispensers for passenger use;
- Communications on board of the vehicles by affixing signs showing the correct way of behaving.

These requirements inevitably lead to additional costs for operators of public road transport services in addition to those that they have to face in normal situations.

In this research, the authors define a new standard cost (Eq. 4) for local public transport services in the post COVID-19 era as the sum of the standard cost under normal pre COVID-19 conditions and the additional costs necessary to meet the Decree of the President of the Council of Ministers indications for contagion containment.

$$CS_{\text{post COVID-19}} = CS + C_x \tag{2}$$

4 Results

4.1 Local Public Transport in Sicily (Italy)

Sicily is the largest island in the Mediterranean (about 25,800 km^2), the Italian region with the largest extension and is the fourth most populous region in Italy (about 5 million residents, 8.4% of total residents in Italy).

The Sicilian road system is about 30,500 km long: about 700 km of motorways, about 3,500 km of roads of State interest while the management of about 26,000 km of roads is under the responsibility of Local Authorities. Sicily is the third Italian region (after Piemonte and Lombardia) by extension of motorway network. Precisely, its extension in relation to the number of inhabitants is equal to 1.3 km^2 per 10,000 inhabitants compared to an Italian average of 1.1 km^2, and that in relation to the territorial extension is equal to 2.6 compared to the Italian average of 2.2 per 100 km^2. For most of the Sicilian territory, the extra-urban public transport system by road is the only alternative mode of transport to private cars. The total volume of journeys to 2016 amounts to 60,215,611 bus * km/year.

Sicily has 83 public road transport companies and the average volume delivered in 2016 is 725,000 buses * km. About 18% of the companies (15 out of 83) provide a higher-than-average annual volume of journeys: this confirms the current fragmentation of the service in Sicily with a large number of companies operating with marginal production volumes (less than 100,000 vehicles km/year). About the 24% of the annual kilometres of suburban services is provided by the company AST (Azienda Siciliana Trasporti) owned by the Sicilian Region, about 9% by SAIS Trasporti, 8% by SAIS Autolinee and 7% by Interbus. The three quarters of the Sicilian companies (exactly 66 companies) provide less than 1% of the total regional supply [31].

Analyzing the data provided by Moovit is it possible to calculate the percentage decrease in the use of public transport during this pandemic period.

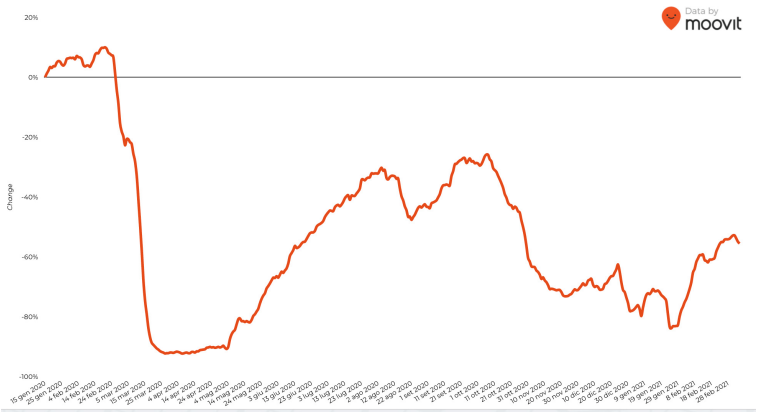

Fig. 2. Sicily public transport report during Covid 19

As can be seen from Fig. 2, the trend in Sicily is above the national average, with a decrease compared to the baseline of 45% [32].

4.2 Questionnaire Through Google Surveys

The starting point for this paper was a survey that aimed at getting a first evaluation on the approach to transport modes in the post COVID-19 period. The survey was

completed online using social and fast communication methods that made it easy and straightforward to respond to the questions picking an answer out of a multiple-choice. It was administered to users mostly interested in suburban public road transport. In fact, most of the subjects investigated live in the municipalities surrounding the city of Enna and move systematically to and from larger urban centres by bus. Only a small part of the investigated users lives in large urban areas with different integrated transport modes (metro, bus, etc.). Below is the model of the questionnaire divided into 4 sections and the most significant results (Table 2).

Table 2. Questionnaire through google surveys

Section	No.	Question
Personal data	1.1	Gender
	1.2	Year
	1.3	Degree
	1.4	Recidence
Transport habits	2.1	How often do you use public transport?
	2.2	What type of public transport do you use most?
Change in transport modes in the post Covid 19 era	3.1	Awareness of the epidemia
	3.2	Do you think you'll use public transport again in the next 6 months?
	3.3	What do you expect from public service providers?
	3.4	Reduction of physical contact with personnel or mechanical obliteration machines
	3.5	Attitude towards prior allocation of seats on public transport
	3.6	Attitude towards leaving seats unoccupied reducing the number of passengers in public transport increasing the social distance
	3.7	Individual devices useful on public transport (gloves and masks)
	3.8	Frequency of visiting public places (shopping centres, cinemas, theatre)
Transport sharing	4.1	Use of shared transport vehicles
	4.2	Frequency of use of means of transport sharing

The results of the survey show that in ordinary conditions (prior to COVID-19) the interviewed users tend not to choose public transport for urban and suburban travels in the Region of Sicily and this is probably also due to the law level of the services offered.

The 35% of respondents do not use public transport and 25% rarely use it (once a week) (Fig. 3a). According to the survey, bus is the preferred public transport mode by almost 58% of respondents (Fig. 3b). This is also due to the low number of trains in Sicily.

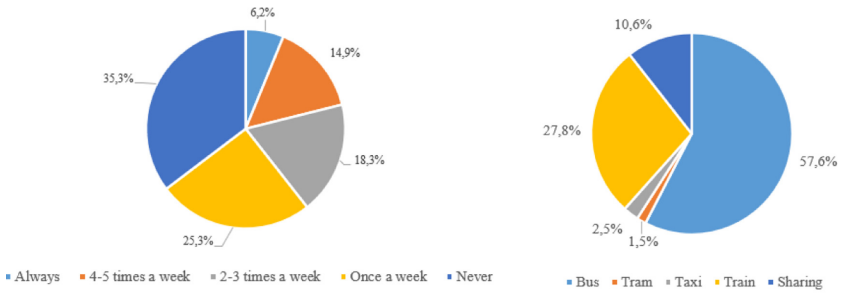

Fig. 3. (a) 2.1 Frequency of use of public transport before outbreak; (b) 2.2 Most used public transport.

As a result of the pandemia, 30% of respondents prefer not to use public transport and 63% prefer to use it only when necessary (Figs. 4a and b). This means that we should expect a reduction in the number of people using public transport in the post-COVID period and consequently in the economic income from ticket sales.

In addition, users confirm that they will use public transport only if precautionary systems are in place, consistent with measures meant to curb contagion on transport vehicles. In fact, 48% of the interviewees ask for a reduction in the number of passengers in order to keep the social distancing among passengers and 29% ask for frequent sanitization interventions on vehicles.

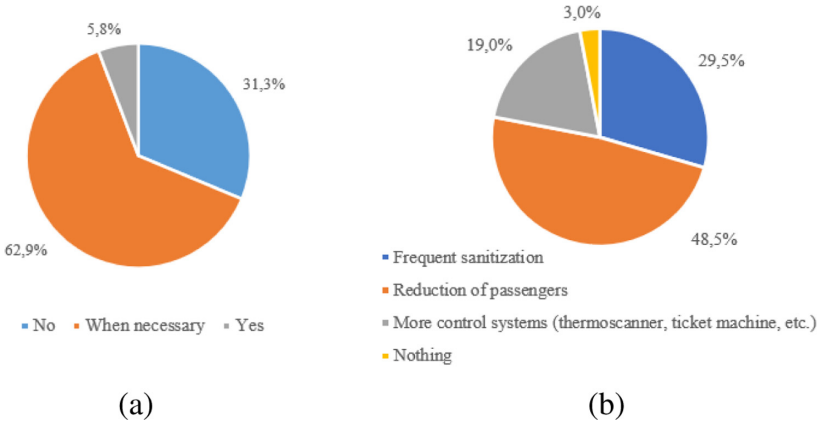

Fig. 4. (a) 3.2 Use of public transport after the outbreak; (b) 3.3 Managers' strategic actions.

In general, the results of the survey are not encouraging for local public transport operators. The paper therefore addresses the issue of standard costs of local public transport services by road and the variation of these costs caused by the COVID-19 outbreak.

4.3 The Cost Increase of the Public Road Transport in Sicily the Post COVID-19 Period

Given the methodology for the determination of the CS standard cost in public road transport, the objective of this study is to determine the variation of the standard cost for the local public road transport in Sicily post-COVID-19 $CS_{\text{post COVID-19}}$ (Eq. 4) where Cx represents the impact of costs relating to protection devices, sanitization, increased on-board controls and reduced passenger capacity, in order to ensure compliance with current anti-COVID legislation.

The investigation scope of the local public road transport service was chosen on the basis of the survey results, considering that most of the respondents are users of the extra-urban public road transport service in Sicily.

We then proceeded with the calculation of the CS on the basis of data provided by the main public road transport company in Sicily, AST (Azienda Siciliana Trasporti), which on its own carried out 24% of the annual trips of Sicilian suburban services[5].

According to the Ministerial Decree no.157 of March 28th 2018, the standard cost referred to the extra-urban service is:

$$CS\left(\frac{€}{bus-km}\right) = 2{,}77 \tag{3}$$

Where:

- Commercial speed VC = 63 km/h
- Annual kilometers km = 14.579.909 km
- Degree of renewal of the fleet A_{KM} = suburban degree of renewal of the fleet €/km = 0,35 €/km, where its value is 5.087.070 €.

As a result of the spread of the COVID-19, the value of CS increased by a certain amount C_x. The value of C_x is given by the costs for the following items per vehicle unit (bus):

- Sanitization: 150 €/g to proceed with daily sanitization and assuming that purchase of equipment and consumables is handled in house by the operator. It has been hypothesized that sanitization is carried out with a frequency of 1–2 times a day depending on the number of trips and passengers. The monthly cost would therefore be equal to 150 €/g per n. 20 days, corresponding to 3,000 €/month;
- Termoscan: one-off purchase in n.2 units for each vehicle to be installed at the two entrance/exit doors. The cost amounts to 2,000 €/cad and therefore totals 4,000

[5] It should be specified that AST provides a mixed service (urban and suburban). For the sake of this study, we selected data related only to the extra-urban service.

€/vehicle. Assuming an amortization time of the technology in 2 years, it is estimated a cost corresponding to about 100 €/month having foreseen the incidence of 10% monthly maintenance;

- Alternating seats (capacity reduction): considering that a bus has an average overall capacity of around 70 seats and that the average occupancy coefficient can generally be considered to be around 60% of this capacity, an average presence of around 42 users is obtained compared to the mandatory reduction to 35 in the case of alternating seats. The post COVID19 situation would therefore lead to a reduction in the number of users on average by about 10% compared to the average. Given the modest loss of the number of users and the variability in the cost of the ticket depending on the journey, given the difficulty of identifying an objective and unambiguous amount and the amount itself, this is considered negligible;
- Electronic ticketing and reserved seats: electronic ticketing is already in use by most operators but with the post COVID19 experience and the reduced availability of seats it is necessary to estimate an implementation of the service, technology and management. This higher cost can be considered negligible if offset by the resulting reduction in staff costs and therefore the transfer of man-hours to other services. Increase in costs equal to 0 €;
- Increased on-board control in order to comply with the rules: since the post COVID19 situation imposes a new behavioral regulation on users, it is necessary to proceed with the implementation of the on-board service that could be offered by the driver himself but with a waste of time and therefore with a loss of service efficiency. For this reason, it is possible to estimate an increase in staff costs of about 15% of the corresponding salary of about 600 €/month;
- Sanitizers and PPE on board (possible sale on site): in order to guarantee the minimum conditions required by the user it is necessary to install at least 2 dispensers containing sanitizing gel inside the vehicle. The supply and installation costs about 150 €/cad, to which must be added to the supply of consumables and maintenance. Based on market research and on the analysis of users' consumption, it is estimated that the cost of supply and installation is negligible because it is much lower than maintenance and recharging, which amounts to about 50 €/g, corresponding to about 1,000 €/month. The PPE provided for in the standard and/or regulation is not taken into account as it is assumed that it is already in disposable condition in order to avoid possible contacts from the outside to the inside of the vehicle. In any case, the PPE is considered to be already owned by the user and is therefore not considered to be costs attributable to the service provider;
- Driver protection and separation systems: in order to protect and safeguard the health of the driver it is necessary to isolate the area occupied by the driver from the transit of users. This intervention has a market survey estimated cost of about € 500 one-off and a total duration of about 2 years. The incidence of the cost is therefore about 15 €/month including ordinary maintenance.

The prices indicated above refer to a market analysis conducted in the territory of the Region of Sicily.

From the sum of the above costs, the C_x cost increase for the service provider amounts to approximately 4,715 €/month for each vehicle in use for extra-urban transport.

Considering that every month a single bus travels an average of 3,355 km (data extracted from the 2019 service map):

$$CS\left(\frac{€}{month}\right) = CS\left(\frac{€}{KM}\right) * Q\left(\frac{km}{month}\right) = 2{,}77\ x\ 3355 = 9.310{,}77\ €/month \quad (4)$$

The latter is the amount that the operator (AST) should receive as public contribution. So the total cost $CS_{post\ COVID\text{-}19}$ is equal to:

$$CS_{Post\ COVID-19} = CS\left(\frac{€}{month}\right) + C_x\left(\frac{€}{month}\right) = 9.310{,}77 + 4.715 = 14.025{,}77\ €/month \quad (5)$$

As a result, costs increased by 34% compared to pre-COVID-19 situation.

5 Discussion and Conclusions

The analysis of the additional costs necessary to maintain the attractiveness of the extra-urban LPT service shows that in some cases the same service becomes economically unsustainable in the post COVID-19 period.

The higher cost of the services requested by passengers must be covered by public spending because it cannot be passed on to users who would otherwise find it neither convenient nor useful to use public extra-urban road transport compared to private transport. The cost of the ticket for public transport by road has already been reduced by regional intervention aiming to guarantee a service to all interested users at a satisfactory level of quality suitable for the mode of transport in question.

The experience of COVID-19 requires a serious reflection on emergency and post emergency situations that must be organized in advance in order to avoid situations of improvisation such as those in progress, which are short-sighted healing interventions that need to be continuously corrected because they are neither scheduled nor planned. Indeed, the current situation leads to choices that neither the public administrations nor the managing authorities themselves had even slightly hypothesized.

This article, through an investigative action based on an online questionnaire, has made it possible to carry out a first preliminary analysis that will be subsequently detailed by increasing the number of users involved. The processing of the answers received from the interviewees made it possible to identify at an early stage the intentions of the systematic users of suburban public transport by road and that concern infrastructural and management interventions.

The article proposes an analysis of the standard costs of local public transport considering three factors:

– Commercial speed is a qualitative (economic) characteristic of the service, which is difficult for the provider to control. In particular, the impact of this variable on the cost can be expected to be significant and non-linear, i.e. a marginal increase in commercial speed reduces the cost to a greater extent for rather slow services than for fairly fast ones. The statistical model adopted by Boitani and Avenali [19], therefore, takes account of this possible non-linearity, assuming a functional form that with respect to commercial speed can behave as a linear function with dashes.

– Regarding the number of service vehicle-kilometres, the size of the service provided, and hence the size of the operators, can have an important influence on the ability of firms to acquire production inputs for which the conditions typical of markets in perfect competition (e.g. vehicles) cannot be found. Therefore, the size of the hero-derived service can be expected to play some role in determining the cost of the service, indicating the presence of economies or diseconomies of scale.
– The large difference in purchase costs between vehicles with different traction types, and between recently purchased vehicles and vehicles still in operation but purchased in the past (which represent a significant difference in the cost of the service) but purchased in the past (which represent an important share of those used overall in Italy), suggests that the degree of modernisation of the rolling stock may represent a driver of the cost of the service, that can be controlled by the operator providing the service.

The infrastructural actions include the installation on the means of transport of specific and dedicated technologies that on average can be activated in short notice. The management activities, on the other hand, involve an organizational change in the service management which also in this case require a longer time to be implemented. In both cases, the activities carried out by the managers of the extra-urban public road transport service include a significant communication and awareness raising action towards the user, who is alternatively forced to use private rather than public transport vehicles with the related economic, environmental and congestion impact. The interventions to be carried out by the Managers are even more complex and time-consuming if the financing has to be covered by the Public Administration, which to date (almost three months after the beginning of the pandemia) has not made it clear. The result of the current situation is therefore that the user, due to the changed approach to the health security measures expected to be carried out in public transport, tend to switch to private transport. It also points out that it is necessary to plan and schedule technological solutions and appropriate funding to provide public transport in general with all the useful and appropriate equipment to ensure a "safe" level of service for users. The specific case of the COVID-19 has led to a sudden collapse of overall mobility due to the lockdown strategy, but if such strategy would not have been chosen, the effect would have been a steep increase in the number of private vehicles on the roads putting the whole urban and suburban transport system in a critical position.

References

1. UITP - Advancing Public Transport: World Metro Figures 2018. In: UITP (2018). https://www.uitp.org/world-metro-figures-2018. Accessed 24 Apr 2020
2. Qian, X., Sun, L., Ukkusuri, S.V.: Scaling of contact networks for epidemic spreading in urban transit systems (2020). ArXiv Preprint ArXiv200203564
3. Morawska, L., Tang, J.W., Bahnfleth, W., et al.: How can airborne transmission of COVID-19 indoors be minimised? Environ. Int. **142**, 105832 (2020). https://doi.org/10.1016/j.envint.2020.105832
4. AppleMaps COVID-19 - Report sui trend di mobilità. In: Apple. https://www.apple.com/covid19/mobility. Accessed 9 Jul 2020

5. Campisi, T., Acampa, G., Marino, G., Tesoriere, G.: Cycling master plans in Italy: the I-BIM feasibility tool for cost and safety assessments. Sustainability **12**, 4723 (2020). https://doi.org/10.3390/su12114723
6. Campisi, T., Torrisi, V., Ignaccolo, M., et al.: University propensity assessment to car sharing services using mixed survey data: the Italian case study of Enna city. Transp. Res. Procedia **47**, 433–440 (2020). https://doi.org/10.1016/j.trpro.2020.03.155
7. Acampa, G., Ticali, D., Parisi, C.M.: Value of travel time: an economic assessment for transport appraisal decision-makers, Rhodes, Greece, p. 160009 (2019)
8. Acampa, G., Marino, G., Parisi, C.M.: Social network as tool for the evaluation of sustainable urban mobility in Catania (Italy). In: Bevilacqua, C., Calabrò, F., Della Spina, L. (eds.) NMP 2020. SIST, vol. 178, pp. 243–253. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-48279-4_23
9. Hawkins, A.J.: Coronavirus is taking a big bite out of public transportation ridership in the US. In: The Verge (2020). https://www.theverge.com/2020/3/13/21179032/public-transportation-coronavirus-covid19-ridership-nyc-sf-la-dc. Accessed 8 Mar 2021
10. Law Decree 19 May 2020 no. 34 ("Decreto Rilancio") Italian Government. In: Gazzetta Uff. https://www.gazzettaufficiale.it/eli/id/2020/03/09/20A01558/sg. Accessed 4 Aug 2020
11. Obeng, K., Sakano, R.: Total factor productivity decomposition, input price inefficiencies, and public transit systems. Transp. Res. Part E Logist. Transp. Rev. **38**, 19–36 (2002). https://doi.org/10.1016/S1366-5545(01)00010-2
12. Fraquelli, G., Piacenza, M., Abrate, G.: Regulating public transit networks: how do urban-intercity diversification and speed-up measures affect firms' cost performance? Ann. Public Coop. Econ. **75**, 193–225 (2004). https://doi.org/10.1111/j.1467-8292.2004.00250.x
13. Cambini, C., Piacenza, M., Vannoni, D.: Restructuring public transit systems: evidence on cost properties from medium and large-sized companies. Rev. Ind. Organ. **31**, 183–203 (2007). https://doi.org/10.1007/s11151-007-9153-9
14. Ottoz, E., Di Giacomo, M.: Diversification strategies and scope economies: evidence from a sample of Italian regional bus transport providers. Appl. Econ. **44**, 2867–2880 (2012). https://doi.org/10.1080/00036846.2011.568399
15. Berechman, J.: Cost structure and production technology in transit. Reg. Sci. Urban Econ. **17**, 519–534 (1987). https://doi.org/10.1016/0166-0462(87)90014-7
16. Cambini, C., Filippini, M.: Competitive tendering and optimal size in the regional bus transportation industry: an example from Italy. Ann. Public Coop. Econ. **74**, 163–182 (2003). https://doi.org/10.1111/1467-8292.00220
17. Filippini, M., Prioni, P.: The influence of ownership on the cost of bus service provision in Switzerland - an empirical illustration. Appl. Econ. **35**, 683–690 (2003). https://doi.org/10.1080/0003684032000056788
18. Boitani, A., Nicolini, M., Scarpa, C.: Do competition and ownership matter? Evidence from local public transport in Europe. SSRN Electron. J. (2010). https://doi.org/10.2139/ssrn.1557151
19. Avenali, A., Boitani, A., Catalano, G., et al.: Un modello per la determinazione del costo standard nei servizi di trasporto pubblico locale su autobus in Italia. Econ. E Polit. Ind. 181–213 (2014). https://doi.org/10.3280/POLI2014-004009
20. Avenali, A., Boitani, A., Catalano, G., et al.: Assessing standard costs in local public bus transport: evidence from Italy. Transp. Policy **52**, 164–174 (2016). https://doi.org/10.1016/j.tranpol.2016.06.007
21. MIT - Ministero delle Infrastrutture e dei Trasporti Decreto ministeriale numero 157 del 28/03/2018. http://www.mit.gov.it/normativa/decreto-ministeriale-numero-157-del-28032018. Accessed 9 Jul 2020

22. Avenali, A., Boitani, A., Catalano, G., et al.: Assessing standard costs in local public bus transport: a hybrid cost model. Transp. Policy **62**, 48–57 (2018). https://doi.org/10.1016/j.tranpol.2017.03.011
23. Decree of the President of the Council of Minister: Decree of the President of the Council of Ministers 26 April 2020 further implementing provisions of the Decree-Law February 23, 2020, n. 6, containing urgent measures regarding the containment and management of the epidemiological emergency from COVID-19, applicable on the whole national territory (2020)
24. Decreto-Legge del 19 maggio 2020, n. 34 Misure urgenti in materia di salute, sostegno al lavoro e all'economia, nonche' di politiche sociali connesse all'emergenza epidemiologica da COVID-19. https://www.gazzettaufficiale.it/eli/id/2020/03/09/20A01558/sg. Accessed 9 Jul 2020
25. Google COVID-19 Community Mobility Report. In: COVID-19 Community Mobility Report. https://www.google.com/covid19/mobility?hl=it. Accessed 9 Jul 2020
26. Cassa Deposito e Prestiti: Luci e ombre della mobilità urbana in Italia: ripartire dal trasporto pubblico (2019)
27. Law fiscal federalism: Law fiscal federalism no. 42/2009 (2009). https://www.gazzettaufficiale.it/gunewsletter/dettaglio.jsp?service=1&datagu=2009-05-06&task=dettaglio&numgu=103&redaz=009G0053&tmstp=1241691584038. Accessed 6 Jul 2020
28. Shleifer, A.: A theory of yardstick competition. RAND J. Econ. **16**, 319–327 (1985)
29. Wang, W., Zhong, M., Hunt, J.: Analysis of the wider economic impact of a transport infrastructure project using an integrated land use transport model. Sustainability **11**, 364 (2019). https://doi.org/10.3390/su11020364
30. Acampa, G., Giustra, M.G., Parisi, C.M.: Water treatment emergency: cost evaluation tools. Sustainability **11**, 2609 (2019). https://doi.org/10.3390/su11092609
31. Regione Sicilia: Piano Integrato delle Infrastrutture e della Mobilità, p. 218 (2017)
32. Moovit Moovit Public Transit Index. https://moovitapp.com/insights/en/Moovit_Insights_Public_Transit_Index-countries. Accessed 9 Jul 2020