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RESEARCH ARTICLE

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MANAGING PUBLIC TRANSPORT DURING COVID-19: AN ANALYSIS OF THE IMPACT AND PREVENTIVE RESPONSE IN ISTANBUL*

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ABSTRACT

The number of passengers in public transport has decreased significantly in major cities around the world due to COVID-19. As residents of many countries work from home, they have avoided public transport to minimize their exposure to the outbreak and have changed their way of traveling within their cities due to major changes in local public transport services. Istanbul is one of the cities most affected by the pandemic in terms of the daily number of passengers using public transportation. For the first time since the pandemic started in Istanbul, the use of urban public transportation has decreased by more than 90 percent. The aim of this study is to examine the measures taken in Istanbul public transport in order to prevent the spread of the coronavirus pandemic. In addition, the trends in public transport and inter-modes demands during COVID-19 are analyzed. The results showed that COVID-19 measures to protect the health of passengers in Istanbul public transport are in line with global practices during the initial stage of the pandemic.

Keywords: *Novel Coronavirus Disease (COVID-19), Public Transportation, Protective and Health Measures, Istanbul.*

Managing Public Transport During COVID-19: An Analysis of the Impact and Preventive Response in Istanbul

COVID-19 SÜRECİNDE TOPLU TAŞIMAYI YÖNETMEK: İSTANBUL'DAKİ ETKİSİNİN VE ÖNLEYİCİ MÜDAHALENİN ANALİZİ

ÖZ

Toplu taşıma araçlarındaki yolcu sayısı, COVID-19 nedeniyle dünyanın büyük şehirlerinde önemli ölçüde azalmıştır. Birçok ülkenin vatandaşları evden çalıştıkları için, salgının etkisini en aza indirmek için toplu taşımadan kaçınmış ve toplu taşıma hizmetlerindeki aksamalar ve riskler nedeniyle seyahat tercihlerini değiştirmişlerdir. İstanbul, günlük toplu taşıma kullanan yolcu sayısı açısından pandemiden en çok etkilenen şehirlerden biridir. İstanbul'da pandeminin başlamasından bu yana ilk kez şehir içi toplu taşıma kullanımı yüzde 90'ın üzerinde azalmıştır. Bu çalışmanın amacı, Koronavirüs ile ilişkili salgının yayılmasını önlemek için İstanbul toplu taşıma araçlarında alınan önlemleri incelemektir. Makale ayrıca COVID-19 sırasında toplu taşıma ulaşım modları arasındaki talebin nasıl değiştiğini ve mevcut eğilimleri analiz etmektedir. Sonuçlar, yolcuların sağlığını korumak için İstanbul'da toplu taşıma araçlarında alınan COVID-19 önlemlerinin salgının ilk aşamasında global uygulamalarla uyumlu olduğunu göstermiştir.

Anahtar Kelimeler: *Yeni Koronavirüs Hastalığı (COVID-19), Toplu Taşıma, Koruyucu ve Sağlık Önlemleri, İstanbul.*

1. INTRODUCTION

A novel coronavirus (nCoV) disease, which causes severe acute respiratory syndrome, first reported in Wuhan/China on December 2019 (Du et al., 2020). This new coronavirus, which is named "COVID-19" by the World Health Organization (WHO), spread around the world just in a few months. About one month after the first case occurred, the epidemic is declared as a global public health disaster (Chung et al., 2020; Du et al., 2020) and as a pandemic on 11 March 2020 (He et al., 2020) by WHO. In less than five months, it is reported in all continents and in 210 countries. Since the first day (31 December 2019) of the appearance of COVID-19 and as of 01 March 2021, 112.348.223 cases and 2.484.324 deaths have been reported by ECDC (2021), whereas, happily the number of recovered cases have also increased. The daily number of reported cases and deaths by continent are shown in Fig. 1 and Fig. 2, respectively (ECDC, 2021).

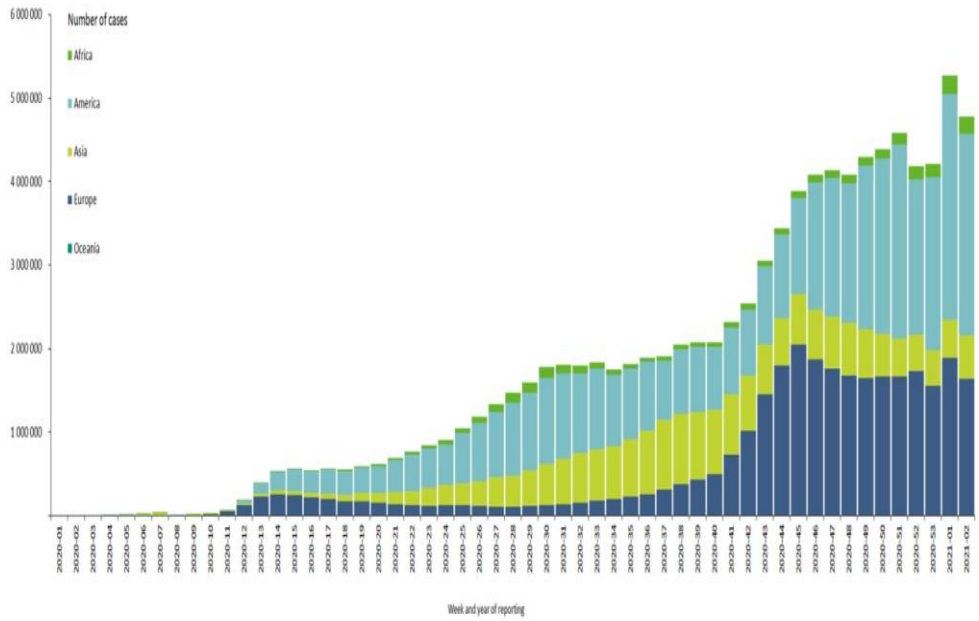


Figure 1. Number of the cases by continent, as of 23 January 2021 (European Centre for Disease Prevention and Control, 2021).

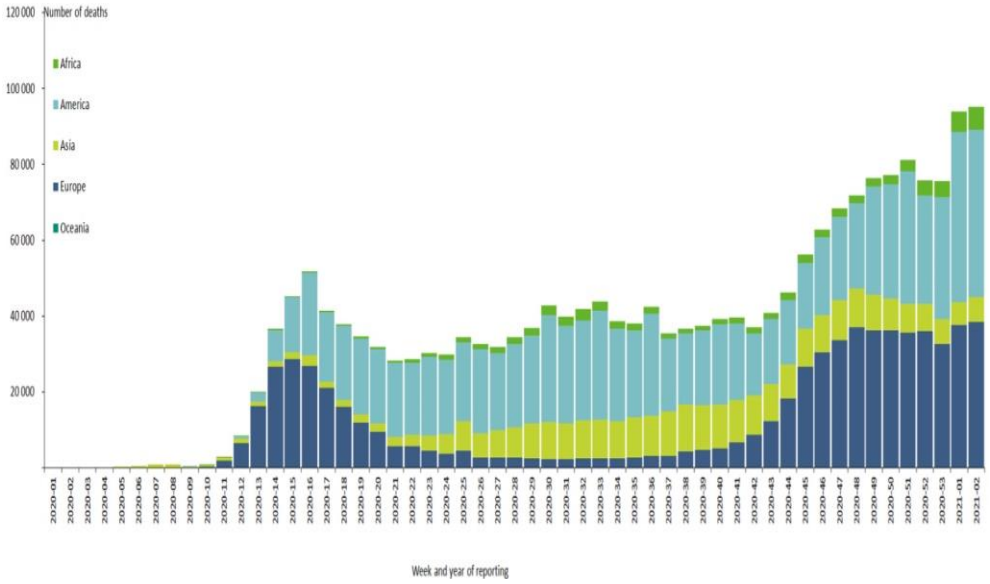


Figure 2. Number of deaths by continent, as of 23 January 2021 (European Centre for Disease Prevention and Control, 2021).

Several aspects of COVID-19 are studied from different points of views by researchers: Maleki et. (2020) forecasted the number of "confirmed" and "recovered" cases by using autoregressive time series models based on two-piece scale mixture normal distributions. Furthermore, Salgotra et al. (2020) developed genetic programming (GP) based models for the prediction of "confirmed" and "death" cases for the most affected states of India and for India as a whole. They concluded by mentioning the high reliability of the proposed models. Accordingly, Tuli et al. (2020) predicted the growth of the cases using machine learning (ML) techniques. They reported that a good prediction could be obtained by applying iterative weighting to Generalized Inverse Weibull distribution. Accurate forecasting models are highly important for managers to develop plans, such as resource utilization of health services, public transportation conditions etc., to fight against COVID-19. On the other hand, Qi et al., (2020) analyzed the spreading dynamics of the COVID-19 with daily average temperature and relative humidity in China. Jenelius and Cebecauer (2020) investigated the impacts of COVID-19 on public transport ridership in Sweden. Henser et al. (2021)

studied the impact of COVID-19 on cost outlays for car and public transport commuting for Sydney Metropolitan.

It is reported by Killerby et al., (2018) that the coronavirus shows a seasonal oscillation, which proves a robust linkage between meteorological factors and virus spread. Unfortunately, it seems that COVID-19 will continue for a while. Forecasting the growth of the pandemic is very important but taking precautions to stop its spreading is even more important to take it under control. Several precautions and quarantines have been applied for a long time by almost all countries, who are suffering from COVID-19. For instance, some of the precautions that are taken by Turkish government are reported in Kilic et al., (2020). Even these precautions helped a lot to prevent the spreading of the virus, later; governments are forced to stretch these precautions and quarantines because of economic and social issues. Once the governments let businesses start again, people had to use public transportation to go to work; even an important percent of people may start using their own private cars. It is a fact that crowded areas accelerate the spread of the virus, and public transportation is one of these crowded places especially in metropolitans such as Istanbul, Mexico City, Shanghai, New York, and Tokyo etc.

Considering the movement of millions of individuals via public transport in a day, the contacts of them seem inevitable, and these contacts will increase the spread of the pandemic if the same social life rules as before the pandemic of COVID-19 is followed. Therefore, countries, who fight against COVID-19, applied several precautions. For instance, Belgium, Portugal, Ireland and Italy rescheduled the public transport, and Slovenia and Slovakia banned or limited public transport services (Baka et al., 2020).

As a result, in order to take the pandemic under control, the management of public transport is vital for metropolitans, such as Istanbul. As being economic capital of Turkey, Istanbul is the most crowded city (TUIK, 2020) with more than 15 million residents. As shown in Fig. 3, the city is served with a wide variety of public transport modes including ferry, tram, metro, bus, and BRT. In Istanbul, approximately, 5.529.506.545 trips (more than 15 million trips in a day) take place by 12 railways/metros, 8 BRT-Bus Rapid Transit lines, more than 3000 buses, hundreds of ferries and jitneys, in a year (IETT, 2020). Therefore, this study analyzes the management of

COVID-19 in Istanbul's Public Transport and develops several precautions, designs, and suggestions. Regimented application of them led to a reasonably foreseeable trajectory of new infection and recovery cases in the city. Since the topic studied in this paper is the first research conducted on developing protective measures for public transport usage in the context of COVID-19, it is a novel study, whose contributions to the literature are very evident. Herewith, it provides a collection of examples of good-practices in public transport during the pandemic, which may inspire policy makers worldwide.

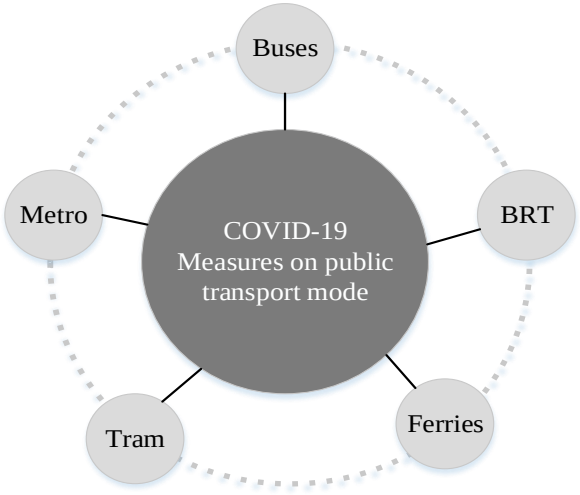


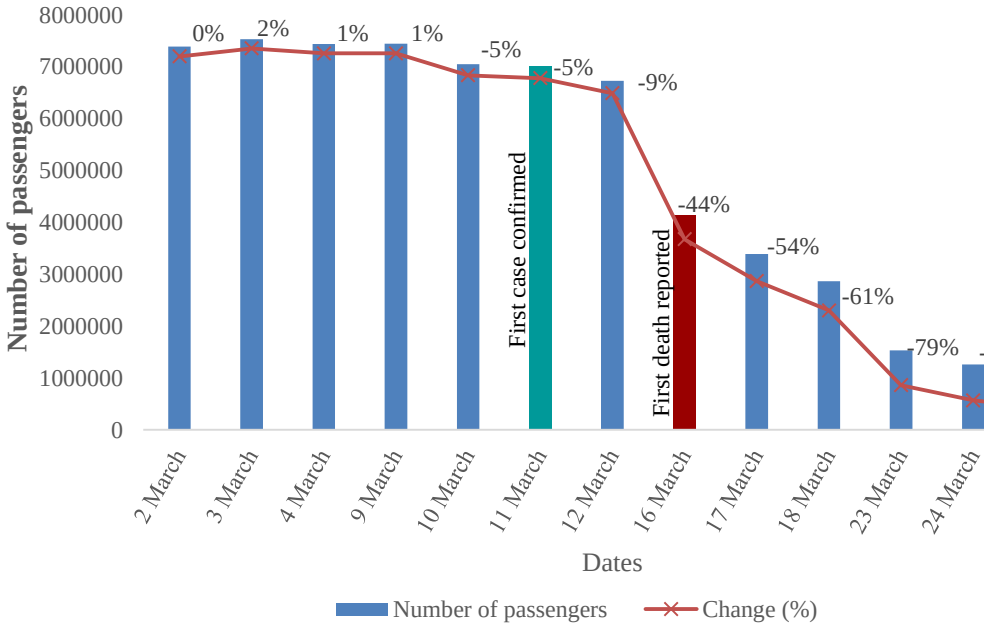
Figure 3. Istanbul public transport modes.

The rest of the paper is organized as follows: Section 2 presents the pre-COVID-19 situation of Istanbul`s public transport. The impacts of COVID-19 on Istanbul`s public transport are provided in Section 3. Section 4 delivers the protective measures on public transport in the context of COVID-19. Finally, the work and describes the future research opportunities are concluded.

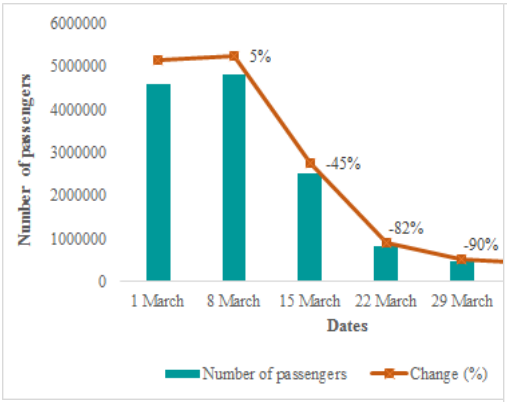
2. THE IMPACT OF COVID-19 ON THE ISTANBUL PUBLIC TRANSPORT

Being the most hit region in Turkey, self-isolation and imperative curfew practices imposed by the government, the impact of COVID-19 on the

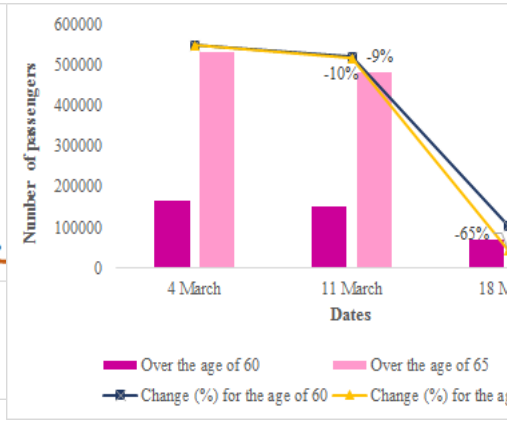
public transport in Istanbul in terms of ridership was ruinous. Fig 4 (a) shows that there is a significant decrease in demand after the first COVID-19 case on 11 March 2020. Demand for Istanbul public transport has dropped during the pandemic by as much as 85 percent. There is also a decrease again after the announcement of the first death on 16 March 2020. Fig. 4 (b) indicates the daily Sunday ridership trend. The number of passengers for those over the age of 60 and 65, who are categorized in the high risk segment, using public transport are shown in Fig. 4 (c). Older adults who have serious underlying medical conditions might be at higher risk of severe illness from COVID-19. So it is of vital importance for older adults to stay at home. Fig. 4 (d) indicates the daily Monday ridership trend. Daily demand trend between 9 and 12 March 2020 is shown in Fig. 4 (e) (IETT Statistics, 2020)



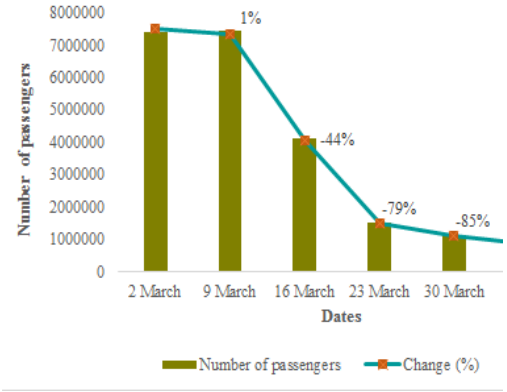
(a) Daily demand trend between 1 and 30 March 2020 (excluding weekends);



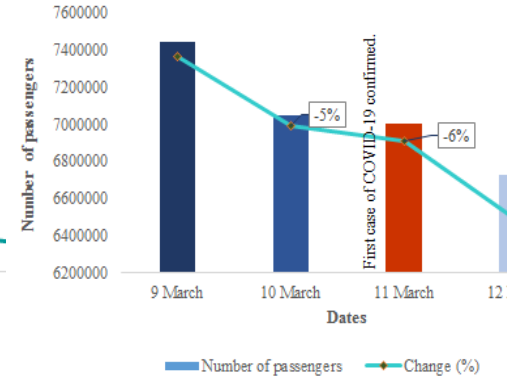
(b) Daily Sunday ridership trend;



(c) The demand trend for elderly travelers;



(d) Daily Monday ridership trend;



(e) Daily demand trend between 9 and 12 March 2020.

Figure 4. Ridership trends.

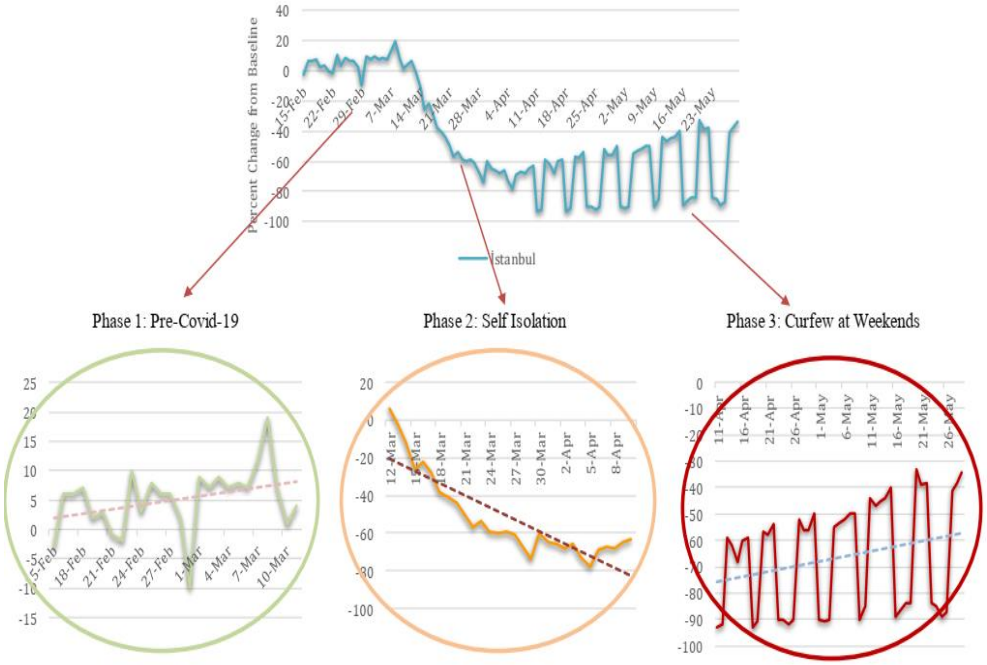


Figure 5. Percent change from baseline on transit stations in Istanbul (Google, 2020).

One of the interesting data source that needs special attention is the Google Mobility Reports (2020) which records anonymously percent changes in visits to public places compared to a baseline. The baseline for the percent change is defined as is the median value, for the corresponding day of the week, during Jan 3–Feb 6, 2020 at the respective location. One of the important dimensions of our interest in the given data is rendered from use of transit stations in the city such as subway, bus, and tram stations. Fig. 5 depicts daily percent changes on the use of public transportation during COVID-19. A closer look on the data reveals COVID-19 period, Feb. 15 to May 29, 2020 consists of three main phases, pre-COVID-19, self-isolation, and weekend curfews.

Some insights can be gained from Fig. 5 with regard to the measures taken by policy makers and their effects on Istanbul's public transportation network. At first stage, until the first case publicly denounced, there is no

indication of self-isolation and voluntary curfew as seen in pre-COVID-19 period. However, announcement of the first case, on March 12 (the end of 11 March), became a turning point where a strong negative trend in the use of public transport modes was observable. In addition, the curfew for elderly people and teenagers was strongly contributing to this negative trend. Additionally, it intensifies with voluntarily reduced activity and increased self-curfew practices during self-isolation phase. Lastly, at the third stage, law-enforced curfews at weekends successfully minimized the possible contact surfaces between people. However, a positive trend on the graph is detectable. This possibly indicates that some portion of the populations gradually softened self-imposed curfew as the spread of the virus and the number of newly infected people gradually decreases. The clear positive trend marks the weekdays where the percent change from baseline has declined from -60% to -35% in the last stage.

We also compared the mobility report data on transit stations of the most populated Turkish metropolitans, Istanbul, Ankara, and İzmir. Three cities provide an overall representative figure for the entire country with their cosmopolitan population. Despite the slight differences among the socio-economic structures and varying shares of public transportation on daily activities of mentioned cities, Fig. 6 shows that daily changes from the baseline on the use of transit stations follow almost a similar path with insignificant deviations. More precisely, all three stages, pre-COVID19, self-isolation, weekend curfews, have been experienced in a similar manner in three cities.

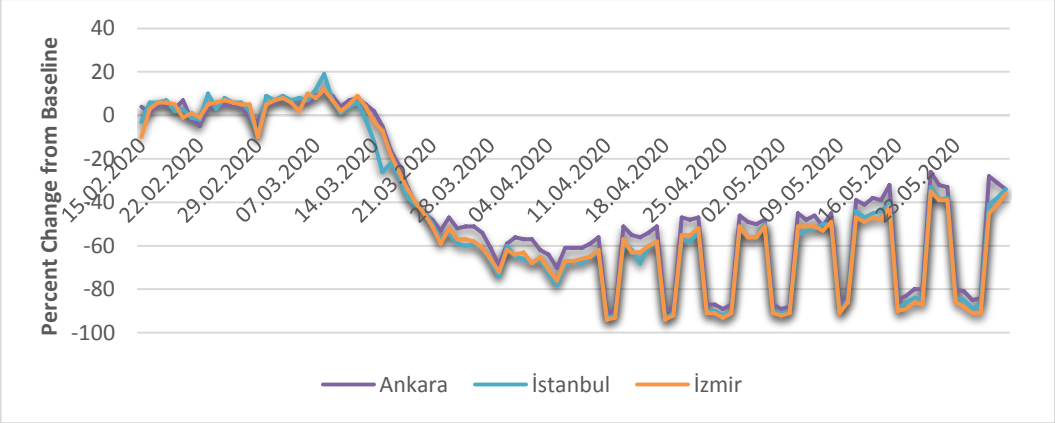


Figure 6. Comparison of three major metropolitans: İstanbul, Ankara, and İzmir (Google, 2020).

3. PROTECTIVE MEASURES IN PUBLIC TRANSPORT IN THE CONTEXT OF COVID-19

The following preventive and controlling measures in the context of COVID-19 have been taken in urban transport modes including road (buses, bus rapid transit-BRT), rail (metro, tramway, light rail, funicular) and maritime (ships, sea buses and motorboats) modes in Istanbul. Table 1 presents timetable of Istanbul's public transport measures during COVID-19 so far and how these measures have developed over time (IETT Istanbul).

Table 1. Timetable of Istanbul's public transport measures during COVID-19.

Date	Action
11 March 2020	All public transport vehicles started to be disinfected daily
18 March 2020	Free public transport for healthcare workers
19 March 2020	Temperature measurement of public transport drivers before the service
20 March 2020	Service changes due to decrease in demand
24 March 2020	Mandatory mask wearing and gloves for drivers
25 March 2020	Limited capacity usage (50%of the license capacity)
26 March 2020	Transparent protection cabinets for driver cabins in 3,000 buses Warning posters are posted to maintain social distancing on public transport
29 March 2020	Temporary bus closures due to closure of Istanbul International Sabiha Gökçen Airport. Seven bus lines (SG-1, SG-2, E-3, E-9, E-10, E-11 and MR60) have been temporarily suspended.
3 April 2020	Mandatory face masks for passengers on public transport.
4 April 2020	Temporary route closures for some of the routes due to closure of Istanbul Airport.
6 April 2020	Metro timetable is updated.
10 April 2020	Thermal camera inspection started at the BRT stations. BRT drivers started to work with protective gowns.
11-12 April 2020	Metro services has been temporarily suspended.
18-19 April 2020	Metro and tram timetables are updated due to curfew. (e.g. reduced frequency)
19 April 2020	Extra public transport services were introduced to the hospitals. 52 km route on the BRT line, all of the BRT stations and 228 BRT vehicles were cleaned/disinfected.
23-26 April 2020	Public transport timetable is updated due to curfew. (e.g. reduced frequency).
1-3 May 2020	Public transport timetable is updated due to curfew. (e.g. reduced frequency).
9-10 May 2020	Public transport timetable is updated due to curfew. (e.g. reduced frequency). Services are provided in 495 lines with a total of 8,609 trips, as well as 70 buses to hospitals.
16-19 May 2020	Public transport timetable is updated due to curfew. (e.g. reduced frequency). Services are provided in 494 lines with a total of 42,340 trips.
23-26 May 2020	Timetables of public transport are updated due to curfew. (e.g. reduced

	frequency). Services are provided in 498 lines with a total of 40,285 trips.
25 May 2020	The right of free public transport for all healthcare workers has been extended for another 3 months.
30-31 May 2020	Timetables of public transport are updated due to curfew. Services are provided in 498 lines with a total of 22,858 trips.
1 June 2020	Nostalgic tram services started again.
4 June 2020	Liquid hand sanitizer should be available in all vehicles. If the vehicle capacity is full, no passenger will be taken.

1. All passengers are required to wear face masks during their trips. Passengers without a face mask are not allowed in all public transport modes including bus, metro, BRT or city line ferries as illustrated in Fig. 7. In addition, drivers have to wear face masks during the pandemic.

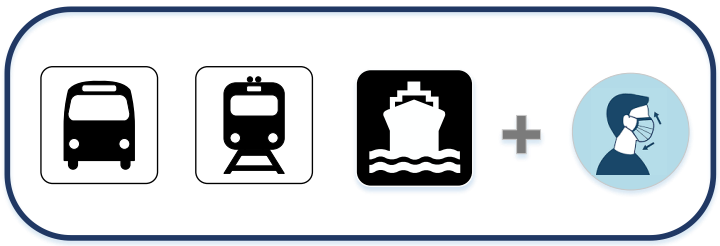


Figure 7. Obligatory face masks on Istanbul's public transport.

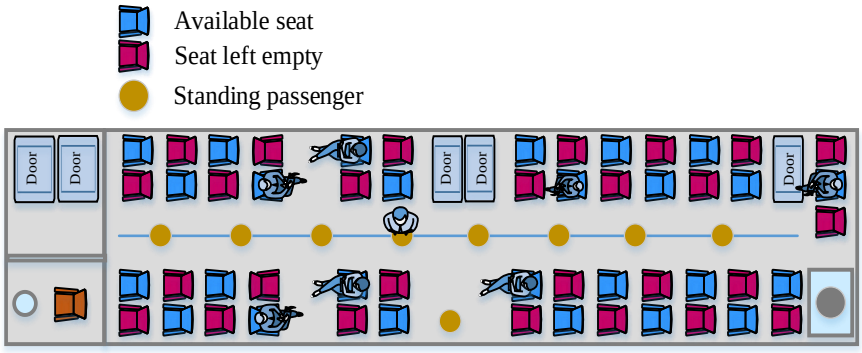
2. To protect drivers on public transport, protective equipment including masks, eye protection and gloves, must be provided to drivers. Drivers should be protected behind glass or plastic panels, as well as with protective barriers. Additionally, signs should be placed to prevent sitting near the driver.

3. The front door of the buses should be closed to protect drivers as illustrated in Fig. 8. Passengers are only allowed to get on and off using the middle and rear doors during the coronavirus pandemic.

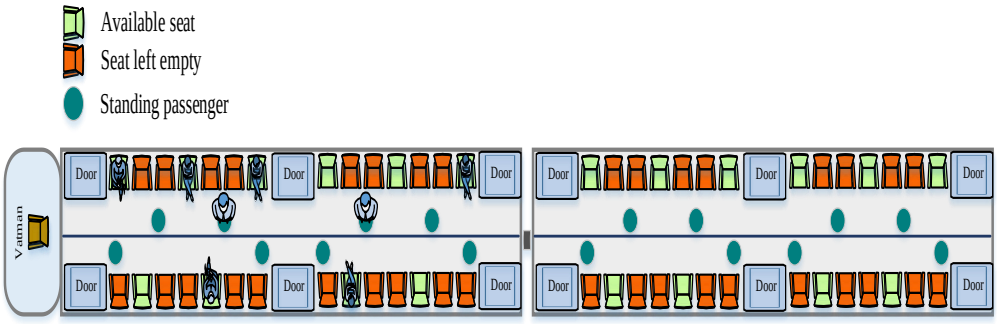
Figure 8. The front door out of use.

4. Passengers in public transport vehicles may not be able to effectively practice social distancing. Therefore, the interior of all public transport vehicles should be redesigned with caution/warning signs to ensure social distancing.

5. Social distance rules are applied in all public transport vehicles. For bus, BRT, metro and tram vehicles, the number of standing passengers should not exceed the number of seating passengers. However, the seats that are placed in a face-to-face arrangement should sit diagonally. In other words, passengers should be prevented from traveling face to face. In addition, at most one-third of the standing passenger capacity can be used in these vehicles. Labels are used to designate the points where passengers can stand as illustrated in Fig. 9.



(a) New bus design;



(b) New metro design.

Figure 9. New bus and metro design to prevent the spread of Covid-19.

6. Creation of isolated areas where suspected passengers are kept.

7. Implementing cleaning and disinfection to the interiors of vehicles, stations and equipment used by passengers. Public transport vehicles are disinfected daily before every trip and when necessary.

8. All passengers and drivers use hygienic hand sanitizers (see Fig. 10) during boarding and alighting.

Figure 10. Hand sanitizers available on stations.

9. Thermal cameras are installed at station entrances.

10. Social distancing posters should be placed at stations and bus stops. An example can be seen in Fig. 11.

Figure 11. Social distancing posters at stations and bus stops.

11. Fig. 12 shows the preference order for travels. If possible, people should continue staying at home unless they need an essential travel. If that is not possible, then people should prefer active transport modes such as walking, or cycling. If that is also not possible, then they should prefer public transport.

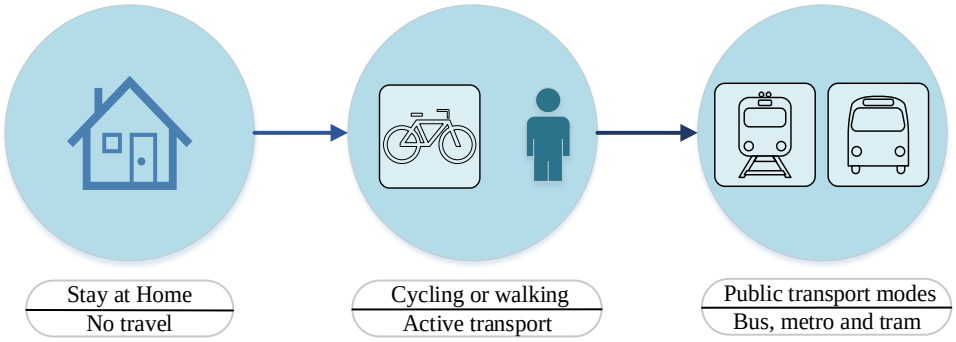


Figure 12. Preference order for travel.

12. Warning and informative videos and posters should be placed all over the stations and public transport vehicles to raise awareness about preventing the spread of coronavirus. Some examples can be seen in Fig. 13.

Figure 13. Preventive measures.

13. Updated timetables for all transport services due to significant drops in passenger demand. In addition to the measures taken by Istanbul's public transport authority, examples of measures from around the world for public transport are shown in Fig. 16.

14. Installation of cabinets that disinfect the whole body against COVID-19 at the main terminal stations as depicted in Fig. 14.

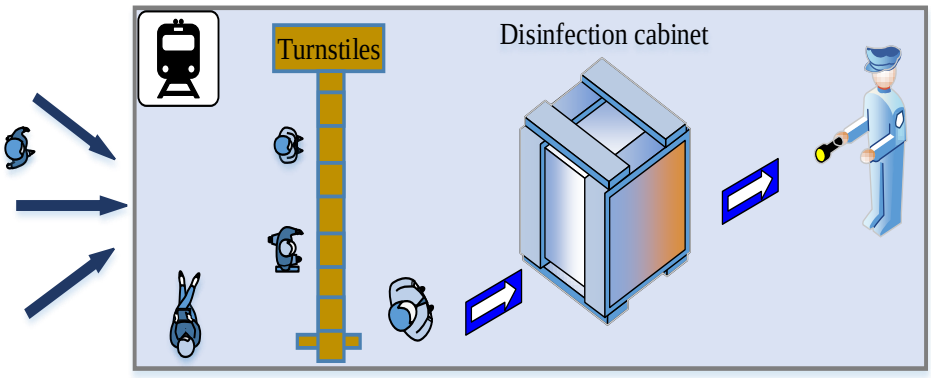


Figure 14. A disinfection cabin at station entrances.

15. In order to prevent transmission of COVID-19 through the surfaces touched often, cash payments are not allowed. Electronic cards, contactless cards, tickets or mobile tickets can be used as payment methods on public transport as shown in Fig. 15.

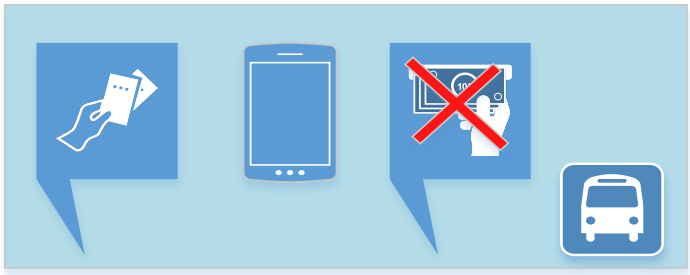


Figure 15. Non-cash payment methods.

Safety measures are implemented in Istanbul public transport against COVID-19. Fig. 16 shows a summary of actions on the Istanbul public transport has taken in response to COVID-19. These are as follows: cleaning and disinfection, social distancing measures, hygiene practices, protective gowns and thermal camera, respectively.

(a) Cleaning in BRT (Haber Turk Newspaper, 2020);

(b) Disinfection in buses (IETT Istanbul, 2020);

(c) Disinfection in buses (Sabah Newspaper, 2020);

(d) Cleaning in metro (CNN Turk, 2020);

(e) Disinfection in stations (NTV News, 2020);

(f) Disinfection in buses (Net Haber Agency, 2020);

(g) Protective equipment (TRT News, 2020);

(h) Eye protection and gloves (Diken Newspaper, 2020);

(i) Social distance in metro (Diken Newspaper, 2020);

(j) Social distance in buses (HaberVer Services, 2020);

(k) Glass or plastic panels in BRT (Hurriyet Newspaper, 2020);

(l) Thermal camera in stations (Diken Newspaper, 2020).

Figure 16. Istanbul's public transport measures against COVID-19.

4. CONCLUSION

As a result of the COVID-19 outbreak, public transport providers have to make significant changes in the way they serve their customers in a rapidly developing and uncertain environment. In this context, considering the analyses conducted on the Istanbul`s public transportation as well as comparisons done, no specific difference caught between the most crowded cities in Turkey, i.e. Ankara, Izmir, in terms of public transport usage, and a strong negative trend in use of public transport modes are detected.

Furthermore, it is shown that the law-enforced curfew at weekends successfully minimizes the possible contact surfaces between passengers. However, a positive trend on line is observed. This trend, possibly, indicates that a specific percent of the people gradually softened self-imposed curfew as the spread of the virus and the number of newly infected people on daily

bases reduced. According to the analyses and researches, to take COVID-19 under control and prevent its spread several suggestions and policies are created; which are wearing face masks during the trips, redesigning interior of the vehicles as pointing out the sitting/standing areas to unsure social distancing, having drivers to wear equipment such as masks, eye protection and gloves, establishing protective barriers between drivers and passengers or stopping the usage of front doors, disinfecting interiors of the vehicles daily or even better trip basis, providing hand sanitizers on vehicles, installing thermal cameras to determine infected people, encouraging people to use their private cars or bicycles if possible instead of public transport modes, informing passengers via videos and posters on stations and vehicles, updating timetables considering the demand, establishing disinfecting cabinets on stations so that passengers can use before getting on vehicles, and encouraging passengers to use electronic cards/tickets instead of cash.

Taking into account all suggestions and policies, the Istanbul`s public transport company has successfully taken all precautions to prevent the spread of the virus of COVID-19 with no delay. It can be inferenced that taking precautions and safety measures help in stopping the spread of the COVID-19, which can be observed from the statistics on the number of cases in Istanbul. Moreover, the results show that people will increasingly use bicycles and scooters and that studies can be conducted on these issues in the future.

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