

Review Paper

Strategy for Safe Passenger Transport during the COVID-19 Pandemic: From Review to Recommendation

Retno Rusdijati¹, Sumarno Adi Subrata²✉, Zulfikar Bagus Pambuko³, Muji Setiyo⁴,
Marcin Noga⁵

¹Department of Industrial Engineering, Universitas Muhammadiyah Magelang, 56172, Indonesia

²Department of Nursing Science, Universitas Muhammadiyah Magelang, 56172, Indonesia

³Department of Islamic Economic Law, Universitas Muhammadiyah Magelang, 56172, Indonesia

⁴Department of Automotive Engineering, Universitas Muhammadiyah Magelang, 56172, Indonesia

⁵Department of Automotive Vehicles, Cracow University of Technology, 31-864 Krakow, Poland

✉ adisubrata@ummgl.ac.id

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Abstract

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The COVID-19 pandemic caused a large-scale disruption to countries worldwide particularly in road traffic changes and people mobility. To respond to this, a titanic amount of published studies had investigated those concerns. However, a study describing mitigation efforts relating to this pandemic in the transportation sector is scarce. On the other hand, the lack of coordination between transportation authorities, public transport operators, and passengers triggers complex issues including the accumulation of passengers at bus stations that potentially increase virus transmission. For this reason, this article intends to investigate and establish strategies for safe passenger transport. The finding of the article presented four basic strategies as follows: First, a coordinated response among stakeholders and government is needed to develop comprehensive policies. Second, coordinated demand management is required to maintain a balance between government policies and citizen demands. Third, provide health education on Personal Protective Equipment (PPE) to public transport crews. Fourth, protecting the passengers and maintaining trust in public transport services. Additionally, it is recommended to provide adequate infrastructure, perform regular check-ups (i.e. assessing body temperature before entering public transportation), provide up-to-date COVID-19 health alert, and implement health protocol. Also, when this pandemic is over, the use of fuel-based transportation needs to be reduced, especially for short trips. To optimize this strategy, the role of government and health authorities on the policy side is crucial. Also, a good response from public transport operators and passengers is the key to defeat the COVID-19 pandemic in the transportation area.

Keywords: Covid-19; Mitigation; Traffic change; Safety driving; People mobility

1. Introduction

The COVID-19 pandemic greatly affected human life presenting challenges to public services and daily activities [1]. Countries having the greatest impact of this outbreak are China, European countries, and the USA. Recently, the prevalence of the COVID-19 infection increased dramatically which potentially disrupts road traffic and people mobility [2], [3]. As a consequence, the condition prompted the local government to initiate a restriction on

transportation and mobility to prevent virus transmission [4]. This restriction refers to the following type of transportation such as maritime, aviation, urban, and railway transport. Also, the government implemented countermeasures for example lockdown measures; prohibition of opening schools, family gatherings, eating out in restaurants, and offices as well.

In addition, several investigations on mobility services have evaluated that the frequency of use of public transport can be the risk of transmitting



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COVID-19 [5], [6]. As the geographical settings and data vary, a consistent pattern of mobility changes influencing public transport is difficult to compare with those using private cars and other types of transport modes. That situation may affect how to determine the strategy along with mitigation to reduce the virus transmission in the transport's modes. Evidence emphasized that vehicles and public transport stations are known to be high-risk environments for the COVID-19 infection because of the limited physical space available between people, the limited health assessment to the crew and passengers, and the abundance of surfaces helping the virus to spread widely [7].

Studies above highlighted the important measures to counteract the COVID-19 infection. However, none of the studies described the impacts of COVID-19 on road traffic changes and people mobility in Asian countries. Additionally, scientifically sound strategies and mitigations for safe driving are lacking. While existing work has reported the pandemic's effects on transportation, the impact on the economic aspect remains unknown, particularly in Asian Countries. Therefore, the study was aimed at exploring the impact of the COVID-19 pandemic on road traffic changes, people's mobility, and economic aspect. Strategy and mitigation for safety driving are also discussed by describing the roles of governments, stakeholders, health authorities, and communities. It is hoped that the finding of the study can encourage authorities and law-enforcing agencies to develop and optimize public-transportation-related interventions which possibly preventing the wide-ranging virus transmission.

2. COVID-19 History and Epidemiology

Historically, the Severe Acute Respiratory Syndrome coronavirus (SARS-CoV) as the leading first-century pandemic, was originated from an animal market in Guangdong Province, China in November 2002, then spread to over 30 countries during 8 months [8]. A total of 2500 cases of MERS-CoV infection were reported with an approximately 35% mortality rate [9]. A study documented that SARS-CoV-2 has similar profiles with SARS in 2003 and Mediterranean East Respiratory Syndrome (MERS) in 2012 [10]. Interestingly, countries with previous exposure to SARS and MERS seem to have fewer cases and

mortality from COVID-19 than countries with no previous exposure [11]. For example, Saudi Arabia, Jordan, Qatar, Germany, Tunisia and the United Arab Emirates (UAE). Even though the effect of MERS was milder than COVID-19, the world government implement the initial assessment and WHO guidelines to reduce the infection and vice versa, increase the care for those suffering virus infection.

Recently, the COVID-19, as the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first documented in Wuhan, China in December 2019 [12]. Recently, this virus is known to be a spillover of an animal coronavirus type and then adapted the specific ability of human-to-human virus transmission [13]. Studies highlighted that COVID-19 is contagious spreading and evolving in human life rapidly [14]–[16]. On 06 November 2020, the World Health Organization (WHO) reported 48.534.508 active cases with 1.231.017 fatality cases [17]. Other data is presented in the Center for Science and Engineering-Johns Hopkins' COVID-19 Dashboard (Figure 1), from January 2020, COVID-19 cases increased cumulatively and evenly across all continents. The growth of confirmed cases is still increasing, as presented in Figure 2.

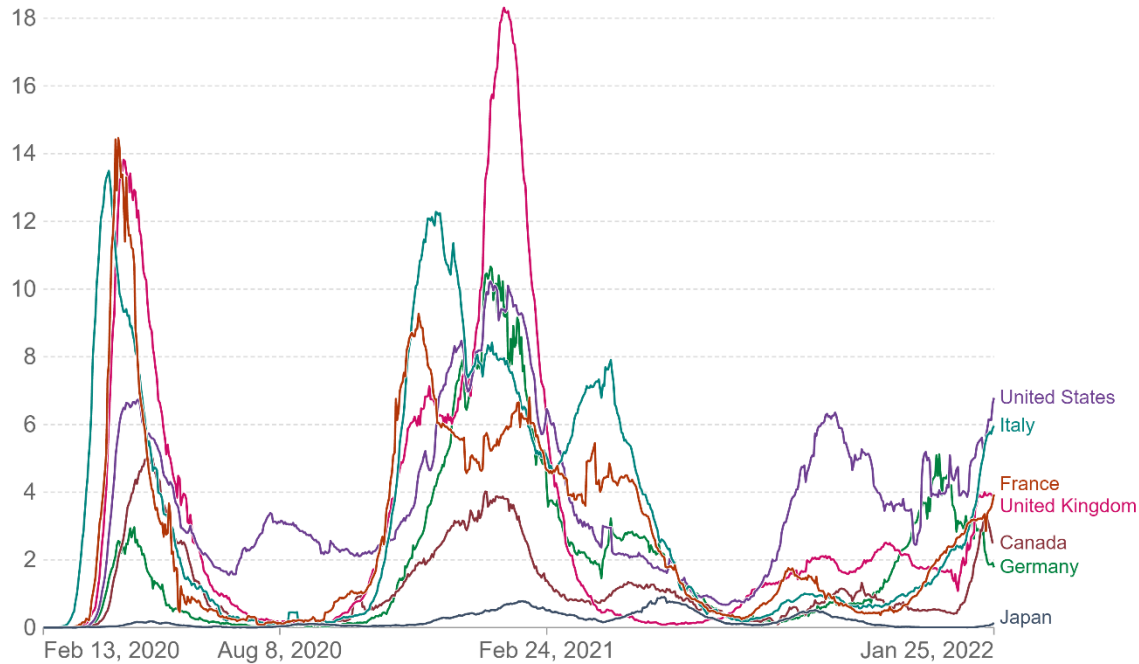
To understand the characteristic of this infection, clinical assessment is vital. This can be achieved by identifying the genetic material of the COVID-19 by Real-Time Polymerase Chain Reaction (RT-PCR) as the gold standard test [18]. However, the sensitivity of its test is not satisfactory. Thus, the diagnosis of COVID-19 should consider the clinical data which can be identified by evaluating several symptoms, ranging from asymptomatic or mild symptoms to severe illness and even death [19]. A study documented common symptoms such as fever,



Figure 1. Cumulative confirmed cases of COVID-19 [20]

Daily new confirmed COVID-19 deaths per million people

7-day rolling average. For some countries the number of confirmed deaths is much lower than the true number of deaths. This is because of limited testing and challenges in the attribution of the cause of death.



Source: Johns Hopkins University CSSE COVID-19 Data

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Figure 2. Trend of confirmed cases of COVID-19 [21]

cough, and shortness of breath [22]. Also, other reported symptoms are malaise, muscle pain, weakness, sore throat, respiratory distress, loss of taste, and or smell [23]. In Wuhan, China, the proportion of COVID-19 patients who experience gastrointestinal symptoms (inappetence and diarrhea) is high and they are more likely to have severe pneumonia and fever [24]. Therefore, it can be pointed out that the pandemic still constituted a public health concern requiring focused efforts based on strong pieces of evidence.

Groundbreaking strategies to reduce the prevalence of COVID-19 infection are urgently needed. As mentioned by a study, there is no recommended therapy for those who were infected by the COVID-19. Moreover, WHO therefore endorses supportive care only during delivering care of the patients [25]. However, frontline clinicians along with researchers have been conducting studies that focused on the host-based and virus-based therapeutics since the outbreak started. For example, Remdesivir, Lopinavir, Ribavirin, Interferon, Corticosteroid, Intravenous Immunoglobulin, Umifenovir, Chloroquine, Hydrochloroquine, Interleukin-6 Inhibitor, and Amantadine [26]–[29]. Finally,

supportive care is still the cornerstone of COVID-19 treatment. Also, when taking care of the patients, the complications should be managed according to the recent guidelines from health authorities. More well-designed Randomized Controlled Trials (RCTs) in COVID-19 are warranted before conclusions on its efficacy can be made to the public.

3. Method

This article used a literature review method involving online databases such as Scopus, SAGE, SpringerLink, PubMed, and Google Scholar. The keywords were 'COVID-19 travel change', 'COVID-19 people mobility', 'COVID-19 safe driving', 'COVID-19 mitigation', 'COVID-19 Asian Country'. The inclusion criteria were English articles relevant to COVID-19, safe driving, and people mobility; studies using quantitative and qualitative design, and articles published from 2019 – 2021. The exclusion criteria were studies not describing COVID-19, safe driving, and people mobility. The initial search from the selected databases retrieved 204 articles. After assessing the article content, 45 articles were

excluded. A further removal was also performed including 63 irrelevant articles. Then, a review of the full text was performed on 96 papers. That process excluded 59 articles because of failing to meet the criteria. Finally, a total of 38 studies were included. All studies describing the strategies were summarized by the authors then discussed in each section. Then, recommendations focusing on the transportation area were established after reviewing all the studies. A proven interaction among safety actions and health impacts was also clearly presented in the result and discussion section.

4. Results and Discussion

4.1. Mitigation preventing the COVID-19 virus transmissions

The expected outcomes of mitigation can be achieved when governments, health authorities, health care workers, and communities work in tandem. Health policy and leadership are also important to be involved, as they can monitor and assess the situation; communication; provide funding, personal protective equipment (PPE); Mitigation and containment; predictive mathematical modeling; and COVID-19 Surgical adaptation phase [30]. Furthermore, rapid responses are crucial to prevent an overload of emergency medical services as happened in Italy [31], [32].

Some countries implemented several measures against the COVID-19 pandemic. In Indonesia, assessment of key impacts and timeline; early and rapid diagnosis; and Issuance of medical guidelines are prioritized [33]. China changed public facilities into emergency hospitals for taking care of infected patients [34]. Korea implemented strict health measures in public transportation for example, using the drive-through and walk-through diagnostic testing along with extensive movement and contact tracing (Figure 3) [35].



Figure 3. a drive-through and walk-through diagnostic testing [35]

Also, Korea used mobile applications for the testing center, communicating movement trajectories for confirmed cases by digital maps and tracking the health and movement of travelers. In addition, self-precaution from passengers is mandatory in Korea for example maintaining a physical distancing, keeping no conversation in the public transport, and using hand sanitizer [36]. Other Asian countries such as the Philippines, Vietnam, Thailand and Indonesia also have specific measures Figure 4.

Likewise in Malaysia, the media promoted the hashtag #stayhome, non-governmental organizations including prison inmates produced PPE for healthcare in hospitals, hosted fundraising events, and built provisional hospitals [37]. The government in Sub-Saharan Africa optimized the role of multidisciplinary nature on environmental health practitioners (EHP) to develop COVID-19-related interventions [38]. Swedish formed a policy describing a close partnership between the local government and the community according to the trust giving the responsibility to individuals and their families [39]. Meanwhile, in Australia, the government optimized comprehensive care that is available to the community via general practice and Aboriginal community-controlled health care services. These strategies were provided by general practitioners (GP), clinical nurses, and other health care professionals serving at the Hospitals [40]. Like the other countries, Saudi Arabia, which potentially becomes a serious hotspot for spreading pandemics particularly when the Umrah and Hajj event, has suspended entry of all those activities. Then on 28 February 2020, Saudi Arabia also banned inbound travel of individuals from COVID-19 affected countries such as including Gulf Cooperation Council (GCC) citizens who traveled to affected countries [41].

At the last, all the individuals have a significant role to help their nation in facing the COVID-19 pandemic. For example, practicing routine hand washing, wearing a facemask or face shield, avoiding touching eyes and nose, and implementing physical along with social distancing in daily activities. It is also important to gain supports from the government across the region as they are the key to decision-making stakeholders in this outbreak.

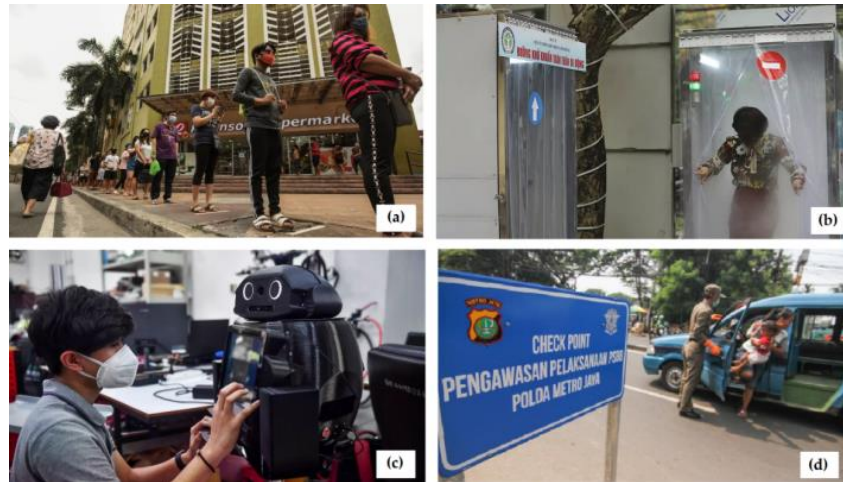


Figure 4. COVID-19 Mitigation in several countries in Southeast Asia: (a) social distancing and activity restrictions in Manila; (b) disinfectant booths in Vietnam; (c) virus-fighting robot in Thailand, and (d) Supervision of large-scale social restrictions programs in Indonesia (Photo a,b,c were taken from <https://hot.liputan6.com/> and d taken from <https://metro.tempo.co/>)

4.2. Lock-down phenomena on roads traffic and air pollution

COVID-19 has reversed conditions around the world, not only limited to healthy and clean lifestyles, lock-down policies and restrictions on activities by the central and local governments have affected the transportation and mobility sectors. In Italy, 40% of COVID-19 infections are caused by the accessibility of transportation. Therefore, proportionally limiting social interactions is proposed as a solution to break the chain of virus transmission, even though this policy has economic consequences [42]. In India, it was reported that 41.65% decided not to travel during the lockdown but 51.31% continued to use public transportation and only 5.3% of people switched from public to private transportation [43]. Each country may have typical problems and solutions, but countries with large populations face the challenge of getting their citizens to apply health protocols and on the other hand, the government must also ensure the safety of their citizens to carry out activities [42], [44]. Recently, a PASS method: P (Prepare – Protect – Provide), A (Avoid – Adjust), S (Shift-Share), and S (Substitute – Stop) was proposed as a solution for transportation safety, although this method is still at a conceptual level [1].

Since the government-imposed lockdowns, millions of people have locked themselves at home (resting or working from home-WFH). As a result, traffic in big cities on normal days shows congestion in 2019, during this lock-down, it looks

empty. For example, as reported by Ian Dickson at <https://360.here.com/>, he has made a map comparing traffic volumes in major European cities on 8 April 2019 and 6 April 2020 [45]. The description of the traffic conditions is given in **Table 1**. Then, in some European countries that apply lockdowns, traffic in many cities has almost disappeared, as shown in **Figure 5**. These figures are based on peak time travel at 8 am on April 8, 2019, and at the same time and road on April 6, 2020. The data is a combination of real-time and historical and the map is color-coded to show traffic volume: the red route as heavy congestion, yellow as moderate, and green as clear.

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Furthermore, Sofia Heisler, a data scientist, reported road conditions in the world using the telemetry method [46]. Data is compared from January 13 to March 16, 2020. As a result, there has generally been a decrease in traffic volume in Cities in the World, but Rome and Madrid are the two cities that experienced the most drastic decreases, -87% and -79%, respectively. Meanwhile, one busy city in the US, Los Angeles, only shows -20%, as presented in Figure 6.

In addition to congestion conditions, the lockdown has also affected air quality. Data from EEA member countries shows the concentration of nitrogen dioxide (NO₂) has decreased in many cities in Europe. NO₂ is a pollutant that is mostly emitted by road transportation. Decreasing in NO₂ levels in several major cities in Europe is presented in Figure 7. Data selected in January, February, March, and April 2020 compared to the same month in 2019, from the European

Environment Agency website [47]. Furthermore, Catherine Collins at <https://sciencebusiness.net/> also reported on the reduction of NO₂ after Europeans restricted activities due to coronavirus. Images taken by one of the Copernicus satellites of the European Space Agency (ESA) show a large reduction in nitrogen dioxide concentrations over Paris, Madrid, and Rome from March 14-25, compared with the same week in 2019. The same applies to China, where the Copernicus satellite recorded a dramatic decline in NO₂ released by power plants, factories and vehicles in all major Chinese cities between late January and February. When EEA reported a decrease in fine particles (such as PM 2.5) which was less significant in Europe, ESA observed a decrease of around 20-30% in fine particles, one of the most important air pollutants, in February 2020 compared to the previous three years [48].

Table 1. The conditions of several large cities in Europe

City - Country	Traffic condition		Traffic reduction
	2019	2020 (COVID-19 period)	
Paris - France	22% of the main roads are congested	Only 0.7% of the main roads are congested	96,8%
Madrid - Spain	12.8% of the main roads are reported to have been congestion	Only 0.5% of the main roads are congested	96%
Rome - Italy	20.1% of the main roads are jammed	Only 0.8% of the main roads experience traffic jams	96%
London - UK	9.2% of the capital's streets are marked yellow or red on the map	Only 0.9% of the capital's streets are marked yellow or red on the map	90,2%

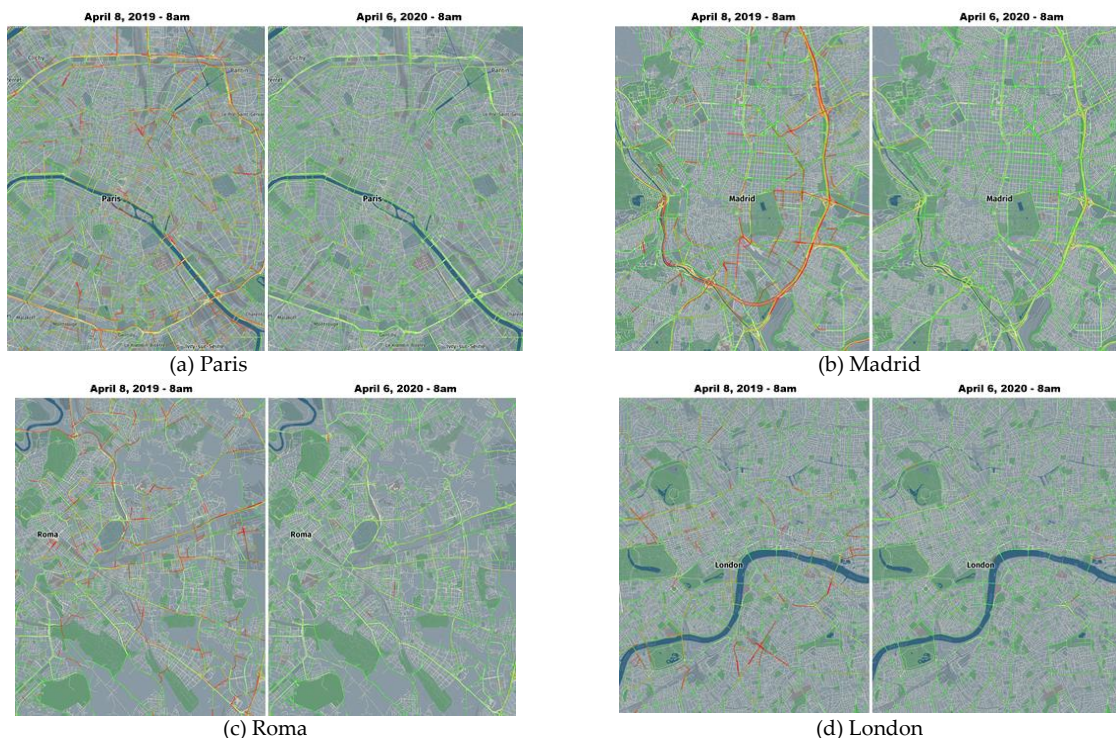


Figure 5. Comparison of traffic in selected countries on 8 April 2019 and the lockdown period (6 April 2020) due to COVID-19 [45]

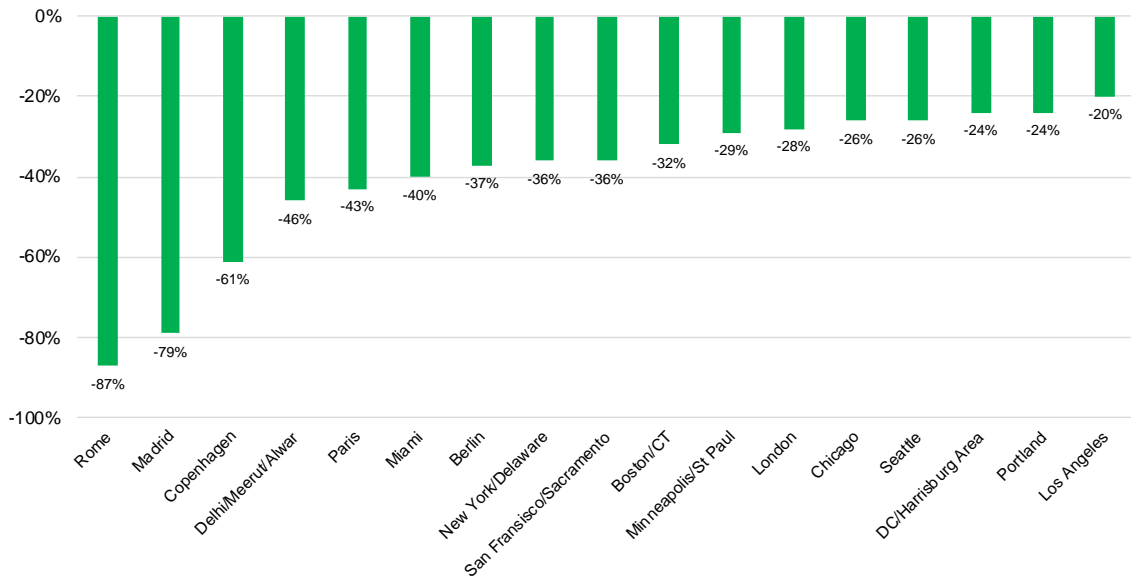


Figure 6. Change in telemetry volume by city: week of January 13-19, 2020 vs March 16-23, 2020



Figure 7. Average weekly concentration ($\mu\text{g}/\text{m}^3$) of nitrogen dioxide (NO_2) in 2019 and 2020 (during COVID-19 lockdown) in European selected cities

4.3. Comprehensive Action for Safe Passenger Transport and Mobility

Public transportation is one of the high-risk facilities for virus transmission. This due to the limited ventilation inside the vehicle, no access control to identify potentially ill people and various common surfaces to touch (e.g. ticket machines, handrails, doorknobs, etc). During the pandemic, this type of transportation has an important role to provide people's mobility. Therefore, comprehensive action needs to be made to prevent or reduce the risk factor of virus transmission. UITP recommends 4 aspects that must be obeyed by public transport stakeholders as follows preparedness, personal protection, reduce close contacts with other people, and reduced working hours [49].

Controlling the health status of staff working in the metro operation is also important, because COVID-19 infection may reduce their productivity and lead to damage for the passengers as well. The strategy can be achieved by performing routine general check-up, providing health education, keeping physical distancing with the other staff in the operating room, using a face mask, using hand sanitizer before entering the working room, limiting the working hours and allowing them to not present to the office when experiencing symptoms (e.g., fever, cough, etc).

Although the lockdown policy was implemented and most people understand the COVID-19 infection, the mobility continues during the times. Therefore, we presented the best practice as a form of campaign for safe driving, one of which we summarize and develop from Transformative Urban Mobility [50]. Then, we give the path in [Figure 8](#).

First, a coordinated response might be needed to establish comprehensive policies. As already known, mobility restrictions significantly reduce the risk factor of COVID-19 infection. However, this will lead to mental health problems [51]–[54]. Furthermore, the lockdown affected income distribution, food availability, unemployment problems, and household economic burdens [55], [56]. Concerns over food supply were also reported [57]. Although mobility is allowed with face masks, it has recently been reported that mask waste has increased along with the increase in confirmed COVID-19 cases [58]. Facial mask

waste is found on roadsides, public places, sewers, sea and coastlines and becomes a burden to the environment [59]. Implementing health education and applying the latest innovation about how to handle medical mask disposal can reduce virus transmission and protect the health status of waste management workers [60].

Second, coordinated demand management is needed for several purposes including maintaining a balance between the government's efforts and commuters from low-income economies. As in India, more than half of commuters continue to use public transportation modes [43]. If the operating schedule is reduced, there will be overcapacity in the passenger space. Likewise in Indonesia, the reduction in operating hours of city buses resulted in long queues at bus stops and stations [50]. Therefore, practical action must be taken by the government, which includes impact assessment, public transport booking and appointments systems, and shift to cycling to reduce passenger crowds in public transport and bus stops.

Third, to protect public transport staff, they must have the correct information to prevent worrying. Their awareness about the risk of transmission must be increased so that they are more careful. Public transport staff should also be given specific training on new methods of interacting with passengers. In addition, all working staff must wear personal protective equipment and disinfectants [61]. Public transportation entrepreneurs or the government are required to monitor the health of their staff through routine checks. Drivers should also be prevented from selling tickets directly. Moreover, the driver's room and passenger room must be separated by a transparent partition. Portable toilets and special facilities must also be provided by the government for public transportation staff, due to the closure of some public facilities. Finally, all facilities used by staff must be managed properly, including transit rooms and canteens for staff.

Forth, the protection of passengers is an important part of driving safety efforts and maintaining trust in public transport services. General information regarding the prevention of virus transmission must be easily available to passengers, such as leaflets, protocols, running text, or tutorials that are broadcast electronically.

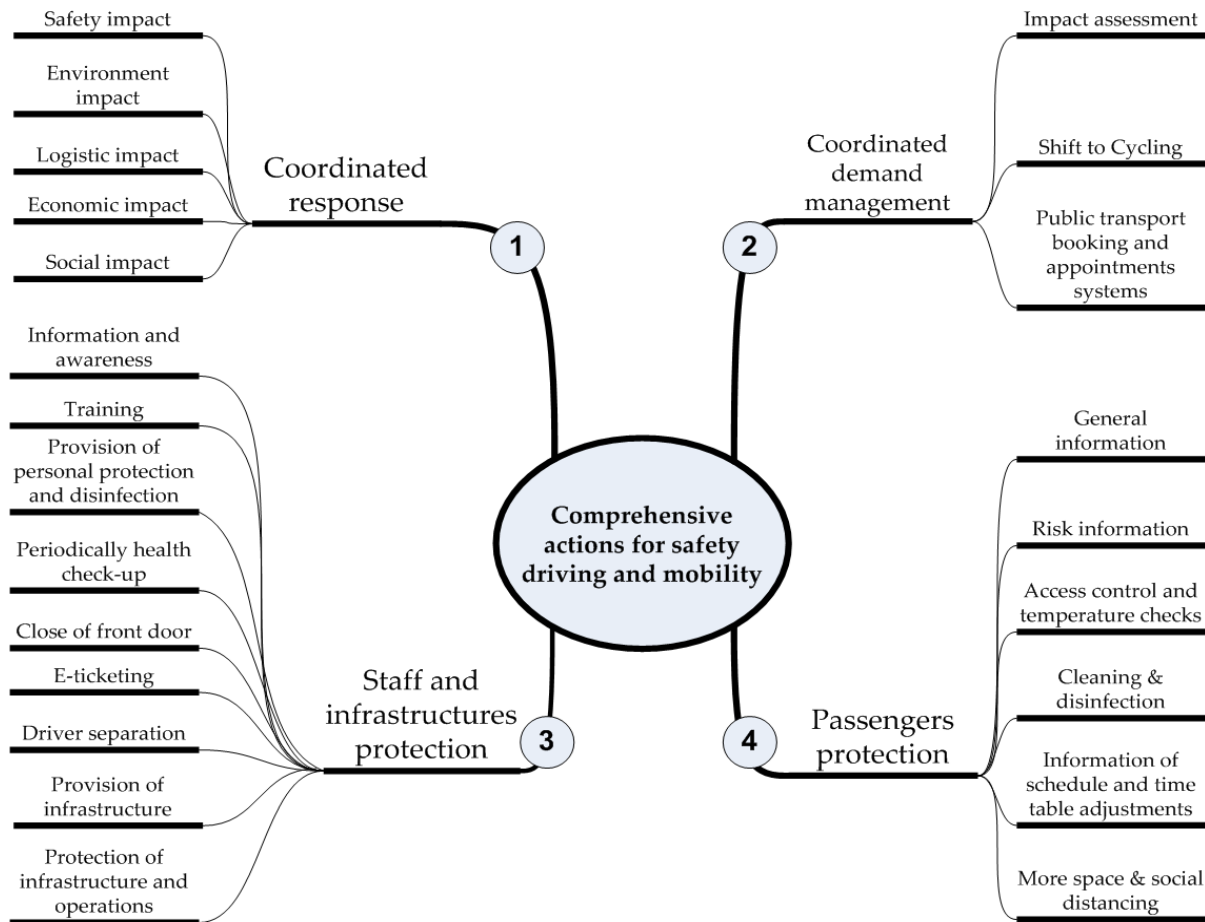


Figure 8. Comprehensive actions for safe passenger transport and mobility

In addition, risk information must also be made available in a transparent manner. All public transport must provide information on public transport schedules and timetable adjustments, in the event of a schedule change. Public transport staff or officers must carry out body temperature checks on all prospective passengers. If there are signs of fever, people are not allowed to enter the station. All parts of the vehicle must be cleaned and sprayed with disinfectants [62]. If necessary, the vehicle is sterilized by UV light [63]. Finally, public transportation must provide more space and social distancing, including only filling a maximum of 50% of passengers from normal capacity. A new strategy to increase occupancy and balance passenger fare can also be done by rearranging passenger seats on the bus, as we stated in the previous work [64].

5. Conclusions

Globally, governments of each country are working to reduce the impact of coronavirus

exposure. Until now, the prevalence of confirmed cases and death due to COVID-19 is increased worldwide. The activity restriction seems to be a good strategy to reduce air pollution, but this will affect the economic problems as the fuel consumption become low. Specifically, for mobility activities with public transportation, a comprehensive solution through good coordination between government-public transport operators-users may be able to reduce the risk of COVID-19 exposure. The coordinated response, coordinated demand management, staff and infrastructure protection, and passenger protection can be used as superior strategies in saving people who must travel by public transport. The efforts of the city government and the active participation of the community in campaigning for vehicle safety and mobility are also essential. For sustainable mobility, even when COVID-19 is over, avoiding the use of fuel-based transportation for a short distance is noble, and replacing it with bicycles or electric vehicles.

Author's Declaration

Authors' contributions and responsibilities

The authors made substantial contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation and discussion of results. The authors read and approved the final manuscript.

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Competing interests

The authors declare no competing interest.

Additional information

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