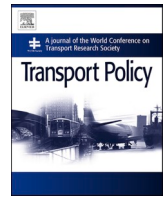




Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Transport policymaking that accounts for COVID-19 and future public health threats: A PASS approach

Junyi Zhang

Mobilities and Urban Policy Lab, Center of Asian Sustainable Mobility Research (ASMO), Graduate School of Advanced Science and Engineering, Graduate School for International Development and Cooperation, Hiroshima University, Japan

ARTICLE INFO

Keywords:
 COVID-19
 Public health
 Pandemics
 Transport sector
 PASS approach
 Policy recommendation

ABSTRACT

The novel coronavirus 2019 (COVID-19) outbreak has had wide-reaching and unprecedented impacts on the transport sector worldwide. At present, there is no globally agreed timeframe for when this pandemic will end. The current and near-future potential impacts must be addressed in a relatively comprehensive and seamless way. The present study proposed a PASS (P: Prepare–Protect–Provide; A: Avoid–Adjust; S: Shift–Share; S: Substitute–Stop) approach for policymaking that accounts for COVID-19 and future public health threats. The PASS approach was illustrated conceptually, and then policy measures were recommended by referring to the past and ongoing best practices. Policymaking challenges and research issues were discussed.

1. Introduction

The outbreak of the novel coronavirus disease of 2019/2020 (COVID-19) has resulted in still-increasing numbers of infections and deaths worldwide. As of September 2¹, the total numbers of confirmed infections and deaths reached 25,757,780 and 875,185 persons, respectively, with the former still showing an upward trend. The countries that are the most impacted have changed from China to European countries, and then the USA over time. Meanwhile, infections and deaths in Brazil, India, and Russia have grown more serious as recently as August. This virus will not disappear and may even resurge over time. It is therefore necessary to prepare for the coming “new normal” (Albani, 2020; Pantuliano, 2020; Park, 2020; Tzannatos, 2020).

According to an expert survey by the World Conference on Transport Research Society (WCTRS) COVID-19 Task Force (Zhang et al., 2020), governments have been implementing various countermeasures, including very strict lockdown measures and prohibition of some out-of-home activities (e.g., schools, offices, gatherings, eating out). A little over half of the experts surveyed (54.6%) reported that in the town or city where they were living, the number of passengers boarding public transport vehicles was restricted, and 22.2% of the experts observed online bookings for use of public transport during the pandemic. About one-third (27.8%) of experts observed that monetary compensation had been given to transport and logistics firms suffering from economic losses as a measure to address the impacts of the

COVID-19 pandemic.

Impacts of COVID-19 on the transport sector and corresponding measures have been widely investigated by many researchers and organizations (e.g., aviation [IATA, 2020a; ICAO, 2020], maritime transport [McCauley et al., 2020; Teoh, 2020], railway [Citroen, 2020; Das, 2020], and urban transport [EIT, 2020a,b]). However, scientifically sound methodologies that are suitable for making policy decisions that can address the current COVID-19 and future public health pandemics are lacking. Therefore, the present study conducted an initial attempt at exploring how to make policy decisions that can address the current COVID-19 and future pandemics, in a relatively comprehensive and seamless manner, by reflecting on the roles of governments, firms, and citizens.

In the context of public health, Evans (1975) and Weinberger (1975) illustrated the activities, responsibilities, and roles of local, state, and federal public health agencies, in terms of effectiveness of the health care system, development of human resources, delivery of care services, and promotion of research and development. Jochelson (2006) also emphasized the use of taxation, bans, regulations, and education, whereas Cho (2017) further pointed out the importance of preparedness capabilities for local governments. Adshead and Thorpe (2007) suggested paying more attention to the key role of people in shaping society, roles of mass media in driving forward the debate that creates the will for change, and the involvement of society at large in promoting, protecting, and developing public health. During the COVID-19

E-mail addresses: zjy@hiroshima-u.ac.jp, junyi24@gmail.com.

¹ <https://coronavirus.jhu.edu/map.html> [Accessed on September 2, 2020].

<https://doi.org/10.1016/j.tranpol.2020.09.009>

Received 4 July 2020; Received in revised form 2 September 2020; Accepted 8 September 2020

Available online 12 September 2020

0967-070X/© 2020 The Author.

Published by Elsevier Ltd.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

pandemic, insufficient consideration paid to all stakeholders in decision making has resulted in serious reputational and financial repercussions (De Longevialle and Wilkins, 2020). The National Academies of Sciences, Engineering, and Medicine (2014) stated that transportation organizations are a part of pandemic planning and response system; they emphasized the roles of these organizations in keeping proper and effective relationships with all stakeholders (related to local public service agencies, emergency management, public health, suppliers and vendors, and end users), via situational awareness and analysis, information sharing and monitoring (e.g., rapid response to rumors), identification of essential transportation functions, and participation in pandemic planning, as well as the resulting good decisions.

The transport sector has responded to the current pandemic in various ways, such as shifting car production to make respirators, turning high-speed trains into rolling hospitals, supporting medical professionals by grounding airline cabin crew with first-responder training, offering free transport to patients and medical staff, and delivering food to vulnerable citizens by taxis and ride-sharing services (Kim, 2020). In fighting against COVID-19 and future pandemics, it is useful to group the transport sector by travel mode: airline, inter-city railway, subway, streetcar, bus, taxi, and truck, and others. Transport services are run by firms, which are either privately owned, government owned, or jointly owned based on public–private partnership. In different countries, the relationships (observed via regulations, subsidies, and supervision: e.g., public transport firms receive more subsidies in the USA and Europe than in Japan [Ministry of Land, Infrastructure, Transport and Tourism, Japan, 2014]) between transport firms and the government are not the same, either. These differences have led to different impacts of COVID-19 on the transport sector (EBP, 2020; European Commission, 2020a; Lawrence and Granath, 2020) and affected the ways of pandemic management interventions (Our World Data, 2020; TUMI, 2020) across countries.

Within each mode, governments, firms and citizens may have a different role in addressing the issues of COVID-19 and future pandemics, although modes may overlap in some cases. First, both freight and passenger transport may involve the use of two or more modes from origin to destination. Second, transport is a derived demand from activity participation (including both private and business/organization activities). In the case of passenger transport, travel party and face-to-face communication intensity (number of members meeting/gathering at destination, closeness between members, and duration of meeting/gathering) at the destination are additional risk factors. Thus, infection risks in the transport sector are multi-faceted because trip chaining, activity chaining, and interpersonal interactions are involved. Interpersonal interactions indicate not only face-to-face communication contacts but also decision-making interactions between persons (e.g., employee and employer, school-age children and their parents, people conducting business meetings, and party hosts and participants). Therefore, seamless measures to prevent/mitigate infection risks should be made with respect to each stakeholder by reflecting multiple activity and travel behaviors, connections across travel modes, and interactions across stakeholders in a comprehensive manner.

In the remaining part of this article, first, a PASS (P: Prepare–Protect–Provide; A: Avoid–Adjust; S: Shift–Share; S: Substitute–Stop) approach is discussed conceptually. Second, policy measures are recommended by referring to past and current best practices. Finally, policymaking challenges and research issues are extensively discussed.

2. PASS approach for policymaking for addressing pandemics: conceptual illustration

Here, a PASS approach is proposed for systematically designing policies that address concerns during COVID-19 and future pandemics (Fig. 1).

The present study did not purposely name this approach. Rather, it was initially named after a review of railway transport policy measures

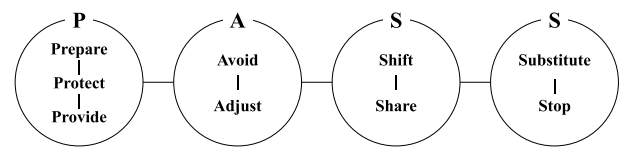


Fig. 1. PASS approach for policymaking for addressing COVID-19 and future pandemics.

for addressing COVID-19 in Japan that revealed a way for it to be generalized. The Ministry of Land, Infrastructure, Transport and Tourism of Japan (2020) reported taking railway transport policy measures stepwise. The central government requested railway operators to **protect** employees and users by wearing masks, washing hands, installing antiseptic solution dispensers, and monitoring the body temperature of employees. Next, the government requested railway operators to encourage transit users to choose telework (i.e., **avoid** trip making) or staggered commuting (i.e., **shift** departure time for commuting). Further, people were requested to **stop** making unnecessary or non-urgent trips after a state of emergency was declared nationwide on April 16, 2020. After observing other good practices and thinking in a systematic way, the present author found that the above PASS can be generalized.

Regarding transport measures that address COVID-19, TUMI (2020) attempted to arrange them within an existing sustainable urban transport framework: Avoid-Shift-Improve (ASI). However, the PASS approach is more systematic and seamless than the ASI framework. To the author's best knowledge, no other integrated frameworks have been proposed. In principle, the proposal of the PASS approach is in line with general system theory proposed by von Bertalanffy in the 1940s, which states that a system is a complex of interacting elements and the whole is more than the sum of its parts (Von Bertalanffy et al., 1995). The PASS approach argues that policy measures that address COVID-19 comprise a system composed of four major policy categories, namely, P, A, S, and S, which are not independent of one another in mitigating/preventing the spread of COVID-19.

2.1. P: Prepare–Protect–Provide

The most important concern is to **prepare** well for pandemics. Considering that transport services are provided by firms, different firms can be expected to compete in their response to COVID-19, via differentiation measures. However, because of the various unknowns regarding COVID-19 and the resulting inability of firms to deal with it properly, market failures may occur. For example, continuing service operation owing to an underestimation of infection risks may enable the spread of COVID-19 through transporting infected passengers. Meanwhile, stopping service operation based on an overestimation of infection risks obviously leads to losses in operation revenues and the resulting economic and social losses associated with the lack of transport for essential workers who maintain essential social functions. Thus, the government should take the lead, considering its special role in society. Providing public goods and handling externalities are essential roles of governments (The Library of Economics and Liberty, 2020). COVID-19 and other public health threats are a kind of externality that is caused by various interactions between human beings and the environment. The current pandemic cannot be handled only by the private sector and citizens. Governments should play a key role in fighting it. The same is true for future pandemics. As general emergency management (including pandemics), the National Academies of Sciences, Engineering, and Medicine (2019) emphasized that transportation agencies are required to address the following eight major challenges: (1) higher expectations and lower tolerance, (2) increased risks from various hazards and threats, (3) cyber risks, (4) use of important transportation resources, (5) multimodal responses to emergency, (6) use of smart

technologies, (7) systematic management (of communication, equipment, facilities, personnel, procedures, and processes), and (8) safe and secure movement of people and goods. Industrial experiences during the current pandemic suggest the essential role of governments in making immediate responses, recovering from the pandemic and rebuilding the society, and optimizing for the new normal (Paydos, 2020). With preparedness by the government in place, transport operators can prepare well within the governmental framework of preparedness. Preparedness by transport operators can be forced (e.g., stipulated by regulations) or voluntary (e.g., out of a sense of professional obligation or social responsibility).

These preparations should be communicated to transport users to encourage or require their preparedness. The above preparedness may further include at least two steps: **preparations** before a pandemic starts in a country/region, and **preparations** before the pandemic starts in a city/town of the country/region. Planning should be positioned on top of preparedness, from a long-term perspective. Since the four-step procedure (Deutsch, 2014) was proposed in the USA in the 1950s, scientific evidence-based transportation planning has become standard practice in many countries. In responding to pandemics, a great challenge is in connecting public health, transportation planning, and urban planning from an interdisciplinary perspective (Ahmed et al., 2020; Giles-Corti et al., 2016; Moatti, 2020).

The most important role for governments is to protect citizens and firms. The second most important role is to **provide** public goods and services that cannot be **provided** by individuals or firms (Slaughter, 2020). Therefore, when a pandemic occurs, governments must first **protect** both transport users and operators, based on the above preparations. Such protection will allow our society and the economy to run as close to usual as possible, before the pandemic becomes very serious. Even for the current COVID-19 pandemic, people have fallen victim to fake and unreliable information on the virus, its impacts, and the relevant countermeasures. Therefore, it is important and necessary to **provide** reliable information in a timely manner via organizations in charge of the management of such information. Governments should **protect** both transport users and operators from fake and unreliable information. For the current pandemic, a study in Japan revealed that poor communication between governments and the public may have been associated with the spread of COVID-19 in its early stages (Zhang, 2020). Communications for fighting against COVID-19 and other public health threats are a complex system, consisting of not only various stakeholders but also interrelated phenomenal elements (e.g., lifestyles vs. behavioral changes, health vs. mobility, employment vs. transport, tourism vs. regional economy, physical distancing vs. social exclusion). Better and effective communications need reliable and convincing information supported by scientific evidence. Better preparation and protection requires better financial support **provided** by governments and other stakeholders. Thus, preparation, protection, and provision are three interconnected elements.

2.2. A: Avoid-Adjust

Because of various unknowns on a virus in the early stages of a pandemic, **avoidance**, an adaptive response among individuals to environmental challenges (Oitzl, 2007), should be regarded as the most important among all measures taken after the occurrence of the pandemic. This is partially in line with the report of Vale and Jardine (2017), who stated that infection avoidance behaviors are the first line of defense against pathogens. **Avoidance** allows transport users to keep away from the virus and transport operators to prevent transport users from being infected when using transport services (e.g., operators should avoid operating crowded vehicles and users should avoid talking without wearing masks and talking loudly). **Avoidance** is also applied to governments; for example, governments should **avoid** making unstable policy decisions, providing inconsistent information, and behaving in contradiction to their instructions to the public (e.g., not wearing masks

even though the public are requested to wear them). To make avoidance work effectively, governments should make proper regulations before a pandemic occurs. Such regulations would allow governments to regulate transport operators, for example, to avoid operating crowded transport services and allow transport operators to require transport users to wear masks. Government officers' and other decision makers' behaviors under pandemics must be regulated, for example, via guidelines (what people should and should not do) with strict punishment for violations. As for avoidance, people may enjoy a temporary sense of relief in the short term; however, avoidance may also lead to increased anxiety (Star, 2020) and social exclusion (He et al., 2020; Wang et al., 2020) in the long-term. Thus, careful attention should be paid to the design of such avoidance-oriented policy measures.

When encountering public health threats, people tend to adjust their behaviors to reduce infection risks. For example, Rudisill et al. (2012) reported on such behavioral adjustments to the avian flu in Europe in 2006 and found that knowledge about and proximity to avian flu risks are influential to behavioral adjustments. While keeping avoidance, transport users need to **adjust** their activities and schedules as well as trip timings to reduce opportunities of being infected or transmitting virus to others. Transport operators need to **adjust** their operation tasks and services in ways appropriate to the pandemic situation. More importantly, governments need to make **adjustments** across departments and across sectors for taking and implementing more effective policy measures for addressing the pandemic. It is not easy to design optimal policies, especially when multiple sectors/departments are involved. Thus, sectoral adjustments or policy adjustments (e.g., Usui, 1996; Abou-Chadi et al., 2020) become important. Addressing the pandemic needs both interdisciplinary insights and cross-sectoral collaboration. To this end, governmental adjustments are crucial. Measures prepared before the pandemic may also need **adjustments**, depending on whether and how much the new virus behaves with respect to the expectations.

2.3. S: Shift-Share

The current pandemic has dramatically changed the way that economic and social systems run. In other words, economic and social systems have to run "in a discontinuous manner with threshold shifts (i. e., bifurcations)" (Benight et al., 2018) from the present equilibrium state. Systems thus need to shift to a new equilibrium state, and stakeholders need to make behavioral shifts, where painstaking efforts are required. **Shifting** indicates a nonlinear change from one state to a different one. Specifically, people who have to make trips need to **shift** their modes to reduce their infection risk (e.g., from public transport to car or active transport mode). Modal shift may also occur owing to unemployment or loss of income during the pandemic, which could limit the ability to buy/lease a vehicle. Meanwhile, measures for addressing the pandemic need collective decisions and actions. **Sharing** of information and resources is critical to collective decisions and actions, because such **sharing** can fill knowledge gaps and further enhance the feasibility and transparency of collective decisions and actions. In addition, trip makers need to pay attention to space **sharing** with others during their use of public transport. Because of the need to **avoid**, **adjust**, and **shift**, people need to think about **sharing** their job responsibilities with others to prepare for the next set of actions (i.e., **substitute** and **stop**). To make protection measures work effectively, transport users may have to **share** their health information, such as during air travel.

Meanwhile, based on preparedness plans, transport operators need to **shift** to the appropriate operation system for the duration of pandemics. Governments need to **shift** from business-as-usual governance to pandemic-sensitive governance. In other words, governments are required to concentrate their efforts on the pandemic by involving all stakeholders. Public transport operators should also impose regulations on space **sharing** to prevent infections from spreading. Different

transport operators may have to **share** their operational resources (e.g., staff, vehicles, and infection information) to survive the pandemic, given the potential staff absences (e.g., if infected or quarantining) or lack of vehicles (e.g., if they need to take them out of service for longer than normal to disinfect). As such, the **sharing** of information on infected passengers and staff is also crucial. Governments may need to promote a **shared** economy under pandemics to address issues of undersupply and resource shortages, such as by deregulating or temporarily amending laws. Governmental departments may also need to **share** their human resources to address effectively and efficiently all pandemic issues.

2.4. S: Substitute–Stop

When the pandemic becomes more serious, people must **substitute** or **stop** activities involving trips. **Substitution–stop** measures may involve serious ethical, legal, and even human rights issues. Therefore, governments must take the lead to make regulations that allow or force transport operators to **stop** service operations. Such regulations or enforcements should be well supported by proper **protection** measures. Subsequently, transport operators can judge whether and how to **stop** operation of their services. During the COVID-19 pandemic, the public has witnessed high-level political posturing and bickering, which wasted valuable time and detracted attention from efforts to fight the pandemic. Governments need to **substitute** face-to-face governmental procedures with online ones. **Substitution** between transport modes may also be needed, such as in the case of a lack of vehicles owing to the need for more thorough disinfection procedures.

2.5. Summary

The **PASS** approach targets transport users and operators (or service providers) as well as governments. Although this **PASS** approach is crucial for successful transport measures amid pandemics, its implementation may bring about various negative impacts on these groups and possibly society at large. To address this, governments and transport operators must implement proper **protection** measures (e.g., economic and institutional). The final **preparation** is also important: after a pandemic, society should not forget to **prepare** for future pandemics. To avoid unnecessary economic losses and social disorders, policymakers may take measures from these four angles (i.e., P, A, S, and S) in sequence or step wise, as seen in the railway transport policies for addressing COVID-19 in Japan. However, P, A, S, and S do not need to be implemented in sequence. For example, different people and operators may adopt different P, A, S, and S, in their own ways, simultaneously, to mitigate the impacts of a pandemic in a comprehensive and seamless manner. P, A, S, and S, as implemented by different stakeholders, are not independent of one another, in terms of the effects on mitigating the spread of infections. In other words, two or more of these four elements display synergistic and complementary effects. The effects will depend on how to implement each of P, A, S, and S via various policy instruments. However, the implementation is not costless. Considering that COVID-19 as well as other public health threats are a threat to everybody (i.e., a “public bad”), governments should collaborate with various funding bodies to take the initiatives in the fight against pandemics with sufficient funding support. For example, [European Commission \(2020b\)](#) summarized a series of financial instruments.

The implementation of policy instruments usually encounters various barriers. For example, [Maqbool and Khan \(2020\)](#) identified ten barriers to the implementation of public health and social measures for preventing the spread of COVID-19: poor safety culture, public stigmatization, and eight lacks (of safety commitment from the public, administrative commitment and support, strict enforcement of regulations, resources, medical facilities, door-to-door services during quarantine, proper communication, and government policies to ensure the implementation of various measures). Similar types of barriers can be found in the transport sector. Meanwhile, the following mental barriers

cannot be neglected: local government’s wait-and-see attitude because of pandemic-related inexperience, absence of guidelines for the transport sector, and fear over the responsibility to make active and preventive measures; people’s unwillingness to cooperate because of various burdens caused by behavioral modifications, concerns about privacy, and trust in government and/or transport operators; and transport operators’ unwillingness to take stricter measures (e.g., ridership control) because of concerns over losses in operation revenues.

3. Policy recommendations based on PASS approach

COVID-19 is often compared with the 1918 Spanish Flu, which occurred a century ago. Modern transportation has been pointed out as having contributed to the rapid and extensive spread of the Spanish Flu worldwide by transporting infected crews and passengers of ships and trains; indeed, outbreaks spread along major transportation routes ([Africa Center for Strategic Studies, 2020](#); [Colvin and McLaughlin, 2020](#); [Killingray, 2003](#); [Rodrigue et al., 2020](#); [Taubenberger and Morens, 2006](#)). As for lessons from the 1918 Spanish Flu, Soper (1919) published a paper in *Science* and pointed out the following.

- [1] People do not appreciate the risks they run.
- [2] In line with human nature, a person who thinks they have only a slight cold is seldom willing to shut themselves up in rigid isolation as a means of protecting others.
- [3] The disease may be transmissible before the patient is aware that they are infected.

Soper further cited the following 12 rules that were recommended at that time. All these recommendations are also applicable to the current pandemic.

- [1] Avoid needless crowding; influenza is a crowd disease.
- [2] Smother your coughs and sneezes; others do not want the germs you would throw away.
- [3] Your nose, not your mouth, is for breathing; get the habit.
- [4] Remember the three C’s: a clean mouth, clean skin, and clean clothes.
- [5] Try to keep cool when you walk and warm when you ride and sleep.
- [6] Open the windows always at home at night and at the office when practicable.
- [7] Food will win the war if you give it a chance; help your body by choosing and chewing your food well.
- [8] Your fate may be in your own hands; wash your hands before eating.
- [9] Don’t let the waste products of digestion accumulate; drink a glass or two of water on getting up.
- [10] Don’t use a napkin, towel, spoon, fork, glass, or cup that has been used by another person and not washed.
- [11] Avoid tight clothes, tight shoes, tight gloves; seek to make nature your ally, not your prisoner.
- [12] When the air is pure, breathe all of it that you can; breathe deeply.

During the Spanish Flu pandemic, the number of passengers on public transport was limited; however, the limitation was not very effective ([Martini et al., 2019](#)). Probably reflecting the development level of science, Soper noted that the experience during the Spanish flu suggests that “it is not desirable to close theaters, churches and schools unless public opinion emphatically demands it. It is not desirable to make the general wearing of masks compulsory. Patients should not be masked except when traveling from one point to another – they need air.” The present author has no intention to criticize Soper. Rather, the author argues that, as can be seen from the current pandemic, science has its own limitations when a new phenomenon suddenly appears, even

though it is also evident that science can progress very rapidly in times of crises.

Here, the author attempts to apply the above PASS approach to make policy recommendations for addressing the ongoing COVID-19 pandemic and future pandemics in a relatively comprehensive and seamless manner.

3.1. “P: Prepare–Protect–Provide” policy measures

3.1.1. “Prepare”

The most critical question when fighting public health threats is this: What should governments prepare for? First, governments must prepare pandemics-driven mindsets by better learning lessons from history (e.g., [Amster, 2020](#); [King, 2020](#)). Similar public health crises have repeatedly occurred in recent human history, including pandemics such as the 1918 Spanish Flu. Recent examples include the Ebola outbreak in 2019, the Ebola hemorrhagic fever outbreak in 2014, the H1N1 influenza virus in 2009, the 2005–2016 Zika fever, and SARS in 2003. The damage brought by COVID-19 suggests that historical lessons have not been learned well. For the current COVID-19 pandemic, while some countries are suffering from heavy losses (losing many lives and observing a rapid increase in cases), why are other countries simply waiting and watching? In this era of globalization, airlines can transport infected passengers from one side of the world to the other within a day. In a metropolitan area, railways can transport infected passengers from a suburban area to the city center within an hour. Even with no guidelines or contingency plans, the developed countries could have been more prepared given current advanced technologies. There are various reasons for such an inaction. For one, those countries with an unexpectedly rapid increase in infections surely underestimated the severity of COVID-19. Thus, it is extremely important for these countries to make use of their lessons to help mitigate the spread of COVID-19 in countries with similar growth of infections. The above arguments are closely related to the capacity building of society, consisting of governments, firms, and citizens. Following the DPSIR + C approach ([Zhang, 2018](#)), to enhance the capacity (C) of society, each stakeholder should properly understand the driving forces (D) of the current pandemic and the resulting pressures (P) leading to the spread of the pandemic, the states (S) of the pandemic (both confirmed/unconfirmed infections and deaths), and impacts (I) on the economy, society, and people’s daily lives. Without a strong understanding of the above D-P-S-I elements, society may be unable to respond (R) effectively to the pandemic. Without sufficient capacity, responses (e.g., laws and regulations, economics measures, technological development, enlightenments) cannot be realized either. Thus, it is extremely important to enhance the capacity of each stakeholder and of society as a whole. To maximize the capacity of society, the government must create a cross-sectoral organization tasked to work on preparations for future pandemics and during a pandemic, by involving experts and transport operators. Such an organization body could allow for and facilitate effective communication across sectors, with reference to all PASS-based measures.

Second, legal and regulatory preparations (or institutional design) should be given top priority to ensure that various during/after-pandemic measures work, with strong support from various social capitals. The absence of rules or inadequate/weak/inconsistent rules will become bottlenecks to the smooth implementation of pandemic measures. For example, during pandemics, emergency goods and services must be delivered via transport systems, and some portions of the transport demand must be met, even in the case of lockdowns. Governments need to prepare relevant laws and regulations for ensuring the smooth delivery of emergency goods and services by involving various stakeholders who could make large-scale deliveries possible in a timely manner. Standards of physical distancing measures and personal protective equipment should be prepared for regulating transport operators, supported by governments, to keep both service employees and users safe. All measures recommended based on the PASS approach should be

well supported by the aforementioned legal and regulatory preparations. However, such preparedness is not everything. For example, although the US Centers for Disease Control and Prevention (CDC [\(2020a\)](#)) has accumulated a rich array of planning and preparedness resources, the current spread of COVID-19 indicates that even the best plans can fail. Such a failure may be directly owing to the lack of willingness for the population to adhere to the plans/guidelines. Generally, how well legal and regulatory rules are prepared and implemented is a reflection of not only governmental capacity but also the capacity of other stakeholders.

Third, governments should prepare policies for supporting guidelines and contingency plans prepared by transport operators. Transport services have both private and public functions/roles in supporting daily mobility, the economy, and society. Therefore, transport operators (both private and public) should prepare for the occurrence of public health pandemics within their capacities. However, the handling of the current COVID-19 pandemic has been beyond the capacities of transport operators, in terms of both monetary and operational capacities. It is too expensive for transport operators to prepare for public health pandemics. They could charge users more, but this may encourage the latter to shift to private cars and motorcycles, leading to more congestion and environmental loads from the transport sector. In theory, governments need to pay the extra costs of preparing for public health pandemics, even though it is difficult to decide how much and how to pay.

Fourth, guidelines and contingency planning for pandemics should be well prepared by transport operators, who should establish a task force by inviting experts. Contingency planning aims to prevent emergent events so that lives, property, and the environment are not at risk ([Dickson, 1992](#)). It is a management process that involves analyses of potential events or emerging situations and sets up agreements with other entities in the preparation of possible responses ([UNISDR, 2009](#)). According to [Meyer and Belobaba \(1982\)](#), contingency planning requires the establishment of a management structure together with a crisis management strategy, through which plans can be developed for different activities that can be used to address most crises, and for formulating draft implementation plans for specific types of crises. [Meyer and Belobaba \(1982\)](#) argued that contingency planning should be better utilized to transform crises into “unique opportunities to implement innovative measures and procedures which would, otherwise, take too long to be adopted or would need to go through a long approval process.” [Dickson \(1992\)](#) emphasized the importance of training and exercising. As summarized by [WHO \(2018\)](#), contingency planning consists of risk analysis, risk mitigation, preparedness actions (identification of preparedness measures to ensure readiness to respond and plan implementation sensitive to the level of needs and/or imminence of risks), contingency plan (to introduce a scenario-based contingency or preliminary response plan and to set preliminary responses, specific objectives, activities, targets, and indicators), action plan, and testing and monitoring. [Fan et al. \(2019\)](#) empirically revealed that cross-agency collaboration and emergency management capacity building are crucial to the success of implementing urban contingency plans. However, in reality, more than one-third of cities/towns in the world have no guideline or contingency plan for any transport system, according to a global expert survey ([Zhang et al., 2020](#)). One more important finding from [Zhang et al. \(2020\)](#) is that countries/regions with lower percentages of guidelines and contingency plans for transport systems are those showing higher infection cases and deaths, although they did not specify whether this finding is coincidental or causal. For making measures that address pandemics issues effectively and efficiently, transport operators should be encouraged to participate in the preparations by government and other stakeholders. In the case where two or more transport operators operate in a city, preparations must be made based on close collaboration across operators because of multimodal trip making features, which need seamless measures across operators. Transport operators should be further encouraged to develop protection and physical distancing technologies.

Fifth, transport users need to make better preparations by forming healthy and “smart” lifestyles. They also have to think in advance about how to take physical distancing measures (e.g., to apply for telework, to buy a bicycle, and/or to buy online meeting tools). People who have a healthy lifestyle are more likely to walk and use a bicycle in their daily lives. The use of smart technologies allows people to meet various needs in life without making a trip (e.g., telework, online shopping, food delivery via online orders, online learning, online medical treatment). In this regard, transportation planning resulting in more use of walking and cycling and urban planning based on various smart technologies are expected to play an important role in preventing/mitigating the infection risk of COVID-19, via improvements in the built environment (Li et al., 2020). Specifically, forming anti-virus habits (e.g., washing hands regularly and getting used to wearing masks) and preparing emergency goods/money are helpful to reducing infection risk and avoiding panic buying. For example, wearing masks was not popular in the Western culture, unlike in Japan. This may partially explain the remarkable differences in the spread of COVID-19 and its impacts on lives between Western countries and Japan, although broad evidence needs to be accumulated and scientifically examined. Considering that pandemics are caused by a variety of unsustainable interactions of human activities and the environment (e.g., Berardelli, 2020; GAVI, 2020; Muhammad et al., 2020), people should be encouraged to form sustainable lifestyles that are in harmony with the environment. In this regard, governments should think carefully about how to incorporate anti-virus habits and sustainable lifestyles into public education, which may reduce public resistance to behavioral rules during future pandemics. Transport users should be better involved in preparations by government and transport operators.

Sixth, governments need to fund and encourage more interdisciplinary research between public health, transportation, and other relevant disciplines. Science and technological innovations are crucial to surviving pandemics (UNCTAD, 2020). For example, population flow has been found to be closely associated with the spatio-temporal spread of COVID-19 in China (Li et al., 2020). However, little is known about the infection risk from using public transport. As such, public transport operators do not know how to operate transport services in such a way as to minimize infection risk. Ferretti et al. (2020) revealed the usefulness of mobile phone applications in implementing contact tracing, social distancing, and quarantine protocols. Considering the huge amounts of Big Data on spatio-temporal human mobility (e.g., transport, social contacts, health conditions) collected via various smart technologies, it is unclear why so much remains unknown. These data have not been maximized to inform policymaking in the current pandemic. Public health experts cannot provide scientific evidence on how many social contacts must be reduced to flatten the spread curve of COVID-19 infection at different stages. In the case of transport operations, the infection risk under a certain passenger density should be predicted; without such a prediction, transport policymakers cannot clarify how much passenger transport volume must be reduced to reduce the spread, and thus making it difficult to encourage voluntary behavioral changes. Big Data have been tapped to provide medical and public health experts with intelligence to anticipate the spread of COVID-19 in three ways: (1) strategic planning; (2) tracking of (possibly infected) individuals; and (3) provision of advice to concerned and possibly infected individuals, by properly addressing privacy issues (Marcus, 2020). However, data sharing in public health faces various barriers, such as technical, motivational, economic, political, legal, and ethical barriers (Van Panhuis et al., 2014). During the current COVID-19 pandemic, public health experts should work more closely with experts in transport, business operation, education, and other relevant sectors. To support this, governments must prepare institutional designs that makes such interdisciplinary and cross-sectoral policymaking possible.

3.1.2. “Protect”

Governments must protect transport users and service providers,

including highly vulnerable people (e.g., essential workers and low-income people) by properly monitoring and supervising the implementation of protection measures that had been prepared in advance. First, because essential mobility should be maintained, the safety of transport personnel is important (ITF-OECD, 2020; ILO, 2020). Second, economic and institutional measures (e.g., compensation for losses of service operation revenue and tax avoidance, evasion, and deferral) have been taken to address the impacts of COVID-19 in developed and developing countries, such as Australia (Public Transport Victoria, 2020), EU states (European Commission, 2020c; Usami et al., 2020), Japan (European Transport Workers’ Federation, 2020), and countries in Asia and the Pacific (ILO, 2020)). Third, to fight COVID-19, smart technologies should be better utilized (Amditis, 2020). Lastly, people need to be protected from fake information on pandemics (Nyilasy, 2020).

Transport operators should protect transport service workers with personal protective equipment (European Transport Workers’ Federation, 2020). Transport users should be protected through the proper sanitization of public transport vehicles/platforms, ventilation, and being obligated to wear masks and avoid talking loudly. For example, wearing face masks has become mandatory on public transport in some European countries (Borrrat, 2020). Physical distancing and protection measures for both staff and users can be enforced. Smart technologies can be used to protect transport users and the public under the scheme of smart cities (Pianta, 2020). More fundamentally, transport users should be advised to wash hands before and after using transport vehicles and avoid touching their face/eyes during trips.

UITP (2020a) summarized two types of protection measures for public transport by reviewing global best practices: (1) disinfection and sanitization, and (2) workforce monitoring. The first type includes frequent disinfection and sanitization of high-touch areas, use of technologies (e.g., ultraviolet light, Ozone, germicidal chlorine-based products, and robots) to disinfect/sanitize vehicles, treatment of high-touch devices (e.g., disabling train open/door push buttons, dismantling all handles inside trains), and demand control (e.g., restricting boarding capacity to 50% on buses). The second type involves the monitoring of workers’ body temperature; supplying of face masks, gloves, hand sanitizers, and vitamin C tablets to staff; installation of intercoms in teller booths to minimize contact between staff and users; use of infrared imaging devices to check the body temperature of users; and isolation of bus drivers from passengers. The above measures need a huge budget; for example, in Maak, 2020, the UK government announced a GBP 283 million funding package to improve public safety and protect services (Media, 2020).

3.1.3. “Provide”

Governments should provide, in a timely manner, scientific and evidence-based information to help users and providers play their respective roles. Governments should also provide immediate financial support to those industries whose operations are strictly regulated. Transport operators should provide antiseptic solution at stations and information on keeping both transport users and service staff safe from the virus. Transport users should be provided with information on the levels of congestion inside public transport platforms/vehicles. Considering the ever-increasing importance of information in the present internet era, transport users should be encouraged to practice better social influences on other persons via social media and within their own social networks. They should be further encouraged (regulated/forced, if necessary) to provide personal health information (e.g., body temperature, immunity proof). For example, the US CDC (2020b) released information on how to protect transport users and operating staff from COVID-19. The Government of Ontario, Canada (2020) provided guidance for public transit agencies and passengers in response to COVID-19. More importantly, transport users should be encouraged to provide information about their spatio-temporal behavioral trajectories to public health authorities and transport operators, in case of infection (e.g., use

of smartphones to track trips, showing personal identity cards to enter subways, use of smartphone-based health codes, and use of location technologies pinpointed to railway and airline seats) (Ko, 2020). These measures involve serious privacy and human rights issues; however, tracing infection trajectories is crucial to preventing further infections. Thus, immediate institutional designs must be made that allow the use of smart technologies by sufficiently addressing negative impacts.

The lessons and limitations of science, as learned from Soper (1919), suggest the importance of better communication with the public: both what are known and unknown need to be conveyed to the public in a proper and not misleading way. Even medical experts need to communicate better with other experts or authorities with greater expertise (and those experts also need to communicate better with them), because scientific evidence accumulates quickly and needs to be applied to practice in a timely manner. Such risk communication is a kind of complex system not only because various stakeholders with different roles and interests are involved but also because of the many unknowns and uncertainties. COVID-19 is a kind of risk, and COVID-19 related communications should have similar features to those for natural disaster risk communications. Meanwhile, COVID-19 is invisible and cannot be detected, like earthquakes or floods, before people are infected. This characteristic makes communications (types and contents of information, ways of information provision, and effective understanding of information via interactions between information providers and receivers) for COVID-19 more difficult, especially with respect to requests for changes in life practices for the public and organizational operations (e.g., schools, firms). Introducing actions too early may bring about unnecessary changes in life and society and result in economic damage and social disorder.

3.2. “A: Avoid–Adjust” policy measures

3.2.1. “Avoid”

Governments must avoid unstable or inconsistent policy decisions. During a pandemic, policymaking is always challenged by the existence of various unknowns and uncertainties. In particular, for policy measures requiring people’s cooperation or regulating people’s behaviors, it is necessary to take measures consistently, conditional on various unknowns and uncertainties. More importantly, government officers/staff need to avoid behaving against their instructions to the public. People in authority must avoid setting bad examples. It is also important to avoid providing inconsistent information. The above are partially supported by observations of people’s behavioral and attitudinal responses to COVID-19 in the early stage of the pandemic in Japan (Zhang, 2020).

Because the use of public transport is riskier compared with other modes (UITP, 2020b), transport operators have to avoid crowding on platforms and operating crowded vehicles. If possible, booking-based public transport should be promoted, because such a booking system allows service providers to guarantee sufficient physical distancing among users by properly controlling demand over time and across lines. Transport operators may also be able to determine when to think about increasing capacity. Transport operators should also avoid actions/behaviors that undermine sustainable development (e.g., waiving environmental targets for governments).

Transport users have to avoid activities/trips needing close physical distances, such as visiting crowded places or using crowded transit vehicles. If crowded places and/or vehicles cannot be avoided, the duration of staying in such places must be reduced. Forwarding fake information related to COVID-19 and transport should be avoided. It is also important to avoid panic buying (e.g., gasoline, masks, and emergency goods), which leads to not only social panic but also traffic congestion.

3.2.2. “Adjust”

Adjustment is an essential part of the planning process in response to changes in the planning contexts (Dames, 1972). Plan adjustment can

“alleviate the tension between the plan and the market as well as facilitate effective pro-growth partnerships between the local state and other economic agents” (Zhu, 2013). Adjustment can be found with respect to planning objectives, instruments, finance, organizations and stakeholders, and evaluation criteria (Fernandes, 2019). The establishment of an adjustment committee or relevant organization is a popular practice in many countries^{2,3,4}. In the event of a pandemic, governments and transport operators may need to adjust the entirety of their preparations according to new contexts or situations. It may become extremely important for governments to make organizational and policymaking adjustments across departments and sectors to assist in decision-making and to implement measures for addressing the pandemic. Policy decisions during a pandemic need to be made by breaking barriers between sectors/departments, even political barriers between ruling and opposition parties. Sheehan and Fox (2020) pointed out that institutional confusion across agencies in response to COVID-19 in the USA resulted in wasted time and lost lives.

Keeping transit open while protecting the health of passengers and staff requires the adjustment of service schedules (frequencies, operating times, number of routes) and sweeping activities by transport operators (Rubiano and Darido, 2020). Transport operators further need to adjust meetings and staff management and then introduce workplace arrangements that are more physical-distancing friendly. For public transport operators especially, it will be extremely important to adjust physical distance between passengers as much as possible. Keeping physical distance means either restricting transport demand or enhancing transport capacity: both are difficult but have to be achieved.

It remains unknown how long we will have to stay at home to help mitigate the spread of COVID-19. Life must go on, however. The economy will be gradually re-opened, although a full-scale re-opening may not happen soon. For a while, we will have to live together with this virus. To avoid/mitigate the risk of infection, physical distancing has to be better practiced. Thus, transport users need to adjust activity plans and schedules and ways of social networking. Activities and trips must take place based on pre-given activity plans and schedules. For reducing face-to-face interpersonal contacts, activity plans and schedules should be well adjusted by meeting the necessary and minimal needs in life (L), which allow people to perform essential activities (A) at proper spaces (S) at proper times (T: both timing and length of time). In other words, a LAST (Life-oriented Activity–Space–Time) approach (Zhang, 2020) becomes relevant and important. For example, people should be encouraged to make trips (e.g., commuting) during off-peak hours instead of during peak hours. Peak-hour charging (both road and public transport) may be needed to encourage behavioral adjustments. People should be encouraged to perform activities (e.g., shopping or meeting) online instead of in person and to seek relaxation without visiting crowded places.

3.3. “S: Shift–Share” policy measures

3.3.1. “Shift”

Governments need to shift to the pandemic-focused governance by involving all stakeholders. Such governance covers information provision and management and highly complicated policy decisions for mitigating the impacts of a pandemic. Because of the extremely important roles of governments in every aspect of the fight against a pandemic, government officers and policy makers must shift their mindsets to a state of emergency. Shifts in mindsets are also requested

² <https://www.toronto.ca/city-government/planning-development/committee-of-adjustment/>.

³ <https://www.pflugervilletx.gov/city-government/boards-and-commissions/board-of-adjustment>.

⁴ https://www.chicago.gov/city/en/depts/dcd/supp_info/administrative_adjustments.html.

from transport operators and users. Shifting passenger traffic from public transport to other modes has to be done; for example, some cities have developed safe and affordable alternatives (e.g., emergency bike lanes, free bike-share, rideshare services) for health care staff and other essential workers (Rubiano and Darido, 2020).

Transport operators also have to shift to their operation system amid a pandemic, by following guidelines and contingency plans prepared before the pandemic. Staff behaviors should be properly regulated. For example, one infected member in a company who participates in a social gathering may lead to the need for self-quarantine of many others, leading to reduction or temporary closure of transport services. Thus, such a pandemic-driven shift needs efforts of all members (general employees and managers) in companies. For such a shift, transport operators are required to make strict regulations regarding their members' behaviors. Although such regulations cannot be applied to company members' families, company members should encourage their family members to take sufficient physical distancing measures as an effort of voluntarily taking shared responsibility.

Transport users need to shift from fixed working hours to flexible ones or staggered commuting, from one mode to another. If trips must be made every day, public transport users and shared mobility users may have to shift to walking/bicycling and car/motorcycle driving to avoid being infected. More importantly, people should be encouraged to shift to a lifestyle suitable to the new normal brought by pandemics. However, the above shifts are not feasible for some essential workers and people without cars and/or motorcycles. Thus, social exclusion (Lyons, 2003; Currie et al., 2010; Varghese and Jana, 2019) must be addressed.

3.3.2. "Share"

Governments need to share information with the public in a timely and interactive manner. This is extremely important to mitigate people's fear about the virus. Information sharing is also crucial for mutual trust via communications between governments and the public. For enabling information sharing, digital epidemiology (e.g., use of COVID-19 app) is crucial, although ethical, social, and legal issues must be better addressed (Cattuto and Spina, 2020).

Supply chains and business operations have been seriously affected by the current pandemic, leading to various under-supply and resource shortage issues. To tackle such issues, governments should promote a shared economy. In the transport sector, shared mobility should be promoted. For example, taxi,⁵ high-speed railway,⁶ and public transport vehicles (Lynott and Heller, 2020) can be used to deliver/transport goods. If physical distances can be ensured, then restaurants and entertainment facilities can be tentatively transformed into office spaces that allow people to work near their homes, thereby avoiding commuting trips.

Transport operators should restrict space sharing, especially for public transport users. If operation resources (e.g., human resources and vehicles) become seriously lacking, operators may have to share their

⁵ <https://news.yahoo.co.jp/articles/2a274fcaff04cf096a94906e2d6f677e616af18e> [Accessed on May 27, 2020]. During the COVID-19 pandemic, in April 2020, the Japanese government made a temporal deregulation (expired by the end of September 2020) that allows taxis to deliver freight services (e.g., foods and drink). Up to May 27, there are 1300 firms and about 40,000 taxis that applied to provide such services. Because of such popularity, now the Japanese government is discussing to make it a permanent rule.

⁶ <https://news.goo.ne.jp/article/asahi/nation/ASN8V5FJ2N8VUTL006.html> (in Japanese): A Japanese high-speed railway company implemented a pilot project to transport fishes by making use of empty seats caused by decrease in ridership due to COVID-19, between August 26 and 28, 2020.

operational resources (e.g., owing to absences of infected staff and lack of disinfected vehicles⁷). Regarding the sharing of operational resources, the successful experience of mutual direct operation (sharing of tracks, other facilities, operation staff, information, and rules) across railway/subway systems in Japan is worth referencing. According to Umehara (2016: p.58), in 2013, Tokyo Metro's total distance traveled using its own lines reached 180,099,000 km, whereas other companies' trains used its lines to travel for 104,554,000 km. In contrast, Tokyo Metro used other companies' lines to run its trains for 104,866,000 km. The cancelling out based on vehicle kilometers operated is the basis for sharing mutual operation costs, such as the use of vehicles and lines. Further, because of the significant reduction of passengers during pandemics, transit operators may provide shared transit vehicles for goods transport, supported by the aforementioned shared mobility policies.

Transport users should start sharing job responsibilities with others as preparation for substitute-stop actions, if jobs are not yet shared. Job sharing has three types: pure, split, and hybrid job sharing; these depend on business objectives, job descriptions, and responsibilities (Daniels, 2011). It is also important to share health information when using urban public transport, inter-city railways, and airlines. For example, ACI and IATA (2020) recommended the collection of passengers' health information in electronic form before arrival at airports, as a measure for passenger contact tracing, and facilitation of the transfer of passengers via one-stop security and health screening to eliminate re-screening during transfer. A certificate of immunity may become a viable tool to facilitate travel when vaccines are successfully produced and widely distributed (IATA, 2020b).

Health experts have emphasized the needs for hiring contact tracers to detect exposed persons quickly (Welch, 2020). Thus, transport users who become infected should be encouraged to share their spatio-temporal behavior trajectories and social contacts, under proper privacy protection. Such information sharing is so crucial to controlling the pandemic effectively and efficiently. In this regard, governments should offer incentive measures for the voluntary sharing of health and behavioral information, and if unsuccessful, stronger enforcement measures. Under a pandemic, everybody should be aware of their social responsibility (Maak, 2020). This, of course, involves not only privacy issues but also ethical ones, which need legal provisions and broad consensus building with the public.

3.4. "S: Substitute-Stop" policy measures

3.4.1. "Substitute"

During a pandemic, unnecessary and non-urgent trips should not be made. Governments should take the initiative to substitute face-to-face procedures with online ones. E-government should be further promoted. Governments also need to take effective policy measures to encourage business operators and the public to substitute trip-driven activities (e.g., meetings, gatherings) with online activities. More importantly, governments should learn to transform the pandemic (crisis) into a new opportunity, because COVID-19 can be a trigger to making significant changes to society.

In the case where facilities to accommodate infected patients are not enough, public transport vehicles can be substituted as isolation units (BBC, 2020), and public transport (including inter-city transport) can be used to transport infected patients (Lynott and Heller, 2020) and medical staff (Wong, 2020). If transport capacity needs to be increased but it is impossible to increase capacity of existing railway systems, then railway operators may have to substitute railways with buses (i.e.,

⁷ <https://news.goo.ne.jp/article/kobe/bizskills/kobe-20200529010.html> (in Japanese): JR (Japan Railway) West has been introduced anti-virus processing to all vehicles (about 5200) under operation since Maak, 2020; however, the processing will take until the end of September 2020, leading to a lack of disinfected vehicles.

allowing buses to replace railways for some rail lines).

Transport users should be encouraged to make full use of online activities (e.g., telework [Kawashima et al., 2020], online meetings [The European Business Review, 2020], online lectures [Li and Lalani, 2020], online shopping [Du, 2020], and online gatherings [Vogels, 2020]). Of course, this substitution measure requires that online services be accessible to as many people as possible. If available, such zero-trip measures would be the best method to prevent the spread of COVID-19, while also recognizing potential negative consequences, such as mental health issues (especially for single-member households), worsened productivity, loss of business that depends on direct communication with customers, and conflicts of job/study with other family activities in multi-member households. Food may be ordered delivered, instead of eating out. Some activities can be postponed. For example, tourism, leisure, and some discretionary activities can be performed after the pandemic. Nonetheless, such postponements usually result in huge economic losses to service providers. People may also reduce trip frequency. People tend to go shopping frequently to purchase fresh foods. In a pandemic, shopping frequency can be reduced through bulk buying. This can also be applied to other activities. People may further reduce trip distance by changing activity destinations. People may also reduce some face-to-face social contacts. There are many issues regarding the reduction of social contact, especially in the business world. However, the rapid progress of the current smart technologies has replaced many face-to-face contacts without worsening their quality. Therefore, face-to-face social contacts can be reduced. Obviously, some issues of social exclusion (e.g., Lyons, 2003; Allen and Farber, 2020) may be present in all the above measures. Thus, it is necessary to protect those socially excluded population groups. For example, UNESCAP (2020) argued for the necessity of providing financial support for employers to maintain job opportunities and of supporting employees and households to ensure minimum living standards. Similar measures are also supported by the European Parliament (Szejna and Kennedy, 2020). The World Economic Forum (2020) further argued for the importance of revisiting the basic income policy to address the various impacts of COVID-19 and other crises. The European Parliament further supports flexible work arrangements and work–life balance (Szejna and Kennedy, 2020). Thus, it is necessary to transform from the current market-oriented society into a life-oriented society in future.

3.4.2. “Stop”

This type of decision might be the most difficult for all stakeholders. The questions are “How much and how long must activities/businesses that are usually performed be stopped?” and “How can they be stopped?” The most extreme case is the lockdown. According to a report released by Statista on April 23, 2020 (Buchholz, 2020), one-third of the world’s population underwent a state of lockdown, which was defined as a situation whereby “governments ordered their citizens to stay at home and only take a minimum of necessary trips outside, while announcing police enforcements and/or fines for people failing to meet the requirements.” In the case of the transport sector, governments should make policies that allow transit operators to stop service operation before the pandemic becomes serious (i.e., to prepare for stopping). This should also be applied to the operation of other businesses, such as offices, stores, and schools. Such policies may be forced, accompanied with punishment for violations, or they may be based on voluntary behavioral changes, accompanied by economic and institutional incentives. Measures for addressing the impacts of COVID-19 need political decisions, for which debates and arguments are essential and critical, especially considering the various unknowns and uncertainties. Debates and arguments must be constructive and evidence based; otherwise, it will be difficult to convince the public to follow governmental instructions/requests/requirements. From a long-term perspective, transport users should also make efforts to change lifestyles, particularly to stop unsustainable human interactions with the environment. Transport operators should also modify their unsustainable

business styles. Behavioral changes toward resilience and sustainability should be made by all stakeholders.

The risk of using public transport remains unclear, as well as the variables that most affect infectivity (e.g., length of time exposed, density of transport passengers, and level of air circulation). Robust scientific evidence is therefore urgently needed. When the outbreak of COVID-19 occurred, some countries locked down their cities, forcing public transport services also to stop. Stopping public transport services has made its own contribution to mitigating the spread of COVID-19, although it does not immediately mean stopping all services. Services should still be provided to essential workers who lack access to cars. In recent years, shared mobility services have been made available and are becoming increasingly popular. To avoid being infected, shared mobility drivers may be unwilling to provide private transport services. Thus, meeting the mobility needs of essential workers will be a key issue in relation to public transport services.

When pandemic situations worsen, transport users have to stop activities involving trips, if possible, and they also need to stop gatherings even at home. If people can work at home without causing any economic losses, such a stopping measure will be very effective to flattening the curve of the pandemic. Stay-at-home restrictions and regulations allow people to perform necessary activities without making trips, and consequently release people from commuting, but staying at home for long periods may have consequences on people’s mental health (Zhang, 2020). It is necessary to mitigate such mental health issues in various ways, where use of online psychological counselling is a popular immediate measure (e.g., Liu et al., 2020). Community-level social capital sources are helpful to improve mental health (Fancourt and Baxter, 2020; Nakagomi et al., 2020) and should be better utilized (via online tools) under the current pandemic. Moreover, a better built environment is beneficial to various health aspects, including mental health (Moore et al., 2018). Thus, from a long-term perspective, it is necessary to improve the built environment based on better physical distancing design (Liddicoat et al., 2020). The challenge is in balancing the stopping of out-of-home activities and serious economic, financial, and job losses. As in transport services, proper economic and institutional compensation should also be made to the public.

4. Conclusions and further challenges

Various policy measures have been proposed and taken to address the impacts of COVID-19. However, creating policy measures in a relatively comprehensive and seamless manner has been relatively under-explored. The present work proposed a new policymaking approach, namely, PASS, for battling the current COVID-19 and future pandemics. Based on this approach, the author made major policy recommendations with respect to each of the four categories: P (Prepare–Protect–Provide), A (Avoid–Adjust), S (Shift–Share), and S (Substitute–Stop), as summarized in Table 1. This new approach was designed to fill the gaps in transport policymaking amid pandemics by covering the major aspects that should be addressed by governments, transport operators, transport users, and the public. The approach reflects the different roles of and relations between these major stakeholders in connecting public health and transport policymaking. Available references for COVID-19 are extremely limited. As such, the author had to rely on ongoing measures taken in different countries to support the proposal and policy recommendations. No one country/city has implemented all the PASS-based policy measures and/or all the policy recommendations, but most of the concepts and policy recommendations can be supported in practice, partially. Empirical evidence and the lack of systematic policymaking approaches support both the proposal of the PASS approach and derived policy recommendations. As for existing policy measures for addressing the impacts of COVID-19, the East and West have shown different views on how to fight COVID-19, as seen in the use of masks and implementation of lockdowns. The current progress of science has not presented sufficient, universally accepted evidence for mitigating the

Table 1
Summary of Policy Recommendations Based on the PASS approach.

PASS	Government	Transport operators	Transport users
P	<p>Prepare</p> <p><i>What's most important is to prepare well for pandemics. The government should take the lead and encourage or require other stakeholders to prepare. Planning should guide every preparedness measure, from a long-term perspective.</i></p> <ul style="list-style-type: none"> ●capacity building: pandemics-driven mindsets (learn lessons from history); create a cross-sectoral organization involving experts and transport operators ●institutional design for all measures ●policies for supporting guidelines and contingency plans as well as training prepared by transport operators ●policies that allow transit operators to stop service operation ●establish standards of physical distancing measures and personal protective equipment ●legal and regulatory preparations ●deregulation of use of smart technology for public health ●physical distancing driven urban and transportation planning (or planning of the built environment) against pandemics ●public education ●supplement budgets to encourage more interdisciplinary research 	<ul style="list-style-type: none"> ●capacity building ●establish task force by inviting experts ●develop guidelines and contingency plans ●training based on guidelines and contingency plans ●participate in preparations by government and other stakeholders ●collaborate across transport operators for seamless measures ●develop protection and physical distancing technologies 	<ul style="list-style-type: none"> ●capacity building ●form anti-virus habits, healthy and “smart” lifestyles ●prepare for physical distancing: e.g., use smart technologies to meet various needs in life without making a trip ●participate in preparations by government and transport operators
	<p>Protect</p> <p><i>The most important role for government is to protect citizens and firms.</i></p> <ul style="list-style-type: none"> ●monitor and supervise protection measures prepared in advance: keep transport users and operators as well as highly vulnerable people safe ●implement economic and institutional measures for protection ●encourage use of smart technologies to better protect transport users and general public under the scheme of smart cities ●protect people from fake information 	<ul style="list-style-type: none"> ●minimize contact between staff and users: e.g., online services ●isolate vehicle drivers from passengers ●workforce monitoring: check workers' body temperature ●service workers' use of personal protective equipment and face masks, etc. ●enforce physical distancing and protection measures for both staff and users ●enforce use of masks ●use smart technologies to check body temperature of users ●disinfection and sanitization: use both conventional and smart technologies to keep clean, especially areas which are touched frequently; ventilation 	<ul style="list-style-type: none"> ●wear face masks and do not touch face/eyes during trips ●wash hands before and after using transport vehicles ●protect other passengers by not talking loudly ●physical distancing during trips
	<p>Provide</p> <p><i>The second most important role of government is to provide public goods and services that cannot be provided by individuals or firms.</i></p> <ul style="list-style-type: none"> ●provide scientific and evidence-based information: both what are known and what are unknown ●provide guidance for public transit agencies and passengers ●provide immediate financial support to those industries whose operations are strictly regulated ●provide institutional framework to allow use of smart technologies by sufficiently addressing privacy and human rights issues 	<ul style="list-style-type: none"> ●provide antiseptic solution at stations ●provide scientific and evidence-based information about how to keep both transport users and service staff safe from the virus ●provide transit users with information about levels of congestion inside public transport platforms/vehicles 	<ul style="list-style-type: none"> ●provide personal health information (e.g., body temperature, immunity proof) ●provide information about spatio-temporal behavioral trajectories to public health authorities, in case of infection ●share accurate information and avoid spreading misinformation via social media and within social networks
A	<p>Avoid</p> <p><i>Avoidance should be regarded as most important among all measures after the occurrence of the pandemic. Negative impacts due to avoidance (e.g., social exclusion) should be addressed.</i></p> <ul style="list-style-type: none"> ●avoid unstable or inconsistent policy decisions ●avoid providing inconsistent information ●government officers/staff need to avoid behaving against their instructions to the general public ●government officers' and other decision makers' behaviors under pandemics must be regulated with strict punishments 	<ul style="list-style-type: none"> ●avoid crowded platforms and operating crowded vehicles: booking-based public transport should be promoted ●avoid providing inconsistent information ●avoid actions/behaviors which undermine sustainable development 	<ul style="list-style-type: none"> ●avoid talking if not wearing masks. ●avoid activities/trips needing close physical distance, e.g., visiting crowded places or using crowded transit vehicles. ●If crowded places and/or vehicles cannot be avoided, the duration of stay in such places should be reduced ●avoid forwarding fake information related to COVID-19 and transport
	<p>Adjust</p> <p><i>All stakeholders need to adjust their activities to reduce infection risks. Policies should be adjusted to incorporate measures against infections. Behavioral adjustments usually do not need big efforts and should be strongly encouraged.</i></p> <ul style="list-style-type: none"> ●adjust preparations to new contexts or situations ●adjust organizational and policymaking processes to incorporate anti-pandemic measures across governmental departments and across sectors 	<ul style="list-style-type: none"> ●adjust service schedules (frequencies, operating times, number of routes) and sweeping activities ●maintain physical distance between passengers as much as possible: either restricting transport demand or enhancing transport capacity 	<ul style="list-style-type: none"> ●adjust activity plans and schedules and ways of social networking ●make trips (e.g., commuting) during off-peak hours instead of during peak hours: peak-hour charging may be needed

(continued on next page)

Table 1 (continued)

PASS	Government	Transport operators	Transport users
S	Shift	<ul style="list-style-type: none"> ●adjust meetings and staff management and introduce more physical-distancing-friendly workplace arrangements 	<ul style="list-style-type: none"> ●perform activities online instead of visiting a physical place ●practice relaxation without visiting crowded places
	Share	<p><i>The current pandemic has forced our economic and social systems to run ‘in a discontinuous manner with threshold shifts (i.e., bifurcations) from the present equilibrium state. Shift indicates a nonlinear change from one state to a different one.</i></p> <ul style="list-style-type: none"> ●shift to a pandemic-focused governance approach ●shift mindsets of policy makers to a state of emergency ●develop safe and affordable alternative travel modes for health care staff and other essential workers ●promote modal shift to active transport 	<ul style="list-style-type: none"> ●shift to flexible working hours or other flexible working arrangements ●modal shift, including shift to active transport ●shift to a lifestyle suitable to the new normal
	Substitute	<p><i>Measures against the pandemic need collective decisions and actions. Sharing of information and resources is the key to collective decisions and actions.</i></p> <ul style="list-style-type: none"> ●information sharing ●promote shared economy and shared mobility ●allow taxi and public transport vehicles to transport goods ●encourage non-office facilities to be tentatively transformed into office spaces for teleworkers ●allow use of contact tracers to quickly detect people exposed to the pathogen ●offer incentive measures for information sharing 	<ul style="list-style-type: none"> ●share health and behavioral information ●share spatio-temporal behavior trajectories and social contacts ●job sharing: pure job sharing, split job sharing, and hybrid job sharing
S	Stop	<p><i>Substitution measures may involve serious ethical, legal and even human rights issues, which should be properly addressed.</i></p> <ul style="list-style-type: none"> ●e-government: substitute face-to-face governmental procedures with online procedures ●encourage business operators and the general public to substitute trip-based activities with online activities ●make online services accessible to all people ●transform the pandemic (crisis) into a new opportunity ●transform from the current market-oriented society into a life-oriented society 	<ul style="list-style-type: none"> ●substitute activities involving trips with online activities ●postpone some activities: e.g., tourism, leisure, and discretionary activities ●reduce trip frequency and distance ●unnecessary and non-urgent trips should not be made
		<p><i>Stop measures may involve serious ethical, legal and even human rights issues, which should be properly addressed.</i></p> <ul style="list-style-type: none"> ●substitute trip-driven activities ●reduce face-to-face business contacts ●public transport vehicles can be substituted as isolation units ●railway operators may have to substitute railways with buses, in the case that the railway capacity is not enough to allow sufficient physical distancing ●use dedicated public transport vehicles to transport infected patients 	<ul style="list-style-type: none"> ●stop activities involving trips ●stay at home and care for mental health ●stop or reduce gatherings, even at home ●change lifestyles to stop unsustainable human interactions with the environment: behavioral changes toward resilience and sustainability
		<ul style="list-style-type: none"> ●stop service operation, but ensure the mobility of essential workers, with proper economic and institutional compensation ●modify unsustainable business styles to stop unsustainable human interactions with the environment: behavioral changes toward resilience and sustainability 	

spread of COVID-19. Nevertheless, the professional insights of scientists merit people's reliance over the political judgment of so-called experts. Having such a mindset may be the only way to allow different countries to learn best practices from one another: by putting aside political and cultural prejudices. As for the transport sector, although the infection risk inside transport vehicles may be lower than in other crowded places, policymakers have to recognize that transport vehicles have surely transported infected persons. Thus, transport policy measures must be a part of the big picture of the fight against COVID-19. In other words, the PASS-based policy measures can only be sufficiently effective if they can be implemented jointly with other public health measures.

Empirical studies need to be conducted to evaluate the effects of the recommended policies and the applicability of the PASS approach as a new policymaking method, although the current COVID-19 pandemic may not allow much time for such evaluations. As stated by Sheehan and Fox (2020), public health policymaking requires an ability to lead to the implementation of a coherent strategy to protect populations. Similarly, in the transport sector, in implementing the policies recommended in this study, proper capacity building (both long-term and immediate) should be required of all stakeholders so that society as a whole can respond better. In the future, empirical and theoretical research should be conducted on the applicability of the PASS approach, effects of the policies recommended in this study, and capacity building for society as a whole to deal with pandemics. Future studies should be further done in different contexts and cultures as well as geographical locations because both types and effects of policies may display various heterogeneities. Other types of systematic policymaking methodologies against pandemics should also be developed.

Declaration of competing interest

No potential conflicts of interest were disclosed.

Acknowledgment

This research was funded by the J-RAPID Collaborative Research/Survey Program for Urgent Research framework (No. JPMJJR2006), Japan Science and Technology Agency. The author would like to thank Prof. Anming Zhang (UBC, Canada) for providing valuable comments on the initial manuscript and Ms. Fuyo (Jenny) Yamamoto (Hiroshima University, Japan) for her English proofing of the initial manuscript and Table 1 of the final manuscript.

References

- Abou-Chadi, T., Green-Pedersen, C., Mortensen, P.B., 2020. Parties' policy adjustments in response to changes in issue saliency. *W. Eur. Polit.* 43 (4), 749–771.
- ACI and IATA, 2020. Safely restarting aviation: ACI and IATA joint approach. Available at: <https://www.iata.org/contentassets/5c8786230ff34e2da406c72a52030e95/safely-restart-aviation-joint-aci-iata-approach.pdf>. (Accessed 27 August 2020).
- Adshead, F., Thorpe, A., 2007. The role of the Government in public health: a national perspective. *Publ. Health* 121 (11), 835–839.
- Africa Center for Strategic Studies, 2020. Lessons from the 1918-1919 Spanish flu pandemic in Africa. Available at: <https://africacenter.org/spotlight/lessons-1918-1919-spanish-flu-africa/>. (Accessed 23 August 2020).
- Ahmed, F., Ahmed, N., Pissarides, C., Stiglitz, J., 2020. Why inequality could spread COVID-19. *Lancet Public Health* 5 (5), e240.
- Albani, M., 2020. There is no returning to normal after COVID-19. But there is a path forward. Available at: <https://www.weforum.org/agenda/2020/04/covid-19-the-ree-horizons-framework/>. (Accessed 4 July 2020).
- Allen, J., Farber, S., 2020. Planning transport for social inclusion: an accessibility-activity participation approach. *Transport. Res. Part D* 78, Article No. 102212.
- Amditis, A., 2020. Opinion: mobility in the aftermath of the covid-19 pandemic. Available at: <https://www.trafficechnologytoday.com/opinion/opinion-mobility-in-the-aftermath-of-the-covid-19-pandemic.html>. (Accessed 4 July 2020).
- Amster, E., 2020. History's crystal ball: what the past can tell us about COVID-19 and our future. *The Conversation*. June 28. Available at: <https://theconversation.com/history-crystal-ball-what-the-past-can-tell-us-about-covid-19-and-our-future-140512>. (Accessed 4 July 2020).
- BBC, 2020. Coronavirus: India to use 500 train carriages as wards in Delhi. BBC News. June 14. Available at: <https://www.bbc.com/news/world-asia-india-53039868>. (Accessed 4 July 2020).
- Benight, C.C., Harwell, A., Shoji, K., 2018. Self-regulation shift theory: a dynamic personal agency approach to recovery capital and methodological suggestions. *Front. Psychol.* 9, Article No. 1738. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6160534/pdf/psysg-09-01738.pdf>. (Accessed 29 August 2020).
- Berardelli, J., 2020. Human impact on the environment may make pandemics more likely, experts warn. CBC News. April 2. Available at: <https://www.cbcnews.com/news/coronavirus-environment-pandemic-infectious-diseases/>. (Accessed 4 July 2020).
- Borrat, D., 2020. Europe's post-lockdown rules compared. Available at: <https://www.politico.eu/article/europe-coronavirus-post-lockdown-rules-compared-face-mask-travel/>. (Accessed 27 August 2020).
- Buchholz, K., 2020. What share of the world population is already on COVID-19 lockdown? Available at: <https://www.statista.com/chart/21240/enforced-covid-19-lockdowns-by-people-affected-per-country/>. (Accessed 4 July 2020).
- Cattuto, C., Spina, A., 2020. The institutionalisation of digital public health: lessons learned from the COVID-19 app. *European J. Risk Regulation* 11 (2), 228–235.
- CDC, the USA, 2020a. Planning and preparedness resources. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/bus-transit-operator.html>. (Accessed 4 July 2020).
- CDC, the USA, 2020b. What bus transit operators need to know about COVID-19. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/bus-transit-operator.html>. (Accessed 4 July 2020).
- Cho, S.-I., 2017. Role of the local government in infectious disease-related public health emergency preparedness and response. *J. Korean Med. Assoc.* 60 (4), 300–305.
- Citroen, P., 2020. COVID-19 and its impact on the European Rail Supply Industry. <https://www.globalrailwayreview.com/article/98741/covid19-european-rail-supply-industry/>. (Accessed 26 August 2020).
- Colvin, C., McLaughlin, E., 2020. Coronavirus and Spanish flu: economic lessons to learn from the last truly global pandemic', *the Conversation*, March 11. Available at: <https://theconversation.com/coronavirus-and-spanish-flu-economic-lessons-to-learn-from-the-last-truly-global-pandemic-133176>. (Accessed 23 August 2020).
- Currie, G., Richardson, T., Smyth, P., Vella-Brodrick, D., Hine, J., Lucas, K., Stanley, J., Morris, J., Kinnear, R., Stanley, J., 2010. Investigating links between transport disadvantage, social exclusion and well-being in Melbourne – updated results. *Res. Transport. Econ.* 29 (1), 287–295.
- Dames, T.A., 1972. The urban planning process. Doctoral dissertation. Purdue University. Available at: <https://core.ac.uk/download/pdf/36709663.pdf>. (Accessed 27 August 2020).
- Daniels, L., 2011. Job sharing at senior level: making it work. Available at: <https://www.thejobshareproject.com/3434hjvk97fgb378fbv/jobsharefullreport.pdf>. (Accessed 4 July 2020).
- Das, M., 2020. Covid-19 impact: 36 per cent drop in Railways cargo in early April. Available at: <https://www.thehindubusinessline.com/economy/logistics/covid-19-impact-36-drop-in-railways-cargo-in-early-april/article31407380.ece#>. (Accessed 26 August 2020).
- De Longevialle, B., Wilkins, M., 2020. COVID-19: a test of the stakeholder approach. Available at: <https://www.spglobal.com/ratings/en/research/articles/200421-covid-19-a-test-of-the-stakeholder-approach-11449022>. (Accessed 4 July 2020).
- Deutsch, C., 2014. Origins of Metropolitan Transportation Planning and the Urban Stakes of Interstate Highway Funding, 1956–1962. *Transportation Research Record*. <https://doi.org/10.3141/2453-12>. Available at: (Accessed 27 August 2020).
- Dickson, J.K., 1992. Contingency planning for emergencies. *Long. Range Plan.* 25 (4), 82–89.
- Du, L., 2020. Virus pandemic pushes Japan's shoppers to finally buy online. Available at: <https://www.japantimes.co.jp/news/2020/04/10/business/coronavirus-japan-shoppers-buy-online/>. (Accessed 4 July 2020).
- EBP, 2020. The Impact of the COVID-19 Pandemic on Public Transit Funding Needs in the U.S. <https://www.apta.com/wp-content/uploads/APTA-COVID-19-Funding-Impact-2020-05-05.pdf>. (Accessed 23 August 2020).
- EIT, 2020a. COVID-19: what is happening in the area of urban mobility. <https://eit.europa.eu/news-events/news/covid-19-what-happening-area-urban-mobility>. (Accessed 26 August 2020).
- EIT, 2020b. COVID-19: what is happening in the area of urban mobility. <https://www.eit-turbanmobility.eu/covid-19-what-is-happening-in-the-area-of-urban-mobility/>. (Accessed 26 August 2020).
- European Commission, 2020a. Future of transport: update on the economic impacts of COVID-19. Available at: https://ec.europa.eu/jrc/sites/jrcsh/files/202005_future_of_transport_covid_sfp_brief.pdf. (Accessed 23 August 2020).
- European Commission, 2020b. Responding to the COVID-19 crisis through financial instruments in the framework of the coronavirus response investment initiative. Available at: https://www.fi-compass.eu/sites/default/files/publications/Responding%20to%20the%20COVID-19%20crisis%20through%20financial%20instruments_0.pdf. (Accessed 25 August 2020).
- European Commission, 2020c. COVID-19: Commission provides guidance on EU passenger rights. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_20_485. (Accessed 27 August 2020).
- European Transport Workers' Federation, 2020. COVID-19: Transport Workers Have a Right to Protective Equipment!. Available at: <https://www.etf-europe.org/covid-19-transport-workers-have-a-right-to-protective-equipment/>. (Accessed 27 August 2020).
- Evans, D.J., 1975. Role of state governments in educating public about health. *J. Med. Educ.* 50 (2), 130–137.
- Fan, B., Liu, R., Huang, K., Zhu, Y., 2019. Embeddedness in cross-agency collaboration and emergency management capability: evidence from Shanghai's urban contingency plans. *Govern. Inf. Q.* 36 (4), Article No. 101395.

- Fancourt, D., Baxter, L., 2020. Differential participation in community cultural activities amongst those with poor mental health: analyses of the UK Taking Part Survey'. *Soc. Sci. Med.* 261. Article No. 113221.
- Fernandes, J.P., 2019. Developing viable, adjustable strategies for planning and management—a methodological approach. *Land Use Pol.* 82, 563–572.
- Ferretti, L., Wymant, C., Kendall, M., Zhao, L., Nurtay, A., Abeler-Dörner, L., Parker, M., Bonsall, D., Fraser, C., 2020. Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. *Science* 368, 619.
- Giles-Corti, B., Vernez-Moudon, A., Reis, R., Turrell, G., Dannenberg, A.L., Badland, H., Foster, S., Lowe, M., Sallis, J.F., Stevenson, M., Owen, N., 2016. City planning and population health: a global challenge. *Lancet* 388, 2912–2924.
- Government of Ontario, Canada, 2020. Guidance for public transit agencies and passengers in response to COVID-19. Available at: <https://files.ontario.ca/mto-guidance-public-transit-agencies-and-passengers-covid-19-en-2020-06-11-v3.pdf>. (Accessed 4 July 2020).
- GAVI – The Vaccine Alliance, 2020. Why human impact on the environment is leading to infections like COVID-19. Available at: <https://www.gavi.org/vaccineswork/why-human-impact-environment-leading-infections-covid-19>. (Accessed 4 July 2020).
- He, J., He, L., Zhou, W., Nie, X., He, M., 2020. Discrimination and social exclusion in the outbreak of COVID-19'. *Int. J. Environ. Res. Publ. Health* 17 (8). Article No. 2933.
- IATA, 2020a. COVID-19 impact on Asia-Pacific aviation worsens. Available at: <https://www.iata.org/en/pressroom/pr/2020-04-24-01/>. (Accessed 26 August 2020).
- IATA, 2020b. *Restarting aviation following COVID-19: Medical evidence for various strategies being discussed as at 09 June 2020*. IATA Medical Advisory Group. Available at: <https://www.iata.org/contentassets/fl163430bba94512a583eb6d6b24aa56/covid-medical-evidence-for-strategies-200609.pdf>. (Accessed 4 July 2020).
- ICAO, 2020. Economic impacts of COVID-19 on civil aviation. Available at: <https://www.icao.int/sustainability/Pages/Economic-Impacts-of-COVID-19.aspx>. (Accessed 26 August 2020).
- ILO, 2020. Social protection responses to the covid-19 crisis: country responses in Asia and the pacific. Available at: https://www.ilo.org/wcmsp5/groups/public/—asia/—ro-bangkok/documents/briefingnote/wcms_739587.pdf. (Accessed 4 July 2020).
- International Strategy for Disaster Reduction (UNISDR), 2009. 2009 UNISDR terminology on disaster risk reduction. Available at: https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf. (Accessed 27 August 2020).
- ITF-OECD, 2020. Transport policy responses to the coronavirus crisis. Available at: <https://www.itf-oecd.org/sites/default/files/transport-policy-responses-covid-19.pdf>. (Accessed 4 July 2020).
- Jochelson, K., 2006. Nanny or steward? The role of government in public health. *Publ. Health* 120 (12), 1149–1155.
- Kawashima, T., Nomura, S., Tanoue, Y., Yoneoka, D., Eguchi, A., Shi, S., Miyata, H., 2020. The relationship between fever rate and telework implementation as a social distancing measure against the COVID-19 pandemic in Japan'. *Public Health*. Available at: <https://doi.org/10.1016/j.puhe.2020.05.018>. (Accessed 4 July 2020).
- Killingray, D., 2003. A new 'imperial disease': the influenza pandemic of 1918–9 and its impact on the British Empire. *Caribb. Q.* 49 (4), 30–49.
- Kim, Y.T., 2020. Transport in the face of the pandemic. Available at: <https://www.itf-oecd.org/transport-face-pandemic>. (Accessed 23 August 2020).
- King, I., 2020. How COVID-19 will change us: seven lessons from the most consequential pandemics in history. Available at: <https://www.csis.org/analysis/how-covid-19-will-change-us-seven-lessons-most-consequential-pandemics-history>. (Accessed 4 July 2020).
- Ko, J., 2020. How China used technology to combat COVID-19 – and tighten its grip on citizens. Available at: <https://www.amnesty.org/en/latest/news/2020/04/how-china-used-technology-to-combat-covid-19-and-tighten-its-grip-on-citizens/>. (Accessed 29 August 2020).
- Lawrence, C., Granath, E., 2020. What Is the Impact of Covid-19 on the Public Transport Sector? <https://www.intelligent-mobility-xperience.com/what-is-the-impact-of-covid-19-on-the-public-transport-sector-a-915170/>. (Accessed 23 August 2020).
- Li, C., Lalani, F., 2020. The COVID-19 pandemic has changed education forever. This is how. Available at: <https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid-19-online-digital-learning/>. (Accessed 4 July 2020).
- Li, S., Ma, S., Zhang, J., 2020. The city-level spread of COVID-19 at its initial stages in China: an analysis of its associations with the built environment factors by reflecting spatial heterogeneity. *Sustainable Cities and Society* (under review).
- Liddicoat, S., Badcock, P., Killackey, E., 2020. Principles for designing the built environment of mental health services. *The Lancet Psychiatry*. [https://doi.org/10.1016/S2215-0366\(20\)30038-9](https://doi.org/10.1016/S2215-0366(20)30038-9). Available at: (Accessed 27 August 2020).
- Liu, S., Yang, L., Zhang, C., Xiang, Y.T., Liu, Z., Hu, S., Zhang, B., 2020. Online mental health services in China during the COVID-19 outbreak'. *Lancet Psychiatr.* 7 (4), e17–e18.
- Lynott, J., Heller, M., 2020. How public transportation provides key lifelines during COVID-19. Available at: <https://www.weforum.org/agenda/2020/04/public-transportation-provides-lifelines-during-covid-19-heres-how/>. (Accessed 4 July 2020).
- Lyons, G., 2003. The introduction of social exclusion into the field of travel behaviour. *Transport Pol.* 10 (4), 339–342.
- Maak, T., 2020. The COVID-19 responsibility we all own. Available at: <https://pursuit.unimelb.edu.au/articles/the-covid-19-responsibility-we-all-own>. (Accessed 4 July 2020).
- Maqbool, A., Khan, N.Z., 2020. Analyzing barriers for implementation of public health and social measures to prevent the transmission of COVID-19 disease using DEMATEL method. *Diabet. Metabolic Syndrome: Clin. Res. Rev.* 14 (5), 887–892.
- Marcus, J.S., 2020. Big data versus COVID-19: opportunities and privacy challenges. Available at: <https://www.bruegel.org/2020/03/big-data-versus-covid-19-opportunities-and-privacy-challenges/>. (Accessed 23 August 2020).
- Martini, M., Gazzaniga, V., Bragazzi, N.L., Barberis, I., 2019. The Spanish influenza pandemic: a lesson from history 100 years after 1918'. *J. Preventive Med. Hygiene* 60 (1), e64–e67.
- McCaulley, D., Teleki, K., Thienemann, G.F., 2020. 8 ways to rebuild a stronger ocean economy after COVID-19. Available at: <https://www.weforum.org/agenda/2020/05/how-to-build-a-bluer-ocean-economy-after-covid-19/>. (Accessed 26 August 2020).
- Media, P.A., 2020. Transport network to get £283m for Covid-19 protection measures Accessible from. on. <https://www.theguardian.com/uk-news/2020/may/23/government-to-spend-283m-to-keep-bus-and-train-passengers-safe>. (Accessed 4 July 2020).
- Meyer, M.D., Belobaba, P., 1982. Contingency planning for response to urban transportation system disruptions. *J. Am. Plann. Assoc.* 48 (4), 454–465.
- Ministry of Land, Infrastructure, Transport and Tourism, Japan, 2020. Survey on the maintenance and revitalization of regional public transport in local cities. Available at: <https://www.mlit.go.jp/pri/houkoku/gaiyou/pdf/kkk120.pdf> (in Japanese: Chiho Toshi Ni Okeru Chiiki Koukyu Koutsu No Iji Kasseika Ni Kansuru Chosa Kenkyu), p.14 (Accessed: August 23, 2020).
- Ministry of Land, Infrastructure, Transport and Tourism, Japan, 2020. Responses to COVID-19 by MLIT, Japan. Available at: <https://www.mlit.go.jp/common/001351363.pdf> (in Japanese: Kokudo Koutsu Syo Ni Okeru Singata Korona Uirusu He No Taiou Jyokyo) (Accessed: July 3, 2020).
- Moatti, J.-P., 2020. The French response to COVID-19: intrinsic difficulties at the interface of science, public health, and policy. *Lancet Public Health* 5 (5), e255.
- Moore, T.H.M., Kesten, J.M., Lopez-Lopez, J.A., Ijaz, S., McAleenan, A., Richards, A., Gray, S., Savovic, J., Audrey, S., 2018. The effects of changes to the built environment on the mental health and well-being of adults: systematic review, 53. *Health & Place*, pp. 237–257.
- Muhammad, S., Long, X., Salman, M., 2020. COVID-19 pandemic and environmental pollution: a blessing in disguise?'. *Sci. Total Environ.* 728 (1). Article No. 138820.
- Nakagomi, A., Shiba, K., Hanazato, M., Kondo, K., Kawachi, I., 2020. Does community-level social capital mitigate the impact of widowhood & living alone on depressive symptoms?: a prospective, multi-level study. *Soc. Sci. Med.* 259. Article No. 113140.
- National Academies of Sciences, Engineering, and Medicine, 2014. A Guide for Public Transportation Pandemic Planning and Response. The National Academies Press, Washington, DC. <https://doi.org/10.17226/22414>. Available at: (Accessed 27 August 2020).
- National Academies of Sciences, Engineering, and Medicine, 2019. A Guide to Emergency Management at State Transportation Agencies. The National Academies Press, Washington, DC. <https://doi.org/10.17226/25557>. Available at: (Accessed 27 August 2020).
- Nyilas, G., 2020. Fake news in the age of COVID-19. Available at: <https://pursuit.unimelb.edu.au/articles/fake-news-in-the-age-of-covid-19>. (Accessed 4 July 2020).
- Oitzl, M.S., 2007. Avoidance. In: Fink, G. (Ed.), *Encyclopedia of Stress*, second ed., pp. 297–301.
- Our World Data, 2020. Public transport closures during the COVID-19 pandemic. Available at: <https://ourworldindata.org/grapher/public-transport-covid?year=2020-08-22>. (Accessed 23 August 2020).
- Pantuliano, S., 2020. Covid-19: 'we won't get back to normal because normal was the problem'. Available at: <https://www.odi.org/blogs/16815-covid-19-we-won-t-get-back-normal-because-normal-was-problem>. (Accessed 4 July 2020).
- Park, A., 2020. Here's how scientists and public-health experts recommend the U.S. gets back to 'normal. Available at: <https://time.com/5829387/coronavirus-reopening-science/>. (Accessed 4 July 2020).
- Paydos, T., 2020. The essential role of government during COVID-19. Available at: <https://www.ibm.com/blogs/think/2020/04/the-essential-role-of-government-during-covid-19/>. (Accessed 23 August 2020).
- Pianta, L., 2020. COVID-19 crisis: a stress-test for smart cities. Available at: <https://www.matchup-project.eu/news/covid-19-crisis-a-stress-test-for-smart-cities/>. (Accessed 4 July 2020).
- Public Transport Victoria, 2020. Refunds, compensation and replacement tickets. Available at: <https://www.ptv.vic.gov.au/tickets/refunds-compensation-and-replacement-tickets/>. (Accessed 27 August 2020).
- Rodrigue, J.-P., Luke, T., Osterholm, M., 2020. Transportation and pandemics. In: Rodrigue, J.-P. (Ed.), *The Geography of Transport Systems*, the fifth ed. Routledge, New York.
- Rubiano, L.C., Darido, G., 2020. Protecting public transport from the coronavirus... and from financial collapse. Available at: <https://blogs.worldbank.org/transport/protecting-public-transport-coronavirus-and-financial-collapse>. (Accessed 4 July 2020).
- Rudisill, C., Costa-Font, J., Mossialos, E., 2012. Behavioral adjustment to avian flu in Europe during spring 2006: the roles of knowledge and proximity to risk. *Soc. Sci. Med.* 75 (8), 1362–1371.
- Sheehan, M.C., Fox, M.A., 2020. Early warnings: the lessons of COVID-19 for public health climate preparedness. *Int. J. Health Serv.* 50 (3), 264–270.
- Slaughter, A.-M., 2020. 3 responsibilities every government has towards its citizens. Available at: <https://www.weforum.org/agenda/2017/02/government-responsibility-to-citizens-anne-marie-slaughter/>. (Accessed 4 July 2020).
- Star, K., 2020. How to reduce your panic-related avoidance behaviors. Available at: <https://www.verywellmind.com/how-to-reduce-your-panic-related-avoidance-behaviors-2584148>. (Accessed 4 July 2020).
- Szpejna, M., Kennedy, A., 2020. Mitigating the employment and social effects of the COVID-19 pandemic. Available at: [https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/652719/IPOL_BRI\(2020\)652719_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/652719/IPOL_BRI(2020)652719_EN.pdf). (Accessed 23 August 2020).
- Taubenberger, J.K., Morens, D.M., 2006. 1918 Influenza: the mother of all pandemics'. *Emerg. Infect. Dis.* 12 (1), 15–22.

- Teoh, P., 2020. The impact of the COVID-19 pandemic on shipping. Available at: <https://www.maritime-executive.com/editorials/the-impact-of-the-covid-19-pandemic-on-shipping>. (Accessed 26 August 2020).
- The European Business Review, 2020. The pros and cons of using online meeting technology. Available at: <https://www.europeanbusinessreview.com/the-pros-and-cons-of-using-online-meeting-technology/>. (Accessed 27 August 2020).
- The Library of Economics and Liberty, 2020. Roles of government. Available at: <https://www.econlib.org/library/Topics/HighSchool/RolesofGovernment.html>. (Accessed 13 June 2020).
- TUMI, 2020. The COVID-19 outbreak and implications to sustainable urban mobility – some observations. Available at: <https://www.transformative-mobility.org/news/the-covid-19-outbreak-and-implications-to-public-transport-some-observations>. (Accessed 23 August 2020).
- Tzannatos, Z., 2020. Europe after Covid-19: back to the old normal, but with new steroids? Available at: <https://www.ekathimerini.com/252303/opinion/ekathimerini/comment/europe-after-covid-19-back-to-the-old-normal-but-with-new-steroids>. (Accessed 4 July 2020).
- UITP, 2020a. Public transport authorities and COVID-19: response from the front line. Available at: <https://www.lek.com/sites/default/files/insights/pdf-attachments/Public-Transport-Authorities-COVID-19.pdf>. (Accessed 4 July 2020).
- UITP, 2020b. Management of COVID-19 guidelines for public transport operators. Available at: <https://www.lek.com/sites/default/files/insights/pdf-attachments/Public-Transport-Authorities-COVID-19.pdf>. (Accessed 4 July 2020).
- Umehara, J., 2016. Technologies to Support Punctual Train Operation. Hidekazu System, Tokyo (in Japanese: Teikoku Unkou O Sasaeru Gijutsu).
- UNCTAD, 2020. Science and innovation funds key to COVID-19 responses and beyond. Available at: <https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2368>. (Accessed 4 July 2020).
- UNESCAP, 2020. The impact and policy responses for COVID-19 in Asia and the Pacific. Available at: https://www.unescap.org/sites/default/files/COVID%20Report_ESCAP.pdf. (Accessed 23 August 2020).
- Usami, J., Fukunaga, S., Hara, H., Nishimura, K., Hyuga, M., 2020. COVID-19: Japanese government financial assistance measures. Available at: <https://www.whitecase.com/publications/alert/covid-19-japanese-government-financial-assistance-measures>. (Accessed 27 August 2020).
- Usui, N., 1996. Policy adjustments to the oil boom and their evaluation: the Dutch disease in Indonesia. *World Dev.* 24 (5), 887–900.
- Vale, P.F., Jardine, M.D., 2017. Infection avoidance behavior: viral exposure reduces the motivation to forage in female *Drosophila melanogaster*. *Fly* 11 (1), 3–9.
- Van Panhuis, W.G., Paul, P., Emerson, C., Grefenstette, J., Wilder, R., Herbst, A.J., Heymann, D., Burke, D.S., 2014. A systematic review of barriers to data sharing in public health. *BMC Publ. Health* 14. Article No. 1144.
- Varghese, V., Jana, A., 2019. Interrelationships between ICT, social disadvantage, and activity participation behaviour: a case of Mumbai, India, 125. *Transportation Research Part A*, pp. 248–267.
- Von Bertalanffy, L., Hofkirchner, W., Rousseau, D., 1995. *General System Theory: Foundations, Development, Applications*, Revised Edition. George Braziller, New York.
- Wang, H., Kwan, M.-P., Hu, M., 2020. Social exclusion and accessibility among low- and non-low-income groups: a case study of Nanjing, China. *Cities* 101. Article No. 102684.
- Weinberger, C.W., 1975. Role of federal-government in educating public about health'. *J. Med. Educ.* 50 (2), 138–142.
- Welch, C., 2020. Contact tracing for COVID-19 will be the most complex health investigation ever. Available at: <https://www.nationalgeographic.com/science/2020/05/coronavirus-contact-tracing-covid-19-complex-health-investigation/>. (Accessed 4 July 2020).
- WHO, 2018. WHO Guidance for Contingency Planning. World Health Organization, Geneva, Switzerland. Available at: <https://apps.who.int/iris/bitstream/handle/10665/260554/WHO-WHE-CPI-2018.13-eng.pdf?ua=1>. (Accessed 27 August 2020).
- Wong, Y.Z., 2020. COVID-19 risk on public transport: what we can learn from overseas. Available at: <https://www.sydney.edu.au/news-opinion/news/2020/03/20/covid-19-risk-on-public-transport-what-we-can-learn-from-overseas.html>. (Accessed 4 July 2020).
- World Economic Forum, 2020. Coronavirus has shown us why we urgently need to make a basic income a reality. Available at: <https://www.weforum.org/agenda/2020/04/coronavirus-made-basic-income-vital/>. (Accessed 27 August 2020).
- Zhang, J., 2018. Social capacity building for environmental management related to transport sector: a broader perspective'. In: Zhang, J., Feng, C.-M. (Eds.), *Routledge Handbook of Transport in Asia*. Routledge, New York, pp. 446–494.
- Zhang, J., 2020. How did people respond to the COVID-19 pandemic during its early stage? A case study in Japan. Available at SSRN: <https://ssrn.com/abstract=3595063>.
- Zhang, J., Hayashi, Y., Lawrence, D.F., 2020. COVID-19 and transport: findings from a world-wide expert survey. *Transport policy* (under review).
- Zhu, Q., 2013. Master plan, plan adjustment and urban development reality under China's market transition: a case study of Nanjing. *Cities* 30, 77–88.
- Vogels, E.A. (2020) From virtual parties to ordering food, how Americans are using the internet during COVID-19. Available at: <https://www.pewresearch.org/fact-tank/2020/04/30/from-virtual-parties-to-ordering-food-how-americans-are-using-the-internet-during-covid-19/> (Accessed: July 4, 2020)".