Optimization of multimodal transportation approaches and related changes in external costs: new scenarios deriving from SARS-Cov-2 pandemic and possible effects within Adrigreen project for ports and airports

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Summary

In the short-term, behavioural changes produced modal shifts and variations in the total amount of passengers. These changes may be useful for understanding the potential impact of mid- and long-term structural shifts. For example, physical distancing is considered fundamental to minimize contagion risk. However, this solution comes with reduced capacity of public transport.

The aim of the present research is to analyse the variations in the volume of passenger traffic of Adrigreen ports and airports deriving from the measures adopted for minimizing contagion risk.

To understand the impact of the Coronavirus disease-2019 (COVID-19) pandemic on the airport and port authorities, the Adrigreen partners were invited to take part to a survey about the measures in place before, during, and after Covid. Moreover, we collected data about passenger traffic and related information.

An online survey was distributed at the terminal buildings of the Adrigreen airports and ports for grasping any changes in the travellers' habits related to transportation.

As a case study, the variation in monthly external costs was evaluated for the passengers going to/from two Adrigreen airports.

Introduction

The outbreak of the Coronavirus Disease-2019 (COVID-19) pandemic has posed a serious health risk to the population around the world with a dramatic impact on daily life.

For the containment of COVID-19 pandemic, several governments have adopted control measures such as quarantine, social distancing, travel restrictions, and contact precautions.

According to De Vos (2020), the potential implications of social distancing on daily travel patterns could be a decrease in the demand for travel in general and in particular for public transport services. Sapolski (2020), has pointed out the underlying mechanism during prolonged stress like a pandemic outbreak, with glucocorticoids (i.e., a class of stress hormones) unbalancing the interactions between the pre-frontal cortex (i.e., the most rational decision-making part of the cortex) and amygdala (i.e., the most emotional part of the limbic system, a region central to fear, anxiety and aggression), with the amygdala becoming more active, dominating the pre-frontal cortex and its decision-making process. For example, overcrowding is subject to perception depending on psychological and environmental factors, rather than people density. Investigating the relationship between COVID-19 perception, travel risk perception, and behaviour among travellers, Neuburger and Egger (2020) have observed higher travel risk perception for females, older people, and the ones with lower travel frequency. Tarasi et al. (2021) have observed differences between the factors affecting travel mode choice for men and women, with women considering more important personal safety, road safety, and ecological footprint than men.

Das et al. (2021) have performed a survey regarding the best measures for shifting back travellers to post pandemic levels of public transport with the rank as follows: (i) reduce stoppage at crowded areas, (ii) cashless fare transactions, (iii) seating arrangement with proper social distancing measures, (iv) provision of personal protective equipment kits, (v) real-time information on seat availability, (vi) limited passengers' allowance, and (vii) regular disinfection of buses at end-to-end stoppage.

On the contrary, a mindfulness attitude to moment-by-moment experiences may be the key for coping with stressful situation in everyday activities (Kabat-Zinn 1994) or extraordinary situations such as travelling for tourism (Stankov et al. 2020).

For the Member States of the European Union, van Essen et al. (2019) have evaluated the external costs (i.e., the difference between social and private costs) of transport including accidents, congestion, noise, and several environment-related categories (e.g., air pollution, climate change, habitat damage, and well-to-tank emissions).

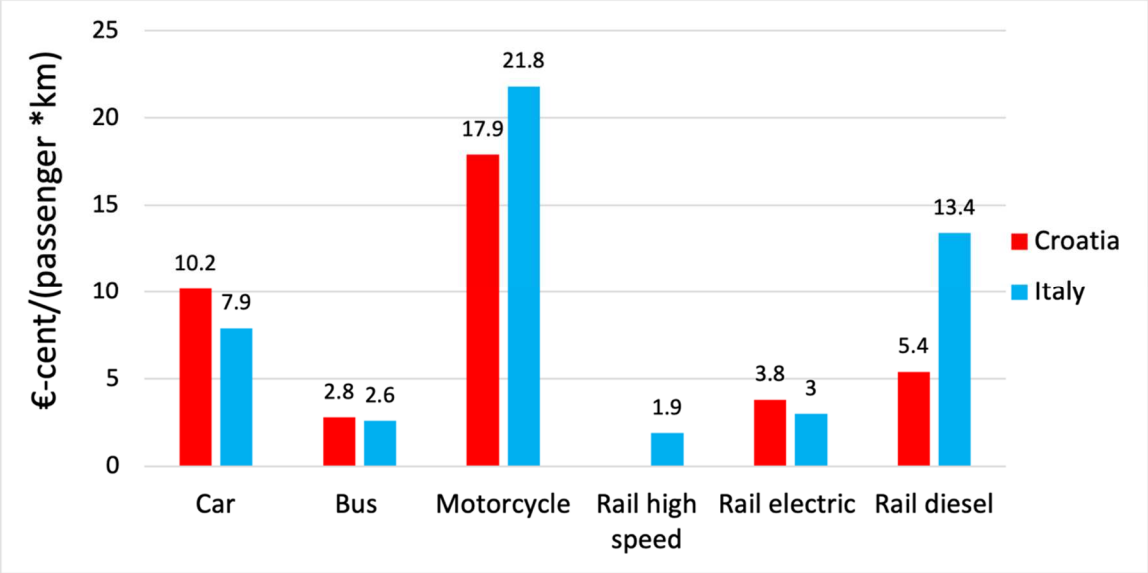


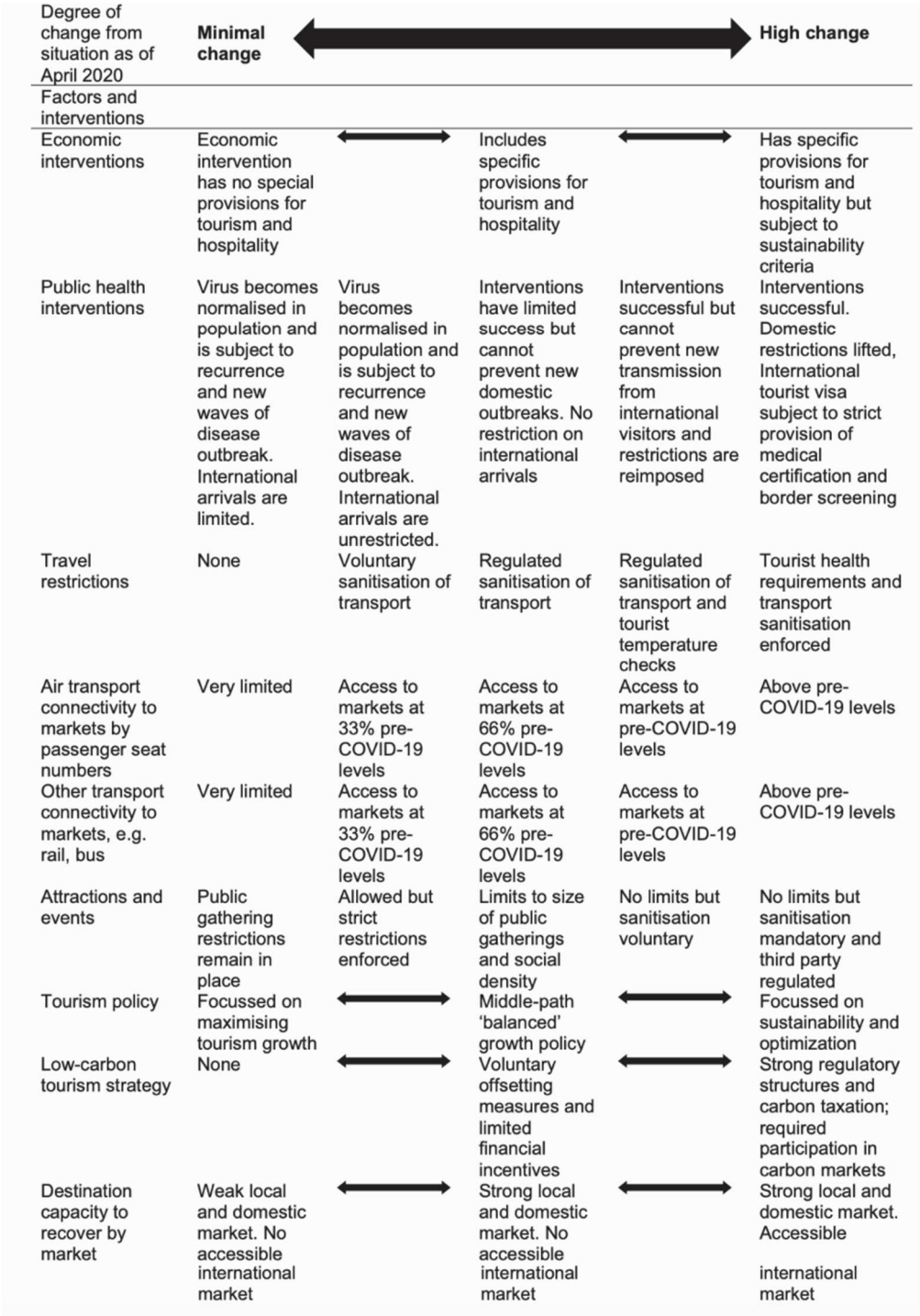
Figure 1. Average external costs (excluding congestion) of passenger transport by transport mode in Croatia and Italy in 2016. Own elaboration based on data from van Essen et al. (2019). Croatia has no value for rail high speed mode because van Essen et al. (2019) considered rail high speed only for the countries with high rail speed infrastructures and not for the countries with only high-speed services.

Figure 1 shows the average external costs (excluding congestion) of passenger transport by mode of transport in Croatia and Italy in 2016. According to van Essen et al. (2019), Croatia and Italy show a similar rank of the average external costs excluding congestion of the different modes of passenger transport, except for car and rail diesel with car/rail diesel having higher costs than rail diesel/car in Croatia/Italy (van Essen et al. 2019).

Cicala et al. (2020) have evaluated the health implications of the variations in air pollution resulting from variations in vehicle travels and electricity consumption relative to stay-at-home policies and other social distancing measures in the United States of America. According to these authors, a month of social distancing could lead to a decrease of about 25% of the baseline 1500 deaths attributable to the exposure to airborne pollutant emissions from vehicles and electricity production.

Hall et al. (2020) have analysed the potential driving factors and interventions that could affect tourism change and recovery in COVID-19 time (Figure 2).

Great attention has been paid to the effects of the Coronavirus pandemic on travellers' attitudes and behaviour to help mobility managers to reshape the offer in the mobility sector and meet new mobility patterns.



Degree of change from situation as of April 2020	**Minimal change**	⟷		⟷	**High change**
Factors and interventions					
Economic interventions	Economic intervention has no special provisions for tourism and hospitality	⟷	Includes specific provisions for tourism and hospitality	⟷	Has specific provisions for tourism and hospitality but subject to sustainability criteria
Public health interventions	Virus becomes normalised in population and is subject to recurrence and new waves of disease outbreak. International arrivals are limited.	Virus becomes normalised in population and is subject to recurrence and new waves of disease outbreak. International arrivals are unrestricted.	Interventions have limited success but cannot prevent new domestic outbreaks. No restriction on international arrivals	Interventions successful but cannot prevent new transmission from international visitors and restrictions are reimposed	Interventions successful. Domestic restrictions lifted, International tourist visa subject to strict provision of medical certification and border screening
Travel restrictions	None	Voluntary sanitisation of transport	Regulated sanitisation of transport	Regulated sanitisation of transport and tourist temperature checks	Tourist health requirements and transport sanitisation enforced
Air transport connectivity to markets by passenger seat numbers	Very limited	Access to markets at 33% pre-COVID-19 levels	Access to markets at 66% pre-COVID-19 levels	Access to markets at pre-COVID-19 levels	Above pre-COVID-19 levels
Other transport connectivity to markets, e.g. rail, bus	Very limited	Access to markets at 33% pre-COVID-19 levels	Access to markets at 66% pre-COVID-19 levels	Access to markets at pre-COVID-19 levels	Above pre-COVID-19 levels
Attractions and events	Public gathering restrictions remain in place	Allowed but strict restrictions enforced	Limits to size of public gatherings and social density	No limits but sanitisation voluntary	No limits but sanitisation mandatory and third party regulated
Tourism policy	Focussed on maximising tourism growth	⟷	Middle-path 'balanced' growth policy	⟷	Focussed on sustainability and optimization
Low-carbon tourism strategy	None	⟷	Voluntary offsetting measures and limited financial incentives	⟷	Strong regulatory structures and carbon taxation; required participation in carbon markets
Destination capacity to recover by market	Weak local and domestic market. No accessible international market	⟷	Strong local and domestic market. No accessible international market	⟷	Strong local and domestic market. Accessible international market

Figure 2. Driving factors and interventions that could affect tourism change and recovery in COVID-19 time. (Hall et al. 2020).

Main findings reported in a study by Lozzi et al. (2020) regarding public transport services in European urban areas during and immediately after the lockdown were (i) the use of public transport and shared mobility services decreased dramatically, while citizens prefer(red) private vehicles such as cars and bicycles, but also walking and (ii) the risk of contagion likely discouraged the use of shared mobility services.

A preference for private cars compared to public transport emerged in a survey performed following the 2020 lockdown in Germany (German Aerospace Center 2020), the United States of America (CNN 2021), and India (Das et al. 2021). Comparing modal choice between pre-covid (2019) and covid situation (2021), Šinko et al. (2021) have observed that a large percentage of areas in Vienna (Austria) shifted from public transport to automobiles (about 44%) or bicycles (about 12%).

In Italy, the travel restrictions during the lockdown produced different modal shift from public transport depending on the geographical location (Figure 3). For example, the impact of Covid measures produced an increase in the share of private mobility at the expenses of public mobility and shared transport in Northwest Italy (Figure 3 a, b), whereas Northeast Italy showed a decrease in public transport and shared mobility with an increase in active mobility (Figure 3 c, d). In Central Italy, the decrease in the share of public transport produced a similar increase in private and active mobility (Figure 3 e, f). In line with the findings reported by Isfort (2020), Brinchi et al. (2020) have observed a more rapid reboot of trips by car compared to public transport in Rome (Central Italy). In South Italy and islands region, the share in active mobility increased at the expenses of private, public or shared mobility (Figure 3 h, g).

In the EU, transport demand likely decreases in the number of trips, average trip distance, and the use of public transport in the short-term following Covid crisis, whereas the evolution of the mobility patterns depends not only on the demand but also on the supply side in the medium term (Christidis et al. 2021).

Efficient public transportation systems aim at discouraging the use of private cars providing travellers with fast, environmental-friendly and cost-effective transport solutions. However, the need for physical distancing challenges the very concept of mass public transportation in urban area (Tirachini 2020). To overcome the impact of COVID-19 on urban mobility and to reduce the use of private and polluting vehicles, Lozzi et al. (2020) suggested to encourage soft mobility, i.e., any human powered (non-motorised) or small e-mobility modes (e.g., e-bike, e-scooter etc.). During peak hours, public transport managers could consider diverting the demand for public transport service to other collective, shared, and sustainable mobility services such as bike sharing (Peters et al. 2020).

Soft mobility and micro-mobility solutions may be suitable for ports, that are generally part of the urban conurbation and not far from the nearby city centre. On the contrary, it is unlikely that the passengers of airports may choose these mobility solutions to commute to the nearby city or multimodal node.

Moreover, public transportation services require a joint effort of port/airport management and local stakeholders on the supply side as well as a more positive attitude towards public transport on the demand side.

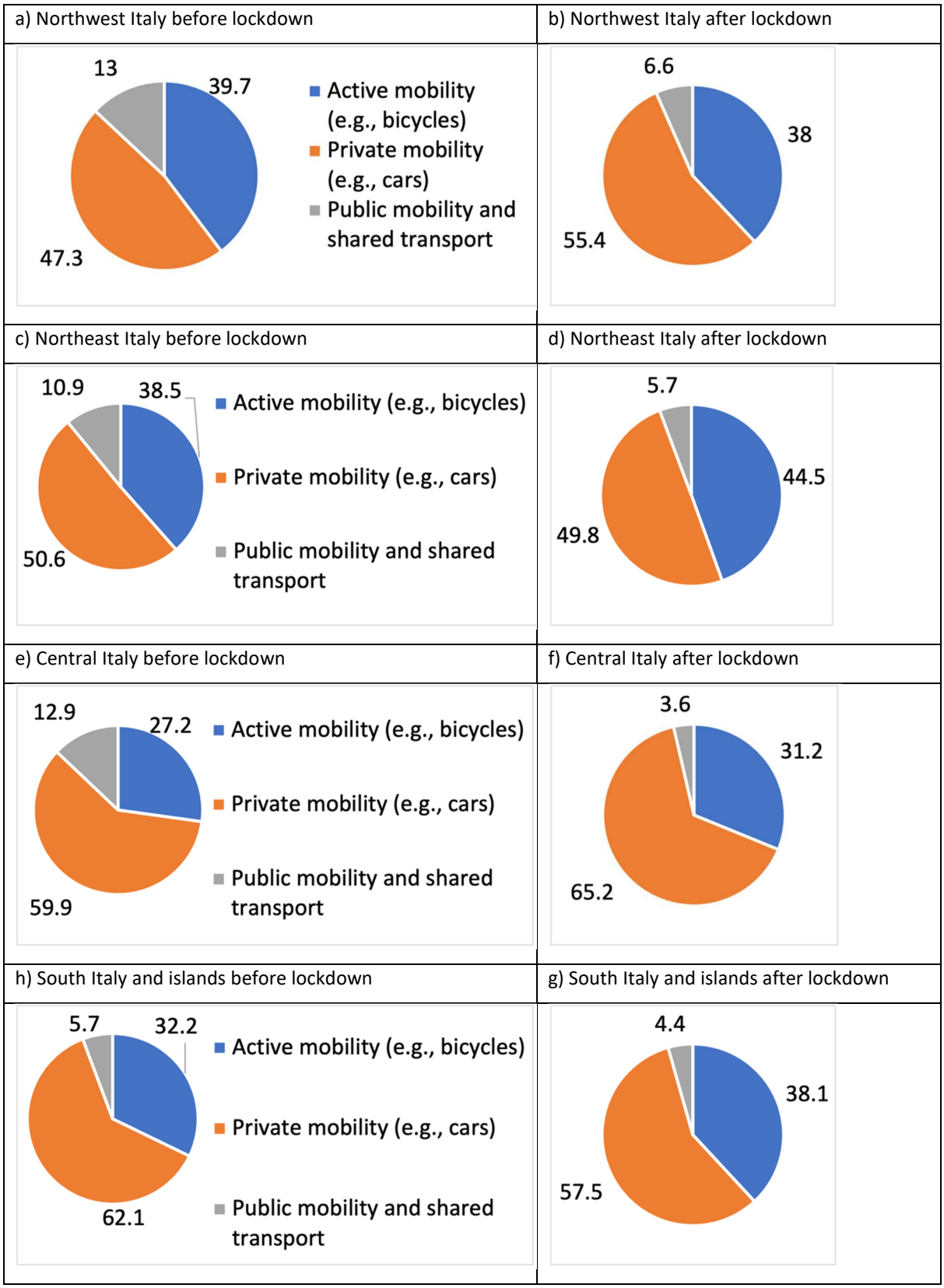


Figure 3. Mobility share before lockdown (i.e., from 1 February to 11 March 2020) and the first 30 days after lockdown (i.e., from 12 March to 10 April 2020) in different regions of Italy, namely (a, b) Northwest Italy, (c, d) Northeast Italy, (e, f) Central Italy, and (h, g) South Italy and islands. Own elaboration based on data reported by Isfort (2020).

For example, according to a survey reported in the ''European Aviation Environmental Report 2019'' (EEA 2019), almost all the airports (namely 98%) were served by public transportation systems. However, less than a half of airports' employees and travellers reported to use public transport to reach the airport infrastructure (EEA 2019).

The general tendence is to not attribute to the airport/port infrastructures the GHG emissions deriving from the travellers going/from to airport/port. For example, the greenhouse gases emissions related to surface access to the airport infrastructures are on-site emissions deriving from non-airport-operator owned sources (Airports Council International 2018). For ports, the emissions deriving from the modes of transportation utilized by the employees are considered indirect sources under Scope 3 (Azarkamand et al. 2020).

Table 1. Resume of the scenarios describing the potential consequences on capacity and aims of public transport serving ports and airports in pre- transitioning to, and post- COVID crisis times.

Scenarios	Description	Aim of the public transport service	Consequences for the supply side
Thumbs up! Travel rebound to pre pandemic time	Reversal of the pandemic, testing facilities and COVID-19 vaccines available to anybody. Improvement in travellers' confidence: no feeling for health insecurity. No travel restrictions	To increase the number of passenger of ports/airports who come to/leave the infrastructure by means other than a single occupant vehicle.	Occupation rate of public transport back to pre-COVID time. Capacity of public transport companies up to **80–100 %**.
Ups and downs Uneven pace of recovery with a bumpy trend of travel demand	Covid-free islands versus travel restrictions between countries or restricted to areas affected by outbreaks. Travellers' confidence is recovering but still with some feeling for health insecurity	To provide transport service while minimizing contagion risk (e.g., Gkiotsalitis and Cats 2020).	Need for bolstering travellers' confidence assuring people distance and setting maximum capacity. Up to **25 %** reduction in vehicle capacity of public transport companies (Lozzi et al. 2020).
Thumbs down Demand disruption and uncertain recovery ask for major changes to the tourist and travel sectors	Outbreaks impose closure of most borders between EU and non-EU countries. Drop in travellers' confidence, with feeling for health insecurity.	To provide transport service while minimizing contagion risk (e.g., Gkiotsalitis and Cats 2020). Optimal service frequency with serious risks for balancing operational costs with passenger costs.	Lower demand for travelling. People distance must be assured. Maximum capacity is needed. Up to **50 %** reduction in vehicle capacity of public transport companies (Lozzi et al. 2020).

Own elaboration based on scenarios depicted by Marques Santos et al. (2020); UNWTO (2020), Eurocontrol (2020).

Table 1 shows three different scenarios analysing the potential impact of variations in capacity and occupation rate of public transport serving ports and airports.

Although the ports and airports within Adrigreen Project offer mostly passenger services, also freight services will be deeply influenced by COVID-19 pandemic and related drawbacks. The new trend in online selling will dramatically reduce wholesale world and magazines while “producer to consumer” approach and single producer to consumer distribution channels will become the standard. This will make local small airports potentially active as hubs for distribution of goods.

Results

Variation in the airports' monthly volume of passenger traffic

From March 2020 to August 2021, the monthly volume of passenger traffic had been far below the pre-pandemic levels (from January 2019 to January 2020) both in Croatian and Italian airports (Figure 4). Both Croatian and Italian airports showed a seasonal trend with higher volumes of passenger traffic in the summer season of 2020 and 2021.

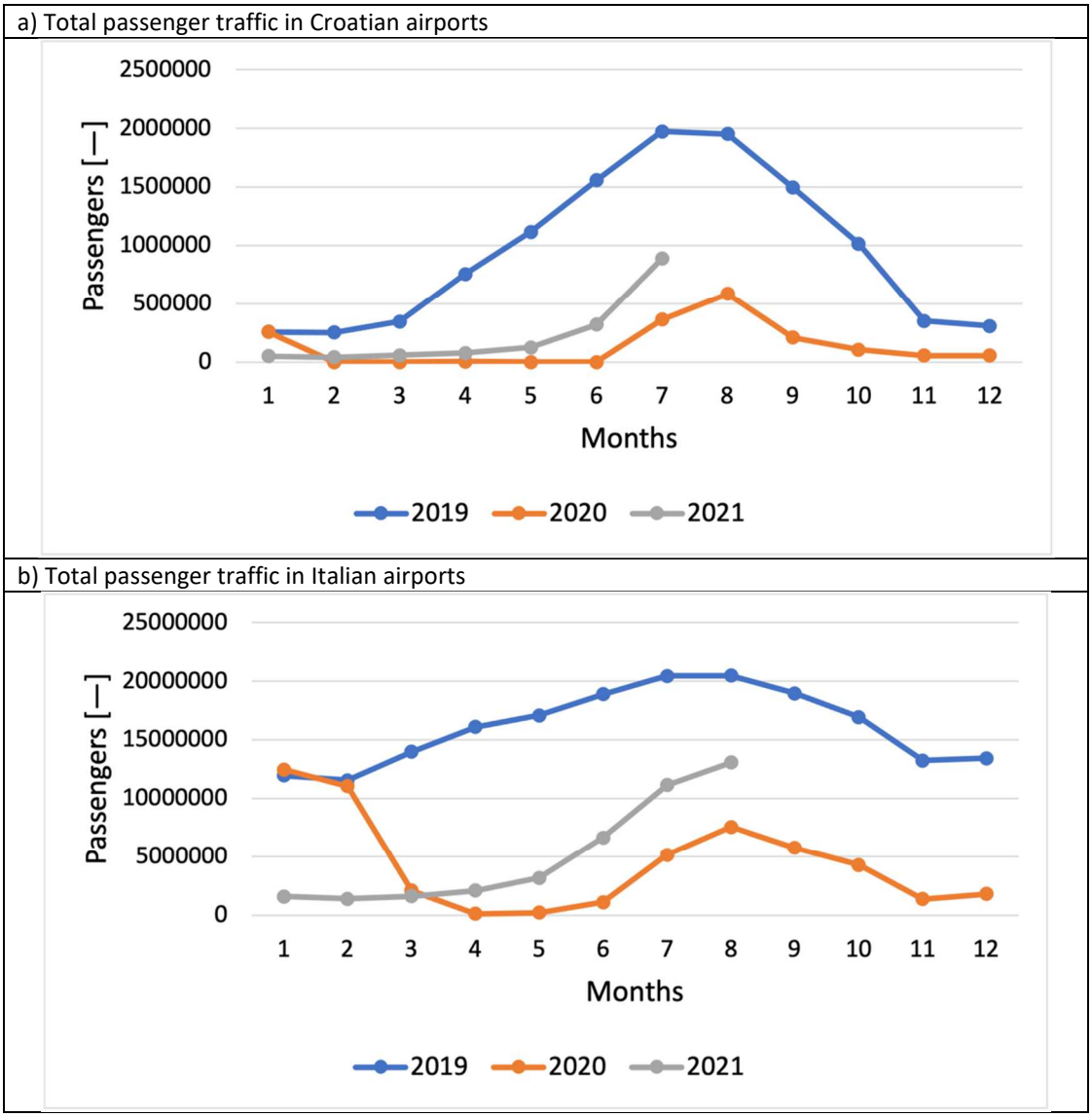


Figure 4. Monthly volume of passenger traffic in (a) Croatian and (b) Italian airports from January 2019 to August 2021. Own elaboration based on data from Assaeroporti (2021), and Croatian Bureau of Statistics (2021).

Figure 5 shows the monthly volume of passenger traffic at airports A1, A2, A3, A4, A5, and A6. With the onset the pandemic and travel restrictions, passenger traffic decreased sharply in all the Adrigreen

airports from March to December 2020 compared to the respective months in 2019. In the first five months of 2021, passenger traffic was low in all the Adrigreen airports, with a trend similar to the last two months of 2020.

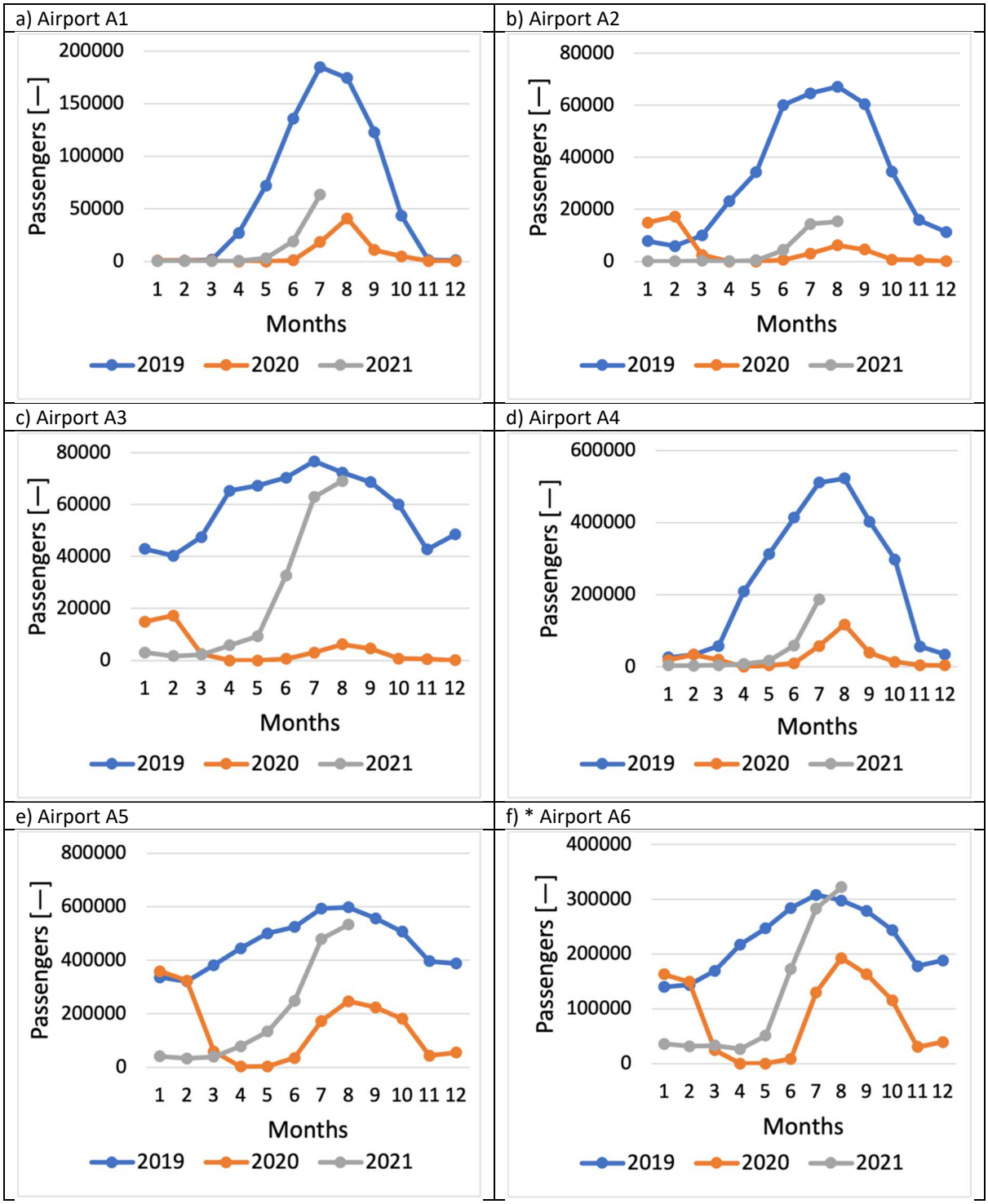


Figure 5. Monthly volume of passengers traffic in Adrigreen airports, namely airports (a) A1, (b) A2, (c) A3, (d) A4, (e) A5, and (f) A6 from January 2019 to August 2021. Own elaboration based on data from Assaeroporti (2021), and Croatian Bureau of Statistics (2021). Data were available till July 2021 for airports A1, and A4. *Airport A6 had been closed for about a couple of weeks between April and May 2021 because of runway maintenance.

Notably, in July and August 2021 airports A3, A5, and A6 showed volumes of passenger traffic comparable to the pre-pandemic time.

Eurocontrol monitors and analyses the impact of COVID on aviation in Europe, with country-level forecasts. These forecasts consider three scenarios, from the fastest recovery to the pre-pandemic volumes of air traffic by 2024 (Scenario 1) to the slowest pace by 2029 (Scenario 3) depending on variables such as the rate of vaccination take-up, outbreaks of new virus strains, passenger confidence, etc.

According to Eurocontrol (2021), Scenario 2 is the most likely, with the 2024 traffic in Europe expected to achieve 95 % of the 2019 level. Figure 6 shows the forecast of air passenger traffic provided by Eurocontrol for Italy between 2021 and 2024.

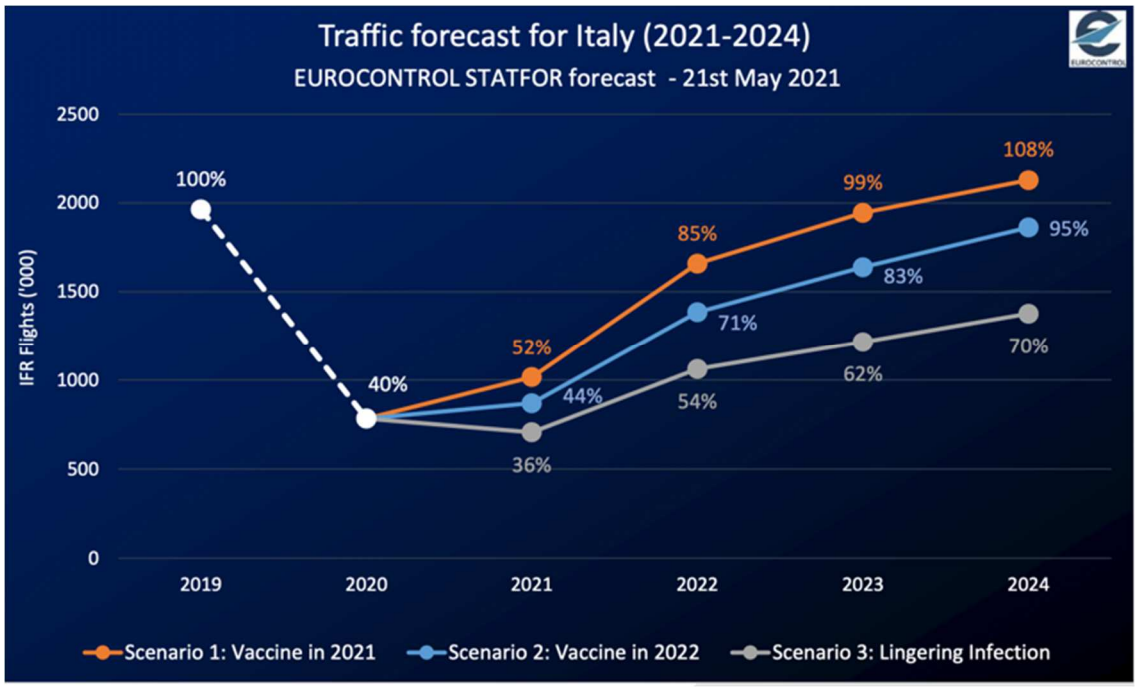
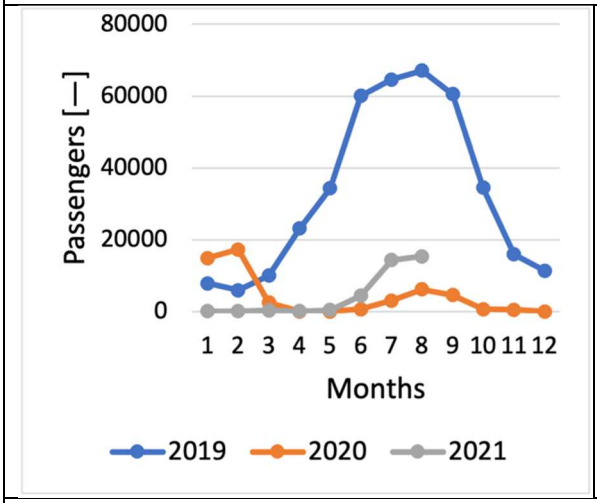


Figure 6. Forecast of air passenger traffic for Italy. (Eurocontrol 2021).

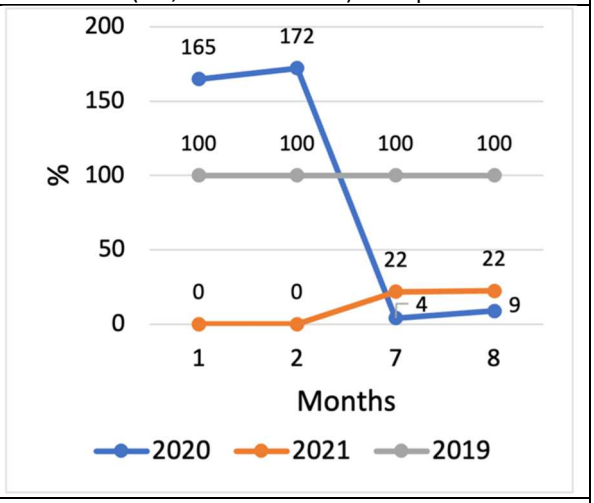
In the next years, not only factors related to containment of the pandemic (e.g., border and travel restrictions, lockdowns, and quarantine zones) but also other factors (e.g., economic situation, travellers' confidence, and risk perception) likely concur in reducing air passenger travel, and in particular international passenger transport (European Commission 2020).

Focus: airport A2

a) Monthly volume of passenger traffic at airport A2 from January 2019 to August 2021



b) Comparison in percentage of monthly volume of total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A2



c) Comparison in percentage of monthly volume of international passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A2

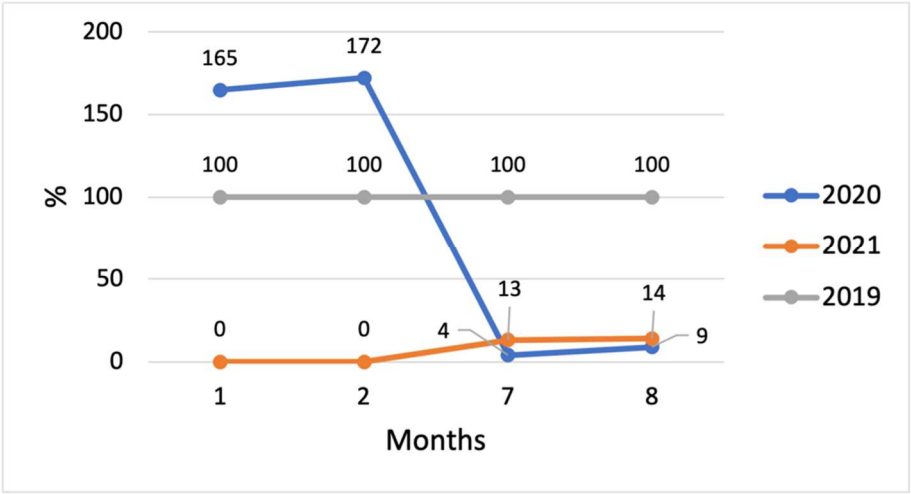


Figure 7. Monthly volume of passenger traffic at airport A2 from January 2019 to August 2021 (a), and comparisons in percentage of monthly volume of (b) total passengers, and (c) international passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August. Own elaboration based on data from Assaeroporti (2021) (panel a), and data provided by airport A2 (panels b, c).

In pandemic time, at airport A2 there was a sharp decrease in the monthly volume of passenger traffic from March 2020 to August 2021 (Figure 7 a). In 2020 and 2021, the high season months of July and August showed a slight increase in the volume of passenger traffic but still far below the volumes in pre Covid time. For example, in July and August 2021 the monthly volume of passenger traffic was up to 22 % of the volume of passenger traffic in the respective months in 2019 (Figure 7 b).

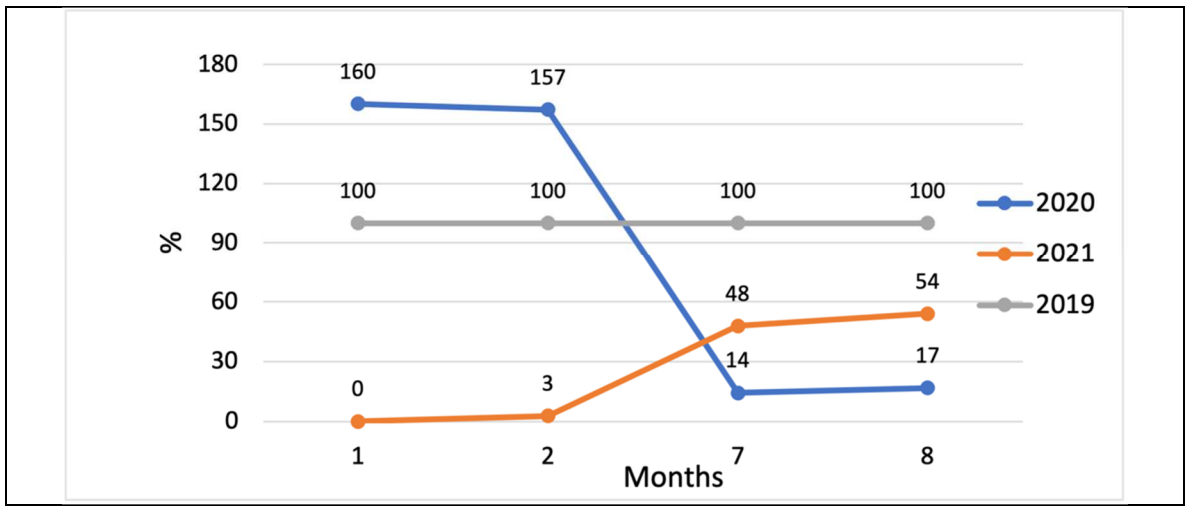


Figure 8. Comparison in percentage of revenues of parking lots between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August at airport A2. Own elaboration based on data provided by airport A2. Data about parking entrance and stays at parking lots were sparse.

At airport A2, there were no national passengers both in 2019 and 2020 for the months of January, February, July, and August (data not shown). In 2021 there were no national passengers in low season months (i.e., January, and February), whereas national passengers were about 40 and 37 % of total passenger traffic in July and August, respectively.

In pandemic time, at airport A2 there was a decrease in the revenues of parking lots both in 2020 and 2021 low season months (i.e., January, and February) and high season months (i.e., July and August) (Figure 8).

In 2020, there was a similar trend in the percentage of monthly revenues of parking lots (Figure 8) and monthly volume of international and total passengers (Figure 7 b, c). In 2021, the high season months brought up to 54 % of the revenues of parking lots in 2019 high season (Figure 8). However, in 2021 high season months the monthly volumes of international and total passengers were far below (up to 22 %) the pre pandemic time. The higher share of national passengers may have played a role in the lower losses in parking revenues observed in July and August 2021.

Data about number of stays and entrances at parking lots were not available. Therefore, it is not possible to evaluate the effect of these variables on the trend of revenues of parking lots.

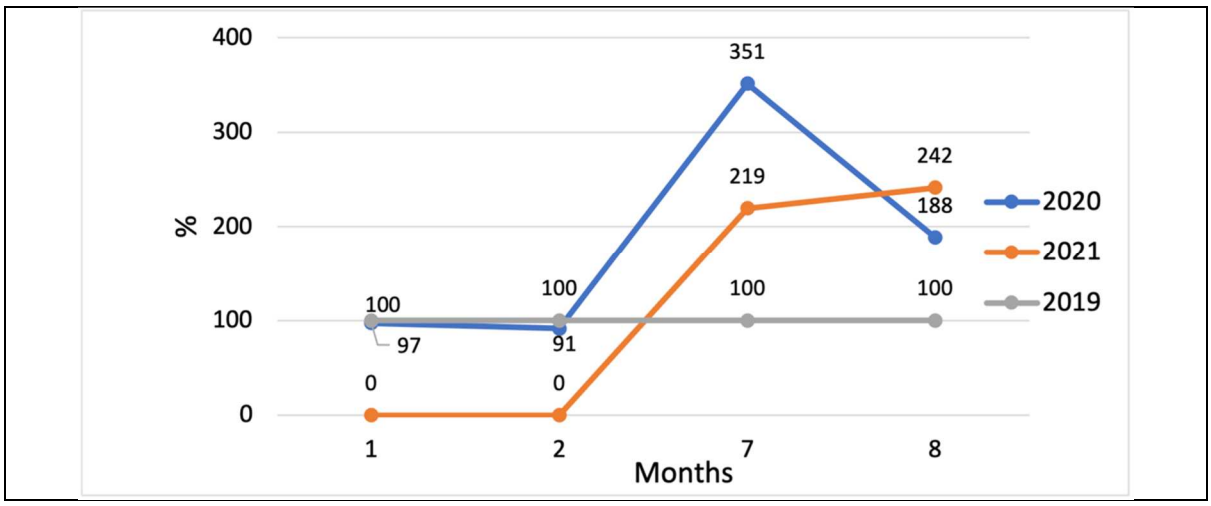


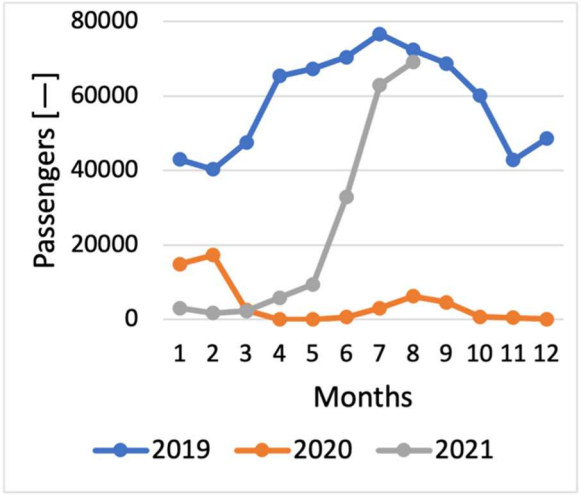
Figure 9. Comparison in percentage of revenues of parking lots per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) for the months of January, February, July, and August at airport A2. Own elaboration based on data provided by airport A2. Data about parking entrance and stays at parking lots were sparse.

To evaluate the variations in the road access to airport A2 with the volume of passenger traffic, the monthly revenues of parking lots were divided by the monthly values of total passengers. Figure 9 shows the 2020 and 2021 revenues of parking lots per total passengers expressed as a percentage of the 2019 values. The 2020 and 2021 high season months showed higher revenues of parking lots per passenger compared to pre-Covid time, with values in the range 88 – 251 % higher the respective values in pre-Covid time.

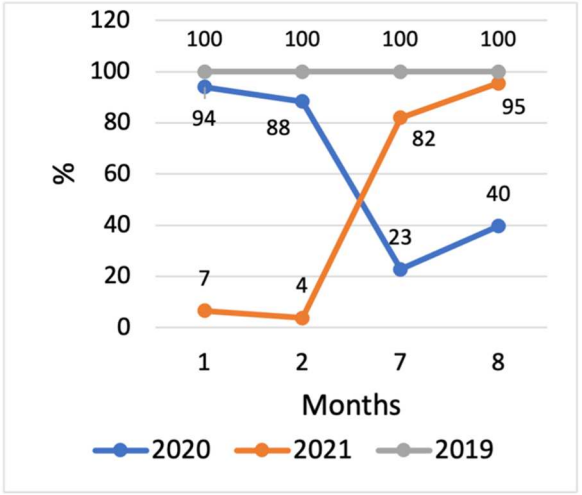
Focus: airport A3

In pandemic time, at airport A3 there was a sharp decrease in the monthly volume of total passenger traffic from March 2020 to May 2021 (Figure 10 a). In 2021, the high season months of July and August showed a sharp increase in the volume of total passenger traffic with values comparable to pre-Covid time. For example, in July and August 2021 the monthly volume of total passenger traffic was up to 95 % of the volume of passenger traffic in the respective months in 2019 (Figure 10 b).

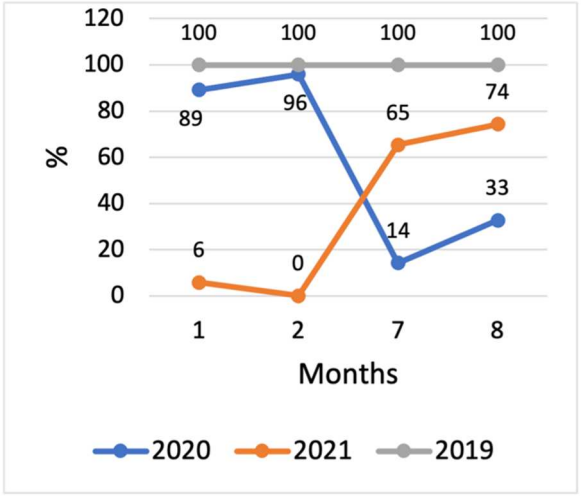
a) Monthly volume of passengers traffic at airport A3 from January 2019 to August 2021



b) Comparison in percentage of total passenger between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3



c) Comparison in percentage of international passenger between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3



d) Comparison in percentage of national passenger between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3

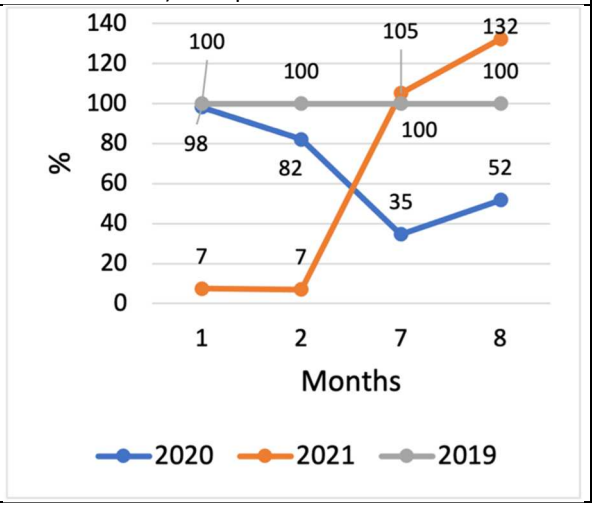
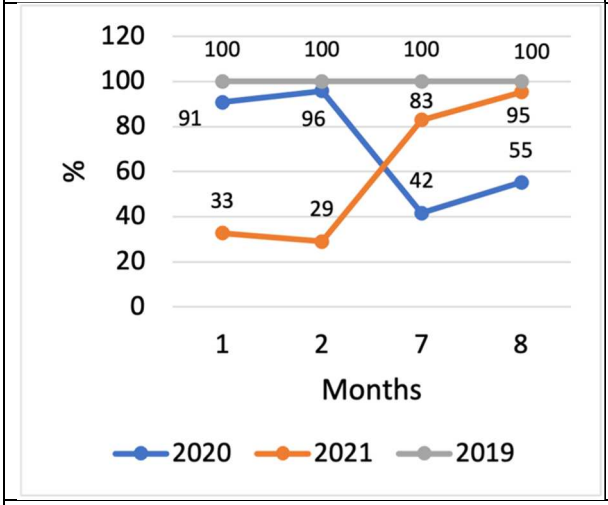


Figure 10. Monthly volume of passengers traffic at airport A3 from January 2019 to August 2021 (a), and comparisons in percentage of monthly volume of (b) total passengers, (c) international passengers, and (d) national passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August. Own elaboration based on data from Assaeroporti (2021) (panel a), and data provided by airport A3 (panels b, c, d).

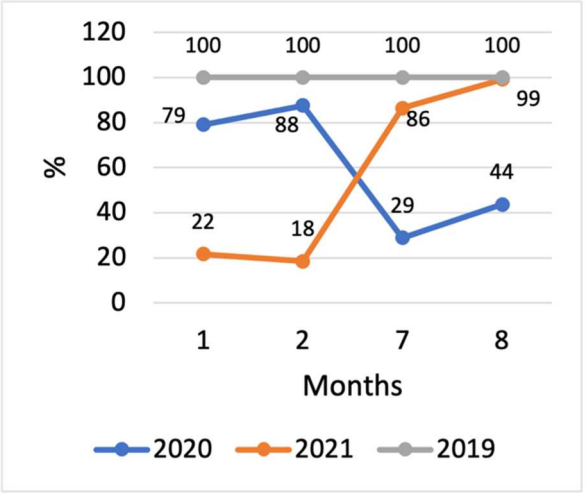
At airport A3, the 2020 low season months showed lower volumes of international (Figure 10 c) and national (Figure 10 d) passengers compared to the 2019 low season months.

In July and August 2020, international passengers were up to 33 % of the volume of international passengers in the respective months of 2019 (Figure 10 c). August 2021 recorded the lowest decrease in the monthly volume of international passengers with 74 % of the volume of passengers in August 2019 (Figure 10 c). The 2021 low season months showed about 7 % of the volume of national passenger traffic in 2019 low season months (Figure 10 d). On the contrary, the 2021 high season months recorded a sharp increase in the volume of national passenger traffic, with values between 5 and 32 % higher than the national passengers in 2019 high season months.

a) Comparison in percentage of number of parking entrances between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3



b) Comparison in percentage of number of stays at parking lots between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3



c) Comparison in percentage of revenues of parking lots between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3

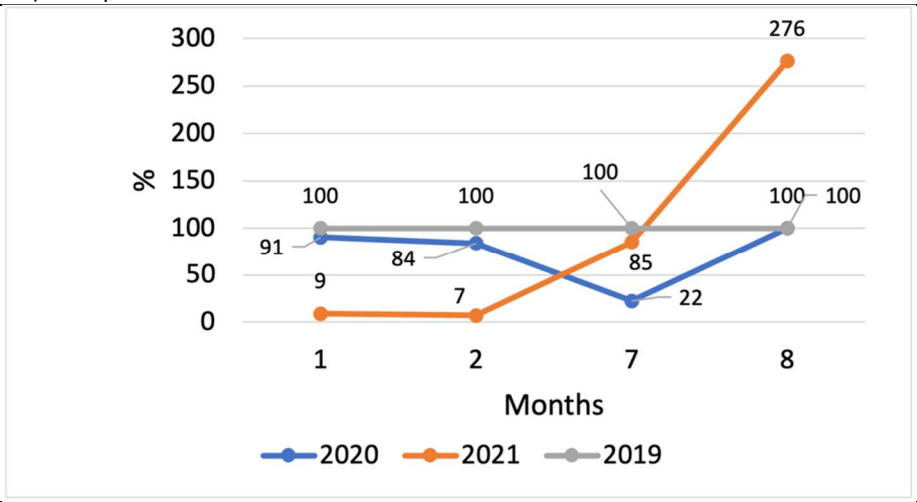
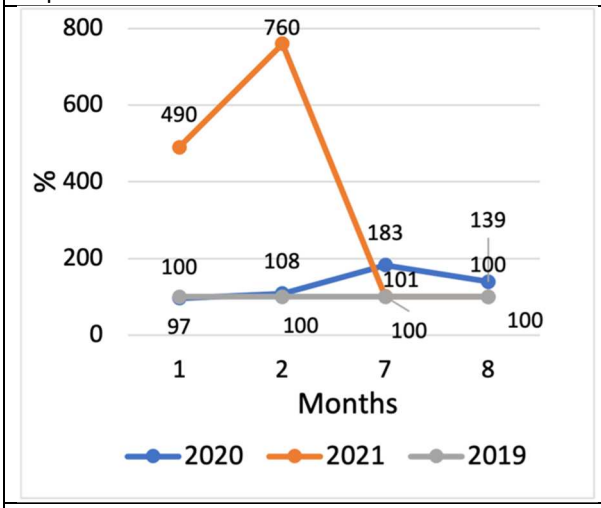
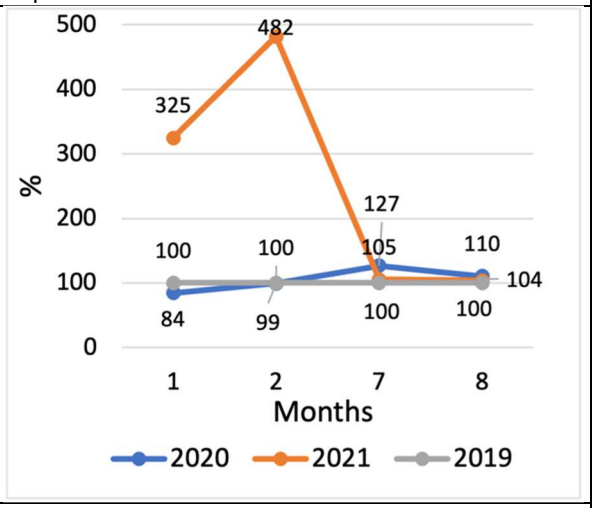


Figure 11. Comparison in percentage of (a) number of parking entrances, (b) number of stays at parking lots, and (c) revenues of parking lots between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August at airport A3. Own elaboration based on data provided by airport A3.

a) Comparison in percentage of number of parking entrances per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3



b) Comparison in percentage of number of stays at parking lots per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3



c) Comparison in percentage of revenues of parking lots per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A3

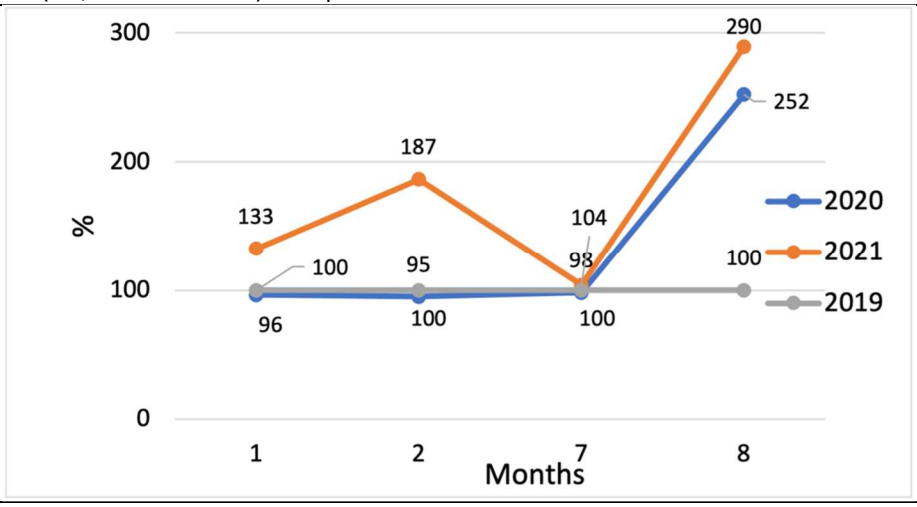


Figure 12. Comparison in percentage of (a) number of parking entrances per total passengers, (b) number of stays at parking lots per total passengers, and (c) revenues of parking lots per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August at airport A3. Own elaboration based on data provided by airport A3.

In pandemic time, at airport A3 there was a decrease in the number of parking entrances and stays at parking lots both in 2020 high season months (i.e., July and August) and 2021 low season months (i.e., January, and February) (Figure 11 a, b) compared to the respective months in pre-pandemic time.

The 2021 high season months recorded values in the number of parking entrances and stays at parking lots comparable to the pre-pandemic high season (Figure 11 a, b).

Notably, in August 2021 the revenues of parking lots were 176 % higher compared to the revenues in August 2019 (Figure 11 c).

To evaluate the variations in the road access to airport A3 with the volume of passenger traffic, the monthly number of stays at parking lots, number of parking entrances, and revenues of parking lots were divided by the monthly values of total passengers (Figure 12).

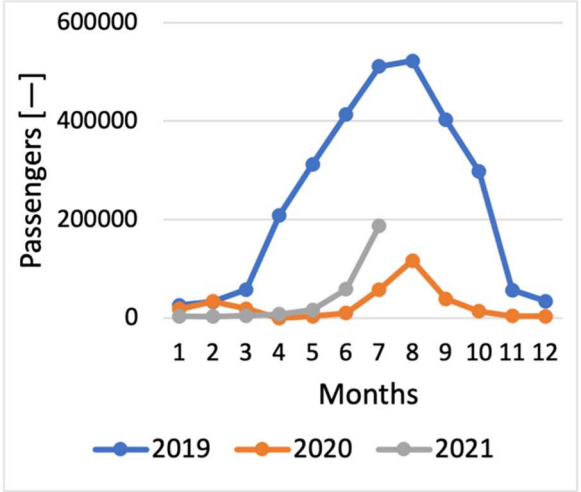
In Covid time (2020 high season months, 2021 low and high season months) there were higher values of number of stays at parking lots and number of parking entrances per total passengers compared to the respective values in pre-Covid time (Figure 12 a, b). The 2021 low season months recorded the highest values of number of stays at parking lots and number of parking entrances per total passengers compared to the pre-Covid low season months, with values in the range 225 – 660 % higher the respective values in pre-Covid time.

In Covid time (August 2020, and 2021 low and high season months) there were higher values (between 4 and 190 %) of revenues of parking lots per total passengers compared to the respective values in pre-Covid time (Figure 12 c).

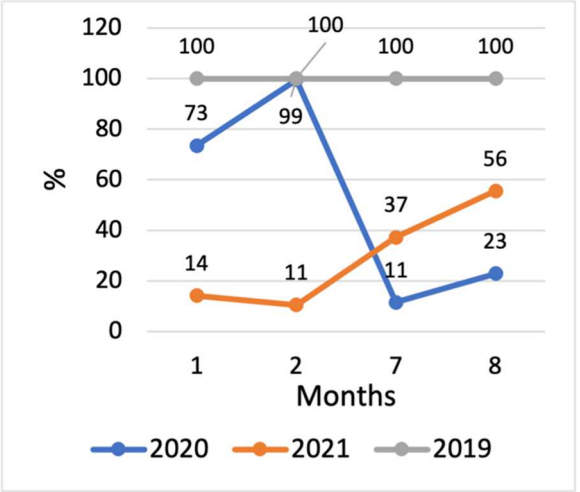
Focus: airport A4

In pandemic time, at airport A4 there was a sharp decrease in the monthly volume of total passenger traffic from March 2020 to July 2021 (Figure 13 a). In 2020 and 2021, the high season months of July and August showed a slight increase in the volume of passenger traffic but still far below the volumes in pre Covid time. For example, in August 2021 the volume of total passenger traffic was about 56 % of the total passenger traffic in August 2019 (Figure 13 b).

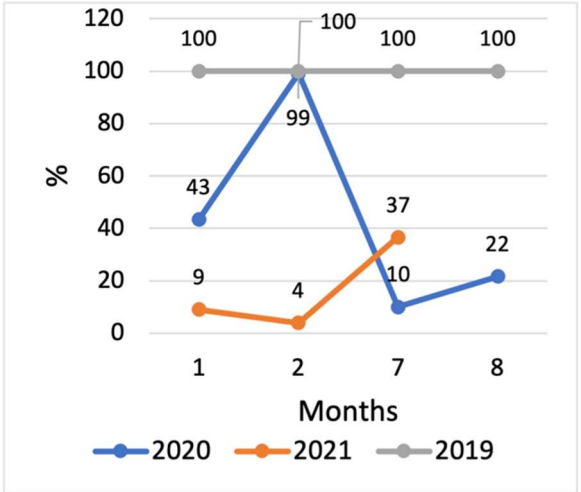
a) Monthly volume of passenger traffic at airport A4 from January 2019 to August 2021



b) Comparison in percentage of total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4



c) Comparison in percentage of international passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4



d) Comparison in percentage of national passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4

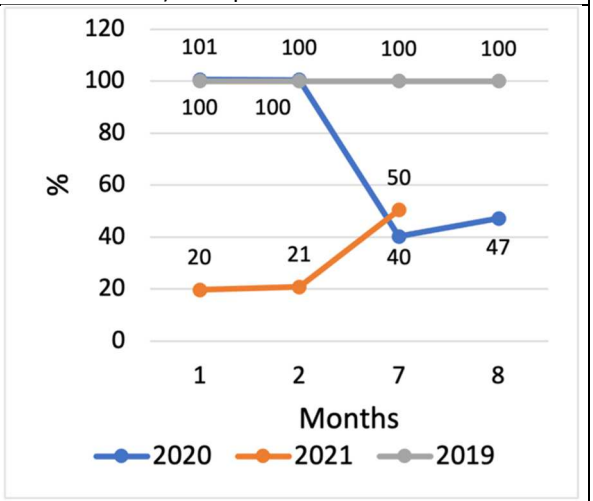
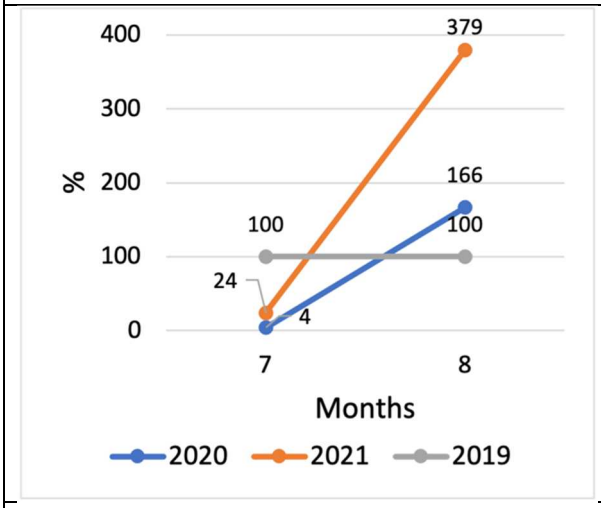
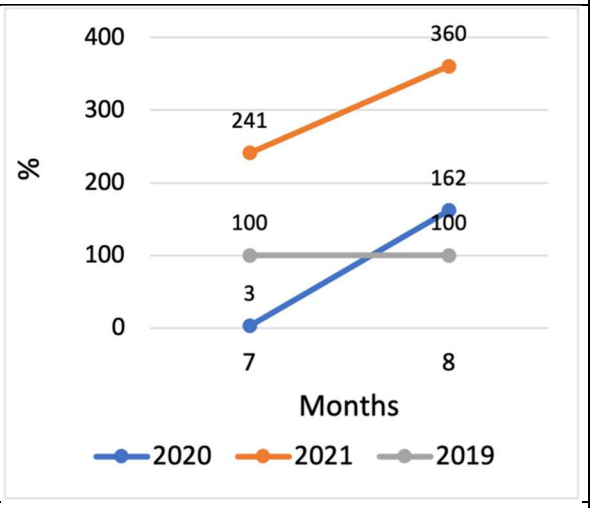


Figure 13. Monthly volume of passenger traffic at airport A4 from January 2019 to July 2021 (a), and comparisons in percentage of monthly volume of (b) total passengers, (c) international passengers, and (d) national passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August. Own elaboration based on data from Croatian Bureau of Statistics (2021) (panel a), and data provided by airport A4 (panels b, c, d).

a) Comparison in percentage of number of parking entrances between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4



b) Comparison in percentage of number of stays at parking lots between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4



c) Comparison in percentage of revenues of parking lots between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4

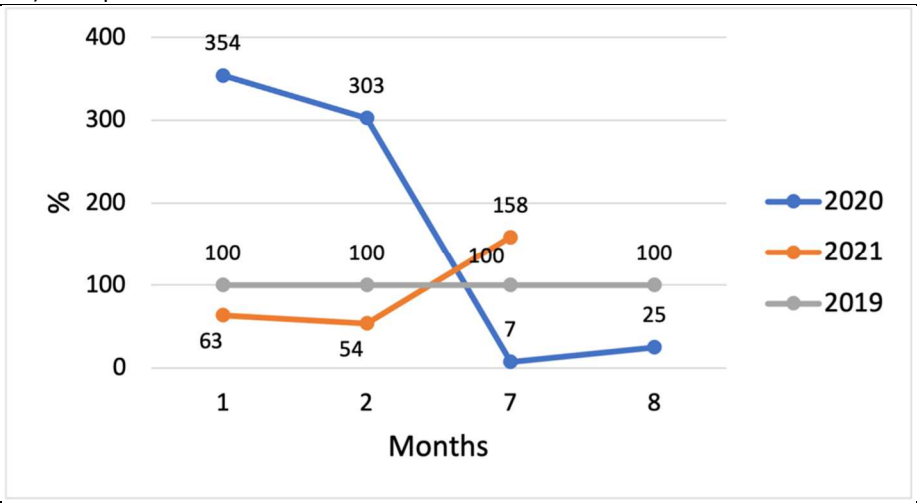
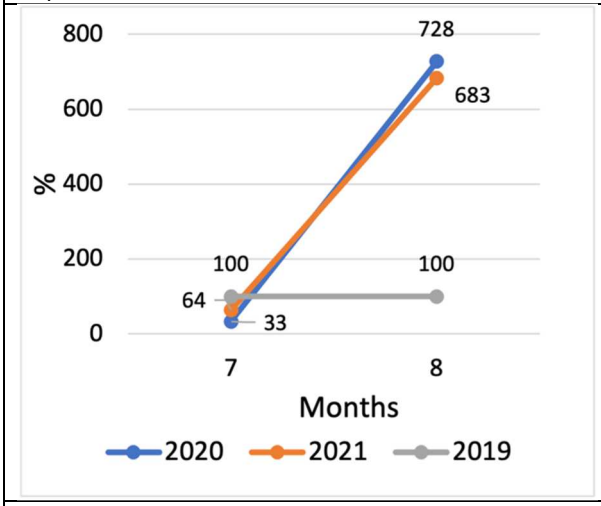


Figure 14. Comparison in percentage of (a) number of parking entrances, (b) number of stays at parking lots, and (c) revenues of parking lots between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August at airport A4. Own elaboration based on data provided by airport A4. Data not shown for the months of January and February in panels a, b.

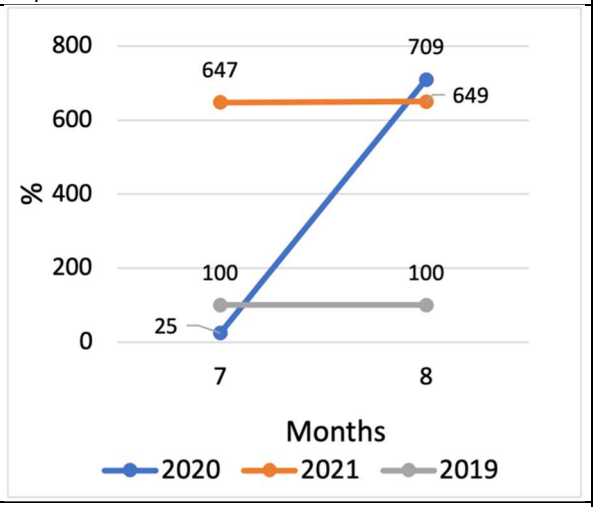
At airport A4, the 2020 low season months showed lower volumes of international passengers compared to the 2019 low season months (Figure 13 c). On the contrary, the values of national passengers in January and February 2020 were about the same of the ones in 2019 (Figure 13 d).

In July and August 2020, international passengers were up to 22 % of the volume of international passengers in the respective months of 2019 (Figure 13 c). Compared to the international passengers, the volume of national passengers showed a lower decrease with values up to 47 % of the volumes in 2019 high season months.

a) Comparison in percentage of number of parking entrances per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4



b) Comparison in percentage of number of stays at parking lots per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4



c) Comparison in percentage of revenues of parking lots per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport A4

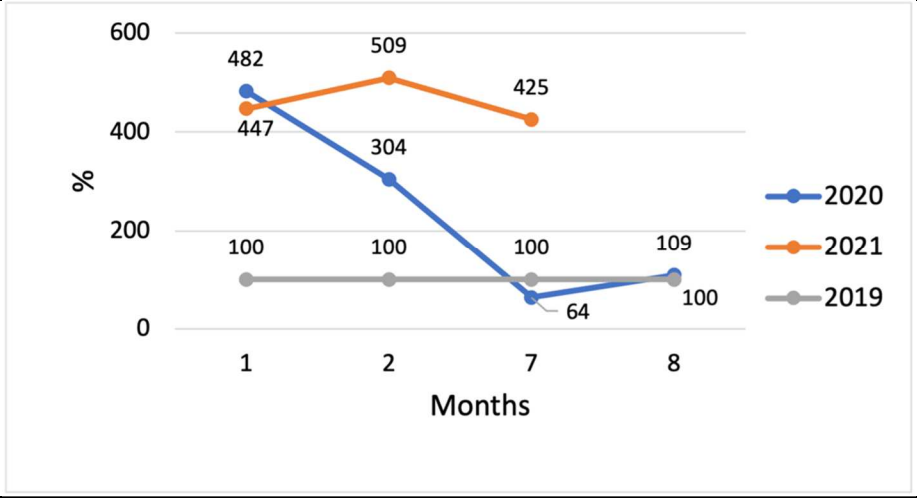


Figure 15. Comparison in percentage of (a) number of parking entrances per total passengers, (b) number of stays at parking lots per total passengers, and (c) revenues of parking lots per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August at airport A4. Own elaboration based on data provided by airport A4. Data not shown for the months of January and February in panels a, b.

In July 2021, the revenues of parking lots were about 58 % higher compared to July 2019 (Figure 14 c). This is likely due to the stays at parking lots about 141 % higher in July 2021 compared to July 2019 (Figure 14 b). Notably, in August the percentages of number of parking entrances (Figure 14 a) and stays at parking lots (Figure 14 b) were much higher (up to 279 %) in pandemic time compared to pre-pandemic time.

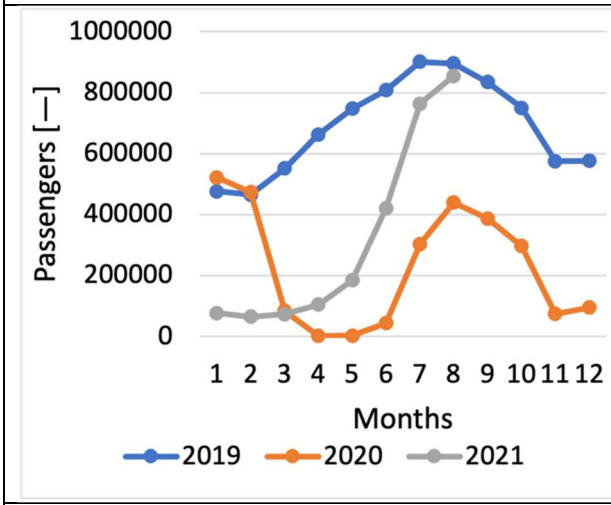
Regarding the number of parking entrances and stays at parking lots, data were not available for the 2019 low season months. Moreover, revenues of parking lots were not available for August 2021.

To evaluate the variations in the road access to airport A4 with the volume of passenger traffic, the monthly number of stays at parking lots, number of parking entrances, and revenues of parking lots were divided by the monthly values of total passengers (Figure 15).

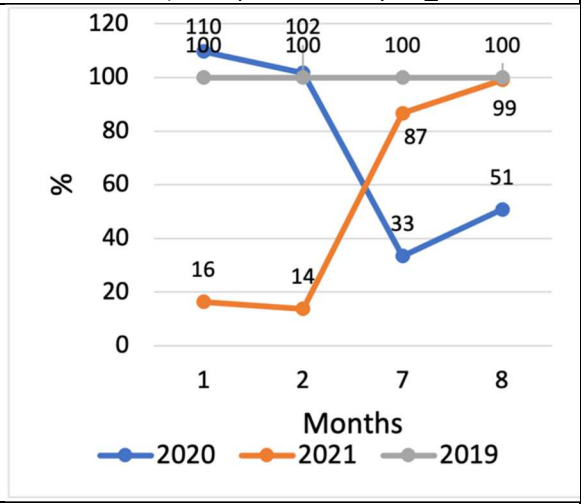
Both in August 2020 and 2021 there were higher values of number of stays at parking lots and number of parking entrances per total passengers compared to the respective values in pre-Covid time (Figure 15 a, b). In Covid time (August 2020, and 2021 low and high season months) there were higher values (between 9 and 409 %) of revenues of parking lots per total passengers compared to the respective values in pre-Covid time (Figure 15 c).

Focus: airport authority A5_A6

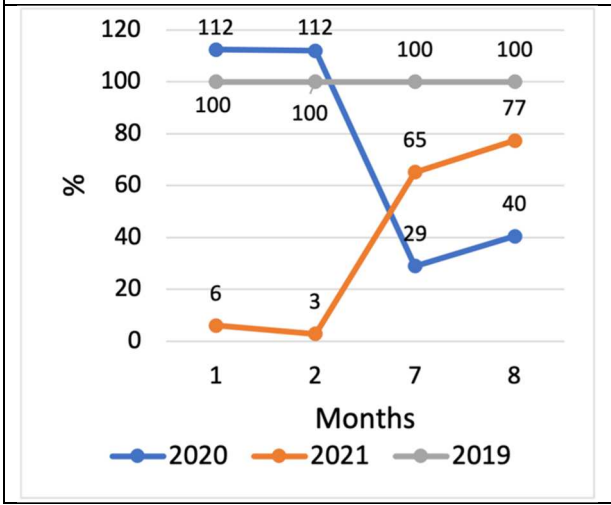
a) Monthly volume of passengers traffic at airport authority A5_A6 from January 2019 to August 2021



b) Comparison in percentage of total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport authority A5_A6



c) Comparison in percentage of international passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport authority A5_A6



d) Comparison in percentage of national passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at airport authority A5_A6

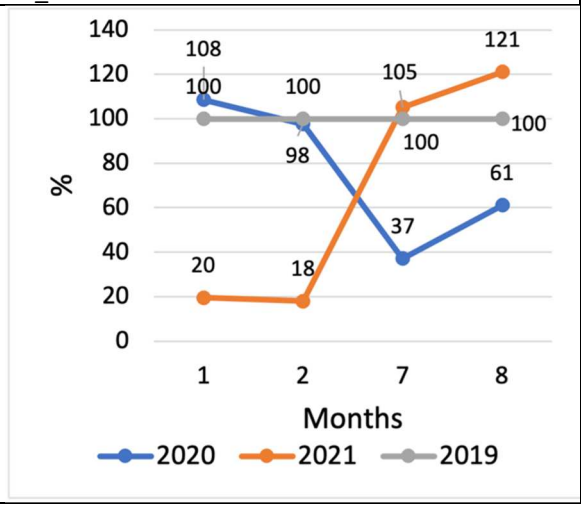


Figure 16. Monthly volume of passengers traffic at airport authority A5_A6 from January 2019 to August 2021 (a), and comparisons in percentage of monthly volume of (b) total passengers, (c) international passengers, and (d) national passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August. Own elaboration based on data from Assaeroporti (2021) (panel a), and data provided by airport authority A5_A6 (panels b, c, d).

In pandemic time, at airport authority A5_A6 there was a decrease in the monthly volume of total passenger traffic from March 2020 to May 2021 (Figure 16 a). In 2020, the high season months of July and August showed an increase in the volume of passenger traffic but still far below the volumes in pre Covid time. In 2021, the high season months of July and August showed a sharp increase in the volume of passenger traffic with values comparable to the pre-pandemic time.

For example, in August 2021 the monthly volume of passenger traffic was about 99 % of the total passenger traffic in August 2019 (Figure 16 b).

At airport authority A5_A6, the values of total (Figure 16 a), international (Figure 16 b), and national passengers (Figure 16 c) in January and February 2020 were slightly higher or about the same of the ones in 2019.

On the contrary, the 2020 high season months showed lower volumes of total, international, and national passengers compared to the 2019 low season months. In August 2020, national passengers were about 61 % of the volume of national passengers in August 2019 (Figure 16 d). Compared to the national passengers, the volume of international passengers showed a higher decrease with values between 29 and 40 % of the values in 2019 high season months.

In pandemic time, at airport authority A5_A6 there was a decrease in the number of parking entrances both in 2020 high season months (i.e., July and August) and 2021 low season months (i.e., January, and February) (Figure 17) compared to the respective months in pre-pandemic time.

The 2021 high season months recorded values in the percentages of number of parking entrances comparable to the pre-pandemic high season.

Data were not available for the revenues and number of stays at parking lots.

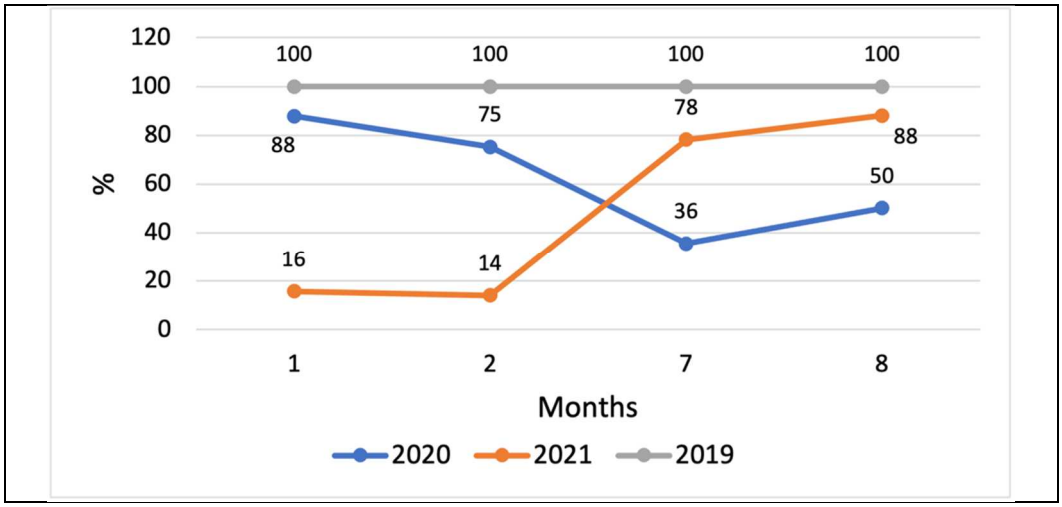


Figure 17. Comparison in percentage of number of parking entrances between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) for the months of January, February, July, and August at airport authority A5_A6. Own elaboration based on data provided by airport authority A5_A6. Data about revenues and stays at parking lots were not available.

To evaluate the variations in the road access to the airports managed by airport authority A5_6 with the volume of passenger traffic, the monthly number of parking entrances were divided by the monthly values of total passengers (Figure 18).

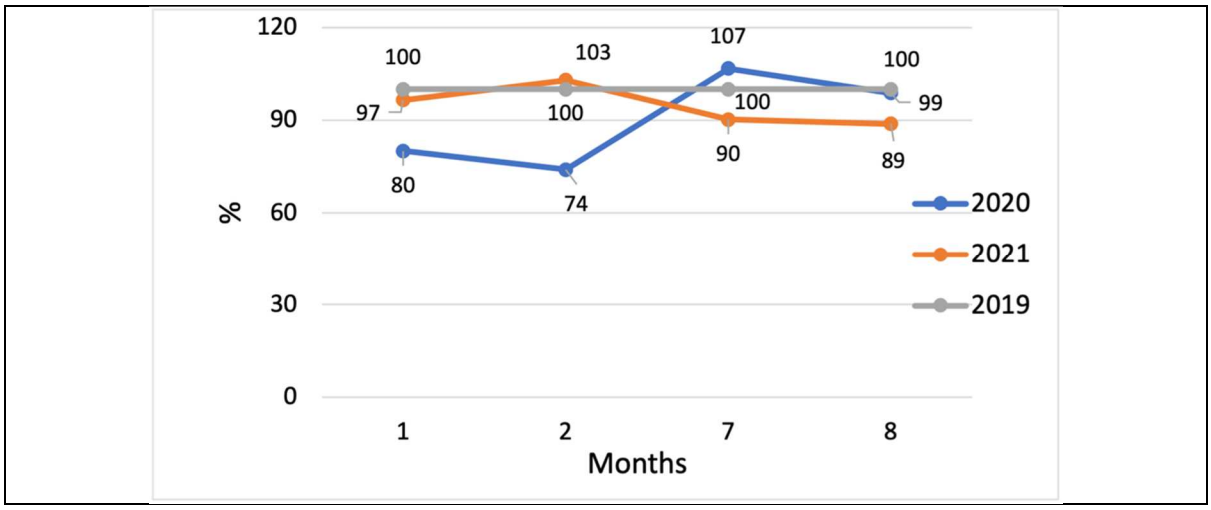


Figure 18. Comparison in percentage of number of parking entrances per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) for the months of January, February, July, and August at airport authority A5_6. Own elaboration based on data provided by airport authority A5_6. Data about revenues and stays at parking lots were not available.

In Covid time (2020 high season months, 2021 low and high season months) the values of number of parking entrances per total passengers were comparable to the ones in pre-Covid time. Notably, the 2021 high season months recorded higher values of national passengers (Figure 16 d) and lower values of number of parking entrances per total passengers(Figure 18) compared to the respective pre-Covid values. This is likely due to the availability of transportation modes alternative to road transportation at one of the airports managed by airport authority A5_A6.

Variation in the ports' monthly volume of passenger traffic

The European Maritime Safety Agency (EMSA) releases monthly reports on the impact of COVID-19 on maritime shipping in the European Union Member States. In 2020, the number of ship calls by passenger ships (Figure 19) and cruise ships (Figure 20) decreased by 46 and 87 %, respectively, compared to 2019. From January to May 2021 the number of ship calls by passenger ships had been up to 37 % lower than the respective months in 2019, whereas from June to August 2021 the number of passenger ship calls had been up to 11 % higher than the respective month in 2019 (Figure 19). From January to August 2021, the number of calls by cruise ships were between 49 and 84 % lower compared to the respective month in 2019. Moreover, the total number of persons onboard cruise ships declined with the onset of the epidemic (i.e., March 2020). In August 2021, the total number of persons onboard cruise ships was far below the pre-pandemic volumes despite of an upward trend from April 2021 (EMSA 2021).

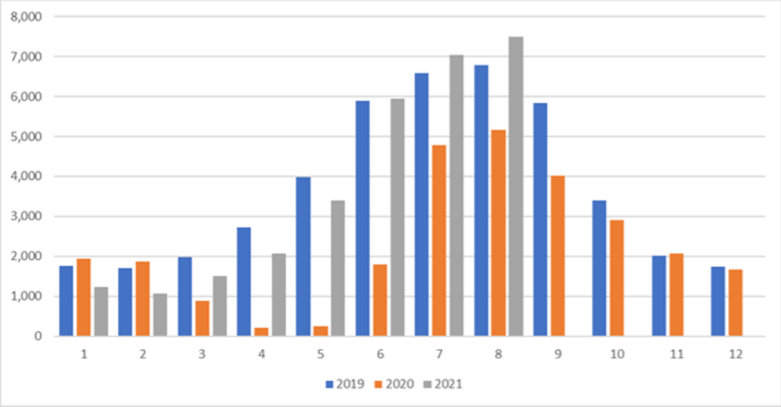


Figure 19. Ship calls by passenger ships reported to the European Maritime Information Network (SafeSeaNet) in 2019, 2020 and 2021 per month. (EMSA 2021).

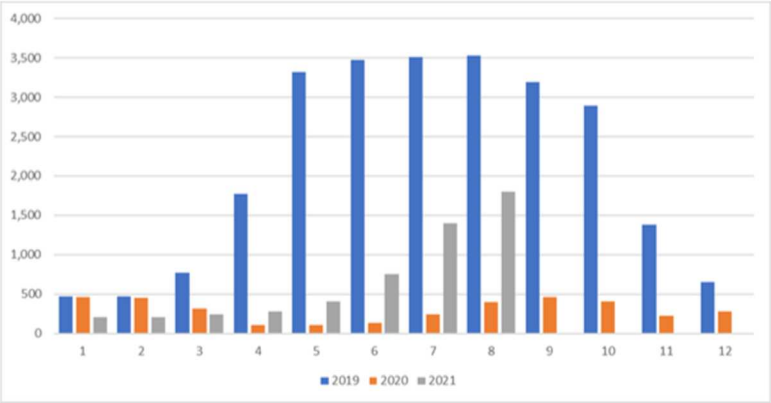


Figure 20. Ship calls by cruise ships reported to the European Maritime Information Network (SafeSeaNet) in 2019, 2020 and 2021 per month. (EMSA 2021).

Croatia and Italy are among the EU Member States that registered the highest decrease in the number of ship calls in 2020 and the first eight months of 2021 compared to the respective time period in 2019 (EMSA 2021). With the onset of the pandemic, in the second quarter of 2020 the traffic of passengers was about 32 % of the volume registered in the same quarter of 2019 (Figure 21). In Croatian ports, in 2020 ship calls were 69 % lower than the ship calls registered in 2019. In the first eight months of 2021, in Croatia ship calls were 37 % lower than the ship calls registered in the respective period in 2019 (EMSA 2021).

Italy recorded a lower decrease in ship calls compared to Croatia, with 18 and 13 % less ship calls in 2020 and the first eight months of 2021, respectively, compared to 2019 (EMSA 2021).

Based on the statistics about Italian ports published by ASSOPORTI (2021), in the first semester of 2021 total traffic of passengers and cruise passengers were about 2 and 9 times, respectively, the passenger traffic in the first semester of 2020.

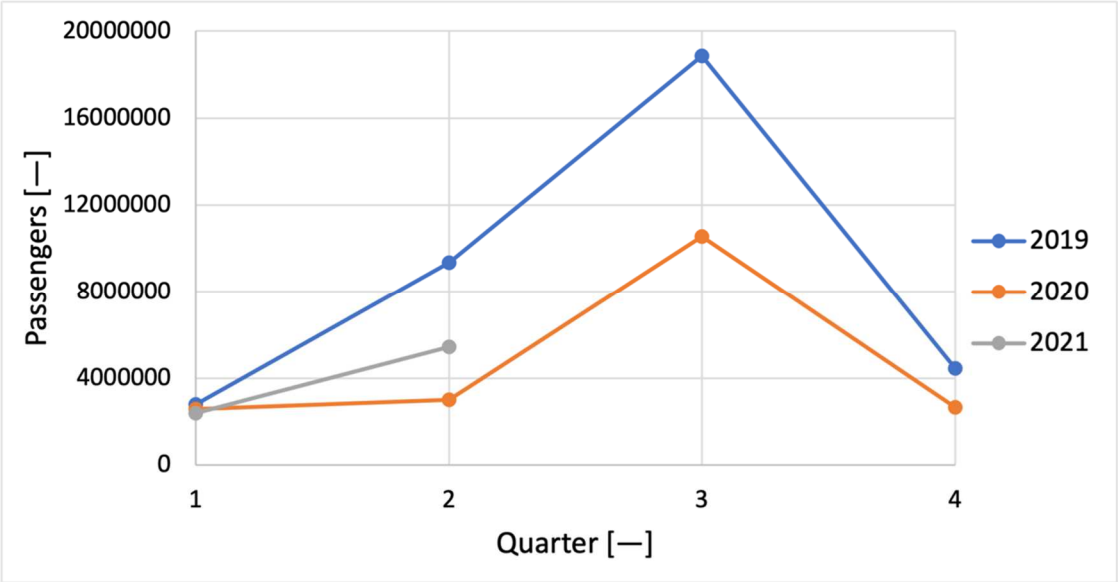
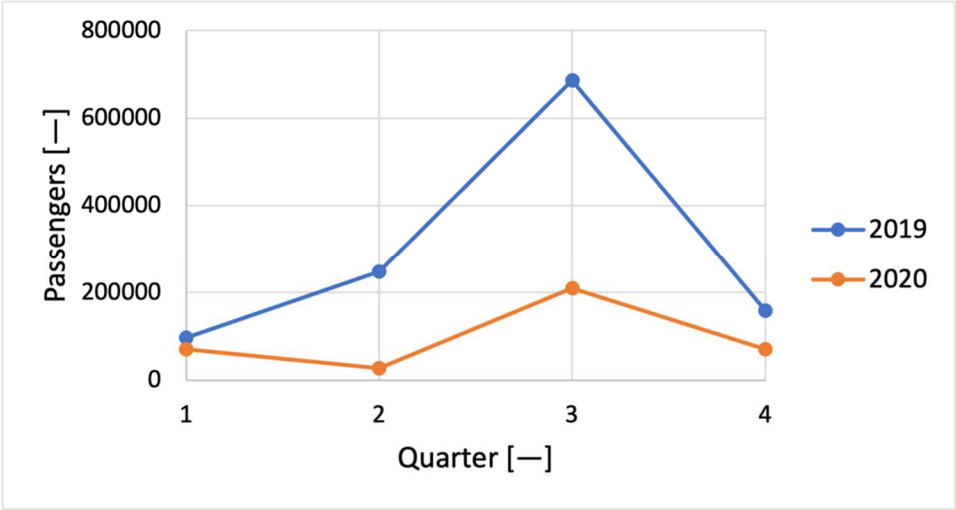


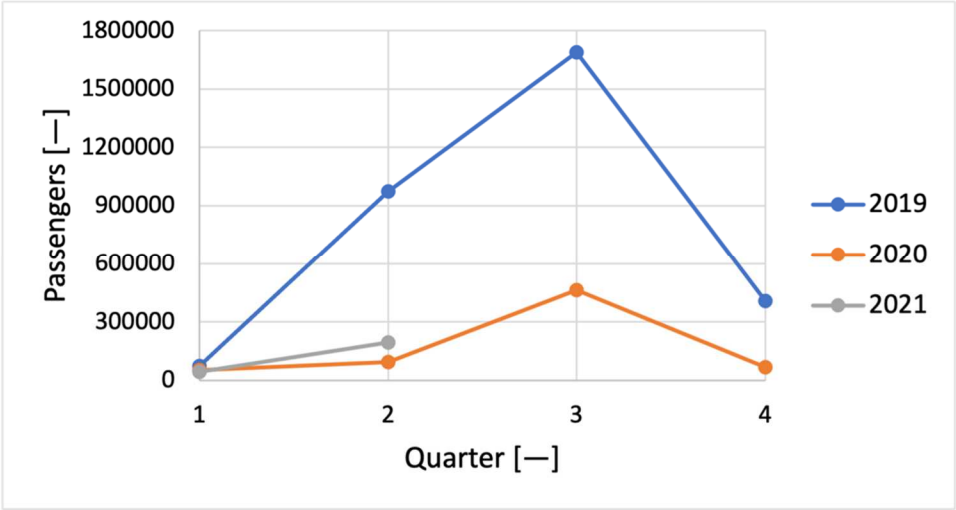
Figure 21. Traffic of passengers in Croatian ports from first quarter of 2019 to the second quarter of 2021. Own elaboration based on data retrieved from Croatian Bureau of Statistics (2021).

Figure 22 shows the traffic of passengers in ports P1, P2, and P3 from the first quarter of 2019 to the second quarter of 2021. The Adrigreen ports scored the highest reduction in passenger traffic in the second quarter of 2020, with values between 3 and 11 % of the passenger traffic in the second quarter of 2019. In the third and fourth quarter of 2020, port P2 registered the highest decrease in passenger traffic compared to the same period in 2019, followed by ports P1, and P2. Notably, at port P3 passenger traffic was about 1.4 times higher in the first quarter of 2021 compared to the same quarter in 2019.

a) Port P1



b) Port P2



c) Port P3

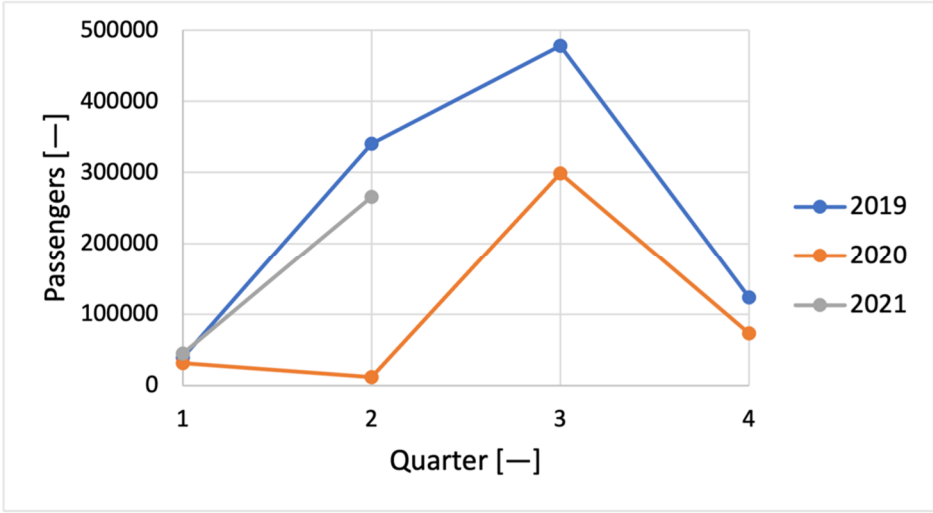
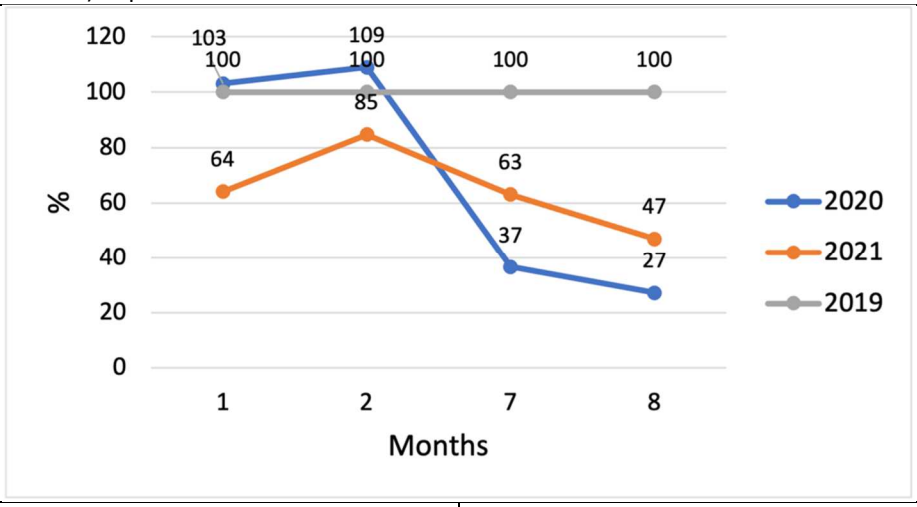


Figure 22. Traffic of passengers from the first quarter of 2019 to the second quarter of 2021 at ports (a) P1, (b), P2, and (c) P3. Own elaboration based on data retrieved from Croatian Bureau of Statistics (2021) and port authority P1 (personal communication). The 2021 data were not available for port P1.

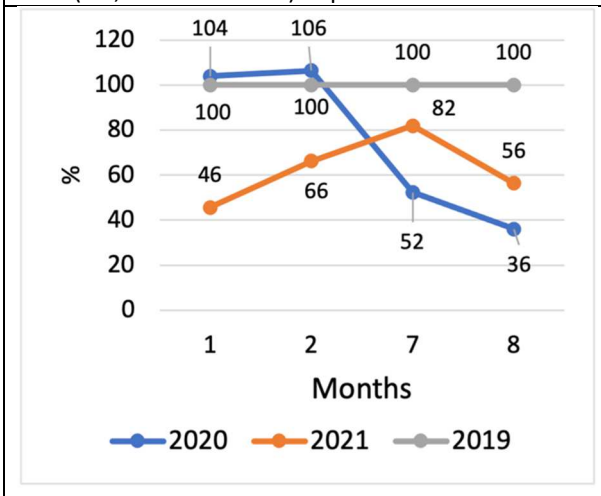
Focus: port P1

In pandemic time, port authority P1 reported that the 2020 and 2021 high season months of July and August showed volumes of passenger traffic between 27 and 63 % of the pre Covid time values (Figure 23 a). The 2020 low seasons months of January and February recorded between 3 and 9 % higher volumes of passenger traffic compared to the 2019 low season months. It should be noted that in Europe the effects of the pandemic were limited to restricted areas of Italy in the last week of February 2020. In 2021, the volume of passenger traffic showed a lower decrease in the low season months compared to the high season months.

a) Comparison in percentage of total number of passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P1



b) Comparison in percentage of cars (number of vehicles) between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P1



c) Comparison in percentage of buses (number of vehicles) between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P1

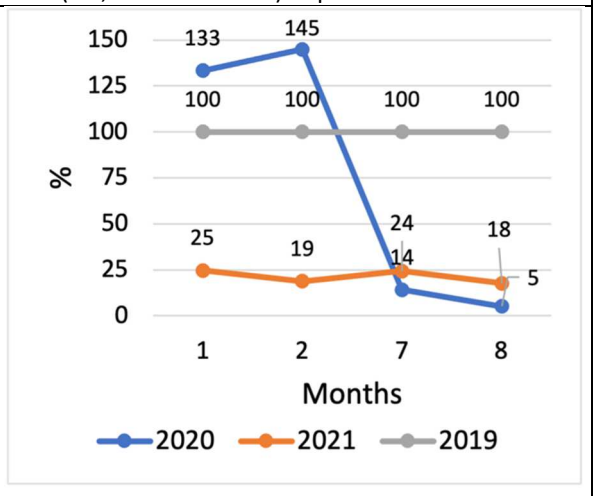


Figure 23. Comparisons in percentage of monthly volume of (a) total passengers, (b) cars, and (c) buses between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August at port P1. Own elaboration based on data provided by port P1. The values of cars and buses were estimated by port authority P1 for August 2021.

In pandemic time, at port P1 the monthly volume of cars (Figure 23 b) and buses (Figure 23 c) were lower both in 2020 and 2021 high season months (i.e., July and August) and low 2021 season months (i.e., January, and February) compared to the volumes in pre-Covid time. However, in pandemic time the monthly volume of cars showed a lower decrease compared to buses, with values in the range from 36 to 82 % (Figure 23 b) and from 5 to 25 % (Figure 23 c), respectively. Moreover, it should be noted that the 2021 high season months recorded a lower decrease in the volume of cars compared to the decrease of total passengers, with values up to 82 % (Figure 23 b) and 63 % (Figure 23 a), respectively.

Port authority P1 estimated the following: (i) volume of passengers with own vehicle, (ii) passengers with no vehicle, (iii) number of persons per car, and (iv) number of persons per bus. The above-mentioned data are not shown.

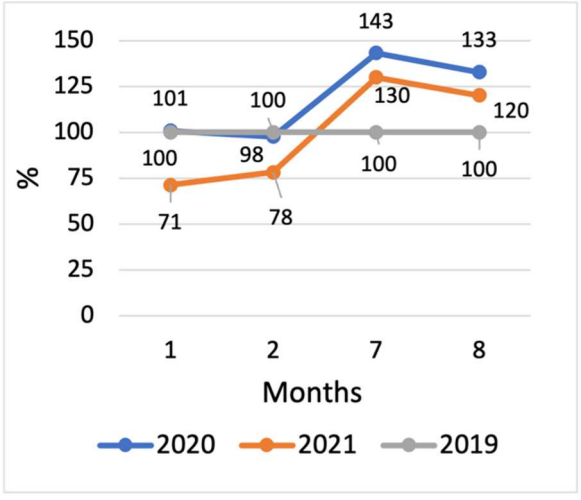
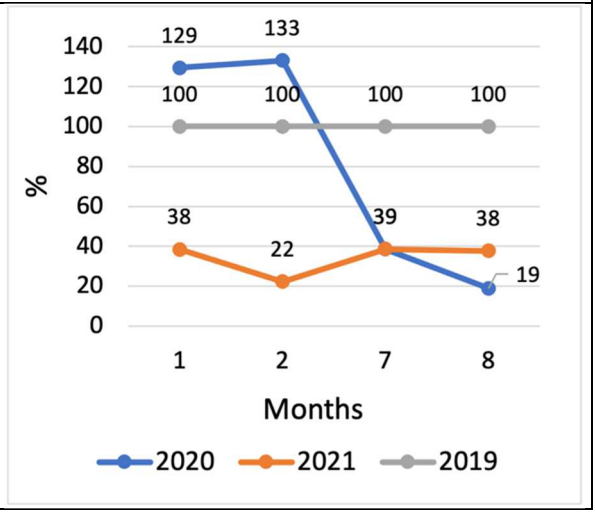
a) Comparison in percentage of number of cars per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P1	b) Comparison in percentage of number of buses per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P1
	

Figure 24. Comparison in percentage of number of (a) cars per total passengers, and (b) buses per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August at port P1. Own elaboration based on data provided by port authority P1.

To evaluate the variations in the road access to port P1 with the volume of passenger traffic, the monthly number of buses and cars were divided by the monthly values of total passengers (Figure 24). Both in 2020 and 2021 high season months, there were higher values of cars per total passengers compared to the respective values in pre-Covid time (Figure 24 a).

In Covid time (2020 high season months, and 2021 low and high season months) there were lower values of buses per total passengers compared to the respective values in pre-Covid time (Figure 24 b).

Focus: port P2

In pandemic time, port authority P2 reported that the 2020 and 2021 high season months of July and August showed volumes of passenger traffic between 1 and 19 % of the pre Covid time values (Figure 25 a). The 2020 low seasons months of January and February recorded between 13 and 48 % higher volumes of passenger traffic compared to the 2019 low season months. It should be noted that in Europe the effects of the pandemic were limited to restricted areas of Italy in the last week of February. In 2021, the volume of passenger traffic showed a lower decrease in the low season months compared to the high season months (Figure 25 a). These trends were similar to the ones observed for port authority P1 (Figure 23).

The passengers with no vehicle were between 75 and 100 % of total passengers in transit at port P2 in 2019, 2020, and 20121 low and high season months. Therefore, panels a and c of Figure 25 have similar trends.

In Covid time, the 2021 low season months recorded higher values of passengers with own vehicle compared to pre-Covid time (Figure 25 b). The 2020 and 2021 high season months recorded monthly volumes of passengers with own vehicle between 55 and 100 % of the pre-Covid time values (Figure 25 b).

In Covid time, the passengers with no vehicle were lower both in 2020 low season months and 2020 and 2021 high season months compared to the respective volumes in pre-Covid time, with values in the range 1– 13 % and 72 –83 % for the high and low season months, respectively (Figure 25 c).

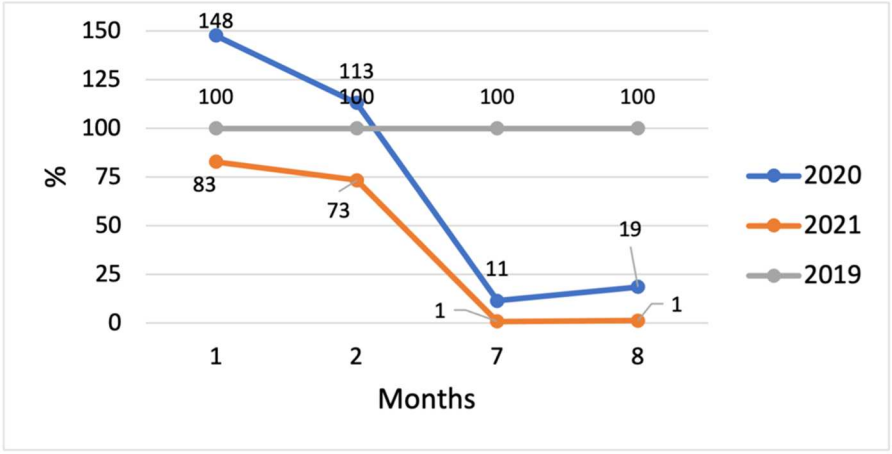
In pandemic time, at port P2 the monthly volume of cars (Figure 25 d) and buses (Figure 25 e) were lower both in 2020 and 2021 high season months (i.e., July and August), and February 2021 compared to the respective volumes in pre-Covid time. However, in pandemic time the monthly volumes of buses showed a lower decrease compared to cars, with values in the range from 0 to 31 % (Figure 25 e) and from 0 to 6 % (Figure 25 d), respectively.

Port authority P2 reported no cars and buses in transit in January 2019. Therefore, no percentages are shown for the volume of cars and buses for January.

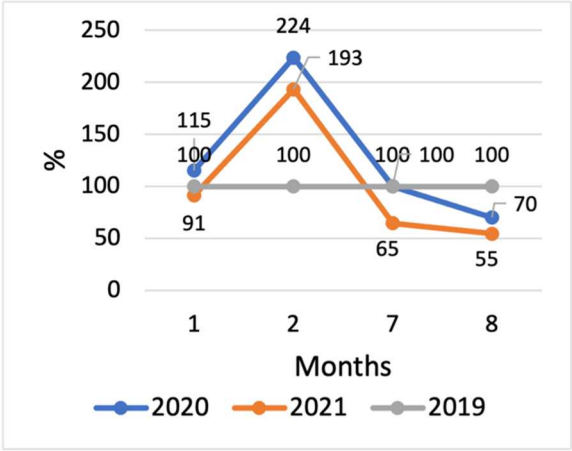
Data about number of stays at parking lots were sparse. Port authority P2 estimated the number of persons per (i) car, and (ii) bus. The above-mentioned data are not shown.

To evaluate the variations in the road access to port P2 with the volume of passenger traffic, the monthly number of buses and cars were divided by the monthly values of total passengers (Figure 26).

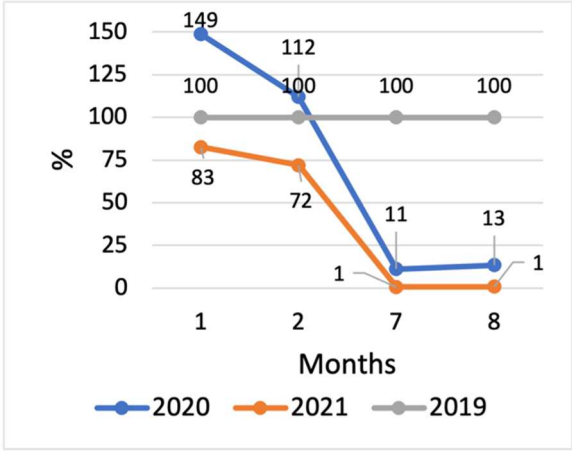
a) Comparison in percentage of total number passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P2



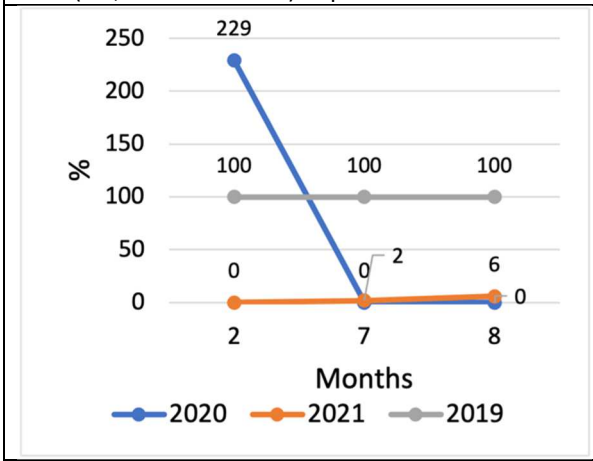
b) Comparison in percentage of passengers with own vehicle between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P2



c) Comparison in percentage of passengers with no vehicle between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P2



d) Comparison in percentage of cars (number of vehicles) between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P2



e) Comparison in percentage of buses (number of vehicles) between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P2

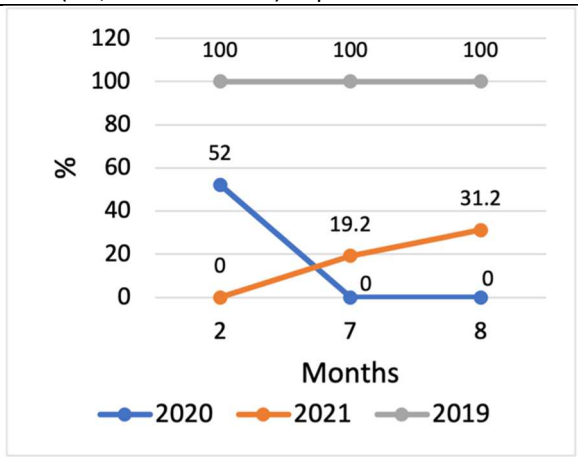


Figure 25. Comparison in percentage of monthly volume of (a) total passengers, (b) passengers with own vehicle, (c) passengers with no vehicle, (d) cars, and (e) buses between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of January, February, July, and August at port P2. Own elaboration based on data provided by port authority P2. Data not shown for the cars and buses in January.

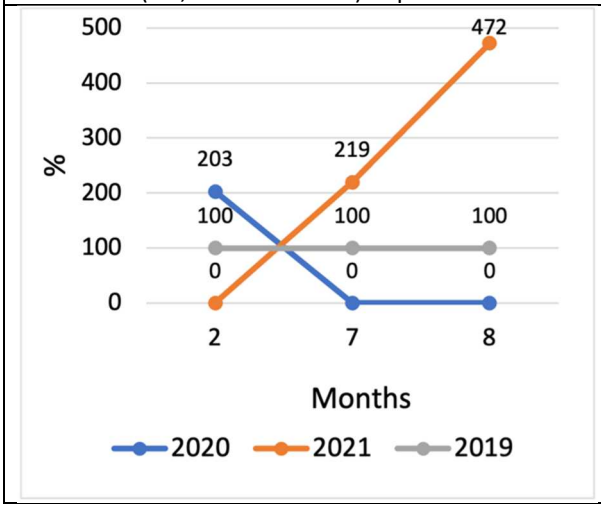
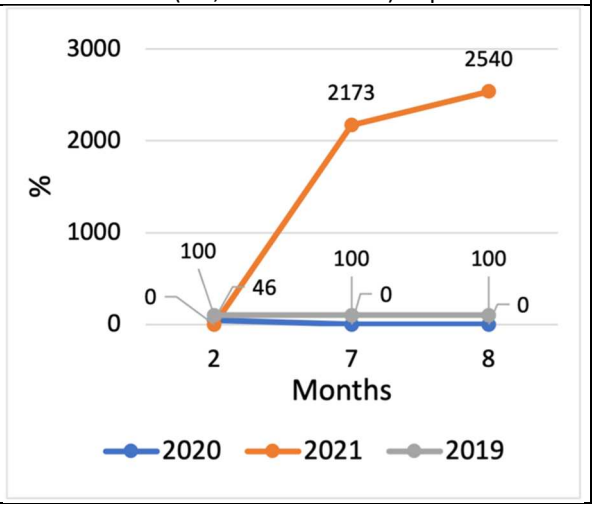
a) Comparison in percentage of number of cars per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P2	b) Comparison in percentage of number of buses per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020 and 2021) at port P2
	

Figure 26. Comparison in percentage of number of (a) cars per total passengers, and (b) buses per total passengers between pre-Covid (i.e., 2019) and Covid time (i.e., 2020, and 2021) for the months of February, July, and August at port P2. Own elaboration based on data provided by port authority P2. Data not shown for cars and buses in January.

Port P2 reported no cars and buses for the month of January 2019. Therefore, it was not possible to express the 2020 and 2021 values of cars and buses as a percentage of the 2019 ones.

In Covid time (2020 high season months, and 2021 low season months), there were no buses and cars at port P2 (data not shown). In 2021 high season months, the number of cars (Figure 26 a) and buses (Figure 26 b) per total passenger were higher compared to the pre-Covid ones.

Adrigreen - post- Covid airport authorities survey

The airport authorities were invited to take part to a quick survey for analysing variations between pre pandemic, pandemic, or post pandemic near future. For example, the airport authorities were interviewed about changes in the measures that are carried out at the terminals, or the alternative mobility offer to arrive/depart to/from the airport before, during, and after the pandemic.
Four airport authorities (i.e., A2, A3, A4, and A5_A6) took part to the survey.

1). Is there monitoring of the modes of transport used by the travellers to/from the airport?

The four airport authorities gave different answers regarding the monitoring of the modes of transport used by the travellers to/from the airport.
Irrespective of the pandemic, an airport authority reported to monitor the modes of transport used by the travellers to/from the airport. At airport A2, the monitoring is on the part of the airport authority before, during and after the pandemic.
Both in pre Covid and Covid time, an airport authority reported to have on schedule the monitoring.
At another airport authority, the monitoring was held out of ordinary management in pre Covid time and thus no monitoring is held during Covid time or planned in post Covid near future.

2). Is there any exchange between the airport authorities and the managers of public transport services serving the airport?

Irrespective of the pandemic, two airport authorities reported no exchange with managers of public transport services serving the airport. On the contrary, two airport authorities reported to have on schedule exchange with managers of public transport services serving the airport before, during and after the pandemic.

3). The following measures are carried out at the terminals:

Irrespective of Covid, two airport authorities (i.e., A4, and A5_A6) reported to have in place measures at the terminal buildings such as (i) contactless / ticketless services for public transport (Figure 27 a), and (ii) real time information to avoid crowds at public transport stops (Figure 27 d).
During the pandemic and in the post covid future, airport A2 implements the reallocation of external spaces to manage flows (Figure 27 b). Irrespective of the pandemic, airport authorities A3 and A5_A6 reallocate external spaces to manage flows (Figure 27 b).

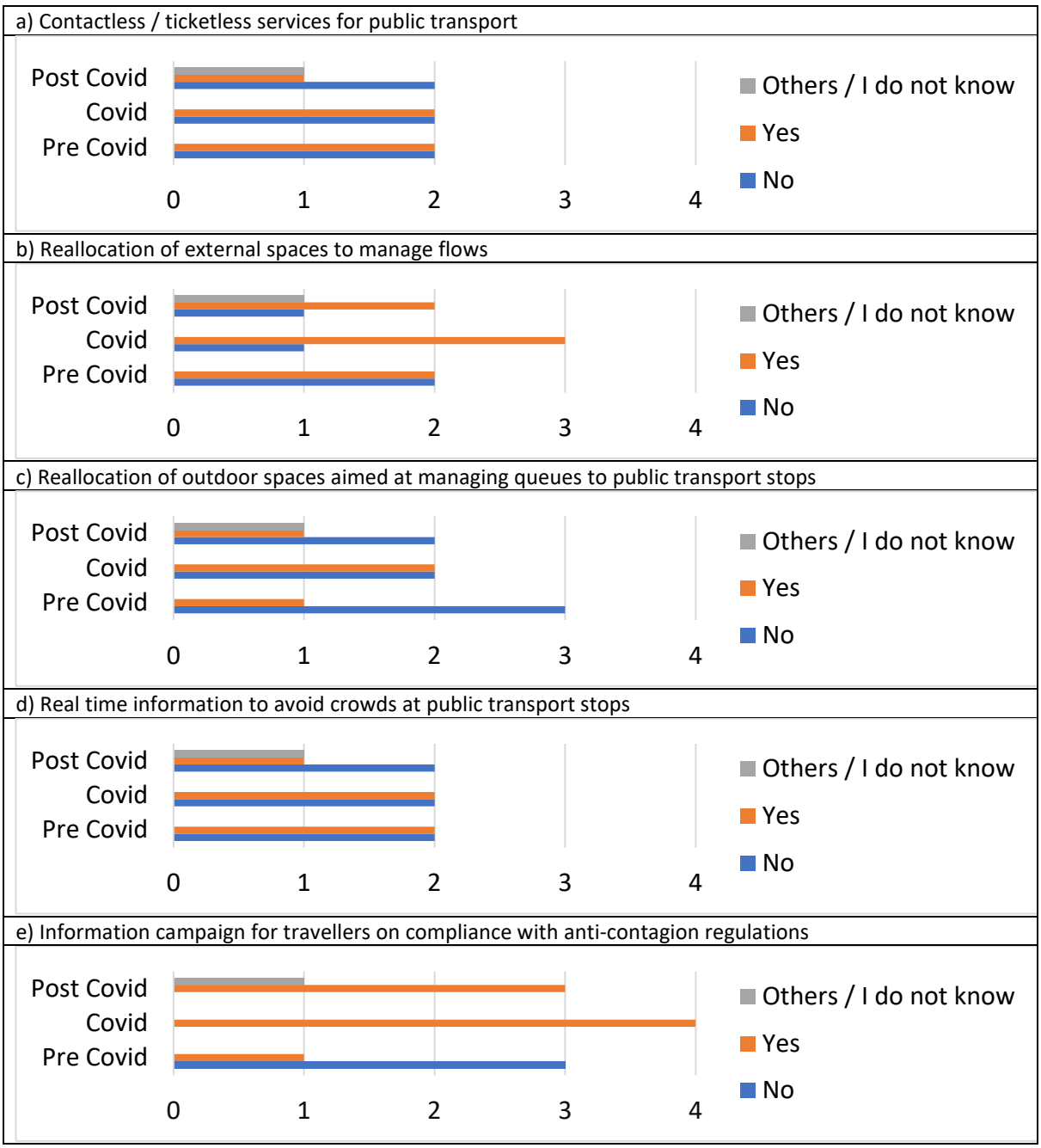


Figure 27.Comparisons between the measures in place at the terminal buildings of the airports before, during and after the pandemic.

Moreover, airport authority A5_A6 implements the reallocation of outdoor spaces aimed at managing queues to public transport stops irrespective of the pandemic (Figure 27 c).

During the pandemic and in the post covid future, airport A4 reallocates outdoor spaces for managing queues to public transport stops.

During the pandemic, the four airport authorities carry out an information campaign for travellers on compliance with anti-contagion regulations (Figure 27 e).

4). A change in the offer of public transport to / from the airport:

There were no substantial changes in the offer of public transport to / from the airports with the pandemic, apart from the restrictions imposed to limit the risk for contagion. For example, during Covid time an airport authority reported that social distancing was attained on public transport by limiting the number of seats available on board. This is a solution that the public transport services likely provided irrespective of the location of the airports.

Irrespective of Covid, an airport authority reported no changes in the offer of public transport to / from the airport. Two airport authorities reported changes in the offer of public transport with seasonality.

5). To arrive / depart to/from the airport, the following alternative mobility offer is available:

For all the four airport authorities, no substantial differences can be noted about the availability of alternative mobility solutions such as e-vehicles, car sharing, and electric bicycles/scooters with the pandemic (Figure 28 a, b, and d). For example, e-vehicles and car sharing were available at airport authorities A4 and A5_A6 before the pandemic and these alternative mobility solutions are going to be so after the pandemic. Moreover, electric bicycles/scooters were available at airport A4 before the pandemic and thus are going to be so in post Covid future. Both airport authorities A2 and A3 had no e-vehicles, car sharing, and electric bicycles/scooters before the pandemic and there is no plan to provide these alternative mobility solutions in post Covid time.

Differences between pre Covid and post Covid time can be noted for alternative mobility solutions such as bike sharing, charging stations, and bicycle/pedestrian paths connected to intermodal hubs or the next city (Figure 28 c, e, and f).

For example, bike sharing is going to be available at airport authority A5_A6 in the near future, whereas bike sharing was already available at two airports (i.e., A3 and A4) before the pandemic.

Two airport authorities (i.e., A4 and A5_A6) reported that charging stations were already available before the pandemic, whereas charging stations are going to be available at airport A2 in post Covid time. Moreover, at airport A2 there will be bicycle/pedestrian paths connected to intermodal hubs or the next city in post Covid time. Two airport authorities (i.e., A3 and A5_A6) reported the availability of bicycle/pedestrian paths connected to intermodal hubs or the next city already before the pandemic. Regarding bicycle/pedestrian paths, it should be noted that the location of the airport infrastructure may hinder the suitability of this solution or the attractiveness for the end users.

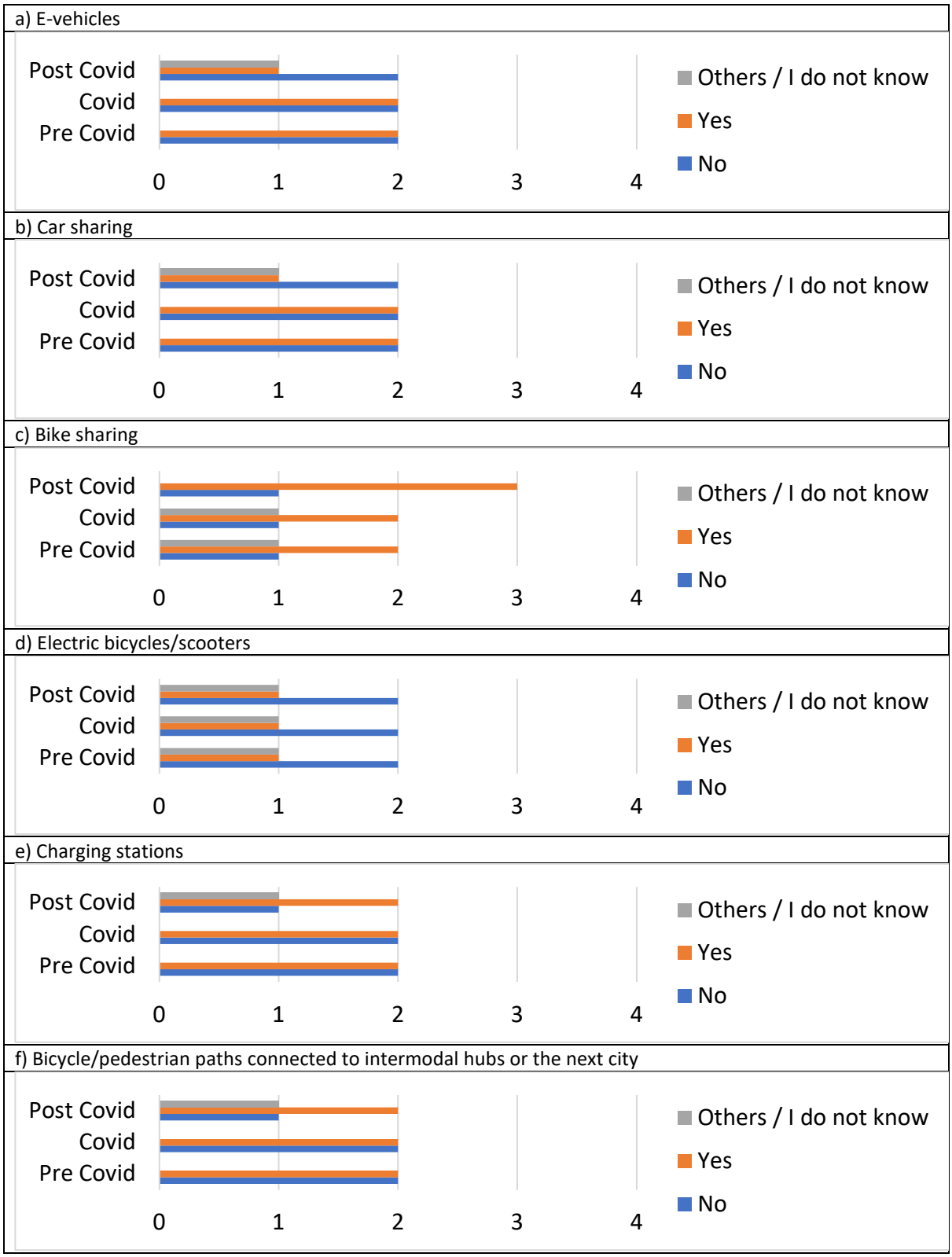


Figure 28. To arrive / depart to/from the airport, the following alternative mobility offer is available before, during and after the pandemic.

Adrigreen - post- Covid port authorities survey

The port authorities were invited to take part to a quick survey for analysing variations between pre pandemic, pandemic, or post pandemic near future. For example, the port authorities were interviewed about changes in the measures that are implemented at the terminals, or the alternative mobility offer to arrive/depart to/from the port before, during, and after the pandemic.
Two port authorities (i.e., P1, and P2) took part to the survey.

1). Is there monitoring of the modes of transport used by the travellers to/from the port?

Irrespective of the pandemic, a port authority reported no monitoring of the modes of transport used by the travellers to/from the port.
Another port authority reported that monitoring was on schedule before the pandemic. Following the pandemic, the monitoring is going to be held by the port authority. Moreover, this port authority reported that the transport service managers provide the monitoring irrespective of the pandemic.

2). Is there exchange between the port authorities and the managers of public transport services serving the port?
3). A change in the offer of public transport to / from the airport:

Irrespective of the pandemic, a port authority shares information on stakeholders' demand with the managers of public transport services serving the port. For this port authority, there are changes in the offer of public transport to / from the airport with seasonality irrespective of the pandemic.
The other port authority reported that there was an exchange with the managers of public transport services serving the port before the pandemic and it is going to be so in the post pandemic future. For this port authority there were scheduled changes in the offer of public transport to / from the airport with seasonality before the pandemic and it is going to be so in the post pandemic future.

4). The following measures are implemented at the terminals:

During and after the pandemic, two port authorities reported to implement special measures that were generally not in place before the pandemic at the terminal buildings. For example, both port authorities implement an information campaign for travellers on compliance with anti-contagion regulations. Moreover, both port authorities reported to reallocate the external spaces of the terminals to manage flows. A port authority reported to reallocate also outdoor spaces for managing

queues to public transport stops during and after the pandemic. This port authority also implements the following measures at the terminal:

- contactless/ticketless services for public transport;
- real time information to avoid crowds at public transport stops.

The last measure was implemented by the port authority before the pandemic, and it is going to be implemented again in the post Covid future.

5). To arrive / depart from the port, the following alternative mobility offer is available:

Irrespective of the pandemic, both port authority reported no alternative modes of transport such as car sharing, bike sharing, electric bicycles / scooters to arrive / depart from the respective ports.
In post Covid future, a port authority plans to provide alternative mobility solutions such as:
- bicycle/pedestrian paths connected to intermodal hubs or the next city;
- charging stations.

Another port authority reported that alternative mobility solutions (such as e-vehicles and charging stations) were already available before the pandemic and they are going to be so in the future.

Adrigreen - post- covid travellers survey

To understand the perception of the respondents about the risk of Covid infection, the respondents were interviewed about their feeling of protection when travelling by public means of transport and the options considered suitable by the travellers for feeling safe about the risk of contagion.

The respondents were interviewed also about their habits about the usage of own vehicle, public transport, or other means of transportation in different contexts (e.g., when travelling or during the stay).

Some questions were about the opinion of the respondents about alternative means of transportation.

The last two questions were about the awareness of the respondents about health and environmental issues.

Travellers were invited to take part to an anonymous online survey by using a QR code or digiting a link. The flyers had been distributed by the Adrigreen airport and port authorities for about two months from August to October 2021 at the terminal buildings.

Unfortunately, only a few survey campaigns got the interest of the travellers, namely surveys at airport A1 with 47 respondents, and at airport A4 with 32 respondents. We report the results of survey at port P1 as the port survey with the highest number (i.e., 13) of respondents although not statistically sound.

Airport authority A1 travellers survey

About the perception of the risk of Covid infection when travelling by public means of transport, most of the respondents has no fears (Figure 29 a). About one third of the respondents answered that sometimes they do not feel protected (Figure 29 a). Only about 6 % of the respondents never feel protected from Covid infection when travelling by public means of transport (Figure 29 a).

Regarding the options considered suitable by the travellers for feeling safe about the risk of contagion, about 50 % of the options of the travellers were represented by the sum of being vaccinated against Covid with physical distancing and face mask (Figure 29 b). About 17 % of the preferences were attributed to avoiding crowded areas (Figure 29 b). This solution is linked to physical distancing. However, to prevent the perception of crowded areas may be not sufficient to limit the access to public transport or indoor areas such as terminal buildings. About a quarter of the options of the travellers were represented by the sum of being tested for Covid with the assurance that nearby people got vaccinated (Figure 29 b).

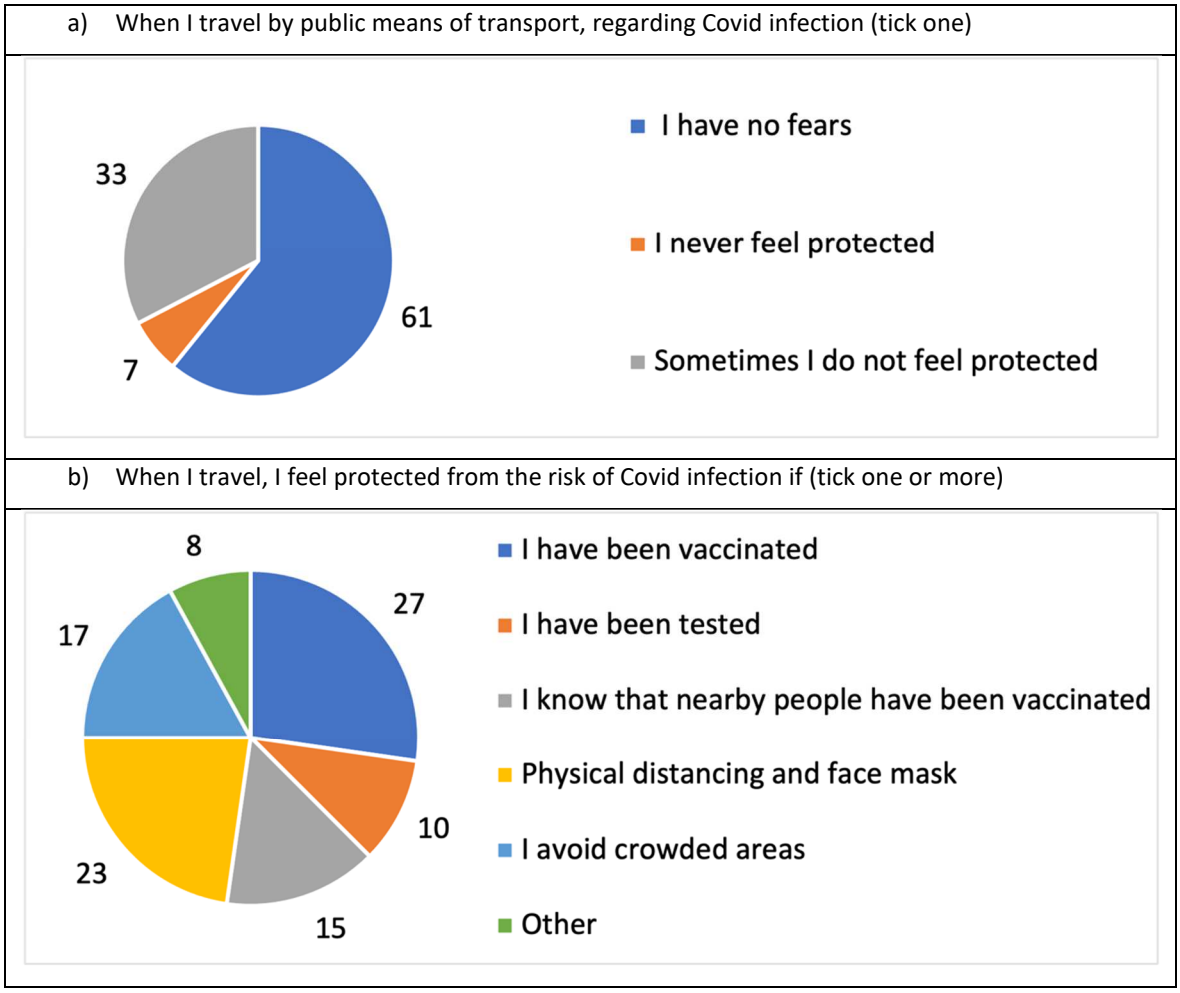
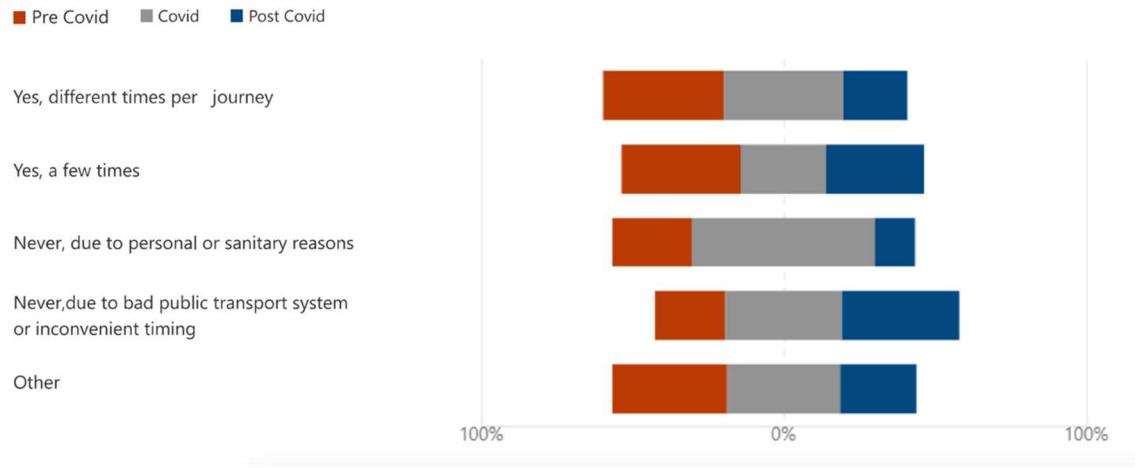
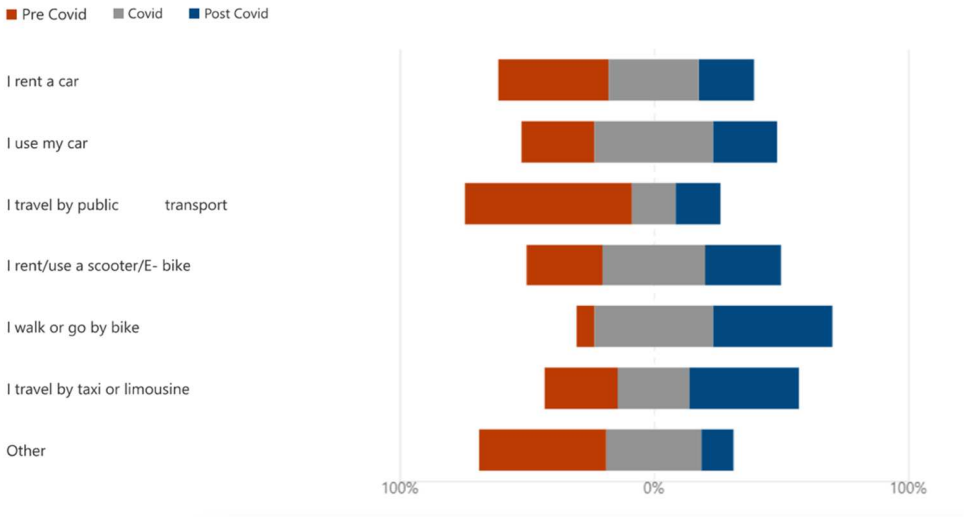


Figure 29. Results in percentage of the travellers survey at airport A1 regarding their Covid risk perception.

a) When I travel, I use public transport



b) Which is your favourite means of transport during your stay?



c) You select the location for the journey depending on

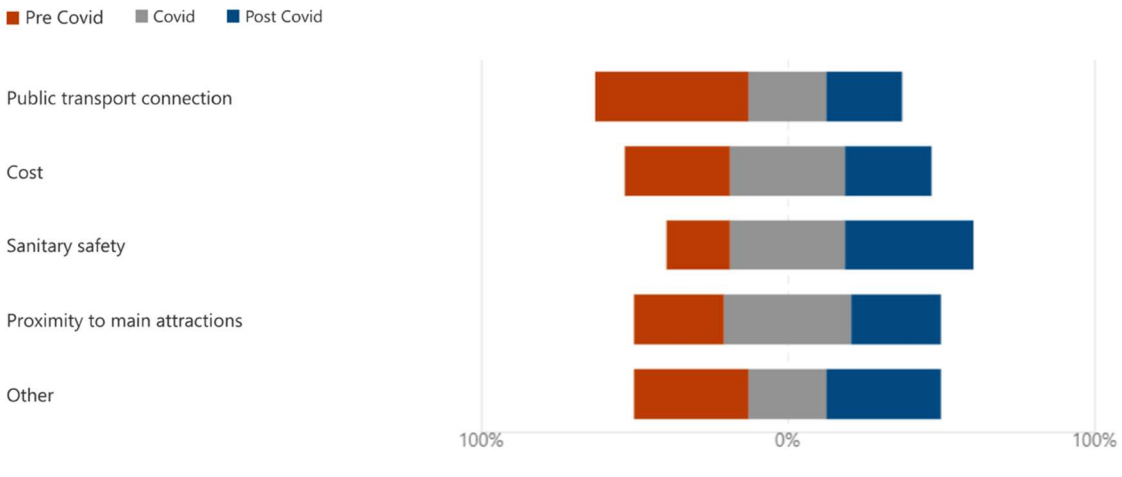


Figure 30. Results in percentages of the travellers survey at airport A1 regarding the habit of using public transport in general and the preferences for the location of the journey. Figures by Microsoft Forms (Microsoft).

About the habit of using public transport when travelling (Figure 30 a), in pre-Covid time the answers were equally distributed with a slight preference for different times per journey and a few times. In Covid time, the highest percentage of preferences was for never using public transport for travelling due to personal or to sanitary reasons. In post Covid future, the highest percentage of preferences was for no travels due to bad public transport system or inconvenient timing, whereas the lowest percentage of preferences was for never using public transport for travelling due to personal or sanitary reasons.

About the favourite means of transport during the respondents' stay (Figure 30 b), in pre-Covid time the most popular options were (i) public transport, (ii) rent a car, and (iii) other means of transport. in pre-Covid time the least popular options were soft mobility solutions such as walking and cycling. In Covid time, the most popular options were (i) own car, (ii) soft mobility, and (iii) rent or use a scooter/e-bike, whereas the least popular was public transport. In post Covid future, the most popular options are soft mobility and rent a taxi or limousine, whereas public transport is the last option.

In pre-Covid time, public transport connection was the most popular reason for selecting the location of the journey (Figure 30 c). In Covid time, the proximity to main attractions showed the highest share of preferences (Figure 30 c). In post Covid future, sanitary safety had the highest share of preferences (Figure 30 c).

About the preference for public transport to/from the airport, the highest share of preferences was for solo travellers (sometimes or always) in pre Covid time (Figure 31 a). In Covid time, the highest share of preferences was for always going to/from the airport by public transport. In post Covid future, the lowest preferences were for (i) sometimes (solo traveller), (ii) never, and (iii) always.

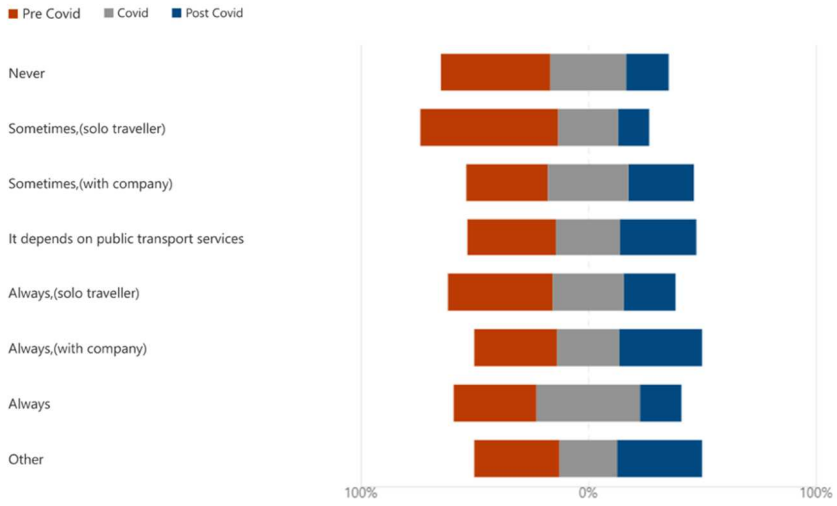
In pre-Covid time, the main reasons for not travelling by public transports to/from the airport, were (i) no convenience, (ii) bad cleaning, (iii) cost, (iv) frequency of connection, or (v) overcrowding (Figure 31 b).

In Covid time, the highest share was for feeling at risk for poor security/safety/health. The same reason had the lowest share in pre-Covid time (Figure 31 b).

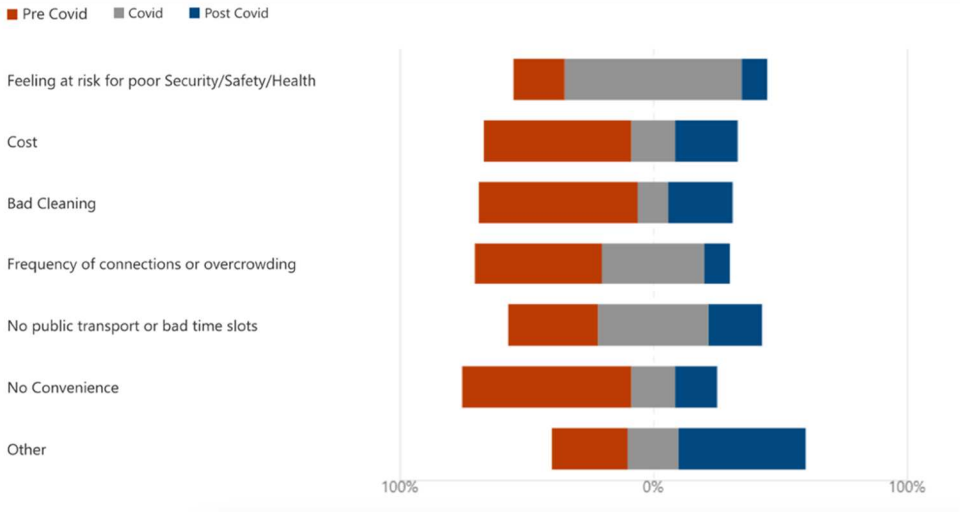
In post-Covid time, the highest share was for other reasons. It is likely that there will be different drivers for not travelling by public transport in post Covid future (Figure 31 b).

In pre-Covid time, timing was the reason with the highest share for travelling by own vehicle to/from the airport, whereas cleanliness was the reason with the lowest share (Figure 31 c). On the contrary, in Covid time timing was the reason with the lowest share. In Covid time the reason with the highest share was feeling safe for security/safety/health, whereas this same reason had the lowest share for the post Covid future (Figure 31 c).

a) I prefer public transport to/from the airport



b) If you do not travel by public transport to/from the airport, could you tell the reason?



c) If you travel by own vehicle to/from the airport, could you tell the reasons?

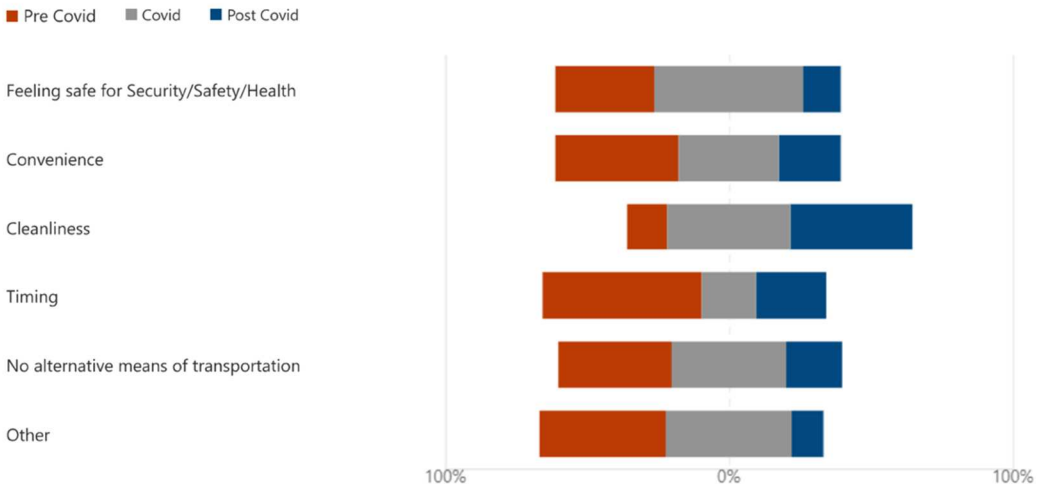
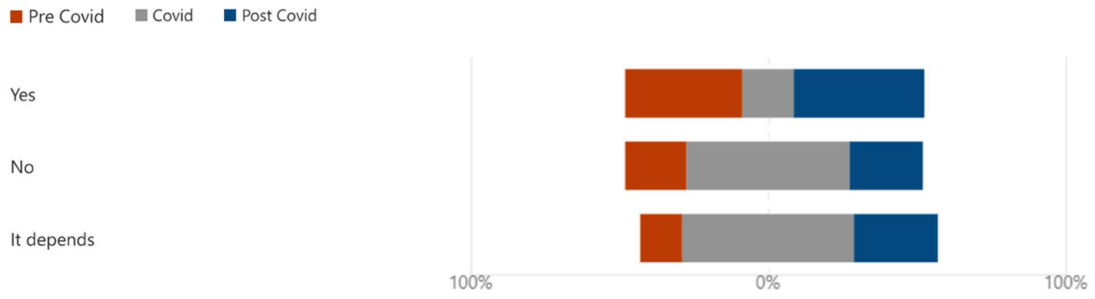


Figure 31. Results in percentages of the travellers survey at airport A1 regarding their habit of using public transport or private vehicle to/from the airport. Figures by Microsoft Forms (Microsoft).

a) Do you consider ''alternative'' (e-bike, scooter etc..) means of transport useful to move from/to the airport?



b) In your opinion, ''alternative (e-bike, scooter etc..) means of transport should be improved regarding

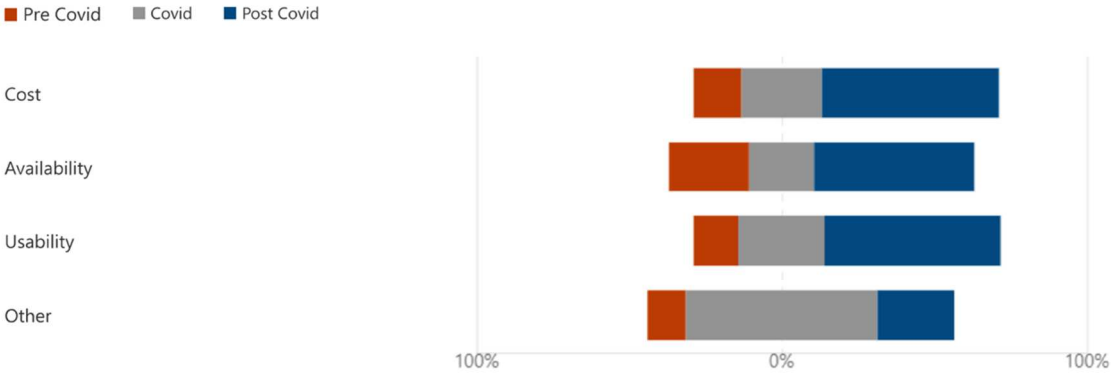


Figure 32. Results in percentages of the travellers survey at airport A1 regarding their opinion about alternative means of transportation. Figures by Microsoft Forms (Microsoft).

In Covid time, the highest share of respondents considers alternative means of transport useful depending on/not useful to move to/from the airport (Figure 32 a). Both in pre- Covid and post Covid time, a slightly higher share of respondents considered alternative means of transport useful (Figure 32 a). In post Covid time, alternative means of transport should be improved regarding cost, availability, and usability (Figure 32 b).

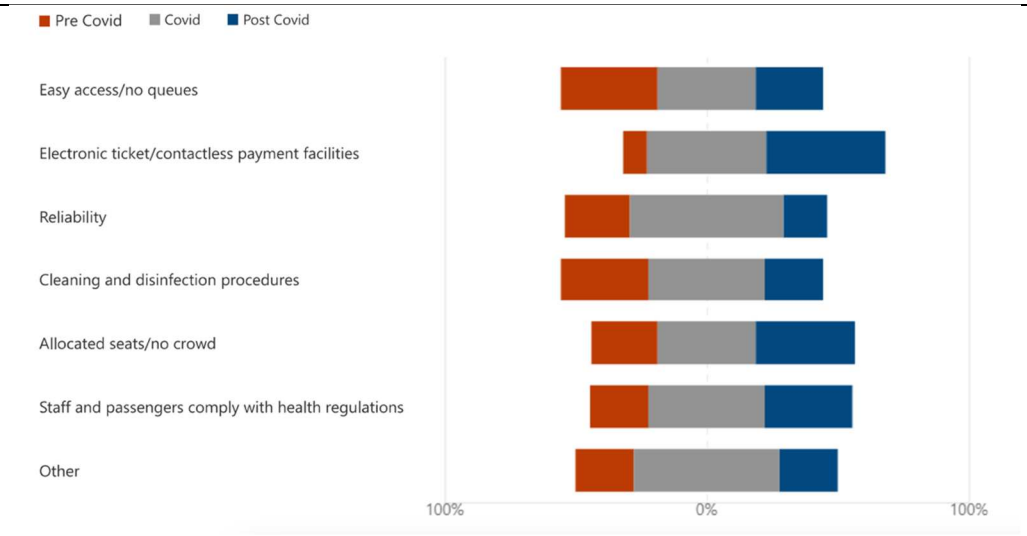
For selecting the mode of transport to/from the airport, reliability was the reason with the highest share in Covid time. On the contrary, reliability was the reason with the lowest share for post Covid future (Figure 33 a).

In pre-Covid time, the reason with the lowest share was electronic ticket/contactless payment facilities (Figure 33 a).

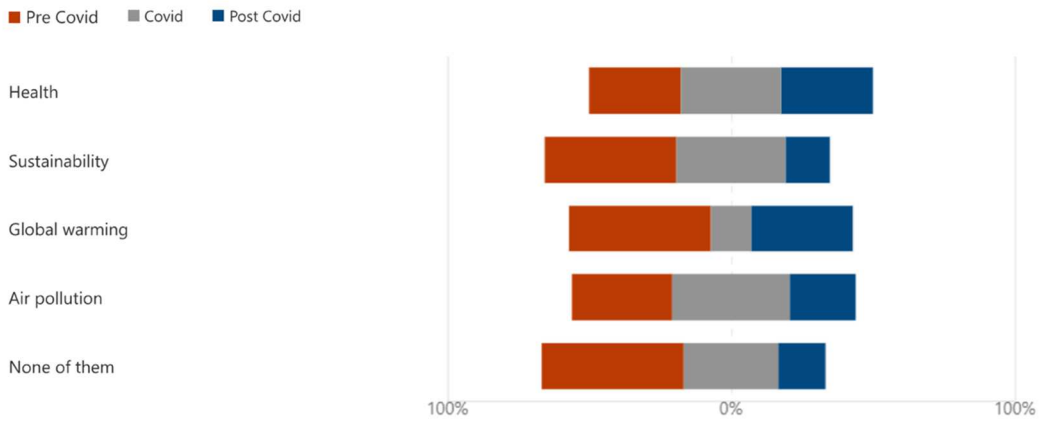
The respondents were interviewed about the issues influential to their daily choices, namely health, sustainability, global warming, and air pollution (Figure 33 b). In pre-Covid time, the highest share was for global warming as well as for none of the above-mentioned issues.

In Covid time, global warming was the issue with the lowest share (Figure 33 b). In post Covid future, sustainability and none of the above-mentioned issues had the lowest share (Figure 33 b).

a) You select the mode of transport to/from the airport depending on



b) Do you consider these issues influential to your daily choices?



c) In your opinion, how the same issues are related to the world of transportation?

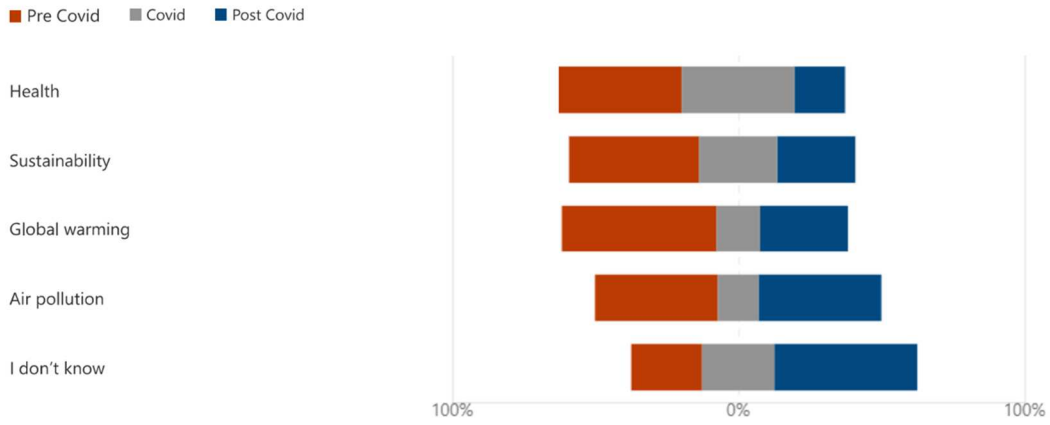


Figure 33. Results in percentages of the travellers survey at airport A1 regarding their awareness about health and environmental issues and the reason for selecting the mode of transport to/from the airport. Figures by Microsoft Forms (Microsoft).

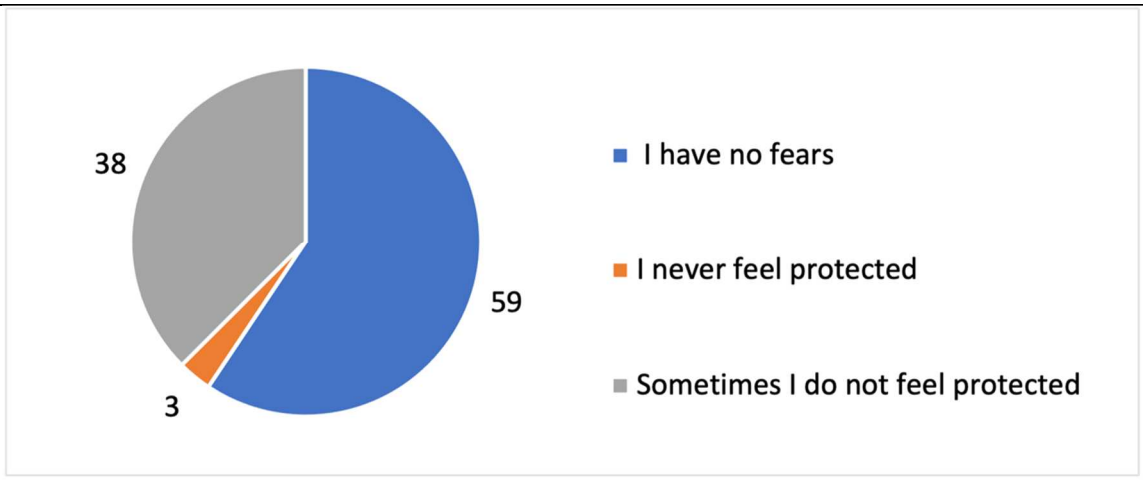
The respondents were interviewed about how the above-mentioned issues were related to the world of transportation (Figure 33 c). Issues such as global warming, sustainability, health, and air pollution had the highest share in pre-Covid time. In Covid time, the issues with the lowest share were global warming and air pollution. In post Covid future, the i-do-not-know answer had the highest share, whereas the lowest shares were for global warming and air pollution.

Airport authority A4 travellers survey

About the perception of the risk of Covid infection when travelling by public means of transport, most of the respondents has no fears (Figure 34 a). About 38 % of the respondents answered that sometimes they do not feel protected, whereas only about 3 % of the respondents never feel protected from Covid infection when travelling by public means of transport (Figure 34 a).

Regarding the options considered suitable by travellers for feeling safe about the risk of contagion, about 59 % of the options of the travellers were represented by the sum of being vaccinated against Covid with physical distancing and face mask (Figure 34 b). About 23 % of the preferences were attributed to avoiding crowded areas (Figure 34 b). About 14 % of the options of the travellers were represented by the sum of being tested for Covid with the assurance that nearby people got vaccinated (Figure 34 b).

a) When I travel by public means of transport, regarding Covid infection (tick one)



b) When I travel, I feel protected from the risk of Covid infection if (tick one or more)

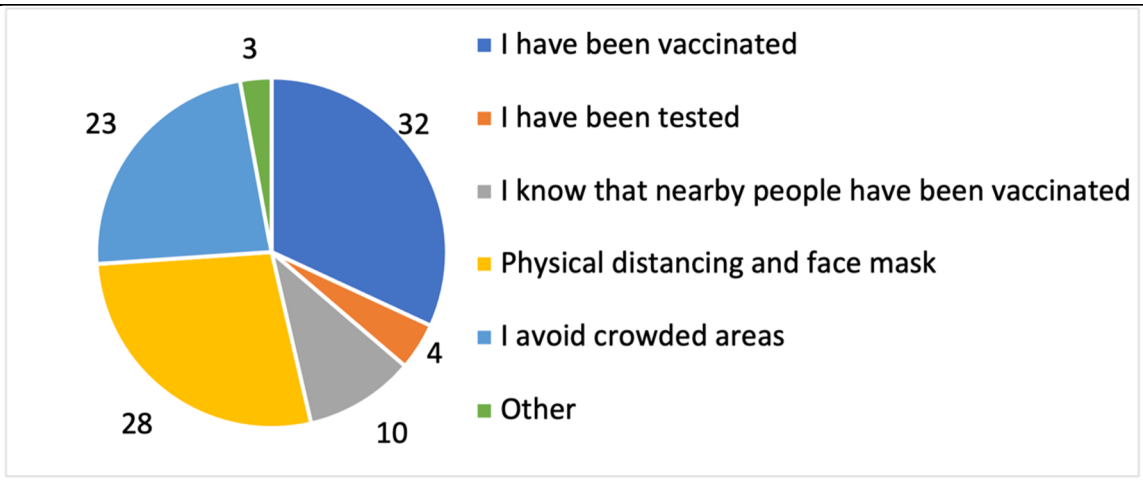
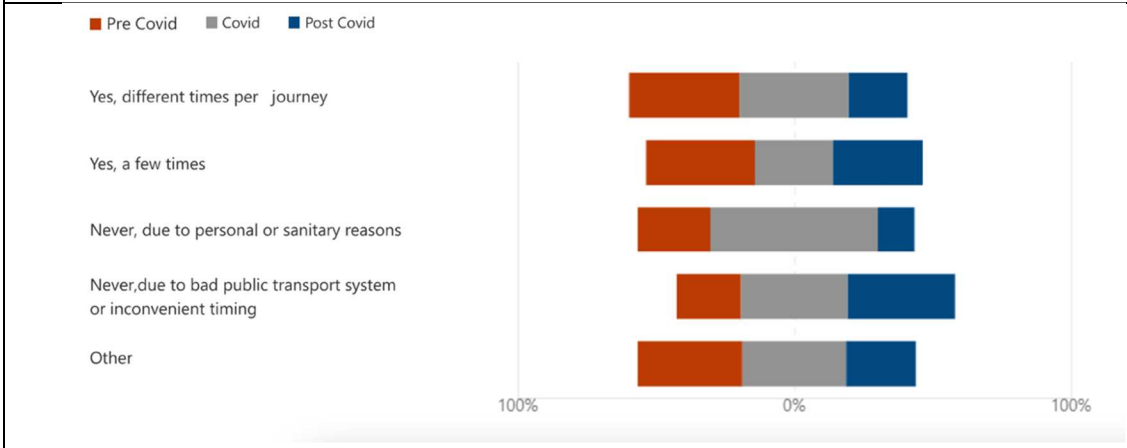
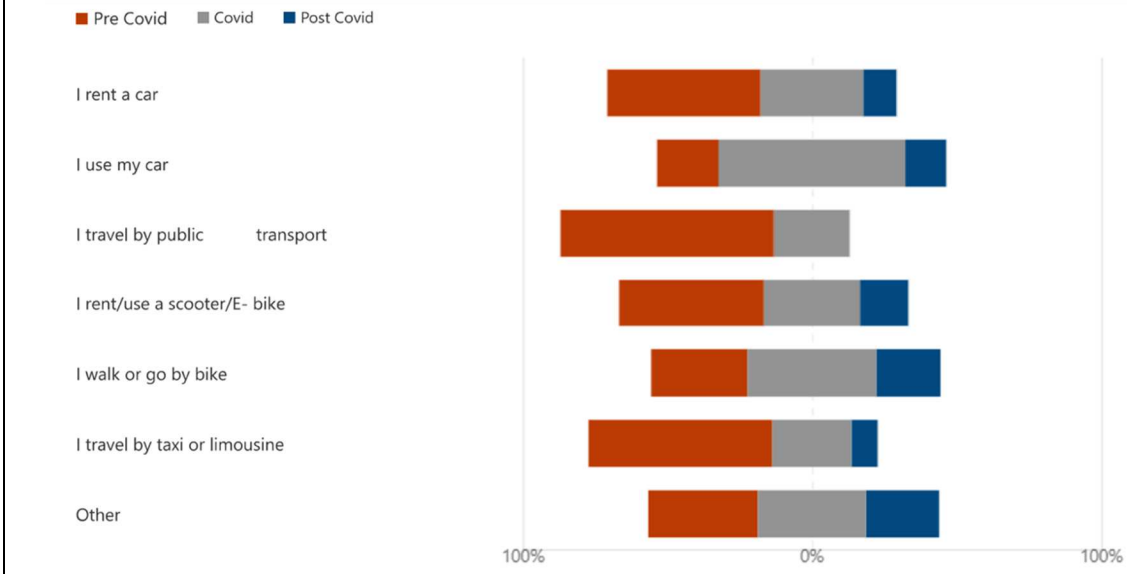


Figure 34. Results in percentage of the travellers survey at airport A4 regarding their Covid risk perception.

a) When I travel, I use public transport



b) Which is your favourite means of transport during your stay?



c) You select the location for the journey depending on

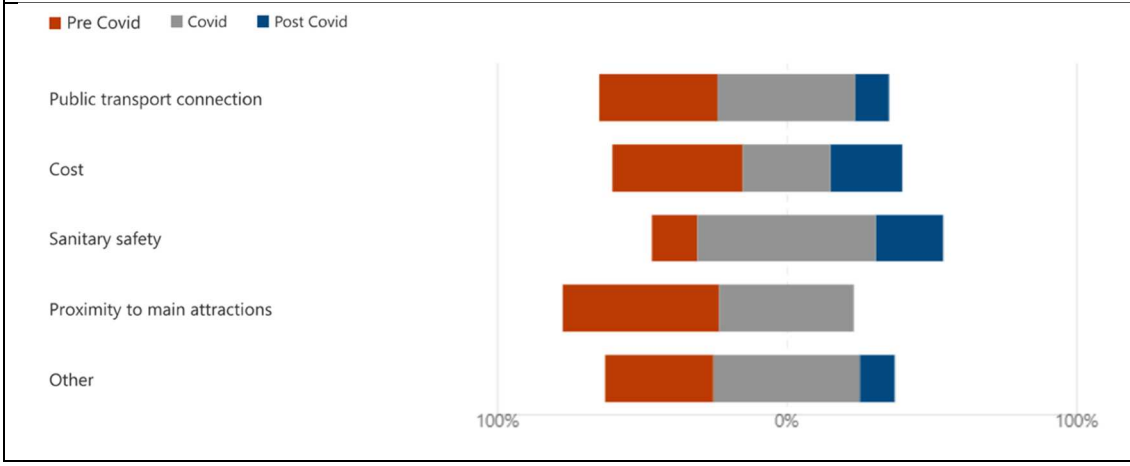


Figure 35. Results in percentages of the travellers survey at airport A4 regarding the habit of using public transport in general and the preferences for the location of the journey. Figures by Microsoft Forms (Microsoft).

About the habit of using public transport when travelling, in pre-Covid time the highest share of preferences was for different times per journey (Figure 35 a). In Covid time, the highest percentages were (i) a few times, never due to (ii) personal or to sanitary reasons, and (iii) bad public transport system or inconvenient timing (Figure 35 a).

In post Covid future, preferences were equally distributed with no clear preference for any of the suggested answers (Figure 35 a).

About the favourite means of transport during the respondents' stay, in pre-Covid time the most popular options were (i) travel by public transport, (ii) travel by taxi or limousine, (iii) rent a car, (iv) rent/use a scooter/e-bike (Figure 35 b). In Covid time, own car was the most popular option (Figure 35 b). In post Covid future, preferences were about the same for the suggested answers with only public transport having no preferences (Figure 35 b).

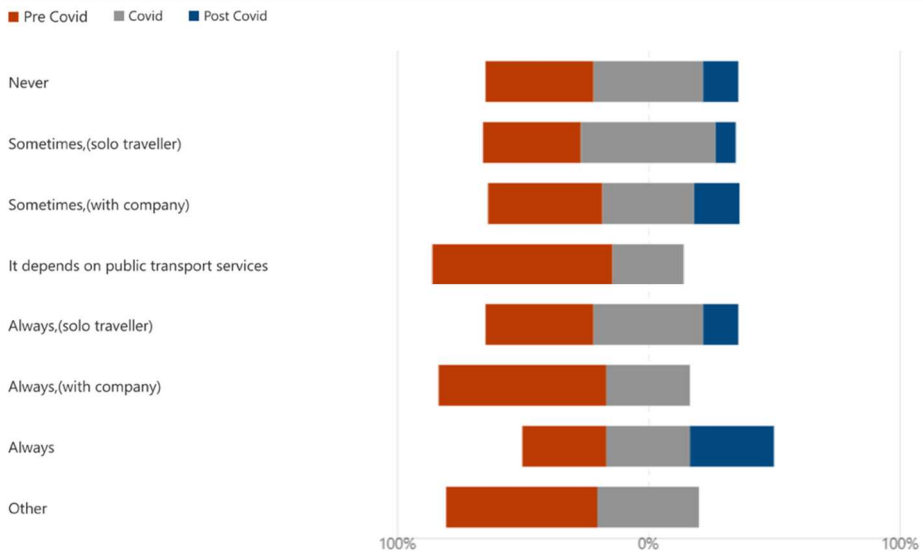
In pre-Covid time, the proximity to main attractions was the most popular reason for selecting the location of the journey (Figure 35 c). In Covid time, the highest share of preferences was for (i) sanitary safety, and (ii) other reasons (Figure 35 c). In post Covid future, preferences were about the same for the suggested answers with only the proximity to main attractions having no preferences (Figure 35 c).

About the preference for public transport to/from the airport, in pre Covid time the highest share of preferences was for (i) it depends on public transport services, (ii) always for the travellers with company, and (iii) other (Figure 36 a). In Covid time, the highest share of preferences was for sometimes going to/from the airport by public transport when travelling alone (Figure 36 a). In post Covid future, preferences were about the same for the suggested answers. However, no preferences were expressed for the following options: (i) it depends on public transport services, (ii) always for the travellers with company, and (iii) other (Figure 36 a).

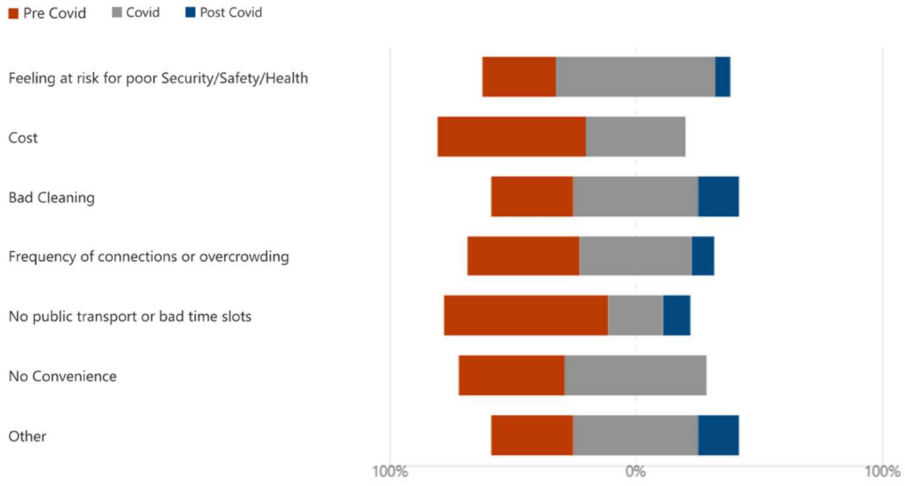
In pre-Covid time, the main reasons for not travelling by public transports to/from the airport, were (i) no public transport or bad time slots, and (ii) cost (Figure 36 b). In Covid time, the highest share of preferences was for (i) feeling at risk for poor security/safety/health, (ii) no convenience, (iii) bad cleaning, and (iv) other reasons (Figure 36 b). In post-Covid future, preferences were about the same for the suggested answers. However, no preferences were expressed for the following reasons: (i) cost, and (ii) no convenience (Figure 36 b).

In pre-Covid time, timing and other reasons had the highest share of preferences for travelling by own vehicle to/from the airport (Figure 36 c). In Covid time, the reason with the highest share of preferences were the following, (i) cleanliness, and (ii) no alternative means of transportation. These same reasons had the lowest share of preferences for the post Covid future (Figure 36 c).

a) I prefer public transport to/from the airport



b) If you do not travel by public transport to/from the airport, could you tell the reason?



c) If you travel by own vehicle to/from the airport, could you tell the reasons?

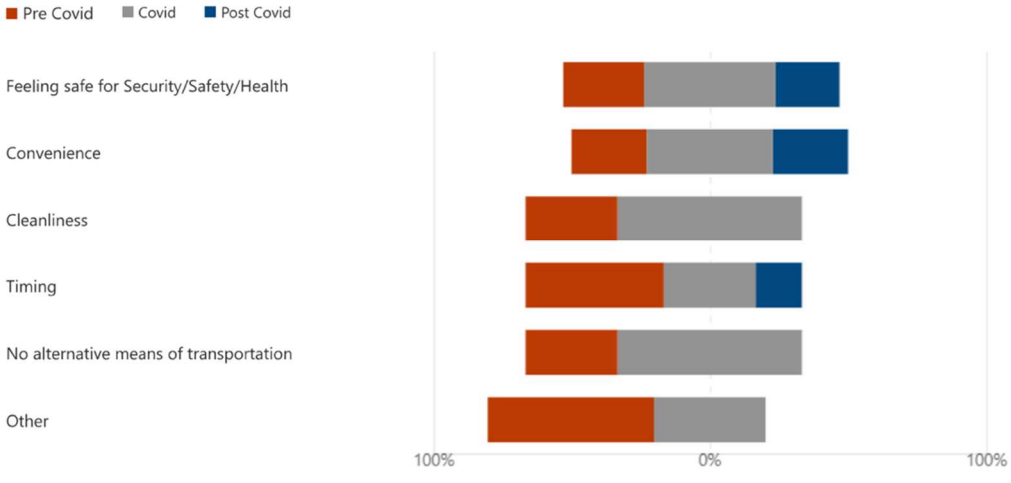
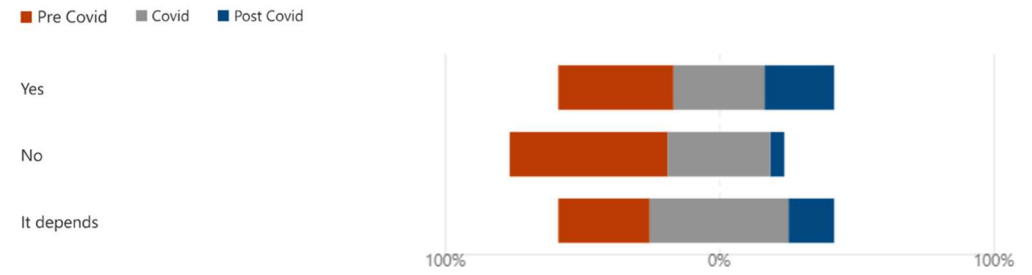


Figure 36. Results in percentages of the travellers survey at airport A4 regarding their habit of using public transport or private vehicle to/from the airport. Figures by Microsoft Forms (Microsoft).

a) Do you consider ''alternative'' (e-bike, scooter etc..) means of transport useful to move from/to the airport?



b) In your opinion, ''alternative (e-bike, scooter etc..) means of transport should be improved regarding

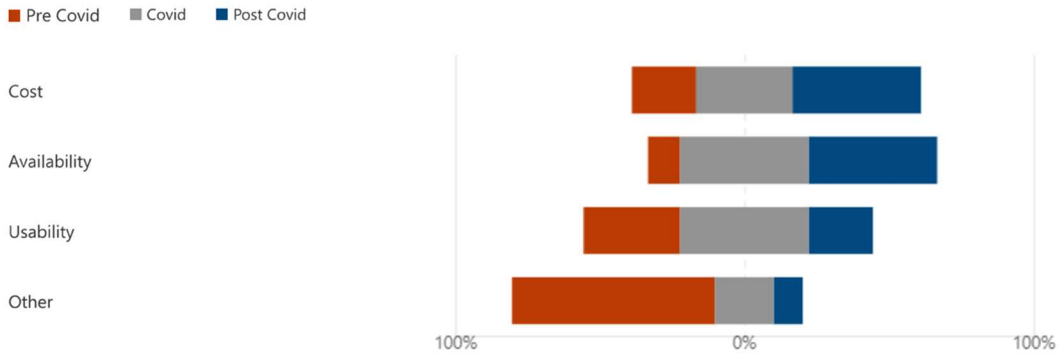


Figure 37. Results in percentages of the travellers survey at airport A4 regarding their opinion about alternative means of transportation. Figures by Microsoft Forms (Microsoft).

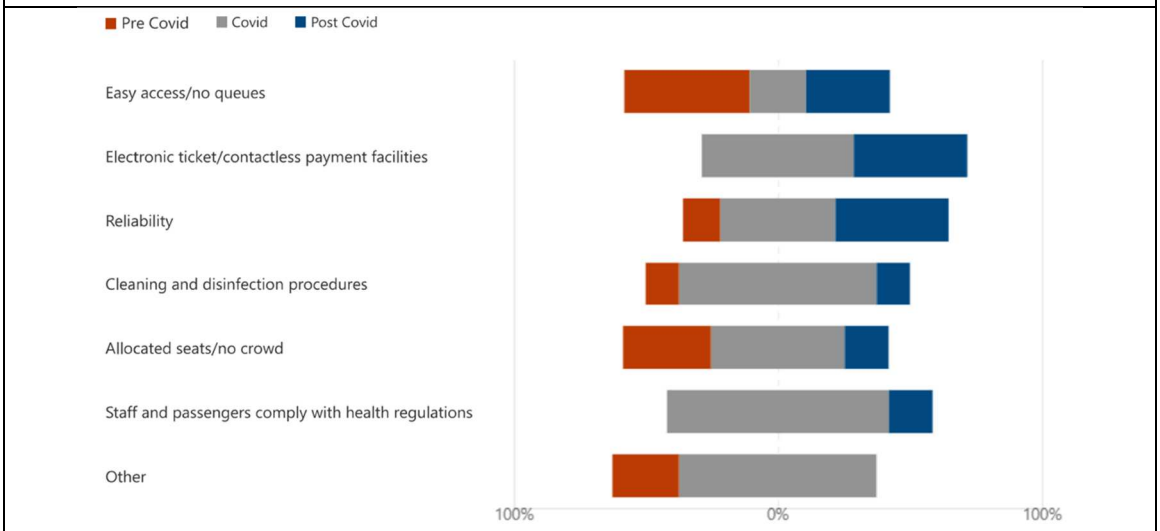
In pre-Covid time, the highest share of respondents does not consider alternative means of transport useful to move to/from the airport (Figure 37 a).In Covid time, the highest share of respondents expressed a conditional option for the alternative means of transport (Figure 37 a). In post Covid time, preferences were about the same for the suggested answers (Figure 37 a).

In pre-Covid time, the highest share of respondents expressed a preference for other characteristics than cost, availability, and usability of alternative means of transport (Figure 37 b). In Covid time and post Covid future, no clear preferences were expressed for the suggested answers (Figure 37 b).

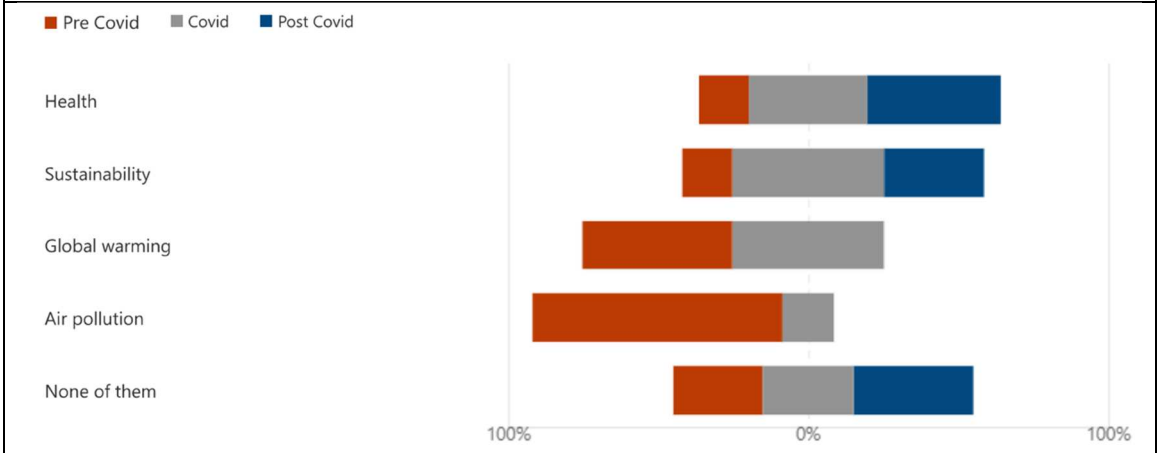
For selecting the mode of transport to/from the airport, in pre-Covid time the reasons with no preferences were (i) electronic ticket/contactless payment facilities, and (ii) staff and passengers comply with healthy regulations. In Covid time, the reasons with the highest share of preferences were the following, (i) staff and passengers comply with healthy regulations, (ii) cleaning and disinfection procedures, (iii) other, (iv) electronic ticket/contactless payment facilities, and (v) allocated seats/no crowd (Figure 38 a).In post Covid future, preferences were about the same for the suggested answers (Figure 38 a).

The respondents were interviewed about the issues influential to their daily choices, namely health, sustainability, global warming, and air pollution (Figure 38 b).

a) You select the mode of transport to/from the airport depending on



b) Do you consider these issues influential to your daily choices?



c) In your opinion, how the same issues are related to the world of transportation?

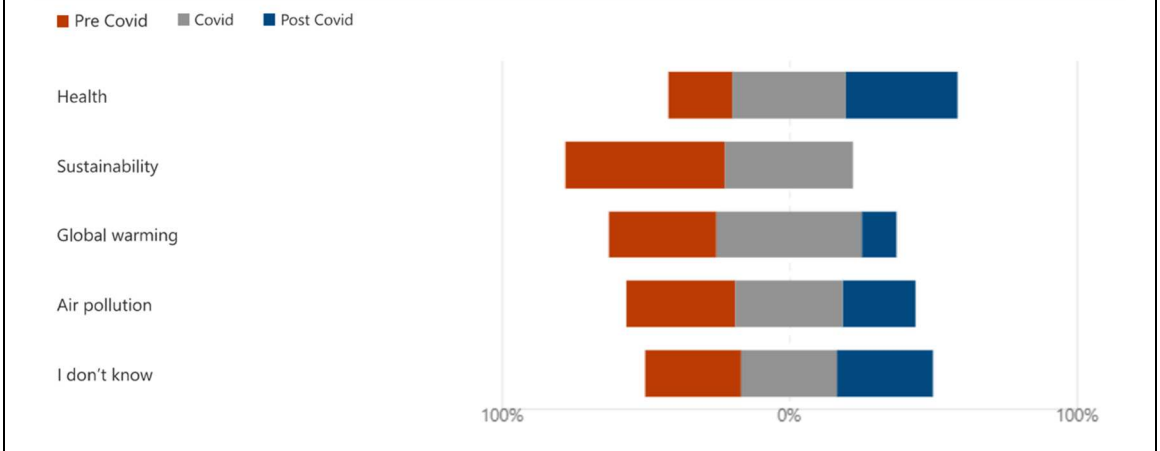


Figure 38. Results in percentages of the travellers survey at airport A4 regarding their awareness about health and environmental issues and the reason for selecting the mode of transport to/from the airport. Figures by Microsoft Forms (Microsoft).

In pre-Covid time, the highest share of preferences was for (i) air pollution, and (ii) global warming. In Covid time, global warming and sustainability were the issues with the highest share of preferences (Figure 38 b). In post Covid future, air pollution and global warming had the lowest share of preferences (Figure 38 b).

The respondents were interviewed about how the above-mentioned issues were related to the world of transportation (Figure 38 c).

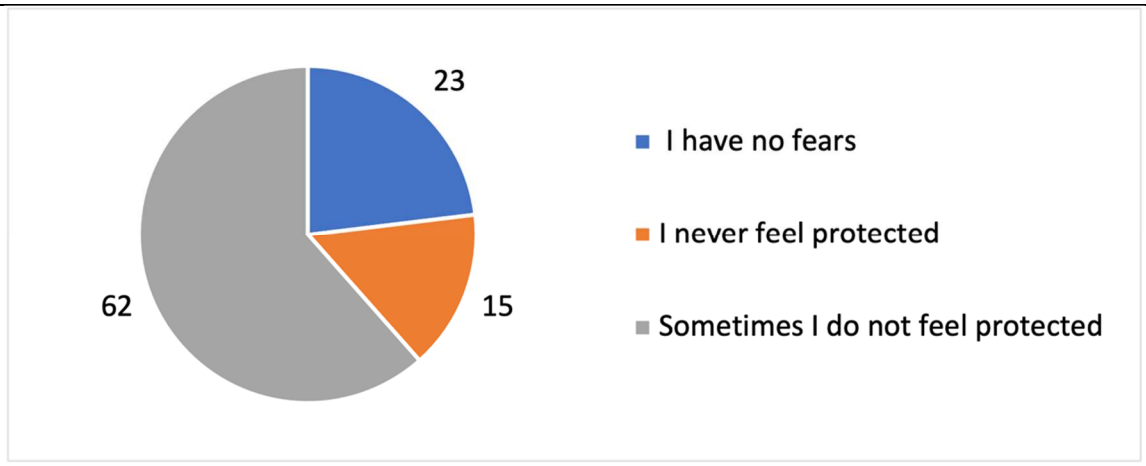
In pre-Covid time, sustainability was the issue with the highest share of preferences. In Covid time, global warming was the issue with the highest share of preferences. In post Covid future, no preferences were expressed for sustainability.

Port authority P1 travellers survey

About the perception of the risk of Covid infection when travelling by public means of transport, most of the respondents sometimes do not feel protected (Figure 39 a). About 23 % of the respondents answered that they do not have fears, whereas only about 15 % of the respondents never feel protected from Covid infection when travelling by public means of transport.

Regarding the options considered suitable by travellers for feeling safe about the risk of contagion (Figure 39 b), about 62 % of the options of the travellers were represented by the sum of being vaccinated against Covid with physical distancing and face mask. About 19 % of the preferences were attributed to avoiding crowded areas. About 20 % of the options of the travellers were represented by the sum of being tested for Covid with the assurance that nearby people got vaccinated.

a) When I travel by public means of transport, regarding Covid infection (tick one)



b) When I travel, I feel protected from the risk of Covid infection if (tick one or more)

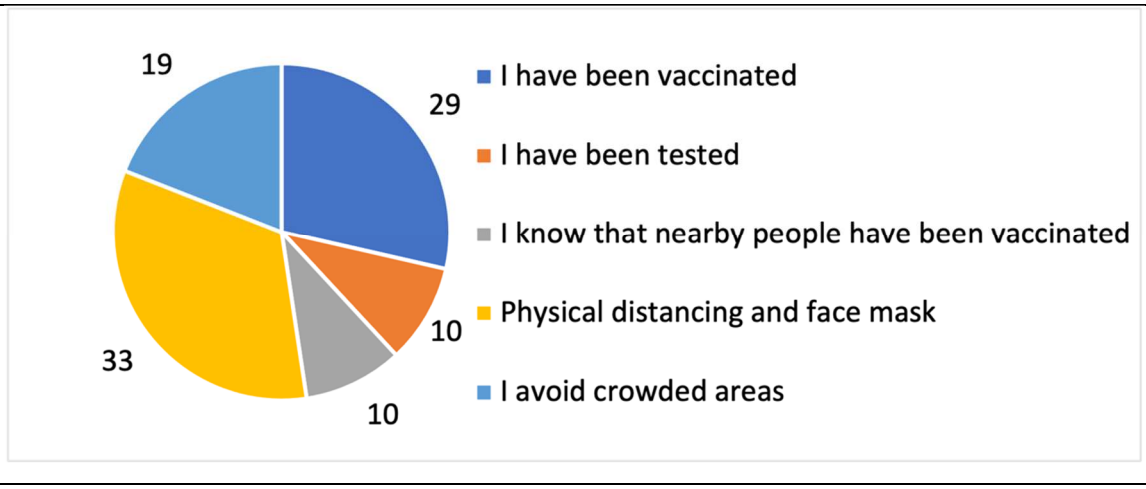
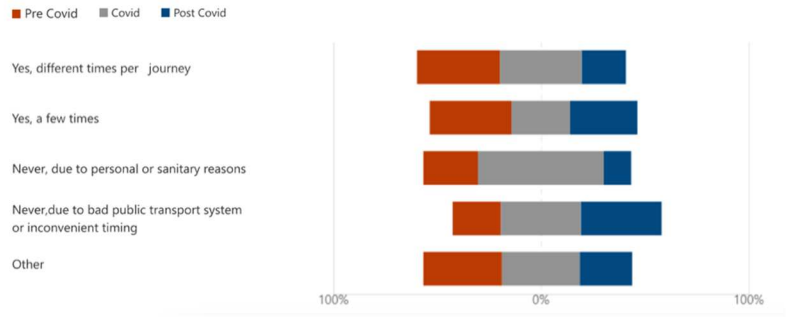
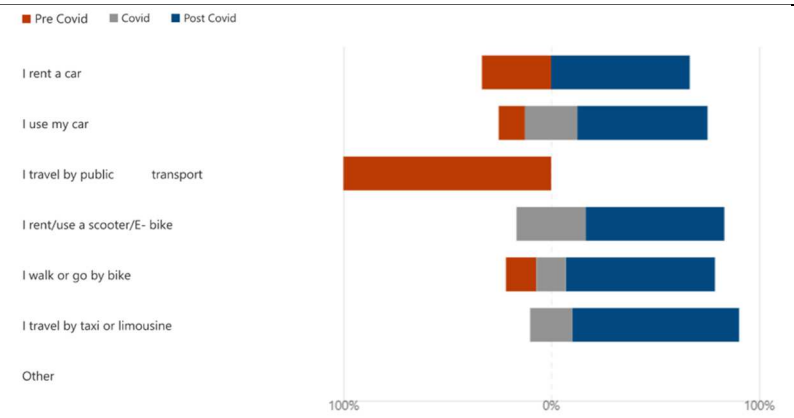


Figure 39. Results in percentage of the travellers survey at port P1 regarding their Covid risk perception.

a) When I travel, I use public transport



b) Which is your favourite means of transport during your stay?



c) You select the location for the journey depending on

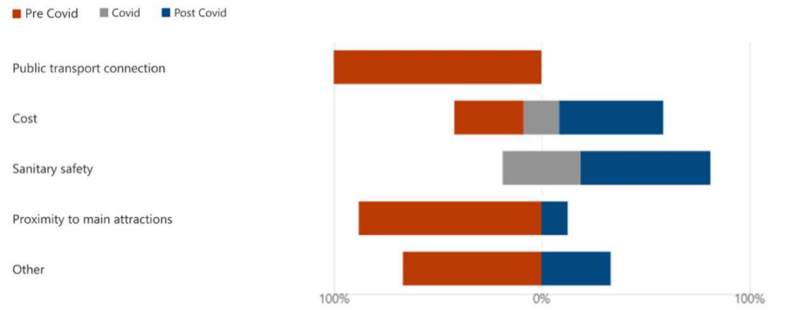


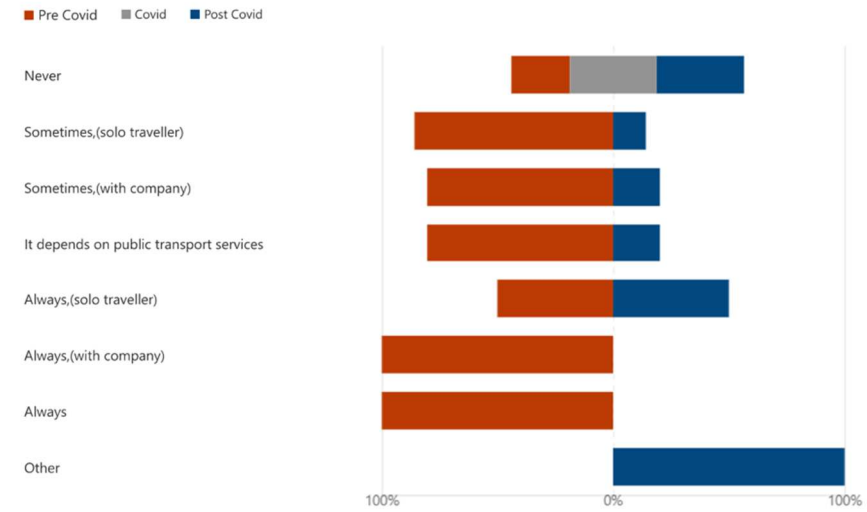
Figure 40. Results in percentages of the travellers survey at port P1 regarding the habit of using public transport in general and the preferences for the location of the journey. Figures by Microsoft Forms (Microsoft).

About the habit of using public transport when travelling, in pre-Covid time the highest share of preferences was for using public transport different times per journey (Figure 40 a). In Covid time, the highest percentage of preferences was for never using public transport due to personal or to sanitary reasons. In post Covid future, the highest share of preferences was for the following answers: (i) never due to bad public transport system or inconvenient timing, (ii) few times, and (iii) other.

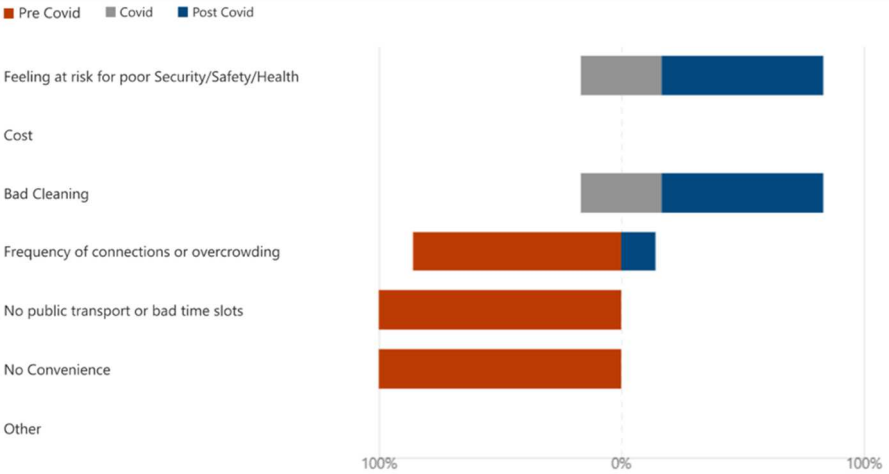
About the favourite means of transport during the respondents' stay (Figure 40 b), in pre-Covid time the most popular option was to travel by public transport. In Covid time, preferences were about the same for the suggested answers. In post Covid future, the highest share of preferences was for the

following answers: (i) use my car, (ii) rent a car, (iii)travel by taxi or limousine, (iv) rent/use a scooter/e-bike, and (v) walk or go by bike.

a) I prefer public transport to/from the port



b) If you do not travel by public transport to/from the port, could you tell the reason?



c) If you travel by own vehicle to/from the port, could you tell the reasons?

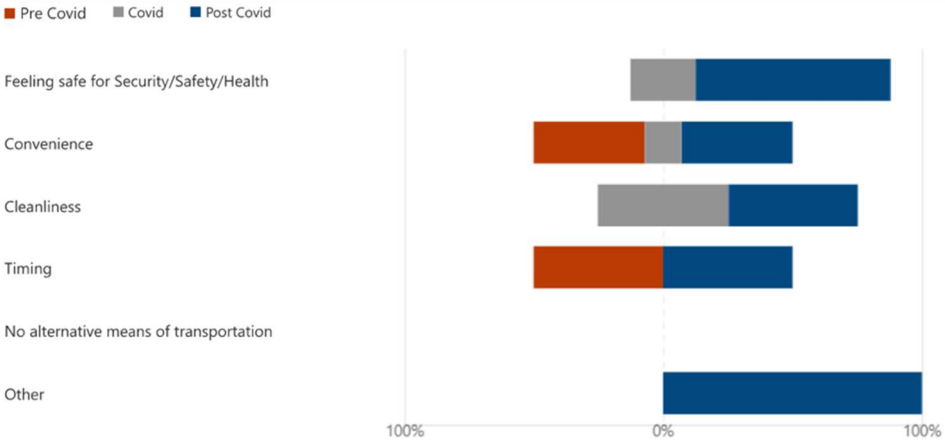


Figure 41. Results in percentages of the travellers survey at port P1 regarding their habit of using public transport or private vehicle to/from the port. Figures by Microsoft Forms (Microsoft).

For selecting the location of the journey (Figure 40 c), the most popular reasons were the following (i) public transport connection, (ii) the proximity to main attractions, and (iii) other reasons in pre-Covid time. In Covid time, the highest share of preferences was for (i) sanitary safety, and (ii) other reasons (Figure 40 c). In Covid time and post Covid future, the respondents expressed the highest share of preferences for the sanitary safety reason (Figure 40 c).

About the preference for public transport to/from the airport (Figure 41 a), in pre Covid time the highest share of preferences was for the following answers: (i) sometimes when travelling alone or with company, (ii) always for the travellers with company, (iii) always, (iv) always when travelling alone or with company, and (v) it depends on public transport services (Figure 41 a).

In pre-Covid time, the main reasons for not travelling by public transports to/from the airport (Figure 41 b), were (i) no public transport or bad time slots, (ii) frequency of connections or overcrowding, and (iii) no convenience. In post Covid future, the highest share of preferences was for (i) feeling at risk for poor security/safety/health, and (ii) bad cleaning.

In pre-Covid time, timing was the reason with the highest share of preferences for travelling by own vehicle to/from the airport (Figure 41 c).

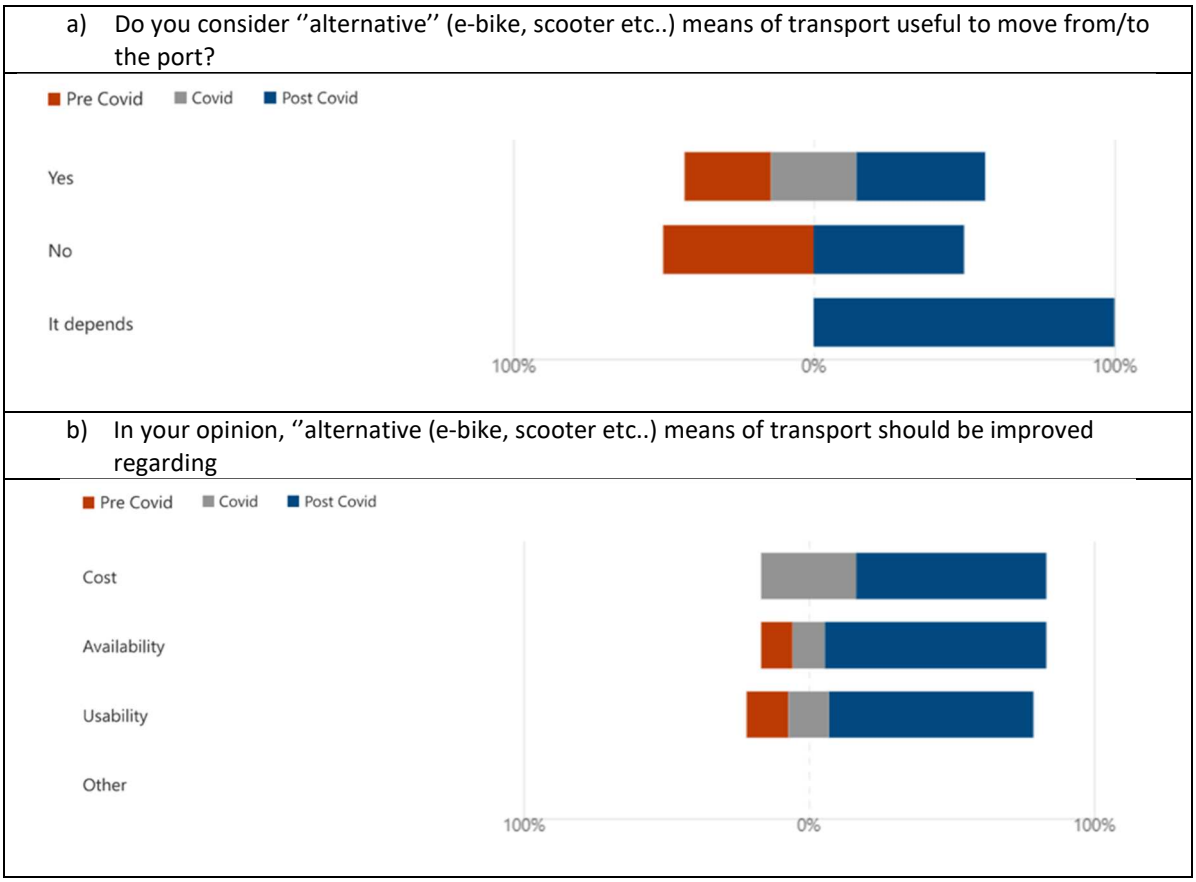
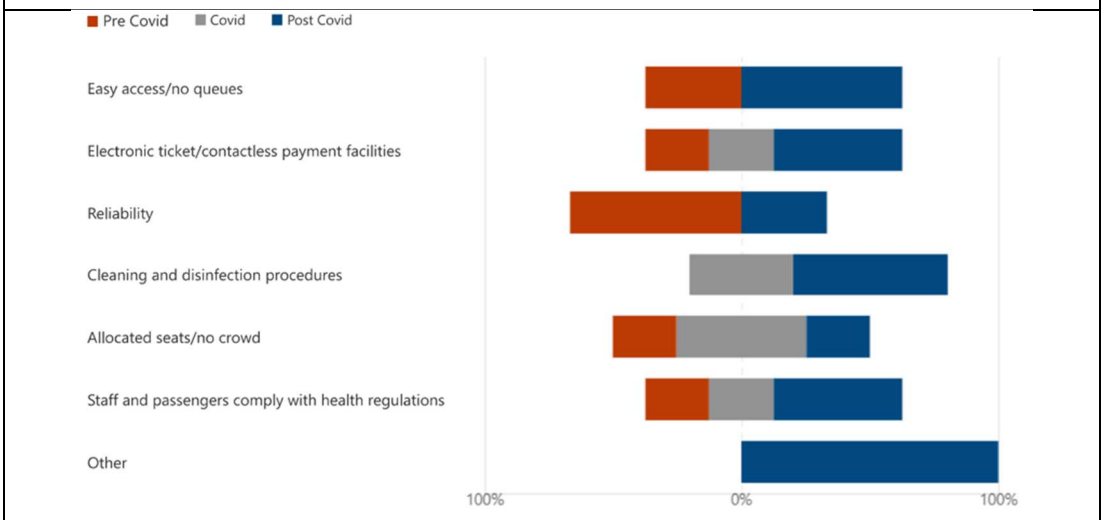
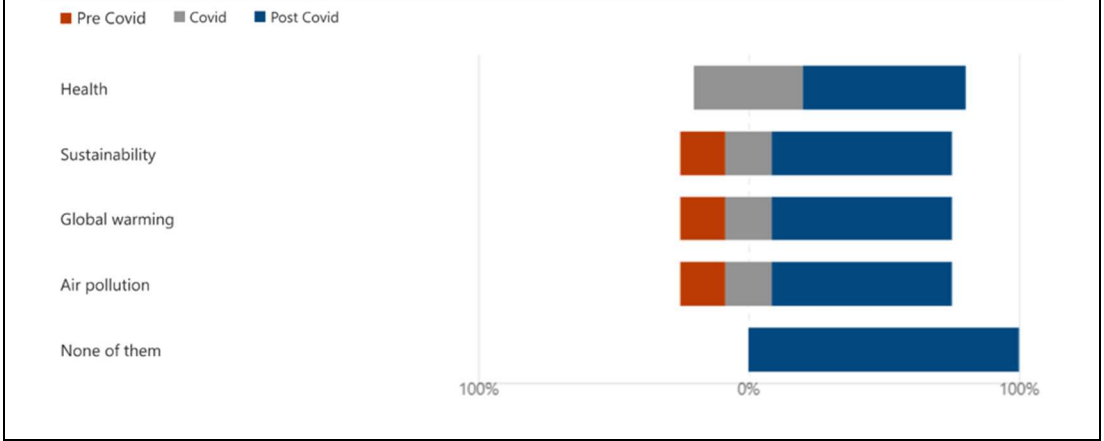


Figure 42. Results in percentages of the travellers survey at port P1 regarding their opinion about alternative means of transportation. Figures by Microsoft Forms (Microsoft).

a) You select the mode of transport to/from the port depending on



b) Do you consider these issues influential to your daily choices?



c) In your opinion, how the same issues are related to the world of transportation?

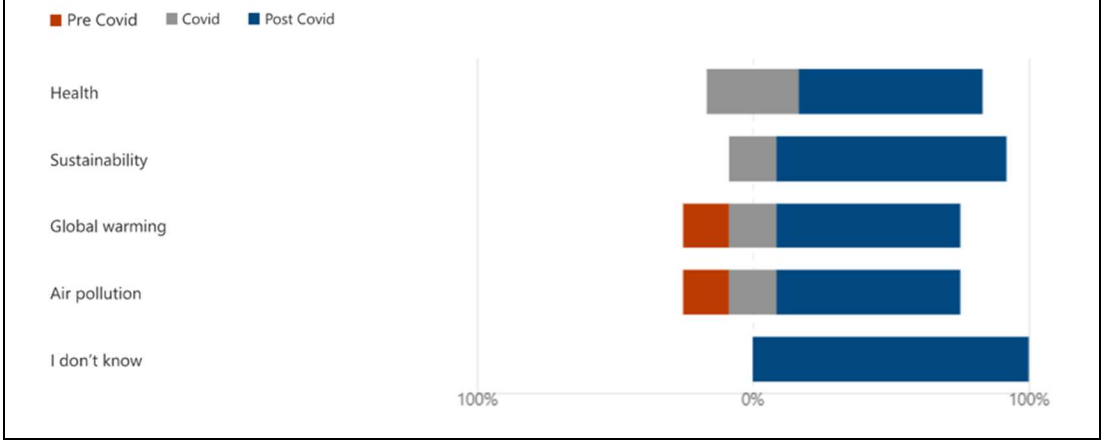


Figure 43. Results in percentages of the travellers survey at port P1 regarding their awareness about health and environmental issues and the reason for selecting the mode of transport to/from the airport. Figures by Microsoft Forms (Microsoft).

In Covid time, cleanliness was the reason with the highest share of preferences. In post Covid future, the reasons with the highest share of preferences were (i) feeling at risk for poor security/safety/health, and (ii) cleanliness, (iii) timing, and (iv) other reasons (Figure 41 c).

In pre-Covid time, the highest share of respondents does not consider alternative means of transport useful to move to/from the port (Figure 42 a).

In post Covid future, the highest share of respondents expressed a conditional or negative opinion about alternative means of transport (Figure 42 a).

In post Covid future, alternative means of transport should be improved regarding the following characteristics: (i) cost, (ii) availability, and (iii) usability (Figure 42 b).

For selecting the mode of transport to/from the port (Figure 43 a), reliability was the reason with the highest share of preferences in pre-Covid time. In Covid time, the reason with the highest share of preferences was allocated seats/no crowd.

In post Covid future, the reasons with the highest share of preferences were the following, (i) easy access/no ques, (ii) electronic ticket/contactless payment facilities, (iii) cleaning and disinfection procedures, and (iv) staff and passengers comply with healthy regulations.

The respondents were interviewed about the issues influential to their daily choices, namely health, sustainability, global warming, and air pollution (Figure 43 b). In post Covid future, the respondents consider the above-mentioned issues as well as other issues influential to their daily choices.

The respondents were interviewed about how the above-mentioned issues were related to the world of transportation (Figure 43 c). In post Covid future, the respondents consider the above-mentioned issues as well as other issues related to the world of transportation.

External costs related to passengers going to/ from airport by road transport

To evaluate the monthly external costs attributable to the passengers going to/from airports A1 and A4, the monthly number of passengers by car and taxi, or bus were multiplied by the average external costs of passenger transport by car or bus and the distances between each airport and the central bus station, as follows:

$$EC_{i,j,l} = d_j \times P_{i,j} \times F_{j,l} \times AEC_l \times 10^{-2}, \quad (1)$$

Where:

$EC_{i,j,l}$ – external costs [€] by road transport with the l-type of vehicle (namely, car and taxi, or bus) for the passengers going to/ from the j-airport (namely, airports A1 and A4) in the i-month of 2019, 2020, and 2021 years;

d_j – distance [km] between the j-airport and the central bus station of the nearby city. For airport A1, we considered the distance of about 7 km between the airport and the central bus station of the nearby city. For airport A4, we considered the distance of about 22 km between the airport and the central bus station of the nearby city;

$P_{i,j}$ – volume of passenger traffic [–] of the j-airport in the i-month of 2019, 2020, and 2021 years;

$F_{j,l}$ – percentage [%] of passenger going to/from the j-airport by the l-type of vehicle. Figure 44 shows modal split in the access to airports A1 and A4 according to the transport offer. For the number of passengers by car and taxi or bus to/from airports A1 and A4, the yearly number of passengers were multiplied by the percentages reported in Figure 44;

AEC_l – average external costs [€-cents/passenger* km] of passenger transport by l-type of vehicle in Croatia. Figure 45 shows the average external costs (excluding congestion) of passenger transport by car or bus in Croatia and Italy in 2016;

10^{-2} – quantity to multiply by €-cents to calculate €.

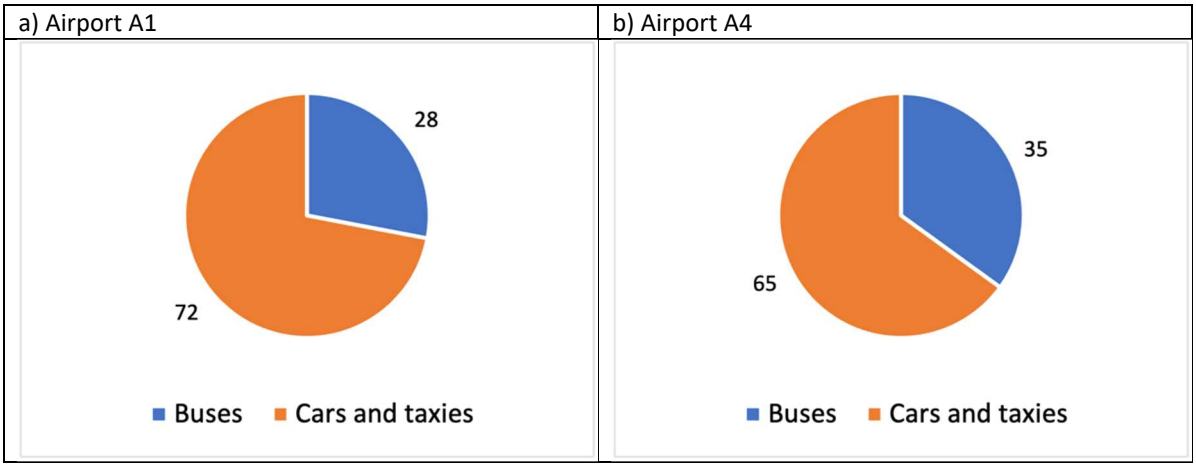


Figure 44. Estimated modal split in the access to airports A1 and A4 according to the transport offer. Own elaboration based on data by Republic of Croatia (2017).

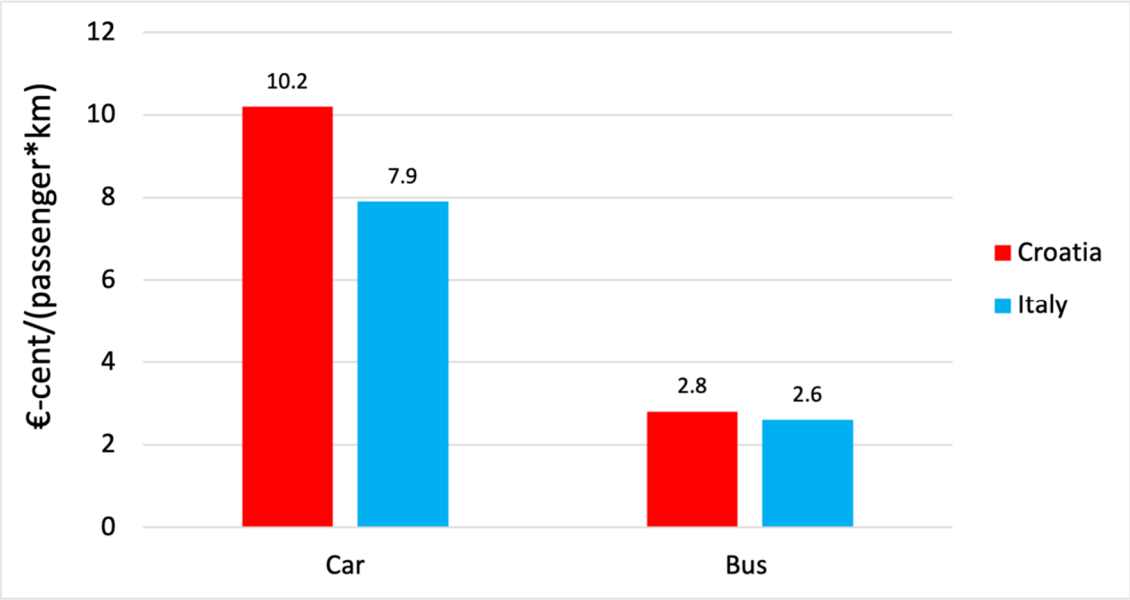


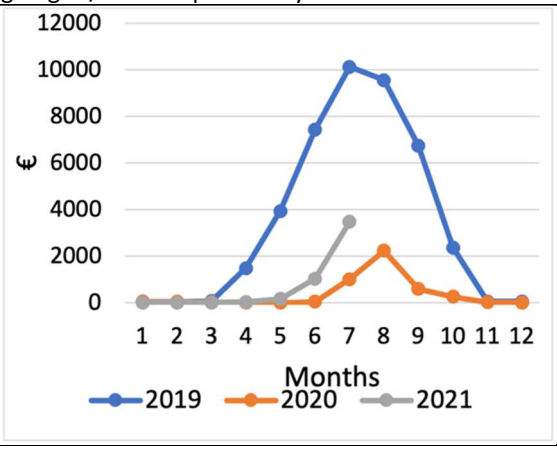
Figure 45. Average external costs (excluding congestion) of passenger transport by car or bus in Croatia and Italy in 2016. Own elaboration based on data from van Essen et al. (2019).

For the passengers going to/ from airport A1, the average external costs by car and taxi were about 9 times the costs attributable to bus (Figure 46 a, b). For the passengers going to/ from airport A4, the average external costs by car and taxi were about 7 times the costs attributable to bus (Figure 46 c, d).

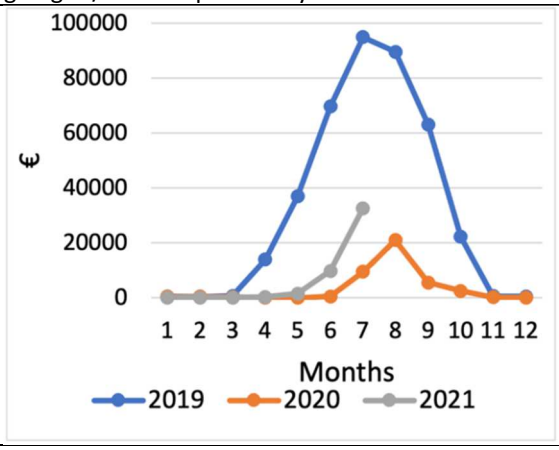
In Covid time, a decrease in passenger traffic led to a similar decrease in percentage of the external costs attributable to road transport. For example, the amount of passenger in 2020 was about 11 % the volume of passenger in 2019 at airport A4. In 2020, the external costs related to passengers going to/ from airport A4 by road transport (i.e., car and taxi, or bus) were about 11 % of the 2019 external costs (Figure 47 b). The same for the first seven months of 2021, with about 18 % of the passenger traffic in the respective time in 2019.

In 2020, the annual number of passengers was about 10 % of the values in pre-Covid time (2019) at airport A1. The decrease in the number of passengers led to the same decrease in the annual external costs with about 10 % of the values in pre-Covid time for the passengers going from/to airport A1 by bus, car, or taxi (Figure 47 a).

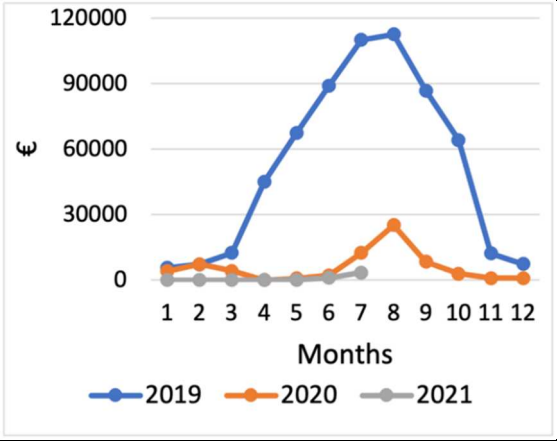
a) Average external costs related to passengers going to/ from airport A1 by bus



b) Average external costs related to passengers going to/ from airport A1 by car or taxi



c) Average external costs related to passengers going to/ from airport A4 by bus



d) Average external costs related to passengers going to/ from airport A4 by car or taxi

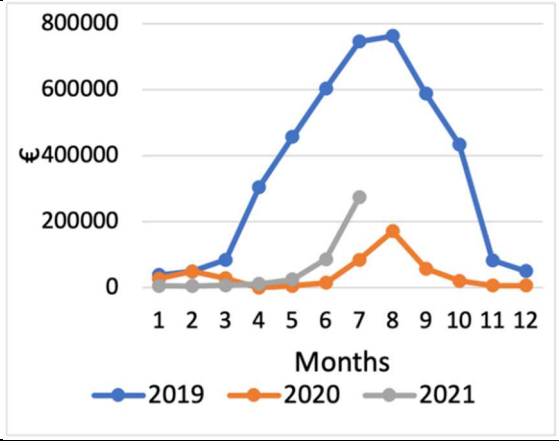
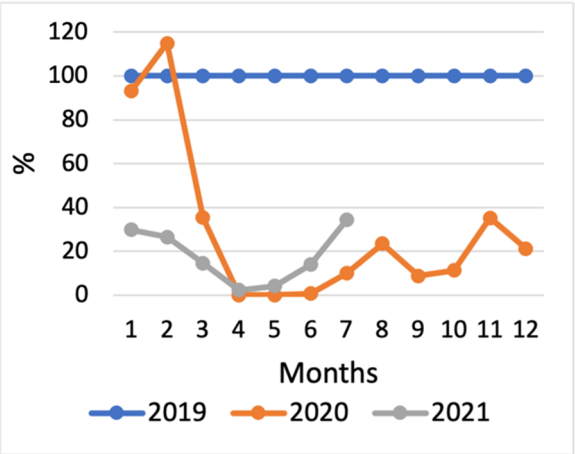


Figure 46. External costs related to passengers going to/ from airport A1 by (a) bus, (b) car or taxi, and to/ from airport A4 by (c) bus, (d) car or taxi in 2019, 2020, and the first seven months of 2021.

a) External costs related to passengers going to/ from airport A1 by road transport expressed as a percentage of the external costs in 2019



b) External costs related to passengers going to/ from airport A4 by road transport expressed as a percentage of the external costs in 2019

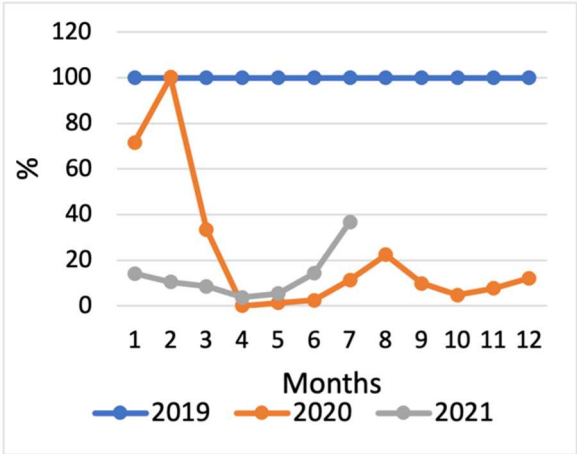


Figure 47. External costs related to passengers going to/ from airports (a) A1, and (b) A4 by road transport (i.e., car, taxi, or bus) expressed as a percentage of the 2019 road transport external costs.

Conclusions

With the onset the pandemic and travel restrictions, passenger traffic decreased sharply at Adrigreen airports and ports in line with the shrink in the volume of national passenger traffic.

At Adrigreen airports there had been a decrease in passenger traffic from March 2020 to May 2021 compared to the respective months in 2019. Notably, in July and August 2021 airports A3, A5, and A6 showed volumes of passenger traffic comparable to the pre-pandemic time.

The Adrigreen ports scored the highest reduction in passenger traffic in the second quarter of 2020, with values between 3 and 11 % of the passenger traffic of the respective period in 2019.

The Adrigreen airport and port authorities were invited to take part to a quick survey for analysing variations between pre pandemic, pandemic, or post pandemic near future. Four airport authorities (i.e., A2, A3, A4, and A5_A6) and two port authorities (namely, P1, and P2) took part to the survey.

During and after the pandemic, two port authorities reported to implement special measures (e.g., information campaign for travellers on compliance with anti-contagion regulations, and reallocation of the external spaces of the terminals to manage flows) that were generally not in place before the pandemic at the terminal buildings.

In post Covid future, a port authority plans to provide alternative mobility solutions such as:

- bicycle/pedestrian paths connected to intermodal hubs or the next city;
- charging stations.

Another port authority reported that alternative mobility solutions (such as e-vehicles and charging stations) were already available before the pandemic and they are going to be so in the future.

There were no substantial changes in the offer of public transport to / from the airports with the pandemic. For all the four airport authorities, no substantial differences can be noted about the availability of alternative mobility solutions such as e-vehicles, car sharing, and electric bicycles/scooters with the pandemic. Differences between pre Covid and post Covid time can be noted for alternative mobility solutions such as bike sharing, charging stations, and bicycle/pedestrian paths connected to intermodal hubs or the next city.

A synthesis is presented of the surveys at two airports (namely A1, and A4) representing the sum of 79 respondents.

About the perception of the risk of Covid infection when travelling by public means of transport, most of the respondents has no fears. Moreover, more than half of the options for feeling safe from the risk of covid infection were represented by the sum of being vaccinated against Covid with physical distancing and face mask.

About the habit of using public transport when travelling, in Covid time the highest percentage of preferences was for never using public transport for travelling due to personal or to sanitary reasons. In pre-Covid time, public transport was the favourite means of transport during the respondents' stay, whereas in Covid time own car or soft mobility solutions were the means of transport with the highest share of preferences.

In pre-Covid time, cost was the reason with highest share of preferences for not travelling with public transport to/from the airport, whereas the highest share of preferences was for feeling at risk for poor security/safety/health in Covid time.

In pre-Covid time, timing was the reason with the highest share of preferences for travelling with own vehicle to/from the airport, whereas the highest share of preferences was for feeling safe for security/safety/health in Covid time.

In Covid time, it-depends-answer had the highest share of preferences for considering alternative means of transport useful to move from/to the airport. In post Covid future, alternative means of transport should be improved regarding cost and availability.

In pre-Covid time, global warming was the most influential issue to the respondents' daily choices. Moreover, sustainability was the issue considered related to the world of transportation with the highest share of preferences.

In Covid time and near post Covid future, a shift in transport mode from public to private modes of transport will likely have higher external costs for Croatia compared to Italy. For example, the average external costs of passenger transport by car were about 2.3 €-cents/(passenger* km) higher in Croatia compared to Italy according to the ''Handbook on the external costs of transport'' by van Essen et al. (2019).

In Covid time and near post Covid future, a decrease in the volume of passenger traffic will likely lead to a decrease in the external costs of road transport to/from the Adrigreen airports and ports. Assuming no changes in the share of passengers going by bus, or car and taxi, a decrease in passenger traffic led to a similar decrease in percentage of the external costs attributable to road transport. For example, in 2020 the amount of passenger was up to about 11 % the volume of passenger in 2019 at two Adrigreen airports. The 2020 external costs related to passengers going to/ from the two Adrigreen airports by road transport (i.e., bus, or car and taxi) were up to about 11 % of the 2019 external costs. Therefore, in near post Covid future the decrease in the volume of passenger traffic will likely act as a buffer for the higher external costs related to any potential shift of passengers from public transport to private vehicles.

Recommendations

Attention should be paid to potential changes in the habits and trends of travellers to modulate the offer of the modes of transport to/from the airport/port infrastructures. Monitoring mobility behaviour, surveys, and analyses should become part of ordinary management of the airport/port infrastructures allocating dedicated resources with the contribution of local and regional stakeholders. The transition to sustainable mobility needs the joint effort of stakeholders, travellers, airport, and port authorities.

On the offer side, the availability of e-vehicles for car sharing could be a solution specifically for the segment of travellers that are not considering public transport as an interesting option to/from the airports/ports. It is likely that the offer of e-vehicles, car sharing, and charging stations would be an interesting offer to better connect the airport infrastructures and intermodal hubs or the next city.

For the ports infrastructures with a location suitable for soft mobility solutions, bicycle/pedestrian paths should be the prerequisite for providing solutions such as e-scooters, e-bicycles, and bicycle sharing to reach intermodal hubs or the next city.

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