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Measures and innovations in airport management for the resumption of tourism in the pandemic

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ABSTRACT: The travel restrictions imposed on air transport due to the pandemic have had socioeconomic impacts in different countries, in addition to the existing negative impacts on public health and the international economy. As airports are the departure points to tourist destinations, there is a need to re-democratize travel to cope with contagious diseases. The main objective of this exploratory study is to propose measures that enable the protection of travelers in airports to reduce or even eliminate travel restrictions imposed by the pandemic. Through a random literature review, as well as the identification of practical cases, this theoretical essay presents measures to contain the spread of respiratory diseases in airports at the strategic management level (such as the review of airport business models), tactical level (such as the identification of the airport innovation index and its priority areas of investment), and operational level (such as constant preventive actions upon the arrival of passengers, visitors, or employees at the airport). It is expected that these measures in airports will encourage safe air transport and the resumption of tourism.

Keywords: Air transport; Innovation management; Socioeconomic development.

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1 INTRODUCTION

The coronavirus disease (COVID-19) pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has caused problems globally for public health (COCCIA, 2021; LAU *et al*., 2021), economy (BEKKERS; KOOPMAN, 2020), and social inclusion (SANTOS; OLIVEIRA; ALDRIGHI, 2021), leading to uneasiness. The issue has drawn the attention of governments and researchers from different nations toward innovations for containing the spread of the disease, especially in relation to travel and air transportation, which mainly involve movement and interactions among people.

The total contribution of travel and tourism to the global GDP has fallen precipitously from 10.4% (USD 9.1 trillion) in 2019 to 5.5% (USD 4.6 trillion) in 2020, a decrease of 49.1%. In the same period, the global GDP retreated to 3.7%. Approximately 60 million jobs were lost worldwide, from 334 million in 2019 to 272 million in 2020. In the case of Brazil, the total contribution of travel and tourism to GDP dropped from 7.7% (BRL 596.9 billion) in 2019 to 5.5% (BRL 402.4 billion) in 2020, a decrease of 32.6%. Meanwhile, there was a 19% decrease in the number of jobs in the sector, from 7.6 million in 2019 (8.2% of total employment) to 6.1 million in 2020 (7.2% of total employment) (WTTC, 2021). Specifically, the aviation sector generates around 840,000 jobs in Brazil and contributes USD 18.8 billion to the country's GDP (IATA, 2021c); that is, the sector has a significant socioeconomic representation. Consequently, any event that interferes with these activities, such as a pandemic, has a significant impact on the generation of employment and income in the country.

Several practical initiatives have been identified to minimize infections and the harmful effects of the pandemic. In Europe, the Digital Green Certificate was implemented — it covers a vaccination certificate, a test certificate, and a certificate of recovery — that can be used in all EU member states to facilitate free internal transit (EC, 2021). In the United States, measures such as the requirement of a negative COVID-19 test (taken within three calendar days of travel), as well as proof of recovery from COVID-19 (within 90 days preceding travel by health care provider) have been undertaken (US, 2021). Even after more than 2 years into the COVID-19 pandemic, there are still extreme cases of entry bans in certain countries. For example, in Japan (JNTO, 2021) foreign visitors, from United States, Germany, and even Iceland, with about 30 deaths registered by the disease (WHO, 2021), need to quarantine for 14 days after arrival.

From the international literature side, there have been several recently published scientific studies on this subject. A large number of Boolean searches were carried out in scientific publications (in 2020 and 2021) databases by the terms "pandemic" and "air transport" (this one in quotation marks): 1,411 documents from the Wiley Online Library base, 576 from Sage, 532 from Scopus, 374 from Science Direct, 112 from Emerald, and 89 from Springer Nature. Although many of these numbers are duplicated, as the same document can be available in two or more databases simultaneously, the significant number of studies on a specific topic such as this during this short period is noteworthy.

Thus, the relevance of the theme has been clearly identified both for the state-of-the-practice and state-of-the-art. Although different studies present strategies and methods to contain the spread of the disease (FURINI; SILVA, 2020; GABER *et al.*, 2009; GOLD *et al.*, 2019; TABARES, 2021; TRENTIN; MORAES; GUIMARÃES, 2020), considering the limited knowledge about this pandemic, there is a need for constant technological vigilance to develop new technologies, products, services, and processes not only to cope with this disease, but also to prepare for and minimize the negative impacts of novel future pandemics.

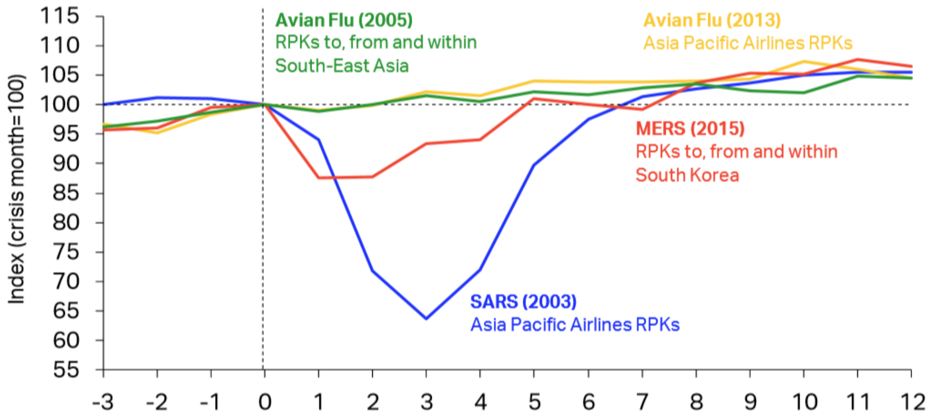
In this context, the main objective of this theoretical essay, developed from publications and practices related to the containment of pandemics in airports, is to propose a framework with initiatives that can guide airport managers in containing the pandemic for the resumption of air transport and tourism. The results would be relevant to developing solutions that enable greater inclusion of people in a safe way for everyone — including travelers who are suspected of being infected — because contagious respiratory diseases are and will continue to be present; thus, it is necessary to learn to live with them.

This paper is organized as follows: Section 2 presents the practical and theoretical proposals related to the containment of the pandemic. Section 3 discusses a framework containing recommendations for the strategic, tactical, and operational management levels of airports to improve the protection of travelers in airports. Finally, in Section 4, the final considerations and recommendations for future studies are provided.

2 PRACTICAL AND THEORETICAL PROPOSALS FOR DEALING WITH THE PANDEMIC

The aviation sector has been impacted from international crises, such as the spread of the highly pathogenic avian influenza (avian flu), SARS, and the Middle East respiratory syndrome coronavirus (MERS-CoV), leading to a significant drop in the number of kilometers traveled by paying passengers — expressed in Revenue Passenger Kilometers (RPK) — as shown in Figure 1.

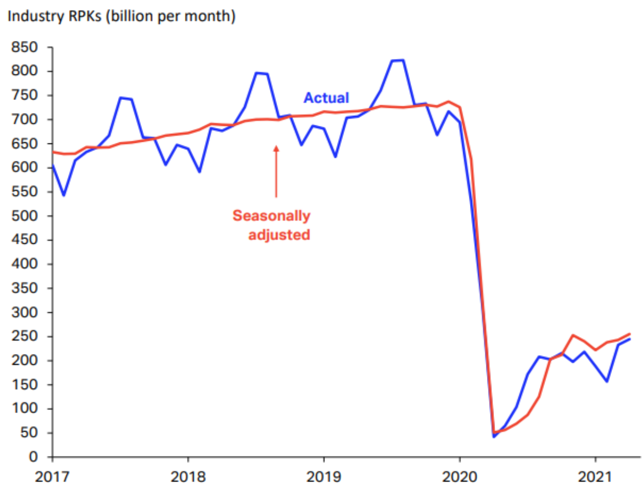
FIGURE 1: MONTHS BEFORE AND AFTER THE START OF THE CRISIS



SOURCE: IATA (2020).

Figure 1 shows the months before and after the start of the crises. It illustrates that the aviation sector recovered after 7 months, which indicates a positive result considering the most recent crisis. However, in relation to SARS-CoV-2, approximately 18 months after its onset, the significant impact on air transport is still visible (Figure 2).

FIGURE 2: AIR PASSENGER VOLUMES (RPKS)



SOURCE: IATA (2021A).

As shown in Figure 2, the sector recovered in this period at the rate of approximately 30% compared to the initial stage, reaching just 250 billion monthly RPKs at the end of the first half of 2021 compared to 830 billion RPKs at the end of 2019. This demonstrates the need for a different strategy for this new exigency.

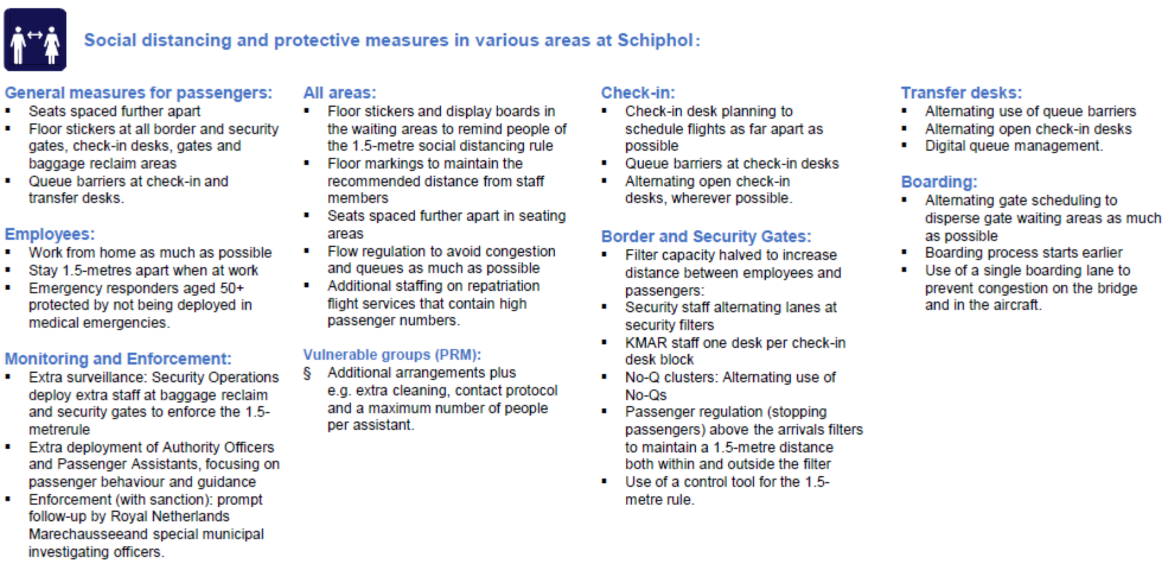
Different proposals have been identified both in practice and in the literature to minimize the impact of COVID-19 on air transport. Studies dealing with the direct relationship between airports and the pandemic have focused on techniques and tools used at airports to identify and reduce the spread of disease. Serrano and Kazda (2020) propose certain measures to increase the paperless process using biometric solutions to ensure minimum human contact.

Further to the health safety protocols proposed by health organizations, several initiatives have been undertaken specifically in the aviation sector and tourism industry. The International Air Transport Association (IATA) and Airports Council International (ACI) present aviation resumption measures among their members—related to aircraft operators, air traffic management, and ground operations—as a joint effort for the preparation and use of management guidance, with suggestions pre- and post-flight (IATA and ACI, 2021). In Brazil, initiatives such as "responsible tourism" ("*Turismo Responsável*," in Portuguese), created by the Ministry of Tourism, have been launched to encourage the adoption of protocols and good management practices to prevent the spread of the disease in establishments in the tourism sector (BRAZIL, 2021).

As a measure to direct certain flights to airports with better passenger screening conditions and lower the chances of spreading the disease, the Tokyo–Haneda International Airport administration advises that passenger flights departing from China or South Korea arriving at an airport in Japan be redirected to the Tokyo–Narita International Airport or Kansai International Airport, which are more than 500 km away from Tokyo (KOBE, 2021).

Simple and immediate actions have also been implemented in different international airports, as in the case of the Amsterdam Schiphol International Airport (AMS). Figure 3 shows the scale-up of business activities that the airport managers adopted, seeking to improve the business through a redesign of processes to increase the number of flights, passengers, and visitors at the airport (SCHIPHOL GROUP, 2020).

FIGURE 3: MAIN MEASURES ADOPTED AT AMS



SOURCE: Schiphol Group (2020).

The measures proposed in Figure 3 are enforced on the passengers, aircraft, airline, and baggage processes, as well as on the landside accessibility and retail, hospitality, and services provided at the airport.

To reduce person-to-person contact during the exchange of documents such as boarding passes, the Ministry of Infrastructure (MINFRA), in partnership with the Federal Data Processing Service (SERPRO), and the Special Secretariat for Debureaucratization, Management and Digital Government of the Ministry of Economy in Brazil proposes an authorization system for passenger access to departure lounges at the São Paulo–Congonhas Airport (CGH) and Rio de Janeiro–Santos Dumont Airport. This is based on biometric control through cameras without the need to present a boarding pass (MINFRA, 2021). Figure 4 shows an example of an access point to the departure lounge with this device.

FIGURE 4: ACCESS TO THE DEPARTURE LOUNGE FROM BIOMETRIC IDENTIFICATION BY CAMERA

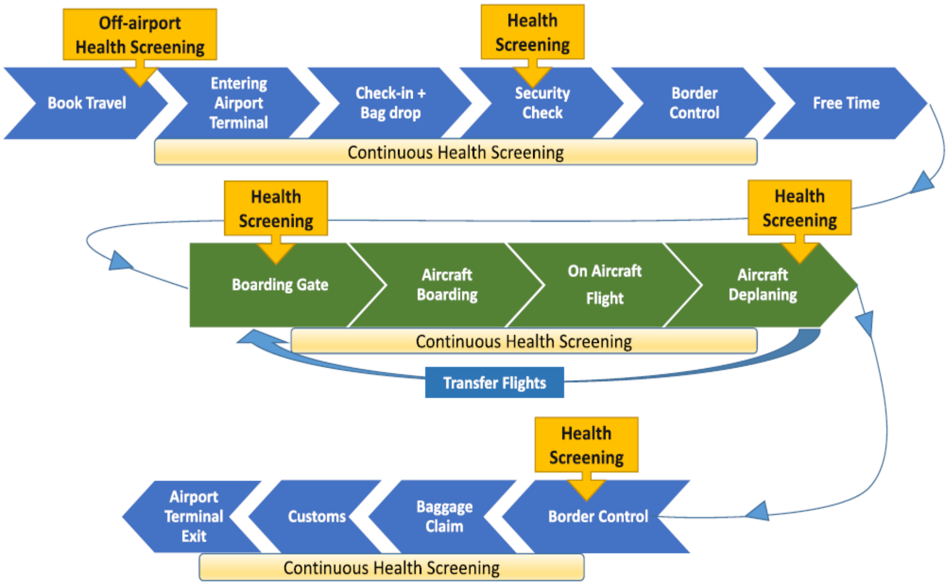
SOURCE: MINFRA (2021).

As shown in Figure 4, the passenger’s facial recognition is processed with their registration photo generated at the time of their check-in. Obviously, the acceptance of the use of these technologies by passengers at check-in must be analyzed at each airport. The study by Negri, Borille and Falcão (2019), with 658 passengers at the airports of the Campinas–Viracopos International Airport, São Paulo–CGH, and São Paulo–Guarulhos International Airport, demonstrates that the probability of using biometrics technologies is 83.23% among passengers who had already used these technologies, and 82.3% among passengers who had never had contact with the biometrics. In contrast, Graham, Kremarik, and Kruse (2020) show that passengers aged 65 or over — who constitute a growing market in tourism due to improvements in quality of life, food standards, and better medical treatments — among the 600 UK residents interviewed, gave least importance to contactless self-service technology when they are at an airport.

Different infectious disease detection techniques for airport terminals have also been proposed, such as blood sampling, serological tests, Polymerase Chain

Reaction (PCR) tests, antigen tests, spectrography (intrusive tests), body temperature measurement by thermographic cameras, respiratory and heart rate tests, or air sniffers (non-intrusive tests). Further, Tabares (2021) suggest carrying out health screening at different possible locations during the entire passenger journey (Figure 5).

FIGURE 5: PASSENGER JOURNEY PROCESSES AND POTENTIAL HEALTH SCREENING LOCATIONS



SOURCE: Tabares (2021)

Besides screening moments of passengers along their journey at the airport (Figure 5), Tabares (2021) also recommends some necessary steps for a pandemic-free airport. These steps include technical advances in infectious detection means with medical validation and automation at the airport facilities, testing to mitigate or replace quarantines, establishment of appropriate industry standards and regulations, adequate health screening responsibility management, worldwide air travel industry stakeholders' commitment, and public opinion demand and support. However, these are generic propositions that do not necessarily have specific applications in certain airports.

To gain insight into access measures in public places such as airports in case of events that gather a large amount of public, it is noteworthy to look at the recent UEFA EURO 2020 European football championship held between June and July, 2021 in 11 cities in different countries—Amsterdam/NZ, Baku/AZ, Bucharest/RO, Budapest/HU, Copenhagen/DK, Glasgow/GB, Munich/DE, London/GB, Rome /IT, Saint Petersburg/RU, and Seville/ES. For said event, several measures were defined regarding travel restrictions and stadium entry requirements. Among these were the obligation to quarantine, providing a negative COVID-19 test result or, in more extreme cases, the EU travel ban for Wales in the case of Amsterdam, and a travel ban or mandatory quarantine period in the case of London (UEFA, 2021). Certainly, in several European airports, such measures also apply in the case of international travel. While most of these extreme measures can be effective, they are believed to be abusive and seriously harmful for tourism.

With a reduction in airport revenues caused by a decrease in passenger movement, some airports have directed their activities to air cargo, as in the case of the London Heathrow Airport (LHR). Despite identifying a reduction close to 90% in the number of passengers, LHR expects a growth of above 1,000% in the number of cargo-only flights in the next few years (LHR, 2021).

Thus, there is a need for strategic planning and management of technological innovations (DODGSON; GANN; SALTER, 2008) with the development of new technologies, products, services, and processes in different areas of airport innovation (CAETANO; ALVES; ALVES, 2021). Such innovations will make the sector immune to the pandemic and other similar diseases that will certainly pose new challenges in the future.

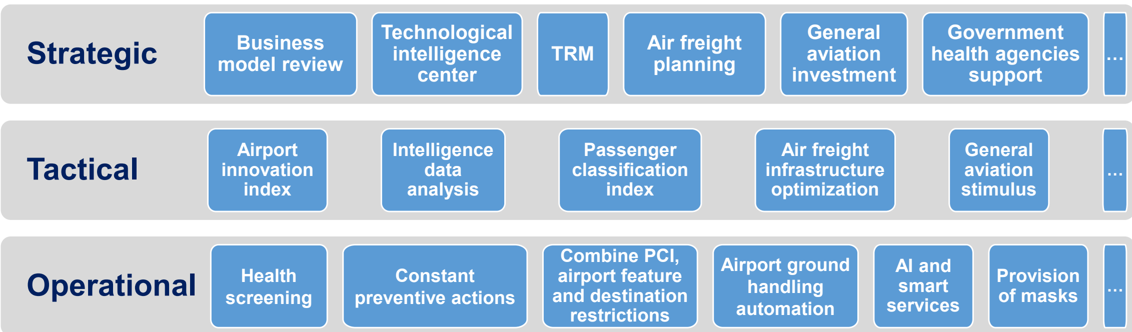
3 FRAMEWORK PROPOSAL FOR AIRPORT INNOVATION AGAINST DISEASE SPREAD

Aside from the proposals already identified in the literature and practice, this framework can support airport managers in establishing procedures to help in maintaining the safety of passengers, visitors, and airport employees, as well as improve tourism productivity through a better planning of innovations in airports for pandemic situations.

Different moments have been considered here, from the strategic planning of the airport to the presence of the passenger in the departure lounge, as the main objective of this proposal is not to limit access to air transport or tourist destinations, but to provide travel conditions for different situations presented by passengers.

The proposed measures are presented at three different organizational management levels of airports, as shown in Figure 6: strategic, tactical, and operational (ANTHONY, 1988).

FIGURE 6: MAIN PROPOSALS FOR DIFFERENT ORGANIZATIONAL MANAGEMENT LEVELS



SOURCE: RESEARCH DATA (2021)

According to Figure 6, each organizational management level has measures that must be enforced at airports, such as the review of the business model and the future planning of the airport at the strategic level, the definition and collection of indicators considered in the actions of the medium term at the tactical level, and the immediate processes carried out at the airport at the operational level, considering only the processing of passengers. Different measures were proposed for each of the three organizational management levels.

3.1 STRATEGIC LEVEL

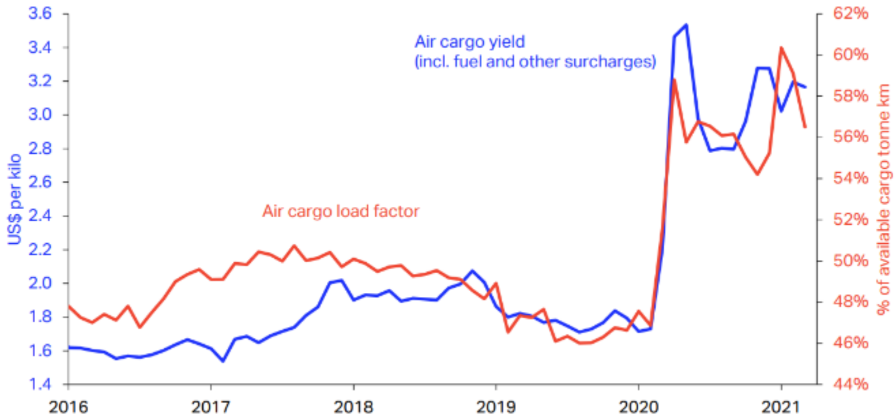
3.1.1 **Business model review**, which should be revised considering the situations of pandemics and disease transmissions, such as SARS-CoV-2, not only as an emergency demand for decision-making but also as a permanent element in the guidelines for the business.

3.1.2 Establishment of a **technological intelligence center** to identify, develop, and implement new solutions in partnership with different research institutions, as well as technology-based companies.

3.1.3 Development and constant review of **technology roadmapping (TRM)** (PHAAL; FARRUKH; PROBERT, 2004) for new products, processes, and services that need to be developed in partnerships with different collaborating and cooperative partners (CAETANO; AMARAL, 2011), such as airlines, the aeronautics industry, passengers, and suppliers.

3.1.4 **Air freight planning** at the airport, taking advantage of the significant growth in the sector obtained during the pandemic, as shown in Figure 7 (IATA, 2021b), to obtain additional revenue for the business. This measure can be executed based on the involvement of different players in intermodal cargo distribution, as well as adopting concepts of innovation applied to air cargo transport (NIINE; KOLBRE; MIINA, 2017).

FIGURE 7: GLOBAL AIR CARGO LOAD FACTOR AND YIELD



SOURCE: IATA (2021b).

According to Figure 7, air cargo transport productivity significantly improved in terms of aircraft occupancy (load factor) and in the yields of transported cargo, despite a fall in the operations of passenger aircraft that are extensively used for cargo transportation.

3.1.5 **Investment in general aviation** to explore the significant market, especially at airports with less traffic. In the Brazilian case, there are 15,573 registered aircraft in the country for general aviation, which are categorized into conventional fixed wings (13.438 or 86%), rotary wings or helicopters (2,078 or 13%), and others, including amphibians (44 or 0.3%)—excluding 640 domestic or international regular commercial aviation aircraft and the 5,665 experimental aircraft identified in 2019 (ABAG, 2020; ANAC, 2020; GAMA, 2020).

3.1.6 **Cooperation agreements between the airport and government agencies** to obtain financial aid for procuring basic items of personal hygiene and protection, such as disinfectants and individual masks—as this is a matter of public health—as well as the availability of public health data.

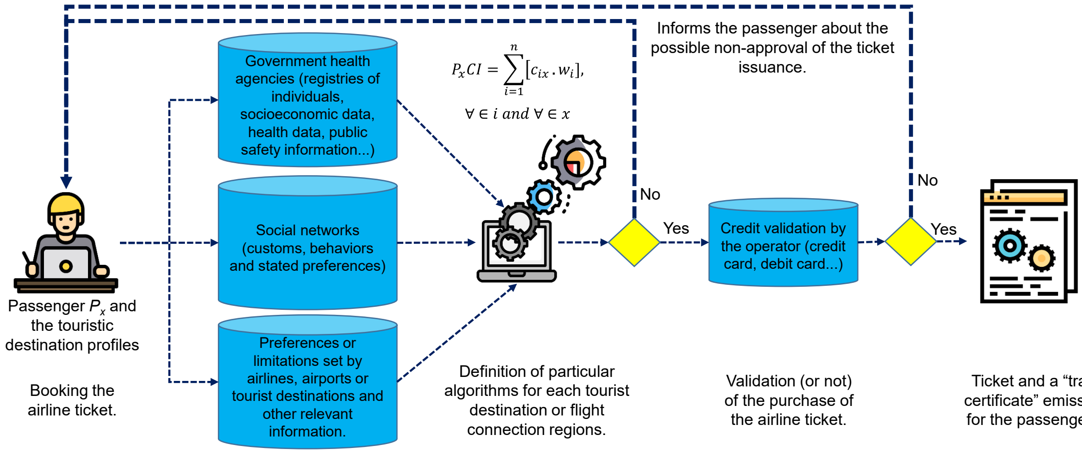
3.2 TACTICAL LEVEL

3.2.1 Identification and monitoring of **airport innovation index** based on operational data or surveys with passengers and airport employees. For this, the proposal presented by Caetano, Alves and Alves (2021) can be used to identify priority areas for airport innovation in passengers and luggage processing, information, communication, passenger services, courtyard and physical elements of the airport, and airport business.

3.2.2 The development of an **intelligence data analysis** on travel restrictions and obligations imposed by different tourist destinations, such as vaccination certificates, along with analyzing consumer behavior to identify the demands and priorities of passengers based on their perceptions of pandemic risks during their travel (GRAHAM; KREMARIK; KRUSE, 2020). Thus, apart from meeting the imposed requirements, it is possible to minimize the negative psychological effects of the pandemic on the traveler by ensuring that airports and aircraft are safe places.

3.2.3 **Passenger classification index (PCI)** is based on the crosschecking of profile data obtained from public health and socioeconomic agencies, social networks, and declarations issued by passengers during air ticket booking. Machine learning resources can be applied for identifying passengers who may present risks to the processes, such as infected passengers or unvaccinated passengers (RODRÍGUEZ-SANZ *et al*., 2021). Figure 8 presents a possible scheme for the flow of data collection and treatment in this classification.

FIGURE 8: FLOW OF INFORMATION TO THE PASSENGER CLASSIFICATION INDEX



SOURCE: RESEARCH DATA (2021).

As shown in Figure 8, when an airline ticket is booked, a series of data about the passenger—such as origin, country of residence, health data, as well as other data provided by government health agencies—in addition to other direct information requested at the time of booking, such as travel restrictions and vaccination requirements, are available. These data are studied using algorithms generated by artificial intelligence (AI), which analyzes and combines data from passenger and tourist destination profiles in real time (IANSITI; LAKHANI, 2020), enabling decision-making by air transport operators.

For the PCI, different classification criteria *c*, and their respective calculated weights *w*, are then mathematically calculated for passenger *x*, as presented in Equation (1), from algorithms that can be devised by machine learning techniques.

$$P_x CI = \sum_{i=1}^{n} \left[c_{ix} . w_i \right], \forall \in i \; and \; \forall \in x. \quad (1)$$

The result of this analysis in case of approval is then redirected to the purchase, and together with the ticket, which can only be a code accessible by electronic device, a "travel certificate" is generated that can be updated or validated moments before the trip. Otherwise, passengers are recommended to adopt certain measures that can meet both the obligations imposed by the airport and the tourist destination such as the constant use of certain personal protective equipment—i.e., a high-performance surgical mask.

It is worth noting that the main function of this "travel certificate" is neither to prevent the passenger from traveling nor to subject him to embarrassing situations. Rather, it is to offer the passenger differentiated treatment in accord with his conditions and possibilities.

3.2.4 **Air freight infrastructure optimization** is a source of additional revenue for airports, simplifying access and obtaining economies of scale when possible.

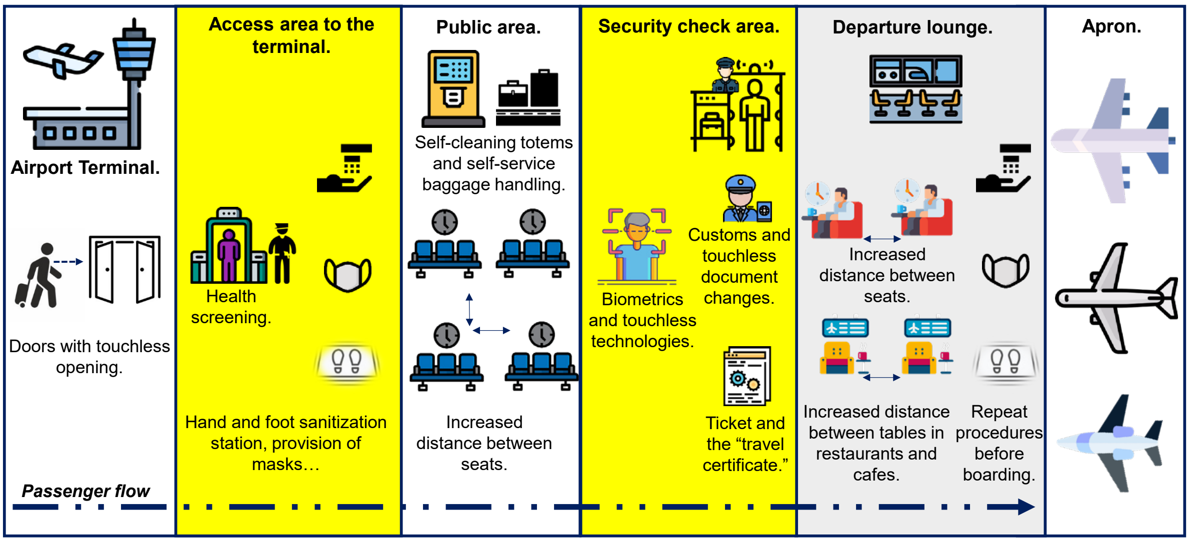
3.2.5 **General aviation stimulus** are exclusive promotions such as the availability of spaces reserved for executive aviation passengers, reduced rates for landing, take-off and aircraft stay fees, and individualized processing of passengers and luggage.

3.3 OPERATIONAL LEVEL

3.3.1 **Health screening** with the measurement of people's temperature by thermographic cameras immediately prior to entering the passenger terminal. In addition to the tests already commonly used at airports such as blood sampling, PCR, and antigen tests, there is a need for the development of new tests that are economical and yield faster results (OLIVEIRA *et al.*, 2021; SILVA *et al.*, 2021), which can be used upon arrival or on the flight. Such information facilitates better decisions regarding an individual in the next operational activities, such as their destination, for a suitable environment within the terminal.

3.3.2 Carrying out **constant preventive actions** upon the arrival of passengers, visitors, or employees at the airport, such as hand and shoe hygiene, touchless doors, maintenance of social distance, and self-services, besides the provision of self-cleaning totems—with touchable surfaces coated with nanotechnology that enables the reduction in their retention of particles. Figure 9 presents a scheme with some of the main operational recommendations.

FIGURE 9: MAIN RECOMMENDATIONS FOR CONSTANT PREVENTIVE ACTIONS



SOURCE: RESEARCH DATA (2021).

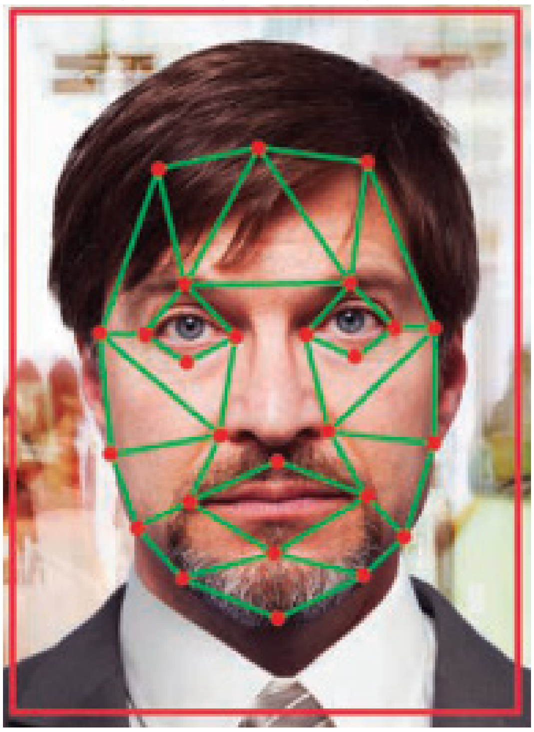
According to Figure 9, alongside the solutions that are already widely used in airports, such as doors with automatic opening, other simple measures can be adopted in areas of identification, health screening, and sanitation (represented in yellow in Figure 9), as well as the readjustment infrastructure in the passenger terminal. These measures provide a wide range of services to people who meet the established health criteria and likewise, to those who do not.

3.3.3 **Combine PCI, airport features and destination restrictions** in defining the best ways to serve passengers during their travel journey, such as offering specific services and providing reserved space for passengers who, for example, do not have a valid vaccination certificate for personal reasons or health restrictions.

3.3.4 **Airport ground handling automation** not only meets the growth of future demands in the sector (TABARES; MORA-CAMINO; DROUIN, 2021) but also reduces baggage handling by operators and spread of contaminants across luggage.

3.3.5 The use of **AI and smart services** in the identification of passengers based on biometric patterns, as shown in Figure 10, to allow access to different areas of the airport or even guide passenger *x* to his boarding gate. Smart services trigger alerts to managers in case of agglomerations above established levels, or intensification of air filtration and robots for cleaning areas with greater occupancy. Automated kiosks can move to areas with greater security for checking in, as well as other smart services through which there may be less dependence on human contact in passenger processing throughout the airport terminal.

FIGURE 10: BIOMETRIC PATTERNS IDENTIFICATION.



SOURCE: SITA (2020)

3.3.6 **Provision of efficient masks** for passengers, visitors, and airport employees, such as the surgical or N95 masks, which according to Cheng *et al*. (2021) significantly reduces the emission of particles into the environment during breathing. Such considerations are depicted in Figure 11a, with the schematic illustration of different regimes of abundance of respiratory particles and viruses, and in Figure 11b, which demonstrates the volume size distributions of respiratory particles emitted during different respiratory activities with and without masks.

FIGURE 11A: DIFFERENT REGIMES OF ABUNDANCE OF RESPIRATORY PARTICLES AND VIRUSES

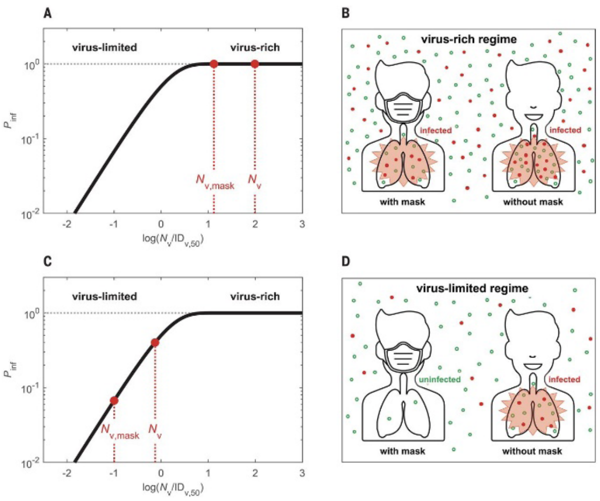
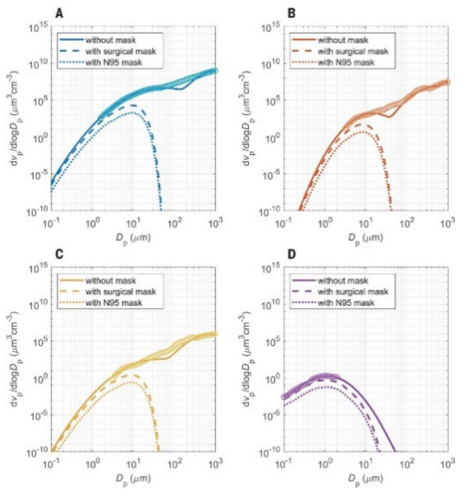


FIGURE 11B: DISTRIBUTIONS FOR SNEEZING (A), COUGHING (B), SPEAKING (C), AND BREATHING (D)



SOURCE: Cheng et al. (2021).

According to Figures 11a and b, in environments with low virus abundance (virus-limited regime), the masks are effective in reducing the spread of the virus. However, even if the use of masks significantly reduces the distribution of particles, in environments with high virus abundance (virus-rich regime), the use of masks should be accompanied with other preventive measures, such as the constant exchange of ambient air—as well as constant maintenance of air-conditioning equipment inside airports—and social distancing (CHENG *et al.*, 2021).

4 FINAL CONSIDERATIONS

Apart from the concerns mentioned in airport management to contain the spread of the disease during the passenger journey across the airport, there is a need to support the business with demand reductions. This includes rethinking financial decisions by reducing operational expenditure, such as searching for strategies to increase revenues through, for example, the concessions of spaces destined for non-aeronautical activities. The search for financial support from governments or optimization efforts for the repositioning of available infrastructure must also be considered, as larger spaces per passenger—owing to social distancing—must be made available at different times (such as check-in, waiting at the lounge, or boarding queue) during their stay at the airport (SERRANO; KAZDA, 2020).

The implementation of such recommendations and constant updates and revisions to procedures can make airports safer from the spread of respiratory diseases. Moreover, the socioeconomics impacts of diseases may be mitigated. These measures allow the reinclusion of passengers into air transport without prejudice or inhumane treatment, and avoid the creation of barriers for travelers who do not meet the sanitary conditions imposed by the different tourist destinations.

Certainly, such measures require additional efforts, such as the involvement of different airport stakeholders in the decisions, as well as the review of airport planning manuals that address the level of service and necessary infrastructure made available by institutions such as IATA and International Civil Aviation Organization.

Further, in a complex organizational environment such as the airport, there is also a need to constantly maintain a culture of innovation at all organizational management levels (strategic to operational), with collaboration among all stakeholders. An innovative culture is essential not only for the airport managers but also for the entire tourism chain, including the service providers in the airport facilities, in tourist destinations, and the tourist itself. This is one of the major factors for the effective protection of travelers against disease. The review of strategies in facing this pandemic and future ones must be conducted constantly to avoid major damage in the future, in relation to negative socioeconomic impacts and the physical and mental health of passengers.

Declaration of Interests

The Author declare no conflict of interest.

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