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Resilience due to Diversity: Academic Concepts for reorganizing post-COVID-19 Air Travel

Working paper

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Abstract

The pandemic of the coronavirus SARS-CoV-2 influences the entire aviation system tremendously. It is already foreseeable that air travel will not be the same in the post-COVID-19 world; still we face high uncertainty in that regard. Among other aspects, novel operational concepts are necessary to ensure social distancing for passengers and employees to minimize transmissions. A trend of airline consolidation is possible, requiring business model innovations. Other aspects to consider are airport security processes, the door-to-door air travel chain, and an increasing demand for bundled travel products and personal travel planner.

This discussion paper reviews novel operational concepts supporting an efficient air transport system in the post COVID-19 world aiming to regain passengers' trust into air travel. Three operational concepts are discussed in detail: (1) an approach towards a novel business model, (2) a travel assistant application, (3) continuous screening measures. Holling's adaptive cycle is used as the underlying theory, showing how air transport players can build up their resilience capacities towards shocks, such as the COVID-19-crisis. Based on the adaptive cycle, it is elaborated that diversity plays a key role in restructuring systems. It is exemplified how academic ideas and concepts can support the aviation industry to fight COVID-19.

Keywords: *adaptive cycle; future aviation; post-COVID-19; pandemic; resilience*

1. Introduction

The coronavirus SARS-CoV-2 pandemic influences industries, humans, and everyday lives around the world. Globally, more than 18 million people are infected[1] by the coronavirus at the beginning of August 2020, with infection rates still growing daily (Johns Hopkins University, 2020). The World Conference on Transport Research Society labels the crisis as *" [...] clearly the biggest social and economic shock since the Great Depression"* (WCTRS, 2020), also affecting the air transport system tremendously. Compared to last year, global flight activities were in spring 2020 decreased by around 80%[2] (IATA, 2020; Pearce, 2020b; SITA, 2020), showing the direct impact of the pandemic on the air transport network. Over 65.5 million direct and indirect jobs are connected to this very sector (Air Transport Action Group (ATAG), 2018). At the same time, air travel can contribute to the global spread of the coronavirus (Daon, Thompson, & Obolski; Gold et al., 2019).

The long-term implications of this crisis are still uncertain. We do not know how flight patterns and travel behavior of passengers might change in the end. The World Health Organization (WHO) warns of the coronavirus that might not go away and develops the status of an endemic (WHO, 2020a). Conversely, we do know that airlines need to operate cost-efficiently, consider increasing safety and security requirements, but also have to keep environmental goals in mind (SITA, 2020). Novel operational concepts and supporting activities are necessary to ensure social distancing for passengers and employees to avoid contamination and minimize infection rates. At the same time, players are predicted to leave the market and the trend of airline consolidation is possible, requiring new business model approaches. Over 200 airlines are headquartered in Europe with the top 20 players already covering 70% of the total offered seats[3] (OAG Official Airline Guide, 2018). Hence, there is a long tail of relatively small airlines, which might not survive the crisis and merge with larger players on the market. Acquisitions but also market stimulation packages are, however, also a chance for businesses to reorganize.

Questions arise how post-COVID-19 air travel could possibly look like; and which concepts and ideas can support cost-efficient, safe, and environmentally friendly operations. First official

[1] Including confirmed cases and recovered cases.
[2] Spring 2020 vs. spring 2019.
[3] Based on schedules flight data 2018.

guidelines, covering some requirements, are already provided by international associations (IATA, 2020; WHO, 2020b). This discussion paper elaborates on novel operational concepts developed by scholars. We aim to shed some light for two pressing challenges: *how can the air transport system reorganize to regain passengers' trust, and how to keep operations running in the post-COVID-19 world.*

The paper aims to show that academic work can also provide support to innovate, adapt and emerge successfully from exogenous shocks, taking the COVID-19 pandemic as an example. As an underlying theory, we use the theoretical framework of resilience theory provided by Holling (Holling, 2001), which is presented in Section 2. Next to many solution proposals, three operational concepts are outlined in more detail in Section 3: (1) a novel business model approach, (2) a travel assistant application, (3) a concept for continuous screening measures. A discussion and further research are delineated in Section 4. Section 5 concludes this paper.

2. Resilience dynamics: infinite adaptive cycle

Systems, such as the air transport system, are constantly changing in a non-linear way. To understand the resilience of a system towards crises, we apply the resilience theory by Holling (2001)[4] using systems thinking. Holling describes resilience as the *"[…] never-ending adaptive cycle of growth, accumulation, restructuring, and renewal"* (p. 392). These four phases (Fig. 1) for undergoing change are defined as (r) exploitation, (K) conservation, (Ω) release, and (α) reorganization. Originally coming from the field of ecology, Holling's resilience concept is also discussed in the light of social systems (Amundsen, 2012; Fath, Dean, & Katzmair, 2015). In the context of this paper, we apply the adaptive cycle metaphor to the air transport system.

[4] An in-depth discussion of the model can be found in Holling (2001).

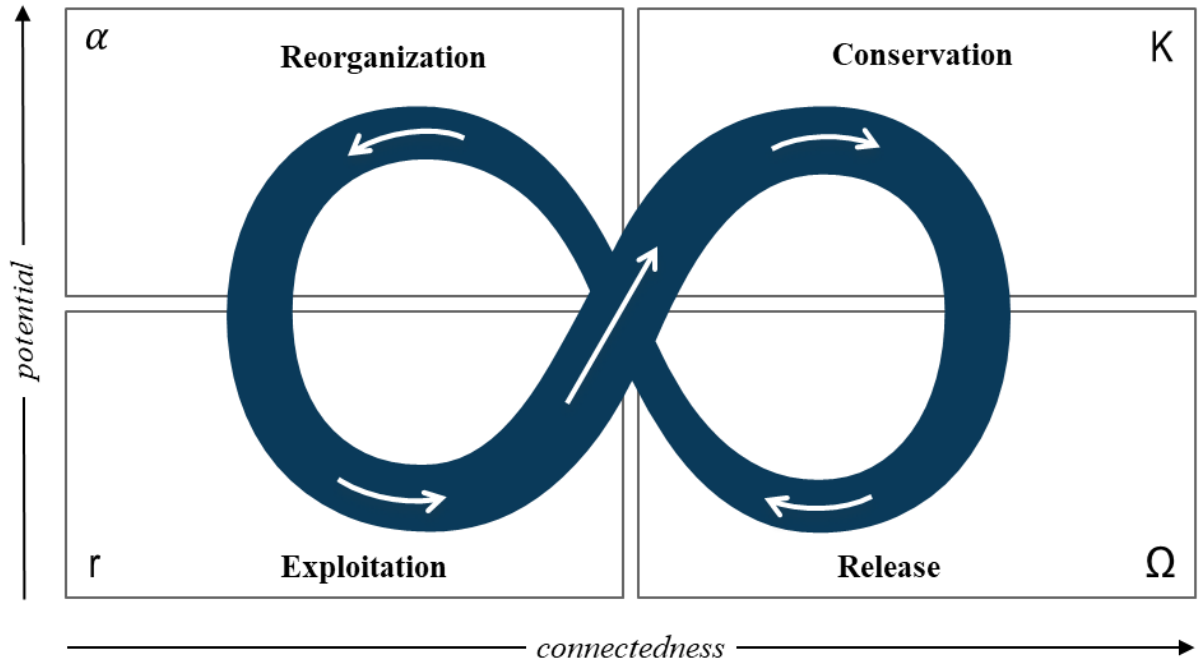

Figure 1: Four phases of the adaptive cycle (adapted from Holling, 2001, pg. 394).

Holling defines resilience to be achieved by adaptive capacities. We assume that the air transport system is currently in the stage of (Ω) release, facing extreme disturbances due to the COVID-19 crisis and the direct and indirect implications on air travel. The system in this phase needs to survive while maintaining its vital functions (Fath, Dean, & Katzmair, 2015). From Holling's perspective, actors in the system can also define a crisis as an opportunity for innovation and restructuring, entering the next phase of (α) reorganization.

To reach the next phase and overcome the crisis, it is advised by theory to seek input from various resources and to leverage diversity. One approach to put that thought into practice is, as we argue, to seek support from academia. Other research already explored the positive relationship between organizational resilience capacity and internal work unit diversity (Duchek, Raetze, & Scheuch, 2019). Hence, we argue to leverage diversity of sources for developing novel operational concepts, such as by seeking support from academia.

The examples below shall provide thoughts how the air transport system can work forward using the theory of the adaptive cycle with insights from academic work. In the next section, we discuss how such opportunities can be a rethinking of the airline business model (example one), the use of

passenger mobile applications in the light of post-COVID-19 travel (example two), and operational health concepts (example three).

3. Innovation and restructuring of the air transport system (operational concepts)

The industry side has also reacted in different ways to enable air travel in the post-COVID-19 world in line with health and hygiene requirements, such as masks on board, keeping the middle seat free, or transforming the cabin for cargo operations (IATA, 2020b; STAT Trade Time, 2020). The following section proposes possible operational solutions developed by academics.

3.1 Example one: novel business model approach

Since the airline sector may be subject to significant changes and challenges as discussed in the introduction, new approaches to rethink existing business models can exhibit several opportunities. With severe overcapacities as well as many players leaving the market already today or in the near future, new models that ensure a competitive market and economic-feasible operations are required. Most recent data shows the steep decline in Revenue Passenger Kilometers (RPK) and the very slow recovery path within the first months of 2020. Forecasts by the International Air Transport Association (IATA) further predict pre-pandemic RPK levels not to be attained before 2024 (International Air Transport Association (IATA), 2020), thus severely affecting airlines' revenues now and in the future. More bankruptcies and increased market consolidation on the airline market are consequences of this.

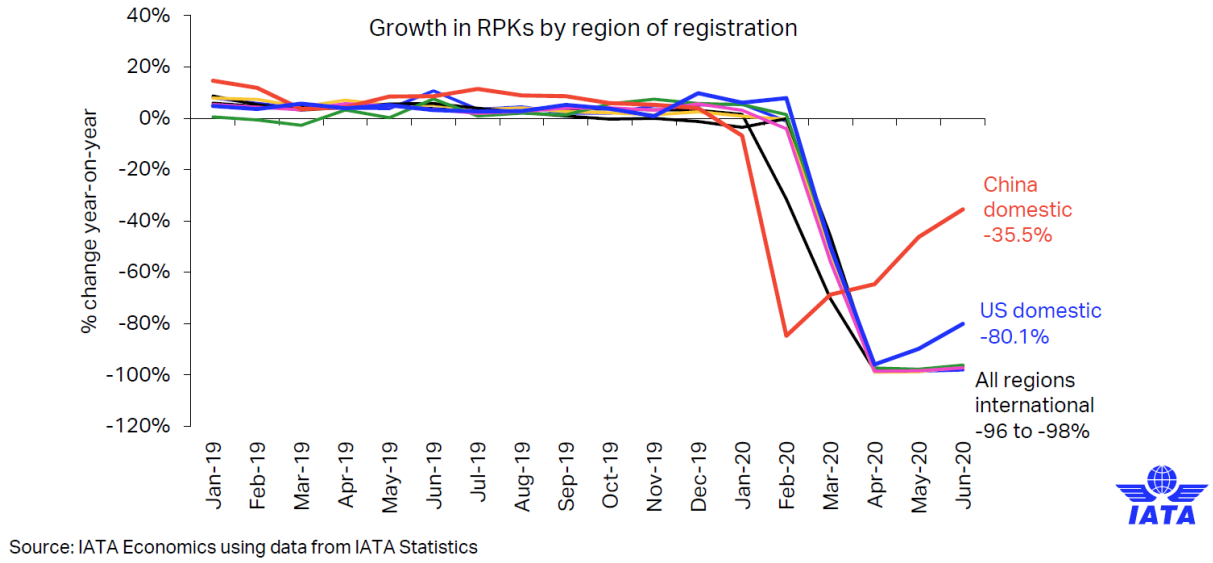

Figure 2: Revenue Passenger Kilometer growth by region (source: International Air Transport Association (IATA), 2020).

Furthermore, an analysis of current load factors shows that these are at historically low levels with 62.9% domestically in June and 38.9% internationally, on average (Pearce, 2020a).

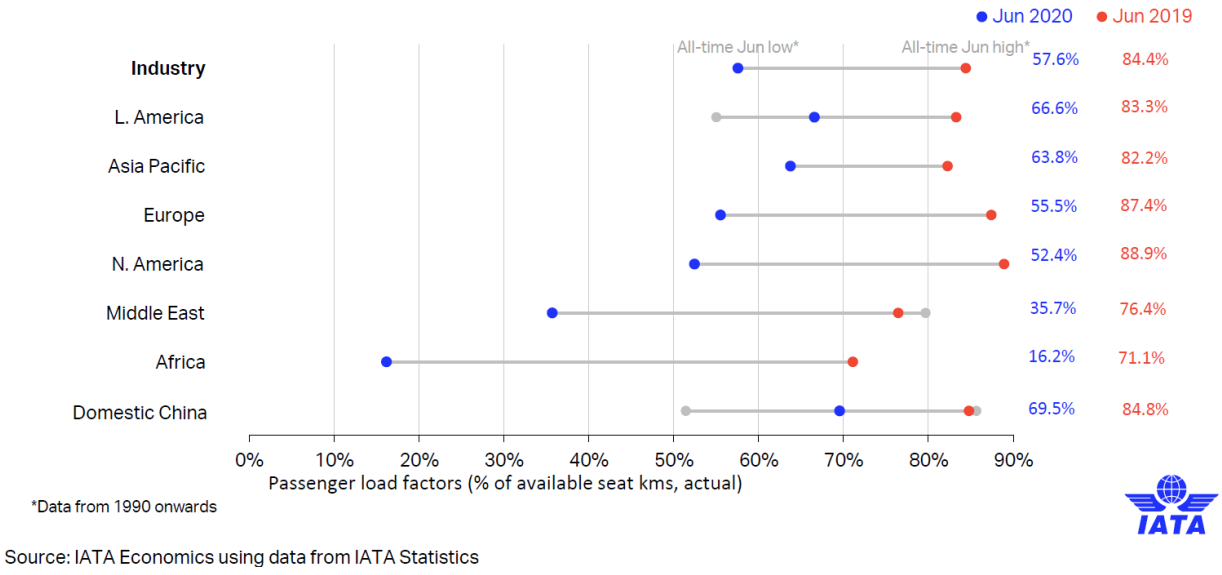

Figure 3: Average aircraft load factors across regions (June 2019 vs. June 2020) (source: (Pearce, 2020a).

One major challenge in the coming years will be the efficient use of available capacities across airlines. Introducing a sharing platform, as depicted in Figure 4, and moving away from the current airline-aircraft ownership model can lead to a better use of aircraft capacities[5] (Plötner, Rothfeld, Urban, & Hornung, 2017a; Plötner, Urban, & Hornung, 2017b; Steinweg et al., 2020). In other words and given uncertainties in travel demand and travel patterns, a novel business model can support efficient operations of aircrafts in the post-COVID-19 world.

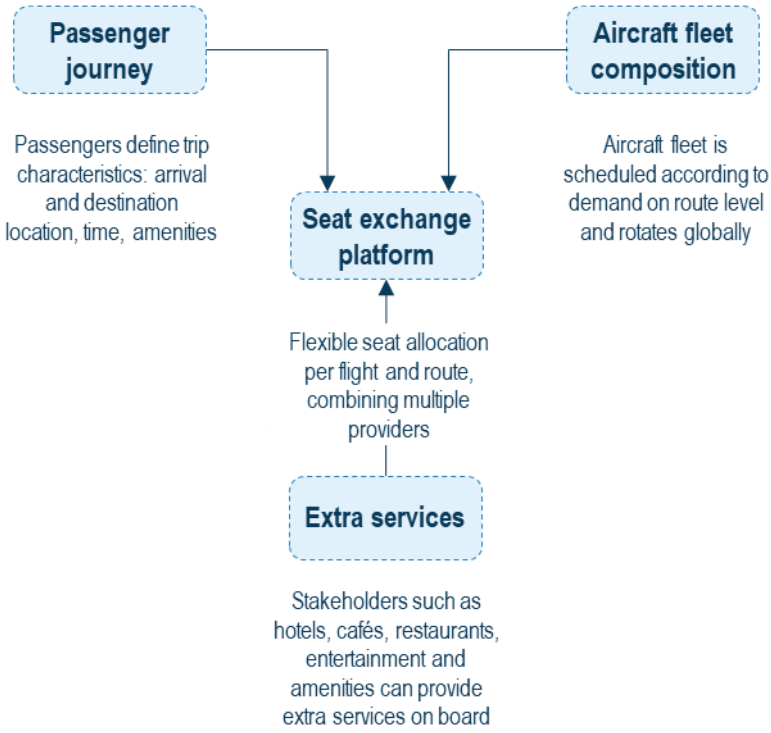

Figure 4: Elements of a seat exchange platform in aviation (source: Paul et al., 2019).

On the long-haul market, for example, the analysis of passenger load factors on airline level shows that, on average, 20% of seats were already empty pre-COVID-19 (Sabre Data & Analytics Market Intelligence, 2016). Due to the pandemic, the load factors have steeply declined as highlighted in Figure 3. Pooling the post-COVID-19 demand in a better way may therefore enable a more efficient use of available capacities, and exhibits an approach to deal with uncertain air travel

[5] These aspects have been addressed in the Bauhaus Luftfahrt Hy-ShAir project; more information can be accessed here: *https://www.bauhaus-luftfahrt.net/en/topthema/hy-shair/.*

demand in the near future. This can be enabled by introducing sharing concepts as they are applied in other (transport) sectors, e.g. car or ride sharing.

The main element of such a new approach in the aviation sector would be the introduction of a seat exchange platform. Aircraft and seat capacities are not operated by individual airlines but shared via a common platform. Seats on a flight can hence be rented by different providers and then sold to passengers. These define their journey by determining their origin and destination; demand between these points is then pooled across multiple providers in order to obtain high aircraft utilization on a route. Those aircraft types can be employed that best fit the required range and passenger capacities, thus enabling a more flexible allocation of resources. An airline does not have to own or lease a whole range of assets, i.e. a diverse aircraft fleet, in order to operate short and long-haul connections (Steinweg et al., 2020). Sharing aircraft across providers in a much more flexible way than we see today may therefore be a feasible business option to be considered post-COVID-19, and potentially reduce the associated risks for individual operators. A first step towards this would be to understand in a detailed way the requirements towards and changes of today's system.

Considering the long-haul market one more time, flexibility of aircraft design in terms of cabin layout for passengers and cargo may become even more important in the future. In the phase of the pandemic, connecting regions by supplying medical products and equipment is of utmost importance. Being able to use aircraft capacities for these services can ensure some business for individual airlines. The adjustment of these capacities in terms of passenger cabins may provide new opportunities in the future as well. A 3-deck passenger concept[6], for example, can include two upper-decks with passenger seating space, and a lower-deck cargo compartment being used for additional passenger services such as sleeping cabins, family areas or working spaces (Paul et al., 2019). These lower deck services can be offered in containers which could be exchanged, just like today, at the airport and those services can be included which meet the demand of passengers on board. Introducing more flexibility in the types of services offered during the flight may also reduce some risk for providers in times of exogenous shocks.

[6] A 3-deck configuration is not necessary for the use of the underfloor. For instance, in the A340-600 at LH there are toilets in the underfloor.

3.2 Example two: mobility integrator reducing touch points

Other aspects to study are entire door-to-door (D2D) air travel chains with regard to bundled travel products and the reduction of touch points for the demand side. Considering air passengers' D2D travel is predicted to become increasingly important in the future, along with the digitalization and personalization of the journey (Kluge, Ringbeck, & Spinler, 2020). Supporting the D2D travel experience, mobility integrators allow passengers to conduct several travel tasks and duties in one application (Schulz, Gewald, & Böhm, 2018). Such travel applications can be installed on personal devices, only accessible by passengers. Tasks such as booking, check-in, rebooking, itinerary search, checking flight status, updates on queues status, booking on-board services, and others can be conducted at own pace and remotely (Höser & Kluge, 2020). Such applications reduce touch points and human contact for the demand side and hence the contamination and infection rate. It is also possible to create the entire travel chain according to certain criteria (low number of persons per compartment/ trip, warnings if airport access and egress modes (trains, busses) are overcrowded, avoiding transfers, etc.), increasing passengers' safety throughout the journey.

Several applications supporting these services are already on the market today. Höser and Kluge (2020) propose a theoretical concept for a Virtual Travel Assistant (VTA) covering the entire door-to-door air travel chain. Originally developed to support intermodal and seamless air travel, the proposed solution can be of high relevance for post-COVID-19 air travel. Using advancements in modularization, local computation, and network monitoring, the VTA focuses strongly on users' privacy, aiming to integrate the entire travel chain and to provide as much remote travel services as possible. Without only focusing on air travel, passengers benefit from a touchless journey, starting when leaving their homes or accommodations to travel to the airport. Main pillars and solution building blocks of the VTA-concept are summarized in Figure 3.

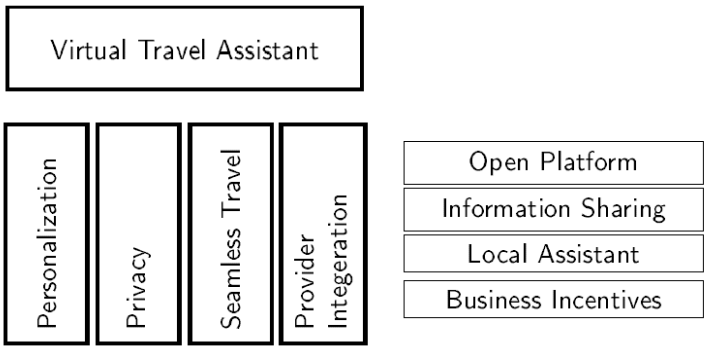

Figure 5: Main pillars of the VTA-concept (source: Höser & Kluge, 2020, pg. 11).

In the light of possible required personal data (such as by launching concepts like the health passport), preserving passengers' privacy can become a main requirement for mobility integrators and of upmost importance for the demand side. The VTA-concept will allow keeping the data integrity of passengers. Mobility applications of that kind could be one way to regain passengers' trust into air travel as passengers have control over the own journey planning and personal data, while reducing touch points to a minimum. Airlines and airports can be in touch with travelers while keeping the required social distance. This would also allow all providers along the travel chain to communicate with their passengers in case of delays, disruptions, or even positive COVID-19 cases (identified after the travel). Such infection-risk applications for the latter case are currently available within some European countries, however, these are currently not linked with each other, cannot communicate or share data.

3.3 Example three: operational health concepts

Within the last example, it is elaborated which aspects the air transport system could learn from former pandemic crises and related academic studies conducted on these very shocks.

3.3.1 Air passenger screening concept

Experience from previous epidemics and pandemics reveal valuable lessons learned for air transport despite the impact from COVID-19 being unprecedented. A retrospective study on the H1N1 influenza (swine flu) pandemic sheds light on potential strategies of air passenger screening (Khan et al., 2013). At an early stage of a pandemic, global regions with a high-risk level need to introduce an exit screening of air travelers and cooperate with other airports to implement an entry

screening for all flights simultaneously, which arrive from a high-risk region. Additionally, it is beneficial to introduce an indiscriminate entry screening at all international airports to extensively monitor the pandemic spread at the most important air transport hubs (Khan et al., 2013).

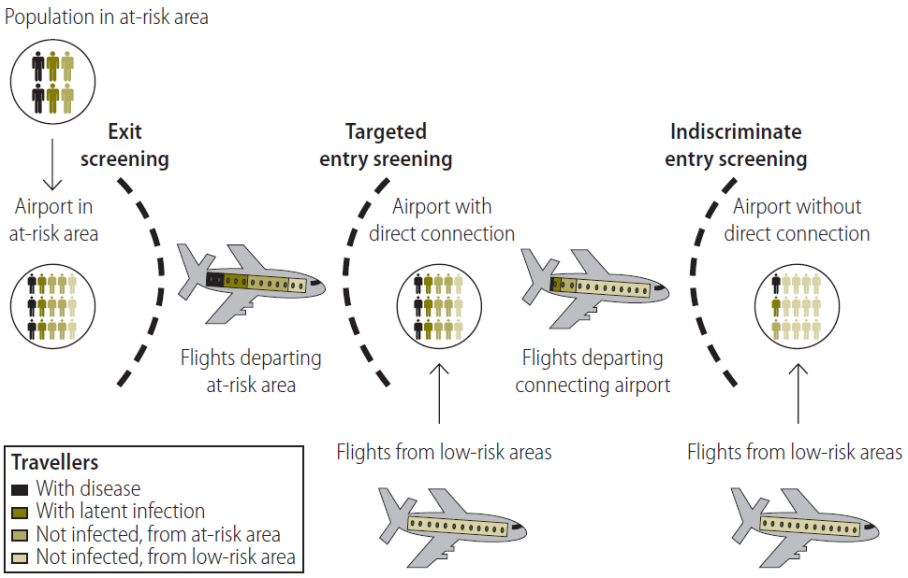

Figure 6: Conceptual framework for the airport-based screening of travelers for infectious diseases (source: Kahn et al., 2013, p. 369).

During the introduction of air traveler screening activities, it is crucial to identify the busiest airports within the network and initiate screening there first. If the 50 busiest airports introduce air traveler screening activities at an early stage of a pandemic, the resulting positive effect on slowing the pandemic spread may almost equal the effect when all airports implement such a measure (Hsu & Shih, 2010). Costs for such measures, which will be higher at large airports compared with smaller regional airports, need to be taken into account in a mitigation strategy for potential future pandemics.

3.3.2 Travel restrictions

Several studies on air travel restrictions have investigated the impact on a pandemic disease spread before and after the occurrence of H1N1 influenza (Bajardi et al., 2011; Epstein et al., 2007). They conclude that air travel restrictions only have a limited impact on slowing the spread of a virus by up to two weeks (Bajardi et al., 2011). Only a drastic reduction of air transport volumes, similar ranges as we currently observe during the first phase of the COVID-19 crisis in 2020, would

provide a supporting effect in decreasing the number of global cases (Epstein et al., 2007). However, if travel restrictions enable a postponement of a pandemic disease spread, this time saved can become crucial for countries and regions to set up a surveillance system and to initiate an expansion of health care capacities. A future strategy to encounter a potential future pandemic carefully has to balance the limited benefits from travel restrictions with the potential from other measures, such as hygiene concepts and social distancing, to continue air transport operations to a certain extent even during a pandemic. As already above, this might for instance apply to air cargo supplying medical products and equipment.

3.3.3 Hand-hygiene mitigation strategies

The WHO recommends frequent and thorough hand washing as one of the major mitigation options for disease spread (WHO, 2020c). Evidence from simulation supports this and identifies an increased hand cleanness at all airports impede the impact from a pandemic. Even a hand washing strategy at the 10 most important international airports within the air transport network has the potential to reduce the spread of a global pandemic (Nicolaides, Avraam, Cueto-Felgueroso, González, & Juanes, 2019). These findings underline the importance of basic yet effective mitigation measures and can be of utmost importance for the air transport system. Consequently, it would be even more effective to extend these measures and implement a feasible hygiene mitigation strategy throughout the entire D2D passenger transport chain and for employees within the air transport system. This would include increased availability of facilities for hand washing at any point in time during a journey, such as at train and metro stations, in the airport and in the cabin, and within staff facilities.

4. Discussion and further research

4.1 Managerial insights

Holling's resilience theory of the adaptive cycle can help to structure ideas and to self-reflect in which phase a system is currently acting. The model is applicable to all kinds of crises. In the light of the adaptive cycle, the outcome after the reorganization phase for each organization is still open and uncertain. It is the stakeholder's responsibility to leverage diverse resources for recovery and the transition into the next phase of exploitation, in which an organization successfully overcomes a crisis with lots of new potential for growth and opportunities to explore. Regarding the air transport system, passengers' trust is regained in that phase and operational processes adapted towards hygiene restrictions and market consolidation trends.

Table 1: Overview presented academic concepts and solutions (own depiction).

	Example	Possible challenges in the post-COVID-19 air transport system	Solution in example
1)	Novel business model approach	• Further and accelerated airline bankruptcies and market consolidation • Decrease in efficient aircraft utilization • Uncertainty in travel demand and travel patterns	• Introduction of **passenger pooling and aircraft sharing concepts** to better **allocate capacities** within the air transport system • Introducing **more flexibility** in assigning aircraft capacities according to demand on particular routes
2)	Mobility integrator reducing touch points	• Contamination and infection with SARS-CoV-2 during travel (passengers & employees) • Increased demand for protection of passengers' personal (health) data • Subsequent detection of positive SARS-CoV-2 cases after journey • Integration of additional health checks during D2D journey	• **Reducing of touch points** for demand side • Creating **seamless travel door-to-door** towards own **preferences** (e.g. during off-peak times, avoid long transits between travel segments) • Strong focus on **data protections of users** • Easy integration of additional travel duties or touch points due to modular system • **Information and communication** channel with passengers internationally

	Example	Possible challenges in the post-COVID-19 air transport system	Solution in example
3)	Operational health concepts	• Uncontrolled and rapid disease spreading across countries • Concealed disease spread through travelers with mild symptoms • Insufficient awareness of importance of hygiene among the population	• **Airport-based screening** of travelers for infectious diseases across all potential departure and arrival airports • **Travel restrictions and travel bans** for travelers from regions indicated as centers of infection • Comprehensive instructions and broad promotion of **hygiene concepts along the entire travel chain** • Increased availability of **hygiene facilities** during travel

The discussed examples in this paper illustrate that academic concepts can support the aviation industry to maintain vital air travel operations (cf. Table 1 for a summary). Diversity is key for the transition into the next phase, and we hence argue that resilience is enabled through diversity in the current COVID-19 crisis. We urge decision makers in the air transport system to consider thought-provoking impulse from the academic field. Also basic yet effective mitigation measures throughout the entire D2D travel chain can be of utmost importance for the air transport system. It is a chance to rethink and adapt air travel towards a better system and a 'new normal'.

Conversely, we also face other challenges that need to be tackled. As the air transport system is already entering the cycle we advise decision makers to emphasize the opportunities of the current COVID-19 induced situation of air transport, and highlight required environmental measures besides the opportunities to reshape the business model, related services and processes. Other aviation scholars such as Gössling et al. (Gössling, Scott, & Hall, 2020), who understand the current situation as a chance to transform towards a more sustainable tourism, agree on this. Chances are high that if we do not tackle this pressing challenge now, we have to pass through the adaptive cycle again, facing the next external shock. However, such compounding crisis have the potential to increase complexity further (Trump & Linkov, 2020).

4.2 Further research

The presented ideas of this discussion paper exhibit initial conceptual solutions and need further development and analysis in order to obtain a detailed assessment of related benefits as well as drawbacks. Therefore, further analysis is required, for example, in the field of business model innovation and how new concepts have the potential to be beneficial for different stakeholders and the associated costs going along with these. This also includes the assessment of incentives in the form of policies or measures fostering such concepts. From a management as well as policy perspective, one should also conduct acceptance studies on the demand side to detect if such concepts can gain the trust of passengers or if additional measurements might be necessary. In addition, other potential future research is essential, such as: cost-related research regarding an international pandemic mitigation strategy; potential environmental benefits from conditions related to subsidies; and questions of whether air transport might be 'better off' not trying to return to the previous growth path but instead choosing 'sustainable growth'. It also needs to be mentioned that the focus of this discussion paper is on the passenger demand side. Measurements to support the operational work of employees working within the air transport system are not considered here but need to be discussed in further research. The system would also need to regain the employees' trust back.

5. Conclusion

This paper elaborates how academic concepts can support the air transport system to cope with exogenous shocks, taken the present COVID-19 crisis as a current example. Holling's resilience theory of the adaptive cycle is used as the underlying theory to explore the question: *how can the air transport system reorganize to regain passengers' trust, and how to keep operations running in the post-COVID-19 world.* We define that the air transport system is currently in the release phase, facing extreme disturbances due to the COVID-19 crisis and the direct and indirect implications on air travel. Three operational approaches are presented in more detail: we discuss how a mobility integrator and operational health concepts could help to regain passengers' trust into air travel. In addition, the airline industry can be subject to major structural changes such as a move towards innovative business model approaches, which include a rethinking of current airline-aircraft ownership model. Since this sector is severely hit, the introduction of potentially disruptive

innovations, as highlighted above, may foster a competitive advantage for first-movers, enable a restructuring of the industry towards achieving emission reduction goals, and at the same time potentially reduce risks and offer the potential for cost reductions.

Finally, we urge decision makers in the air transport system to consider thought-provoking impulse from the academic field to tackle the current challenges of the COVID-19 crisis but also to keep environmental goals in mind.

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