Environment International 156 (2021) 106719

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

COVID-19 pandemic and innovation activities in the global airline industry: A review

Joseph Amankwah-Amoah

Kent Business School, University of Kent, Kent ME4 4TE, United Kingdom

ARTICLE INFO

Handling Editor: Thanh Nguyen

Keywords:
COVID-19
Stimulated innovations
Innovations
Business development

ABSTRACT

Despite the valuable contributions of scholars to the COVID-19 pandemic, limited scholarly attention has been paid to the opportunities unleashed by the crisis. As many industries have been turned upside down and markets rendered uncertain, the crisis is also propelling waves of innovation activities. In this paper, we developed the concept of "CoviNovation" to denote the firm's innovation emerging from, rooted in or accelerated by the crisis. Our analysis yielded insights on innovations inspired by COVID-19 across the global airline industry, including inflight social distancing, utilizing touchless technologies at airports, disinfecting aircraft with UV, open-middle-seat policy, accelerated use of biometrics in check-in and COVID-19 insurance. The theoretical and practical implications of the COVID-19-inspired innovations examined.

1. Introduction

The twentieth and early twenty-first centuries of global business history have been punctuated by multiple crises and events that propelled innovations. In the first quarter of the year 2020, the coronavirus pandemic (COVID-19) permeated national borders with ease with destructive economic and social consequences for both developed and developing nations (Worldometers, 2021). The COVID-19 pandemic's effects can be further demonstrated by over 173,286,047 cases and more than 3.7 million fatalities impacting every territory and nation around the globe (Worldometers, 2021). Although COVID-19 has unleashed ostensibly "insurmountable challenges" to organizations, many have demonstrated their capacity to innovate through the crisis and sow the seeds towards becoming more resilient in the future (Fretty, 2020). The ongoing COVID-19 crisis, coupled with technological breakthroughs, has created both a fertile and hostile environment for firms to transform their value chain and innovate. Despite the proliferation and multiple emerging streams of research on COVID-19, previous research has yielded very limited insights into innovation activities triggered by the crisis. This research deficit is surprising given that innovation can spring out of crisis events (Heinonen & Strandvik, 2020).

Against this background, this paper examines the nature and dynamics of COVID-19-inspired innovations. We illustrate our analysis with insights from the global airline industry. The COVID-19 pandemic prompted even the most efficient organizations to explore new ways of innovating (Heinonen & Strandvik, 2020) culminating in COVID-19-inspired innovations, what we term "CoviNovation". We develop the "CoviNovation" to denote the firm's predictable and unpredictable innovations emerging out of crisis, rooted in crisis, or accelerated by crisis. This is a unique capability in a sense that not many firms are adept at responding to or surviving crisis let alone emerging from it with innovative capability. These innovations are inspired by the pandemic and tailored to not only respond to it but improve organizational agility, resilience, and overall market competitiveness.

Accordingly, the paper makes contributions to the current discourse on the effects of the COVID-19 pandemic on business organizations (Heinonen & Strandvik, 2020; Sheng et al., 2020; Morawska et al., 2020). Despite a steady stream of COVID-19, there remains limited insight into firms' innovation activities stemming from the crisis. Building on crisis-driven innovation literature (Bessant et al., 2015) and Barney's (1991) notion of the resource-based view of the firm, this paper develops the concept of "CoviNovation" to denote the firm's competences and resources anchored in innovation emerging out of, rooted in, or accelerated by crisis. Besides developing and outlining the features of the "CoviNovation" construct, our study also contributes to the literature by demonstrating how COVID-19-led innovations have manifested in the global airline industry.

The rest of the paper is organized in the following sequence. In the following section, a review of literature on crisis-led sustainable innovations is presented. The effects of COVID on innovation activities in the global airline industry are then outlined. This is then followed by an analysis of the implications of the study from both theoretical and

E-mail address: J.Amankwah-Amoah@kent.ac.uk.

https://doi.org/10.1016/j.envint.2021.106719
Received 3 May 2021; Received in revised form 9 June 2021; Accepted 11 June 2021
Available online 21 June 2021

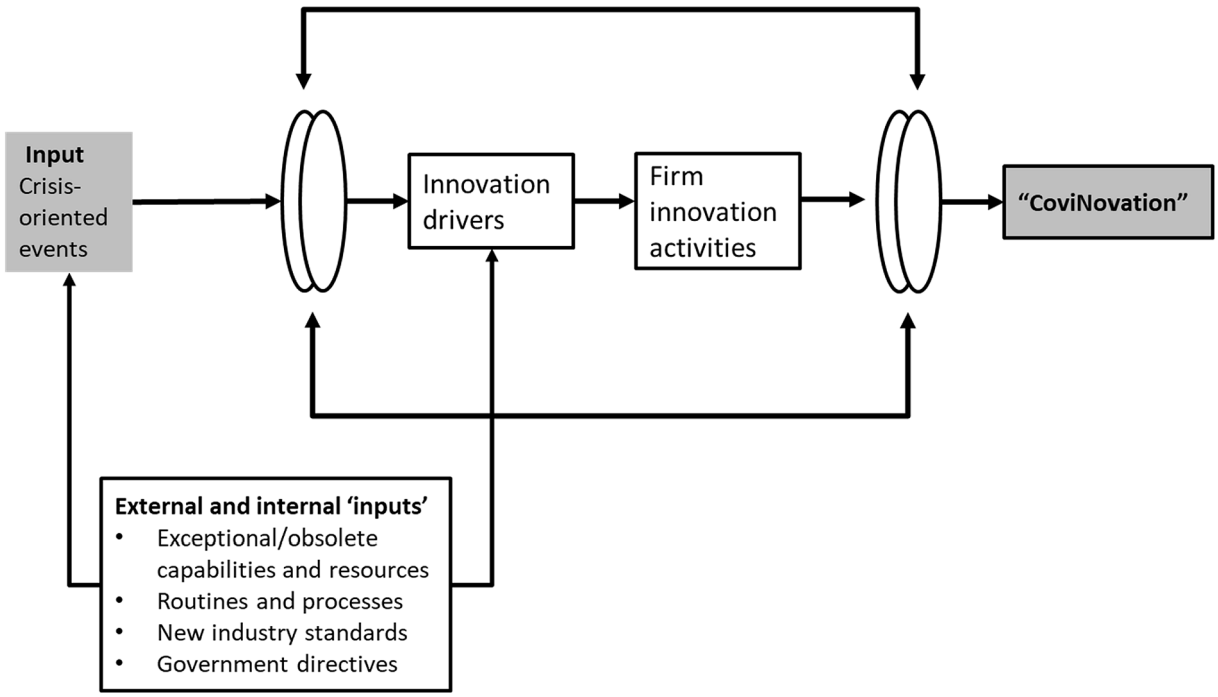

Fig. 1. A general model of evolution of "CoviNovation"

practical standpoints.

2. A "CoviNovation": A conceptual development

Defined as the mechanism through which a firm creates new processes, products or services for the market, innovation has been found to have positive effects on firms' performance and their overall market competitiveness (Li & Atuahene-Gima, 2001). Recently, adversity and crisis have been found to incentivize some firms to innovate which can then equip them to weather crises (Heinonen & Strandvik, 2020). Some prior studies have suggested that economic crises force firms to decrease investment in innovation and also firms' willingness to invest in innovation activities also declines (Archibugi, Filippetti, & Frenz, 2013). By utilizing collaborative efforts during a crisis, firms are better able to combine resources and expertise within other organizations to respond to crises in a more effective and speedy manner. During a crisis, organizations can also be forced to deviate from the traditional planned approach to innovation.

One line of research has demonstrated that crises can force organizations to develop fast-paced problem-solving approaches, coupled with process and procedure changes (Bessant Rush & Trifilova, 2015; Amankwah-Amoah, 2017). Some past studies have demonstrated that under resource-constrained conditions, some firms flourish by introducing innovative process design, products, and services that are even more adaptable and affordable (Hossain, 2018, 2020). Such products and services are often tailored to consumers in the developing world where high upfront cost is often a major barrier to access (Hossain, 2018, 2020). Accordingly, such resource-scarce solutions or approaches to innovation can equip firms in a crisis environment to thrive and remain competitive.

Prior research has suggested that crises often prompt firms to halt current innovation projects, nevertheless, firms that can tap into public funding are often less likely to abandon such investments (Paunov, 2012). It has been suggested that demand shock and financing constraints that stem from crises can weaken the position of firms and render many innovation activities unsustainable (Paunov, 2012). Research suggests that business innovations require integration of suppliers, customers, and other stakeholders into the innovation processes to have a more enduring impact (Enkel, Gassmann, & Chesbrough, 2009).

Innovation is vital during crises, partly because of new demands imposed by different stakeholders and also risk of standing still which can lead to business failure. Recent literature suggests that crisis can force firms to rely on existing resources and expertise to neutralize familiar threats, however, different sets of resources and know-how are often needed to handle new threats and events (Dalgaard-Nielsen, 2017). Prior research suggests that in the face of external shocks, some firms are better able to absorb the shock due to their financial resources buffer, which then provides them with space and time to realign the new realities (Amankwah-Amoah, 2014, 2016). During this process, some firms innovate by adopting a more customer-oriented approach, and discarding old and obsolete routines and processes (Amankwah-Amoah, 2016). Organizations are likely to adopt new measures that rectify current defects in the processes and techniques during crises. As demonstrated by Schilling (2020), such process innovations are often typified by minimizing errors and defects, and discarding obsolete routines. In tandem with the process innovations are often new product innovations geared towards enhancing the marketing competitiveness of the business (Schilling, 2020). Firm innovation is often rooted in forging collaboration with customers, suppliers, and competitors to stay attentive to their concerns.

Rooted in the resource-based perspective (see Barney, 1991) is the contention that the possession of exceptional capabilities and resources underpin firms' market competitiveness. Consistent with this line of thinking, we contend that the pandemic can stimulate innovations and trigger a quest for new sources of capabilities and resources to innovate. Recent years have witnessed escalating incidents of organizations ushering in low-cost innovations anchored in environmental sustainability orientations and resource-conservation initiatives in responses to crises (Hossain, 2018, 2020). Such innovative endeavors can be viewed as vital strategic resources for firms, which can be enduring in securing market advantage (Hossain, 2018, 2020). Broadly speaking, resources and capabilities are vital in an organization's innovation efforts and success. Indeed, the abundance of firm-specific resources fosters conditions that allow employees to experiment with novel ideas, thereby influencing innovation-oriented activities (Yang, Liu, Gao, & Li, 2012).

Throughout the previous and current century, innovations have emerged from numerous sources. One outcome of COVID-19 is that financial and human resources are under considerable strain, thereby forcing firms to innovate creatively using fewer resources whilst responding to the current challenges at hand. The fast-paced global business environment has now been rendered more turbulent by COVID-19, culminating in innovative responses by some organizations.

A distinguishing characteristic of this COVID-19-led innovation is the context-specific and inspired nature of the innovations; nevertheless, the innovations can be leveraged in the post-crisis period. Stemming from crisis events is not only the need for firms to engage in new product innovation (i.e., introduction of goods or services to the market) but also process innovation and process improvements (Heinonen & Strandvik, 2020). The coronavirus outbreak not only revealed the fundamental weaknesses of many business models, including faulty routines and processes, but also accelerated the process of business collapse. In the face of such a multifaceted landscape of threats, the ability to rebuild disrupted systems or processes to make organizations more responsive to environmental disruption is by itself a unique capability that can be harnessed to produce process innovations (Dalgaard-Nielsen, 2017). To develop a framework for understanding "CoviNovation", we conceptualized crisis as input-triggering innovation activities culminating in the innovations that are generally event specific. As depicted in Fig. 1, crisis-oriented events, coupled with internal and external resources of a firm, can serve as a driver of innovation activities leading to vital sources of firm-market competitiveness.

3. COVID-19 and innovation activities: The case of the global airline industry

The global airline industry has been shaped by multiple reforms championed by governments over the years (Amankwah-Amoah et al., 2021) including the Chicago Convention (i.e., the Convention on International Civil Aviation 1944, US Airline Deregulation Act 1978 and the EU's Internal Market for Aviation 1992 (Amankwah-Amoah, 2020a; Doganis, 2006). These have ushered in a more competitive and integrated global industry. The coronavirus pandemic has led to "the biggest shock since the Second World War", culminating in a sharp decline in consumer spending, job losses, and multiple countries closing national borders (The Economist, 2020, p. nd), thereby forcing many organizations to institute remote working (Amankwah-Amoah, 2020b). In sharp contrast to sectors such as manufacturing, the service-oriented businesses typified by face-to-face contact have struggled to operate in an era where social distancing is required (The Economist, 2020). Countries that are largely dependent on manufacturing such as China have been able to restart substantial parts of their economy, whereas many of the developed nations which are largely dependent on the service sector have had multiple false starts, including reverting to lockdowns in some localities (The Economist, 2020).

Pertaining to this crisis is the multitude of government response measures such as social distancing, national and local lockdown measures, and border closures. In October 2020, the Airports Council International World and the International Air Transport Association (IATA) called on policymakers and governments to help ensure a globally unified approach to testing travelers as an alternative to multiple and different cumbersome quarantine measures around the globe (IATA, 2020b). The aim was to provide confidence to nations in reopening national borders without quarantine measures. Owing to global slowdown and shutdown of air travel, airlines were forced to ground most of their fleets. Due to COVID-19 travel restrictions, the industry has experienced job losses with around 4.8 million jobs either being lost or under threat (IATA, 2020b). The pandemic has placed greater emphasis on health and safety of workers and passengers (IATA, 2020b). Thus, more stringent cleanliness standards have become a key feature of airlines' operations. Nevertheless, the COVID-19 pandemic has also driven or turbo-charged some innovations and seen the introduction of new technologies such as remote and telephone doctor consultations, video conferencing, remote working, and a shift from largely relying on cash to contactless payment systems. Below, we outline a number of examples of "CoviNovation".

3.1. Disinfecting aircraft with ultraviolet light (UV)

As health and hygiene were pivotal to airlines in helping to enhance their market competitiveness, with many airlines embracing cutting-edge technologies to improve sanitization. In July 2020, JetBlue announced the trial of novel ultraviolet technology for onboard cleaning systems. The airline utilized the ultraviolet-light system to clean aircraft cabin surfaces, which was seen as effective in killing bacteria and viruses when properly applied (Singh, 2020a). Besides JetBlue, Qatar Airways and other airlines have also utilized the technology. In September 2020, Qatar Airways, the Doha-based airline, became one of the first global airlines to commence the process of disinfecting its aircraft using ultraviolet technology for cabin cleaning (Boon, 2020c). These sanitization devices, manufactured by Honeywell, are the size of a beverage cart. Although the UV light has been demonstrated to eradicate many viruses and bacteria, not all aircraft used by the airline were cleaned by this technology (Boon, 2020c). Therefore, there is potential for this to be scaled up. Besides harnessing new technologies, airlines have also introduced measures such as inflight mandatory face coverings (Singh, 2020a).

3.2. Touchless technologies at airports

Another innovation is the amplification and acceleration of touchless technologies at airports. The pandemic "has underscored the need for the highest degree of hygiene within aircraft cabins" giving the potential for the virus to spread via surface contact, thereby making the disinfecting of touchpoints vital (Pande, 2020, p. nd). By introducing new processes and routines across the activities at airports to minimize face-to-face contact, airlines seek to provide greater confidence to travelers about their security and safety measures. For instance, airlines such as United Airlines have introduced new touchless processes at Heathrow Airport in London (Singh, 2020c). By introducing the first touchless check-in experience of any airline at the airport, United took a major leap forward in ushering in a more enduring innovation for the industry (Singh, 2020c). Although airlines have historically been using technology to allow check-in and self-scanning of boarding passes for some time, this advances this direction of travel. Indeed, many operators view reducing touchpoints as one of the most effective ways of curtailing the spread of the virus whilst at the same time harnessing latest technologies to improve their processes (Singh, 2020c).

3.3. Block middle-seats approach/open-middle-seat policy

Anticipating and responding to crises often requires firms to adopt new procedures to address customers' and stakeholders' concerns. Most airlines have innovated by implementing inflight social distancing measures and additional sanitary efforts as a means of addressing not only governments' directives but also consumers' concerns over possible transmission during travel. In this direction, in mid-2020 JetBlue introduced a practice of blocking middle seats on its larger jets as well as aisle seats on smaller planes (Singh, 2020b). In the midst of the pandemic, three of the four biggest US airlines—American, Delta, and Southwest—adopted an initiative that sought to "block the sale of middle seats" to offer inflight social distancing as an early response to the crisis (Glusac, 2020, p. nd). Other airlines including Alaska Airlines also adopted the initiative of blocking middle seats to provide reassurance to customers (Glusac, 2020). By blocking middle seats, it has been suggested that this can actually half the risk of virus transmission on an aircraft (Barnett, 2020; Singh, 2020b). Besides the inflight measures, the airline has also performed temperature checks for the customer-facing

crew to help minimize or curb the spread of the virus (Singh, 2020b). Nevertheless, recently "American (Airlines) has joined United (Airlines) in selling all available seats on its planes as demand allows, while Southwest has extended its commitment to less density" late 2020 (Glusac, 2020, p. nd). Although many temporary airlines adopted this seating innovation of blocking the middle seat to ensure an element of inflight social distancing, this approach helps but fails to meet the advocated six feet of social distance (Bailey, 2020d).

3.4. Inflight social distancing

Some airlines have adopted a variety of approaches to inflight social distancing, for instance, besides wearing face masks, Indian airlines have supplied middle-seat passengers with gowns to restrict or avoid contact in an attempt to restore travelers' confidence to pre-crisis levels (Bailey, 2020a). However, most business-class seats have a "footprint of at least a meter squared", thereby helping to incorporate an element of inflight social distancing (Bailey, 2020a).

3.5. Deep cleaning

Our analysis indicates that the pandemic necessitated new processes in order to weather the storm and deliver future success. As contemporary pandemics appear the sources of airline' competitive advantage appears to have shifted hygiene with many adopting new deep-cleaning approaches to provide reassurance to their customers. According to Ahlgren (2020), the pandemic has ushered in a new era leading to a "surge of cabin cleaning frenzy among airlines", thereby forcing them to adopt "hospital-grade disinfectants to kill any lingering viral particles". As observed by Pande (2020, p. nd), "gone are the days of skipping aircraft cleaning, some airlines are now frequently deep cleaning planes". Among the airlines that have embraced this new regime of "enhanced cleaning" is Emirates with its disinfection policies that entail comprehensive cleaning of surfaces including windows, seatback screens, in-seat controls, panels, and overhead lockers (Loh, 2020). By seeking to implement strict disinfectant protocols after flights and going beyond the standard cleaning procedures, many airlines including Emirates and Cathay Pacific sought to provide assurance to travelers of the highest cleaning standards adopted (Ahlgren, 2020; Loh, 2020). Indeed, United Airlines started to apply "an antimicrobial coating to seats, tray tables, armrests, overhead bins, lavatories and crew stations" whereas Delta Air Lines has also begun "installing hand sanitizer stations onboard each of its aircraft" (Clarke, 2020, p. nd).

Due to the importance of safety and cleanliness, some airlines have sought to harness their outside expertise to demonstrate the highest level of cleanliness to support their offerings. In this direction, United Airlines has also partnered with Clorox, the cleaning company, in launching the CleanPlus focusing on three key areas: cleanliness, prioritizing well-being, and innovation to denote its "commitment to delivering industry-leading cleanliness" (Globetrender, 2020, p. nd). To be seen as the cleanest airline in terms of deep and surface cleaning, carriers are seeking to place greater emphasis on enhanced meeting and exceeding of IATA industry and government regulatory obligations. Airlines around the world have adopted a facemask requirement on flights (Pande, 2020). Besides the deep-cleaning protocol that is instigated if an infected passenger was onboard, airlines are also cleaning planes for both short- and long-haul flights (Pande, 2020). Despite these measures to ensure clean and safe cabins, many travelers are also anxious about being situated in "close proximity to strangers with unknown hygiene standards" (Bailey, 2020d, p. nd). This can dissuade many from non-essential travel and encourage some on short-haul flights to switch to alternative forms of transport that provide assurance.

3.6. Biometric check-in

The positive effects of COVID-19 are illustrated by the introduction of the accelerated use of biometric technology. By biometric boarding, we are referring to "where facial recognition is used to confirm passenger identity" at airports (Hayward, 2020, p. nd). Biometric data encompassing iris scans and fingerprints have proven to be generally effective in verifying one's identity. In the wake of the pandemic with potential transmission through touch, the biometric boarding process replaces the conventional manual check of documents and passports (Hayward, 2020). For some time, travelers have seen biometric or facial-data technology increasingly being utilized by airport immigration. Indeed, in the US, the first biometric terminal was launched in Hartsfield-Jackson Atlanta International Airport in 2018 (Pitrelli, 2020) but has since been adopted by other airlines and its use accelerated by the pandemic. As Pitrelli (2020, p. nd) puts it, many airports in collaboration with airlines have shifted from using driver licenses and passports to utilizing facial-recognition and iris-scanning biometrics to authenticate one's identity.

Among the responses was Spirit Airlines' introduction of a biometric check-in system at airports in New York and Chicago to minimize face-to-face interaction (Boon, 2020b). Accordingly, the airline became one of the "first to make biometric check-in assistance available to domestic customers and the first to attempt to combine it with automated self-

Table 1
Summary of some airlines' "CoviNovation" activities.

Nature of "CoviNovation"	Description and dynamics of the effects	Example of selected airlines	Environmental and quality-of-life implications
Disinfecting aircraft cabins with ultraviolet technology.	Harnessing the ultraviolet disinfection technology to address consumers' concern and demand for highest levels of cleanliness.	Qatar Airways, JetBlue, etc.	Minimize virus transmission mechanisms by reducing face-to-face contact. Usher in new and efficient technologies for the future. Foster change in human and airline behavior to adopt new technologies and processes.
Flight crew wearing personal protective equipment.	To respond to social pressures and government directives.	Most, if not all.	
Deep cleaning.	New cleaning and safety procedures above and beyond the standard cleaning procedures – competing on hygiene.	Most, if not all, e.g., Cathay Pacific, Qantas, Korean Air, Singapore Airlines, and Emirates.	
Inflight social distancing measures and temporary blocking middle seats.	Seating innovations – blocked middle seats.	JetBlue, Delta, and Southwest.	
Touchless technologies at airports.	Harnessing touchless technology to reassure consumers that their risk of catching COVID-19 is reduced.	United, etc.	
New touchless processes.	Introduction of contactless processes to decrease touchpoints in response to the crisis.	Air Canada, Malaysia Airlines, etc.	

Data sources: synthesized by the authors from: Amankwah-Amoah et al., 2020; Bailey, 2020b; Bailey, 2020c; Boon, 2020c; IATA, 2020a; Moores, 2020; Aviation, 2020; Singh, 2020a, 2020b, 2020c; Vetter, 2020.

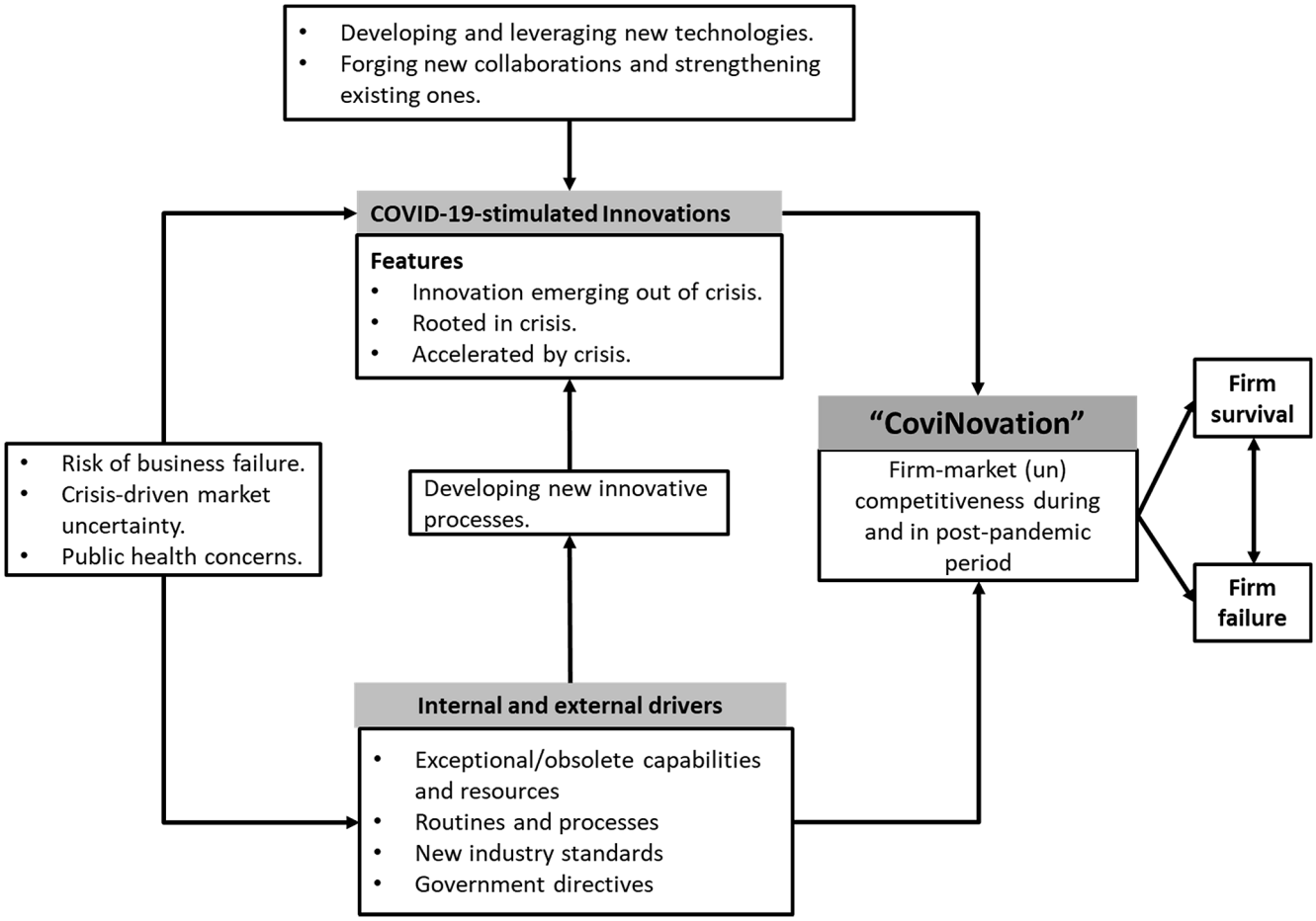

Fig. 2. Drivers and development process of "CoviNovation"

bag-drop capabilities that limit face-to-face interactions and save travelers time" (Clarke, 2020, p. nd). In the US, for instance, biometric data capture and boarding is underway in around 20 major airports (Hayward, 2020). Delta has also initiated biometric recognition use at Atlanta airport and British Airways has sought to use biometric data for internal flights (Hayward, 2020). Table 1 summarizes the different approaches adopted by different airlines and the nature of the "CoviNovation".

3.7. COVID-19 insurance

Among the initiatives adopted by airlines such as Emirates, WestJet, Etihad, and Virgin Atlantic is the introduction of no-charge COVID-19 travel insurance and medical cover for some customers (Singh, 2020e). These were geared towards protecting against unforeseen medical costs associated with COVID, quarantine accommodation costs as well as to provide assurance and thereby enhance consumers' confidence in air travel. In September 2020, Eurowings joined the number of airlines offering this insurance scheme to passengers to try to restore passenger confidence to the pre-pandemic level (Boon, 2020a). This provides opportunities for firms to diversify their offering and tap into new sources of revenue. Fig. 2 illustrates our model and integration of insights from the industry illustrating the construct of "CoviNovation".

4. Discussion and conclusions

In this paper, we examined the nature and dynamics of COVID-19-inspired innovations. We developed an integrated approach and advanced the concept of "CoviNovation" to denote the innovation opportunities stemming from COVID-19. Evidence was drawn from the global airline industry to illustrate a number of COVID-inspired processes and product innovations that were implemented in an attempt to respond to the crisis. Although the crisis has led to the disruption of well-established routines and processes, the threats to the survival of multiple global airlines appear to have encouraged employees to embrace change. Our inquiry has revealed that global airlines have innovated across the value chain to respond to the crisis. Among the ample innovations stemming from the crisis or COVID-19-inspired innovations are inflight social distancing, disinfecting aircraft with UV, utilizing touchless technologies at airports, an open-middle-seat policy, accelerated use of biometrics at check-in, and COVID-19 insurance. By seeking to offset disruption caused by the COVID-19 pandemic, many organizations have embraced innovation via seeking insights from partners, customers, and governments in implementing new processes. In regard to the theoretical contributions, we contribute to crisis-driven innovation literature (Bessant et al., 2015) by advancing the "CoviNovation" perspective to counterbalance some of the overwhelming emphasis on the effects of COVID on businesses. Besides the contributions to innovation and COVID-19, our study provides insights into how some firms have turned the crisis into an opportunity via innovation. In light of the dearth of research on COVID-induced innovations, our study fills an important void in the current literature by elucidating some of the developments in attempting to respond to the crisis via adopting innovative processes.

Notwithstanding the contributions to theory, our findings may help practicing managers to make better sense of the changing environment ushered in by COVID. Rather than viewing the crisis as an existential threat, organizations need to refocus their attention towards innovating

as a means of taking advantage of the opportunities whilst neutralizing the threats. Our research findings would suggest that innovations do not necessarily have to be major breakthroughs. Many airlines have focused on thorough cleaning of aircraft to reassure their customers of their high standards. To keep pace with the competition and remain at the forefront of health and safety requirements, airlines are now competing on hygiene grounds as a cornerstone of tools to outwit competitors. In addition, many airlines will need to implement touchless technologies to reduce costs and offer the highest level of hygiene as a means of competing. There is a possibility that the innovations are likely to be context-specific. Thus, the innovations emerging from the crisis may require a higher degree of adaptation and transformation to make them relevant in new contexts, i.e., post-COVID-19. Given that the COVID-19 pandemic typifies a degree of interdependencies of national economies (Baroukiet al., 2021), there is a need for governments to ensure that the innovations noted here have long-term positive effects in reducing waste. There is also a need for governments to drive policies that motivate firms to reduce investment in measures and innovations that help to reduce air pollution. This is important in light of the allure that COVID-19 offers firms to minimize their environmental commitments.

Regarding direction for future research, the industry-specific nature of our analysis curtails our ability to extend the findings to other industries. However, it is worth noting that the crisis is likely to have triggered resource-scarce and crisis-inspired innovations in other industries. Research can explore innovations inspired by COVID-19 in industries such as manufacturing, hospitality, and tourism. There is also a need for studies to examine the long-term effects of these innovations and their sustainability. Future research could also focus on examining the sustainability of these innovations in the post-crisis phase.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Ahlgren, L. (2020). How Airlines Are Cleaning Planes Amid The Coronavirus Outbreak. 10.07.2020, from: https://simpleflying.com/coronavirus-clean-planes/.

Amankwah-Amoah, J., 2014. Old habits die hard: A tale of two failed companies and unwanted inheritance. Journal of Business Research 67 (9), 1894–1903.

Amankwah-Amoah, J., 2016. An integrative process model of organisational failure. Journal of Business Research 69 (9), 3388–3397.

Amankwah-Amoah, J., 2017. Integrated vs. add-on: A multidimensional conceptualisation of technology obsolescence. Technological Forecasting and Social Change 116, 299–307.

Amankwah-Amoah, J., 2020a. Stepping up and stepping out of COVID-19: New challenges for environmental sustainability policies in the global airline industry. Journal of Cleaner Production 271, 123000.

Amankwah-Amoah, J., 2020b. Note: Mayday, Mayday, Mayday! Responding to environmental shocks: Insights on global airlines' responses to COVID-19. Transportation Research Part E: Logistics and Transportation Review 143, 102098.

Amankwah-Amoah, J., Khan, Z., Osabutey, E.L., 2021. COVID-19 and business renewal: Lessons and insights from the global airline industry. International Business Review 30 (3), 101802.

Amankwah-Amoah, J., Khan, Z., Wood, G., 2020. COVID-19 and business failures: The paradoxes of experience, scale, and scope for theory and practice. European Management Journal. https://doi.org/10.1016/j.emj.2020.09.002.

Archibugi, D., Filippetti, A., Frenz, M., 2013. The impact of the economic crisis on innovation: Evidence from Europe. Technological Forecasting and Social Change 80 (7), 1247–1260.

Bailey, J. (2020a). Post COVID-19 Flying Will Bring Huge Passenger Seat Innovation. Retrieved 12.10.2020, from: https://simpleflying.com/covid-19-passenger-seat-innovation/.

Bailey, J. (2020b). The Hidden Benefits Of COVID-19 On Aviation. https://simpleflying.com/aviation-covid-19-benefits/.

Bailey, J. (2020c). Inside Air New Zealand's Big Bet On Digital. https://simpleflying.com/inside-air-new-zealands-big-bet-on-digital/.

Bailey, J. (2020d). Airline Seating Innovations In A Post Pandemic World. Retrieved 12.10.2020, from: https://simpleflying.com/airline-seating-innovations-post-pandemic/.

Barnett, A. (2020). Covid-19 Risk Among Airline Passengers: Should the Middle Seat Stay Empty?. medRxiv. doi: https://doi.org/10.1101/2020.07.02.20143826.

Barney, J., 1991. Firm resources and sustained competitive advantage. Journal of management 17 (1), 99–120.

Barouki, R., Kogevinas, M., Audouze, K., Belesova, K., Bergman, A., Birnbaum, L., HERA-COVID-19 working group, 2021. The COVID-19 pandemic and global environmental change: Emerging research needs. Environment international 146, 106272.

Bessant, J., Rush, H., Trifilova, A., 2015. Crisis-driven innovation: The case of humanitarian innovation. International journal of innovation management 19 (06), 1540014.

Boon, T. (2020a).Eurowings Becomes The Latest Airline To Roll Out COVID-19 Insurance. 10.10.2020, from: https://simpleflying.com/eurowings-covid-19-insurance/.

Boon, T. (2020b). Spirit Airlines Introduces Biometric Check-In In New York And Chicago. 10.10.2020, from: https://simpleflying.com/spirit-biometric-check-in/.

Boon, T. (2020c). Qatar Airways Begins Disinfecting Aircraft Cabins With UV. Retrieved 10.10.2020, from: https://simpleflying.com/qatar-airways-uv-cabin-disinfection/.

Clarke, P. (2020). Innovative Ways Airports and Airlines Are Handling COVID-19 Pandemic. Retrieved 12.10.2020, from: https://www.travelpulse.com/gallery/airlines/innovative-ways-airports-and-airlines-are-handling-covid-19-pandemic.html?image=8.

Dalgaard-Nielsen, A., 2017. Organizational resilience in national security bureaucracies: Realistic and practicable? Journal of Contingencies and Crisis Management 25 (4), 341–349.

Doganis, R., 2006. The Airline Business, 2nd edition. Routledge, London.

Enkel, E., Gassmann, O., Chesbrough, H., 2009. Open R&D and open innovation: exploring the phenomenon. R&d Management 39 (4), 311–316.

Fretty, P. (2020). Tale of COVID-19: Crisis Inspiring Innovations. Retrieved 08.10.2020, from: https://www.industryweek.com/technology-and-iiot/media-gallery/21126839/tale-of-covid19-crisis-inspiring-innovations.

Globetrender (2020). 12 innovations making air travel safer in the age of COVID-19. Retrieved 12.09.2020, from: https://globetrender.com/2020/07/08/innovations-coronavirus-flying-air-travel-safety/.

Glusac, E. (2020).5 Things We Know About Flying Right Now. Aug. 20, https://www.nytimes.com/2020/08/20/travel/airplanes-coronavirus.html.

Hayward, J., 2020. Should We Worry About The Rise Of Biometric Boarding? Retrieved 12.10.2020, from: https://simpleflying.com/biometric-boarding-worry/.

Heinonen, K., Strandvik, T., 2020. Reframing service innovation: COVID-19 as a catalyst for imposed service innovation. Journal of Service Management. https://doi.org/10.1108/JOSM-05-2020-0161.

Hossain, M., 2018. Frugal innovation: A review and research agenda. Journal of Cleaner Production 182, 926–936.

Hossain, M., 2020. Frugal innovation: Conception, development, diffusion, and outcome. Journal of Cleaner Production 262, 121456.

IATA (2020a). Looming Cash Crisis Threatens Airlines. Retrieved 12.10.2020, from: https://www.iata.org/en/pressroom/pr/2020-10-06-01/.

IATA (2020b). ACI World and IATA in Joint Push for Globally Consistent Approach to Testing. Retrieved 08.10.2020, from: https://www.iata.org/en/pressroom/pr/2020-10-07-01/.

Li, H., Atuahene-Gima, K., 2001. Product innovation strategy and the performance of new technology ventures in China. Academy of Management Journal 44 (6), 1123–1134.

Loh, C., 2020. Emirates Spending Up To 8 Hours Deep Disinfecting A Single Airbus A380. Retrieved 12.10.2020, from: https://simpleflying.com/emirates-aircraft-disinfecting/.

Moores, V., 2020. Aviation Firms Gear Innovations Toward Mitigating COVID-19 Risk. Retrieved 08.10.2020, from: https://aviationweek.com/air-transport/airlines-lessors/aviation-firms-gear-innovations-toward-mitigating-covid-19-risk.

Morawska, L., Tang, J.W., Bahnfleth, W., Bluyssen, P.M., Boerstra, A., Buonanno, G., Yao, M., 2020. How can airborne transmission of COVID-19 indoors be minimised? Environment international 142, 105832.

Pande, P., 2020. How COVID-19 Has Changed Flying. Retrieved 12.10.2020, from: https://simpleflying.com/how-covid-19-has-changed-flying/.

Paunov, C., 2012. The global crisis and firms' investments in innovation. Research policy 41 (1), 24–35.

Pitrelli, M.B. (2020). Five ways the pandemic may change airports for the better. https://www.cnbc.com/2020/05/27/what-will-flying-be-like-how-coronavirus-is-changing-airports.html.

Schilling, M.A., 2020. Strategic Management of Technological Innovation, 6th edition. McGraw Hill, Boston.

Sheng, J., Amankwah-Amoah, J., Khan, Z., Wang, X., 2020. COVID-19 Pandemic in the New Era of Big Data Analytics: Methodological Innovations and Future Research Directions. British Journal of Management.

Singh, J., 2020a. WestJet Becomes The Latest Airline To Offer COVID-19 Insurance. Retrieved 12.10.2020, from: https://simpleflying.com/westjet-covid-19-insurance/.

Singh, S., 2020b. JetBlue Trials New Ultraviolet Onboard Cleaning System. Retrieved 12.10.2020, from: https://simpleflying.com/jetblue-ultraviolet-cleaning-system/.

Singh, S., 2020c. JetBlue Will Keep Blocking Middle Seats Until September 8th. Retrieved 12.10.2020, from: https://simpleflying.com/jetblue-middle-seats-blocked-september/.

Singh, S., 2020d. How COVID is revolutionising touchless airport technology. Retrieved 12.10.2020, from: https://simpleflying.com/touchless-airport-technology-covid/.

Sustainable Aviation (2020). Our mission. Retrieved 05.05.2020, from: https://www.sustainableaviation.co.uk/.

Economist, The, 2020. Winners and losers. Retrieved 12.10.2020, from: https://www.economist.com/leaders/2020/10/08/the-pandemic-has-caused-the-worlds-economies-to-diverge.

Vetter, D., 2020. How coronavirus could help us fight climate change: lessons from the pandemic. Retrieved 01.05.2020, from: https://www.forbes.com/sites/davidrvetter/2020/03/30/how-coronavirus-could-help-us-fight-climate-change-lessons-from-the-pandemic/#17169665abc7.

Worldometers, 2021. Coronavirus Cases. Retrieved 05.06.2021, from: https://www.worldometers.info/coronavirus/.

Yang, J., Liu, H., Gao, S., Li, Y., 2012. Technological innovation of firms in China: Past, present, and future. Asia Pacific Journal of Management 29 (3), 819–840.