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Christoph Buck
Centre for Future Enterprise, School of Management, Queensland University of Technology; Fraunhofer Institute for Applied Information Technology FIT
christoph.buck@qut.edu.au
Australia

Thomas Kreuzer
FIM Research Center, University of Bayreuth; Fraunhofer Institute for Applied Information Technology FIT

Anna Maria Oberländer
Chair of Information Systems and Business Process Management, University of Bayreuth

Maximilian Röglinger
Chair of Information Systems and Business Process Management, University of Bayreuth

Michael Rosemann
Centre for Future Enterprise, School of Management, Queensland University of Technology

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Christoph Buck
Centre for Future Enterprise, School of Management, Queensland University of Technology; Fraunhofer Institute for Applied Information Technology FIT
christoph.buck@qut.edu.au
Australia

Thomas Kreuzer
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Anna Maria Oberländer
Chair of Information Systems and Business Process Management, University of Bayreuth

Maximilian Röglinger
Chair of Information Systems and Business Process Management, University of Bayreuth

Michael Rosemann
Centre for Future Enterprise, School of Management, Queensland University of Technology

Abstract:

Exogenous shocks, such as COVID-19, significantly change fundamental premises on which economies and individual organizations operate. The light-asset nature of digital technologies provides the potential to not only facilitate an immediate crisis response, but also to catalyze novel innovation types to address the societal and economic changes caused by exogenous shocks. As digital innovation became a relevant part of organizations' COVID-19 responses and given that a corresponding structured knowledge base did not exist, we found the need to better understand crisis-driven digital innovation. Drawing on prior knowledge from crisis management and organizational ambidexterity as a theoretical lens, we present four patterns of crisis-driven digital innovation, classified along two dimensions: (1) driven by a sense of urgency or ambition and (2) focusing on exploitative or explorative innovation. Based on a thorough analysis of digital innovation cases during the COVID-19 crisis, we illustrate and discuss these four patterns and their emerging properties to explain how and why they led to digital innovation in the context of the crisis. Our work contributes to the explanatory knowledge on digital innovation in times of crisis, helping researchers and practitioners to understand and develop digital innovation in response to exogenous shocks.

Keywords: Digital Innovation, Innovation Patterns, Organizational Ambidexterity, Crisis Management, Sense of Urgency, Sense of Ambition, COVID-19.

[Department statements, if appropriate, will be added by the editors. Teaching cases and panel reports will have a statement, which is also added by the editors.]

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1 Introduction

"*When life gives you lemons, make lemonade*" is an often-cited quote promoting a positive attitude in the face of misfortune. However, what to do when overwhelmingly buried in lemons? Transferring this analogy to the years 2020/21, COVID-19 has caused one of the biggest global challenges for societies and economies since World War II. Due to the massive restriction of physical contacts, organizations faced adverse market conditions and changing customer demands, i.e., more lemons than they could seemingly handle. For most organizations the curbs on physical contact led to a shortage of business and customers on a much bigger scale compared to earlier pandemic-related crisis such as the 2002/03 SARS pandemic in China and the 2009-10 swine flu pandemic. However, despite all the "lemons" that organizations were certainly given by the COVID-19 pandemic, it also triggered them to innovate and benefit – be it as lemonade or as whiskey sour.

What separates organizations' innovation responses to survive the COVID-19 crisis and/or to enable post-crisis growth from previous comparable crisis (Bar Am, Furstenthal, Jorge, & Roth, 2020; Brem, Viardot, & Nylund, 2021; Krogh, Kucukkeles, & Ben-Menahem, 2020) is today's high accessibility and maturity of digital technologies and increased digital literacy in society. As a result, many crisis responses centered around digital innovation (DI) emerged in the form of novel processes, products, services, and business models supported or enabled by the (re-)combination of digital technologies (Nambisan, Lyytinen, Majchrzak, & Song, 2017; Yoo, Henfridsson, & Lyytinen, 2010). Caused by the rigid anti-COVID-19 regulations which specifically restricted physical contact and mobility, organizations had to expand digital technologies to keep their daily business going (Kraus et al., 2020; McKinsey, 2020).

As a result of the COVID-19 induced radical environmental change, many organizations reacted with digital initiatives that appear expectable. For instance, previously analog operating businesses delivered their value propositions through digital channels such as retail stores' click-and-collect solutions, virtual fitness, or virtual wine tastings (Adarkar, Hyde, Maxwell, & Sridharan, 2020; Wade & Bjerkan, 2020). Beyond these somewhat predictable DIs, however, the COVID-19 pandemic also produced entirely new DI activities. An interesting and rather counterintuitive reaction can be seen in the cosmetic retailer Lin Qingxuan. The organization impressively leveraged its situation of urgency (i.e., the closure of 40% of their stores and a 90% drop in turnover) to explore new means of customer service and sales activities (Reeves, Fæste, Chen, Carlsson-Szlezak, & Whitaker, 2020; Spencer et al., 2020). Lin Qingxuan equipped its quarantined salespeople with digital technologies to enable them to become social media influencers and feed outsized online live events. Through highly individualized customer service, the organization was able to attract more than six million followers and to fill 60,000 person large-scale live stream shopping events with more than 100 online advisors (Alibaba Clouder, 2020; Reeves et al., 2020). Its DI activities caused the company's sales to skyrocket, with a YOY growth of 120% in February 2020 (with a peak of 200% in the Wuhan region) by leveraging new opportunities of customer loyalty and retention (Reeves et al., 2020).

Although the academic literature acknowledges the growing opportunities of DI (Berghout, 2020; Y. Chen & Roldan, 2021; Thomas et al., 2020), we lack a rigorously developed and well-structured understanding of DI responses that reflects the diversity of crisis-driven responses (Carugati, Mola, Plé, Lauwers, & Giangreco, 2020). While the Information Systems (IS) literature provides a mature body of knowledge on the nature and implementation of DI (Ciriello, Richter, & Schwabe, 2018; R. Kohli & Melville, 2018; Yoo et al., 2010), to the best of our knowledge, crisis-driven DI has hardly been covered from a theoretical perspective in the IS and in crisis management contexts. However, such an understanding is fundamental to ensuring that organizations have valid grounds for decision-making and guidance for immediate DI implementation decisions in future crisis situations. As the examples cited indicate, organizations use the far-reaching and often unexpected possibilities of DI to counter the effects of a major crisis. Thus, research on DI and crisis management needs a foundation to better understand DI-related response options and dependencies for organizations when confronted with unexpected crisis. In short, we find that being buried in lemons is a tough challenge, however, thriving is possible if one leverages the opportunities that come with the lemons.

Considering the severity of the COVID-19 crisis' economic impacts (e.g., an expected global GDP loss of USD 76.69 billion in a best case scenario (Statista, 2021)), the increasing vulnerability to crisis of our society and DI's growing significance (Henfridsson, Nandhakumar, Scarbrough, & Panourgias, 2018; R. Kohli & Melville, 2018; Vega & Chiasson, 2019), we argue that the phenomenon of DI in times of crisis

merits closer scientific inspection. Thus, we ask: *What DI patterns are emerging in response to exogenous shocks such as the COVID-19 crisis?*

To address this question, we chose a two-stage research approach. Taking a crisis management perspective and drawing on organizational ambidexterity (OA) as a theoretical lens (Niederman & March, 2019), we deductively derived and characterized patterns of crisis-driven DI accounting for the drivers of DI (Baumbach, Oberländer, Röglinger, & Rosemann, 2020; Cordes & Rosemann, 2020; Kotter, 2008) as well as the DI focus (He & Wong, 2004; Jansen, van den Bosch, & Volberda, 2006; March, 1991). Specifically, we considered whether an organization had to respond to the crisis because of a *sense of urgency* (e.g., a new regulation forced the closure of physical retail stores), or chose to respond to new opportunities emerging with the crisis with a *sense of ambition* (e.g., by identifying new customer demands arising from citizens being in enforced isolation). To study the DI focus, we distinguished between *exploitation* (i.e., referring to DI actions and outcomes that refine existing offerings associated with certainty and low organizational effort) and *exploration* (i.e., referring to DI actions and outcomes that create radically new offerings associated with uncertainty and high organizational effort). As a result, we present four patterns of crisis-driven DI derived from the literature. To evaluate and refine these patterns, we analyzed secondary data from 43 organizations implementing DI during the COVID-19 crisis. By analyzing cases assigned to the patterns, we were able to extract their descriptive essences in the form of emerging properties, i.e., core actions and attributes. In sum, our work contributes to the explanatory knowledge of DI in times of crisis, laying the foundation for researchers and practitioners to understand and design crisis-driven DI.

The remainder of the paper is structured as follows: First, we provide an overview of the domain and the theoretical background on DI, the nature of exogenously induced crisis, and OA as a theoretical lens. Second, we elaborate on our research approach and present our results, i.e., four patterns of crisis-driven DI, along with emerging properties and illustrating cases. Finally, we discuss the study's results and limitations, and conclude with suggestions for future research.

2 Domain and Theoretical Background

2.1 Digital Innovation

The emergence of digital technologies has led to new value-creating opportunities, which requires and enables organizations to develop DI (Benbasat & Zmud, 2003; Nambisan, Wright, & Feldman, 2019). More specifically, the nature of traditional innovation has changed, giving rise to DI driven by the constitutive characteristics of digital technologies, i.e., *(re-)programmability, data homogenization*, and its *self-referential nature* (Yoo et al., 2010). Re-programmability means that a device's operational logic is isolated from its physical embodiment. Data homogenization refers to the dynamic information storage, transmission, and processing of information as analog signals are converted into binary numbers. The self-referential nature refers to positive network effects of DI, where DI relies on the use of further digital technologies.

While traditionally research into DI centered around the digitalization of internal processes (Fichman, 2004; Nambisan et al., 2017; Swanson, 1994), more recent IS research has focused on digital technologies' transformative effects on products, services, and business models (Ciriello et al., 2018; Vega & Chiasson, 2019; Yoo et al., 2010), for instance, digitalizing functions of and adding digital capabilities to physical products (Yoo et al., 2010). As a result, different conceptualizations of DI have emerged that particularly differ in terms of the covered innovation outcomes. Whereas, for example, Yoo et al. (2010) provided a product-centric definition referring to the "carrying out of new combinations of digital and physical components to produce novel products" (p. 725), most DI articles refer to a broader understanding that includes novel processes, products, services, and business models that result from the use of digital technologies either as a means or an end (e.g., Fichman, Dos Santos, and Zheng (2014), Nambisan et al. (2017) Vega and Chiasson (2019)). This implies that the DI outcome does not necessarily need to be digital, as long as it is made possible through the use of digital technologies (Nambisan et al., 2017). The DI outcome can be further distinguished from traditional innovation in terms of generativity and convergence (Yoo, Boland, Lyytinen, & Majchrzak, 2012). Generativity describes expansion possibilities for DI, as digital content can be transformed and transmitted across products and industries. Convergence means that separate components of digital technologies can be easily combined to create DI thanks to digital standards (Ciriello et al., 2018; Henfridsson et al., 2018).

The relevance of DI is reflected in the growing body of IS literature, where for instance R. Kohli and Melville (2018) identified seven DI research streams, following the DI actions from initiation to development to exploitation of DI outcomes, also accounting for the roles of the external competitive environment and the internal organizational environment. Owing to the COVID-19 crisis' newness, few academic articles – beyond practitioner-oriented guidance and studies in the healthcare context – have been published on COVID-19's impacts on (digital) innovation. Among the few, Hartmann and Hartmann (2020), for instance, focus on frontline innovation in the police context. Lee and Trimi (2021) elaborate on the role of convergence innovation for managing the COVID-19 pandemic and for reaching the path to the post pandemic future with a focus on sustainability. Y. Chen and Roldan (2021) outline COVID-19 induced course adjustments to a DI class with a focus on the possibilities of transforming the emerging challenges into opportunities.

Against this theoretical foundation, we seek to better understand crisis-driven DI pursued by organizations during COVID-19. Thereby, referring to the definition of Nambisan et al. (2017), we broadly understand DI as "the creation of (and consequent change in) market offerings" (p. 224) leading to novel processes, products, services, and business models supported or enabled by the (re-)combination of digital technologies, whereas the outcomes themselves do not necessarily need to be digital (Fichman et al., 2014; Nambisan et al., 2017; Vega & Chiasson, 2019). Further, we followed the definition of innovative as something that is perceived as new by an organization, where "it matters little […] whether or not an idea is objectively new as measured by the lapse of time" (Rogers, 1995, p. 401).

2.2 The Nature of the Crisis

A crisis is a situation that threatens an organization's goals and values as well as its survival. While some academic work has also included a weakening or degenerating process in organizational operations and its environment (T. A. Williams, Gruber, Sutcliffe, Shepherd, & Zhao, 2017), we follow the common definition of a crisis as an "extreme, unexpected or unpredictable event" (Doern, Williams, & Vorley, 2019, p. 3) that confronts an organization with a new, surprising and only partially predictable decision situation (Pearson & Clair, 1998; Wenzel, Stanske, & Lieberman, 2021). In other words, a crisis represents an exogenous shock that causes important environmental changes for an organization (Dutton, 1986). Crisis alters the predictability of the environment (Osiyevskyy & Dewald, 2018) and require immediate action (Dutton, 1986).

So far, most studies in the field of crisis responses refer to natural disasters (McEntire, Fuller, Johnston, & Weber, 2002; Sakurai & Chughtai, 2020), industrial crisis (Buchanan & Denyer, 2013), leadership changes (Hannah, Uhl-Bien, Avolio, & Cavarretta, 2009; James, Wooten, & Dushek, 2011), and organizational learning (Hossain, 2018; Lampel, Shamsie, & zur Shapira, 2009). Wenzel et al. (2021) group existing crisis-focused work from management scholars to infer four categories of crisis responses: *retrenchment*, *persevering*, *innovating*, and *exit*. While retrenchment (i.e., narrowing a firm's business activities), persevering (i.e., sustaining a firm's existing business activities) and exit (i.e. discontinuing a firm's business activities) describe rather passive response strategies, innovating opens up opportunities of strategic renewal to an organization (Wenzel et al., 2021). The new circumstances caused by the COVID-19 crisis created digital opportunities that were previously "unthinkable or unfeasible" (Wenzel et al., 2021, p. 11) and determined a "relaxation of the ´normal´ constraints around decision-making" (Bryson, 1981, p. 181), which has led to a massive increase of DI (Faraj, Renno, & Bhardwaj, 2021; Soto-Acosta, 2020).

Although current IS literature extensively shows that organizations leverage digital technologies to improve performance in untroubled environments (Sun, Wright, & Thatcher, 2019; Tams, Thatcher, & Craig, 2018) or focus on improving the effectiveness of existing routines in turbulent environments (Burton-Jones & Straub, 2006; Po-An Hsieh & Wang, 2007), this does not yet include any insights on DI-enabled responses to a crisis. The majority of the related IS literature deals with disaster management to aid crisis response (Beydoun, Dascalu, Dominey-Howes, & Sheehan, 2018; Reuter & Kaufhold, 2018), "without providing theoretical frameworks and models that could help understand IT use in the face of such brutal transformations" (Carugati et al., 2020, p. 763). Among the few studies we found, most authors have focused on digital technologies' innovation capabilities in crisis situations and their specific application. Thus, they often took a rather narrow perspective of technology application (Beydoun et al., 2018; Reuter & Kaufhold, 2018; Thomas et al., 2020). They focused, for instance, on efficient information management during a crisis (Cong-cong Lin, Li, Zheng, & Wang, 2015), sociotechnical phenomena involved in crisis response (Thapa, Budhathoki, & Munkvold, 2017), crisis response information networks

(Pan, Pan, & Leidner, 2012), and the roles of digital platforms (Nan & Lu, 2014), social media (Guo, Liu, Wu, & Zhang, 2020; Lalone, Toups, & Tapia, 2020), or other specific digital technologies (Thomas et al., 2020).

As a crisis, like COVID-19, requires immediate action, an organization's perception of the new environmental circumstances is identified as the antecedent of its strategic responses (Osiyevskyy & Dewald, 2018). Regarding DI in times of crisis, we relate this perception to either a *sense of urgency* or a *sense of ambition*. A *sense of urgency* is caused by the perception of the crisis as an immediate threat to the survival of the organization, which leads to a focus on minimizing a crisis' negative impacts by using and adapting digital technologies. We define a *sense of urgency* as a driver for DI, forcing an organization to react to a threat to its survival (Doern et al., 2019; Hannah et al., 2009; Kotter, 2008). Consequently, urgency-driven DI (Fichman, 2004; Nambisan et al., 2017; Swanson, 1994) seeks for DI to bring its weakened system back into alignment (Carugati et al., 2020; T. A. Williams et al., 2017). In contrast, organizations which perceive the crisis with a *sense of ambition* experience the new situational conditions as an opportunity-rich environment where digital technologies enable new forms of value creation (Baumbach et al., 2020; Cordes & Rosemann, 2020; Verheul & van Mil, 2011). We define a *sense of ambition* as a driver for DI, empowering an organization to leverage the crisis-driven environmental changes to enhance or renew its value propositions (Taleb, 2013). Consequently, ambition-driven DI opens up the digital opportunity space of an organization by addressing emerging customer needs and new markets (Ciriello et al., 2018; Vega & Chiasson, 2019; Yoo et al., 2010) that ultimately lead to outcomes that outperform the pre-crisis status (Linnenluecke, 2017; Sakurai & Chughtai, 2020).

In sum, we find organizations to perceive a crisis in two ways (with a *sense of urgency* and with *a sense of ambition*) which represent the main drivers of an organization's DI responses (Table 1). More specifically, if an organization can no longer operate daily business as intended, it perceives a crisis with a *sense of urgency*; if it can take advantage of opportunities created by the crisis, it perceives a crisis with a *sense of ambition*.

Table 1. Two Drivers of Crisis-driven Digital Innovation

Driver of crisis-driven DI	Definition
Sense of urgency	An organization is unable to conduct daily business as intended and perceives the crisis as an immediate threat to its survival. The organization focusses on minimizing the negative impacts of the crisis and on bringing its weakened system back into alignment (Carugati et al., 2020; Kotter, 2008).
Sense of ambition	An organization can take advantage of the exogenous shock and perceives the crisis as an opportunity-rich environment. The organization is able to satisfy new customer needs and to serve new market segments (Baumbach et al., 2020; Cordes & Rosemann, 2020).

2.3 Organizational Ambidexterity

DI relates to the fundamental challenge of balancing evolutionary and revolutionary change (Božič & Dimovski, 2019; Tushman & O'Reilly, 1996). This is becoming ever more important in the context of exogenous shocks such as the COVID-19 crisis, which fuel the pace of discontinuous change (Magnussen, Nilsson, & Kizito, 2019). As the balance between exploitation and exploration is particularly relevant for organizations' responses when facing an exogenous shock's impacts (Blume, Oberländer, Röglinger, Rosemann, & Wyrtki, 2020), we used OA as a theoretical lens (He & Wong, 2004; Jansen et al., 2006; March, 1991) to examine DI emerging in response to the COVID-19 crisis.

OA represents a multifaceted research stream that focuses on an organization's ability to explore new business opportunities while also exploiting its existing business, so as to balance long-term and short-term success (Tushman & O'Reilly, 1996). March (1991) underlined this dual focus from a learning perspective, defining exploration as "experimentation with new alternatives" (p. 85), which is associated with risk-taking and more organizational effort (He & Wong, 2004), while exploitation refers to the "refinement and extension of existing competencies, technologies, and paradigms" (p. 85), associated with problem-solving, control, less uncertainty, and less organizational effort (He & Wong, 2004).

Diverse literature streams have contributed to the understanding of OA, such as organizational learning, organizational design, and technological innovation (Raisch & Birkinshaw, 2008; Werder & Heckmann,

2019). For detailed reviews, see Gibson and Birkinshaw (2004), Gupta, Smith, and Shalley (2006) and Werder and Heckmann (2019) (who have a specific IS focus). Innovation research has established the concept of *innovation ambidexterity*, which shifts the focus from the organizational learning process perspective to an innovation outcomes one (Božič & Dimovski, 2019; Jansen et al., 2006; Mueller, Rosenbusch, & Bausch, 2013). While explorative innovation seeks to create "radically new products, services, or business models that serve new customer needs or create new demands" (Mueller et al., 2013, p. 1609), exploitative innovation seeks to create enhanced offerings to address the demands of existing customers or markets (Abernathy & Clark, 1985; Benner & Tushman, 2003; Mueller et al., 2013). Chatterjee, Moody, Lowry, Chakraborty, and Hardin (2020) even found evidence that exploitative innovation positively influences explorative innovation.

Many scholars have emphasized the need for ambidexterity (Kang & Snell, 2009; Linhart, Röglinger, & Stelzl, 2018). Since exploitation and exploration have different objectives and compete for scarce resources, OA must be well-managed if it is to drive corporate growth (He & Wong, 2004; Müller, Påske, & Rodil, 2019) and performance (Gibson & Birkinshaw, 2004; Lubatkin, Simsek, Ling, & Veiga, 2006). While the IS literature has extensively investigated exploitation and exploration in normal, comparably untroubled times, e.g., in the context of IT transformation programs (Gregory, Keil, Muntermann, & Mähring, 2015; Newell, Huang, Galliers, & Pan, 2014) or to leverage digital opportunities (Baumbach et al., 2020; Park, Pavlou, & Saraf, 2020), it offers few perspectives to researchers and practitioners in the context of crisis (Carugati et al., 2020). To address this gap and account for the challenge of balancing evolutionary and revolutionary change in times of crisis, we followed the OA perspective to analyze actions and outcomes of crisis-driven DI. Thereby, we specifically differentiate an organization's innovation focus between exploitation and exploration (Table 2).

Table 2. Two Foci of Crisis-driven Digital Innovation

Focus of crisis-driven DI	Definition
Exploitation	The digital innovation actions and outcomes relate to problem-solving and control to create enhanced processes, products, services, and business models, associated with high certainty and low organizational effort (He & Wong, 2004; Jansen et al., 2006; March, 1991).
Exploration	The digital innovation actions and outcomes relate to experimentation and risk-taking to create radically new processes, products, services, and business models, associated with low certainty and high organizational effort (He & Wong, 2004; Jansen et al., 2006; March, 1991).

3 Research Approach

To identify and characterize patterns of DI emerging in response to an exogenous shock such as the COVID-19 crisis, we followed a two-stage research approach (Figure 1) according to principles of deductive and inductive reasoning (Gregory & Muntermann, 2011).

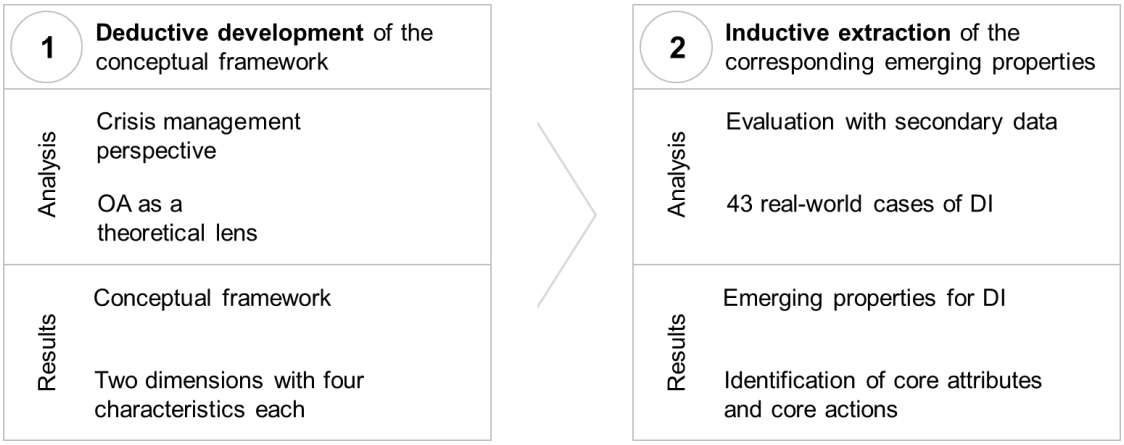

Figure 1. The Two-stage Research Approach

First, as our research topic is located at the intersection of crisis management and DI, we screened the literature in both research fields and at their convergence to gain an overview of related work addressing our research question. Thereby, we were particularly interested in studies and theories that help explain how a crisis affects organizations and their DI initiatives. Conducting multiple workshops within the author team, we deductively developed a conceptual framework of how organizations can respond to a crisis with DI based on IS and management literature. More specifically, we decided to take a crisis management perspective and to draw on OA as a theoretical lens for our deduction efforts.

In sum, our analysis of the academic discourses on crisis management and OA revealed two dimensions of crisis-driven DI: (1) DI driver and (2) DI focus, revealing four possible patterns of crisis-driven DI. (Find more details on the dimensions in Section 2.) Thus, we combine the characteristics of the two dimensions into a 2x2 matrix comprising four patterns as our conceptual framework of crisis-driven DI: *urgency-driven exploitation, urgency-driven exploration, ambition-driven exploitation, ambition-driven exploration.* We take a static perspective of analysis and, thus, assume that the characteristics in each dimension are mutually exclusive at a given point in time, i.e., an organization developing a DI is either driven by a sense of urgency or a sense of ambition and the focus of the DI is either exploitation or exploration.

Second, to evaluate the patterns and to inductively extract their descriptive essence in the form of emerging properties, we applied the four patterns of crisis-driven DI to secondary case data to classify and characterize real-world examples. We understand emerging properties as new (Henle, 1942), structurally different (O'Connor, 1994) characteristics (i.e., actions and attributes) describing organizations pursuing DI driven by the (COVID-19) crisis (Katz & Gartner, 1988; McKelvey, 1982). While secondary data needs to be used with caution, it has the potential to provide new insights for phenomena that researchers cannot sufficiently explore due to difficulties in obtaining relevant primary data, which fits the context of our work (Sumantra Sarkar, Petter, & Ghosh, 2020).

As a result, we ensured high applicability and explanatory power of the deductively derived patterns of crisis-driven DI and drew from insights into the real-world examples to further specify and differentiate these patterns. For data collection, we conducted a structured case search to identify organizations' innovative digital responses to the COVID-19 crisis, focusing on leading international practitioner-oriented journals with a high turnover to cover recent cases, i.e., *Harvard Business Review, MIT Sloan Management Review,* and *California Management Review* (Foss & Saebi, 2017). As an abundance of peer-reviewed publications on the outbreak of the COVID-19 crisis in February 2020 are not expected in the short term, we extended our search to the business-driven management outlets *McKinsey Global Institute* and *ManagerMagazin*. For these five journals, we used the search string ("Corona" OR "COVID" OR "Pandem*"). To find cases beyond business journals, we also conducted a Google search following the search string ("Corona" OR "Covid" OR "Pandemic") AND ("Company" OR "Business") AND ("Response" OR "Reaction" OR "Strategy"). We limited our search to the period February 1 to June 30, 2020. From the final data set of 61 cases, we were able to extract 43 cases of DI that describe innovative responses to the COVID-19 crisis related to the creation of enhanced or novel processes, products, services, or business models that were enabled or supported by the use of digital technologies (Nambisan et al., 2017).[1] We excluded 18 cases that referred to non-digital innovation. Table 3 and Table 4 show the number of cases per industry and country.

Table 3. Number of Cases per Industry[2]

Industry	Digital Retail	Fashion and Beauty	Financial Service	Food and Beverages	Health Care	Manufacturing	Retail	Software Development	Other (<2)
Number of Cases	4	3	7	5	5	3	3	4	9

Table 4. Number of Cases per Country

Country	Canada	China	Finland	Germany	UK	USA
Number of Cases	1	25	1	2	1	13

Interestingly, more than half of the cases in the final sample stemmed from Chinese organizations. We relate this finding to a threefold explanation: First, China was the world's first country with a documented COVID-19 outbreak in December 2019 (Hui et al., 2020), so naturally organizations there had to react

[1] For a complete overview of the cases and their references, see Appendix A.
[2] Industries aggregated in the column "Other (<2)" include agriculture, art and culture, education, entertainment, hotel and travel, and social media.

earlier, and successful cases of crisis-driven DI were also reported earlier and to date were more numerous. Second, China had experienced a less severe but similar exogenous shock with the 2002/03 SARS pandemic, so that organizations may have exhibited innovative reactions to countermeasures (e.g., lockdowns) and may have built complementary resources and capabilities so as to react faster. Third, China's political system may favor swift, innovative reactions in the context of DI in China (Băzăvan, 2019). In recent years, Chinese organizations have significantly improved their innovation capabilities and are substantially investing in DI (Chatterjee et al., 2020; Chung & Tan, 2017; Gillon et al., 2012).

We studied the identified 43 cases in-depth based on publicly available secondary data, whereas three co-authors classified them independently according to the deductively derived dimensions and characteristics of the conceptual framework. In terms of coding, the co-authors followed the definition of the four analysis characteristics as shown in Table 1 and Table 2 to ensure comparability of their results. Regarding the DI driver, coding included an assessment of the impact of the exogenous shock on the daily business of the organization, e.g., whether their processes, products, services, and business models rely on physical interactions and to what extent they were able to follow business as usual. In simple terms, each co-author decided whether the organization developed the DI at hand because they had to (*sense of urgency*) or because they wanted to (*sense of ambition*). Regarding the DI focus, coding was based on the novelty of the DI from the organization's perspective and extent to which their outcome differs from the organization's pre-pandemic processes, products, services, and business models, e.g., whether they aimed at addressing new markets and/or customer demands. The classification results of the three co-authors were then compared in a workshop within the full author team and ambiguous cases were discussed. We collectively reflected on the available secondary data to understand why its interpretation could be different between the three coding co-authors and clarified potential misunderstandings in the available data. As a result, we were able to unanimously classify all 43 cases as one of the four patterns of crisis-driven DI.

Taking our set of 43 classified cases, we conducted a detailed analysis on each pattern, using axial and selective coding techniques for aggregation and abstraction (Wolfswinkel, Furtmueller, & Wilderom, 2013). In five workshops within the author team, we jointly identified commonalities between the cases assigned to each pattern and extracted their descriptive essences in the form of emerging properties, i.e., core actions and core attributes of the related organizations.

4 Results

4.1 Patterns of Crisis-driven Digital Innovation

We here present the four patterns of crisis-driven DI (Figure 2). Complying with the presented literature on crisis management and OA as a theoretical lens, each pattern relates to one driver and one focus of DI during times of a crisis.

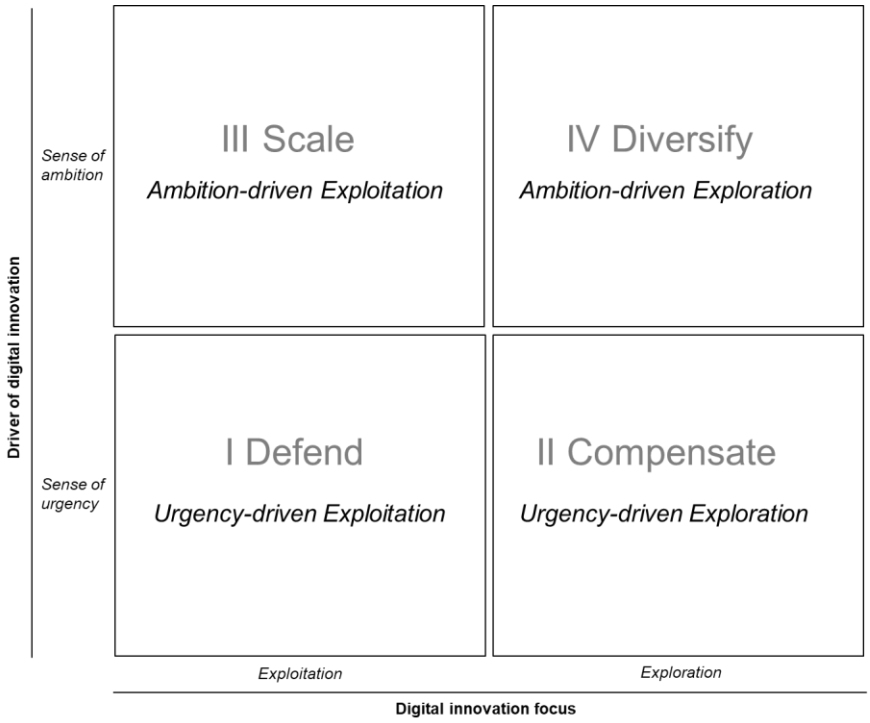

Figure 2. Deductively Derived Patterns of Crisis-driven Digital Innovation

First, there are two ways an organization can perceive a crisis and is hence driven to innovate, i.e., classifying the two perceptual states of a crisis relating to a sense of urgency vs. a sense of ambition. Second, to characterize the DI focus, we distinguish between exploitation (e.g., referring to DI actions and outcomes that enhance existing offerings, associated with more certainty and less organizational effort) and exploration (e.g., referring to DI actions and outcomes that create radically new offerings, associated with less certainty and more organizational effort). Descriptions of our literature-based understanding of these characteristics can be found in Section 2. Combining the dimensions and characteristics in line with the combinatorial possibilities, we derived four patterns of crisis-driven DI.

For an intuitive classification, we named the patterns according to the respective overarching theme we identified when deductively developing the framework. Thus, the (I) *defend* pattern relates to *urgency-driven exploitation*, describing DI cases that were developed from a *sense of urgency* (as organizations could not operate their daily business as intended) aiming at the digitalization or digital enhancement of existing offerings for short-term survival. The (II) *compensate* pattern describes *urgency-driven exploration*, where the *sense of urgency* was transformed into the exploration of radically new ways of dealing with the crisis. The (III) *scale* pattern describes *ambition-driven exploitation*, characterizing DI cases that were developed from a *sense of ambition* with the aim to incrementally enhance and *scale* existing digital offerings. The (IV) *diversify* pattern describes *ambition-driven exploration*, targeting novel crisis-related opportunities beyond existing offerings. We understand the patterns to be applicable to different types of crisis in today's digital age as we derived them from the general literature on DI, crisis management, and OA.

4.2 The Patterns' Emerging Properties

To evaluate the patterns and to inductively extract their descriptive essence, we used the four patterns of crisis-driven DI to analyze and classify 43 cases of DI during the COVID-19 crisis. Table 5 shows the number of cases we assigned to each pattern (an individual assignment of all cases is shown in Appendix A).

Table 5. Number of Cases per Pattern of Crisis-driven Digital Innovation

Pattern of crisis-driven DI	(I) Defend (Urgency-driven Exploitation)	(II) Compensate (Urgency-driven Exploration)	(III) Scale (Ambition-driven Exploitation)	(IV) Diversify (Ambition-driven Exploration)
Number of Cases	**14** (33%)	**9** (21%)	**12** (28%)	**8** (18%)

To clearly differentiate between the patterns and to account for the specifics of DI responses during the COVID-19 crisis, we extracted the patterns' descriptive essences in the form of emerging properties relating to core actions and attributes of the organizations pursuing one pattern. Specifically, core attributes represent the contextual factors of the organization types related to a specific pattern, for instance, regarding their previous experience with digital technologies and the time focus of the DI. We refer core actions to the DI actions we found organizations undertaking during the crisis to develop DI, for instance, regarding targeted innovation outcomes, customer interactions, and levered digital technologies (Chatterjee et al., 2020; Ciriello et al., 2018; Yoo et al., 2010). In contrast to the general descriptions of the patterns in Section 4.1, the inductively developed emerging properties more specifically relate to the COVID-19 crisis by drawing from respective secondary case data.

We combine and present the four patterns of crisis-driven DI and their emerging properties in Figure 3, before we illustrate them in more detail in the following sub-sections. In each sub-section, we first give an overview of our findings regarding each pattern and the emerging properties of the assigned cases. Thereafter, we describe one assigned case in detail, which we selected because they were well-documented and offered the most clarity to demonstrate the patterns' properties. We conclude each section by providing further examples of each pattern from our case sample. We selected these further examples as they offer additional insights into emerging properties that were not or only partially shown in the prior detailed case descriptions.

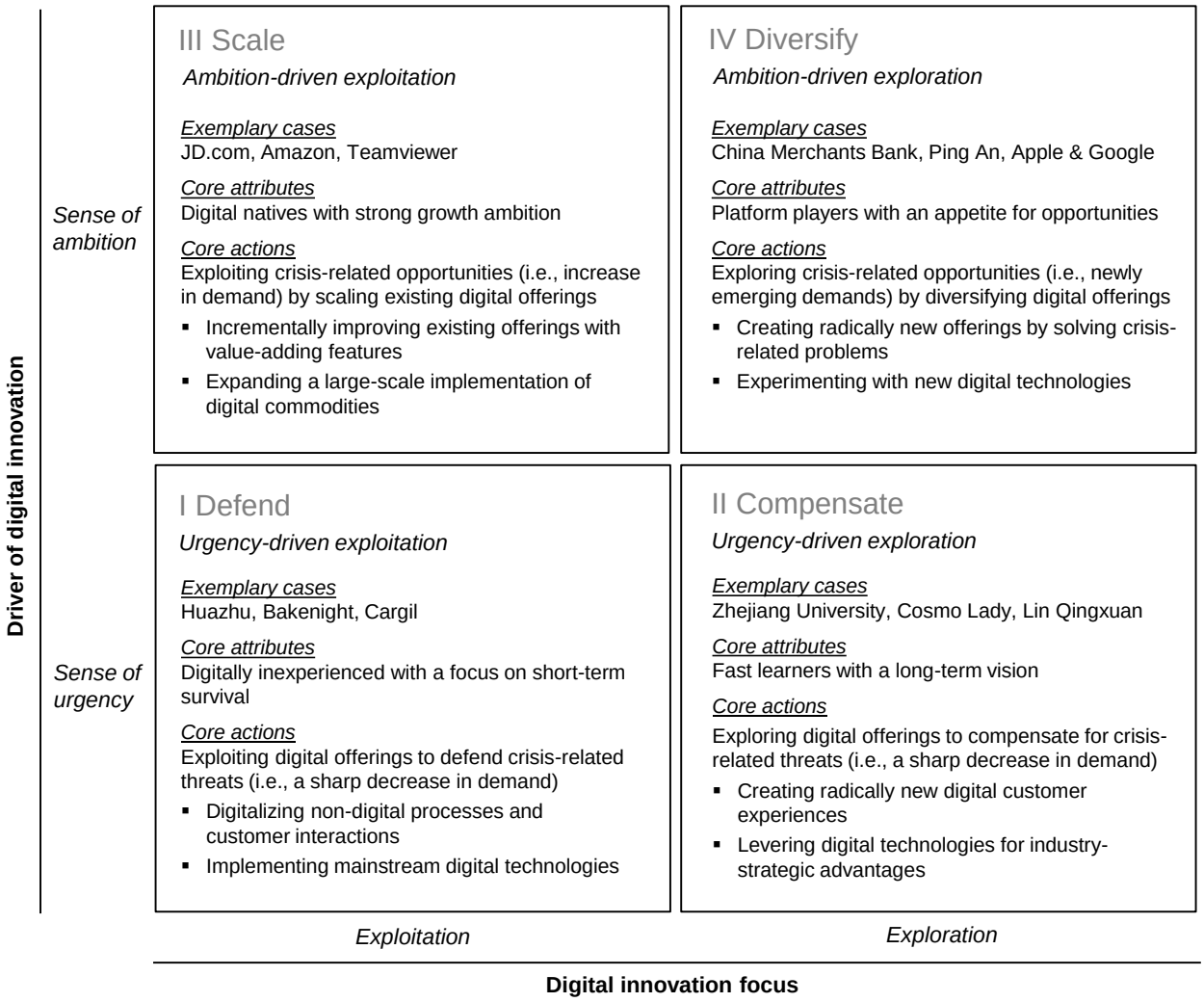

Figure 3. Patterns of Crisis-driven Digital Innovation and their Emerging Properties

4.3 Description of the Patterns and Exemplary Cases

4.3.1 Defend (Urgency-driven Exploitation)

The *defend* pattern covers organizations that were unable to operate their day-to-day business operations under the given COVID-19 conditions and were therefore forced to exploit digital offerings to defend against crisis-related threats. We found that the organizations pursuing the pattern *defend* were digitally fairly inexperienced, for instance owing to their prior business model not requiring it. Hit by COVID-19 restrictions, they focused on short-term survival by implementing mainstream digital technologies that allowed for the digitalization of their (previously analog) processes and customer interactions.

For example, Huazhu, a Chinese multi-brand hotel management group that operated 6,000 hotels in 400 cities across China (Huazhu, 2020a) was significantly affected by the COVID-19 crisis, as cities were locked down and governments instituted travel restrictions (Wroten, 2020). Huazhu was forced to instantly close almost 50% of its hotels in February 2020, which were located in high-risk cities. Hotels that were allowed to remain open faced demanding government requirements for hygiene and safety measures, a declining number of customers, and daily uncertainty regarding the spread of the pandemic and corresponding countermeasures. Huazhu was hence in an urgent need to react. Driven by a *sense of urgency*, it opted to exploit mainstream digital infrastructure to keep its employees and partners informed and safe (e.g., by leveraging an internal information platform), to implement digital customer processes (e.g., creating novel non-contact services such as robot delivery), and, ultimately, to keep operations going (Wroten, 2020). The company stated that its investment in technology greatly contributed to its

ability to remain open during COVID-19 in China (Escobar, 2020). Huazhu's brands were one of the first to reopen, achieving a rate of 93.5% of hotels back in operation by the end of March 2020 (Huazhu, 2020b). Further, Huazhu reported a 62% occupancy, up from single digits just a few days before, and 15-20% higher than its second-closest peer (Huazhu, 2020b).

Other examples of the *defend* pattern included a German provider of baking workshops, Bakenight, whose main offering exclusively relied on physical interactions, and who switched from offline to online workshops to keep its business going. The agricultural giant Cargill implemented digital signatures to handle contactless delivery within its supply chain, and the education organization New Oriental Group offered its courses via a live-streaming platform (Das, Vinay, & Liangliang, 2020; Schrage, 2020).

4.3.2 Compensate (Urgency-driven Exploration)

The *compensate* pattern covers organizations that were unable to operate everyday business activities under the COVID-19 conditions and were (similar to *defend*) threatened by revenue losses. In contrast to merely defending existing customer demands by digitalizing processes and interactions with a fairly short-term focus, these companies explored digital customer experiences to compensate for crisis-related threats. However, owing to the short-term nature of the COVID-19 crisis and the severity of its impacts, companies following this pattern had little time for experimentation and needed to rapidly acquire necessary capabilities while moving into unknown territories. They pursued a fairly long-term vision of digitalizing their business beyond the COVID-19 crisis by leveraging digital technologies that provide industry-strategic advantages and that create radically new customer experiences.

For instance, universities could opt to digitally broadcast existing lectures for existing students (i.e., *defend*), but could also use the crisis to engage in an explorative digital teaching approach that conveys knowledge in new ways to students as well as to novel customer segments, creating radically new learning experiences (i.e., *compensate*). Our case search led us to a Chinese university following the *compensate* pattern – Zhejiang University (ZJU). Founded in 1897 in the city of Hangzhou, ZJU had more than 30,000 students in August 2019 (Zhejiang University, 2019). As China continued to battle the COVID-19 crisis in 2019, its universities had to follow public health guidance, shut down their campuses, and stop all teaching courses based on physical interactions. Fortunately for ZJU, it had just finished the development of its online learning platform, Learning at ZJU, which had launched in November 2019. While it was not prepared for a complete shift from offline to online teaching, the platform gave ZJU a foundation to start from. On 24 February 2020, ZJU officially started teaching online, offering more than 5,000 courses not only to previously enrolled students, but also to newly enrolled eager learners nationally and worldwide (Wade & Bjerkan, 2020). Further, ZJU cooperated with Alibaba to launch the live-streaming app DingTalk ZJU which, together with Learning at ZJU, became the standard for its online courses. ZJU immediately shifted its core business to digital channels and was therefore able to create radically new customer (i.e., student) experiences, for instance by adapting teacher-student interactions and ubiquitous learning techniques to a new and digitalized environment. It levered the potential of a live-streaming app and an online learning platform to gain industry-strategic advantages, for instance by gaining media coverage. In April 2020, its learning platform attracted 570,000 visits and its live-streaming app achieved a total audience of 300,000 (Wade & Bjerkan, 2020).

Other cases of the *compensate* pattern included fashion and beauty retail companies (e.g., Lin Qingxuan, Cosmo Lady, and Michael Kors) that decided to not simply switch to online retail, but to step up the promotion of its sellers as social influencers, engaging digitally instead of physically with its customers (Reeves et al., 2020). Also, the Chinese entertainment organization Huanxi Media Group refrained from publishing its movies in theaters and, instead, broadcasted them via video-streaming apps to respond to the demands of both existing and new customers (Das et al., 2020).

4.3.3 Scale (Ambition-driven Exploitation)

The *scale* pattern covers cases of organizations that were able to do their daily business as usual under COVID-19. We found most organizations in this pattern to be digital natives with strong growth ambitions whose business models hardly relied on physical interactions and/or whose offerings fit customer demands during the COVID-19 crisis. Thus, there was no urgent need to act, but rather opportunities to enhance and to scale existing digital offerings to exploit crisis-related opportunities. Given the high demand, companies could incrementally improve their offerings with value-adding features and could opt for large-scale implementation of digital commodities.

JD.com, a Chinese internet company operating a global e-commerce platform with more than 180,000 employees (JD.com, 2020), was one example of the *scale* pattern. JD.com's digital business model was barely threatened by the COVID-19 crisis, and its daily business could continue with only a few restrictions (Chengyi Lin, 2020). Although JD.com was already in a strong position, it grew more robustly than similar online retailers (Reeves et al., 2020). According to Chengyi Lin (2020) and articles on the company's corporate blog (Cao, 2020), this was due to JD.com very rapidly rolling out digital technologies to provide non-stop services, high product availability, and consistent delivery times. In less restricted regions, JD.com noticed that customers were also trying to avoid physical contact, and it implemented a new contactless delivery pickup system based on mobile codes and deposit boxes. To maintain high availability and consistency, JD.com used its own AI platform, demographic data, and a self-developed infectious disease model to improve its supply chain management system. Further, JD.com already had a telemedicine business unit in place that previously accounted for only a small percentage of its total revenue. JD.com anticipated an increase in the demand for online health consultations and quickly ramped up its telemedicine business' capacity. With the COVID-19 crisis increasing the demand for online retail, JD.com, being a digital native, was placed in a position where it was not forced to act. However, the exogenous shock of the crisis fueled the company's *sense of ambition* to grow and exploit by incrementally improving existing offerings with value-adding features. Because of its DI efforts for adapting its delivery processes, JD.com's order fulfilment rate remained at 95%, while its same-day and next-day delivery promises during the crisis were almost unaffected, and its cost per delivery reached an all-time low (Chengyi Lin, 2020). Compared to before the COVID-19 crisis, the monthly consultations for its telemedicine business multiplied tenfold. Overall, JD.com's annual forecast expects its revenue to grow by 23.1% on 2019 to USD 111.8 billion (Business Wire, 2020).

Besides e-commerce giants similar to JD.com (e.g., Amazon and Alibaba), we also found providers of digital collaboration tools following the *scale* pattern. TeamViewer, for instance, adapted its video conferencing tool to the requirements of online teaching and collaborated with Microsoft to seamlessly integrate its tool into Microsoft Teams (Teamviewer, 2020). Slack began offering one-to-one live consultations, created new webinar programs in response to a growing demand, and implemented new security features targeted to remote working (Butterfield, 2020; S. Williams, 2020).

4.3.4 Diversify (Urgency-driven Exploration)

The *diversify* pattern covers organizations that were able to go about their daily business under COVID-19 conditions. While these companies did not depend on physical interactions and were not forced to act, nonetheless, we found that they were hungry to explore crisis-related opportunities. In contrast to cases of the *scale* pattern, they had few or no offerings in place that targeted crisis-related demands that they could easily scale up. Companies in the *diversify* pattern were keen to search for novel ways to address crisis-related problems by diversifying their existing digital offerings. Thus, they experimented, for example, with (to them) novel digital technologies to create radically new offerings and/or levered the potentials of their existing or newly developed platforms.

As an example, we present the financial service provider China Merchants Bank (CMB), which employs more than 70,000 people (China Merchants Bank, 2020). CMB faced the COVID-19 crisis from a strong competitive position, with a number of digital services already in place, such as the CMB app (China Merchants Bank, 2020). Building on the app's already established digital infrastructure, CMB explosively increased contactless online wealth management business during the COVID-19 crisis (K. T. Chen, 2020). However, CMB also launched new features in an anti-epidemic zone within its app, where it provided new digital services beyond the financial services context. CMB levered its app as a medical service platform with various third-party suppliers, where app users could access real-time COVID-19 data and could also organize online counselling services with doctors and could find further helpful stay-at-home services, such as food delivery and online courses (Adarkar et al., 2020). Although the crisis fueled its established wealth management business (K. T. Chen, 2020), CMB developed the ambition to explore radically new digital offerings beyond the finance context so as to address its customers' problems in the crisis and positioned itself as a platform provider. More than 100 million customers have visited its anti-epidemic zone, and more than 1.6 million have relied on its remote counselling services from 50,000 doctors (Adarkar et al., 2020).

In our sample of the *diversify* pattern, two other financial service providers, China Construction Bank and Ping An, followed a similar approach to CMB and leveraged digital platforms targeted at crisis-related problems (Adarkar et al., 2020; Adelaide Business School, 2020). Other examples included tech

companies; for instance, Apple and Google developed an AI-based contact tracing app (Pisano, 2020), and the software developer Slightly Robot deployed an app designed for wearable devices that encourages users to not touch their face (Kaur, 2020).

5 Discussion and Further Research

5.1 Contribution and Theoretical Implications

As an exogenous shock, the COVID-19 pandemic has triggered a global humanitarian and economic crisis. To survive, organizations worldwide had to adapt from one moment to the other to completely new environmental conditions. Observing COVID-19 affected cases clearly shows that organizations adapted in different ways to the environmental changes through different forms of DI. While previously organizations were able to react to crisis and discontinuous change by means of traditional innovation management (Birkinshaw, Hamel, & Mol, 2008; Hamel, 2006; Wenzel et al., 2021), today's ubiquitous accessibility and the embeddedness of digital technologies form a breeding ground for (unexpected) digitally-enabled innovative responses in the form of DI. Consequently, the perceived shortage of analog business and perceived overflow of digital opportunities led to different possibilities of DI. Companies that are naturally unfavored by the crisis, e.g., by relying on physical contacts, were able to leverage DI for survival as well as for economic growth. Hence, organizational responses driven by both a sense of urgency as well as ambition vary from defending existing business by digitalizing value propositions, e.g., virtual wine tasting, to the exploration of new digital business opportunities, e.g., transforming salespeople into social media influencers. In our study, we explored the *DI patterns emerging in response to exogenous shocks such as the COVID-19 crisis*. Based on knowledge from related research fields, we have outlined four patterns of crisis-driven DI. By applying the four patterns to 43 cases of organizations pursuing DI in response to this crisis, we were able to extract the patterns' descriptive essences in the form of emerging properties, i.e., core actions and attributes, and gained noteworthy overarching as well as pattern-specific insights.

In summary, our work contributes to the explanatory knowledge of DI in times of crisis, laying the foundation for researchers and practitioners to understand and design crisis-driven DI. Further, we address the fact that research and practice have not yet fully understood and explained the antecedents, contextual conditions, and initiation of different DI types (R. Kohli & Melville, 2018; Vega & Chiasson, 2019). Specifically, we contribute to the knowledge on crisis-driven DI deepening the theoretical understanding of organizations' OA in times of crisis (Carugati et al., 2020). In this way, we add to the intensive discussion on how organizations react to crisis (Blume et al., 2020; Davidsson, Recker, & Briel, 2018; Soumodip Sarkar & Osiyevskyy, 2018) by outlining patterns of crisis-driven DI together with emerging properties that provide initial (i.e., nascent) explanations on how and why DI emerged in some particular real-world situations (Gregor, 2006) (i.e., the context of the COVID-19 crisis). While we argue that our deductively developed framework of crisis-driven DI patterns applies to various kinds of crisis in the digital age, the inductively developed emerging properties, i.e., by drawing from secondary case data, more specifically relate to the COVID-19 crisis. As a result, our work supports researchers and practitioners in understanding and better explaining crisis-driven DI. In this regard, we understand our contribution as a nascent theory for explaining in line with Gregor (2006), Fawcett and Downs (2016), and Leidner (2018). Our work also lays the foundation for more elaborate qualitative (e.g., expert interviews, in-depth case studies) and quantitative explanations on specific relationships between organizational characteristics and DI success as well as the foundation for further theory-led design of crisis-driven DI.

As for theoretical implications, we found the four patterns of crisis-driven DI to reveal new questions for research, whereby the findings of our evaluation provide initial insights. More specifically, building on the introduced patterns of crisis-driven DI, we derive a set of four propositions that provide directions for further research (Table 6). Research propositions usually emerge from case-based empirical evidence and lay the foundation for theory construction (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; A. K. Kohli & Jaworski, 1990). According to Eisenhardt and Graebner (2007), propositions are more robust if they are based on multiple cases, which is in line with our research approach. However, notably, our propositions do not represent fully-fledged hypotheses that were tested based on the available secondary data. Instead, we see this as a stimulus for future research and seek to motivate IS researchers to examine the propositions in detail in the future.

Table 6. Propositions Informed by the Digital Innovation Patterns

P1	**Not every organization can pursue every DI pattern.**
P2	**Urgency-driven DI is favorable for exploitative innovation outcomes if there is a digital way to run the business.**
P3	**Ambition-driven DI is favorable for explorative innovation outcomes if there is a fit between an organization's existing digital resources and new market opportunities.**
P4	**Accessibility of a DI pattern depends on the digital maturity and resource base of an organization.**

First, there is the question of whether every organization must or even can pursue one of the patterns in light of a crisis. We found that all cases in our data sample which involve an active creation of DI could be classified in terms of one of the outlined four patterns of crisis-driven DI. However, during our search for real-world cases, we also identified several organizations that did not engage in DI during the crisis at all (e.g., many airlines), but instead applied "hibernation" (i.e., retrenchment) strategies; for instance, trying to reduce costs and overhead as much as possible and asking for aid from the government until the situation improves. This finding is in line with the work of Wenzel et al. (2021) who identified four types of strategic responses to crisis, thereof, three not related to innovation (i.e., retrenchment, persevering, exit). Moreover, our analysis indicates that not every company has the necessary capabilities to pursue every pattern. We noted during the application of our framework that it is crucial to carefully investigate and understand an organization's initial situation and resource base before the crisis to appropriately assess and interpret its innovation driver (i.e., *sense of urgency* vs. *sense of ambition*) as well as its context-dependent innovation focus (i.e., *exploitation* vs. *exploration*). While some organizations may have implemented digital channels to interact with their customers for years (e.g., Amazon) to innovatively exploit them during the crisis, others (e.g., universities) had to explore novel digital communication infrastructures to create DI for their students and stakeholders. Thus, the initial resource base, e.g., digital infrastructure and capabilities, and the internal and external context of companies heavily influence which patterns are accessible to them. In this regard, we also found that in particular large companies are able to keep various patterns accessible by taking appropriate precautions. JD.com, for instance, has a very broad presence across many industries and as such was able to scale up its most fitting business unit, i.e., digital health care, when the crisis hit. As a first proposition (P1), we therefore state that *not every organization can pursue every DI pattern.*

Second, our findings induce the question of why an organization follows one specific pattern and if there is any favourability in the choice of pattern. In this regard, we considered *defend* and *diversify* as intuitive response patterns when deriving them from the literature. On the one hand, organizations respond from a high *sense of urgency* with *exploitation* (*defend*) to stabilize their declining business and revenue streams. Accordingly, in our sample, we found more *urgency-driven* cases that relate to *exploitation* (14/43) than to *exploration* (9/43), which suggests that *urgency-driven DI* may be favorable for exploitative innovation. We hypothesize that many organizations that are severely affected by an exogenous shock do not have the resources available to engage in the risky and potentially costly exploration of new business opportunities. Instead, they may engage in more focused, *urgency-driven exploitation*, with a short-term survival focus, or may not engage in DI at all. This is particularly the case if there is a digital way to run the business (e.g., leveraging digital instead of physical interactions with customers). As a second proposition (P2), we therefore find that *urgency-driven DI is favorable for exploitative innovation outcomes if there is a digital way to run the business*.

Third, organizations respond from a high *sense of ambition* and carry out *exploration* (*diversify*) to find opportunities for new offerings that satisfy newly emerging customer demands. Accordingly, we found more *ambition-driven* cases that relate to *exploration* (12/43) than to exploitation (8/43). We argue that many organizations engaged in *exploration* levered their existing digital resources (such as CMB's existing app) to create new offerings that address emerging market opportunities (such as CMB's online health counselling). As a third proposition (P3), we therefore find that *ambition-driven DI is favorable for explorative innovation outcomes if there is a fit between an organization's existing digital resources and new market opportunities.*

Fourth, we identified two further, seemingly less intuitive DI patterns in the context of crisis. With the *scale* pattern, we have shown that organizations also exploited DI driven by ambition during the crisis. We found some particularly technology-focused (digital native) organizations reacting to crisis-driven increases in the demand for their products and services by expanding and enhancing their existing business and the market position associated with it. Examples from our sample include Slack, Alibaba, JD.com, and the Chinese social video platform Kuaishou. Also, the *compensate* pattern relates to organizations that were threatened by the crisis and that perceived a strong *sense of urgency* to react while nonetheless engaging

in *exploration* by leveraging digital technologies and creating radically new customer experiences. Examples from our sample include the retail organizations Hangzhou Intime and Lin Qingxuan, which explored new ways of digitally interacting with their customers, and ZJU, which levered the full potential of online teaching. While our case collection is neither exhaustive nor fully representative, these findings show that there may be differences concerning the feasibility, viability, and desirability among the patterns of crisis-driven DI. As a fourth proposition (P4), we therefore find that the *accessibility of a DI pattern is dependent on the digital maturity and resource base of an organization*.

By addressing and enhancing our propositions towards fully-fledged hypotheses, future research can use our findings as a basis for generating prescriptive knowledge and theory development in the context of DI in times of crisis. Potential results include theories for predicting, i.e., Types III and IV in terms of Gregor (2006), based on quantitative empirical studies that fully explore the relationship between specific patterns and economic success in the short and long term. Along these lines, it may be of particular interest to study drivers and barriers to success related to specific patterns. Further research could build on the patterns to develop theories for design and action, i.e., Type V (Gregor 2006), and provide methods and tools that support decisions regarding choice of patterns and guide the subsequent development of DI.

5.2 Practical Implications

Regarding practical implications, we evaluated and refined the patterns by analyzing secondary data of 43 organizations implementing DI during the COVID-19 crisis to extract emerging properties, i.e., core actions and attributes. In doing so, our inductively induced results also reveal practical value for organizations that face a crisis and those that aim to prepare for a future crisis (Moeini, Rahrovani, & Chan, 2019).

First, the four patterns of crisis-driven DI and the corresponding case collection (and good practices) provide organizations with an overview of possible DI-based solutions and may motivate practitioners to evaluate and adopt DI responses from other organizations. Thereby, the four patterns define the design space for DI-driven responses to a crisis and practitioners should specifically consider the patterns' emerging properties when deciding on their next steps. For instance, organizations can examine which core attribute resonates and aligns the most with their overall strategy or analyze which core actions are feasible given their resource base and market conditions. Along these lines, organizations may even strive to move from one pattern to another, especially regarding their DI focus. For instance, as organizations that perceived the crisis with a *sense of urgency* were forced to act quickly, there may be a tendency toward first exploiting existing offerings digitally. After stabilizing their revenues, organizations that pursued the *defend* pattern (urgency-driven exploitation) may benefit from learning from the *compensate* pattern (urgency-driven exploration) in a next step. Defining and following paths from one pattern to another may also support an organization's overall growth strategy, as they build resources and capabilities necessary to pursue a new pattern during a crisis and are then able to further leverage these resources and capabilities after the crisis ends. The concept of the four patterns of crisis-driven DI enables organizations to steer different business units individually through a crisis and to strategically manage both commonalities (and synergies) and differences with regard to an overall DI strategy.

Second, the four patterns of crisis-driven DI support practitioners in their planning and preparation for future crises similar to COVID-19 and hence enable them to increase their overall resilience. Thus, organizations prepare themselves to be able to react to environmental changes and take advantage of emerging digital opportunities to realize outcomes that outperform the pre-crisis status (Linnenluecke, 2017; Luthans, Avey, Avolio, & Peterson, 2010; Sakurai & Chughtai, 2020). As resilient organizations have the ambidextrous intention and ability to bring about both stability and progress in a crisis, an exogenous shock acts as an external enabler of opportunities for DI. More specifically, practitioners could integrate our results in their risk and scenario planning (Worthington, Collins, & Hitt, 2009), where they analyze and evaluate each pattern or a combination of patterns from a strategic and economical perspective and decide on the most fitting precautions. Building on this, practitioners can use the four patterns specifically to develop resources and capabilities. The core attributes and core actions describing the patterns can be built up as a target for the development of technological foundations (e.g., digital infrastructure), strategic resources, knowledge, skills, and routines. This can lead to a higher level of resilience as the organization can specifically seize the opportunities that arise, caused by a crisis, by pursuing the respective patterns.

Further, practitioners can use the four patterns of crisis-driven DI as a lens through which they can study cases of crisis-driven DI in their environment, e.g., of competitors, and can collect data regarding the

potential success of each pattern and can consequently detail the pattern for their specific environment. For instance, practitioners may find that JD.com's broad presence across many industries allowed it to follow multiple patterns during the crisis, which may motivate them to explore digital business models beyond their current models as a precaution for a crisis like COVID-19. And last, practitioners might even aim to conduct scenario planning and risk management on the level of business units and derive different response strategies to crisis for each unit, i.e., each unit preparing to follow another pattern.

5.3 Limitations

As with any research, there are limitations to our work that may stimulate future research. First, the cases of crisis-driven DI we used as a foundation for evaluating and refining the patterns do not provide a complete overview of all the crisis-driven DI implemented during the COVID-19 crisis. We derived all our cases from secondary data and there results are hence restricted by our selection of sources (i.e., our focus on the business and management domain), the time period in which we searched, and the public availability of information. We addressed this issue by including multiple cases, thus providing between 8 and 14 exemplary cases per pattern. Nevertheless, the disadvantages of secondary as compared to primary data remain and biases in our interpretation of the data are therefore possible. Thereby, our analysis of the cases and assigning them to the four patterns of crisis-driven DI followed an interactive and integrative approach in which the author teams intensively analyzed, discussed and jointly assigned all identified cases. As a result, the analysis has limitations in terms of the reliability of the results. In addition, new DI are continually emerging that may yield a far-reaching new database at an advanced level of the pandemic or post-crisis. Further, and as mentioned in Section 3, our case sample has a bias towards Chinese organizations. This may influence the generalizability of our results as China's market conditions but also their crisis management differ from other countries and geographical regions and affect organizations' ability to respond. Yet, given that a structured knowledge base on crisis-driven DI did not exist, our sample is a reasonable starting point for a timely investigation of crisis-driven DI (Sumantra Sarkar et al., 2020). Future research may also focus on abandoned or unsuccessful DI and may engage in cross-country or cross-industry investigations. Further, in-depth case studies are required to study the de facto DI actions in times of crisis, from DI initiation to implementation (R. Kohli & Melville, 2018). Studying a broader sample of cases, possibly during other crisis, could enable researchers to investigate whether the emerging properties, specific to the COVID-19 pandemic, also apply to other types of crisis.

Second, as our analysis relied on secondary and publicly available data, we had no in-depth knowledge about, for example, organizations' existing DI initiatives, their current resource portfolio, and their digital and management capabilities. Thus, we were not able to perfectly assess the organizations' individual starting points for the observed crisis-driven DI. Moreover, while we did consider the organizations' industry and country when discussing the cases (see Table 3 and Table 4), we did not conduct an in-depth analysis of these context data nor did we include other data such as organization size and type, e.g., incumbent, small and medium-sized enterprise (SME), or start-up. Nevertheless, there might be valuable insights in collecting and analyzing such data, especially in terms of organization size, industry affiliation, industry dynamics, digital maturity, and resource availability (e.g., slack resources) (Eremina, Lace, & Bistrova, 2019; Karim, Carroll, & Long, 2016; Voss, Sirdeshmukh, & Voss, 2008). For example SME and start-ups with less (digital) resources available might be much scarcer in terms of DI in comparison to incumbents (Bouncken, Pesch, & Kraus, 2015; Soluk & Kammerlander, 2021). In contrast, factors like flat organizational hierarchies, organizational culture, short decision-making paths, and a high degree of employee autonomy that are characteristics of SMEs (Child & Hsieh, 2014; Francioni, Musso, & Cioppi, 2015; Pahnke & Welter, 2019), might also lead to faster and more flexible responses and, thus, could accelerate DI. Future research could investigate these blind spots and contribute to a more detailed understanding of how organizations perceive a crisis and what components are needed to pursue an exploitative or explorative DI focus. Accordingly, context-specific variables should be included in future studies to better understand antecedents and outcomes of DI. In that light, it might be interesting for future research to study a broader set of factors influencing the ability of organizations to pursue specific patterns and thus further explore the causal relationship between characteristics of organizations and the followed pattern.

Third, we applied a static perspective on the crisis-driven DI patterns by sorting the cases under investigation to exactly one pattern each. In the future, however, a dynamic perspective should also be applied when studying organizations pursing several DI patterns simultaneously or varying their response strategies over time. Especially possible transitions from one DI pattern to another might be interesting to study, for instance from urgency to ambition as a driver, and from exploitative to explorative innovation as

an outcome. Thereby, future research could examine if there are economically dominant strategies of traversing through the matrix, e.g., related to industry or size of an organization. Further, our static view did not allow for an examination of the innovation process, the identification and actualization of digital affordances, nor the required organizational effort for DI according to the four patterns. Future research should focus on these internal processes to gain a better understanding of crisis-driven DI.

Fourth, we took an optimistic perspective on crisis-driven DI. Future research should also account for negative effects of DI in the context of crisis, studying how crisis-driven DI influence societal and economic challenges, for instance, in relation to social inclusion, the digital divide, and digital sovereignty. Future research can take our present findings and further explore the reasons for companies to pursue one pattern. It may be interesting to analyze individual cases in depth via single case studies to understand internal decision processes and dynamics leading to a response strategy and to examine to what extent there was any freedom of choice at all.

6 Conclusion

John F. Kennedy noted that, in Chinese, the word ‘crisis’ is made up of two characters, one representing danger and the other opportunity. While the linguistics may be crude, the sentiment seems true (Bar Am et al., 2020). Along these lines, we have taken an optimistic perspective on crisis-driven DI and followed a two-stage research approach by combining deductive and inductive reasoning. We first deductively derived four patterns of crisis-driven DI from the literature on DI, crisis management, and OA. Thereby, we found that a crisis drives organizations to implement DI out of a *sense of urgency* or a *sense of ambition*, with a DI focus on either *exploitation* or *exploration*. To evaluate and refine the identified patterns, we then inductively drew from secondary data on 43 organizations implementing DI as a response to the COVID-19 crisis. We found that each case can be assigned to one of the four patterns. Further, we analyzed the cases within each pattern and were able to extract the descriptive essences of the crisis-driven DI patterns in the form of emerging properties, i.e., core actions and attributes of organizations pursuing a specific pattern. We explained each pattern and their emerging properties in more detail by presenting exemplary cases.

The key contribution of our research is a nascent theory for explaining DI in times of crisis, laying the foundation for researchers and practitioners alike to understand and design crisis-driven DI. We thereby believe the four patterns to be also relevant for crisis research and management in general while the identified emerging properties specifically relate to the COVID-19 pandemic. Pandemic crises such as COVID-19 and other exogenous shocks will become more frequent as the world is becoming more interconnected (Beverungen et al., 2021). Thus, organizations of all types have to enhance their OA and will be asked and enabled to leverage digital technologies to innovate and effectively react in light of such crisis. In our view, this study is theoretically and practically relevant, and we trust that it provides fellow researchers with a foundation from which to continue research into DI in the context of crisis.

We conclude with the insight for DI in times of crisis that there are numerous ways to free oneself from the situation of being buried under lemons besides the intuitive reaction of squeezing lemonade, and interesting solution spaces open up through the use of digital technologies..

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Appendix A: Cases of Crisis-driven Digital Innovation

Cases of Crisis-driven Digital Innovation

Table 6. Overview of 43 Cases of Crisis-driven Digital Innovation

ID	Organization	Country	DI	Driver of DI	Outcome of DI	Pattern	Source[3]	References
1	Alibaba	China	Digitally enhanced processes	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	HBR	(Greeven & Yu, 2021)
2	Allbirds	USA	Digital social marketing and sales	Sense of ambition	Exploration	Diversify (Ambition-driven Exploration)	Google	(Marketing to China, 2020)
3	Amazon	USA	Digital partnering with Lyft	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	MIT Sloan	(Pisano, 2020)
4	Ant Financial	China	Digital COVID-19 related products	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	HBR	(Reeves et al., 2020)
5	Apple and Google	USA	Contact tracing app	Sense of ambition	Exploration	Diversify (Ambition-driven Exploration)	HBR	(Wade & Bjerkan, 2020)
6	Bakenight	GER	Online workshops	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	Google	(Bakenight, 2020)
7	Bank of China	China	Online live shows	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	MGI	(Adarkar et al., 2020)
8	Beaverton Toyota	USA	Contact-less customer interactions	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	MIT Sloan	(Knowles et al., 2021)
9	Bimber Distillery	UK	Online events and workshops	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	MIT Sloan	(Wade & Bjerkan, 2020)
10	Bosch (Chinese division)	China	Remote manger training	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	HBR	(Das et al., 2020)
11	Cargill	USA	Digitalized supply chain processes	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	MIT Sloan	(Schrage, 2020)
12	China Construction Bank	China	Digital crisis platform	Sense of ambition	Exploration	Diversify (Ambition-driven Exploration)	MGI	(Adelaide Business School, 2020)
13	China Merchants Bank (CMB)	China	Digital COVID-19 related products	Sense of ambition	Exploration	Diversify (Ambition-driven Exploration)	MGI	(Adarkar et al., 2020; Adelaide Business School, 2020; Chen, 2020; China Merchants Bank, 2020a, 2020b)
14	China Minshing Bank	China	Digitally enhanced processes	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	Google	(Panetta, 2020)

[3] HBR = Harvard Business Review; MIT Sloan = Business School of the Massachusetts Institute of Technology; MGI = McKinsey Global Institute; CMR = California Management Review

15	Cosmo Lady	China	Digital social marketing and sales	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	HBR	(Reeves et al., 2020)
16	Hangzhou Intime	China	Digital social marketing and sales	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	Google	(Panetta, 2020)
17	Huami	China	Data-driven business model	Sense of ambition	Exploration	Diversify (Ambition-driven Exploration)	MIT Sloan	(Wade & Bjerkan, 2020)
18	Huanxi Media Group	China	Livestreaming of movies	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	HBR	(Das et al., 2020)
19	Huazhu	China	Digitally enhanced processes	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	HBR	(Escobar, 2020; Huazhu, 2020a, 2020b; Reeves et al., 2020; Wroten, 2020)
20	JD.com	China	Digital health care	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	HBR	(Lin, 2020)
21	JD.com	China	Digitally enhanced processes	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	HBR	(Business Wire, 2020; Cao, 2020; JD.com, 2020; Lin, 2020)
22	Kuaishou	China	Online cloud classroom	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	HBR	(Reeves et al., 2020)
23	Lin Qingxuan	China	Digital social marketing and sales	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	HBR MIT Sloan	(Reeves et al., 2020)
24	Master Kong	China	Digital sales channels	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	HBR	(Wittbold et al., 2020)
25	Master Kong	China	Digitally enhanced supply chain	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	CMR	(Kaur, 2020)
26	Michael Kors	USA	Digital social marketing and sales	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	Google	(Marketing to China, 2020)
27	New Oriental Group	China	Livestreaming platform	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	HBR	(Das et al., 2020)
28	Nike China	China	At-home workouts	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	MIT Sloan	(Wade & Bjerkan, 2020)
29	OptimizeRx	USA	Health alerts for cloud-based platforms	Sense of ambition	Exploration	Diversify (Ambition-driven Exploration)	CMR	(Kaur, 2020)
30	Partners HealthCare	U SA	Online health care	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	HBR	(Wittbold et al., 2020)
31	Ping An	USA	Digital ecosystem business	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	HBR	(Greeven & Yu, 2021)
32	Ping An	China	'Do it at home' service	Sense of ambition	Exploration	Diversify (Ambition-driven Exploration)	MGI	(Adarkar et al., 2020)

33	Slack	USA	Scaling-up of digital resources	Sense of ambition	Exploitation	Scale (Ambition-driven Exploitation)	MIT Sloan	(Butterfield, 2020)
34	Slightly Robot	USA	'Immutouch' app	Sense of ambition	Exploration	Diversify (Ambition-driven Exploration)	CMR	(Kaur, 2020)
35	TeamViewer	GER	Scaling-up of digital resources	Sense of ambition	Exploration	Scale (Ambition-driven Exploitation)	Manager-magazin	(Manager Magazin, 2020)
36	Trip.com Group	China	Digitally enhanced processes	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	HBR	(Das et al., 2020)
37	Wuhan Wuchang Hospital	China	Robots as hospital staff	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	HBR	(Wittbold et al., 2020)
38	Zhejiang University	China	Online teaching	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	MIT Sloan	(Wade & Bjerkan, 2020; Zhejiang University, 2019)
39	Zhongnan Hospital	China	AI-driven CT scan	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	HBR	(Wittbold et al., 2020)
40	MilkCrate	Canada	Online events and workshops	Sense of urgency	Exploration	Compensate (Urgency-driven Exploration)	Google	(Blackwell, 2020)
41	Texas Hill Country Wineries association	USA	Online events and workshops	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	Google	(Danze, 2020)
42	Monterey Bay Aquarium	USA	Virtual knowledge sharing	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	Google	(DeAngelis, 2020)
43	Amos Rex	Finland	Virtual tours	Sense of urgency	Exploitation	Defend (Urgency-driven Exploitation)	Google	(Amos Rex, 2021)

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About the Authors

Christoph Buck is a research group leader at the Fraunhofer Institute for Applied Information Technology FIT (Germany) and an adjunct associate professor at the Queensland University of Technology (Australia). After graduating in business administration at the University of Bayreuth, he completed his Doctorate at the university's Faculty of Law and Economics. Christoph has led numerous transformation projects with asset-intensive incumbents in the areas of digitalization and innovation. His research interests include digital transformation, innovation systems, digital ecosystems, and information privacy.

Thomas Kreuzer is a research assistant at the Research Center Finance & Information Management (FIM) of the University of Augsburg and the Project Group Business and Information Systems Engineering of the Fraunhofer Institute for Applied Information Technology (FIT). His research interests centre around business process management, customer-centricity in processes and digital innovation. Thomas studied Industrial Engineering (B.Sc.) with a focus on finance, operations, and information management as well as information-oriented business administration (M.Sc.) at the University of Augsburg.

Anna Maria Oberländer

Anna Maria Oberländer is a post-doctoral researcher at the University of Bayreuth, the Research Center Finance & Information Management (FIM) and the Project Group Business and Information Systems Engineering of the Fraunhofer Institute for Applied Information Technology (FIT), where she co-heads a research group and manages the Digital Innovation Lab as a co-founder. Her research interests centre around digitalisation, digital innovation, digital transformation, and the (industrial) Internet of Things. Anna has a background in strategy consulting with McKinsey & Company, where she supported clients in the advanced industries and financial services sectors with a focus on large-scale digital transformation.

Maximilian Röglinger holds the chair of Information Systems and Business Process Management at the University of Bayreuth as well as is Adjunct Professor in the School of Management at Queensland University of Technology. Maximilian serves as Deputy Academic Director of the Research Center Finance & Information Management (FIM), where he also heads the business process management (BPM) group, and works as Head of Fraunhofer FIT's Project Group Business and Information Systems Engineering. Maximilian Röglinger's activities in research and teaching centre around customers, business processes, and IT as well as digitalization.

Michael Rosemann is the Director of the Centre for Future Enterprise and Professor at the Business School, Queensland University of Technology. His main areas of research are the management of innovation, business processes and trust. Dr Rosemann published more than 350 refereed papers and his eight books are available in five languages. He is on the editorial board of 10 international journals and has globally conducted invited keynote presentations at academic and professional conferences. Dr Rosemann is also the Honorary Consul for the Federal Republic of Germany in Southern Queensland.