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The application of digital technologies in company responses to COVID-19: an integrative framework

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ABSTRACT

The COVID-19 pandemic has challenged organisations to adapt and redesign their processes and management practices in response to the rising emergency. Governments across the globe have implemented strategies to reduce infection and mortality, and build resilience. Most response strategies and actions have leveraged the potential of digital technologies (DT). However, despite the importance of DT in supporting business continuity, an integrative framework describing how DT can support organisational responsiveness in relevant disruptions is still not available. This research presents the outcomes of a web and social content analysis of 40 world-leading corporations facing the COVID-19 emergency. The study identifies how these organisations have used DT in 12 activities related to the management of operations, human resources, and customers. For each activity, a set of digital enablers are identified, and the deriving organisational value is outlined. The contribution of this research lies in reinvigorating and advancing the scholarly discussion on the centrality of DT for the enhancement of organisational preparedness in critical scenarios. From a managerial perspective, this research provides business leaders and managers with a checklist useful to define digital-enhanced business continuity plans.

1. Introduction

The coronavirus (COVID-19) epidemic presented an extraordinary threat to organisations worldwide. The disruption has forced companies to undertake fast actions critical for survival (e.g. protecting employee safety) as well as more long-term oriented actions aimed to create new value (e.g. leveraging new customer needs and purchase patterns). In both cases, the potential offered by digital technologies (DT) to provide rapid and effective responses has been highlighted.

Government efforts have also relied on the adoption and integration of DT for pandemic planning, surveillance, testing, contact tracing, quarantine and healthcare (Whitelaw et al. 2020). In particular, four interrelated DT, i.e. Internet of Things, big-data analytics, AI and blockchain, have been adopted to augment traditional public-health strategies for tackling COVID-19, i.e. monitoring, surveillance, detection and prevention, and mitigation of the impact on healthcare (Ting et al. 2020).

A large research stream has analysed the implications of COVID-19 for human resources (Carnevale and Hatak 2020), innovation (Chesbrough 2020), supply chain resilience (Ivanov 2020; Ivanov and Dolgui 2020) and digital sales (Kim 2020). However, there is limited evidence on the

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organisational use of DT to deal with extreme events such as COVID-19 (Dwivedi et al. 2020; Leonardi 2020; Papadopoulos, Baltas, and Balta 2020). A study specifically focused on how DT can support business continuity and the ability to respond to emergencies is still not available. In this regard, the COVID-19 emergency represents a particularly interesting context in which to address a number of research curiosities of relevance for both academicians and practitioners: (a) *How DT have supported or enhanced organisational responses to COVID-19?* and (b) *What value can be obtained by organisations adopting digital technologies into emergency responses?*

To achieve our research goal, we conducted a content analysis of web-based information of 40 world-leading corporations. We identified the ways in which the corporations used DT to deal with the emergency, and how DT has supported 12 core activities, with associated digital enablers and value, related to the management of operations, human resources and customers. The remainder of the paper is structured as follows. Section 2 presents some of the literature streams on the topic of digital technology to support organisational transformation and resilience in case of disruptive events. Section 3 describes the research process undertaken. Section 4 presents the findings in terms of the digital-enhanced responses and obtained value whereas Section 5 discusses the theoretical and managerial contributions of the study. Section 6 concludes the paper with limitations and avenues for further research.

2. Digital technologies and organisational responses in emergencies

Digital technologies are extensively studied in relation to their potential to support transformation within organisations and the society (e.g. Hess et al. 2016; Majchrzak, Markus, and Wareham 2016; Ardolino et al. 2018; Vial 2019). At the organisational level, the impact of digital technologies is investigated in terms of required or enhanced organisational agility (e.g. Chan et al. 2018; Margherita, Sharifi, and Caforio 2020), working practices (e.g. Umans et al. 2018; Eaton and Heckscher 2020; Leonardi 2020), business models (e.g. Kiel, Arnold, and Voigt 2017; Rachinger et al. 2018), capabilities (Warner and Wäger 2019) and supply chain competitiveness (Nasiri et al. 2020).

With specific reference to the scope of this research paper, the value deriving from digital technologies might lie in an enhanced capability of predicting, identifying and preparing to face future events (Wang et al. 2016; Papadopoulos et al. 2017; Altay et al. 2018), especially within supply chains and disruption risks (Ivanov, Dolgui, and Sokolov 2019). The increased ability of organisations to continue business over major disrupting forces is strictly related to the resilience of those organisations and their capacity of facing emergencies and recovering from disruptions through timely and effective responses.

Resilience has been a popular topic amongst researchers at both at an intra-organisational level (e.g. Ambulkar, Blackhurst, and Grawe 2015; Parker and Ameen 2018) and inter-organisational level (e.g. Brandon-Jones et al. 2014; Gunasekaran, Subramanian, and Rahman 2015; Kim, Chen, and Linderman 2015; Behzadi, O'Sullivan, and Olsen 2020; Gu, Yang, and Huo 2021; Hosseini, Ivanov, and Blackhurst 2020). A specific stream of research contributions has investigated the topic of disaster and supply chain resilience (e.g. Zobel and Khansa 2014; Sahebjamnia, Torabi, and Mansouri 2015; Sahebjamnia, Torabi, and Mansouri 2018; Scholten, Stevenson, and van Donk 2019; Wong et al. 2020).

As an organisational capacity, resilience is influenced by factors such as supply chain structure, risk management culture and technology (Bode et al. 2011; Kim, Chen, and Linderman 2015; van Der Vegt et al. 2015; MacDonald et al. 2018; Parker and Ameen 2018; Pettit, Croxton, and Fiksel 2019). In this regard, Gu, Yang, and Huo (2021) have argued that the use of IT to deal with resilience can be both in terms of exploiting current structured processes (IT exploitation) and in terms of investigating unstructured process (IT exploration). DT such as blockchain can increase transparency and traceability among value chain members (Zelbst et al. 2019), whereas artificial intelligence, business analytics and Internet of Things (IoT) could help in enhancing forecasting methods and logistics operations and healthcare.

The concept of resilience is crucial in a scenario of emergency management, which requires decreasing the probability of accidents and dealing with the aftermath of an event by reducing the negative impact (Petak 1985). Digital technologies are today transforming emergency management (Misra, Roberts, and Rhodes 2020), e.g. by supporting collaborative planning and scenario modelling, software simulation, and shared decision-making (Bañuls, Turoff, and Hiltz 2013; Hernantes et al. 2013).

An array of relevant studies has investigated the development of Emergency Management Information Systems (Turoff 2012) and decision support frameworks that can protect against the outcomes of disruptive events (Schätter et al. 2019). Luo et al. (2020) discussed the relevance of building sustainable emergency management based on intelligent information processing, whereas Yang, Yang, and Plotnick (2013) studied the application of tools of the Internet of Things to enhance emergency response operations. In the medical sector, the adoption of big data was studied to show how they could vastly support accurate infectious disease models and forecasts (Bansal et al. 2016). Chakraborty, Bhatt, and Chakravorty (2020) showed how the use of digitised technology in hospitals influences care service responsiveness.

3. Research process

We analysed web-based content about leading corporations in relation to the COVID-19 outbreak. Content analysis is a research method that allows studying communication in a systematic, objective and quantitative manner for the purposes of measuring variables (Wimmer and Dominick 2000). It involves systematic observation of texts to which labels are assigned to indicate the presence of meaningful content. Several examples of web content analysis are described in the corporate context, such as the study of website disclosures to study the environmental reporting of global corporations (Jose and Lee 2007), and the study of Fortune 50's Facebook sites to assess how companies use social media to reach consumers (McCorkindale 2010). In our study, we realised a research process involving the steps outlined in Figure 1.

In the first step (*Content Identification*), we defined the sample of organisations to include in the study, and the related sources through which to obtain relevant content. We looked at the Fortune 'Global 500' ranking of 2019 and, based on the availability of the information needed for our research, we considered the first 40 companies starting from the beginning of the ranking. The focus on big corporations was based on the assumption that large organisations representation can be extensively impacted by the COVID-19 disruption at both the local level (community) and
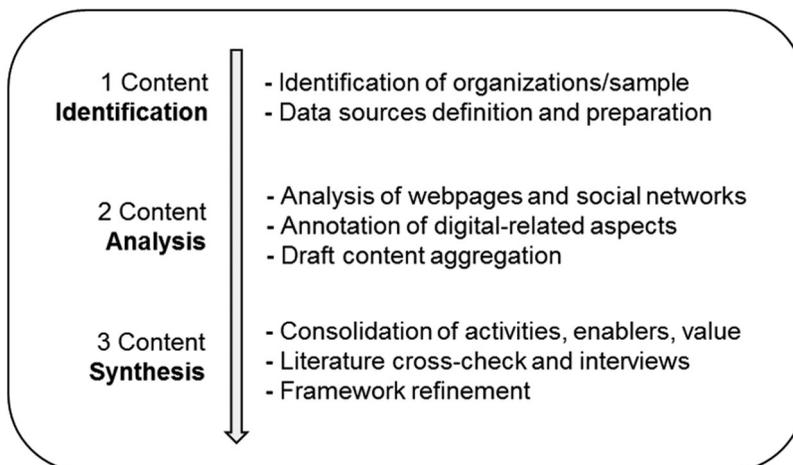

Figure 1. Steps of the research process.

Table 1. Companies, countries and industries.

No.	Company	Country	Industry
1	Allianz	Germany	Insurance: Life, Health (stock)
2	Alphabet	USA	Internet Services and Retailing
3	Amazon.com	USA	Internet and Direct Marketing Retail
4	AmerisourceBergen	USA	Wholesalers: Health Care and Drug Distribution
5	Apple	USA	Computers, Office Equipment
6	AT&T	USA	Telecommunications
7	Axa	France	Insurance: Life, Health (stock)
8	Berkshire Hathaway	USA	Insurance: Property and Casualty (stock)
9	BP	UK	Petroleum Refining
10	Cardinal Health	USA	Wholesalers: Health Care
11	Chevron	USA	Petroleum Refining
12	China State Construction Eng.	China	Engineering & Construction
13	Costco Wholesale	USA	General Merchandisers
14	CVS Health	USA	Health Care: Pharmacy and Other Services
15	Daimler	Germany	Motor Vehicles & Parts
16	Exxon Mobil	USA	Petroleum Refining
17	Fannie Mae	USA	Diversified Financials
18	Ford Motor	USA	Motor Vehicles & Parts
19	Gazprom	Russia	Energy
20	General Electric	USA	Industrial Machinery
21	General Motors	USA	Motor Vehicles & Parts
22	Hon Hai Precision Industry	Taiwan	Electronics, Electrical Equip.
23	Honda Motor	Japan	Motor Vehicles & Parts
24	JPMorgan Chase & Co.	USA	Financials
25	Kroger	USA	Food & Drug Stores
26	McKesson	USA	Wholesalers: Health Care
27	Mitsubishi	Japan	Trading
28	Ping An Insurance	China	Insurance: Life. Health
29	Royal Dutch Shell	Netherlands	Petroleum Refining
30	SAIC Motor	China	Motor Vehicles & Parts
31	Samsung Electronic	South Korea	Electronics, Electrical Equip.
32	Saudi Aramco	Saudi Arabia Arabia	Mining, Crude-Oil Production
33	Total	France	Petroleum Refining
34	Toyota Motor	Japan	Motor Vehicles & Parts
35	Trafigura Group	Singapore	Trading
36	UnitedHealth Group	USA	Health Care: Insurance and Managed Care
37	Verizon Communications	USA	Telecommunications
38	Volkswagen	Germany	Motor Vehicles & Parts
39	Walgreens Boots Alliance	USA	Food & Drug Stores
40	Walmart	USA	General Merchandise

global level (impact on international markets). Besides, the degree of technology maturity and digital adoption in those organisations are normally higher than in small and medium organisations. The number of companies selected allowed including a well-diversified group of organisations operating in different countries and industries. Table 1 reports the alphabetical list of the companies, along with the headquarter country and industry.

For each company, we looked at two data sources: (a) corporate webpages dedicated to COVID-19 and (b) LinkedIn posts providing updated information on how organisations are facing the emergency. Whereas the detailed analysis of organisational responses should be based on direct company knowledge, obtaining the availability of such information for a large number of multinational corporations is quite complex. The gathering of web-based data offers in such perspective a direct and timely source of relevant company information. We reported in a table the demographic data (i.e. home country, industry) and the web addresses of corporate sites and LinkedIn pages of the organisations.

In step 2 (*Content Analysis*), we captured information on the identified companies in terms of response activities and digital enablers. We accessed (May 2020) about 400 web pages and LinkedIn posts of organisations and we manually extracted and annotated relevant information using two

labels: (1) *activities* undertaken at different levels by organisations to react to the health emergency and (2) *digital* enablers adopted by organisations to support those activities. We triangulated using corporate videos and top management interviews available on the web. We generated a long list and draft aggregation of responses activities and digital-related information.

The last step 3 (*Content Synthesis*) was aimed to build an integrative framework of activities, digital enablers and value generated by the organisations. First, we refined the outcomes of the content extraction phase using a cross-check with approaches and cases described in the digital innovation and emergency management literature. We looked at extant contributions defining taxonomies of technologies and types of response actions undertaken by organisations. Finally, we conducted four interviews with managers of companies operating in the IT industry, aerospace, tourism and retail. The goal was to obtain further insights on the completeness of the framework and the real applicability of the same. Interviews were conducted by telephone (October 2020) using two reflection points, i.e. (1) *Please describe the experience of your organisation in the COVID-19 crisis in terms of actions implemented, enabling factors and obtained value* and (2) *Please validate or integrate the model by suggesting new components or evaluation perspectives*. The duration of each interview was about 30 minutes. All the content was transcribed and quotes were used to come up with a refined framework of digital-enabled response activities.

4. Findings

We found that most of the company responses that leveraged the potential of DTs fall into three groups, i.e. (1) activities related to operations and supply chain management; (2) activities related to human resources and workplace management; and (3) activities related to customers and relationship management. Based on the analysis of the 40 organisations, we isolated 12 different activities and identified, for each one, the digital enablers and the value obtained by the organisations through the adoption of digital technologies.

Concerning digital enablers, whereas some of them are represented by technologies, systems and applications supporting the execution of response activities, other enabling factors are mostly associated with underlying skills and knowledge of relevance to support those activities. Concerning value, whereas it is not possible to 'isolate' the impact generated by company responses, we retrieved ideas of framing the deriving value in terms of five macro-areas. These are (1) better support to customers, employees or other stakeholders; (2) enhanced business intelligence and organisational awareness; (3) improved image of the organisation as a socially responsible corporation; (4) improved health security; and (5) improved process and organisational efficiency.

4.1. Activities, digital enablers and value related to operations management

The first area of activities undertaken by the organisations in response to the outbreak concerns the management of company *operations*, here including inbound and outbound logistics, and production. One of the first areas in which organisations started to experience the challenges of the pandemic was logistics, and particularly all the processes involved with order management, warehouse replenishment and management, product/materials tracking and outbound product delivery. In relation to such activities, companies needed to ensure the monitoring of product and inventory flows within the organisation and across the supply chain, and to optimise the levels of stock in the light of the transforming market demand.

Whereas larger corporations have already in place technology-driven procedures and methods able to address those needs, we retrieved in most websites and social network posts the reference to a number of technological tools of specific importance for the current emergency. These include RF-ID tags and readers, QR codes, robots to automatise product handling, and optimisation software to improve stocks and support decisions, as well as ERP (Enterprise Resource Planning) and CRM (Customer Relationship Management) portals able to integrate enterprise resources with customer

requests. The 'new' needs generated by the health emergency highlighted the relevance of digital skills and knowledge associated with workflow management, process issue mapping, process reengineering and supply chain analysis and reporting. The adoption of the described tools and capabilities have allowed the companies to achieve benefits which can be mostly defined in terms of enhanced operational and market intelligence, organisational security and efficiency based on optimised resource management.

In relation to production, two main areas of response activities were identified, i.e. the reengineering of current manufacturing activities to address the health emergency, and the reconversion of production and service activities to provide support to business partners and the larger ecosystem. Concerning production reengineering, most of the efforts described in company sources were aimed to enhance the security of plants, shops and business premises. This has required the adoption of tools like process modelling systems, sensors and optimisation/planning software, along with purposeful process and project management skills and knowledge. Benefits achieved by companies could be defined in terms of enhanced employee security and efficiency based on the redesigned production/service activity to align with the changing market conditions.

Concerning conversion of production, the observation of companies allowed to identify the use of 3D printing, e.g. in the production of protection devices or medical parts, as well as of demand forecast and optimisation software, and product lifecycle management platforms, including CAD/CAE systems. Required skills, additional or already in place in the organisations, are represented by rapid and virtual prototyping, and new product development. The key benefits associated with the undertaking of the described response activities are in terms of capacity to support partners and customers and enhanced corporate image based on the ability to serve the community.

In the operations endeavour, another activity undertaken by companies in response to the rising emergency was the ongoing monitoring of the supply chain and the estimate of the overall impact on the organisation. We found in company websites and social network posts evidence of the adoption of advanced business analytics tools, decision support systems, digital platforms like ERP and SCM (Supply Chain Management) systems, and simulation software to define potential scenarios of evolution. Companies leveraged specific skills and capabilities such as technology forecasting, supply chain planning, industry reports and supply chain data analytics. The main value created by the organisations can be described in terms of enhanced business intelligence (market and supply chain knowledge and insights) and operational security (especially for customers and employees). Table 2 shows a snapshot of activities, digital enablers and value related to operations.

Table 2. Activities, digital enablers and value related to operations.

Activities	Digital enablers	Value
[1] *Revise order management, warehousing, product/materials tracking and delivery*	*Digital tools and systems:* RF-ID systems and QR codes, optimisation software, robotics, ERP and CRM portals *Digital skills and knowledge:* digital workflows, issue mapping, process reengineering and supply chain analysis and reporting	• Business intelligence • Supply chain security • Logistic efficiency
[3] *Reengineer production to enhance security and optimize flows*	*Digital tools and systems:* sensors and tracking devices, optimisation software, process modelling systems, *Digital skills and knowledge:* process and project management	• Operational intelligence • Process efficiency
[2] *Convert production to deliver protective materials or diversify the portfolio*	*Digital tools and systems:* 3D printing, demand forecast tools, optimisation software, Product Lifecycle Management, CAD/CAE systems *Digital skills and knowledge:* product design, rapid and virtual prototyping, new product development	• Community/partner support • Corporate image and social responsibility
[4] *Monitor supply chain, estimate the impact of disruption and define future scenarios*	*Digital tools and systems:* advanced analytics tools, decision support systems, simulation software ERP and SCM portals *Digital skills and knowledge:* technology forecasting, industry reports, supply chain analytics	• Business intelligence • Supply chain security

4.2. Activities, digital enablers and value related to human resources

The second area of digital-enabled activities undertaken by companies in response to the outbreak concerns human resources, and particularly the actions aimed to track infections and prevent new infections while ensuring assistance to employees and enhance workforce productivity and well-being.

Concerning consultation and assistance, the study of web pages and social network posts revealed the use of telemedicine systems and remote assistance devices, as well as employee corporate portals and chat systems, including tools like Chatbots. These systems required the development of specialised organisational skills in the area of telemedicine and artificial intelligence, as well as virtual coaching and psychological support. The main value obtained could be described in terms of enhanced capability to support employees and improved organisational security.

In relation to employee tracking and status reporting, companies used tools like infrared scanners and digital thermometers, tracking applications and tools like QR code and GPS, video surveillance platforms, and HR analytics platforms. Digital skills and relevant knowledge included thus employee reporting, status monitoring dashboards and infection handling protocols, while value obtained is deriving from enhanced corporate intelligence and organisational security.

Concerning employee training, organisations have leveraged the emergency to develop new competencies in the workforce. These have included both workplace and business-related competencies and more emergency and resilience development capabilities.

Organisations have used content authoring tools, video meeting applications, simulation platforms, MOOCs and other corporate platforms providing epidemiological resources and dedicated training modules. Skills relate to digital content authoring and virtual classroom design and development, whereas benefits are in terms of enhanced employee productivity and workforce security.

Finally, companies have adopted a number of measures specifically addressed to support human resource efficiency and remote productivity. These include videoconference and remote collaboration systems, network and cloud-based applications, and corporate portals hosting useful information for employees. In terms of required skills and knowledge, organisations have leveraged existing or newly developed (smart) working procedures, workflows and digital handbooks. The main value generated is in terms of enhanced efficiency, security and support to the workforce. Table 3 shows a snapshot of activities, digital enablers and value related to human resources.

4.3. Activities, digital enablers and value related to customers

The third area of digital-enabled or digital-enhanced responses to the outbreak was the management of customers and customer relationships. In particular, organisations showed specific attention to redefine the customer touchpoints and buying process, to track customer behaviour and flows, to provide ongoing customer support and services, and to adapt marketing messages and communication style to comply with the rising emergency.

Concerning facility and buying process redesign, most of the analysed companies adopted contactless payment devices to reduce the utilisation of (physical) monetary transactions. Besides, the access to company shops or plants was limited or strictly regulated to avoid people gathering in reduced areas, and infection prevention and sanitisation procedures were applied. Tools used are near-field communication (NFC) devices, contact centres and digital channels for online sales and services. Relevant skills and content used include digital payment procedures and standards, customer profiling and tracking, and shop/plant layout reconfiguration. Benefits achieved by the organisations can be outlined in terms of enhanced customer intelligence and overall organisational and customer security.

Concerning customer tracking, companies adopted purposeful customer apps, RF-ID and GPS-based systems. Involved digital skills are represented by customer analytics, whereas digital portals are social networks and corporate portals. Digital content includes business intelligence
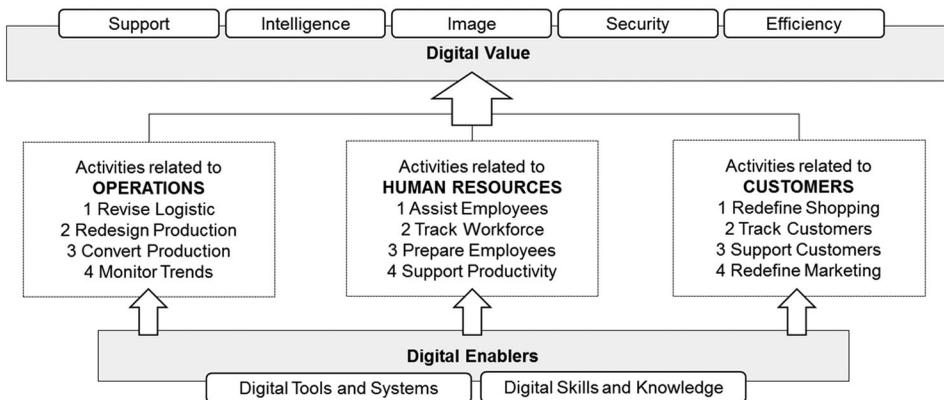
Table 3. Activities, digital enablers and value related to human resources.

Activities	Digital Enablers	Value
[1] *Ensure medical consultation and physical/psychological assistance*	*Digital tools and systems:* telemedicine devices, employee corporate portals, Chatbots *Digital skills and knowledge:* telemedicine, virtual coaching, artificial intelligence, employee analytics	• Workforce support • Employee well-being and productivity/efficiency
[2] *Track employees and develop status reporting for exposed and infected*	*Digital tools and systems:* infrared scanning, QR code and GPS, tracking apps, video surveillance platforms, thermoscanner, HR analytics platforms *Digital skills and knowledge:* employee reports and factsheets, infection handing protocols	• Workforce support • Employee well-being and productivity/efficiency • Organisational security
[3] *Create training opportunities to upskill employees and enhance preparedness*	*Digital tools and systems:* content authoring tools, simulation platforms, MOOCs, corporate platforms, HR analytics applications *Digital skills and knowledge:* content authoring, webinar design and delivery, virtual training	• Employee productivity • Workforce security
[4] *Support job productivity and remote collaboration*	*Digital tools and systems:* videoconference tools, remote collaboration tools, networks and cloud applications, corporate portals *Digital skills and knowledge:* digital and smart working, workflows and procedures, digital handbooks	• Workforce support • Employee security and productivity

reports and benefits are in terms of enhanced support and corporate intelligence. In relation to customer service, the analysed organisations used digital tools like intelligent applications such as Chatbots and blockchain applications. Digital skills concern customer relationship management and involved platforms are customer contact centres and social networks. Digital content used is represented by customer contractual data and the obtained value can be discussed in terms of enhanced customer support and overall corporate image.

Finally, concerning branding and marketing, organisations leveraged the use of sentiment analysis tools, social networks and social media analytics to investigate the emergency customer trends and discussion topics. For this purpose, relevant skills and enabling knowledge are represented by web marketing and digital content analysis, social big data and marketing reports. The organisational value is in terms of enhanced market intelligence and corporate image as a socially responsible organisation. Table 4 shows a snapshot of activities, digital enablers and value related to customers.

In Figure 2, we report a snapshot of the 12 digital-enabled or digital-enhanced response activities related to operations, human resources and customers. The chart also reports the digital enablers, i.e.

Figure 2. Framework of activities, digital enablers and value.

Table 4. Activities, digital enablers and value related to customers.

Activities	Digital enablers	Value
[1] *Change shop or facility access and buying/payment process*	*Digital tools and systems:* NFC and contactless payment devices, customer contact centres, digital channels *Digital skills and knowledge:* digital payment procedures and industry standards, customer payment data, shop/plant layout redesign	• Customer and market intelligence • Organisational security
[2] *Track customer mobility and build fact-based customer reports*	*Digital tools and systems:* customer apps, RF-ID and GPS devices, social networks, corporate portals *Digital skills and knowledge:* customer analytics, customer purchase patterns	• Customer support • Customer and market intelligence
[3] *Ensure customer service, warranties and support*	*Digital tools and systems:* Chatbots and intelligent agents, customer contact centres, social networks, blockchain applications *Digital skills and knowledge:* Customer relationship management, service management, customer and contracts data	• Customer support • Corporate image and social responsibility
[4] *Redefine brand strategy and marketing messages and activities*	*Digital tools and systems:* Sentiment analysis algorithms, social media analytics, social networks *Digital skills and knowledge:* Digital content analysis, social media management, social big data, web marketing reports	• Market intelligence • Corporate image and social responsibility

tools and systems and skills and knowledge, and the main sources of organisational value outlined, i.e. support, intelligence, image, security and efficiency.

The next section presents a discussion of the achieved findings along with a twofold theoretical and practitioner perspective.

5. Discussion

Findings from the study can be discussed along two main directions. First, in terms of advancements achieved with respect to theory on DT-enhanced emergency management and organisational responsiveness. Second, in terms of practical implications for policymakers and managers engaged to define proper business continuity and emergency management plans.

5.1. Theoretical implications

Whereas recent literature has analysed the impact of DT on the public management and answer to the pandemic outbreak (e.g. Ting et al. 2020; Whitelaw et al. 2020), a study specifically focused on investigating how DT can support the organisational ability to respond to emergencies was still not available.

This study contributes to the extant academic discussion at a threefold level. First, the outcomes of the study provide new evidence on how digital technologies can support the implementation of rapid and effective responses to emergencies. In particular, we have contributed to the understanding of how world-leading organisations deal with an emergency (focusing on the COVID-19 pandemic) by leveraging the use of DT. The main value of the study is the formation of a framework to identify what kind of responses and digital enablers have been implemented to handle the critical situation. Furthermore, the proposed framework presents the multi-dimensional impacts obtained through those responses and digital enablers.

Second, the emergency (COVID-19) and the deriving business disruption have required the adoption of DT to support three types of crucial responses, which involve operations and supply chain management, human resources and workplace management, and customers and relationship management. The obtained findings are in line with previous literature that considers the importance of DT in supply chain management (Hess et al. 2016; Nasiri et al. 2020), customer relationship management (Cenamor, Rönnberg Sjödin, and Parida 2017; Loebbecke and Picot 2015), and workforce

management (Owusu 2020; Pan 2020), as well as in digital transformation (Ardolino et al. 2018; Bharadwaj et al. 2013; Vial 2019). Utilising DT in the domain of operations, human resources and customers, can mitigate the disruptive effects of the crisis and enhance business continuity through the provision of critical prediction (e.g. Wang et al. 2016; Papadopoulos et al. 2017; Altay et al. 2018) and development of traceability and transparency (Zelbst et al. 2019). Such capabilities, along with different forecasting methods in different domains of the organisation (i.e. operation, customer, workforce), can allow companies to successfully face critical situations like COVID-19.

Finally, the study advances the discussion on value drivers that can be obtained by organisations by adopting digital technologies into emergency responses. We showed that companies can leverage digital technologies to not only achieve increased organisational security, intelligence and efficiency but they can also strengthen the ability to support customers and employees, and improve the organisational image. Whereas a broad literature has investigated the impact of digital technologies on company operations and business models, and different taxonomies of benefits have been defined, we have provided insights on a possible taxonomy of benefits and impact areas elicited by the adoption of DT in the ongoing crisis.

DT represent critical enablers in emergency management, and new studies are needed to frame which emergent DT (e.g. advanced analytics, cognitive computing) can provide their potentialities to (a) limit the potentially negative effects of emergencies on company operations and (b) leverage innovative technologies to create new value out of the critical scenario.

5.2. Managerial implications

The COVID-19 outbreak has brought several disruptive effects for organisations in terms of identifying new priorities, reconfiguring the supply chain disruptions, and addressing shifts in customer demand, workforce safety and productivity. In the unfolding crisis, business continuity is strongly tested and the role of digital technologies is crucial to enhance the effectiveness and sustainability of responses.

The lack of preparation for dealing with disruptive incidents can have irreparable consequences for organisations. From a practitioner perspective, this paper provides managers with an evidence-based checklist to design and implement digital-driven business continuity. The paper offers a taxonomy of 12 activities related to enhance supply chain continuity and logistic security and efficiency, empower and support the in-house and remote workforce, and support and engage customers virtually. The proposed framework includes a focus on response activities and digital enablers, and a taxonomy of five potential value creation dimensions.

Due to COVID-19, organisations face numerous challenges and uncertainties. Thus, they have to develop multiple scenarios for future strategic actions, and develop awareness on different strategic choices available according to capabilities and goals. Scenarios are tools to trigger and accelerate the process of organisational learning, and organisations are required to develop a stakeholder approach, be proactive, and adopt an integrated approach that will improve the everyday life of the local, national and global communities. Given such premises, the paper offers managers a twofold major contribution. First, it provides an inventory of the type of response activities, digital enablers and values supported by DT in critical situations. Secondly, it provides guidelines for managers on how to achieve resilience, business continuity using DT in a critical situation. Managers, depending on their focus and remit, could use these activities, enablers and values to create strategies on how to deal with the repercussions of emergencies (including COVID-19) as well as guidance on how to assess/evaluate plans dealing with such emergencies.

6. Conclusions

Organisations need to build resilience against numerous types of disruptions and events that threaten the continuity of their business processes (Sahebjamnia, Torabi, and Mansouri 2018). The COVID-

19 pandemic has challenged companies to change their supply chain, customer relations and human resource management practices in response to the arising emergency. Whereas extreme disruptions have devastating effects on business and supply chain performance (Papadopoulos et al. 2017), the pandemic was a natural accelerator towards the use of digital tools and platforms. These have gradually supported new forms of work and collaboration within the organisation and between the organisation and its partners and have enabled new opportunities for increasing productivity and developing new forms of value as well. We presented the outcomes of a web and social content analysis of 40 world-leading corporations.

In this study, we have identified how organisations have used DTs to provide effective answers to the emergency and 12 core processes, with associated digital enablers and multi-dimensional impact. We provided food-for-thought to those who would like to engage more with the role of DTs in organisational resilience and responsiveness in a scenario of emergency management. The study is not without limitations. Although emergency response and business continuity have mostly been associated with large corporations, the concept should be extended also to small and medium organisations. In such a perspective, the focus on global companies is somehow a limitation. In fact, while it is true that large organisations can be extensively impacted by the COVID-19 disruption at both local and global levels, the fact that the degree of technology maturity is higher itself renders them more capable of responding through digital enablers. Nevertheless, this paper provides an integrative classification of digital-enhanced responses, which has a value to support further specialisation studies in the context of large corporations as well as for comparative studies conducted with small and medium organisations.

Second, the content available online is the publicly available information on responses, which may not necessarily be the description of real actions undertaken by companies. The access to real company knowledge, where possible, would thus allow strengthening the model by adding real decisions and actions implemented by managers. Notwithstanding these limitations, it may be beneficial to conduct both quantitative and qualitative research on the impact of DT-enabled strategies for emergency management on companies' performance and sustainability, as well as on how different strategies play out with different stakeholders vis-à-vis impacts on the work-life balance of employees. Finally, further studies will be addressed to provide a more distinct representation of the results in relation to the different companies and groups (e.g. clustering studies, similarities in relations to industries and countries, etc.) and the order categories (processes, company areas, specific responses) included in the framework.

Disclosure statement

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