Emerging technologies in emergency situations (guest editorial)

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Emerging Technologies in Emergency Situations (Guest editorial)

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<td>Editorial</td>
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SCHOLARONE™
Manuscripts
Emerging Technologies in Emergency Situations
(Guest editorial)

1. The role of emerging technologies in emergency situations

The world is witnessing an unprecedented upheaval in global operations and supply chains (Azadegan & Dooley, 2021; Scholten et al., 2020). Increasingly occurring natural disasters and the COVID-19 pandemic have plunged organisations into a state of emergency, with many fighting for their very survival (Ivanov, 2020; Queiroz et al., 2020; Schleper et al., 2021). Be they large or small, short-lived or sustaining for some time, emergency situations present a potential risk to an individual’s health and livelihood, organisational and societal welfare, and to the wider environment (van de Walle & Turoff, 2008; Sarkis, 2021). Emergency situations typically require urgent action to restore operations to the previous scenario or new strategies for survivability and adaptation to an entirely new context (Ivanov & Dolgui, 2020b; O’Flynn, 2020). Due to the scale and immediacy of these events, a range of actors is often involved, including governments, non-governmental organisations, and businesses, that need to work together to mitigate threats to life and property. To find a way out of today’s emergency situations, managers urgently require guidance on how to rapidly redeploy operational resources and build resilience (Ivanov & Dolgui, 2021; Remko, 2020). Emerging technologies such as those related to industry 4.0 are well-positioned to help organisations rebuild and reconfigure their resilience capabilities (Koh et al., 2019; Spieske & Birkel, 2021).

Recent scholarly work on emerging technologies has deepened our understanding of Industry 4.0 in a supply-chain context, including research on Blockchain (Wamba & Queiroz, 2020), Artificial Intelligence (AI) (Dwivedi et al., 2019), Big Data Analytics (Fosso Wamba & Akter, 2019; Kache & Seuring, 2017), the Internet of Things (IoT) (Schroeder et al., 2020) and 3D printing (Kapletia et al., 2019; Roscoe et al., 2019). However, one area that has received limited scholarly attention is deploying emerging technologies in emergency situations. Technology has always been and continues to act as an enabler of enhanced performance. Despite the scarcity of research, it is clear that emerging technologies can act as a coordination mechanism and flexible manufacturing tool when responding to emergencies (Queiroz & Fosso Wamba, 2021), supporting localised manufacturing close to the point of need (Srai et al., 2020). Recent advancements in digital technologies can enhance planning, mobilisation, and
management during emergency situations. For example, AI and business analytics can quickly identify populations in distress (Fosso Wamba et al., 2021). Social media combined with Big Data Analytics can coordinate the relief efforts of local volunteers during disasters (Dubey et al., 2019; Sharma & Joshi, 2019). Distributed manufacturing technologies such as 3D printing offer organisations the potential for point-of-care manufacture of life-saving medicines, implants, equipment, and devices within the vicinity of an outbreak or disaster (Srai et al., 2020; Phillips et al., 2020). Other recent cutting-edge technologies like Blockchain can improve information sharing during and after highly disruptive pandemic outbreaks and, consequently, enhance critical data visibility such as inventory levels throughout the supply network (Remko, 2020).

1.1. Aims of this special issue (SI)

While scholars have identified the coordination mechanisms needed to provide a synchronised response to emergency situations such as natural disasters (Holguín-Veras et al., 2012; Oloruntoba & Gray, 2006; van Wassenhove, 2006), the processes required to deploy emerging technologies during such situations had received limited attention (Dubey et al., 2020; Queiroz et al., 2020; Remko, 2020). Moreover, while recent scholarly work has considered the importance of organisational and dynamic capabilities in developing industry 4.0 technologies (Roscoe et al., 2019; Xu et al., 2018), the significance of fostering capabilities for the deployment of emerging technologies in emergency situations is under-researched (de Giovanni, 2019; Koh et al., 2019; Sarkis, 2012). More specifically, the scale of disruption caused by COVID-19 has amplified the challenges presented by natural and man-made disasters, increasing the need for new strategies, capabilities, and creativity in responding to emergency situations (Ivanov, 2020; Remko, 2020; Schleper et al., 2021).

The aim of this special issue is to understand how organizations and their supply chain partners can build the capabilities and coordination mechanisms required to deploy and utilise emerging technologies in emergency situations. The special issue intends to stimulate a debate among academic scholars, practitioners, and government representatives on the latest advances in emerging technologies and their application in the context of natural and man-made disasters as well as disease outbreaks such as COVID-19.
2. The interplay between emerging technologies, emergency situations, and operations management

Emerging technologies refer to a set of unproven or early-stage innovations with the potential for beneficial impact that can help remodel business and operations management dynamics (Dolgui & Ivanov, 2020). On the one hand, emerging technologies can bring different benefits for organisations and their supply chains. On the other hand, there are some potential risks and challenges associated with emerging technologies (Dolgui & Ivanov, 2020; Koh et al., 2019). From the lens of benefits, emerging technologies such as AI, Blockchain, Big Data Analytics, 3D printing, IoT, and Digital Twins can reshape operations and supply chain relationships, bringing more efficiency and minimising costs throughout an operation. Interaction and integration between emerging technologies can improve response times and visibility considerably in emergency situations, helping organisations mitigate and recover from a crisis (Dubey et al., 2020; Ivanov, 2021; Queiroz & Fosso Wamba, 2021).

Furthermore, emerging technologies can play a decisive role in the highly disruptive emergency situation presented by COVID-19, in which supply chains can not revert to early forms but need new strategies for survivability and adaptability (Ivanov & Dolgui, 2020b). However, emerging technologies can also be untested and have unintended consequences in certain circumstances. Therefore, their application should be carefully assessed with a systems perspective to understand better operational dependencies and how such technologies will change stakeholder behaviours. Table 1 highlights examples of disruptive emergency situations, the role of emerging technologies, and the consequences to operations and supply chain management.

Table 1. Examples of the interplay between emerging technologies, emergency situations, and operations management

<table>
<thead>
<tr>
<th>Type of emergency situation</th>
<th>Emerging technologies applications</th>
<th>Implications to operations management</th>
<th>Related literature</th>
</tr>
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<tbody>
<tr>
<td>Pandemic outbreaks</td>
<td>Blockchain for information transparency and visibility through the network</td>
<td>With Blockchain applications, operations management can gain a considerable advantage in tracking the distribution of critical products. Information sharing through the network can be in real-time to minimise supply chain disruptions.</td>
<td>(Lohmer et al., 2020; Remko, 2020)</td>
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<td></td>
<td>Digital Twins enable unprecedented real-time monitoring of the disruptions through the network</td>
<td>Digital Twin technology can help build dynamic capabilities in operation by integrating different sources of information, making</td>
<td>(Burgos &amp; Ivanov, 2021; Ivanov &amp; Dolgui, 2020a)</td>
</tr>
<tr>
<td>Event Type</td>
<td>Description</td>
<td>Application</td>
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<tr>
<td>Climate issues (i.e., wildfire, tornado, tsunami, flood, hurricane, earthquake, typhoon, etc.)</td>
<td>Social media combined with sophisticated algorithms/Big data to support all stages of the crisis (i.e., preparation, mitigation, response, recovery)</td>
<td>With social media, algorithms, and big data approaches, operations and supply chain managers can be more efficient by gaining a deeper understanding and visibility of the necessary resources for critical regions. Thus, the distribution of water, food, and medical supplies can be more responsive. Also, the prediction for the hospital care and treatment plans can be more effective. (Sarker et al., 2020; Saroj &amp; Pal, 2020; Watson et al., 2017)</td>
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<td>Humanitarian crisis (derived from resources scarcity, conflicts, migration, etc.)</td>
<td>Drones/Unmanned Aerial Vehicle (UAV) and the Internet of Things used to support search and rescue in humanitarian operations relief</td>
<td>Drones can perform a decisive role in humanitarian operations like medical supplies and food distribution in hard-to-reach regions. Drone technology can be combined with IoT applications for activities such as search and rescue. (Ayamga et al., 2021; Bravo et al., 2019)</td>
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<td>Terrorist attacks (humanitarian relief)</td>
<td>Smartphone platforms with communication apps (i.e., WhatsApp) to make available the necessary resources, track the victims, support evacuation strategies, etc.</td>
<td>Smartphone platforms can assist operational coordination during and after a terrorist attack by using different applications that enable more precise information about the location, conditions, and demand for medical supplies and vehicles for victims transportation, etc. (Bayiyeh, 2018)</td>
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<tr>
<td>Artificial Intelligence techniques to support diagnostic processes and predictions, telemedicine, and hospital operational procedures</td>
<td>Artificial Intelligence can support lean hospital operations effectively by identifying critical demands of resources for patients allocation. Also, it can help the operations manager during the patient journey by providing quick diagnosis, prediction, and treatment</td>
<td>(Luengo-Oroz et al., 2020; Queiroz &amp; Fosso Wamba, 2021)</td>
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<tr>
<td>Humanitarian crisis (derived from resources scarcity, conflicts, migration, etc.)</td>
<td>3D Printing/Additive Manufacturing for support scarcity of medical supplies and medical equipment, and point-of-care production of medicines and therapies</td>
<td>By deploying 3D printing technologies, humanitarian operations enable a rapid response for the in-field manufacture of critical medical equipment/parts that often takes several weeks or months in a regular supply chain. For example, in conflict regions, there is often a recurrent need for the field ready 3D printing of prosthetics. Rapid and improved recovery from traumatic injuries (tissue, organs) through the use of leading-edge regenerative medicines and bioengineered blood products. (Phillips et al, 2018; Corsini et al., 2020; Kovács &amp; Falagara Sigala, 2021) (Spear et al., 2018)</td>
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3. Papers selected for the special issue – emerging technologies in emergency situations

In this Special Issue, we invited scholars and practitioners to provide insights on the challenges facing operations and supply chain managers when adopting, implementing and diffusing emerging technologies in emergency situations. Based on this call, we received a significant number of manuscripts that were carefully handled by the guest editors, the editors-in-chief team, and a fantastic team of reviewers. Accordingly, six high-quality papers were selected for the special issue. The papers cover different types of emerging technologies in a range of emergency contexts. Table 2 summarises these papers by highlighting the main emerging technology explored, the emergency situation, and the methodological approach.

<table>
<thead>
<tr>
<th>Title of the paper</th>
<th>Authors</th>
<th>Emerging technology</th>
<th>Emergency situations</th>
<th>Methodological approach</th>
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<tbody>
<tr>
<td>Supply Chain Resilience in Mindful Humanitarian Aid Organizations: The Role of Big Data Analytics</td>
<td>Dennehy, Denis; Oredo, John; Spanaki, Konstantina; Despoudi, Styliani; Fitzgibbon, Mike</td>
<td>Big Data Analytics</td>
<td>Humanitarian relief supply chains</td>
<td>Survey with Partial Least Squares Structural Equation Modelling (PLS-SEM)</td>
</tr>
<tr>
<td>Managing Emergency Situations with Lean and Advanced Manufacturing Technologies: An Empirical Study on the Rumbia Typhoon Disaster</td>
<td>Chong, Alain; Pu, Xiaodie; Chen, Meng; Cai, Zhao; Tan, Kim Hua</td>
<td>Advanced Manufacturing Technologies (AMTs)</td>
<td>Typhoon disaster</td>
<td>Survey with Archival Data</td>
</tr>
<tr>
<td>Understanding Analytics Empowerment Capability to Tackle Emergency Situations</td>
<td>Akter, Shahriar; Bandara, Ruwan J.; Sajib, Shahriar</td>
<td>Big Data Analytics</td>
<td>Emergency service operations</td>
<td>Survey with Partial Least Squares Structural Equation Modelling (PLS-SEM)</td>
</tr>
<tr>
<td>The Mitigating Role of Blockchain-Enabled Supply Chains During the COVID-19 Pandemic</td>
<td>Lam, Hugo K. S.; Xiong, Yangchun; Kumar, Ajay; Ngai, Eric W.T.; Xiu, Chunyu; Wang, Xinyue</td>
<td>Blockchain</td>
<td>COVID-19 Event Study</td>
<td></td>
</tr>
<tr>
<td>Exploring the Application of Blockchain to Humanitarian Supply Chains: Insights from Blockchain Project</td>
<td>Baharmand, Hossein; Maghsoudi, Amin; Coppi, Giulio</td>
<td>Blockchain</td>
<td>Humanitarian supply chain</td>
<td>Focus Group, Semi-Structured Interviews</td>
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</table>
The first paper in the Special Issue “Supply Chain Resilience in Mindful Humanitarian Aid Organizations: The Role of Big Data Analytics” (Dennehy et al. 2021) is focused on humanitarian relief supply chains. Using empirical survey data and archival information collected from NGOs, government development agencies and consultancy think tanks focused on humanitarian relief, the authors develop a model to capture the interplay between collective mindfulness and Big Data Analytics. By employing Partial Least Squares Structural Equation Modelling (PLS-SEM), the paper offers empirical evidence that organisational mindfulness plays an essential role in enabling resilient humanitarian relief supply chains as opposed to simply facilitating Big Data Analytics in a humanitarian context.

The paper by Chong et al. (2021) “Managing Emergency Situations with Lean and Advanced Manufacturing Technologies: An Empirical Study on the Rumbia Typhoon Disaster” investigates the impact of lean manufacturing techniques on the financial performance of companies negatively affected by emergency situations. It subsequently explores the role of advanced manufacturing technologies in complementing lean manufacturing to enhance financial performance in emergency and non-emergency scenarios. The paper shows interesting results that include an inverted U-shaped relationship between lean manufacturing and financial performance. More importantly, they identify the interactive effects of advanced and lean manufacturing technologies in influencing financial performance in emergency and non-emergency situations.

The third paper, entitled “Understanding Analytics Empowerment Capability to Tackle Emergency Situations” (Akter et al., 2021), analyses the interplay between an analytics empowerment capability and its effect on strategic emergency service agility and emergency service adaptation. Using PLS-SEM, the results unveil that an analytics empowerment capability is framed by analytics culture, technology, and tools, information access, decision making, knowledge, and skills, as well as training and development. The findings highlight the partial mediator effect of strategic emergency service agility in the relationship between analytics empowerment capability and emergency service adaptation.
The fourth paper by Lam et al. (2021) explores the mitigating role of Blockchain-enabled supply chains during the COVID-19 pandemic. The authors use an event study approach to identify the financial impacts of COVID-19 between those organisations that adopted Blockchain and those that did not. The paper presents evidence that Blockchain-enabled supply chains play a decisive role in mitigating the negative outcomes of COVID-19, particularly for those with lean and complex supply chains.

The paper by Baharmand et al. (2021) “Exploring the Application of Blockchain to Humanitarian Supply Chains: Insights from Humanitarian Supply Blockchain Project,” also concentrates on Blockchain technology. The authors investigate the key drivers and barriers to the adoption of Blockchain technology in humanitarian supply chains. They collect data using a focus group and semi-structured interviews and identify visibility, collaboration, accountability, traceability, trust, time efficiency, and cross-sector partnerships as the main drivers to the adoption of Blockchain technology. The main barriers to adoption include the lack of technical skills and training, privacy concerns, regulatory problems, lack of resources, pilot scalability issues, and governance challenges. Finally, they highlight that Blockchain can improve visibility and traceability, consequently adding value and transparency for humanitarian supply chains.

The final paper by Dominguez-Péry et al. (2021) “Improving Emergency Response Operations in Maritime Accidents using Social Media with Big Data Analytics: the MV Wakashio Disaster Case Study” investigates the contribution of Big Data Analytics integrated with Social Media in order to improve the emergency response operations before and in the course of maritime accidents. The authors used BDA approaches in a real-time dataset from Twitter, considering the MV Wakashio maritime disaster. Their findings indicate that ship’s organisation, official institutions, and the wider community play a fundamental role in the operations response success. Also, they highlight that the integration of Social Media with Big Data Analytics techniques can add value contributing to a collective sense-making in this type of emergency situation.

4. Implications and research opportunities for the fields of production and operations management: Uncertainties are the only certainties

Considering the complexity of the emergency situations highlighted in this special issue, it is clear that emerging technologies will continue to play a decisive role in future emergency situations. As we noted earlier, the frequency and severity of emergency situations seem to be ever-increasing, requiring further technological advances and
managerial knowledge of how to adopt and deploy emerging technologies during crises. While this special issue takes a first step along the path of discovery, we feel it prudent to outline several promising future research areas for academics and practitioners.

First, we call on researchers to investigate how traditional operations management approaches such as lean thinking, just-in-time, and just-in-case can be enabled by emerging technologies during and after emergency situations. Some technologies can enhance the efficiency of firm operations. Others can enhance the firm’s ability to ward off or mitigate emergencies. An assessment of how emerging technologies affect the relationship between operations management approaches and performance (i.e., as moderating or mediating factors) can be a valuable contribution to the literature.

Second, we call on researchers to consider how novel yet less applied management theories that can shed light on how to integrate disparate emerging technologies within emergency response networks. One example of such theories is resource orchestration theory (Sirmon et al., 2011). This theory considers the role of managers in structuring resources and bundling them into capabilities. Resource orchestration theory can help explain how emerging technologies can be used in tandem to mitigate the effects of emergency situations. Another useful theory is that of organisational information processing theory (Premkumar et al., 2005). Organisational information processing theory explains how firm performance is improved when the information needs of an organisation align with information processing capabilities. By enhancing the information processing of the firm, emerging technologies can help buffer uncertainty and thereby improve performance. The behavioural theory of the firm (Cyert and March 1963) is another less applied but useful theory in this domain of inquiry. The behavioural theory of the firm explains how firms make decisions based on a coalition of groups, functions, and departments. Decisions to be made may be different based on the information available to each group. By allowing for better sharing of information, emerging technologies can help create consensus among the groups. Perhaps even more interestingly, the theory suggests that some groups, functions, or departments may not be interested in an optimal solution to organisational challenges. Instead, they may look for “good enough” solutions to face such challenges. By offering better awareness, how emerging technologies can improve decisions such that they move beyond satisficing (Simon, 1955) and towards optimal ones, particularly in facing emergency situations, can be very interesting. A final noteworthy theory is that of Simons’ Levers of Control (Simons, 1995). Simons suggests that managers use different control mechanisms to
direct and nurture performance. Among others, controls include diagnostic and interactive control systems. Whereas diagnostic controls are one-way directives, interactive controls offer means for feedback from different functions back to managers. Whether and how different emerging technologies can be categorised as control systems and how their application can improve performance is certainly a viable approach to the use of this theory.

Third, we see potential in identifying the cultural and behavioural factors that inhibit and enable the deployment of emerging technologies by multiple emergency response actors. For instance, it is well-established that certain government agencies, national NGOs, and local NGOs show different behaviour during humanitarian disasters (See Shaheen et al. 2021, for example). Of particular interest is how emerging technologies such as Blockchain, AI and Big Data can act as coordination mechanisms between networks of emergency response organisations. Next, we call on researchers to develop managerial frameworks and taxonomies that explain how and when to deploy emerging technologies to support resilience, adaptability, and survivability in large-scale and prolonged emergency situations, such as pandemic outbreaks. Further, we see an opportunity for future researchers to determine how emerging technologies can support supply chain redesign during large-scale emergencies, including offshoring, nearshoring, onshoring and distributed approaches. Finally, we call on future researchers to explore the role of emerging technologies in supporting a circular economy approach to minimising waste and stockouts during emergency situations.

5. Concluding remarks
The interplay between emerging technologies, emergency situations and operations management is a nascent area of research. The rapid spread of COVID-19 around the globe has reinforced the urgency to understand how technologies such as AI, Additive Manufacturing, and Blockchain can help organisations build more effective methods of responding to emergency events. Each paper in this special issue offers valuable insights for academics and practitioners on the adoption and use of different emerging technologies in a variety of emergency contexts. Researchers have been presented with many fruitful areas of inquiry to build on this nascent area of scholarship. The only certainty in today’s disruptive world is uncertainty, and these new challenges require new technological solutions and previously untapped capabilities.
Acknowledgments
This special issue results from an intensive collaboration between scholars, practitioners, guest editors, editors-in-chief, associate editors, contributing authors, and the journal's staff. We especially want to thank all the reviewers for the fantastic and exceptional feedback for the authors in all rounds. We would also like to give special thanks to Constantin Blome and Cristina Gimenez, editors-in-chief of the International Journal of Operations & Production Management, and Martin Schleper, editorial assistant, for their outstanding support and suggestions during this special issue. Finally, the guest editor team would like to thank especially to the Emerald Publishing staff. The assistance of this excellent team was exceptional during all stages to release this special issue on time.

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