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Thematic Section - Resilient and innovative operations management

Toward the development of a Preparedness and Response Protocol for epidemics and pandemics

Fabíola Negreiros de Oliveira[a*], Daniel Eckhardt[a], Adriana Leiras[a], Paulo Gonçalves[b], Irineu de Brito Junior[c], Hugo Tsugunobu Yoshida Yoshizaki[d], Frederico Ferreira Pedroso[e]

[a]Pontifícia Universidade Católica do Rio de Janeiro, Rio de Janeiro, RJ, Brasil

[b]Università della Svizzera Italiana, Lugano, Switzerland

[c]Universidade Estadual Paulista "Júlio de Mesquita Filho", São José dos Campos, SP, Brasil

[d]Universidade de São Paulo, São Paulo, SP, Brasil

[e]World Bank Group, Washington, DC, United States of America

*negreiros.fabiola@gmail.com

Abstract

Paper aims: The paper aims to analyze preparedness and response for epidemics and pandemics, taking as reference the COVID-19 pandemic, to provide a foundation for developing a preparedness and response protocol to guide Civil Defenses fighting against health threats. For this purpose, we present the results of interviews carried out with Brazilian Civil Defenses, evaluating the role and the type of responsibility (in charge or supportive) of 12 entities in four key areas: (i) awareness and training; (ii) surveillance; (iii) information and communication; (iv) logistics and supplies.

Originality: The role of Civil Defenses in health threats still needs to be explored in academia. We often see Civil Defenses working to reduce risks and damages suffered by the population in case of disasters such as floods, landslides, and fires. In this paper, we go deeper into Civil Defense's role and show that its efforts can be headed to face biological disasters such as the COVID-19 pandemic. In this sense, the paper is original as it brings an innovative outlook on the role of Civil Defense, providing inputs for developing a preparedness and response protocol for epidemics and pandemics.

Research method: We analyze 12 Brazilian Civil Defenses from different States in Brazil. The results were gathered through 9 interviews via video call and three responses from a questionnaire that guided the interviews. We evaluated data from Civil Defenses individually, and then using content analysis, we categorized the data to structure the results and raise essential insights.

Main findings: Most of the actions taken by the Civil Defenses during the pandemic response included logistics-related activities such as storage, transportation, distribution of required supplies, and mobilization of supply operations.

Implications for theory and practice: The findings emphasize the capacity of Civil Defenses to act in a vast scope of disasters, including biological disasters. Also, this study helps practitioners to develop guidelines and protocols to support Civil Defense in preparedness and response activities to epidemics and pandemics.

Keywords

COVID-19. Civil Defense. Pandemics. Preparedness. Response.

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1. Introduction

The world has experienced an increase in the emergence of several infectious diseases, especially zoonoses, transmissible from animals to humans (World Health Organization, 2020a). Ebola, SARs, MERs, swine flu, and

others have unfolded worldwide, threatening human well-being, ecosystems, and economic development. In recent decades, emerging infectious diseases accounted for direct costs of more than USD100 billion (UN Environment Programme, 2020). The Global Risks Report (World Economic Forum, 2021) identifies infectious diseases as one of the top 10 risks in terms of economic impacts for the next ten years. In the following decades, researchers estimate that flu pandemics will cause average annual losses of approximately $570 billion.

The recent COVID-19 pandemic brought severe health and economic issues and behavioral, psychosocial, and technological impacts to the world. It has exposed a collective failure to prioritize preparedness and response actions (World Health Organization, 2020b). Most countries were not well prepared for the COVID-19 pandemic. They underestimated the risk when the outbreak emerged, and many did not count on plans to respond to this type of disaster (Allain-Dupré et al., 2020). As seen by the different policies implemented worldwide, governance and decision-making to respond to the burden imposed by the COVID-19 pandemic have become a key challenge for many countries (Zhang & Shaw, 2020).

Governance is crucial to increasing institutional capacities in the face of disasters and pandemics. In the context of risks and disasters, governance means defining competencies and formal and informal coordination of organizations and public and private actors through common ideals, laws, regulations, and norms to reduce the risks of disasters and their impacts (Tierney, 2012). It also reflects that disaster governance policies and programs tend to be reactive, focusing on solving problems revealed by recent events - much of which is observed in the case of the COVID-19 pandemic - rather than relying on comprehensive risk and vulnerability assessments (Tierney, 2012).

The World Health Organization (WHO) states that signatory countries should take responsibility for internalizing the agreed international commitments, such as the recommendations for governments to develop and strengthen their pandemic preparedness and response protocols (Rodrigues et al., 2020). Developing such mechanisms allows countries to mitigate the consequences imposed by the disease and better respond to these events, building a more robust national response capacity to future emerging infectious diseases (World Health Organization, 2020b).

Since each type of disaster affects a diverse range of specialties, the primary activity of a specific area frequently prevails. In the case of COVID-19, the initial action comes from the area of Health, as it is a biological disaster (Rodrigues et al., 2020). However, according to the frame of classification, characteristics, and disaster actions of the National Policy for Civil Protection and Defense (Portuguese Acronym: PNPDEC), when a disaster is classified as level III (public calamity), whose damage and losses cannot be overcome by local governments, the normality reestablishment depends also on the mobilization and coordination of Civil Defense (Rodrigues et al., 2020). As the COVID-19 pandemic stood out for being a disaster different from the others, reaching global scales, it was necessary the intervention not only from health agencies; but also from Civil Defense.

Civil Defense or Civil Protection is an effort to protect the population from man-made and climate-related disasters, conceptualized as a cycle. The life cycle of a disaster, proposed by Alexander (2003), is a standard guide for characterizing and analyzing the logistic systems in emergency contexts. It encompasses four phases through which any type of calamity can be analyzed: mitigation to reduce risks and hazards, preparedness for imminent impacts, response to emergencies, and recovery of human and infrastructure systems. Unlike other disasters, COVID-19 showed that most countries were unprepared for this global pandemic, recognized as an unprecedented disaster. Thus, the response phase was hampered due to the lack of preparedness and readiness actions worldwide. During the Covid-19 race, however, some countries have faced this battle better than others. Nations such as Israel, Chile, and the United Arab Emirates (UAE) implemented efficient strategies and good practices at the beginning of the immunization schedule, managing to vaccinate the population quickly to reduce the number of total deaths (Peter et al., 2023).

Civil Defense processes are often designed to deal with immediate emergencies, protect the citizens, and restore essential services and facilities destroyed or damaged by disasters. The objectives of Civil Defense are to save a life, minimize loss of property, create conditions for shelter, food, and medical care for victims, maintain continuity of production, and keep high up the morale of the people.

In this paper, we analyze two specific phases of the disaster: preparedness and response for epidemics and pandemics, taking as reference the COVID-19 pandemic. We present the results of interviews with Brazilian Civil Defenses from 12 national states, aiming to identify their actions, challenges, and lessons learned during the COVID-19 response. Also, from the relevant literature, we raise four key areas of action and understand the role of Civil Defense in each area. Thus, the question posed in this study is: What is the Civil Defense's role in facing health threats such as epidemics and pandemics? In this way, we provide a foundation for developing a preparedness and response protocol that support Civil Defenses in preparedness and response activities to epidemics and pandemics. The outputs provided in this work can be replicated in Civil Defenses in other countries,

contributing to increase readiness for subsequent infectious diseases that can threaten the world again. To the best of our knowledge, this is the first study to propose a Preparedness and Response Protocol for Civil Defense action in health crises such as COVID-19. The guidelines presented in this work can help in the case of a new disease resurgence. They may contribute to the resilience process and maturity of the Civil Defenses.

The paper is structured as follows. We begin by reviewing the relevant literature. Then, Section 3 describes the research methodology, while Section 4 presents the results and discusses the role of Civil Defense in key areas of action. Finally, Section 5 brings conclusions, limitations, and future research directions.

2. Relevant literature

Emerging infectious diseases (EID) significantly burden global public health and economies. Their emergence is highly driven by socioeconomic, environmental, and ecological factors (Jones et al., 2008). Although diseases are a natural phenomenon, globalization, urbanization, human practices, and climate change have fueled imbalances in the ecosystem, increasing the probability of new infectious diseases. Moreover, millions of people worldwide lack basic sanitation and live in poor housing structures, favoring the incidence of infections (Lima & Costa, 2015).

Infectious diseases can be categorized as epidemics when the disease rapidly spreads, affecting many people in a specific location within a short period (Last, 1989; Llanes et al., 2019). A pandemic, in turn, is characterized when the epidemic reaches large proportions and affects several countries in more than one continent (Morens et al., 2009). Since 2005, when Severe Acute Respiratory Syndrome (SARs) stroke, the World Health Organization elaborated recommendations to encourage nations to prepare for this event. This WHO report points out that the SARs was the closest to a pandemic the world had experienced since 1968 (Rodrigues et al., 2020). More recently, documents have been elaborated on general priorities for risk reduction, disaster preparedness, and control, including pandemic disasters. This is the case of the 2015-2030 Sendai Framework for Disaster Risk Reduction, developed by the United Nations Office for Disaster Risk Reduction (UNDRR) (Etinay et al., 2018).

In Brazil, governance efforts to build more robust preparedness and response national capacity to disasters, including emerging infectious diseases, resulted in Law No. 12,608, of 2012. It was instituted, establishing the PNPDEC, providing for the National Civil Protection and Defense System (Portuguese Acronym: SINPDEC) and the National Civil Protection and Defense Council (Portuguese Acronym: CONPDEC), authorizing the creation of a Disaster Information and Monitoring System (S2iD). These Systems indicate an effort to emphasize not only response and recovery actions but also preparedness measures.

Civil Defense agencies in Brazil hold legitimacy, qualification, and credibility to lead, together with the strategic nucleus, disaster management in all its spheres of power (Tarin, 2020). It also emphasizes that Civil Defense can play a greater role in constructing strategies to combat COVID-19 precisely because it is installed in most Brazilian municipalities and close to communities. The author also emphasizes that the active participation of Civil Defense in the management of the pandemic is important because there is no contingency plan that guarantees human security for the whole community, stating that such perception is supported by the Emergency Plans. Contingencies to face COVID-19 have been made in the environment of health entities.

Disaster management operations comprise four phases: mitigation, preparedness, response, and recovery. The first phase, mitigation, includes activities that look at preventing and reducing disaster risks and their impacts; preparedness is related to training and maintenance of supplies and other preparedness activities to respond to a disaster. The response is the phase that seeks to respond to the unwanted event, minimizing its effects, by using resources and emergency procedures guided by plans to preserve life. Finally, recovery is related to activities that aim to restore normality to all those affected by long-term actions (Altay & Green III, 2006; Van Wassenhove, 2006). According to Holguín-Veras et al. (2012), several disaster agent characteristics can affect emergency preparedness and response activities, such as the speed of onset, which can be sudden or gradual; the time between the identification of the disaster agent and the onset of its effects in a particular place; the magnitude of impact; the scope of impact, e.g., flood water after torrential rain or debris after an earthquake; and the temporal duration of impact. A wide range of conditions can determine the characteristics of a humanitarian operation.

In addition to the four phases of a disaster, the ability to respond and recover from a disaster is intrinsically related to the concept of resilience. Peng et al. (2017) state that this concept is widely used in disasters. According to Christopher & Peck (2004), resilience portrays the ability of a system to re-establish itself or improve performance more quickly after an interruption in the flow, such as a disaster. In this context, we can highlight the Maturity Models for humanitarian logistics systems, which significantly contribute to the literature on disaster preparedness, providing a diagnosis of the 'organizational maturity' with which aid is provided in a

place (Gonzalez-Feliu et al., 2020). To improve disaster management and reduce impacts, Maturity Models are being proposed to support stakeholder decision-making in disaster situations (Resende et al., 2022). Maturity Models generally allow organizations to assess their process's maturity stage during disaster operations and identify strategies that can evolve in these stages. As mentioned, some countries have faced COVID-19 better than others since their processes holed higher maturity and robustness regarding primary healthcare and online systems (Peter at al., 2023). The following topic approaches specific issues related to the two specific phases of the disaster discussed in this article: preparedness and response.

2.1. Disaster preparedness and response

The literature on preparedness and response is vast. For decades, several authors have emphasized the importance of embedding preparedness actions toward developing a robust response. Disaster preparedness entails drafting national plans and legislation for disaster management, training and strengthening institutions and staff who work as first respondents, and educating and raising awareness in the population, especially in the most vulnerable communities (Wisner et al., 2002; Leiras et al., 2014). Disaster response, in turn, depends mainly on the preparedness phase, which provides the basis for a prompt response. Necessary conditions for a satisfactory response include the availability of trained human resources, adequate communication, access to transport and logistics, and protocols for each type of emergency (Rodrigues et al., 2020). In this regard, measures related to awareness and training, surveillance, information and communication, and logistics and supplies are crucial in a disaster's preparedness and response phase. Also, in this phase, coordination mechanisms are especially important to ensure an efficient response.

2.1.1. Awareness and training

Awareness and training should be carried out across the community through disaster reduction education programs. These are essential components of community-oriented disaster risk management. Educative campaigns, community involvement, and health education efforts must be encouraged and evaluated for effectiveness. In Liberia, public health education campaigns developed during the Ebola epidemic included community education about symptoms and disease transmission, the importance of isolating infected people, and self-protective and hygiene measures (Southall et al., 2017). Therefore, in epidemics and pandemics, awareness and training usually involve educating and training people on good hygiene and cleaning practices, waste disposal, personal protective equipment (PPE), social distancing, and lockdown. The awareness and training of the population must be ongoing, and health education messages must be specific and straightforward, focusing mainly on themes such as health risks and practices that eliminate these risks.

2.1.2. Surveillance

Surveillance is one of the key elements in preparedness for epidemics and pandemics (Pascapurnama et al., 2018). It prepares society for an early response to potential health threats. As mentioned, health departments usually take control and responsibility for infectious diseases. An effective disease surveillance system is essential to detecting disease outbreaks quickly before they spread, cost lives, and become difficult to control. Effective surveillance can improve disease outbreak detection in emergency settings, such as in countries in conflict or following a natural disaster. Early Warning Systems (Epidemiologic Surveillance) can detect epidemic-prone diseases, such as acute respiratory infections, allowing the region or country better prepare for the disease. It is recommended to use such a surveillance system as a key instrument of public health to monitor infectious diseases under normal circumstances regularly (Pascapurnama et al., 2018).

2.1.3. Information and communication

For an adequate response, information must be analyzed, quickly disseminated, and communicated to the population. The mass media plays a crucial role in transmitting and updating information (Fontainha et al., 2017). When responding to a disaster, it is vital to have a comprehensive communication plan customized for different audiences to communicate relevant, correct information during the event (Aliyu, 2015). Health workers and community leaders are essential in social mobilization in disaster response. Their participation in the response can improve the population's acceptance of interventions (Aliyu, 2015). In biological disasters,

information about disease statistics (total infected, deaths, and recovered), preventive and restrictive measures, and availability of rapid testing and vaccination centers are primarily relevant.

2.1.4. Logistics and supplies

Logistics, in turn, is one of the key elements for humanitarian interventions. The prioritization, transport planning, and distribution of emergency supplies are essential activities managed by the logistics area. Access and distribution systems should ensure that essential supplies reach those in need as soon as possible (World Health Organization, 2006). As humanitarian organizations have responded to different types of disasters, the set of relief items has become more varied, including simple items, such as food, and more complex items, such as debris-removing equipment (Taupiac, 2001; Lamenza et al., 2019), which leads to a greater complexity when storing, transporting and distributing the relief items. Also, logistic planning is equally necessary since it is usually possible to predict the types of disasters that can distress a region and the needs that such disasters will probably engender (Jahre & Jahre, 2019). In the case of the COVID-19 pandemic, for example, as the outbreak unfolded globally, it became clear that supplies were a vital component of the response – especially personal protective equipment to safeguard the health of frontline workers (Cunha et al., 2022; United Nations International Children's Emergency Fund, 2021).

2.2. COVID-19 response worldwide

The COVID-19 pandemic has taken people's lives and severely affected the economy. Due to the strict lockdown, manufacturing and logistics activities have been suspended, affecting the demand and supply of numerous products due to the restrictions imposed. COVID-19 impacts have been observed in all economic sectors, such as the automotive and aviation, tourism, oil, construction, food, healthcare systems, and others (Chamola et al., 2020). During the pandemic, the priority of all nations was to save human lives. Still, a massive shortage of essential items like medicine, food, medical equipment, medical equipment, and PPE made it challenging to fight the disease (Singh et al., 2021). The importance of logistics services became even more relevant in response actions. Indeed, much can be learned from humanitarian supply chains for managing supply chain disruptions caused by the pandemic. In recent work, Kovács & Sigala (2021) present some of the main lessons learned from the global pandemic. The first one is that preparedness pays off. The COVID-19 pandemic has exposed that preparedness is not satisfactory at any tier or organization in the supply chain but needs to be considered across the supply chain and all sectors. Speed in decision-making is indispensable to humanitarian supply chains. It helps humanitarian organizations rapidly adapt to demand fluctuations and supply disruptions in diverse types of humanitarian disasters (Dubey & Gunasekaran, 2016). The pandemic response also encouraged the emergence of innovative technologies such as additive manufacturing (3D printing) of medical equipment (Attaran, 2020; Kovács & Sigala, 2021) or of blockchain applications to track contagion (Marbouh et al., 2020). Finally, the production changeover for the pandemic response reveals the private sector's importance in adapting its production capacity (Kovács & Sigala, 2021).

During the COVID-19 pandemic, Civil Defense was in charge of many activities and contributed to developing response and coordinated mechanisms. Civil Defense entities worldwide have worked with health institutions to provide sustained support to communities. In Guyana, South America, international institutions handed over 48 housing units to the Ministry of Public Health through the Civil Defense to improve the country's regional capacity for the COVID-19 response (Guyana, 2020). The Brazilian government, for example, used vehicles of Civil Defenses to transport necessary supplies, especially PPEs, and respirators, to hospitals. Some Civil Defenses were also responsible for mortuary management due to COVID-19 (Brito Junior et al., 2021).

In the case of Nordic countries, some national preparedness acts, such as the 2008 Civil Protection Act in Iceland and the 2003 Civil Protection Act in Sweden, underpinned the initial COVID-19 response in these countries. Regulations for infected people tracing differed somewhat between the countries. In Iceland, where civil preparedness seemed to have been more prominent on the political agenda, a specialized contact tracing team within the Civil Protection Department was responsible for contact tracing (Saunes et al., 2022).

In addition to the Civil Defense actions observed during the pandemic, post-pandemic actions are essential to highlight. The United Nations suggests 55 actions for post-covid Brazil, focusing on social protection, education, sustainable development, and the digital economy. In this sense, the active participation of Civil Defense in managing the post-pandemic actions is essential to restore the population's health, social and economic conditions, allowing the role foreseen for the Civil Defense of the manager responsible for the multisectoral

articulation. In this sense, cooperation with Health can monitor economic and psychosocial impacts in the short, medium, and long term after COVID-19.

3. Methodology

From the relevant literature, it is possible to cluster preparedness and response actions into areas such as (i) awareness and training; (ii) surveillance; (iii) information and communication; and (iv) logistics and supplies. Our literature findings show that papers addressing preparedness (pre-event phase) often focused on presenting issues related to awareness, training, and surveillance, whereas articles addressing disaster responses generally covered communication; and logistics and supplies mechanisms. These key areas were the basis for developing the questionnaire in the interviews conducted with Brazilian Civil Defenses. Interviews occurred through video conferences from October to December 2020 and lasted approximately 2 hours. Our sample of respondents included Civil Defenses of different States in Brazil. The choice of such Civil Defenses was based on the states with the highest number of COVID-19 deaths in Brazil, which also concentrated the majority of the Brazilian population, approximately 73% (Instituto Brasileiro de Geografia e Estatística, 2010).

A schema of the methodology approach is presented in Figure 1. Firstly, we conduct a systematic literature review following the steps of Thomé et al. (2016). Based on our literature foundation, we developed the questionnaire that will serve as the basis for the interviews, and finally, we compiled and analyzed the data using Excel spreadsheets.

Figure 1. Methodology approach of the study.

A case study approach was selected to evaluate the role and the type of responsibility (in charge or supportive) of 12 entities of Civil Defense in four key areas. Case studies are a popular way of characterizing and studying humanitarian logistics (Gonzalez-Feliu et al., 2020). We present here the proposed methodology, based on the following structure, according to Yin 2018:

Aim of the case study: The case study aims to analyze preparedness and response for epidemics and pandemics, taking as reference the COVID-19 pandemic, to provide a foundation for developing a preparedness and response protocol to guide Civil Defenses fighting against health threats.

Yin (2018) proposes a project step that formalizes the research questions, and defines the case study project (single or multiple) and criteria for interpreting findings. In this case, we use a single case study with 12 Civil Defenses analyzed to characterize it. In the preparation step, we develop a case study protocol, provide an overview of our case study (research questions and objectives), and explain our data collection procedure. For the data collection step, Yin (2018) recommends using multiple sources of evidence, as using several sources allows for more detailed data collection. Data collection occurred over three phases and drew from the following sources of data: (i) literature review; (ii) answers to an online questionnaire by the interviewees; (iii) individual interviews.

Eight interviews were carried out with Civil Defenses of São Paulo, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, Paraná, Minas Gerais, Pará, and Espírito Santo States. We also interviewed the head of the National Civil

Defense. These interviews were guided by a structured questionnaire composed of closed and open questions divided into two parts. The first part encompassed 37 questions and focused on obtaining information about the Civil Defense's performance, challenges, and lessons learned in the COVID-19 response in 2020. Then, the second part was composed of 20 questions intended to understand the role of Civil Defense in the mentioned key areas: (i) awareness and training; (ii) surveillance, (iii) information and communication; and (iv) logistics and supplies. Each of the areas had 2 to 5 closed questions. With each area comprising a range of activities, whether focused on preparedness or response, interviewees were asked about the role of Civil Defense in each activity and the type of its responsibility/accountability: in charge of that activity or supporting other institutions (such as the Ministry of Health, Education, Communication, Social Development). To determine whether Civil Defense should take responsibility or not for each specific activity and the responsibility type entrusted to the Civil Defenses, we adopted a threshold of 50% of the answers.

The questionnaire was also sent to other Civil Defenses through a web-based platform. Thus, we obtained responses from three more states: Ceará, Maranhão, and Goiás, resulting, therefore, in a total of 11 Brazilian Civil Defenses evaluated (see Figure 2) plus the National Civil Defense. It is essential to highlight that Civil Defenses from Ceará, Maranhão, and Brasília had more than one respondent answering the questionnaire, resulting in a total of 19 responses to be evaluated.

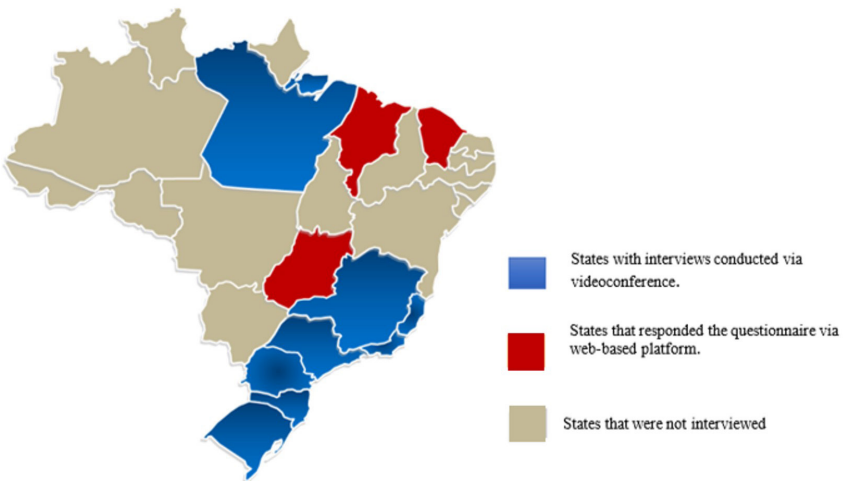

Figure 2. Map of the Brazilian states where the interviewed Civil Defenses are located.

The positions of the interviewees in their Civil Defenses included: The Head of the response department of the State Civil Defense; Chief of Staff and Media Advisor; Disaster Management Superintendent; Coordinator; Executive Secretary; Director of Civil School; Head of the Risk Management Department; Chief of Staff; Assistant State Coordinator for Civil Defense; Response Director; General Disaster Response Coordinator and Disaster Management Director. Although only eight interviews were carried out (the maximum possible number), the responses were complemented through the online questionnaire, summing up 19 responses analyzed, as mentioned.

Data analysis involves examining, categorizing, and tabulating evidence to produce discoveries based on empiricism (Yin, 2018). We evaluated data from Civil Defenses individually, and then using content analysis, we were able to categorize the data to structure the results and raise important insights. Our data analysis was performed by the authors of this paper using *Excel*. It encompassed examination, tabulation, categorization, and recombination of the results to gather discoveries and insights based on empiricism. After collecting and analyzing the data, we sought to present as a product a detailed panel of Civil Defense practices applied in the fight against COVID-19 and the interaction of Health systems and other entities with Civil Defense. Qualitative and quantitative data on COVID-19, reports and perceptions of interviewees, and a conclusion on the role and responsibility of Civil Defense in each of the key areas are presented here.

With the interviews and responses from the questionnaire, we identify the main activities carried out by Brazilian Civil Defenses and their role during the current COVID-19 pandemic. Identifying the areas of Civil Defense action and its expected responsibilities in each activity of the previously mentioned areas was also possible.

It is essential to highlight that the small sample of respondents precludes us from raising more robust and confirmatory conclusions. Also, this sample only encompasses Brazilian Civil Defenses, which further restricts our insights. The questionnaire comprises qualitative questions, which are highly based on respondents' perceptions.

4. Preparedness and response protocol

This section presents the results obtained with the subject of Civil Defenses. Firstly, we present the performance of the Civil Defenses, identifying its main actions, challenges, and lessons learned during the COVID-19 response in 2020. Then, we raise key action areas to evaluate the activities in which Civil Defenses should take responsibility and the type of responsibility in preparedness and response to epidemics and pandemics.

4.1. Brazilian Civil Defenses response to the COVID-19 pandemic

Approximately 45% of respondents accumulate more than five years of experience in Civil Defense, while 17% have 3 to 5 years of experience, totalizing 62% of respondents with at least three years of experience. Around 67% of respondents said their Civil Defenses have general protocols to respond to epidemic and pandemic shocks. However, these protocols are designed for the most common disasters faced by the Brazilian Civil Defenses, such as floods, cyclones, droughts, and landslides. They are not focused and specific for epidemics and pandemics. The COVID-19 pandemic further emphasized the importance of defining particular guidelines for infectious diseases that lead to epidemics or pandemics. In this sense, all the interviewees agreed with the importance of developing protocols with guidelines and strategies focused on preparedness and response to epidemics and pandemics.

Civil Defenses play a crucial role in natural disasters, such as floods, cyclones, and droughts - most of the time assuming control of response operations and carrying out preparedness actions. This usually does not occur in the case of infectious diseases (such as dengue, zika, or COVID-19), where health departments generally take this responsibility. However, during the COVID-19 pandemic, Brazilian Civil Defense was considered a critical actor in responding to this disaster. Actions raised by the studied Civil Defenses during the COVID-19 response included:

(i) Articulation with government institutions;

(ii) Logistical activities such as receiving, storing, transporting, and distributing supplies. For example, Civil Defense vehicles were used to transport medicines and respirators;

(iii) Awareness campaigns to the dissemination of information related to protective and hygiene measures regarding COVID-19;

(iv) Conducting training and capacity building for municipal Civil Defenses;

(v) Notification of emergency situation (SE) of states affected by COVID-19;

(vi) Support in operational activities such as organizing sanitary barriers, organization of flu vaccinations, feasibility of rapid test for COVID-19;

(vii) Participation in management meetings at the Ministry of Health and the Civil House;

(viii) Support to Ministry of Health; Education, Communication and Social Assistance;

(ix) Monitoring of mortuary management related to COVID-19;

(x) Identification and support for vulnerable populations.

The transfer of monetary resources is conducted following the Decrees of Emergency Situation and State of Public Calamity carried out by the municipalities listed in the S2iD system, following Law 12,608/2012, under the responsibility of Civil Defense. Besides the aforementioned actions, in the case of COVID-19, the transfer of resources was carried out with the approval of the National Secretariat for Civil Defense and Protection under the Ministry of Regional Development. In contrast, the Ministry of Health carried out command and control.

Brazilian Civil Defense also took necessary actions, especially in logistics-related activities. Approximately 85% of the interviewed Civil Defenses have distributed donations to the population. Humanitarian supplies such as food, personal hygiene and cleaning products, and personal protective equipment (such as masks and gloves) came from diverse entities such as private companies, civil society, non-governmental organizations, and government directly to the Civil Defense that managed the storage of these items and distributed them to

the population. Regarding the role of Civil Defense in the removals/displacement of bodies, only 13% of the Civil Defenses were responsible for this activity.

Challenges are common in any disaster. Natural disasters arising from the external environment are intrinsically challenging to manage and respond to (Giannakis & Papadopoulos, 2016; Oliveira et al., 2019) since some disasters are challenging to predict - as in the case of the COVID-19 pandemic, an unprecedented event. We identified some challenges raised by Civil Defenses while responding to the COVID-19 pandemic:

(i) Need to adapt models for receiving supplies, as well as adapting spaces per new safety, social distancing, and hygiene protocols;

(ii) Establishment of restrictive protective measures to ensure that the Civil Defense team was not affected by the disease;

(iii) Lack of knowledge and information about the new pandemic, as it is a unique, unprecedented disaster;

(iv) Lack of protocols to guide first actions;

(v) Difficulty in identifying partners to make donations and volunteers to help in supporting the most vulnerable population;

(vi) Staff work restrictions due to social distancing and lockdowns;

(vii) Lack of financial resources for logistics and assistance in general;

(viii) Difficulty in understanding Civil Defense as a system and not as an operational body.

As challenges, lessons learned are also frequent in every disaster. We highlight the need for more protocols to guide the first actions. Indeed, all the respondents affirmed that Civil Defenses were unprepared to face such a catastrophic disease. We also identified the lessons learned from Civil Defense' perspectives during the pandemic.

(i) Structure prior identification of measures and partners that can help meet critical demands, ensuring support to the population;

(ii) Develop disaster preparedness actions and protocols for epidemics and pandemics;

(iii) Act in an integrated way, joining forces with institutions and private entities;

(iv) Greater and better articulation between entities (articulate more than execute);

(v) Facilitate the synergistic action of government agencies;

(vi) Create specific protocols to better respond to this type of disaster.

Although many measures taken by Civil Defenses during the response to COVID-19 have had an operational nature, all the respondents recognize Civil Defenses as a coordinating and articulating actor in emergency relief activities, including in disasters such as epidemics and pandemics. Facing such a multifaceted pandemic, disaster governance should consider several institutions' joint and coordinated action. According to the respondents, Civil Defense should be considered the system responsible for coordinating actions and articulating initiatives related to the phases of preparation and response. Effective coordination must be executed between and among independent areas to produce a coherent and integrated effort. Disaster risk management depends on coordination mechanisms between sectors and relevant stakeholders at all levels. It requires the full involvement of all State institutions of an executive and legislative nature at the national and local levels (Federal Emergency Management Agency, 2019). According to the interviewees, Civil Defenses coordinate with public and private sectors, pursuing mutual reach, partnership, and complementarity between functions. In this sense, respondents raised the following activities related to coordination:

(i) Provide direction and coordination among regional Civil Defense Emergency Management teams;

(ii) Coordinate the distribution of humanitarian donations from diverse organizations;

(iii) Coordinate essential services to support the national response;

(iv) Contribute to the planning process coordination, including the development of the National Action Plan;

(v) Coordinate recruitment and selection of volunteers and welfare issues such as the provision of accommodation;

(vi) Carrying out coordination between health institutions, government, and private sector.

Coordinate preparing documents for acquiring adequate disaster preparedness and response resources and procedures for managing funds. During the COVID-19 response, the role of coordination between Civil Defense and other entities became evident. Some Civil Defenses in Brazil have established formally coordinated commissions for emergency crisis response, which included relevant national-level authorities from different sectors and other relevant stakeholders, in line with existing emergency preparedness plans. Also, along with militaries, the Civil Defense worked to coordinate the establishment of logistical bases for the requested supplies and the distribution of these items.

4.2. Key areas of action and responsibility

We identified the four key areas presented here and addressed them in disaster preparedness and response from the relevant literature. In this way, it was possible to categorize the related contents into four key areas: (i) awareness and training; (ii) surveillance; (iii) information and communication; (iv) logistics and supplies.

This subsection evaluates the responsibility of Civil Defenses in the mentioned key areas of action. As previously detailed, each area comprises a range of activities. The goal is to understand if Civil Defenses should take responsibility for the action ('yes' or 'no') and the type of responsibility ('in charge' or 'supportive' – which means that Civil Defense will only support another organization, such as the Ministry of Health, Education, Communication, Social Development, among others). It is essential to highlight that 50% (in the number of responses) was our limit to establish whether Civil Defense should assume responsibility for this activity and what type of responsibility it should assume. In this sense, for example, if 50% or more of respondents recognize such activity within the scope of Civil Defense, it can be concluded that it is part of the Civil Defense's role. To determine 50%, we conducted a brainstorming among the authors of the paper, and we also validated it with the interviewees. It is also important to highlight that all interviewees hold a high degree of commitment, experience, and maturity in developing Civil Defense activities.

4.2.1. Awareness and training

Activities related to awareness and training were considered in the scope of Civil Defenses. Civil Defense supports institutions such as the Ministry of Health, Education, and Communication. A specific action for which Civil Defense can be held responsible is volunteering. Most Civil Defenses have a website for registering volunteers to get involved in activities that help to reduce the damage to people affected by disasters of any nature. Table 1 describes all the awareness and training-related activities, the role of Civil Defense, and the type of responsibility.

Table 1. Role and responsibility type of Civil Defense in awareness and training activities.

AWARENESS & TRAINING	ROLE OF CIVIL DEFENSE?		TYPE OF RESPONSIBILITY	
	YES	NO	IN CHARGE	SUPPORTIVE
Raising awareness of the disease and its symptoms	✔			✔
Raising awareness about preventive measures	✔			✔
Raising awareness of measures to be taken in case of disease infection	✔			✔
Conducting mass awareness campaigns about the epidemic/pandemic	✔			✔
Volunteering	✔		✔	✔
Training the community (general population, other institutions) to respond to the outbreak, epidemics, and pandemics	✔			✔
Training the community (general population, other institutions) on hygiene practices and preventive measures to combat the diseases	✔			✔

4.2.2. Surveillance

Surveillance prepares the community for an early response to potential epidemics/pandemics. As mentioned, health departments usually take control and responsibility for infectious diseases. As shown in Table 2, Civil Defenses can assume responsibility for activities such as 'registering and maintaining reliable information about the health needs of infected people' and 'developing a system/apps enabling the disease monitoring, and the most affected municipalities in the State', being in this case, only a support system for other institutions, especially the Ministry of Health.

Table 2. Role and responsibility type of Civil Defense in surveillance activities.

SURVEILLANCE	ROLE OF CIVIL DEFENSE?		TYPE OF RESPONSIBILITY	
	YES	NO	IN CHARGE	SUPPORTIVE
Registering and maintaining reliable information about the health needs of infected people	✓			✓
Developing an Early Warning System for Epidemics (Epidemiological Surveillance)		✓		
Developing a monitoring system to follow up on the number of cases, deaths, and recovery of the epidemic/pandemic		✓		
Developing a system/apps enabling disease monitoring, and the most affected municipalities in the State	✓			✓

4.2.3. Information and communication

Regarding information and communication, all interviewees considered these activities as the scope of Civil Defenses. Civil Defense is a supportive system in all the activities for institutions such as the Ministry of Health, Communication, and Education. In the case of infectious diseases, critical information that should be shared with the population includes:

- Disease statistics (total infected, deaths, and recovered);
- Restrictive measures (social distancing, lockdown policies);
- Preventive measures (use of personal protective equipment, hygiene, and health procedures);
- Rapid testing sites;
- Vaccination (target population, vaccination centers).

Table 3 describes all the information and communication-related activities, the role of Civil Defense, and the type of responsibility.

Table 3. Role and responsibility type of Civil Defense in information and communication activities.

INFORMATION & COMMUNICATION	ROLE OF CIVIL DEFENSE?		TYPE OF RESPONSIBILITY	
	YES	NO	IN CHARGE	SUPPORTIVE
Installing information systems that allow the dissemination of information to communities in real-time	✓			✓
Gathering reliable media channels to disseminate accurate information	✓			✓
Gathering lists of emails and contacts that can be used to disseminate information quickly	✓			✓
Developing specific documents for communication - for different audiences - to communicate relevant and correct information before, during, and after the epidemic/pandemic.	✓			✓

4.2.4. Logistics and supplies

Activities related to logistics and supplies were highly considered within the scope of Civil Defenses, which is, in this case, the system in charge of most activities. Logistics is a vital part of the successful response, which have the role of providing the resources required by response personnel and the affected population, in good condition, at the right time, to the right place, and in the right quantities. Civil Defenses are responsible for most activities in this area, even in disasters such as epidemics and pandemics. Table 4 describes the logistics and supplies-related activities, the role of Civil Defense, and the type of responsibility.

Table 4. Role and responsibility type of Civil Defense in logistics and supplies activities.

LOGISTICS & SUPPLIES	ROLE OF CIVIL DEFENSE?		TYPE OF RESPONSIBILITY	
	YES	NO	IN CHARGE	SUPPORTIVE
Providing a functioning supply chain in support of essential services and critical national supplies during the epidemic/pandemic	✓			✓
Requesting authorized resources and facilities to meet response actions	✓			✓
Identifying the need for humanitarian supplies and purchasing them	✓		✓	
Receiving, storing, and managing stocks of donations and supply purchases	✓		✓	
Conducting and coordinating the screening of supply kits, equipment, and materials	✓		✓	
Carrying out the distribution of supply donations (water, food, personal protective and hygiene equipment such as masks, alcohol gel, and medicines)	✓		✓	
Providing appropriate systems and warehouses for logistic activities, and administrative support for the logistical network	✓		✓	
Providing transport, accommodation, and food for response personnel (including volunteers)	✓			✓
Providing safe place/shelters for those affected by the epidemic/pandemic	✓		✓	
Maintaining visibility and management of critical equipment and supplies in case of epidemics/pandemics	✓			✓
Developing inventory maintenance policies for supply items to prevent and respond to the disease	✓			✓

5. Conclusion

The COVID-19 pandemic has tested the responsiveness of disaster relief organizations. This paper presents the key actions, challenges, and lessons learned from 12 Civil Defenses during the COVID-19 response in 2020. Furthermore, from the relevant literature, we raise four key action areas and understand the role of Civil Defense in each area. For this purpose, we developed a questionnaire that guided our interviews with the Civil Defenses in Brazil.

The designation of responsibilities for each entity is based on the scale of the disaster. According to the size of the event, the interaction and coordination of the response with other entities may be necessary. Disaster management in Brazil suggests a staggered mobilization of different stakeholders according to the disaster evolution. The respondents emphasized the importance of Civil Defense as a coordinator of any disaster, including biological threats.

Following the literature, this work shows that Civil Defense can play a more significant role in developing strategies to deal with COVID-19; that is, Civil Defenses have the competence to deal with biological disasters

in their scope of responsibility. The active participation of Civil Defense in the management of the pandemic is essential because no contingency plan guarantees human security for the whole community, stating that the Emergency Plans support such perception. The COVID-19 crisis has shown several disruptive events of different natures, which have intensified risks and social disbelief. The interaction between Health and Civil Defense was mostly in operational logistics in the three government domains. During the response, most of the actions the Civil Defenses took were related to logistics, such as storage, transportation, and distribution of required supplies.

Consequently, the respondents pointed out Civil Defenses as responsible for logistic-related activities. Civil Defenses carried out several supply operation mobilizations to fight Brazil's pandemic, emphasizing its role in such activities. The transfer of money and notification of emergency of states affected by COVID-19 were also conducted by Civil Defenses.

Although Civil Defense is not considered the principal actor responsible for responding to a pandemic disaster, it can participate in several activities, whether in awareness and training, surveillance, information and communication, and logistics and supplies. The discussion we bring in this paper about the role of Civil Defense can help build guidelines toward developing a preparedness and response protocol to deal with health threats. Since infectious diseases are increasing, preparedness and response protocols can improve the beneficiary experience in these events.

This research also presents some limitations. To determine whether Civil Defense should assume responsibility for each activity and what type of responsibility, we assume most people's answer (50%). Despite the respondents' high level of experience, we understand this as a limitation of our analyses, which may not reflect the opinion of all respondents, but it reflects the majority. In this sense, for example, if 50% or more of respondents recognize such activity within the scope of Civil Defense, it can be concluded that this activity is part of the Civil Defense's role.

We interviewed 12 of the 26 Civil Defenses. The sample can be considered good but insufficient to raise more confirmatory conclusions about the results. As Brazil is a heterogeneous country, and each state has differences in culture, socioeconomic and environmental conditions, future studies can extend this work to the remaining states of the country, assessing the role and activities of these Civil Defenses in the Covid-19 response. From this work, future studies also can elaborate drafts of protocols to be evaluated in practice by the Civil Defenses. Also, this study can be extended to other Civil Defenses worldwide, contributing to scale-up readiness for the following infectious disease that can threaten the world again.

6. Preparedness and Response Protocol's online access

To access the Preparedness and Response Protocol, see the Banco Mundial (2021) material.

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References

Alexander, D. (2003). Towards the development of standards in emergency management training and education. *Disaster Prevention and Management*, *12*(2), 113-123. http://dx.doi.org/10.1108/09653560310474223.

Aliyu, A. (2015). Management of disasters and complex emergencies in Africa: the challenges and constraints. *Annals of African Medicine*, *14*(3), 123-131. http://dx.doi.org/10.4103/1596-3519.149894. PMid:26021392.

Allain-Dupré, D., Chatry, I., Michalun, V., & Moisio, A. (2020). *The territorial impact of COVID-19: managing the crisis across levels of government*. Paris: Organisation for Economic Co-operation and Development.

Altay, N., & Green III, W. G. (2006). OR/MS research in disaster operations management. *European Journal of Operational Research*, *175*(1), 475-493. http://dx.doi.org/10.1016/j.ejor.2005.05.016.

Attaran, M. (2020). 3D printing role in filling the crit-ical gap in the medical supply chain during COVID-19 pandemic. *American Journal of Industrial and Business Management*, *10*(5), 988-1001. http://dx.doi.org/10.4236/ajibm.2020.105066.

Banco Mundial. (2021). *Protocolo de Preparação e Resposta para surtos, epidemias e pandemias*. Retrieved in 2023, May 10, from https://shre.ink/PPRDefesaCivil.

Brito Junior, I., Cunha, M. H. C., Tozi, L. A., Franzese, L. A., Frazão, M. L. S., & Bressane, A. (2021). Managing funerary systems in the pandemic: lessons learned and an application of a scenario simulation in São Paulo City, Brazil. *Journal of Humanitarian Logistics and Supply Chain Management*, *11*(3), 481-492. http://dx.doi.org/10.1108/JHLSCM-09-2020-0078.

Chamola, V., Hassija, V., Gupta, V., & Guizani, M. (2020). A comprehensive review of the COVID-19 pandemic and the role of IoT, drones, AI, blockchain, and 5G in managing its impact. *IEEE Access: Practical Innovations, Open Solutions*, *8*, 90225-90265. http://dx.doi.org/10.1109/ACCESS.2020.2992341.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management*, *15*(2), 1-14. http://dx.doi.org/10.1108/09574090410700275.

Cunha, L. R. A., Antunes, B. B., Rodrigues, V. P., Ceryno, P. S., & Leiras, A. (2022). Measuring the impact of donations at the Bottom of the Pyramid (BoP) amid the COVID-19 pandemic. *Annals of Operations Research*. In press. http://dx.doi.org/10.1007/s10479-021-04378-5.

Dubey, R., & Gunasekaran, A. (2016). The sustainable humanitarian supply chain design: agility, adaptability and alignment. *International Journal of Logistics Research and Applications*, *19*(1), 62-82. http://dx.doi.org/10.1080/13675567.2015.1015511.

Etinay, N., Egbu, C., & Murray, V. (2018). Building urban resilience for disaster risk management and disaster risk reduction. *Procedia Engineering*, *212*, 575-582. http://dx.doi.org/10.1016/j.proeng.2018.01.074.

Federal Emergency Management Agency. (2019). *National response framework* (4th ed.). Washington, DC: U.S. Department of Homeland Security/Federal Emergency Response Agency.

Fontainha, T. C., Leiras, A., Bandeira, R. A. M., & Scavarda, L. F. (2017). Public-private-people relationship stakeholder model for disaster and humanitarian operations. *International Journal of Disaster Risk Reduction*, *22*, 371-386. http://dx.doi.org/10.1016/j.ijdrr.2017.02.004.

Giannakis, M., & Papadopoulos, T. (2016). Supply chain sustainability: a risk management approach. *International Journal of Production Economics*, *171*, 455-470. http://dx.doi.org/10.1016/j.ijpe.2015.06.032.

Gonzalez-Feliu, J., Chong, M., Vargas-Florez, J., Brito Junior, I., Osorio-Ramirez, C., Piatyszek, E., & Altamirano, R. Q. (2020). The maturity of humanitarian logistics against recurrent crises. *Social Sciences*, *9*(6), 90. http://dx.doi.org/10.3390/socsci9060090.

Guyana. Department of Public Information. (2020). *UNHCR pre-manufactured housing units to boost COVID-19 quarantine and isolation capacity across the administrative regions in full operations*. Retrieved in 2011, December 1, from https://dpi.gov.gy/unhcr-pre-manufactured-housing-units-to-boost-covid-19-quarantine-and-isolation-capacity-across-the-administrative-regions-in-full-operations/

Holguín-Veras, J., Jaller, M., Van Wassenhove, L. N., Pérez, N., & Wachtendorf, T. (2012). On the unique features of post-disaster humanitarian logistics. *Journal of Operations Management*, *30*(7-8), 494-506. http://dx.doi.org/10.1016/j.jom.2012.08.003.

Instituto Brasileiro de Geografia e Estatística – IBGE. (2010). *Censo 2010: Estimativas da população.* Rio de Janeiro: IBGE. Retrieved in 2011, December 1, from https://www.ibge.gov.br/estatisticas/sociais/populacao/9103-estimativas-de-populacao.html

Jahre, M., & Jahre, M. (2019). Logistics preparedness and response: a case of strategic change. In S. Villa, G. Urrea, J. A. Castañeda & E. R. Larsen (Eds.), *Decision-making in humanitarian operations: strategy, behavior and dynamics* (pp. 3-29). Cham: Palgrave Macmillan. http://dx.doi.org/10.1007/978-3-319-91509-8_1.

Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L., & Daszak, P. (2008). Global trends in emerging infectious diseases. *Nature*, *451*(7181), 990-993. http://dx.doi.org/10.1038/nature06536. PMid:18288193.

Kovács, G., & Sigala, I. F. (2021). Lessons learned from humanitarian logistics to manage supply chain disruptions. *The Journal of Supply Chain Management*, *57*(1), 41-49. http://dx.doi.org/10.1111/jscm.12253.

Lamenza, A. A. D. S., Fontainha, T. C., & Leiras, A. (2019). Purchasing strategies for relief items in humanitarian operations. *Journal of Humanitarian Logistics and Supply Chain Management*, *9*(2), 151-171. http://dx.doi.org/10.1108/JHLSCM-09-2018-0060.

Last, J. M. (1989). *Diccionario de epidemiología*. Barcelona: Salvat.

Leiras, A., Brito Junior, I., Peres, E. Q., Bertazzo, T. R., & Yoshizaki, H. T. Y. (2014). Literature review of humanitarian logistics research: trends and challenges. *Journal of Humanitarian Logistics and Supply Chain Management*, *4*(1), 95-130. http://dx.doi.org/10.1108/JHLSCM-04-2012-0008.

Lima, Y. O. R., & Costa, E. A. (2015). Regulamento sanitário internacional: emergências em saúde pública, medidas restritivas de liberdade e liberdades individuais. *Vigilância Sanitária em Debate: Sociedade, Ciência & Tecnologia*, *3*(1), 10-18.

Llanes, I. R., Oliveira, F. N., & Leiras, A. (2019). Análise das operações humanitárias durante a resposta à epidemia de ebola na África. In Associação Brasileira de Engenharia de Produção (Org.), *XXXIX Encontro Nacional de Engenharia de Produção* (pp. 1-13). Rio de Janeiro, Brazil: Associação Brasileira de Engenharia de Produção. http://dx.doi.org/10.14488/ENEGEP2019_TN_STO_291_1647_38374.

Marbouh, D., Abbasi, T., Maasmi, F., Omar, I. A., Debe, M. S., Salah, K., Jayaraman, R., & Ellahham, S. (2020). Blockchain for COVID-19:Review, opportunities and a trusted tracking sys-tem. *Arabian Journal for Science and Engineering*, *45*(12), 9895-9911. http://dx.doi.org/10.1007/s13369-020-04950-4. PMid:33072472.

Morens, D. M., Folkers, G. K., & Fauci, A. S. (2009). What is a pandemic? *The Journal of Infectious Diseases*, *200*(7), 1018-1021. http://dx.doi.org/10.1086/644537. PMid:19712039.

Oliveira, F. N., Leiras, A., & Ceryno, P. (2019). Environmental risk management in supply chains: a taxonomy, a framework and future research avenues. *Journal of Cleaner Production*, *232*, 1257-1271. http://dx.doi.org/10.1016/j.jclepro.2019.06.032.

Pascapurnama, D. N., Murakami, A., Chagan-Yasutan, H., Hattori, T., Sasaki, H., & Egawa, S. (2018). Integrated health education in disaster risk reduction: lesson learned from disease outbreak following natural disasters in Indonesia. *International Journal of Disaster Risk Reduction*, *29*, 94-102. http://dx.doi.org/10.1016/j.ijdrr.2017.07.013.

Peng, C., Yuan, M., Gu, C., Peng, Z., & Ming, T. (2017). A review of the theory and practice of regional resilience. *Sustainable Cities and Society*, *29*, 86-96. http://dx.doi.org/10.1016/j.scs.2016.12.003.

Peter, L. L., Schroeder, L., Oliveira, F. N. D., & Leiras, A. (2023). Logistics of Covid-19 vaccines: main challenges in theory and practice. *Production*, *33*, e20220036. http://dx.doi.org/10.1590/0103-6513.20220036.

Resende, H. F. P., Cardoso, P. A., Fontainha, T. C., & Leiras, A. (2022). Maturity model for evaluating disaster and humanitarian operations. *International Journal of Productivity and Performance Management*. In press. http://dx.doi.org/10.1108/IJPPM-03-2021-0149.

Rodrigues, K. F., Carpes, M. M., & Raffagnato, C. G. (2020). Disaster preparedness and response in Brazil in the face of the COVID-19 pandemic. *Revista de Administração Pública*, *54*(4), 614-634. http://dx.doi.org/10.1590/0034-761220200291x.

Saunes, I. S., Vrangbæk, K., Byrkjeflot, H., Jervelund, S. S., Birk, H. O., Tynkkynen, L. K., Keskimäki, I., Sigurgeirsdóttir, S., Janlöv, N., Ramsberg, J., Hernández-Quevedo, C., Merkur, S., Sagan, A., & Karanikolos, M. (2022). Nordic responses to Covid-19: governance and policy measures in the early phases of the pandemic. *Health Policy*, *126*(5), 418-426. http://dx.doi.org/10.1016/j.healthpol.2021.08.011. PMid:34629202.

Singh, S., Kumar, R., Panchal, R., & Tiwari, M. K. (2021). Impact of COVID-19 on logistics systems and disruptions in food supply chain. *International Journal of Production Research*, *59*(7), 1993-2008. http://dx.doi.org/10.1080/00207543.2020.1792000.

Southall, H. G., DeYoung, S. E., & Harris, C. A. (2017). Lack of cultural competency in international aid responses: the Ebola outbreak in Liberia. *Frontiers in Public Health*, *5*, 5. http://dx.doi.org/10.3389/fpubh.2017.00005. PMid:28197401.

Tarin, D. (2020). O desastre provocado pela COVID-19: a crise na gestão pública e o papel da Defesa Civil na prevenção e resposta. In N. Valencio & C. M. Oliveira (Eds.), *COVID-19: crises entremeadas no contexto de pandemia (antecedentes, cenários e recomendações)* (pp. 57-71). São Carlos: UFSCar/CPOI.

Taupiac, C. (2001). Humanitarian and development procurement: a vast and growing market. *International Trade Forum*, *4*, 7-10.

Thomé, A. M. T., Scavarda, L. F., & Scavarda, A. J. (2016). Conducting systematic literature review in operations management. *Production Planning and Control*, *27*(5), 408-420. http://dx.doi.org/10.1080/09537287.2015.1129464.

Tierney, K. (2012). Disaster governance: social, political, and economic dimensions. *Annual Review of Environment and Resources*, *37*(1), 341-363. http://dx.doi.org/10.1146/annurev-environ-020911-095618.

UN Environment Programme – UNEP. International Livestock Research Institute. (2020). *Preventing the next pandemic: zoonotic diseases and how to break the chain of transmission*. Nairobi: United Nations Environment Programme/International Livestock Research Institute.

United Nations International Children's Emergency Fund – UNICEF. (2021). *COVID-19 response: mobilizing supply operations to fight the pandemic*. New York: UNICEF. Retrieved in 2021, September 2, from <https://www.unicef.org/supply/stories/covid-19-response-mobilizing-supply-operations-fight-pandemic

Van Wassenhove, L. N. (2006). Humanitarian aid logistics: supply chain management in high gear. *The Journal of the Operational Research Society*, *57*(5), 475-489. http://dx.doi.org/10.1057/palgrave.jors.2602125.

Wisner, B., Adams, J., & Adams, J. (2002). *Environmental health in emergencies and disasters: a practical guide*. Geneva: World Health Organization.

World Economic Forum. (2021). *The global risks report* (15th ed). Cologny: World Economic Forum.

World Health Organization. (2006). *Working together for health: the World Health Report 2006*. Geneva: World Health Organization.

World Health Organization. (2020a). *Zoonoses*. Geneva: World Health Organization.

World Health Organization. (2020b). *A world in disorder: Global Preparedness Monitoring Board annual report 2020*. Geneva: World Health Organization.

Yin, R. K. (2018). *Case study research and applications: design and methods*. Thousand Oaks: Sage Publications.

Zhang, H., & Shaw, R. (2020). Identifying research trends and gaps in the context of COVID-19. *International Journal of Environmental Research and Public Health*, *17*(10), 3370. http://dx.doi.org/10.3390/ijerph17103370. PMid:32408679.