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The war of Brazilian Firefighters in the Fight Against Covid-19

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Case study

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Abstract

Introduction

The years 2020 and 2021 were marked by the pandemic of SARS-CoV-2, a virus that infected 167 million more people, causing about 3.4 million deaths worldwide. And, because of this, the main global health agencies (WHO, governments, emergency services, hospitals and other health professionals), sought means of protection for workers on the front line to combat the pandemic. The Fire Brigades of Brazil, had the need to adopt new protocols of actions, which would mitigate the progress of the disease, justifying the importance of curbing the effects of the pandemic in their corporations and other victims of COVID-19.

Case description

The objective of this work is to propose the systematization of control and combating future pandemics, seeking to contribute with a model of assistance protocol that adapts to the needs of health institutions. The study is a literature review and is based on data collected through a questionnaire applied to the Brazilian Fire Departments in the 26 states and the Federal District.

Discussion and evaluation

With the mapping of the actions carried out, it was possible to identify which actions were implemented, which involve the creation and development of new service protocols such as the use of specific PPE, care with the disposal of contaminated materials and behavioral changes, avoiding contamination. Within the mapping carried out in the corporations, it is possible to obtain relevant data in the fight against the coronavirus, such as (use of new PPE, exclusive vehicles, testing of personnel, infected firefighters, number of deaths, stress, change in work routines).

Conclusions

With the coronavirus pandemic, the Fire Brigade promoted an alignment between needs and decision making, through internal protocols of related actions, which were essential in the search to mitigate the impacts caused by the pandemic. Such actions serve as a model to be used in other work environments.

Highlights

- The work of professionals facing the pandemic
- Difficulties, strategies and actions that Brazil has implemented in facing Covid-19;
- Actions of the group of Brazilian Firefighters;
- Changes in work routines to avoid contagion by Covid-19;
- Strategic alignment, prevention, and protection of the work team;

1. Introduction

The outbreak of the new SARS-CoV-2 virus was documented in December 2019 by the Chinese government. Its origin and, subsequently, epicenter were located in the city of Wuhan, Hubei province, China [1-3]. Li [3] state that the first cases of people infected by Covid-19 were workers and customers of a seafood market in Wuhan, which handled live animals (approximately 55% of the 47 cases reported until January 1st, 2020). The local outbreak spread rapidly throughout China and later globally, and was officially categorized as a pandemic on March 11th, 2020 [4].

In Brazil, the first SARS-CoV-2 case was confirmed on February 26th, 2020, in São Paulo – SP [5]. However, even before, the Brazilian government already prepared to face the pandemic, declaring the human infection by the coronavirus as a national public health emergency, according to the ordinance no. 188 of February 2nd, 2020 [6]. Thus, via the Center of Operations in Public Health Emergencies (COE-nCoV), the government coordinated actions and authorized several entities, including the Brazilian Fire Departments, to start the activities of planning, organization, coordination, and measures of control to be employed during the outbreak of the disease.

Brazil has been facing an increasing death toll caused by SARS-CoV-2, and the situation has been gradually worsening in several Brazilian states. The most worrying aspect is the doubling of the mortality rate, which is estimated from 5 to 7 days, as shown in the study conducted by the Imperial College London 2020. The study analyzed the active transmission rate of Covid-19 in 48 countries and found that Brazil presents a high transmission rate (R_0 of 2.81). Large capital cities, such as São Paulo, Rio de Janeiro, Recife and Fortaleza, have been the main focuses of spread for Covid-19. Moreover, there are concerns and signs that the virus is spreading throughout all the cities in the country that do not present an adequate health structure, public or private, to face the disease [7].

It is relevant to mention that Brazil has a particular challenge in comparison with other countries in its territorial extension, as well as its climate diversity. The country has continental dimensions, being almost as large as Oceania and slightly smaller than Europe. Another factor to be considered is social inequality; numerous people live in residential clusters, known as *favelas*, that lack the minimal adequate infrastructure of sewers and water supply to conduct proper sanitation. Social distancing is much more difficult in those situations as well, considering the proximity of the houses. Moreover, Brazil has a large indigenous population that is currently highly threatened by the Covid-19 outbreak. Another factor is cultural, seeing that uninformed people struggle to comprehend the impact of the disease and do not follow the necessary sanitary measures. An additional aggravating factor is the enormous number of informal jobs.

In order to face the disease in this Brazilian scenario, several governmental actions have been taken, both in research, from basic science to epidemiology, and in the fast production of personal protective equipment, ventilators and test kits, as well as solid actions coordinated by the Fire Departments located in several Brazilian states and cities. It is an essential function of Public Health in any country to act

towards minimizing the impacts of the Covid-19 pandemic through measures geared towards the population, which include the firefighters' activities. However, both labor activities and work conditions are noticeably potential sources of exposure to the virus [3]. The security is important in all environments, whether it is the community, companies or educational environments [8]. Thus, it is necessary to create prevention strategies for those who are required to keep working in essential activities and in the stages of work flexibility in order to protect them [9]. In this context, it is extremely relevant to comprehend how work activities and conditions may contribute to the spread, especially to establish and adopt strategies that minimize the risks of contagion.

This paper conducted a systematic literature review through a bibliographic search about the theme and its foremost authors. Its purpose is to present the main strategies to face Covid-19 adopted by the State Fire Departments in Brazil seeking to mitigate the impacts caused by the pandemic, following the World Health Organization's guidelines. Several essential factors were assessed, including the use of proper PPE, the psychological impact, the decontamination techniques employed, the caution in the disposal of infected materials, the development of care protocols, and other elements of individual and collective control.

This work is organized into five chapters. The first introduces the subject and contextualizes the study. Chapter 2 contains the literature review encompassing aspects of the SARS-CoV-2 global pandemic. Chapter 3 presents the methodology, describing the steps followed to achieve the paper's objectives. The fourth chapter characterizes the environment of data collection for the development of the study and the results found, as well as the challenges identified throughout the project. Chapter 5 presents the conclusion of this work and the sixth and final chapter contains considerations and recommendations.

2. Literature Review

2.1 Systematic bibliometric review about Covid-19

This section conducted a systematic bibliometric review that, after data mining, presented a total of 19 papers. They provided relevant data for this study, contributing to the work's evolution. Thus, under the lens of actions taken to face the pandemic in several countries, the papers were mapped and presented in Table 1, describing the relation and the work of emergency teams, Fire Departments, researchers, and data management technologies in the context of the Covid-19 pandemic.

Table 1 displays the main works developed. They encompass, in addition to the relevance of the themes, a timeline that goes from 2004 to 2020, according to their bibliometrics. They will be more clearly assessed in Chart 1, further below.

Table 1 – Portfolio of papers related to the area

Title	Year	Number of citations	Impact Factor	InOrdinatio
Part 12: Education, implementation, and teams: 2010 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations [10]	2010	165	4.572	165.005
Electronic Personal Protective Equipment: A Strategy to Protect Emergency Department Providers in the Age of COVID-19 [11]	2020	8	4.292	108.004
Focus on Mental Health During the Coronavirus (COVID-19) Pandemic: Applying Learnings from the Past Outbreaks [12]	2020	7	0	107.000
Mitigating the Psychological Impact of COVID-19 on Healthcare Workers: A Digital Learning Package [13]	2020	1	2.468	101.002
Startups in times of crisis – A rapid response to the COVID-19 pandemic [14]	2020	1	1.322	101.001
Protecting the Prehospital Professional First Aid Teams from Airborne Viral Particles in the Case of Out-of-Hospital Pediatric Cardiac Arrest during the COVID-19 Pandemic [15]	2020	0	1.010	100.001
Teaching at the paramedics school of the City of Munich during the COVID-19 pandemic [16]	2020	0	0.532	100.001
Covid-19, Mental Health and Psychological First Aid [17]	2020	0	0.285	100.000
Business Intelligence applied to Emergency Medical Services in the Lombardy region during SARS-CoV-2 epidemic [18]	2020	0	0.219	100.000
Moral Injury in Times of COVID-19 [19]	2020	0	0	100.000
“Firefighters do not stay at home”: Results of group discussions about presenteeism of firefighters with acute respiratory infections [„Die Feuerwehr muss immer kommen “: Ergebnisse aus Gruppendiskussionen über Präsentismus bei akuter Atemwegserkrankung unter Beschäftigten der Feuerwehr] [20]	2018	0	0.200	80.000
Prehospital care training in a rapidly developing economy: a multi-institutional study [21]	2016	9	1.872	69.002
Applying the lessons of SARS to Pandemic influenza: An evidence-based approach to mitigating the stress experienced by healthcare workers [22]	2008	48	1.248	28.001

Title	Year	Number of citations	Impact Factor	InOrdinatio
Anthrax letters: Personal exposure, building contamination, and effectiveness of immediate mitigation measures [23]	2010	20	1.338	20.001
Pandemic influenza and excess intensive-care workload [24]	2008	20	7.185	0.007
SARS: Coping with the impact at a community hospital	2005	24	2.376	-25.998
Loss of paramedic availability in an urban emergency medical services system during a severe acute respiratory syndrome outbreak [25]	2004	23	2.963	-36.997
Emergency medical services utilization during an outbreak of severe acute respiratory syndrome (SARS) and the incidence of SARS-associated coronavirus infection among emergency medical technicians [26]	2004	18	2.963	-41.997
Innovation and challenges in funding rapid research responses to emerging infectious diseases: Lessons learned from the outbreak of severe acute respiratory syndrome [27]	2004	4	1.373	-55.999

Source: the authors (2021)

Considering the low number of works about the theme, the first analysis observed the year of publication of the papers in the portfolio, shown in Figure 1.

Figure 1 shows the number of works published from 2004 to 2020. The analysis illustrates the importance of studies approaching the proposed theme. The next analysis observed the authors in the portfolio employing the software VOSviewer to ascertain the density of authors and their publications, as shown in Figure 2.

The data generated by the software VOSviewer shows that the portfolio is composed of 108 authors, and Figure 2 identifies Huei-Ming Ma, M. as the foremost author, having published two papers in the final portfolio, both as a coauthor. The other authors appear with only one paper, with 19 main authors and the remaining names as coauthors.

The next goal was to identify the central keywords in the portfolio of papers, employing the keyword network function of the software VOSviewer, as shown in Figure 3.

Figure 3, containing the data generated by VOSviewer, shows that the central keywords mentioned in the portfolio are “Humans” and “Human”, occurring in ten and seven papers (53% and 37%), respectively. The following most frequent keywords are “Epidemic”, “Emergency Medical Services” and “Severe Acute Respiratory Syndrome”, each present in five papers. The term “First Aid” is also present among the main

keywords, occurring in three papers of the portfolio. The analysis of the main keywords illustrates that the portfolio of scientific papers is aligned with the theme of this work, which aims to map and explore first-aid actions taken by Fire Departments to face Covid-19. The next step was to analyze the foremost terms mentioned in the papers' body texts, differing from the last analysis, which only addressed the keyword field. With that purpose, the word cloud function of the software Nvivo 12 was employed, as shown in Figure 4.

Figure 4 shows that the main words mentioned in the papers are related to health and the outbreak, such as "Covid", "SARS", "health", "cardiac", "resuscitation", "care", "hospital", "medical support", and "emergency". Similarly, to the analysis presented in Figure 2, the focus of the papers lies on human health related to pandemics and epidemics, as in the case of Covid-19.

The list of the main works about the SARS-CoV-2 and the global pandemic identified by the literature review is displayed in Chart 1, which presents the contents of the works and their contributions to this study. They complement their relevance through actions related to the theme in several countries, especially those that have suffered greater social impacts.

Chart 1 – Qualitative analysis of the portfolio of papers

Papers related to SARS-CoV-2 and Fire Departments	General aspects	Author, year	Relevance and contributions
Part 12: Education, implementation, and teams: 2010 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations	Extended view on the care of patients undergoing cardiorespiratory arrest, stressing the necessary cautions for the prehospital care team to mitigate the possibility of contamination.	[10]	It highlights the risks of contamination faced by first responders during procedures of cardiopulmonary resuscitation. It reinforces the need for constant training and the correct use of PPE provided to the workers. It emphasizes the caution with airborne particles emitted by patients in cases of orotracheal intubation.
Electronic Personal Protective Equipment: A Strategy to Protect Emergency Department Providers in the Age of COVID-19	Description of the need for intensive protection measures geared towards the emergency care teams (doctors, firefighters, nurses, etc.) involved in attending to possible Covid-19 victims, avoiding contagion and the spread of the virus among these workers and the population.	[11]	It develops technological tools and IoT devices to aid healthcare teams in facing the SARS-CoV-2 pandemic. It assesses digital triage tools of suspected cases (physical barriers), through telehealth, electronic PPE, isolation protectors, among others.
Focus on Mental Health During the Coronavirus (COVID-19) Pandemic: Applying Learnings from the Past Outbreaks.	Psychosomatic assessments amid the SARS-CoV-2 pandemic. The relation between the disease, symptoms and aggravations due to the social isolation of people infected and the quarantine period, involving healthcare workers, patients, and society.	[12]	It describes the relationship between clinical and neuropsychiatric signs in infected people during the period of total social isolation and quarantine following the WHO. It explores the feelings caused in individuals, such as boredom, anger, loneliness, depression, anxiety, panic, among others, entailing diverse reactions in the mental health of these patients.
Mitigating the Psychological Impact of COVID-19 on Healthcare Workers: A Digital Learning Package.	Psychological impacts on the frontline workers facing Covid-19. Strategies of self-care that promote health related to sleep, eating, mental hygiene, feelings, healthy behaviors, among others.	[13]	It promotes, through digital IoT tools of stress management, mechanisms that support the healthcare workers directly facing coronavirus, including personal actions that stimulate physio-psycho-social welfare.
Startups in times of crisis – A rapid response to the COVID-19 pandemic	Effects of the pandemic on the commercial relationships of companies and startups, due to lockdowns, social isolation, and the threats	[14]	It reports the impacts of Covid-19 on the global economy, entailing companies closing, lay-offs, and other effects. It suggests re-adaptations to businesspeople, such as technological innovation,

	of extension and bankruptcy. The importance of a new entrepreneurial view in business, through attitudes and decision-making, to survive in the market.		changes in concepts and behavior, entrepreneurial strategies and decision-making, new ways to serve the public.
Protecting the Prehospital Professional First Aid Teams from Airborne Viral Particles in the Case of Out-of-Hospital Pediatric Cardiac Arrest during the COVID-19 Pandemic.	The prehospital care of children who are suspected Covid-19 cases. Conducted by the French Fire Department, concerning the cautions and new protocols of the disease.	[15]	It stresses the importance of the correct use of PPE for the response teams, reinforcing the caution with children due to their frailty, especially in cardiorespiratory arrest cases that require orotracheal intubation, so as to avoid major injuries for the children and possible contamination of the emergency teams.
Teaching at the paramedic's school of the City of Munich during the COVID-19 pandemic	Effects of the pandemic on teaching, pointing to difficulties in continuing the classes of the instruction course of paramedic firefighters, due to the interruption of activities following WHO's recommendations of social isolation and distancing. Therefore, the instructors were required to adapt, developing virtual classrooms and facilitating the access for the students.	[16]	It points to strategies developed by the teaching team during the Covid-19 pandemic and social isolation, favoring the teachers and students of the paramedic instruction course of Germany's Fire Department. The strategies include the development of virtual classrooms that promote proper training even in lockdown. They required considerable effort and numerous work hours of dedication and adaptation from the entire technical teaching staff, demanding much more effort than the in-person activities.
Covid-19, Mental Health and Psychological First Aid.	It links the coronavirus pandemic to a list of factors that may aggravate the immunological effects in infected patients. Individuals with mental disorders associated with psychosomatic disorders have higher chances of presenting more severe cases of SARS-CoV-2 viral infection.	[17]	It describes the extreme importance of professional treatment and therapy for psychiatric patients (due to their higher immunological frailty), even during mandatory quarantine and social isolation caused by Covid-19. The recommendation also applies to healthcare professionals and the general population, due to the threat of psychosocial effects caused by the disease.
Business Intelligence applied to Emergency Medical Services in the Lombardy region during SARS-CoV-2 epidemic.	After the detection of the first Covid-19 case in Italy, the city of Lombardia decided, jointly with the Secretary of Health and Emergency Medical Service (ARES), to employ	[18]	It promotes data gathering through a digital tool linked to the IoT known as Business Intelligence (BI). It aims to capture relevant data as soon as a call arrives at the Fire Department, such as the number of calls received, triage, classification, and

	a technological tool able to measure relevant data to aid the State and towns in relocating patients according to their susceptibility degree, minimizing costs, optimizing time, and protecting lives.		directing patients to hospitals and clinics. It identifies clusters and epidemic patterns of SARS-CoV-2 infection through the data crossing conducted by the tool, directing the priority cases with more agility.
Moral Injury in Times of COVID-19	Application and practice of psychological care by the specialized team (psychologists and therapists) to healthcare workers in the frontlines against the coronavirus. It seeks to mitigate the impacts caused by moral and psychological factors, from the families of patients to the entire emergency team if necessary.	[19]	It stresses the importance of the availability of multi-functional teams of emergency care in psychological health. They offer aid to family members of patients in grave conditions for several reasons (like the lack of ICU vacancies, delays in transportation, among others), and to the healthcare team (doctors, firefighters, nurses and other professionals directly involved) that feel exposed and psychologically vulnerable during their work. It addresses moments in which professional ethics are put to the test due to real physical conditions concerning beds in hospitals, age of the patients, biotypes, and clinical conditions; aspects of choice between life and death.
“Firefighters do not stay at home”: Results of group discussions about presenteeism of firefighters with acute respiratory infections [„Die Feuerwehr muss immer kommen “: Ergebnisse aus Gruppendiskussionen über Präsentismus bei akuter Atemwegserkrankung unter Beschäftigten der Feuerwehr	Respiratory diseases are the main factor of absence from work in Germany. The training and use of PPE by workers exposed to pathogenic substances are fundamental to promote health. The German Fire Department has been promoting preventive actions seeking to be better equipped due to possible pulmonary diseases caused by fighting large fires, contact with chemicals, and viral diseases.	[20]	It presents the efforts of the German Fire Department to protect its staff through the proper use of PPE and training. Moreover, developing investigation methods that identify possible respiratory diseases among the personnel. Small safety actions were promoted, such as materials related to the main diseases, the incentive to communicate superior officers in case of trouble breathing, severe colds, or possible respiratory complications after attending to patients, in addition to encouraging them to seek medical assistance immediately in case of malaise.
Prehospital care training in a rapidly developing economy: a multi-institutional study.	Concerned with prehospital care training and education for laypeople, it seeks to offer the initial knowledge on first aid to enable citizens to act properly and safely in the case of an accident,	[21]	It seeks to promote the teaching and training on first aid and use of PPE to the lay public, through medical professionals specialized in accidents and trauma on roads. The instruction course addresses a wide public, from younger to older, professionals or not, involving

	providing the victim with the initial care until the arrival of the medical service team.		students, taxi drivers, ambulance drivers, among others who potentially use roads daily. The training demonstrates the main actions to be taken in case of an incident.
Applying the lessons of SARS to Pandemic influenza: An evidence-based approach to mitigating the stress experienced by healthcare workers	Relationship between professional stress facing the pandemic and the search for mental health during difficult times, through the assessment of stress levels and the first psychological assistance. After the influenza outbreak, a behavior change was adopted, like prevention tips against the flu.	[22]	It aims to develop and stimulate organizational culture through processes of incentive to resilience, seeking to promote organizational health through training and psychological advising, improving the health indices among the collaborators.
Anthrax letters: Personal exposure, building contamination, and effectiveness of immediate mitigation measures	First study on Anthrax (bacillus anthracis) contamination in government offices in the USA, sent as letters containing dry spores that act as airborne particles infecting government agents (2001).	[23]	It stimulates mitigation actions developed by government leadership through protocols, seeking to avoid the contamination and spread of the disease. It reinforces the proper use of PPE, handling methods, exchange of contaminated PPE, among others.
Pandemic influenza and excess intensive-care workload.	It highlights that the best way to maintain proper and accurate assistance during a pandemic is through maximum protection, providing PPE, training and guidelines on preventive actions against contamination to firefighters, doctors, nurses, police officers, and other workers in the frontlines.	[24]	It seeks to promote more caution among the teams exposed to treating the disease in ICUs, avoiding their contamination and consequent absence from work, in addition to the pain, grief, and further contamination of their families. The period of internment of the infected patients is prolonged depending on the severity of their case, increasing the chances of contagion.
SARS: Coping with the impact at a community hospital	The caution of the Canadian healthcare workforce in areas with a higher number of cases, in hospitals that are reference in the treatment, and other professionals involved, increasing the levels of epidemiological monitoring to minimize the rate of infection.	[28]	It encourages the teams responding to SARS to get regularly tested for Covid-19, mitigating the stress and the fear of contagion from infected professionals who might be asymptomatic, avoiding the transmission in the workplace and the consequent spread through their residences.
Loss of paramedic availability in an urban emergency	Reports of contamination of healthcare professionals by the	[25]	It reinforces the need for healthcare professionals to wear PPE in the care of every Covid-19 case. It

medical services system during a severe acute respiratory syndrome outbreak	viruses SARS-1 and SARS-2 in Canada. They required isolation and quarantine of numerous infected workers due to the lack of awareness concerning the use of PPE by the healthcare system managers.		presents the main cautions, the correct disposal, and especially the proper exchange after each occurrence, avoiding cross-transmission and personal contamination among the workers.
Emergency medical services utilization during an outbreak of severe acute respiratory syndrome (SARS) and the incidence of SARS-associated coronavirus infection among emergency medical technicians	Assessment of the healthcare teams contaminated by SARS in Taipei, Thailand (CHECAR PAÍS, POSSIVELMENTE TAIWAN). It reports the first cases of contagion by the virus and the need for training the medical teams facing the disease directly. It seeks strategic planning that safeguards the teams, providing the proper PPE and regular tests for the disease.	[26]	It advocates the need for protocols of care to SARS victims involving healthcare professionals so as to facilitate the work and optimize resources and time. Strategic actions include positioning ambulances, different teams for the care of suspected cases, infected patients, and interned individuals.
Innovation and challenges in funding rapid research responses to emerging infectious diseases: Lessons learned from the outbreak of severe acute respiratory syndrome	Efforts conducted by Canadian health organizations during the spread of SARS-1. Incentives to the planning of informative actions, updated and effective, regarding the handling, transportation, reception, and internment of patients.	[27]	It conducts the first research on SARS seeking to highlight mechanisms of control and protection. Moreover, it aims to raise awareness among professionals about aspects of prevention and protection against the virus.

Source: the authors (2021)

Chart 1 was elaborated through bibliographic assessments, searches and data mining, application of the methodological instrument, and thorough reading of the papers aiming to identify real contributions. The 19 papers of the portfolio were subdivided into themes as follows.

Nine papers approach the need for extra caution for the teams of healthcare professionals who are exposed in the actions facing the pandemic [28]; the use of proper PPE, the lack thereof, and safety mechanisms. Actions like the measures that should be taken by first responders in the care of adult [10] or children [15] victims of cardiorespiratory arrest, as well as by those who work in ICUs [24]. Furthermore, safety actions established through protocols [26], related materials and training [27], organized by department commanders [20], and concerning procedures and protocols designed [23] for the correct disposal of equipment after contact with infected victims [25].

Four papers are directed towards psychological aspects developed by the healthcare professionals, infected patients, and their families involved in fighting SARS-CoV-2. They address the relation between the spread of the virus throughout the world and the consequent feelings of doubt, fear, and stress caused by the impacts of the pandemic globally. In addition to those feelings, the social isolation from friends and families [12] also caused numerous people to present psychological disorders [22]. For professionals who already had psychological support in therapy [17], it is crucial to seek support from multi-functional healthcare teams [19].

The next four papers identified are directed towards the development of new technologies and tools, such as the Internet of Things, to aid health management by enabling workers to measure their stress levels through applications [13], which detect acute cases of the disorder through self-assessment. Other examples include the creation of vestibules and totems of triage by the Fire Department [18] and of self-care [11], as well as telehealth, which allows people to conduct initial assessments remotely under the clinical guidance of healthcare teams. Besides the physical and emotional conditions, the financial aspects are also observed [14] in firms closing and all of the economic chaos caused by the pandemic, demanding re-adaptations and strategies from the leading startups of today.

Finally, concerning education and professional qualification, two papers highlight the need, even amid the difficulties of social distancing, for continuing the activities through virtual meetings and individual training rooms, even opening space for the general public [21] by offering basic instructions to train them if the need arises.

The leading journals identified by the search were Resuscitation, Journal of the American Medical Informatics Association (JAMIA), International Journal of Environmental Research and Public Health, Journal of Business Venturing Insights, Prehospital and Disaster Medicine, Notfall & Rettungsmedizin, Irish Journal of Psychological Medicine, Acta Bio-medica: Atenei Parmensis, Journal of health service psychology, Zentralblatt für Arbeitsmedizin Arbeitsschutz und Ergonomie, Journal of Surgical Research, Canadian Journal of Public Health, Journal of Occupational and Environmental Hygiene (3), Academic Emergency Medicine (3), and Safety Science (3).

2.2 The current scenario of the global pandemic

The impact caused by SARS-CoV-2 has brought, throughout the globe, a moment of alertness, precaution and review of concepts regarding healthcare systems. The first reports on pandemics that affected the population are dated from 1918 to 2020 in Europe, Germany, the USA and other countries, with the “Spanish Flu” [29] caused by the H1N1 Influenza virus, which killed nearly 100 million people. In 2009, the “Swine Flu”, caused by the H1N1 Influenza C virus, killed over 575 thousand people.

In Asia, the first suspected cases of SARS associated with the coronavirus were reported in February 2003, in Taipei, Thailand, as defined by the WHO [26]. In December 2019, pneumonia cases of unknown etiology were detected in the city of Wuhan, Hubei province, in China [26]. The virus is named Severe

Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), causing the Coronavirus Disease 2019 (Covid-19) that caused the global pandemic declared on March 11th 2020.

Seeking to restrain the spread of the virus, the WHO declared the SARS-CoV-2 epidemic outbreak and promptly started several restriction measures, such as social isolation, sanitary barriers limiting mobility (roads, airports, urban transport), sanitation measures, closure of schools, universities, commercial and leisure centers, among others. Starting with Wuhan and other regions initially affected and extending those measures throughout the world, decreeing the need for a lockdown of the entire population [30].

The virus quickly spread; seeing that its lethality was still unknown, tourists coming from China took it to numerous countries around the world [18]. European countries, the United States, and Brazil stand out in the number of infection cases. Promptly, the services of urgency and emergency were put into action (AREU – Azienda Regionale Emergenza Urgenza), organizing into epidemic clusters of combat to the pandemic in Europe. In the USA, the Center for Disease Control and Prevention (CDC) initiated preventive measures and actions to mitigate the impacts in the country, reinforcing the distribution of PPE units and starting lockdowns [11].

The concern with the increasing number of cases was taken seriously by Asian governments. The Center for Disease Control in Thailand encouraged the social isolation of the population and conducted antibody tests for SARS-CoV. The first cases of infection detected were among teams of firefighters, nurses, and doctors [26]. During this period, medical and emergency services were quickly organized to create treatment structures for ambulances, paramedics, hospitals, and other professionals. Those actions focused on the protection of patients, the community, and especially the teams working in healthcare. Thus, it is crucial that efforts and measures are adopted to face the quickly-spreading pandemic [22].

International health organizations instituted healthcare protocols and each country designated its prevention measures. It is worth highlighting the importance of training, guiding, and equipping healthcare professionals so that they do not become victims or potential vectors of the virus [4]. For the general population, the WHO recommends social distancing, wearing masks, and washing hands with water and soap or hand sanitizer [31].

Besides every precaution measure recommended to the population, one of the most relevant aspects at the moment is the caution and protection of healthcare teams, especially those who act in the front lines against Covid-19. Firefighters, first responders, doctors, nurses, and technicians carry out first aid and often encounter patients in severe stages of the disease, with trouble breathing or even in cardiorespiratory arrest, which require procedures that involve airborne particles emitted by the patients, increasing chances of contagion. For that reason, those workers need to wear the appropriate PPE and be trained to take the necessary precautions with their lives and their families [10].

The concern with the healthcare teams is not limited to their physical welfare or their contamination with the virus. Special care is required with psychosomatic diseases that have, for several reasons, increased

the number of leaves of absence and internment rates among healthcare professionals. Factors include depression, panic disorder, eating and sleeping disorders, among others, which lower immunity and increase chances of contagion. The concern of those workers is related to the excessive labor, higher risks, transmission of the disease to colleagues and especially their families. Many are isolated from their family lives to lower the chances of bringing the disease into their homes, increasing the chance of falling ill [12].

[13] stresses that the global pandemic has overburdened healthcare systems in unprecedented fashion. This situation is reflected in every country, but especially in their healthcare teams actively facing it. In the United Kingdom, researchers from the National Institute for Health Research (NIHR) observed the high levels of stress in the healthcare teams tackling the coronavirus, causing numerous absences, ailments, and deaths. Seeking to mitigate those impacts, they developed, through the Internet of Things, digital tools that measure the stress levels of these professionals, facilitating quick responses by experts to the physio-psychological complaints expressed by workers to avoid more severe grievances.

Another strong aspect, due to the nature of the pandemic, concerns the four actors (Government, University, Companies, and Community), which are engaged in different actions to diminish the impacts on the population. The Government acts through the public and private organizations responsible for healthcare, the University through research, mass production of equipment and elements necessary for facing the pandemic, and strategies to promote public tranquility, the Companies through the production of goods and services also directed at the pandemic, boosting the global economy and providing jobs and care [14], and the Community through the organization of volunteer actions like production of PPE, collecting food for people in need, among several others.

3. Methodology

To conduct this research, an in-depth search was carried out on four databases: Science Direct, Scopus, Web of Science, and Publimed. The search identified papers that presented the terms “Covid-19” (and its variants “SARS-CoV-2” and “coronavirus”), “First Aid”, “Fire Department”, “fire brigade”, “voluntary action”, and “Pandemic” in their abstracts, titles, and keywords, without time restrictions so as to obtain an all-encompassing set of results. The protocol proposed by Pagani et al. (2015; 2017) was employed. The search on the five databases returned 46 documents, which are tracked below in Table 2.

Table 2 – Final search on the databases

Keyword combinations		Databases				
		Science Direct	**Scopus**	**Web of Science**	**PubMed**	**Scielo**
		Search settings				
		Type of document: Papers and Reviews				
		Search the fields: Title-Abstract-Keywords				
1	(“COVID-19” OR "SARS-CoV-2" OR "coronavirus") AND “First Aid”	3	5	1	8	0
2	(“COVID-19” OR "SARS-CoV-2" OR "coronavirus") AND (“Fire department*” OR "fire brigade*")	0	7	0	2	0
3	("COVID-19" OR "coronavirus" OR "SARS-CoV-2") AND "voluntary action*"	0	0	0	0	0
4	“Severe Acute Respiratory Syndrome” AND “First Aid”	0	6	0	1	0
5	“Severe Acute Respiratory Syndrome” AND (“Fire Department*” OR "fire brigade*")	0	0	0	0	0
6	“Pandemic” AND (“Fire department*” OR "fire brigade*")	1	4	3	5	0
Total per database		4	22	4	16	0
TOTAL		**46**				

Source: the authors (2021)

The resulting papers were then analyzed according to Equation 1 from the Methodi Ordinatio, considering their Impact Factor (IF), Publication Year and Number of Citations.

$$InOrdinatio = (IF/1000) + \propto [10 - (ResearchYear - PublishYear)] + (Ci) \quad (1)$$

The application of Equation 1 ordered the papers in the final portfolio by their scientific relevance. After the systematic analysis, the portfolio was analyzed employing the software applications Vosviewer and Nvivo. Thus, the results presented in this paper concerning the fight against Covid-19 were obtained through a detailed bibliographic review about the theme and, especially, the decision-making at uncertain moments of the actions developed and adopted by the State Fire Departments in Brazil. Based on the results found, a list of sustainable actions was elaborated encompassing all of the initiatives adopted by the State Fire Departments in Brazil investigated.

Thus, aiming to comprehend the routine of Brazilian firefighters in the fight against Covid-19, a questionnaire was elaborated as a research tool, containing 34 questions that were employed as

indicators of the actions conducted by the brigades, as follows:

- Number of workers by brigade per state.
- Changes in the PPE of first responders acting in the prehospital care of Covid-19 victims (coverall, apron, N95 mask, others?);
- Was there a shortage of PPE available in the market for acquisition and prompt delivery (was there scarcity or shortage?);
- Did the brigade conduct training (instructions) on the use of PPE specific for the care of coronavirus victims?
- What kind of instructions were provided?
- What PPE specific for facing Covid-19 is available in your state?
- What PPE specific for facing Covid-19 is not yet available?
- What decontamination products were made available for the brigade's vehicles and quarters?
- Were there vehicles assigned specifically to SARS-CoV-2 cases?
- Were protocols and guidelines developed and presented to the staff for the prevention against the virus in the brigade quarters and at home (internal communications, videos, among others?)
- Was the Standard Operating Procedure (SOP) adopted in the care of suspected/confirmed Covid-19 victims?
- Was the SOP adopted for the decontamination of first responders and ambulances that act in prehospital care after attending to suspected/confirmed Covid-19 victims?
- Were internal control mechanisms adopted to gather information concerning firefighters affected by the pandemic? What kind of control?
- Does your brigade have a contingency plan for maintaining operational services during the pandemic in the case of casualties among the personnel?
- Were internal control mechanisms adopted to gather information concerning firefighters affected by the pandemic? What kind of control?
- Did your brigade adopt any other procedures, such as protocols, app development, among others, that were not included in the previous questions?
- What is the number of victims (suspected or confirmed) attended to since the beginning of the pandemic?
- How many suspected/confirmed Covid-19 victims have been attended to or transported in Fire Department ambulances in your state?
- How many firefighters have been infected during the care of suspected/confirmed Covid-19 patients?
- Does the brigade provide psychological assessments to the firefighters directly involved in fighting the pandemic? Have workers been removed due to stress, depression, or panic disorder?
- How many firefighters are contaminated or in observation? How many have recovered or died from Covid-19?

This questionnaire was sent to the 26 Brazilian States and the Federal District, seat of the Federal Government. All of the States studied provided responses. The analysis of the responses revealed the actions taken to mitigate the impacts caused by the pandemic, according to WHO recommendations. Several essential factors were assessed, including the proper use of PPE, the psychological impact, the decontamination techniques employed, the caution with the disposal of infected materials, the development of care protocols, and other elements of individual and collective control. After analyzing the results, a generic management model employed by the brigades was structured, seeking to clearly explain how the actions are planned. The Plan-Do-Check-Act (PDCA) cycle was employed for that purpose.

3.1. Ethics

This study was analyzed by the Committee of Ethics in Research of the Federal University of Technology, Paraná – Brazil and received the authorization to be conducted in June 2020, under the no. CAAE 32427420.8.0000.5547, in accordance with the Declaration of Helsinki.

It is worth highlighting that the bibliographic review conducted in this research did not find similar works. Therefore, this work presents a relevant academic and social contribution, paving the way for future studies due to the originality of the findings presented regarding the main strategies adopted by Brazilian Fire Departments against the spread and contagion by SARS-CoV-2 in their staffs, prioritizing lives and the safety in the services provided.

4. Case Description

4.1 Scenarios and actions taken to face Covid-19 in Brazil

In Brazil, as previously described, the first case of SARS-CoV-2 infection was confirmed on February 26th, 2020. The male patient, age 61 and resident of São Paulo, had traveled to Italy. After this confirmation, Brazil's Ministry of Health, jointly with state and municipal health secretaries of São Paulo, started to investigate the case and search for possible contacts with the patient during the flight, in his residence, and at the hospital. According to the Ministry of Health, on the day when the first case was confirmed, 59 cases had been tested and discarded and 20 patients were under investigation, over seven Brazilian states (Paraíba, Pernambuco, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo, and Santa Catarina).

With the knowledge of the actions taken in other countries, the Ministry of Health, jointly with state and municipal authorities, implemented measures of social isolation in order to contain the spread of the pandemic. Several states suspended classes in public and private institutions, prohibited activities that involved crowds, closed commercial centers like malls, and conducted awareness campaigns about the risks and measures against the disease. These actions generated fear among the population, which reacted by stockpiling food and cleaning products, causing a shortage of products like hand sanitizer and

surgical face masks, for instance. The shortage of essential products, especially for the teams in the front lines against the pandemic, created concerns regarding the protection of the workers' health and safety.

Given that the exposure to Covid-19 represents an imminent hazard to the health of workers and other people at workplaces, companies around the world implemented new measures to avoid negative impacts on the workers' health and safety, meeting the specific standards and regulations of each country. Moreover, each country established measures to better inform the population, as recommended by the WHO. Brazil instituted, in 1990, the Organic Law of Health – Law no. 8.080/90, which regulates the conditions of promotion, protection, and recovery of health, as well as the organization and functioning of the corresponding services [32]. This document stresses that health is a fundamental human right, being the responsibility of the State to provide the conditions indispensable to its full realization (2nd article, caput). It also states that the duty of the State "does not remove that of the people, families, companies, and society" (2nd paragraph).

The Technical Note no. 01/2020 [33] highlights the action of the Labor Public Ministry facing the decree of Public Health Emergency of International Importance for the new coronavirus (Covid-19). The note provides recommendations to the state and municipal sanitation authorities regarding the adoption and compliance with measures to protect the worker's health and safety, especially healthcare workers involved in the transportation, support, and assistance to potential infection cases. It emphasizes the availability and proper use of personal protective equipment (PPE) and collective protective equipment (CPE) indicated by local, national, and international health authorities according to the most up-to-date guidelines, regardless of possible changes in labor organization that may become necessary, in accordance with the Technical Note no. 04/2020.

Although they are not under these laws, the firefighters belonging to the Brazilian Fire Department are state public employees, as well as state military personnel serving the Fire Department, which is an auxiliary and reserve institution of the Brazilian Army (Federal Constitution of 1988, art. 144) [34]. Each brigade is autonomous and has its own legislation. The surveys conducted revealed that 95% of the respondents have adapted their operational routines to provide better safety and occupational health conditions to the firefighters attending to suspected/confirmed Covid-19 victims. The results show that, even though they are not under the national health system or the Ministry of Health, the Brazilian Fire Departments have adopted safety measures for their workers following the guidelines from the World Health Organization and the Ministry of Health.

In this context, facing those demands, the groups of Brazilian Military Fire Departments started to adopt measures to prevent the contamination of their staffs in and out of the work environment. These measures included simple guidelines, such as properly washing hands with water and soap, and complex measures, such as decontaminating an ambulance after the care of an infected victim. The measures were not limited to the work environment, seeing that the military firefighter may get infected during work and become a vector for the disease.

4.2 Legal attributions of the Fire Department in Brazil

According to Article 144 of the Federal Constitution of 1988 [32], the execution of civil defense activities is a responsibility of the military Fire Departments, in addition to the other attributions defined by law. Civil defense activities are a “set of actions of prevention, aid, assistance, and recovery aiming to avoid disasters and minimize their impacts on the population, reestablishing social normalcy”. Aid actions include “actions of immediate response to disasters seeking to help the population affected, including search and rescue, first aid, prehospital care, and urgent medical and surgical care” (Brasil, 2010). These professionals answer to the State Governors, each with their legislation.

An analysis of the state laws reveals that they all directly or indirectly mention terms related to actions of search and rescue, firefighting, public help, prevention actions, and civil defense. They also mention the responsibility of public order, which represents a set of actions formed by the concepts of public safety, public tranquility, public salubrity, and respect of people’s dignity [35]. Thus, the services provided by the Brazilian Fire Departments are linked to public tranquility, one of the pillars of the concept of public order presented by the Federal Constitution, which demonstrates the importance of maintaining the services provided by those institutions.

Under the constitutional lens of keeping public tranquility, the Fire Departments had the forethought to elaborate contingency plans, considering the possibility of casualties among their personnel, which could be infected by the virus. However, the casualties could not affect the services provided to maintain public order and continue to assist the population. Thus, seeking to avoid the collapse of the system of trauma care and public services of search and rescue, the Fire Departments of each state adopted measures to avoid crowds [36]. The measures include changes in the administrative office hours, adoption of a home office system for the possible activities, maintenance of personnel on regular vacations, canceling training sessions, prohibition of office staff meals in brigade quarters, canceling the daily break to hoist the national flag, among others.

In general, office services, such as the service of fire prevention, had their demands reduced due to social isolation. Therefore, firefighters of the sector had their work hours reduced or worked from home. The return of activities in the prevention sector occurred gradually, starting with scheduled appointments.

5. Discussions And Evaluation

The research conducted in this work searched for information in the systematic literature review and in the data collected through the application of the questionnaires to all brigades, resulting in the discovery of aspects and needs linked to the coronavirus pandemic in Brazil. It was possible to observe how the Brazilian Fire Departments organized their work through crisis management in the fight against Covid-19, and what were their main needs facing the increasing number of people infected and attended to in the country.

The research process revealed several cases of managing the fight against Covid-19 by Brazilian Fire Departments, over 26 States and the Federal District. Several aspects stand out in the results – the actions are isolated and punctual, and most of them refer to situations in which the organization has already implemented them and they are working. They facilitate the training of personnel, the assignment of responsibilities in the Covid-19 combat program, and the monitoring and control of the indicators of pandemic management.

Fire Departments across the country, which have the constitutional attributions of public help (prehospital care) and civil defense (actions to face public calamities), have adapted their operational and administrative routines, their personal protective equipment, and their action protocols to face the demands created by the pandemic effectively. These procedures were adapted especially because firefighters are exposed to contact with possible victims of the disease. Thus, protocols of care, decontamination, disposal of infected materials, and safety were established, prioritizing the health of the workers and their families.

Each country developed procedures according to its reality of healthcare demands and the number of victims infected, hospitalized, and dead, organizing the entire healthcare system based on the WHO guidelines about the lethality of the virus, the methods of contamination, and the required adaptations, protections, and changes. It was not different in Brazil. The first cases of the disease entailed a prompt repositioning of the healthcare systems. Brazil, due to its continental dimensions, presented different realities in each region, reflecting on the actions developed by the Fire Departments of these locations. Given the demands in each state, the local Fire Department realigned its personnel, equipment, vehicles and other aspects, as illustrated by Figure 7.

The relevant data presented by this work were found through the application of a questionnaire containing 34 questions that measured several aspects linked to the activities of Brazilian Fire Departments. It also revealed the main actions developed through the new protocols for the care of SARS-CoV-2 victims. After receiving the responses from the Fire Department of each State, the data obtained were measured and presented in Figure 7. The actions taken to mitigate the impacts by each brigade, in terms of general cautions and procedures of physio-psycho-social nature, sought to protect and safeguard lives consciously, responsibly, safely, and sustainably. The items listed below are related to the information presented in Figure 7 and summarize the main results found by the questionnaires responded by the Fire Departments.

1. Through all of the States interviewed, 100% of Brazilian Fire Departments declared to have adapted PPE specifically to attend to Covid-19 victims, according to their needs (lack of providers for prompt delivery, shortages in the market, increasing demand for assistance, among others) due to the fast evolution of the pandemic, as well as the need for other protective equipment like coveralls, face shields, aprons, and PFF2/N95 masks for collective and individual safety.

2. Approximately 22% of the States informed that they assigned ambulances exclusively for coronavirus victims. A substantial factor for that to occur is that these States feature more inhabitants, higher per

capita income, and more professional firefighters. The sum of those factors affords more refined strategic planning. Moreover, this action considerably decreases the chances of contaminating a victim transported in the same vehicle for non-Covid related reasons, like a trauma-related injury.

3. 55% of the States tested firefighters who presented symptoms for Covid-19, whereas 45% tested the entire staff for the disease.

4. 64% of the brigades interviewed reported deaths of firefighters infected by SARS-CoV-2. These data represent an alarming factor, as they show that despite all of the protocols, guidelines, and cautions before providing care, the staff can still be infected. It reinforces, even more, the need to monitor these workers in all aspects, providing safe, healthy, and stress-free environments (physio-psycho-social aspects). It is worth highlighting that, even though the military firefighters are acting in environments with a higher probability of infection, it is not possible to confirm that the contamination occurred at the workplace, seeing that they are susceptible to the infection in other environments of their social life.

5. 78% of the States have recorded infections among firefighters, which occurs due to all circumstances related to the global pandemic, such as the lack of rapid tests for the population, the delays in deliveries of PPE caused by shortages in the market, and the improper use by the population, entailing a shortage of equipment for healthcare workers that exposes them to the risks even more.

6. Regarding stress-related problems observed since the beginning of the pandemic, 43.8% of the brigades reported cases of firefighters that presented symptoms, requiring treatment or absences from work.

7. 96% of the respondents affirmed that they received instructions for their day-to-day, both in their work and social routines, to mitigate contamination risks and avoid becoming transmission vectors of the virus. Approximately 74% received written guidelines (informative documents), 48% received verbal instructions, and 63% were trained via orientation videos, developed to meet the demand for information on how to avoid the contamination and spread of the virus.

8. Approximately 44% of the Fire Departments interviewed adopted remote work via home office for their staff, respecting individual aspects of their personnel, encompassing people in risk groups, pregnant women, and people with chronic diseases. The measure is especially effective to avoid contact between a large number of workers in the workplace, which is restricted to the exact number of firefighters required to meet the daily demands.

9. New Standard Operating Procedures (SOP) were developed and adopted due to the need for adaptations and preventive technical norms created by the Covid-19 pandemic. 56% of the respondents declared to have developed specific protocols seeking to mitigate the impacts caused by the pandemic.

10. The questionnaire revealed that 56% of the respondents suffered from the lack of PPE due to shortages of the product in the market. Among the shortages most encountered were PFF2/N95 masks, in 41% of the States, followed by biological protection coveralls, in 26%, and disposable surgical masks,

in 7%. Among the equipment that was not available to military firefighters, the PFF2/N95 respirator (mask) stands out. It is an affordable and accessible piece of equipment that was acquired indiscriminately by people not belonging to the healthcare field at the start of the pandemic. Initially, the lack of knowledge on SARS-CoV-2 globally entailed an exacerbated and unnecessary search for PPE by the general population, which in turn caused a rampant increase in demand. As a consequence, a shortage of work equipment was observed for healthcare professionals involved in emergency, prehospital, and intrahospital care, as reported by Tedros A. Ghebrevesus, director of the World Health Organization [37].

11. The first coronavirus cases in Brazil were reported in March 2020. The pandemic took on unprecedented proportions, reaching 1,800,827 infection cases, 1,078,763 recovered patients, and 70,938 deaths on July 11th, 2020. With these numbers, the country ranks as the second most affected country by the pandemic.

The 27 Fire Departments investigated employ approximately 68,986 professionals across 5,570 Brazilian cities. Numerous mitigating actions were implemented to minimize the impacts of the pandemic on these workers. The most common were adaptations in personal protective equipment for firefighters who act in prehospital care, an action taken by 100% of the Fire Departments. This illustrates that, even though they do not belong to the national system of public health but rather to public security and civil defense secretaries, the Fire Departments adopted this measure of crucial importance to mitigate the risks of spreading the virus, seeing that the firefighters act in direct contact with suspected/confirmed Covid-19 victims.

Measures to avoid contamination in the brigade quarters, in the residences of firefighters, and especially attending to suspected/confirmed Covid-19 victims were essential to protect the internal public. They were fundamental to preserve tranquility and safety for the firefighters during work and to maintain public order through the actions performed by these brigades.

Safety measures were implemented individually by each State, according to their particularities and individual characteristics. These actions are listed in the next topics. Moreover, further guidelines were given to the civil public to avoid contamination, through orientations to maintain social isolation via vehicles with speakers, educational videos directed at the civil public, the development of protocols to disinfect bus terminals, a telehealth platform jointly with healthcare professionals, a Covid-19 helpline, attending to the population via drive-through, and mass testing of possible infected patients. Some States provided musical presentations from the Fire Department band, playing Brazilian popular music on 30-meter tall mechanical platforms with the purpose of bringing entertainment to the public in social isolation.

Therefore, numerous measures and efforts by the brigades throughout Brazil were implemented to safeguard lives, mitigate the impacts of the virus spreading through the population, and protect the workers directly facing SARS-CoV-2. It is certain that, all over the world, actions were taken by the health

organizations responsible for the welfare of the population, albeit late in some cases. In Brazil, the measures were quickly put into practice seeking to minimize the spread of the disease. Nevertheless, the country is now the epicenter of the pandemic.

5.1 Mitigating measures and strategies in Brazil

In Brazil, Fire Departments are state institutions, and each one developed its planning individually. Nevertheless, the structures of the management systems may be similar. As an example, the management structure in Paraná State is presented below.

The management system described above presents the following actions:

- STRATEGIC LEVEL – the creation of the Covid-19 Technical Chamber (TC), under the direct command of Paraná's Fire Department commander, to conduct the ACTION PLANNING. The technical chamber developed protocols and defined the actions to be performed in the state through the publication of the NI 005 by the command of the Fire Department of the Military Police of Paraná State.
- TACTICAL LEVEL – based on the actions defined by the Covid-19 TC via the NI 005, the operational unit commanders, supported by the logistical sector of the Fire Department general command, acted to enable the execution of the planned actions, through the acquisition of PPE, training, adaptations in the facilities, among others.
- OPERATIONAL LEVEL – the Sub-units and Fire Stations under the operational units perform the actions described by the NI 005 and report the improvements and adaptations to the Covid-19 TC in order to perfect the actions and continually enhance the procedures.

The proposed model for mitigating actions in the State Fire Departments in Brazil was based on the good practices found. It was structured and conceptualized through a questionnaire and the Plan-Do-Check-Act Cycle. The PDCA cycle was employed to execute this management model so as to comprehend and clarify the actions performed. The actions employed in the PDCA may be put into practice in every stage of planning – strategic, tactical, and operational.

- **PLAN:** In Brazil, the SARS-CoV-2 pandemic has brought a progressive and alarming increase in the number of people infected. The situation required the elaboration of effective strategies directed at firefighters and other healthcare teams involved in facing the disease (the use of specific PPE, protocols of care and decontamination, guidelines to mitigate the spread of the virus, changes in the administrative and operational routine of the Fire Department, among others).
- **DO:** To present a real reflex of the Brazilian situation, this research sought, through the collection of data from every state, to point to the real demands, such as the number of infected and professionals required to meet the demand, and the amount of PPE and vehicles available. Protocols of care, training, and safety (individual and collective) were developed, in addition to the implementation of technological strategies for triage and monitoring.

- **CHECK:** The analysis of the States and cities revealed the real needs encountered by the healthcare services (shortage of professionals, PPE, ICU beds, among others). The daily data presented by the WHO demonstrating the advance of the pandemic entailed a response from the Ministry of Health, which adopted protection measures directed at the most affected States.
- **ACT:** Brazil currently ranks second in the number of cases worldwide. It is worth highlighting that the country lacks Disaster Management strategies, such as investments in public health and expanding healthcare staff, pandemic-related strategies like training, new technologies, standardization of protocols throughout the country, among others. These actions aim to minimize the impacts like the ones caused by SARS-CoV-2: thousands of infected requiring assistances, prolonged internment in ICUs, infected firefighters and other healthcare professionals, psychological disorders, and numerous deaths. It is also worth pointing out that several other aspects may be listed by future studies.

The strategies indicated in the PDCA cycle demonstrate that the Crisis Management adopted by the Brazilian Fire Departments in the pandemic is to be regarded as crucial and determinant for the welfare of the population. Moreover, it can serve as an example for other countries, with the possibility of adaptation to other realities. It also must be constantly improved, seeing that it may serve as a model to be adopted to address other aspects of disaster management, such as adverse climate events.

Crisis management seeks to rapidly establish mechanisms of direct protection for the brigade with special attention to the staff attending to Covid-19 victims, creating epidemiological barriers against the virus through the new protocols elaborated, specific PPE, training and orientations, vehicles assigned specifically to these cases, information on the correct handling and disposal of infected materials, sanitation, and safety. Thereby, the Brazilian Fire Departments created physical and digital tools, developed with the support of the four actors – the Government (firefighters), the University (research and development), the Industry (manufacturing PPE and donations), and the Community (NGOs, associations, and other interested parties via the donation of PPE, among others) – as well as other technical and human resources required for the effective fight against the pandemic.

The Brazilian Fire Departments are institutions committed to the protection of life, always seeking to provide social welfare and maintain public tranquility. They have demonstrated a highly-conscious posture of managing the fight against Covid-19, creating committees constituted by representatives from the entire community to manage the local risks. Their purpose was to identify the regional pandemic-related problems clearly so as to establish a plan of continuous improvement towards mitigating or eliminating those problems. These committees, following the individual norms of each brigade, were crucial tools to assist the general command in the decision-making, management, control, prevention, preparation, and effective response actions and measures aiming to reestablish the normal routine of activities performed by the brigades when the pandemic numbers decrease.

5.2 Actions adopted to mitigate and prevent contamination by Covid-19

5.2.1 Actions directed at firefighters

According to [30], risk mitigation is an interdisciplinary process of decision-making based on the assessment of risk and exposure. The concept directly involves the analysis of political, socioeconomic, and epidemiological data, but especially data related to healthcare and work safety to adopt regulatory actions and select appropriate behaviors in the fight against Covid-19. The authors are confident that, as of the writing of this paper, many countries have adopted measures of risk mitigation and future planning, especially ones that are late in the course of the pandemic like Brazil, and have learned from their experiences.

The brigades adopted several actions to attend to their employees and avoid that infected military firefighters become vectors of transmission of the virus to other firefighters and their families. Orientations through internal norms, video-lessons, and verbal guidelines were presented to the firefighters to impede the spread of the virus in the internal environment. Other actions included removing the military uniform before entering the mess hall and quarters, washing hands and using hand sanitizer frequently, decontaminating the uniform and removing it after attending to victims, staying in the quarters with a clean uniform, wearing masks the entire time spent in the quarters and public places.

Moreover, further guidelines were designed for military firefighters to avoid contamination in their residences and social environments. Measures include decontaminating the uniform at home, taking a shower immediately before leaving the quarters or after arriving home, not mixing the military uniform with the clothes of family members, among others.

5.3 Conclusions

The general lack of comprehension regarding Covid-19 led to widespread confusion and mixed advice from professionals and authorities. The global community was taken by surprise with the fast spread and contagion. However, countries have been applying risk mitigation measures at an unprecedented level.

The year 2020 will be forever marked in history as the period of spread of the SARS-CoV-2 virus, causing the global pandemic and entailing millions of infected and numerous deaths worldwide. The quick intervention by health organizations has been fundamental in the fight against Covid-19, seeking to establish new protocols of care for coronavirus victims. The efforts start with the strategies adopted by emergency services that are often the first contact of healthcare agents with suspected/confirmed victims of the virus infection.

This study fulfilled its proposed objectives, seeing that it identified the main actions performed by the Brazilian Fire Departments to face the SARS-CoV-2 pandemic. It measured the activities developed under the lens of Crisis Management, established through new protocols of care for Covid-19 victims in the effort to protect the workers in the front lines against the disease. The measures included the use of

specific PPE, ambulances and equipment assigned specifically to Covid-19 cases, creation of protocols and guidelines to be followed, decontamination processes, permanence within the quarters, correct disposal of infected materials, disinfection of vehicles, asepsis, among others. This paper intends to highlight the importance of creating confidence, developing protocols that assist emergency services, improving the effective communication and information sharing between countries, enhancing the learning process, and finally, perfecting the process of risk governance.

The conceptual analysis conducted by this study had the purpose of providing a structure to the numerous risk mitigation measures adopted by the Brazilian Fire Departments. The authors collected and grouped risk mitigation measures employing tools of scientific research. The intention is that the information found can be available for every country facing the Covid-19 pandemic, as well as contributing to a backward input of information in the planning systems of Fire Departments globally regarding situations of this nature.

This paper presents new protocols and action mechanisms for emergency and healthcare services that can be duplicated and developed in other countries, according to their needs and demands. Moreover, further studies can be developed to answer the following questions:

- What psychosomatic disorders were incurred by healthcare professionals after the pandemic and what actions have been taken for prevention and treatment?

- What care protocols created are effective and relevant for continuous use within the brigades?

- What future strategic actions could be developed in case of new pandemics or adverse climate events?

- What protocols or standards can be adopted as groundwork in case of new pandemics?

- How to perfect the actions developed up to now and predict future actions?

- Every management process encounters barriers, but they have not been mapped. What are they and how to mitigate them?

It is necessary to develop further studies directed at the proposed theme. The analysis conducted by this work contributes to guide the research on good practices in institutions like the Fire Departments.

Declarations

• Ethics approval and consent to participate

This study was analyzed by the Committee of Ethics in Research of the Federal University of Technology, Paraná - Brazil and received the authorization to be conducted in Juner 2020, under the no. CAAE 32427420.8.0000.5547, in accordance with the Declaration of Helsinki.

• Consent for publication

I Rosângela de França Bail, give my consent for information about myself/my child or ward/my relative (circle as appropriate) to be published in Journal of Big Data, BIGD-D-21-00140, corresponding author Rosângela de França Bail (rosangelabail@hotmail.com or bailrosangela@gmail.com)

I understand that the information will be published without my/my child or ward's/my relative's (circle as appropriate) name attached, but that full anonymity cannot be guaranteed.

I understand that the text and any pictures or videos published in the article will be freely available on the internet and may be seen by the general public. The pictures, videos and text may also appear on other websites or in print, may be translated into other languages or used for commercial purposes.

I have been offered the opportunity to read the manuscript. Signing this consent form does not remove my rights to privacy.

• Availability of data and materials

Not applicable

• Competing interests

Not applicable

• Funding

Not applicable

• Author contribution statements

R.A.B O and R.F. B processed the experimental data, performed the analysis, drafted the manuscript and designed the figures. A.O.M, J.L.K and D. M. G. C were involved in planning and supervised the work. All authors discussed the results and contributed to the final manuscript.

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Figures

Figure 1

Year of publication of the papers Number of papers / Year of publication Source: the authors (2021)

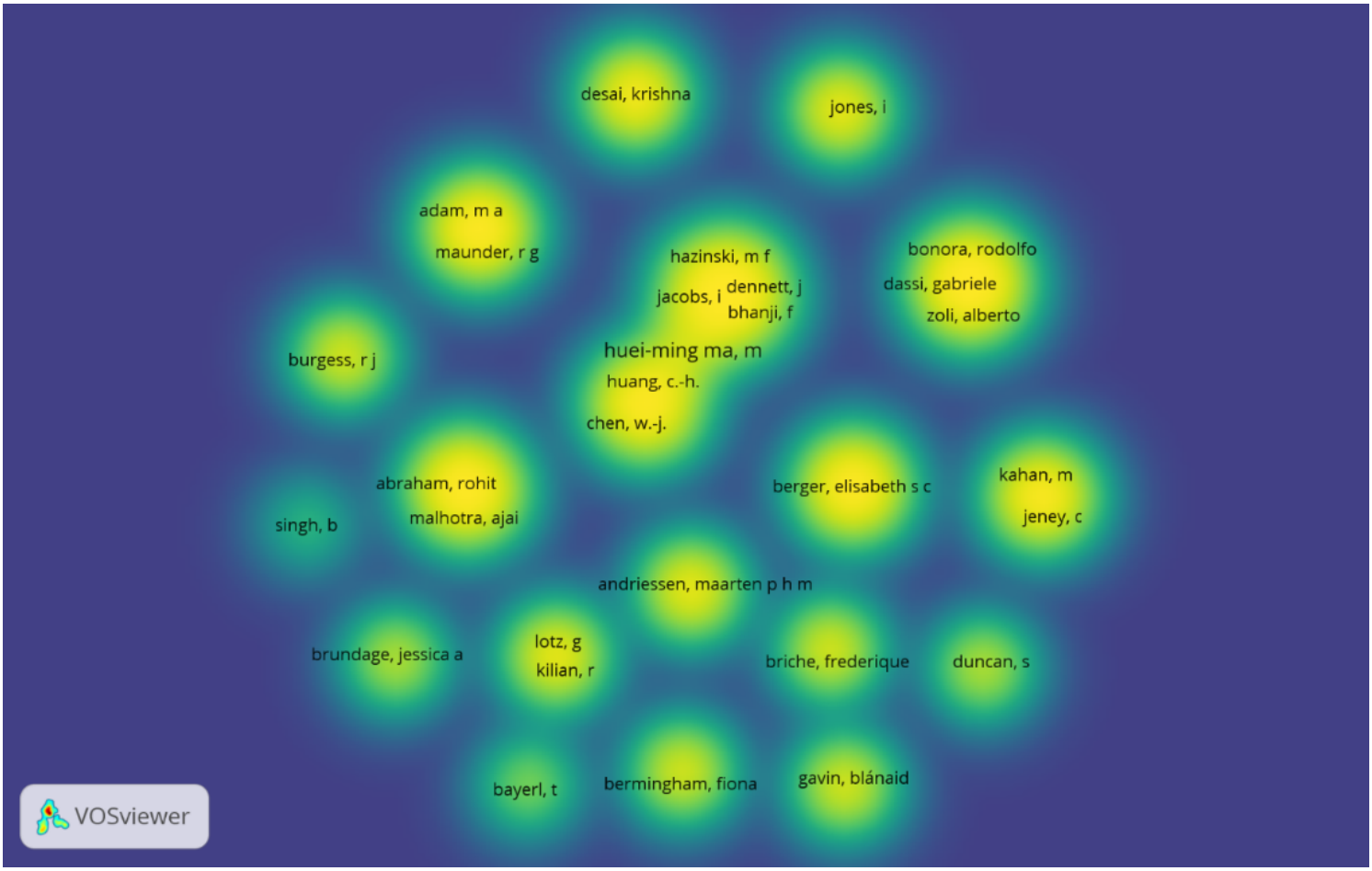

Figure 2

Author density. Source: the authors (2021)

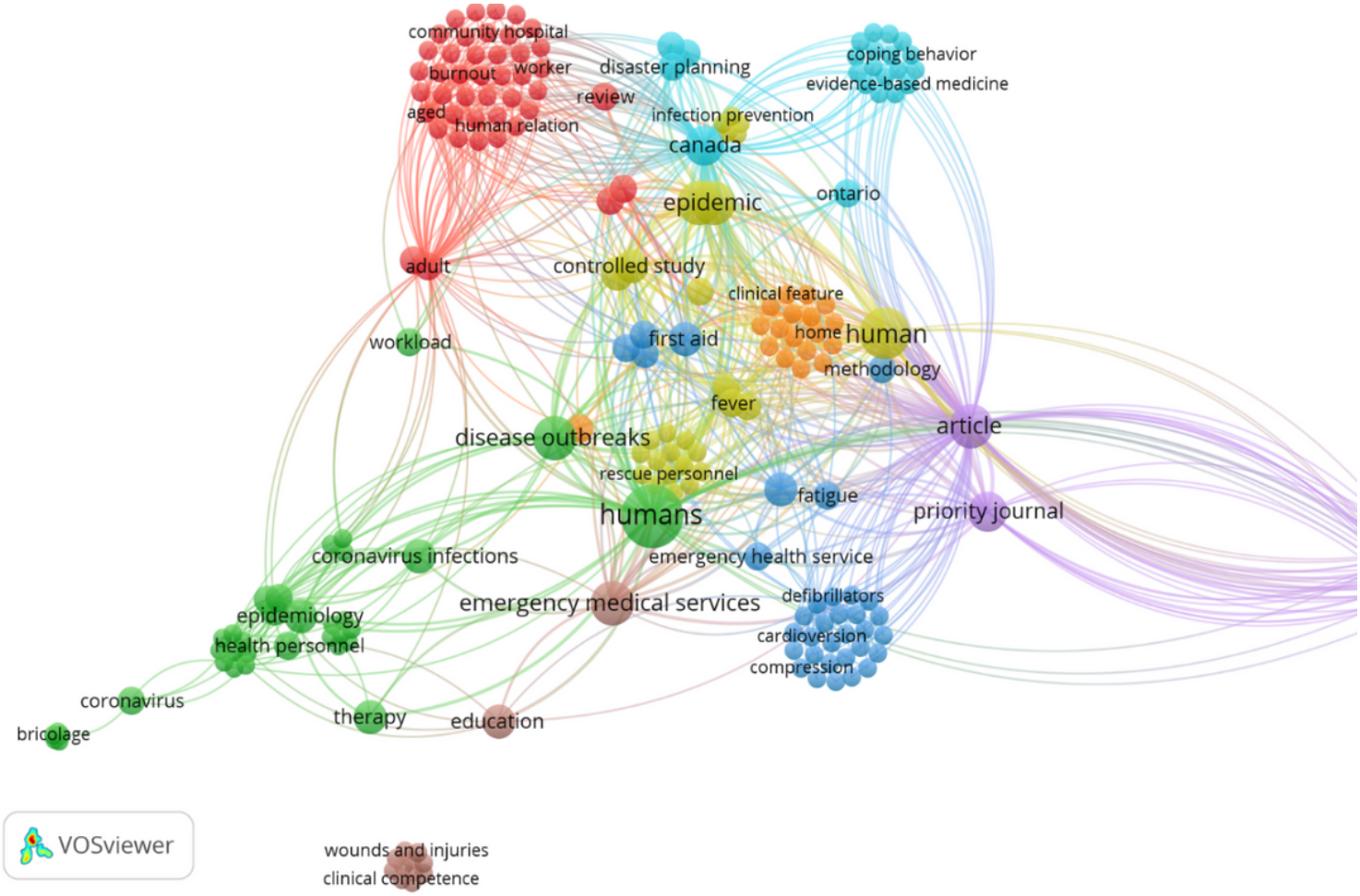

Figure 3

Keyword network Source: the authors (2021)

Figure 4

Word cloud with the main terms mentioned in the papers. Source: the authors (2021)

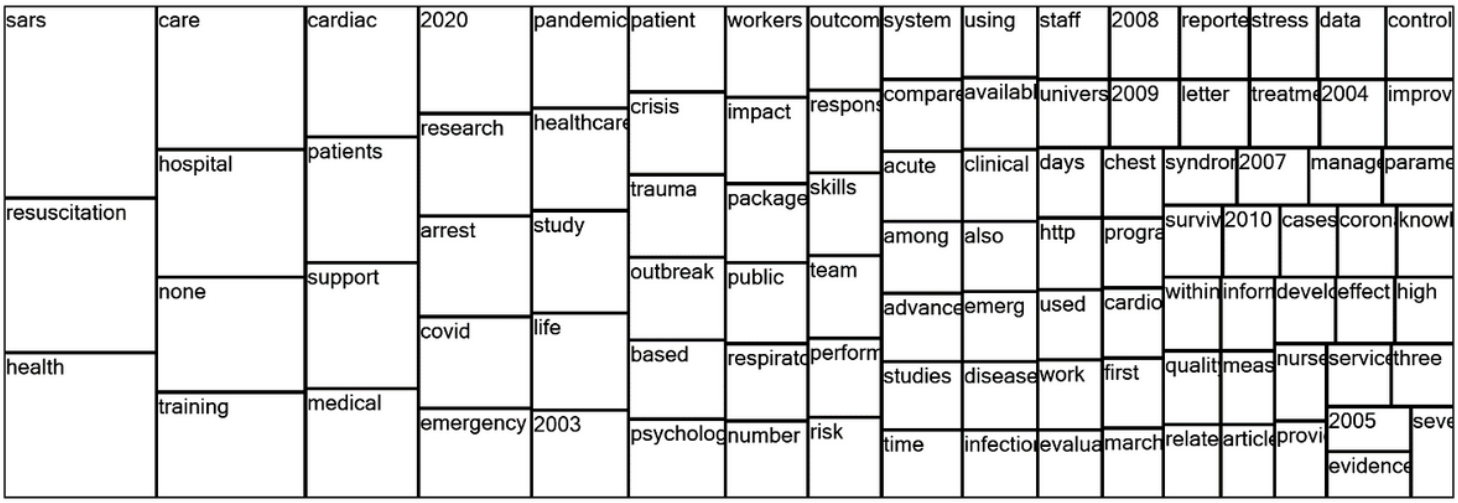

Figure 5

Main words mentioned in the papers. Source: the authors (2021)

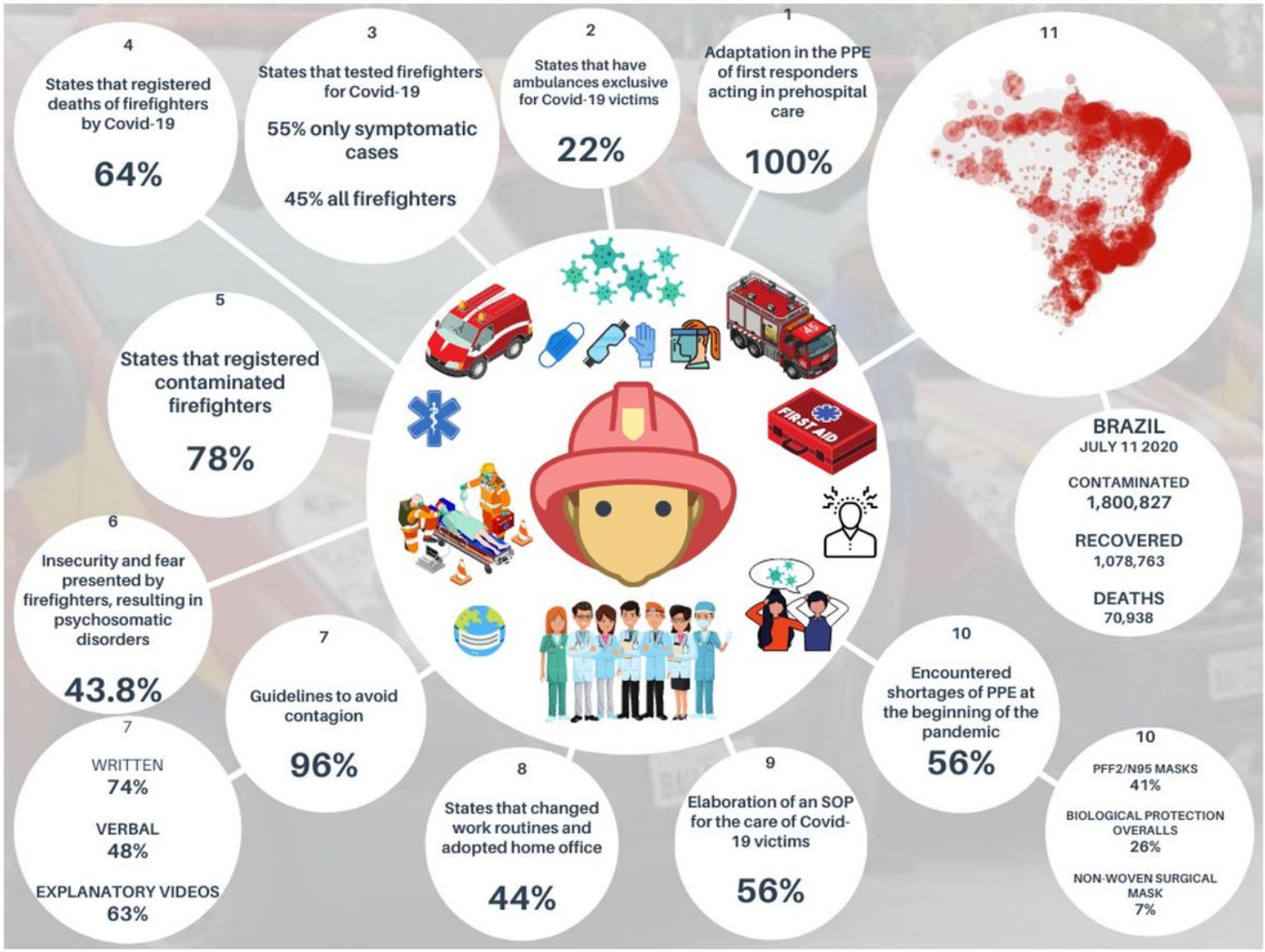

Figure 6

Procedures adopted by Brazilian Fire Departments facing Covid-19 Source: the authors (2021)

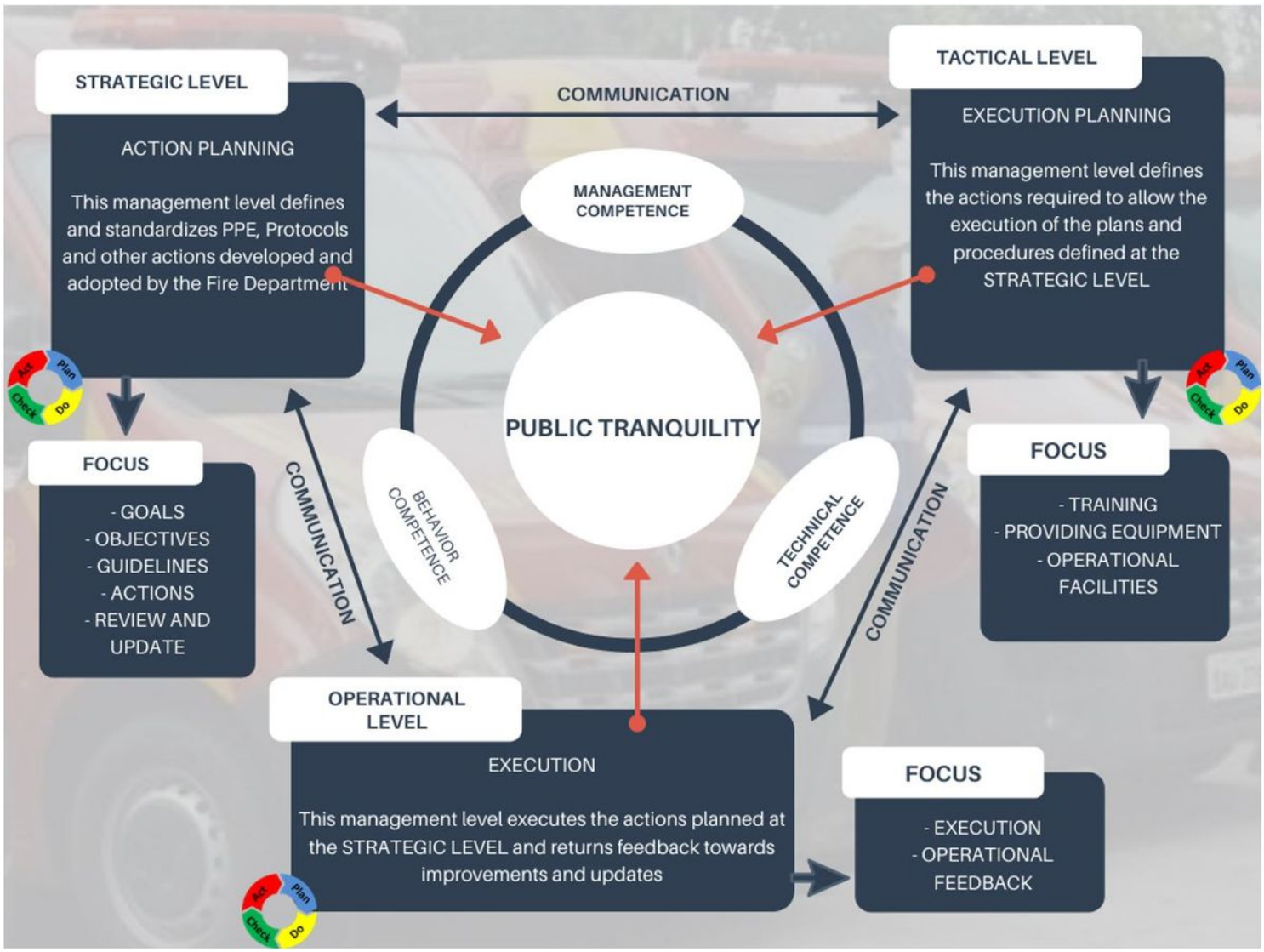

Figure 7

PDCA strategic levels Source: the authors (2021)

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