Myopia during emergency improvisation: lessons from a catastrophic wildfire

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The authors humbly dedicate this work to the people who lost their lives in the 2017 wildfires in Portugal.

The authors acknowledge National Funds through Fundaç~ao para a Ci^encia e Tecnologia (FCT), award no. UID/ECO/00124/2013 and POR Lisboa, award no. LISBOA-01-0145-FEDER-007722.

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Abstract

Purpose – The purpose of this paper is to explore how a number of processes joined to create the micro-level strategies and procedures that resulted in the most lethal and tragic forest fire in Portugal's history, recalled as the EN236-1 road tragedy in the fire of Pedrógão Grande.

Design/methodology/approach – Using an inductive theory development approach, we consider how the urgency and scale of perceived danger coupled with failures of system-wide communication led fire teams to improvise repeatedly.

Findings – This study shows how structure collapse led teams to use only local information prompting acts of improvisational myopia, in the particular shape of corrosive myopia, and how a form of incidental improvisation led to catastrophic results.

Practical implications – This research offers insights into the dangers of improvisation arising from corrosive myopia, identifying ways to minimize them with the development of improvisation practices that allow for the creation of new patterns of action. The implications for managing surprise through improvisation extend to risk contexts beyond wildfires.

Originality/value – This article stands out for showing the impact of improvisational myopia, especially in its corrosive form, which stands in stark contrast to the central role of attention to local context highlighted in previous research on improvisation. At the same time, by exploring the effects of incidental improvisation, it also departs from the agentic conception of improvisation widely discussed in the improvisation literature.

Keywords Improvisation, Improvisational myopia, Incidental improvisation, Intuition-rationality, Forest fires, Portugal

1. Introduction

On an extremely hot day, the 17th of June 2017, between 19:50 and 20:40, 66 people died in a series of accidents caused by a forest fire of Dantesque proportions.[1] Thirty-four of these fatalities occurred around 20:10 on the Estrada Nacional 236-1 (National Road 236-1, hereinafter EN236-1) within an area of six square kilometers in Pedrógão Grande, central Portugal (Comissão Técnica Independente[2], 2017; Guarda Nacional Republicana[3], 2017). The press described EN236-1 as the "Road of Hell" (Ribeiro, 2017), and the "Road of Death" (*Observador*, 2017), with being there likened to being "Inside Hell" (*Visão*, 2017). The fatalities on EN236-1 represented the most shocking and dramatic impact of the Pedrógão Grande fire in Portugal.

Investigation revealed that a series of events combined to induce operatives on the ground to make a series of improvised actions on the EN236-1 and elsewhere. By improvisation we refer to action that is deliberate, spontaneous, and novel (Cunha et al., 1999; Moorman and Miner, 1998). It involves effort not fully designed in advance that contains deviations from prior plans or routines, and the impact of which possibly varies in terms of its value to the improvising unit (Cunha *et al.*, 2017; Moorman and Miner, 1998). Improvisation during the Pedrógão Grande fire complex was portrayed by the media as a factor contributing to the disaster by compounding problems.

By contrast, a popular theme in practitioner writing often praises improvisation as a tool for rapid adaptation (Abrantes *et al.*, 2018). Scholarly work in organization studies that builds contingency models of the impact of improvisations often positions them as part of a solution (see e.g. Hadida *et al.*, 2015; Weick, 1993). In crisis response, improvisation plays a key role and goes hand in hand with preparation. Without improvisation the necessary flexibility to cope with changing conditions is

[1] Although initially assessed as 64, the official and independent evaluation of the human losses registered a final number of 66 dead (65 civilians plus 1 volunteer firefighter – the last victim died one month after the fire), and 254 wounded (of which 241 were civilians, 12 were firefighters and 1 a member of the GNR, the national law-enforcement agency) (source: CEIF 2017, GNR: Guarda Nacional Republicana).

[2] Hereinafter Independent Technical Commission or ICT.

[3] Hereinafter National Republican Guard, or GNR.

lost, and without preparation the necessary clarity and efficiency of the response is compromised (Mendonça, 2007). In fact, the innovative capacity inherent in improvisation promotes crisis readiness (Parnell and Crandall, 2021). However, when poorly executed, improvisation can have disastrous consequences (Giustiniano et al., 2016). The case of the Pedrógão Grande fire does not diminish the role of improvisation. Instead, it underscores the reality that improvisation resulting from poor planning and poor preparation introduces unnecessary risks that can be minimized.

An important contingency typically seen as crucial to fruitful improvisation is the attention paid to physical and temporal aspects of the local context. Attending to local, real-time information during improvisation can enable rapid adjustment to novel situations and coordination through shared observation (Cunha *et al.*, 2017). To focus attention heavily on information that is immediately locally perceivable can be seen as deliberately myopic behavior, an important topic in theories of learning and adaptation (Levinthal and March, 1993). We analyze the case of the Pedrógão Grande fire to shed light on the development of specific features of myopia during improvisation as well as to initiate discussions on the dangers of both in disaster contexts. We address a gap in existing research on improvisation: how and why a focus on the immediate physical and temporal context typical of improvisation can harm real-time responses to crisis situations in systematic and predictable ways. We frame our research question asking: *how can different forms of myopia during crisis-driven improvisation play a role in events that precipitate disasters?*

Answering our research question is crucial for a number of reasons, including its far-reaching consequences. We study this important yet under-researched micro-level side of improvisation in the context of unpredictable events. We do so as a component of safety and risk management (Hardy *et al.*, 2020). We explore pathways in how well-intentioned agents may end up being catastrophically engulfed in events by problematic circumstances having extreme consequences. We theorize that catastrophe is especially likely when improvisational action intended to alleviate and reduce risk from a natural disaster is combined with ill-prepared execution alongside myopic activity. In such

cases, organizational improvisation, instead of creating robust action (Bechky and Okhuysen, 2011), can produce disastrous outcomes.

The dangers of surprise-driven improvisation can be mitigated, for example with emergent coordination, predesigned back-up scripts, or mindful organizing. However, these remedies are not foolproof. We lay out several key boundary conditions within which these fixes can be neutralized. With this study we make two main contributions to the improvisation literature. We identify improvisational myopia and the destructive potential of its most perverse form, *corrosive myopia*, defined as paying primary attention to the local context, both physically and temporally, ignoring (intentionally or unintentionally) relevant system-level information and thereby undermining operational action with possibly irreversible and disastrous results. We also explore the concept of *incidental improvisation*, which refers to improvisational action that occurs merely by chance, without prior intention or calculation, as a result of the immediate need to respond to disruptive events, in contrast to the agentic conception of improvisation, which prevails in the literature.

2. Literature review

Emergency management systems routinely strive to deal with unpredictability in several ways and have developed richly layered approaches to do so in the face of adversity. These systems consist of a disparate set of resources (people, technologies, and procedures) drawn from many agencies, which are articulated in order to cope with an unfolding crisis or emergency (Gonzalez, 2010; Smith and Dowell, 2000).

Successful handling of emergencies implies a capacity to organize chaos (Kendra & Wachtendorf, 2003; Vidal & Roberts, 2014) either by anticipatory design or by skilled emergent design of novel action. In crisis response, planning aims to eliminate risk and uncertainty to allow decision-makers to have more control over the crisis (Fink, 1986). While this is the goal, the options for doing so are often limited given the time pressure, complexity, and uncertainty that characterize crisis situations (Van de Walle *et al*., 2016). Therefore, planners must also create appropriate systems

of resources and protocols to deal with likely hazards that occur despite prevention efforts, i.e., backing up plans for varied contingencies (Mendonça and Wallace, 2007). These systems must provide sufficient structure for the response to be effective, but at the same time allow flexibility for agents on the ground to locally self-organize in light of the particular conditions of the crisis (Paraskevas, 2006). In this way, the systems can respond to the singularity and uniqueness of each emergency scenario (Bechky & Chung, 2018). The goal is to establish clear *processes* that identify specific roles and temporal order in the development of authority structures that can be used even when threatening events are not fully envisaged (Bigley and Roberts, 2001). In this way systems can become resilient through the creativity and initiative of their enactors, allowing them to respond appropriately under extreme conditions (Kendra & Wachtendorf, 2003). That is, the systems are able to continue to meet their objectives in the face of the extreme challenges of the unfolding crisis (Barasa *et al*., 2017).

These pre-designed processes can anticipate that some level of improvisation may occur and provide a pre-designed process through which *constrained* improvisation might unfold. Bigley and Roberts (2001) define this type of improvisation as being guided by common goals of achievement and avoidance. Nevertheless, not all occasions in which improvisation will be seen as necessary can be anticipated, as they are often triggered by unpredictable events. Such problem-driven improvisation can embody a threatening perceived necessity (Fisher and Barrett, 2019) or enact a practice that contravenes cultural respect for hierarchy, rather than be an expression of creative agency.

2.1. Improvisational myopia

Exploring this case in which the convergence of design and execution of novel action patterns occurred in a challenging life and death context (Suarez and Montes, 2019) led us to probe the role of myopia during improvisation. By *improvisational myopia*, we refer to paying primary attention to local context both physically and temporally during improvisational action instead of to complete

system level information (Levinthal and March, 1993). We will explore improvisation and myopia under extreme challenging conditions, in contrast to recent work on improvisation pertaining to organizational surprises that are more common (e.g., O'Toole *et al.*, 2020). In myopia, actors respond to what they can infer, sense, or extrapolate from the local and immediate context facing them.

Improvisation necessarily involves some degree of myopia given that the improviser does not have complete information on as-yet-to-be completed action patterns. Myopia can become manifest in different ways. We distinguish *intrinsic improvisational myopia* from what we term *focusing myopia*, in which attention to local context helps the improviser create novel actions that are especially well aligned with a local context. The case developed here, in contrast, raises the possibility of *corrosive myopia*, in which attention that is primarily paid to local details harms rather than helps the improvising entity, and can lead to irreversible and disastrous unintended outcomes. Acknowledging that improvisation may usually be myopic to some degree, given the lack of plans and experience combined with a perception of urgency, we engage the concept in order to investigate what makes it catastrophic within an extreme and surprising environment marked by danger, uncertainty, and rapid change. Improvisation in risk management is a practice that has yet to receive sustained attention (Hardy et al., 2020). Its predominant focus has been on preventing situations in which improvisation may be necessary, in spite of research that identifies its frequent occurrence in disaster situations (Mendonça and Wallace, 2007).

2.2. Sensemaking in improvisational contexts

According to Weick (1993), socially constructed reality is the continuous product of efforts to establish order and make sense of what is happening. Sensemaking corresponds to processes by which people seek to give meaning to events of increasing ambiguity and to provide plausible explanations that enable action in the midst of chaos (Weick *et al.*, 2005). Sensemaking is often oriented to (re)producing an orderly environment in which agents can act (Hardy *et al.*, 2020). When

organizational agents are subject to *extreme events*, i.e. events that cannot be prevented by the organization and have the potential to produce significant physical, psychological, or material damage (Hällgren *et al.*, 2018), risks unfold unforeseeably as *cosmology episodes*. These episodes consist of severe disruptions of everyday order in which "people suddenly and deeply feel that the universe is no longer a rational, orderly system" (Weick, 1993, p. 633), and lose a sense of both what is happening and the means to reconstruct that sense. Restoring meaning requires action that builds a relationship between *frames* (past moments of socialization or organizational routine) and *cues* (present moments of experience) (Weick, 1995). Framing current cues sets a reference that allows people to account for what is going on (Colville *et al.*, 2013). When confronted with cosmology episodes, organizational agents run unusually high risks of making destructively wrong decisions because the rules or routines may be inadequate for the situation (Dunbar and Garud, 2009). Moreover, they may use new cues to make sense of previous processes rather than to promote a new understanding of the unfolding reality (Sherman and Roberto, 2020). The adequacy of their sensemaking is, therefore, conditioned by the constraints imposed by earlier frames of sensemaking (Colville *et al.*, 2013).

Our analysis of the EN236-1 case explores and maps new conceptual terrain for the theory of improvisation in organizations in several ways. The context did not match improvisation triggered by a sensemaking process imbued with intrinsic excitement or joy, as flagged in much work on jazz and theater (Fisher and Barrett, 2019). The actions described also did not highlight improvisational responses that were making sense of unexpected positive opportunities (Cunha *et al.*, 2017). In the wildfire context before us, the improvisation setting involved extreme physical danger, pervasive lack of valid shared information with which sensemaking could proceed, and the ever-present risk of dangerous surprise. From the viewpoint of the actors involved, the compounding factors in this setting forced the actors to act myopically with unexpected outcomes that represented both unanticipated and incidental improvisation.

The perceived need to act in the face of cosmology episodes can drive out the potential for valuable focusing myopia and spur unintended corrosive myopia, highlighting the problematic nature of improvising in extreme contexts. When organizational agents' capabilities for action are limited by events, negative implications of corrosive versus focusing myopic improvisation can arise. Such events, combined with a lack of capacity to restore meaning, can prove fatal.

3. Research case

3.1. The Pedrógão Grande fire complex

We use the case of the EN236-1 as a "developmental process research" (Langley and Tsoukas, 2017), in which one outcome, in this case a tragic fire, constituted the starting point for a study which tracks backwards in order to reconstruct and explain what happened. We begin with a straightforward account of events. The Pedrógão Grande cluster of interlinked fires reached their height on June 17th, 2017. Although not the only factors, atmospheric conditions were severe on that day (Comissão Técnica Independente, 2017), including a thunderstorm that helped create *downbursts* (powerful wind phenomena) that accelerate a fire and increase its destructiveness (Veríssimo, 2017). The fire had an unprecedented impact. In addition to causing 66 deaths, it injured 254 people, destroyed 485 houses, and burnt 53,000 hectares of land, including 20,000 hectares of forest, affecting 2,018 farmers at a cost of €21m and 49 companies at a cost of €31m (https://www.bbc.com/news/world-europe-44438505, CEIF, 2017).

The most dramatic feature of the disaster was the number of human victims, which greatly exceeded past forest fires. A total of 66 people died in the overall conflagration, 34 of whom perished on the EN236-1 road alone. The newly designed national system for dealing with emergency situations (Emergency Communications System) was described in accounts of the fire as an "opaque" public-private partnership (Dinis, 2017, p. 44), whose communication failures contributed to the tragedy. It was a tragedy in which reality proved incomprehensible for the

organizational agents, who felt powerless and without resources to overcome the challenges (Clément and Roux-Dufort, 2020).

3.2. Focal fatal episode: The EN236-1 event – the decisive 25 minutes.

The overall forest fire complex that engulfed EN236-1 and its environs was a catastrophic event, unpredictable in the extreme, terrifying in its intensity, and all-consuming with its fierce heat, smell, and sound. The specific episode that led to the exceptional death toll on EN236-1 occurred between 19:45 and 20:10 on June 17th (Table I). These 25 minutes are the stage for the tragic events that constitute the central element of this article. Figure 1 shows a schematic map of areas affected by the fire surrounding EN236-1 and several key events explored here.

Table I. Timeline of *salient* events; highlighted the time period corresponding to the improvisational action which is the focus of this study (for the complete reconstruction of the event, please refer to Appendix 1)

	June 17
…	
14:43	Start of the fire according to the report of GNR
…	
18:50	GNR cuts traffic in IC8 (knot of CM 1166, near Pedrogão Grande), 9.0 km east of the knot with EN236-1.
…	
19:02	GNR cuts traffic in IC8 (knot of M 516), 6.6 km east of the knot with EN236-1
…	
19:16	GNR cuts traffic in IC8 (knot of CM 1170), 3.5 km east of the knot with EN236-1.
…	
19:38	SIRESP (*Integrated System for Emergency and Safety Networks in Portugal* - the Portuguese emergency communications system) station in Pedrógão Grande, one of the 16 that cover the area of the fire, suffers transmission cuts and operates only in local mode.
19:44	The Command Post informed that there are houses burning in several localities.
19:45	First failures of GSM (*Global System for Mobile communications)*. The Fire Department of Pedrógão Grande informs about the loss of low frequency signal.
19:45	GNR cuts traffic in IC8 in the knot with EN236-1. Traffic from the West is redirected in three possible directions: U-turn in the same IC8 heading West; EN236-1 South towards Figueiró dos Vinhos or EN236-1 North towards Castanheira de Pêra.
19:49	Announcement of rural fire in Castanheira de Pera. Seven operatives and two vehicles mobilized.
19:53	CDOS (District Command of Relief Operations) Coimbra informs CDOS Leiria that the locality of Vermelho is surrounded by fire.
19:58	Pedro Nunes, Operational Commander of the Center North region, arrives in the operational theatre.
20:06	CDOS Leiria requests two ambulances for transport of evacuees.
20:10	Probable time when the fire reaches EN236-1.
20:15	GNR cuts traffic in IC8 in the Figueiró dos Vinhos – West knot (knot of EN237), 3 km west of the knot with EN236-1.
…	

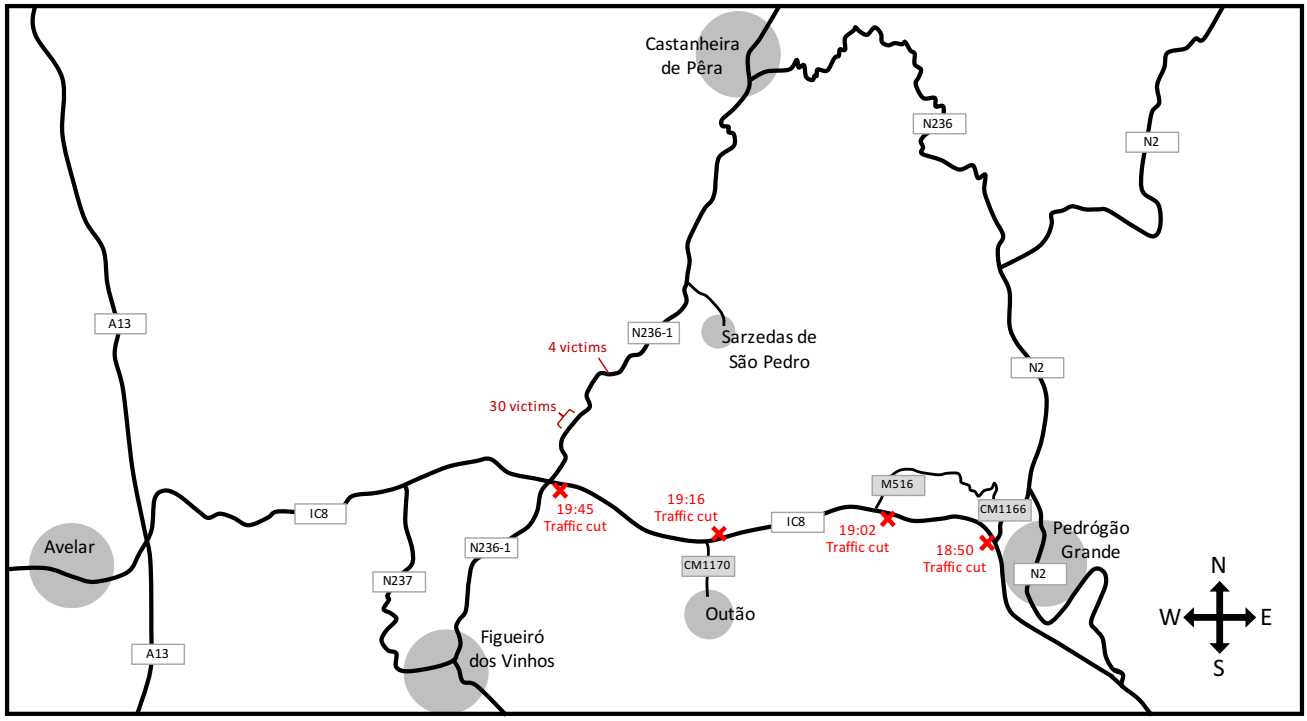
Sources: Expresso (2017), Comissão Técnica Independente (2017), and mainly Pedro *et al.* (2017).

We must go back in time about an hour to better understand the critical decision that was taken at 19:45. At 18:50, as the fire approached the major road IC8 from the east, a patrol from the National Republican Guard (GNR) began to close this route to east-bound traffic. The patrol moved west from the town of Pedrógão Grande, imposing four closures in sequence: at 18:50 they cut the traffic on the IC8 near Pedrógão Grande at the junction with road CM1166; at 19:02 they cut the IC8 2.4 kilometers further to the west at the junction with the M516; at 19:16, moving another 3.3 kilometers west, they cut the IC8 at the junction with the CM1170; and at 19:45 they cut the IC8 again 3.2 kilometers further west at the junction with the EN236-1 (see Table I). When the local officials cut off eastbound traffic on IC8 at its junction with EN236-1, they redirected traffic westward on the IC8 or onto the EN236-1 heading either south or north. At around 20:00 one of the patrol members moved 1.3 kilometers on EN236-1 northwards to check on a dark cloud of smoke coming in. Upon returning to the intersection of EN236-1 and IC8, he realized that the smoke cloud was even closer, and decided to remove all the bystanders on the EN 236-1 viaduct over the IC 8. Authorities did not cut the traffic going either north or south on the EN236-1 at this time.

This last roadblock turned out to come at a crucial moment. Around 20:00 there was a collapse of the convection column causing a local downburst with dramatic consequences in the evolution of the fire. As reported by a local citizen “it went completely dark and immediately afterwards a large fireball appeared (...) a kind of bomb that burst out of nowhere and opened the sky in a flash of flames that spread sparks, or tongues of fire, in all directions” (Independent Technical Commission, 2017, p. 67). Between 20:00 and 20:10 the fire reached a propagation speed of “15.2 km/h, a value almost unparalleled in the literature concerning forest fires” (p. 67). It was during this period that the fire reached and engulfed the EN236-1 coming from the east but spreading in all directions – to the northwest, west, and southwest. At about 20:10 on the EN236-1 about 1.5 kilometers north of the crossing with the IC8, 30 people lost their lives, and at the same time, 1.5 kilometers further north, 4

more people died (Independent Technical Commission, 2017). In other words, about 25 minutes after the IC8 was cut at the junction with the EN236-1, 34 people perished less than three kilometers from that location. At 20:15 the patrol retreated further west on the IC8, cutting off access to the EN236-1 from the IC8. Overall, citizens following directions received on the IC8 thought they were avoiding the fire danger and ended up driving directly into the horrific blazes on the EN236-1 northbound.

Figure 1. Schematic map of areas affected by the fire surrounding EN236-1, identifying the areas where there were casualties in EN236-1 and the traffic cuts in IC8



4. Method

The case was selected for study for two major reasons. First, it is an example of a case that breaks the heart. As suggested by Whiteman (2010) a case that breaks the heart helps scholars connect analytically and emotionally with their data and the people they study, a connection without which scientific accounts may be less rich and potentially misleading. Making conceptual sense of the organizational aspects of this tragedy was an important and urgent matter. Second, given the high public profile of the case, detailed public data were abundant and accessible. We decided to use public reports as the main source of data because these reports were heavily scrutinized by the public

and the media, which does not render them uncontested but helpful in making scholarly sense of the process.

The findings are subsequently presented in terms of a temporal narrative of unfolding stages. Major disasters have traditionally constituted important cases for systematic scrutiny (Weick, 1993). As exemplifications of "the extraordinary" they can be used all the better "to understand the ordinary" (Weick, 2018, p. 3). Major accidents constitute extreme cases (Eisenhardt, 1989b) that provide unique windows for approaching "hard to get at" organizational phenomena (Hällgren, *et al.*, 2018, p. 112).

4.1. Data collection

The case narrative was constructed by using a number of mostly public sources (Table II): official reports, and media clips collected on a daily basis from immediately after the event for a period of twelve months until June 2018, when the government's official investigation concluded (*Expresso*, 2018). Using written sources is not free of problems, namely the proximity in relation to the facts (in the case of newspaper reporting) and in the case of public inquiries, the distance from the facts, as well as the role of the latter in restoring a public sense of control and normalcy (in the case of official reports). These sources constitute a practical way of getting access to data in difficult contexts (Brown, 2018). By using proximate and distant data we sought to mitigate the drawbacks of the two data sourcing approaches.

After six months had elapsed, expert recommendations on measures to be implemented for the future had become more consistent and linked to evidence, signaling a crystalizing interpretation of the causes and effects of the disaster by the authorities involved. Nonetheless, as planned, we remained alert and actively collected data on the emergence of additional details up until one year after the event. For validation purposes we interviewed two expert informants, both of whom were GNR personnel who acted as liaison officers between the command center and the GNR operatives on the ground. The GNR was the entity responsible for closing roads, rendering assistance,

evacuating people from endangered places, and creating safe passage for firefighters and others. The two interviewees covered the entire time span of the incident, from 17:00 on June 17th to late afternoon on June 18th.

Together, these data collection approaches provide confidence in the richness of data. Our multiple points of contact with the case helped us construct a data set beginning immediately after the fire and continuing for twelve-months using the sources listed in Table II. To construct a detailed case timeline (Table I, Appendix 1), we incorporated selected and ample media coverage (Table II), describing for the process as it unfolded. An important missing data point is the decision makers' demographics, which may influence the predisposition to improvise as well as the quality of the improvisation.

Table II. Inventory of data sources

Data type	Specification	Data contents
Official reports Reports provide official analysis of the different facets of the disaster.	Centro de Estudos sobre Incêndios Florestais, Universidade de Coimbra	Led by Domingos Xavier Viegas, from the University of Coimbra, the study was requested by the Government.
	Comissão Técnica Independente	General analysis of the Pedrógão and adjacent area wildfires.
	GNR	Produced by the National Republican Guard, the police force that was in the terrain overseeing the traffic.
	IPMA	Issued by the institute that oversees meteorology, dissects the weather conditions in the situation of disaster.
	SIRESP	Released by SIRESP the communications infrastructure.
Press sources including articles and videos	Total: 359 national and international press articles	Press articles allowed the sensemaking of the entire process, with a combination of reporting and analysis that complemented the official reports. Pieces were collected from a variety of sources: *Expresso, El País, Financial Times, i, Negócios, Público, The Guardian, Visão*. Some media sources were used abundantly (e.g., *Público*) other episodically.
Direct participants' interviews	Interviews with two National Republican Guard officers who were the liaison officers between the command center and National Republican Guard operatives.	The interviews focused on the officers' direct perspective on the events and the complex repercussions that the failure of the communications system had for the capacity of field agents to make decisions and improvise.

4.2. Data analysis

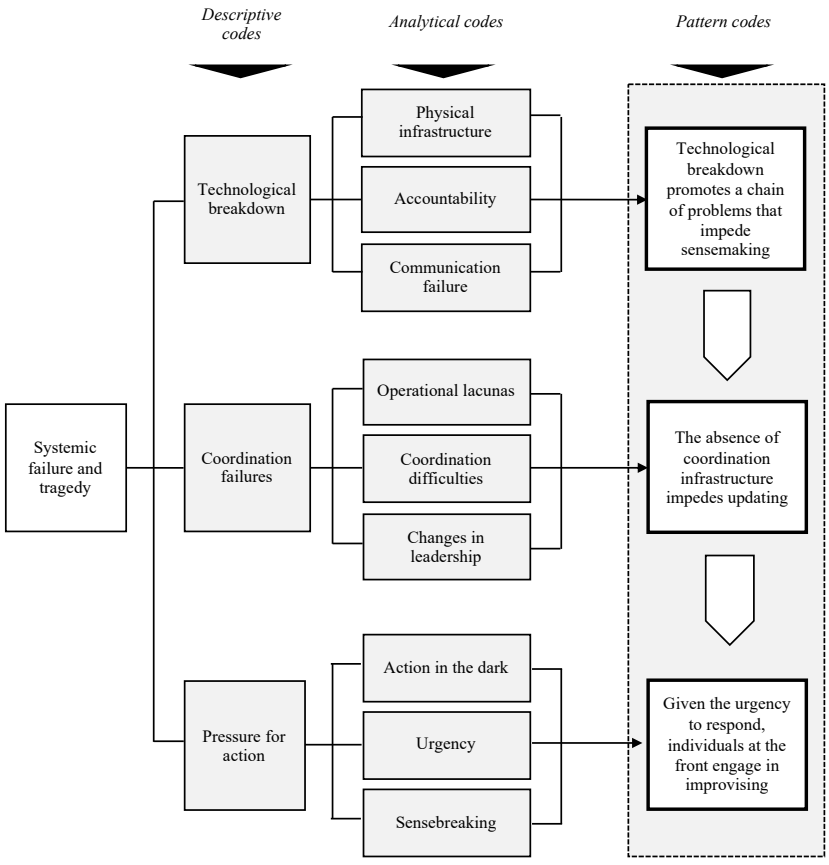
The analysis proceeded in three main steps: first, the construction of a detailed chronology of events (Appendix 1) to serve as a basis. Second, we analyzed the reports as our main source of data, categorizing the features that led to the improvisation. We treated documentation as text, analyzing it to identify relevant keywords that were subsequently clustered in conceptual categories around three types of codes: descriptive, analytical, and pattern (Miles and Huberman, 1994). *Descriptive codes* included the conceptual categories observed in the field at the beginning of the study. These included technological breakdown, coordination failures, and pressure for action. For each code we defined keywords and developed a list of semantic descriptors of these keywords. In this way we were able to identify a particular category in the text. Next, we extended the initial list of semantic descriptors through an inductive reading of the data transcripts; for example, using terms that were systematically used in the text. Table III shows the complete list of descriptors for the three categories. This list allowed us to systematically code all the sentences in the text referring to the categories and their corresponding keywords (see Catino and Patriotta, 2013).

Table III. Descriptive codes

Category	Definition	Semantic descriptors
Technological breakdown	The failure of the technological support of the emergency management system, namely the communication sub-system.	Communication difficulties, unable to communicate, radios not working, mobile network failure, lack of communications, shadow zones, blank zones, network vulnerability, communications disruptions, communications collapse, communications breakdown.
Coordination failures	Failures in the harmonization and control of the various activities and agents in command, combat and support to the populations during the fires.	Lack of coordination, affected coordination, bad organization, diminished coordination, incoordination, no real coordination, coordination failures, disorganized, disoriented, no guidance, command changes, impaired coordination.
Pressure for action	The perceived need to act felt by the agents on the ground due to the evolving emergency situation.	Need to act, required action, forced to mobilize, evacuation needs, need to assist populations, need to cut off traffic, follow the fire evolution, risk perception, free enterprise of agents, danger to human life, adjusting to fire evolution.

The next stage of coding was to specify the broader descriptive codes into *analytical codes*. These codes were more detailed and disaggregated specifications within the broad categories, which permitted a nuanced understanding of meanings (for example, physical infrastructure and accountability). The list of codes was progressively expanded with iterative reading of the documents. For example, we observed several references to action performed "in the dark", without any contact with the command post due to communications failure. Next, we built inductive patterns and identified relationships across categories, the *pattern codes*. For example, we considered the effect of the infrastructure breakdown in triggering a chain of problems that impeded sensemaking, which translated in part into coordination difficulties. These referenced relationships between previously coded categories are represented in Figure 2, illustrating the coding systems. Finally, we articulated our interpretations with the existing theory, in order to make theoretical sense of the case in light of prior relevant research.

Figure 2. Data structure



5. Findings

As the events timeline (Table I, Appendix 1) indicates, the Pedrógão Grande system of wildfires grew increasingly aggressive. We next analyze how three key factors converged to confront agents on the ground with the perceived need to improvise, and to do so using only geographically and local temporal information as the framework for sensemaking. The tragic likely[4] consequence of this convergence of events was the deaths of 34 people in their vehicles overtaken by flames as they attempted to flee the firestorm that raged across and around the EN236-1. The breakdown in the communications systems created the perceived imperative to improvise and also created a situation in which agents on the ground could rely only on direct perceptions about where the fire had been, where it was at any moment, and in what direction it was moving. In other words, the broader fire events created a situation of incidental improvisation and myopia. These factors also combined at the system level with difficulties with emergent coordination in the context of a cosmology episode. Our focal agents on the ground were confronted with a "never-before-seen" type of situation, that arose in the absence of sufficient structure to guide action.

5.1. Factor 1: Communication breakdowns

The breakdown of the communications infrastructure played a critical role in the loss of lives. Aerial Portugal Telecom (PT) cables were destroyed by the fire, causing a blackout and communication systems failures, triggering the series of events ending in catastrophic deaths. The Emergency Communications System failures allowed communications only in "local mode," meaning that communications were possible only between terminals of the same network. For example, the Pedrógão Grande station suffered transmission cuts at 19:38 on June 17th. The fire is estimated to have reached EN236-1 at 20:10 (see Table I). Communication failures persisted for days: normal

[4] It is not possible to establish a direct cause-effect relationship between GNR action and deaths on the EN236-1, but the report of the Independent Technical Commission (2017) leaves this issue open and refers to the existence of traffic congestion on the EN236-1 in both directions.

functioning of the Pedrógão station resumed only on June 19th at 11:44. During the fatal hours of the fire 537 calls failed to go through (Valente, 2017a).

5.2. Factor 2: Difficulties with emergent coordination

Network failure instantaneously produced coordination difficulties regarding the effective following of prior plans and standard operating routines. The President of the National Association of Professional Firefighters argued that destruction of communication antennas caused "disinformation of those commanding forces on the ground" (Faria and Valente, 2017, p. 4). The consequence was the creation of communication gaps that led to "operational directives" (specific action instructions) that differed for the different parties involved (Faria and Valente, 2017, p. 4). Agents in the field were unable to follow the coordination routines previously designed around a centralized information system (Independent Technical Commission, 2017). The "lack of coordination and failures of command" have repeatedly been considered as contributing to the deaths on EN236-1 (Valente, 2017b; see also Independent Technical Commission, 2017).

Other coordination challenges arose. Changes in leadership aggravated communication problems: in an interval of three hours (19:30-22:30) there were three separate operational commanders (Independent Technical Commission, 2017). The ANPC (the civil protection agency) reported that the Pedrógão Grande fire did not trigger a population evacuation strategy but was initially aimed at defense of dwellings rather than evacuation. A shift to evacuation occurred only as the enormity of the blaze became evident. As a result of the isolation and lack of coordination of the emergency services, vehicular flight along the road (see time 19:45 on Table I) occurred as traffic was redirected from IC8 to other routes, including the junction with EN236-1.

5.3. Factor 3: Corrosive versus focusing myopia during improvisation

In general, during the time period and area of the EN236-1 events, the agents on the ground lacked central guidance on how to set priorities in action, and in which areas to cut roads. They assumed

responsibility for taking action to reduce the fire's harmful impact, but were essentially left with local information to guide that action. In short, they engaged in myopic improvisation created by the inaccessibility of global information concerning the evolution of the fire complex rather than by the deliberate and skillful attention to real-time local information. They perceived the need to continuously take action in response to the evolving situation, as seen in their adjustment of the IC8 road cuts as they saw the fire moving west. When the agents on the ground decided to cut traffic on the IC8 at the junction with the EN236-1, they also decided *not* to cut north-bound traffic on the EN236-1 as part of their improvised action pattern. They did not perceive sufficient danger on this route and had no information about the progress of the fire beyond their own local assessment. As in all situations, the agents had theoretical choices of doing nothing, following prepared routines, or improvising a novel action. As our GNR informants pointed out, doing nothing was not an option from their perspective.

The team on the ground lacked information on where and how the fire was moving (temporal myopia), information that had major implications regarding their choices of roads to recommend or close. Each local setting was disconnected from real-time information on fires on other fronts (geographical myopia) and faced the challenges of knowing what to do in the absence of information on how the broader fire complex was evolving (Oliveira, 2018). Given the immediate and visible sense of danger and since they could no longer use the communication system, they chose to improvise. Improvisation in this context occurred because the teams on the ground faced situational complexity and communications collapse that left them "in the dark" … "on their own" (Costa, 2017, p. 15). The improvisers had only local information on the fire's movements and no complete awareness of the four different fires converging toward the road. They could not zoom out to understand the system from a higher level because they lacked the means to do so. Without knowing what was happening beyond their ability to observe directly, the GNR agents made a critical decision that subsequent reports suggest contributed to harmful outcomes.

These factors leave unresolved the question of why the ground team made the choices they did while improvising road cuts. Two possible microprocesses are suggested by field data itself. First, since the team had already cut the IC8 several times before, with apparent success, they decided to continue in this course of action. Second, there were cues of an altered situation, but not sufficient to change the prior pattern of cutting traffic as if the danger were only from the east and not from north or south. As mentioned earlier, at the time of this critical decision the GNR had local information that a dark column of smoke was approaching. This information was enough to make the intuitive decision to explore what was going on and even remove the bystanders from the viaduct. Based on their experience they recognized a pattern of danger in the approaching smoke cloud. Although their intuition may have told them something different (as suggested by the removal of people from the viaduct), they did not have the ability to integrate this information into their improvisational decision-making process. They were unable to manage the intuition-rationality tension and did what they knew how to do, which was to cut the IC8 to prevent harm from fire coming from the east. They could not or did not engage in sense making that interpreted the potential cue of the smoke as a prompt to add another cut in traffic, this time to the north. The result was an impaired improvisational action with dramatic consequences.

In contrast to this situation, the improvisation literature has generally emphasized the positive value of myopic action. Using what we call *focusing myopia*, deliberately paying attention to local information enables both better design of novel action and also coordination. It prevents overreliance on prior action designs that may not fit the current reality, while shared local information can directly support coordinated action, as all participants weigh the same unfolding information. In focusing myopia, local information improves the effectiveness of improvisation (Miner *et al.*, 2001). In this case of corrosive myopia, however, the lack of global knowledge of the fire's progress and the inability to manage the paradoxical tension of intuition-rationality reduced the respondents' capacity to give adequate meaning to the situation, and to underestimate the imminent danger. Given the lack

of both reliable overall information as well as the nuances of contextual details, a productive "process of revising provisional sensemaking to incorporate new cues" (Christianson, 2019, p. 45) was not possible. Impeded sensemaking was occurring in the context of a sense-shattering occasion (Weick, 1993).

It should be stressed that these personnel were not negligent. They did what they could with their training and experience. They too were victims of the dire circumstances, and lived through a dramatic experience that marked them forever. The context faced by these officers included the extremely high speed of the fire's propagation, the convergence of four sub-fires on the northern arm of the EN236-1 road, and the downburst phenomenon associated with the events. In retrospect and with access to all this information, blocking the EN236-1 going north would have been the *wiser* improvisational move. According to the Independent Technical Commission (2017, p. 99), at "20:05, the fire was (…) about to come to EN236-1, where around 20:10 it caused the majority of victims (…)." More generally, the Independent Technical Commission report clearly states that the consequences of the unavailability of global information may have prevented GNR teams on the ground from making more adequate decisions.

6. Discussion

This paper makes two main contributions to the improvisation literature as well as to organizational practice. From a theoretical standpoint, the article reveals how improvisational myopia can take on a corrosive character; and how improvisational action can be eminently incidental in contrast to the agentic perspective of improvisation. From an applied perspective we discuss how to reduce short-sightedness in improvisational action and mitigate the effects of corrosive myopia through proper preparation and training.

6.1. How myopia shapes improvisational action

Improvisation has often been presented as a potentially important activity in the face of urgency and extreme conditions, as a vehicle for reducing organizational vulnerability (e.g., Eisenhardt 1989a; Weick, 1993). However, it can have a varied impact, depending on many factors (Giustiniano *et al.*, 2016). This study reveals how improvisational myopia can become corrosive, which shaped the improvisational action around EN236-1 and the overall Pedrógão Grande fire.

Improvisation occurred when sophisticated and much anticipated centralized communication systems failed in the absence of effective backup systems or informational redundancies. Both geographical and temporal myopia were increased and shaped by objective constraints, which restricted the agents' attention to the immediate physical context and their temporal awareness to what was known at the moment, in contrast to knowledge about the directions and dynamics of the fire's progress that they could not directly observe. The combination of corrosive myopia with the catastrophic stakes for action severely limited the operatives' ability to make sense of their situation. When people cannot "anomalize" and conduct fruitful proactive sensemaking (Barton *et al.*, 2015), the outcomes of actions taken may be destructive. In this case, allowing people to continue to travel eastward on the IC8 (see Appendix 1) would take them into the fire coming west, however, their simultaneous decision to cut traffic heading east and permit traffic going north on EN236-1, directed people into the fire, unbeknownst to all involved.

Improvising actors use real-time local cues to both design and coordinate action that is sensitive to novel and emerging conditions (Cunha *et al.*, 2017; Miner *at al*., 2001). Where these processes cannot occur because of a communication failure, the actors have limited understanding of the ways in which fast-moving problems at the system level are evolving, even though they have good information regarding their immediate context (Garnett and Kouzmin, 2007). The complex combination of circumstances in which improvisation took place went far beyond the apprehension of the improvising agents. The rupture of prior structure created a context in which people operated

in the absence of even minimal guidelines. In the absence of global information, a cosmology episode confronted the agents with the advent of corrosive rather than focusing myopia, resulting in inappropriate sensemaking (Weick, 1993). Although we cannot have definitive insight into their mental processes, the failure can be seen as an instance of the inability to use intuitive sensemaking (Bartlett *et al.*, 2013) adequately to manage the intuition-rationality tension, an important feature of improvisational decision making in times of crisis (Tabesh and Vera, 2020). Further, they appear to have taken refuge in a known and tested routine, cutting the road to prevent drivers moving into a fire to the east. The actions they took were improvisational in the sense that as a whole they were novel and not predesigned, but within the specific sequence they enacted, they did not take sufficiently novel action compared to their own recent choices.

6.2. Incidental versus agentic improvisation

Much of the literature that addresses real-time management of risk has done so from a controlling rather than an improvisational perspective (Hardy *et al.*, 2020). We balance this tendency and depart from the frequent theorization of improvisation as a positive agentic process, associated in the practitioner literature with the potential for innovation and adaptation (Barrett, 2012). Scholarly work has emphasized improvisation leading to both helpful and harmful outcomes. Both current theory and evidence imply that effective improvisation requires advanced skills (Vera and Crossan, 2005) and proper conditions. Our study shows that in some cases, particularly when incidental improvisation is at play, these resources may simply be absent and the likelihood of failure is magnified.

In incidental improvisation, actors are confronted with a perceived constraint in which they can only improvise or face obliteration, given the urgency of immediate threats. This contrasts with a substantial body of improvisation research that starts with the assumption that improvisation represents an agentic activity (e.g., Magni, *et al.*, 2018). Improvisation scholars often emphasize that improvisation can be triggered by unexpected problems, opportunities, or intrinsic exhilaration

(Fisher and Barrett, 2019), but we lack precise theory about whether or how they may differ as they unfold. The emphasis on the incidental aspect of improvisation implies that some forms of problem-driven improvisation may differ from processes involved in the more agentic improvisation. This latter type of improvisation is sustained by a balance between structure and flexibility that allows the improvisational action to be coherent (Cunha *et al.*, 2003). When structures collapse, skillful improvisation cannot overcome contextual challenges. The absence of adequate response strategies informed by oversight and coordination, meant *improvising over nothing in a contextual void*, leaving actors to create a new action pattern without appropriate shared referents (Miner *et al.*, 2001).

6.3. Implications for improvisational practice

Preparation and planning are crucial in responding to crisis situations but eliminating the need to improvise is unrealistic (Mendonça, 2007). Therefore, the destructive potential of improvisation must be considered carefully, and especially when improvisation takes on a character of corrosive myopia. Two key questions arise for improvisational practice that are worth discussing: how can organizations be responsive to rapid, unexpected changes in the environment and not become shortsighted; and how can managers and other crisis responders be taught to improvise in ways that do not engender myopia or lessen its effect?

Regarding the first question, the study shows that emergency management system's resilience can depend on the systemic articulation between the different geographies and services composing a complex network of organizations (Kahn *et al*., 2018). In the case of EN236-1 the telecommunications relied on aerial transmission that was an early casualty of the firestorm. In such circumstances, given the interaction of parts of the system, having units or people with ample improvisational skills will not lead to successful action if other layers of the system cannot support such improvisations because of technological failure. Emergency management systems designers need to consider not only redundancies to replicate regular processes but also to consider designing

back-up systems that can support improvisation (Mendonça and Wallace, 2007). When technology is viewed as a stand-alone element on which a system relies, its affordances are non-trivial, especially in non-routine and emergency situations, in which telecommunication coordination is vital to build an oversight of a complex and fast evolving system of fire that is wreaking devastation.

In addition, as far as sensemaking is concerned, our results also reveal the importance of considering challenges to the creation of meaning during disruptive contexts, so that effective reactive strategies can be generated. A valuable recognition process is highly dependent on shared and collective long-term memory (Burke *et al*., 2006; Endsley and Smith, 1996). Practice with interpreting events under extreme conditions and in the presence of major surprises seems a minimal step toward preparing organizations to engage in productive sensemaking, especially when the shared common values of a singular organization cannot be relied on because of the need for coordinated sensemaking between different organizations. In some cases, as herein, additional factors related to emergent coordination arise that cannot be solved through shared understanding of prior history.

Regarding the second question, the remedies for the dangers of improvisation that springs from corrosive myopia that arises from material constraints presumably can be enriched through changes in the physical context or through improvisers developing practices to take such myopia into account as they create novel patterns of action. Barton and colleagues (2020) argue that critical situations cause confusion and negative emotions. These emotions need to be addressed through what they term “relational pauses”, types of huddles (short briefings designed to support opportunities to stay informed, review events and revise plans) that allow members to express their feelings and intuitions and, in this way, to “anomalize” (Barton *et al.*, 2015) rather than to normalize warning signals.

Relational pauses may create space for people to express themselves and inform the intuitive side of a sensemaking process. Intuitive sensemaking may be especially important at moments of severe lack of access to information (De Rond *et al.*, 2019), and the blend of analysis and intuition is salient

in improvisational decision making under ambiguous situations (Tabesh and Vera, 2020). These may help to incorporate feelings that something wrong is happening even though there is no clear evidence of what it is (Weick and Sutcliffe, 2001). Training for more skillful improvisation would then require going beyond improving skills for rapid rational calculations of context, to include skills for noticing nonobvious cues and enhancing productive imagination about response options. Intuitive sensemaking can be trained. The ability to recognize and analyze cues and patterns, translating non-conscious monitoring into a conscious cognitive process, can be developed by simulation-based training programs (Bartlett *et al.*, 2013).

6.4. Conclusion

Improvisation can be seen as intrinsically myopic. In some cases focusing myopia may be crucial for designing fruitful novel action because it focuses attention on the key design needs for that situation. However, in other contexts, attention restricted to a local context can compound disaster and represent corrosive myopia. In scenarios where improvisational action has wider temporal and geographic effects, the inability to see beyond local cues can create problems of sensemaking and coordination among the various operational agents. However, these limitations can be mitigated by developing back-up systems that support improvisation, and by improving collective sensemaking skills and agents' abilities to manage the intuition-rationality tension through adequate preparation and training. This conclusion helps to explain why improvisation, most often thought of as an antidote to disaster, sometimes aggravates disaster. Our motivation for this research is to contribute toward advancing theory on the causes of failed improvisations so that we can learn how to mitigate them.

References

Abrantes, A.C.M., Passos, A.M., Cunha, M.P. and Santos, C.M. (2018), "Bringing team improvisation to team adaptation: The combined role of shared temporal cognitions and team

learning behaviors fostering team performance", *Journal of Business Research,* Vol. 84, pp.59-71.

Barasa, E., Mbau, R. and Gilson, L. (2018), "What Is Resilience and How Can It Be Nurtured? A Systematic Review of Empirical Literature on Organizational Resilience", *International Journal of Health Policy and Management*, Vol. 7 No. 6, pp. 491-503.

Barrett, F.J. (2012), *Yes to the mess: Surprising leadership lessons from jazz*, Harvard Business Review Press, Boston, MA.

Bartlett K., Nolan M. and Marraffino A. (2013), "Intuitive sensemaking: From theory to simulation based training", in Schmorrow D.D. & Fidopiastis C.M. (Eds), *Foundations of augmented cognition, lecture notes in computer science*, Springer, Berlin, Heidelberg, pp.3-10.

Barton, M.A., Sutcliffe, K.M., Vogus, T.J. and DeWitt, T. (2015), "Performing under uncertainty: Contextualized engagement in wildland firefighting", *Journal of Contingencies and Crisis Management*, Vol. 23 No. 2, pp.74-83.

Barton, M.A., Christianson, M., Myers, C.G. and Sutcliffe, K. (2020), "Resilience in action: leading for resilience in response to COVID-19", *BMJ Leader*, leader-2020.

Bechky, B.A. and Chung, D.E. (2018), "Latitude or latent control? How occupational embeddedness and control shape emergent coordination", *Administrative Science Quarterly*, Vol. 63 No. 3, pp.607-636.

Bechky, B.A. and Okhuysen, G.A. (2011), "Expecting the unexpected? How SWAT officers and film crews handle surprises", *Academy of Management Journal*, Vol. 54 No. 2, pp.239-261.

Bigley, G.A. and Roberts, K.H. (2001), "The incident command system: High-reliability organizing for complex and volatile task environments" *Academy of Management Journal*, Vol. 44 No. 6, pp.1281-1299.

Brown, A.D. (2018), "Making sense of the war in Afghanistan", *Critical Perspectives on Accounting*, Vol. 53, pp.43-56.

Burke, C.S., Stagl, K.C., Salas, E., Pierce, L. and Kendall, D. (2006), "Understanding team adaptation: A conceptual analysis and model", *Journal of Applied Psychology*, Vol. 91 No. 6, pp.1189-1207.

Catino, M. and Patriotta, G. (2013), "Learning from errors: Cognition, emotions and safety culture in the Italian air force", *Organization Studies*, Vol. 34 No. 4, pp.437-467.

CEIF (2017), *O Complexo de Incêndios de Pedrógão Grande e Concelhos Limítrofes, Iniciado A 17 de Junho de 2017*, Report, Universidade de Coimbra.

Christianson, M.K. (2019), "More and less effective updating: The role of trajectory management in making sense again", *Administrative Science Quarterly*, Vol. 64 No. 1, pp.45-86.

Clément, M.-L. and Roux-Dufort, C. (2020), "Too late to act: when crises become tragic", *Management Decision*, Vol. 58 No. 10, pp.2139-2153.

Colville, I., Pye, A. and Carter, M. (2013), "Organizing to counter terrorism: Sensemaking amidst dynamic complexity" *Human Relations,* Vol. 66 No. 9, pp.1201-1223.

Comissão Técnica Independente (2017), *Análise e apuramento dos factos relativos aos incêndios que ocorreram em Pedrógão Grande, Castanheira de Pera, Ansião, Figueiró dos Vinhos, Arganil, Góis, Penela, Pampilhosa da Serra, Oleiros e Sertã, entre 17 e 24 de junho de 2017*, Report, Assembleia da República, Lisboa.

Costa, F.S. (2017), "Tudo o que falhou em Pedrógão", *Expresso*, 21 October, p.15.

Cunha, M.P., Cunha, J.V. and Kamoche, K. (1999), "Organizational improvisation: What, when, how and why", *International Journal of Management Reviews*, Vol. 1 No. 3, pp.299-341.

Cunha, M.P., Kamoche, K. and Cunha, R.C. (2003), "Organizational improvisation and leadership: A field study in two computer-mediated settings", *International Studies of Management & Organization*, Vol. 3 No. 1, pp.34-57.

Cunha, M.P., Miner, A.S. and Antonacopolou, E. (2017), "Improvisation processes in organizations", Langley, A. and Tsoukas, H. (Eds), *The Sage handbook of process organization studies,* Sage, Los Angeles, CA, pp.559-573.

de Rond, M., Holeman, I. and Howard-Grenville, J. (2019), "Sensemaking from the body: An enactive ethnography of rowing the Amazon", *Academy of Management Journal*, Vol. 62 No. 6, pp.1961-1988.

Dinis, D. (2017), "O que quer o Governo do SIRESP?", *Público*, 22 August, p.44.

Dunbar, R.L. and Garud, R. (2009), "Distributed knowledge and indeterminate meaning: The case of the Columbia shuttle flight", *Organization Studies,* Vol. 30 No. 4, pp.397-421.

Eisenhardt, K.M. (1989a), "Making fast strategic decisions in high-velocity environments", *Academy of Management Journal,* Vol. 32 No. 3, pp.543-576.

Eisenhardt, K.M. (1989b), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp.532-550.

Endsley, M.R. and Smith, R.P. (1996), "Attention distribution and decision making in tactical air combat", *Human Factors*, Vol. 38, pp.232-250.

Expresso (2017), "Momento zero do fogo de Pedrógão", 24 June, p.40.

Expresso (2018), "Investigação de Pedrogão chega ao fim", 6 January, p.48.

Faria, N. and Valente, L. (2017), "Falhas no SIRESP já tinham acontecido e ajudam a explicar descoordenação", *Público*, 21 June, pp.2-4.

Fink, S. (1986), *Crisis Management: Planning for the Inevitable*, American Management Association, New York.

Fisher, C.M. and Barrett, F.J. (2019), "The experience of improvising in organizations: A creative process perspective", *Academy of Management Perspectives,* Vol. 33 No. 2, pp.148-162.

Garnett, J. L. and Kouzmin, A. (2007), "Communicating throughout Katrina: Competing and complementary conceptual lenses on crisis communication", *Public Administration Review*, Vol. 67, pp.171-188.

Giustiniano, L., Cunha, M.P. and Clegg, S. (2016), "The dark side of organizational improvisation: Lessons from the sinking of Costa Concordia", *Business Horizons*, Vol. 59 No. 2, pp.223-232.

Gonzalez, R.A. (2010), "Developing a multi-agent system of a crisis response organization", *Business Process Management Journal*, Vol. 16 No. 5, pp. 847-870.

Hadida, A.L., Tarvainen, W. and Rose, J. (2015), "Organizational improvisation: A consolidating review and framework", *International Journal of Management Reviews*, Vol. 17 No. 4, pp.437-459.

Hällgren, M., Rouleau, L. and de Rond, M. (2018), "A matter of life or death: how extreme context research matters for management and organization studies", *Academy of Management Annals*, Vol. 12 No. 1, pp.111-153.

Hardy, C., Maguire, S., Power, M. and Tsoukas, H. (2020), "Organizing risk: Organization and management theory for the risk society", *Academy of Management Annals*, Vol. 14 No. 2, pp.1032-1066.

Kahn, W.A., Barton, M.A., Fisher, C.M., Heaphy, E.D., Reid, E.M and Rouse, E.D. (2018), "The geography of strain: Organizational resilience as a function of intergroup relations", *Academy of Management Review*, Vol. 43 No. 3, pp.509-529.

Kendra, J.M. and Wachtendorf, T. (2003), "Elements of resilience after the world-trade center disaster: Reconstituting New York City's Emergency Operations Centre", *Disasters*, Vol. 27 No. 1, pp.37-53.

Langley, A. and Tsoukas, H. (2017), *The SAGE handbook of process organization studies*, Sage, London.

Levinthal, D.A. and March, J.G. (1993), "The myopia of learning", *Strategic Management Journal*, Vol. 14, pp.95-112.

Magni, M., Palmi, P. and Salvemini, S. (2018), "Under pressure! Team innovative climate and individual attitudes in shaping individual improvisation", *European Management Journal*, Vol. 36 No. 4, pp.474-484.

Mendonça, D. (2007), "Decision support for improvisation in response to extreme events: Learning from the response to the 2001 World Trade Center attack", *Decision Support Systems*, Vol. 43 No. 3, pp.952-967.

Mendonça, D. and Wallace, W. (2007), "A cognitive model of improvisation in emergency management. Systems, Man and Cybernetics, Part A: Systems and Humans", *IEEE Transactions*, Vol. 37 No. 4, pp.547-561.

Miles, M.B. and Huberman, M.A. (1994), *Qualitative data analysis,* 2nd ed., Sage, London.

Miner, A.S., Bassof, P. and Moorman, C. (2001), "Organizational improvisation and learning: A field study", *Administrative Science Quarterly*, Vol. 46 No. 2, pp.304-337.

Moorman, C. and Miner, A. (1998), "The convergence between planning and execution: Improvisation in new product development", *Journal of Marketing*, Vol. 62 No. 3, pp.1-20.

Guarda Nacional Republicana (2017), *Pedrógão Grande - Relatório final e despacho referente ao processo de inquérito Nº 06/17*, Report, Guarda Nacional Republicana.

Observador (2017), "As fotos na estrada da morte", 18 June, available at: https://observador.pt/2017/06/18/as-fotos-na-estrada-da-morte/ (accessed 8 January 2020).

Oliveira, M. (2018), "Foram 17 as falhas fatais no combate ao fogo de Pedrógão", *Público*, 28 September, p.12.

O'Toole, J., Gong, Y., Baker, T., Eesley, D.T. and Miner, A.S. (2020), "Startup responses to unexpected events: The impact of the relative presence of improvisation", *Organization Studies*, https://doi.org/10.1177/0170840620937859.

Paraskevas, A. (2006), "Crisis management or crisis response system? A complexity science approach to organizational crises", *Management Decision*, Vol. 44 No. 7, pp. 892-907.

Parnell, J. A. and Crandall, W. R. (2021), "What drives crisis readiness? An assessment of managers in the United States: The effects of market turbulence, perceived likelihood of a crisis, small-to medium-sized enterprises and innovative capacity", *Journal of Contingencies and Crisis Management*, https://doi.org/10.1111/1468-5973.12350

Pedro, T.L., Lopes, F. and Guerreiro, J. (2017), "Como foram as horas do Inferno", *Público*, 15 July, pp.2-9.

Ribeiro, L. (2017), "A estrada do Inferno", *Visão*, 22 July, pp.32-41.

Sherman, W.S. and Roberto, K.J. (2020), "Are you talkin' to me?: the role of culture in crisis management sensemaking", *Management Decision*, Vol. 58 No. 10, pp.2195-2211.

Smith, W. and Dowell, J. (2000), "A case study of co-ordinative decision-making in disaster management", *Ergonomics*, Vol. 43 No 8, pp.1153-1166.

Suarez, F.F. and Montes, J.S. (2019), "An integrative perspective of organizational responses: Routines, heuristics, and improvisations in a mount Everest expedition", *Organization Science*, Vol. 30 No. 3, pp.573-599.

Tabesh, P. and Vera, D.M. (2020), "Top managers' improvisational decision-making in crisis: a paradox perspective", *Management Decision*, Vol. 58 No. 10, pp.2235-2256.

Valente, L. (2017a), "Falharam 537 chamadas na hora fatídica em Pedrógão Grande", *Público*, 3 November, pp.8-9.

Valente, L. (2017b), "Actual plano de articulação no terreno é suficiente para a ANPC", *Público*, 18 September, p.8.

Van de Walle, B., Brugghemans, B. and Comes, T. (2016), "Improving situation awareness in crisis response teams: An experimental analysis of enriched information and centralized coordination", *International Journal of Human-Computer Studies*, Vol. 95, pp.66-79.

Vera, D. and Crossan, M. (2005), "Improvisation and innovative performance in teams", *Organization Science*, Vol. 16 No. 3, pp.203-224.

Veríssimo, A. (2017), "A metereologia, por si só, pouco importa", *Negócios*, 22 June, p.11.

Victorian Bushfires Royal Commission Final Report (2009), Report, Government Printer for the State of Victoria, Melbourne.

Vidal, R. and Roberts, K.H. (2014), "Observing elite firefighting teams: The triad effect", *Journal of Contingencies and Crisis Management*, Vol. 22 No. 1, pp.18-28.

Visão (2017), "Dentro do Inferno", 22 June, p.1.

Weick, K.E. (1993), "The collapse of sensemaking in organizations: The Mann Gulch disaster", *Administrative Science Quarterly*, Vol. 38, pp.628-652.

Weick, K.E. (1995), *Sensemaking in organizations*, Sage, London.

Weick, K.E. (2018), "Book review: Mark de Rond: Doctors at war", *Administrative Science Quarterly*, Vol. 63 No. 1, pp.1-4.

Weick, K.E. and Sutcliffe, K.M. (2001), *Managing the unexpected*, Jossey-Bass, San Francisco.

Weick, K.E., Sutcliffe, K.M. and Obstfeld, D. (2005), "Organizing and the process of sensemaking", *Organization Science,* Vol. 16 No. 4, pp.409-421.

Whiteman, G. (2010), "Management studies that break your heart", *Journal of Management Inquiry*, Vol. 19, pp.328-337.

Appendix 1. Timeline of events – 17 June to 23 June, 2017. Highlighted is the time period corresponding to the improvisational action which is the focus of this study

	June 17
10:00	Pedrógão Grande is considered to be under very high risk of fire. Civil Protection in yellow alert.
14:28	Possible start of the fire according to the testimony of the Spanish firefighter Aitor Soler.
14:38	IPMA (i.e., *Institute for the Ocean and Atmosphere*) detects first electric discharge in the area, although far (23 kms) from the site of the fire. Other similar phenomena take place until 14:48.
14:39	Daniel Saúde, a civilian, makes a phone call to 112 when he saw smoke in Escalos Fundeiros. This phone call defines as "moment zero".
14:43	Start of the fire according to the report of GNR (i.e., National Republican Guard)
14:43	Alert of rural fire in Escalos Fundeiros, Pedrógão Grande, district of Leiria. 52 operational, 13 vehicles and one helicopter are mobilized.
14:52	Alert of rural fire in Fonte Limpa, district of Coimbra.
15:07	Classification of occurrence changes to the status of "high importance". CNOS (i.e., *National Relief Operations Command*) requests heavy bomber helicopter of amplified attack.
15:10	Augusto Arnaut, commander of the fire brigade of Pedrógão Grande assumes the command of the operations.
15:11	Operational apparatus is reinforced with the arrival of fire brigades from Leiria. 93 operatives and 245 vehicles and two aerial resources.
15:12	One more helicopter is called.
15:40	Alert of rural fire in Moinhos Fundeiros, Figueró dos Vinhos, Leiria.
16:24	COS (i.e., *Commander of Relief Operations*) installs PCO (i.e., *Operational Command Post*) in Escalos Fundeiros.
16:26	Alert of rural fire in Pinheiro do Bordalo, Pedrógão Grande.
17:01	Three fronts of intense fire are identified.
17:08	Mário Cerol, second operational commander of the Leiria district departs for the site.
17:13	COS (i.e., *Commander of Relief Operations)* requests presence of INEM (*Institute of Medical Emergency)* team in operational theatre.
18:14	Four fronts of fire, 60% of them "burning freely".
18:25	New helicopter is actioned. Ten minutes later two Army's track machines are actioned.
18:48	News from LUSA (a Portuguese news agency) refers to the first threat to houses.
18:50	GNR cuts traffic in IC8 before the Industrial Zone knot (knot of CM 1166, near Pedrogão Grande), 9.0 km east of the knot with EN236-1.
18:53	New electric discharge cloud-ground is registered, closer to the fire (7.3 km)
18:58	VCOC (i.e., *Command and Communications Vehicle*) positioned in Escalos Fundeiros, advises that it does not have access to SADO (i.e., *Operational Decision Support System)* because of lack of access to Internet. **This is the first notification of a communication failure.**
19:02	GNR cuts traffic in IC8 in the Troviscais/Mosteiro knot (knot of M 516), 6.6 km east of the knot with EN236-1
19:06	Observation in the zone of Cardigos of a pattern suggestive of downburst – a phenomenon in which descending currents that are extremely strong and organized spread in several directions as they hit the ground. Several identical phenomena are observed in the Center and Alentejo regions, mostly with only local consequences.
19:16	Intensification of the fire, which peaks at 19:50 to 20:00. A downburst is presented as a possible explanation.
19:16	GNR cuts traffic in IC8 in the Vila Facaia/Graca/Outáo knot (knot of CM 1170), 3.5 km east of the knot with EN236-1.
19:25	Dispatch of a vehicle in Mosteiro with three occupants, to a burning area. One of the occupants suffers burns to 90% of the body.
19:36	IPMA (i.e., *Institute for the Ocean and Atmosphere*) classifies an occurrence in Cardigos as a macroburst, which propagates westward. Wind reaches 117km per hour at 650 meters of altitude.
19:38	SIRESP (emergency communications system) station in Pedrógão Grande, one of the 16 that cover the area of the fire, suffers transmission cuts and operates only in local mode.
19:44	"Posto de Comando" (i.e., *Command Post*) informed that there are houses burning in several localities.
19:45	First failures of GSM (*Global System for Mobile communications)*. The Fire Department of Pedrógão Grande informs about the loss of low frequency signal. **This is a further communication failure.**

19:45	GNR cuts traffic in IC8 in the knot with EN236-1. Traffic from the West is redirected in three possible directions: U-turn in the same IC8 heading West; EN236-1 South towards Figueiró dos Vinhos or EN236-1 North towards Castanheira de Pêra.
19:49	Announcement of rural fire in Castanheira de Pera. Seven operatives and two vehicles mobilized.
19:53	CDOS (i.e., *District Command of Relief Operations*) Coimbra informs CDOS (i.e., *District Command of Relief Operations*) Leiria that the locality of Vermelho is surrounded by fire.
19:58	Pedro Nunes, Operational Commander of the Center North region, arrives in the operational theatre.
20:06	CDOS (i.e., *District Command of Relief Operations*) Leiria requests two ambulances for transport of evacuees.
20:10	Probable time when the fire reaches EN236-1.
20:15	GNR cuts traffic in IC8 in the Figueiró dos Vinhos – West knot (knot of EN237), 3 km west of the knot with EN236-1.
20:25	Rural fire in F. dos Vinhos, No record of mobilization of means. **The absence of a record suggests a further communication failure.**
20:25	Civilian reports of a missing person in the place of Mó, surrounded by fire.
20:26	SIRESP (the emergency communications system) station in Malhadas and Pampilhosa da Serra enters local mode. **This is a further change to a more restricted communication status.**
20:29	LUSA (a news agency) reports that the population of Pedrógão Grande is afraid that the fire is provoking electricity cuts and is out of control because of strong winds. **These electricity cuts involve further communication failure.**
20:30	Ten victims in the place of Nodeirinho.
20:32	SIRESP (the emergency communications system) station in Serra da Lousã enters local mode. **This is a further change to a more restricted communication status**.
20:45	Municipal plan of emergency is actioned in Pedrógão Grande.
20:54	New cloud-ground electrical discharge registered by IPMA (*Institute for the Ocean and Atmosphere*) at 8.3 kms from the fire.
20:55	CNOS (*Relief Operations Command*) contacts the chief of informatics and communications of Civil Protection soliciting the repositioning of the antennas of SIRESP (emergency communications system) in the regions of Pedrógão Grande and Figueiró dos Vinhos **A further sign of communication challenges.**
21:00	GNR has 17 patrols in Pedrógão, with 37 military and 19 vehicles. Of the several forces on the ground this is the only force with no redundant or alternative communication networks. **Agents are forced to use conventional networks, which have been affected by the communication failures.**
21:04	Civilian informs that in the place of Várzeas-Vila Facaia houses are being consumed by fire.
21:09	4-year-old is reported missing in Lameira Fundeira.
21:12	SIRESP (emergency communications system) informs ANPC (*Civil Protection Agency*) of the fall of the base stations: Serra da Lousã, Malhadas and Pampilhosa da Serra
21.13	20 people surrounded by fire in Pobrais.
21:15	The cabinet of the secretary of State of Internal administration request two SIRESP mobile stations to be requisitioned to the area. SGMAI (i.e., *General Secretariat of the Ministry of Internal Affairs)* received no reports of problems with communications. **A further sign of communication problems.**
21:20	ANPC (i.e., *Civil Protection Agency)* reports first mortal victim in road Alagôa to Vila Facaia.
21:22	Because of difficulties with SIRESP (emergency communications system), use of "Rede Operacional de Bombeiros" (i.e*., Firefighters Operational Network*) (redundant network).
21:29	ANPC (i.e., *Civil Protection Agency)* solicits SIRESP (emergency communications system) to introduce two mobile stations. It is informed that Station 1 is non-operational and station 2 is under repair. **A further sign of communication problems.**
21:44	Sargento-Ajudante Martins circulates through IC8 encountering several patrols.
21:55	ANPC (i.e., *Civil Protection Agency)* updates means on the ground: 475 operatives supported by 142 vehicles, including 4 aerial means.
22:04	PCO (i.e., *Operational Command Post)* requests two teams of psycho-social support.
22:15	GNR closes EN236-1 after locating the first of the 34 mortal victims in this road: 30 in a small section of the road (north of IC-8) and 4 some kms ahead. Another 12 mortal victims were found in access routes to EN236-1 to which they had flocked in attempt to escape fire.
22:26	Situation Room of GNR requests collection of corpse between Alagôa and Vila Facaia and collection of 4 corpses on the road between Castanheira de Pedrógão and Sarzedas de São Pedro.
22:30	The President of the Republic leaves Lisbon to Pedrógão.
22:30	Presumed time of the deaths in Pedrógão.
22:48	The cabinet of the SGMAI (i.e., *General Secretariat of the Ministry of Internal Affairs)* and the ANPC (i.e., *Civil Protection Agency)* are informed that GNR's mobile station cannot be sent to the site as it is

	being repaired after a piece was broken during the Pope's visit to Fátima. **This is a further communication failure**.
23:15	CDOS (i.e., *District Command of Relief Operations)* Leiria contacts CNOS (i.e., *National Relief Operations Command)* informing that it cannot make contact with PCO (i.e., *Operational Command Post)* via the telecom operators of their personal phones. **This is a further communication failure**.
23:30	ANPC (i.e., *Civil Protection Agency)* asks EDP (an energy company) to mobilize electrical generators for energy provision in Figueiró dos Vinhos and Pedrógão.
23:45	The Government makes the first report of the case: 19 deaths, all civilians, 16 dead, burnt alive, inside their cars in EN236-1 and 3 who have died from smoke inhalation in Figueiró. 20 people are missing.
	June 18
01:00	Minister of Internal Affairs arrives on site.
01:02	CDOS (i.e., *District Command of Relief Operations*) solicits an emergency meeting to CNOS' (i.e., *National Relief Operations Command)* Emergency Operations Officer to insist that PT Telecom (a telecommunications company) solve the constant breakdown of SIRESP (emergency communications system) and Internet in the PCO.
01.02	The Protection and Relief Intervention Group of the GNR arrives in the theatre of operations with 44 military and 14 vehicles.
01:20	The President speaks about the tragedy for the first time.
02:21	CNOS (i.e., *National Relief Operations Command)* requests support from Spain.
02:30	Meeting of the "Comissão Distrital de Proteção Civil" (i.e., *District Commission of Civil Protection*). The "Plano Distrital de Emergência" (i.e*., Emergency District Plan*) is activated for the three counties.
02:37	Team of the INML (i.e., *National Legal Medicine Institute)* for dealing with massive disasters travels to Pedrógão. Several PJ (investigation police) transports are already on the scene.
03:15	Prime-Minister advises that the fire has possible been provoked by a dry storm.
03:21	CNOS (i.e., *National Relief Operations Command*) requests support from the European Emergency Response Coordination Centre.
03:53	SIRESP (emergency communications system) base station of Figueiró dos Vinhos enters local mode. **A restriction of communication channels.**
04:10	Secretary of State updates the number of dead: 25.
09:30	The national director of PJ (investigation police) excludes criminal original informing that the tree hit by the lighting has been found.
09:32	SIRESP (emergency communications system) mobile station is activated in the area of Pedrógão. **A change in communication channels.**
10:00	Secretary of State updates the number of dead: 57.
10:00	Tests to activate mobile station begin. **A further sign of communication problems.**
11:10	CDOS (i.e., *District Command of Relief Operations)* tries to communicate with SIRESP (emergency communications system) and ROB with no success **A further sign of communication failure.**
12:00	Update of the number of dead: 58
12:14	SIRESP (emergency communications system) base station in Pedrógão is disconnected by order of SGMAI (i.e., *General Secretariat of the Ministry of Internal Affairs)* communicate only via the mobile station in order to avoid interference **A further sign of communication failure.**
13:20	SIRESP (emergency communications system) base station in Pampilhosa is disconnected by order of SGMAI (i.e., *General Secretariat of the Ministry of Internal Affairs)*. **A further sign of communication failure.**
13:53	SIRESP (emergency communications system) base station in Malhadas is disconnected by order of SGMAI (i.e., *General Secretariat of the Ministry of Internal Affairs)*. **A further sign of communication failure.**
15:45	SIRESP (emergency communications system) base station in Lousã is disconnected by order of SGMAI (i.e., *General Secretariat of the Ministry of Internal Affairs*). **A further sign of communication failure.**
16:55	**Communication failures persist.**
23:05	Update of the number of dead: 62.
	June 19
11:44	SIRESP (emergency communications system) base station in Pedrógão resumes normal functioning. **Communication channel reopens**.
12:04	Due to failures in the communications network ANPC (*Civil Protection Agency)* requests dislocation of the SIRESP (emergency communications system) base station in Pedrógão to Chã de Lavares.
20:15	Update of the number of dead: 64.
21:10	SIRESP (emergency communications system) base station in Figueiró resumes normal functioning. **Communication channel reopens.**

	June 20
12:43	Activated bilateral protocol with Morocco.
15:27	SIRESP (emergency communications system) base station in Malhadas resumes normal functioning. **Communication channel reopens.**
19:15	SIRESP (emergency communications system) base station in Pampilhosa resumes normal functioning. **Communication channel reopens.**
	June 22
23:49	ANPC (*Civil Protection Agency*) changes the classification of the Pedrógão fire to "Conclusion".
	June 23
18:30	Preliminary data of the ICNF (i.e., *Institute for Nature Conservation and Forests)* reveal that the fires of the Center region consumed almost 53,000 hectares. It is the largest burned area ever in Portugal.

Sources: Expresso (2017), Comissão Técnica Independente (2017), and mainly Pedro *et al.* (2017).