

# Changing collaborative tools. Introductory Dynamics of Digital Collaborative Tools in Civil Security's Ecologies of Artifacts.

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## ABSTRACT

Introducing new digital collaborative tools in civil security is a recurrent issue in crisis informatics research. Our work aims to understand key dynamics in the introduction of the tools used for collaboration by civil security through the lens of the concept of ecology of artifacts (EoA). We identify multiple evolutionary movements based on real-life tool's cases inside the EoA of French firefighters of the Moselle region (SDIS57). Our research method is based on qualitative data collection through inter-service training observations and semi-directive interviews with active professionals. A thematic analysis reveals a dense, sometimes redundant and inter-connected EoA, constantly evolving through at least 6 movements: 4 related to the introduction of a new digital collaborative tool (personal-to-organizational, bottom-up, top-down and horizontal), 1 related to the realignment of an adopted tool and 1 related to a tool's replacement. Our research aims to facilitate the introduction of future digital collaborative tools for civil security and guide crisis management system's design and policy makers) towards working with pre-existing EoA instead of replacing it.

## Keywords

ecologies of artifact ; civil security ; introduction of digital collaborative tools; collaboration

## INTRODUCTION

Civil security services' populations (*i.e.* firefighters, health services, government official, police, etc.) base their work on a set of digital collaborative tools, sometimes specifically created for crisis management like Robust (Jendreck et al., 2023) or Nishikawa et al.'s tracking map web application (2018). But 45 per cent of implemented tools for crisis management are deemed unnecessary by their users, and 39 per cent of their needs are unfulfilled, calling for new tool to be introduced (Elmasllari, 2019). This shows issues in the current tool introduction process and we identify a need for a better understanding of collaborative tool introduction dynamics in civil security.

The introduction of new tools is a recurrent topic in ISCRAM research. Studies identify obstacles and facilitators when civil protection agencies adopt collaborative tools (Al-Akkad & Raffelsberger, 2014; Farnham & Pedersen, 2006; Fertier et al., 2016; Robinson et al., 2015), and collect use cases of collaborative tools from civil security users' perspectives (Elmasllari, 2019). However, such analysis usually focus on one specific tool at a time, setting aside all that can be learned by considering all the available tools as an ensemble. This narrow focus can create discrepancies between research findings and the realities of the technological environment, as well as challenges in tool introduction. For example, a new digital tool may be rejected because it does not integrate well with the other existing tools within the civil security collaborative work environment. In this context, we identify two key gaps:

first, a lack of understanding of the existing collection of collaborative tools in civil security, and second, a gap in understanding how the introduction of a new digital collaborative tool impacts or is influenced by the other tools already in use.

Our work proposes the Ecology of Artifacts (EoA) framework to fill these gaps. By approaching the collection of civil security's digital collaborative tools and practices as an EoA, we enable the simultaneous consideration of multiple tools in their evolutionary dimension at a grouped, organizational or personal level (*i.e.* Bødker et al., 2017; Furniss et al., 2011).

While research about EoAs has been growing these last years (Cormi et al., 2022, Lyle et al., 2020, Larsen-Ledet et al., 2020), the ecologies of artifacts of firefighters has not benefited from enough consideration despite the important challenges it poses for cooperation and coordination through technology.

Through our study, we aim to contribute to a better understanding of the introduction mechanisms of new digital collaborative tools within civil security's EoA. Our study seeks to understand the dynamics involved in the introduction of a new digital collaborative tool into civil security's EoA, drawing on real-world cases of civil security tools. To achieve this, our research approach is informed by CSCW and practice-based computing (e.g., Wulf et al., 2018; Ley et al., 2012).

We start by presenting related work addressing the digital collaborative tools in civil security, their introduction, and the concept of EoA. Then, we present our qualitative research approach in the context of our field work at French firefighters of Moselle's workplace (SDIS57). It consists of a thematic analysis of 27 semi-directive interviews and 1 inter-service training observation with Moselle's civil security professionals. Our findings depict a dense collection of sometimes redundant and inter-connected tools composing French civil security's EoA. These EoAs are constantly evolving through at least 6 identified introductory dynamics, which we call *movements*. We present them with details as the main contribution of our study. We discuss the different movements we identified regarding the evolution of EoAs and potential learnings for the future of crisis management technology deployment and design.

## RELATED WORK

After detailing digital collaborative tools in civil security services, we report on previous work on introducing those tools. We highlight in particular that supporting cooperation in civil security through technology is complex. It involves the use of many different tools, and research shows a blending between professional and non-professional technology. Then we present the concept of ecology of artifacts (EoA) as a relevant perspective for accounting for this complexity.

### a. Digital Collaborative Tools in Civil Security Services

In this article, we designate all software and hardware involved in collaborative activities as digital collaborative tools. We focus on civil security's groupware, collaborative software that professionals use to manage their organization and operations. The initial definition of groupware comes from Ellis et al. (1991) in Computer-Supported Cooperative Work (CSCW), stating that groupware are "computer-based systems that support groups of people engaged in a common task (or goal) and that provide an interface to a shared environment." (Ellis et al., 1991). Among the most known typologies of groupware, Baecker et al. (1995) categorize different kinds of software applications (*i.e.* message systems, multi-user editors, video conferencing) in two dimensions: synchronous/asynchronous and multiple/same meeting sites. The digital collaborative tools considered in this study are primarily software solutions that support cooperation, coordination, and communication among various civil security actors.

### b. Challenges in the introduction of digital collaborative tools in crisis management

The introduction of IT emergency response and collaboration tools is reported as a challenging issue involving a complex alignment between the offer and users' needs. This subject is a major interest for CHI, specially in the light of recent emerging technologies for the workplace like the growing use of social networks by emergency response services for example (Elmasllari, 2019). (Reuter, 2022). In our work, we focus on when the tools are introduced and on the mechanisms of its introduction: why has it been introduced, for what reasons, how is it supposed to be use for, etc. Therefore, we focus on phases happening outside of any efforts related to adoption, feedback, and/or use facilitation. This interests still benefits from the multiple studies about success/failure factors in new technology's adoption (*i.e.* interoperability issues, trust in technologies, resistance to change). For example, Granholm (2017) explained that getting knowledge about a new technological tool's use during a crisis puts an extra load on the professionals. Elmasllari shows that emergency responder's reject attitude towards IT and proposes

elements to tackle this rejection to future system's designers. We will not focus on identifying additional factors, as many authors have already addressed this aspect extensively.

Most research about deploying digital collaborative tools in civil security focus on one tool. For example, Farnham and Pedersen (2006) followed the field deployment of a peer-to-peer collaboration system (Groove) that was provided for supporting ephemeral work groups during the Katrina hurricane. Heard et al. (2014) designed a teleconferencing system over maps for supporting shared situational awareness they evaluate with a field deployment for school closure decisions during winter weather. de Lanerolle et al. (2010) follow the deployment of a distributed asynchronous information-sharing platform (Collabit) that aims to create a common operating picture of events and provide incident update channels. All these studies highlight the complexity of introducing a new tool in civil security practices.

However, they do not consider existing tools in their analysis, even though Robinson et al. (2015) highlighted the complexity of technical infrastructure in emergency response situations as a potential challenge in the introduction of new tools. A key issue is the integration process when introducing a new tool in a landscape crowded with digital tools (Munkvold, 2023). More knowledge is needed about the introduction of new artifacts and how such integrations are achieved. This underscores the need for further studies aimed at better understanding the success of digital collaborative tool introductions in relation to the broader technological environment already in place.

### c. Artifact ecologies' definition

Civil security collaboration is supported by a dense web of hardware and software (Robinson et al., 2015, Potter, 2016). Those are the everyday tools civil security professionals are using.

This echoes the concept of Ecology of artifacts (EoA) defined by Jung et al. (2008) as “the set of physical artifacts that a person possesses, and that allows a certain level of interactivity through digital technologies”. About ten years later, Lyle et al. (2020) point to the diverse terms used in HCI research to describe user interaction across multiple artifacts that echo the concept of EoA, meaning they are defined as a set of artifacts (software, hardware, and devices) that a person (or a group of persons) uses while supporting their cooperation.

The dimensions that can be considered through the EoA concept slightly vary depending on the theoretical frameworks used (e.g., Activity Theory, Distributed Cognition), but the core interests remain consistent. Rossitto et al. (2014) provide an excellent example of an EoA study of collaborative work through their field study of the constellation of technologies in use in a nomadic work setting among university students working on projects. These students employ a wide range of artifacts to manage their projects, including whiteboards, screens, laptops, videoconferencing applications like Skype, Jaiku, or Basecamp, cell phones, post-its, and others. These tools are not always used together but are selected depending on the specific context. These elements constitute the students' collaborative EoA, which Rossitto et al. describes in great detail to enhance the understanding of nomadic work.

Bødker and Klokmoose (2012) use the notion of EoA to account for the evolution of the collection of artifacts owned and used by a person. They focus on how tensions in use and the introduction of a new artifact (for instance, a smartphone as a replacement for a cellphone) lead to a reconfiguration of a personal EoA, for instance, discarding the digital music player because the smartphone offers this feature. Further work expands the application of the concept to account of the description and evolution of EoA at the scale of collectives and organizations (Korsgaard et al., 2022) with new artifacts integrated or discarded along the evolution of a group activity at different scale (Rossitto et al., 2014; Bødker et al., 2016). The ability to consider personal, grouped and organizational levels is an original lens brought by the concept of EoA, unlike with the concept infrastructure (Robinson et al., 2015). Moreover, EoAs allow us to consider the complex organisation of such a sociotechnical, digital and material collaborative ensemble, that may not interfere with the infrastructural perspective, but that we will not be observing further in this work.

Larsen-Ledet et al. (2020) point that not all artifacts of an EoA are used simultaneously and that an intersection of one or some artifacts belonging to the members' personal EoA is shared on the occasion of cooperation. They call the resulting intersection of individual or organization EoAs an *aligned ecology of artifacts*. It is assembled to achieve a cooperative practice, for instance, in their study on collaborative writing. The success of the aligned EoA for user support appears to be key in keeping or recruiting an artifact in a personal or organization EoA. Indeed, introducing an artifact that prevents or compromises the collaborative practice impairs cooperation and may lead to its discarding. In our fieldwork and analysis, we are interested in such aligned EoA and the cases shared about introducing a new artifact in the EoAs of civil security organizations.

## PARTICIPANTS AND METHODS

In order to better understand civil security's artifact ecologies changes through time, we have initiated a qualitative study in order to build a view of the available digital collaboration tools and their use. SDIS57, a departmental unit of firefighters, was selected to serve as the source of our study. First, as a background for the presentation of our findings, we position the SDIS57 in the organization of civil security in the French context (a). Then we present our research approach inspired by CSCW and practice-based computing (Wulf et al., 2018; Ley et al., 2012). Our fieldwork articulates document analysis, observation (b) and interviews with key stakeholders (c). We provide details about our method and present our thematic analysis approach (d) that focuses on the cases shared by our informants about the arrival and disappearance of digital collaboration tools in their daily practices.

### a) The organization of French civil security

In France, the management of natural crises, social crises, and technological crises is carried out by civil protection personnel. The professions involved are mainly fire departments (SDIS) managed by operational centers on a departmental level (CODIS), hospital staff (SAMU), police and gendarmerie services, regional health department (ARS), zonal prefectures (CEMIZA) and the zonal headquarters (EMIZ).

The civil protection services are hierarchically organized at different levels, from local areas to national supervision. At the local level, we find all the services operating on the ground that can intervene physically. In order to give an overview, in France there are:

- 94 SDIS (Services Départementaux d'Incendie et de Secours or firefighters), operationally coordinated by 96 CODIS (Centres Opérationnels Départementaux d'Incendie et de Secours),
- 105 emergency medical services (SAMU),
- 101 prefectures (CEMIZA),
- 17 regional health departments (ARS)

Each of these departments has its own organization and process, and they are also used to cooperate. They are all subject to the same higher hierarchical authorities at departmental (COD), zonal (EMIZ / COZ), and national (COGIC) levels. Our study focuses on the SDIS of Moselle (57), containing approximately 5.000 firefighters for a population of approximately a million people.

### b) Observation

In line with other field studies on artifact ecologies (Bødker et al., 2016; Hutchins & Klausen, 1996), field observations allow us to grasp the uses and practices of digital collaborative tools. That's why we started our process by attending a half-day inter-service training session in Metz (France) in the spring of 2024, involving the fire department, SAMU (emergency medical service), police, armed services, headquarters and various international civil protection observers. The aim of these mock crisis situations is for civil protection professionals to train their practice in close-to-real situations. Thanks to the volunteers we met during this training, we also had the opportunity to visit buildings dedicated to crisis management, in particular control rooms, and PCs, nomadic command centers. In general, we observed the collaborative practices at play, the various collaborative digital tools used, the equipment used and the actual means of communication in the field. Feedbacks from these observations take the form of field notes.

### c) Interviews

We have conducted 27 semi-directed interviews (Table 1) with different professionals from French civil security (some we met several times). Each interview lasted between 1h and 1h30 and was conducted either by videoconferencing, phone or face-to-face at their workplace.

The semi-structured interviews were conducted based on a pre-written interview guide with open-ended questions. The non-exclusive questions focused mainly on civil security organizations, digital tools used daily, and existing collaborative practices, both during and since the COVID period. All participants agreed to be recorded. Transcriptions were made with Whisper on the Humanum research platform<sup>1</sup>.

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<sup>1</sup><https://www.huma-num.fr/>

ID	Job	Nb of exchanges	Department
SDISSANTE1	Fire station manager & director of medico-social establishment	2	SDIS
SDIS1	Head of column	1	SDIS
SDIS2	Company Commander	1	SDIS
SDIS4	Preventionist	2	SDIS
SDIS5	R&D Advisor	3	SDIS
SDIS6	Territory advisor	1	SDIS
SDIS7	Head of administrative coordination	2	SDIS
SDISPREF1	Liaison officer	1	SDIS and prefec-ture
SDISEMIZ1	Business advisor	4	EMIZ and SDIS
SDISEMIZ2	Health executive	1	SDIS then EMIZ
SDISEMIZ3	Human relations	1	SDIS then EMIZ
SDISEMIZ4	Training Department Manager	1	SDIS then EMIZ
SDISEMIZ5	Center and unit manager	1	SDIS then EMIZ
CEMIZA1	Interministerial Chief of Staff	1	CEMIZA
CEMIZA2	Support services	2	CEMIZA
EMIZ1	Department Commander	1	EMIZ
ARS1	Departmental Manager	1	ARS
SDISCODIS1	Room and unit manager	1	SDIS and CODIS
COZ1	Lieutenant-colonel	1	COZ

**Table 1. List of all interviewee's ID, department, jobs, and number of exchanges**

#### d) Thematic analysis

We have conducted a thematic analysis of our interview transcripts and field notes (Braun and Clarke, 2021). We extracted quotations from each interview. We first ordered them by period (*i.e.*, COVID or post-COVID), affiliation, tool and/or practice and stored them on a protected web-based document-sharing space. We approached our analysis by adopting a practices-based computing studies lens, based on field-study ethnographic and CSCW work (Wulf et al., 2018; Ley et al., 2012). Our thematic analysis was partly theoretically driven by the concept of EoA. Regarding the introduction of digital collaboration tools, our approach has been driven by the emergent themes and the recurrent arrangements we identified in the cases shared by our informants.

## FINDINGS

In this section, we present the characteristics of civil security's EoA and develop the multiple introduction movements among civil security's ever-changing EoA. We illustrate each kind of movement with a real-life case of a tool.

#### a) Density, redundancy and interconnected digital collaborative tools in the SDIS57 EoA

According to the professionals, the SDIS57's EoA contains a lot of digital collaborative tools. This density generates negative reactions, as illustrated in the following quote:

*"Because there are too many things... After that, people don't know where to look. [...] When you multiply things, it's complicated."* SDISEMIZ2

Some of these tools are redundant. For instance, for the storage and sharing of digital files, the professionals mentioned several artifacts such as Alfresco, NextCloud, RESANA, and an internal NAS. In practice, these tools are used while staying at the office between interventions to share documents and co-write them with professionals from the same or different services. Professionals also mention that they store completed mission reports on cloud solutions, allowing them to access the documents even when working remotely. Professionals are used to switch from one tool to another according to several criteria (*i.e.* sharing capacity, department belonging, size, activity.), but they only use one or two of these artifacts on a daily basis, highlighting the presence of multiple redundant artifacts for communication within their EoA.

This redundancy is also evident in the communication channels: e-mails, Whatsapp, Rocketchat, texts or phone calls, are the most reported. The professionals we met identify e-mail as the primary communication channel for official communications or national orders, typically accessed via their mobile phones or computers, while

WhatsApp is used for more informal communication, such as coordinating with firefighters in southern France or quickly checking colleagues' availability during major fires. Professionals must also choose which tool to use based on various criteria (*i.e.* information traceability, urgency, confidentiality) again highlighting the heterogeneous nature of their EoA.

We also identify several videoconferencing tools, ranging from Lifesize to Zoom to Klaxoon to Microsoft Teams to WebConfComu. Firefighters use these tools for meetings with professionals located far from the meeting organizer, such as in southern France for the SDIS57, noting that it reduces travel time and risks. They also relied heavily on them during the COVID-19 period to minimize the risk of contamination. Even in the post-COVID-19 era, they continue to use various videoconferencing tools, depending on the preferences of the meeting participants, demonstrating the presence of many redundant tools serving the same function within their EoAs. However, the unused tool are not decommissioned but are simply set aside until needed again.

The ecology of the civil security population's artifact also contains some intercommunicating tools that interact and are combined to accomplish a goal. For example, a telephone report, a report on SYNERGI and many emails exchanges can be combined in order for the operational center CODIS to trigger the crisis intervention process, call in the available professionals and keep track of its unwinding, as illustrated in the following quote:

*"A CODIS will call back the COS which is activated and say "we have a particular event [...] going on", and the COS will take note of circumstantial elements, which will be followed by the creation of events in SYNERGI."*  
CEMIZA1

The multiple tools available within one's EoA are used in conjunction to initiate and support the intervention.

Following our investigations, we built a partial typology of civil security tools, representing its complex composition:

- Human resources tools are used to manage the different aspects of firefighter's everyday life ensuring they receive appropriate support in their professional work. (*i.e.* Agendis, Artémis, Antibia, Escort, Medisap, GEEF);
- Operational management systems are used to manage on-site operations in real time during a crisis, for example, to track the number of deployed professionals and trucks, available ambulances, etc. (*i.e.* ORSEC-SYNERGI, SYNAPSE);
- Mapping tools are used to manage on-site operation in real time during a crisis, visually representing the overall situation, such as displaying the spread of a fire or identifying the locations of the nearest water sources, etc. (*i.e.* Geocarto, IDIC-SI, Tacmap, Crimson tactic);
- Communication channels, official and/or unofficial, as previously stated, are used for a variety of information sharing, both during crisis interventions for crisis management and outside of crisis events for everyday communication with colleagues (*i.e.* GLPI tickets, Rocketchat, WhatsApp, texts, Viapel, Bluemind, Zimbra, MAARCH courrier);
- Videoconferencing tools are primarily used to attend meetings without the need for travel and/or to mitigate health risks during the COVID-19 pandemic (*i.e.* WebConfCommu, Microsoft teams, Google meet, Facetime, Lifesize, Zoom);
- Project management tools are mainly used by project managers to track team tasks and achievements, outside of practical interventions. For example, executives in the direction department may use them to create presentations, mental maps, and share collaborative thinking spaces during meetings (*i.e.* Klaxoon, z0 Gravity);
- Platforms are used to store and/or share documents with different individuals and/or during remote work for example, as previously stated (*i.e.* a protected internal Cloud, an internal NAS, Alfresco, RESANA, NextCloud);

These digital collaborative tools are shared at different levels: within fire stations (*e.g.* Agendis for daily operational organization of schedules), between fire departments (*e.g.* switching to the SDIS54's servers in the event of intranet failure), with other services such as the health sector, headquarters or police (*e.g.* ORSEC-SYNERGI for operational crisis management on a regional or national scale), and so on.

## b) Evolutions in the Ecology of Artifacts (EoA) of SDIS57

Our analysis shows that the civil security EoAs is changing through different movements. That may involve already existing artifacts, as well as newly introduced tools. We identified 6 evolutionary dynamics related to the introduction of a new tool and/or the new function of an old tool. First, 4 ways to introduce a new tool in civil security's EoA:

- 1) the introduction of a new digital collaborative tool coming from a personal ecology to an organizational EoA ([WhatsApp](#)<sup>1</sup> case);
- 2) the bottom-up introduction of a new tool initially used by one individual later spread to the rest of the service ([Kdelib](#)<sup>2</sup> case);
- 3) the top-down vertical organizational introduction of a new tool ([Agendis](#)<sup>3</sup> case);
- 4) the horizontal introduction of a tool from one service to another ([Crimson Tactic](#)<sup>4</sup> case);

Second, a way of reusing already adopted tools:

- 5) Integrating already available tools to create a new aligned EoA (COVID-19 intervention screening case);

And last, the replacement of old tools by new ones, combining introduction and decommissioning:

- 6) the organizational request for tool replacement ([Artémis/Smartémis](#)<sup>5</sup> case);

We detail each of those movements in the following section.

### 1) From personal to organizational EoA -

#### [WhatsApp](#)<sup>1</sup> case

Professionals in a private context initially used some tools that gradually became part of their professional organizational ecology. For instance, WhatsApp, an instant communication application initially used inside one's family, is now widely used for rapid, unofficial and instantaneous exchanges of information both within and between departments, as shown by the following quote:

*"For example, [...] we used sandbag Whatsapp groups to inform all our divers that we were in a flooding phase and that we needed personnel. As a result, we managed to repatriate a large number of people thanks to this system."*  
SDISEMIZ5

In this example, Whatsapp is being used to contact flood-experts firefighters in order to operationally intervene during a crisis situation. However, the use of WhatsApp is a source of tension because it is not recommended by the IT department, mainly due to the unwarranted confidentiality of exchanges. Moreover, the use of WhatsApp for instant communication is redundant with Rocketchat, which is similar but warrants confidentiality through restricted use through professional computers and its configuration by the IT department. Professionals find themselves juggling depending on the information to be shared and the recipient, as this quote illustrates:

*"WhatsApp is much more practical for managing volunteers, clearly. But RocketChat is more, shall we say, professional messaging"* SDISEMIZ2

Firefighters do not mention Rocketchat on their own when they recount an operational experience.

<sup>1</sup><https://www.whatsapp.com/>

<sup>2</sup><https://dockdelib.qualigraf.fr/Accueil.html>

<sup>3</sup><https://play.google.com/store/apps/details?id=fr.astillia.AgendisMobile&hl=fr&pli=1>

<sup>4</sup><https://www.crimson.eu/fr/solutions/crimson-tactic>

<sup>5</sup><https://play.google.com/store/apps/details?id=com.sis.smartemis&hl=fr&pli=1>

## 2) Bottom-up introduction, coming from one individual and extending to the whole organization - Kdelib<sup>2</sup> case

The push to introduce a new tool into civil security's EoA can also originate from a local worker's initiative and be generalized to the rest of the organization, as we saw in the personal-to-organizational movement. This is the case with the Kdelib software, which is used by the SDIS to draft, keep track and digitally sign administrative documents and procedures (*i.e.* budget management, administrative meetings), even though it might not be its initial objective. Executive professionals recall the use of Kdelib to draw reports for the director boards to sign. This tool appeared in 2021 in the SDIS57 EoA following the initiative of an individual to answer his need for a document version-management tool, as described in this quote:

*"There were errors in the version because it didn't fit at all. [...] I did some prospecting and came across a tool that was, in fact, my choice, which is Kdelib." SDIS7*

In order to introduce Kdelib in their organizational EoA, this person had to 1) prospect, 2) have the tool validated by their managers, and then 3) a) train future users to its use, and b) handle the after-sales negotiations with the external company. This process allowed the tool to be introduced to the rest of the SDIS57 and to various partners (*i.e.* administration, health services, management, etc.) that are still using it to write and validate documents, as shown in the following quote:

*"It's a hierarchical circuit. You send it to your department head [...] who can make corrections or send it back to the writer with comments [...] The line manager then sends it to the deputy director. The deputy director then sends it to the legal department [...] Then it comes to me." SDIS7*

Still, in practice, KDelib has to be combined with other artifacts such as emails and phone calls to be effectively used. While providing a common space for all concerned professionals, Kdelib does not suffice to support inter-personal exchanges and communication, as the following quote shows:

*"After that, you have to share it with your supervisor, so the supervisor doesn't necessarily receive the email. [...] then push it to the administrative coordination department [...] he'll call me and say, 'I've made some corrections' [...] so I'll sort it out, I'll get my document back, I'll divide it up again, and then I won't see it any more." SDISEMIZ2*

Therefore, firefighter's EoA contain Kdelib, but in practice, its use is mediated by the use of other communication tools.

## 3) Top-down vertical introduction of a new tool - Agendis<sup>3</sup> case

As a third way of introducing new tools into civil security's EoA, our informants mention a frequently used vertical top-down way, where the organization formally compels the local professionals to work with a certain tool. For example, in 2014, the civil security's headquarters imposed the use of Agendis for HR, a multi-platform private software package for managing schedules and operational planning. Agendis is being used on an everyday basis by all professionals in order to access their working hours or check on the formations they have to do for example.

A team has been set up to roll it out to 150 professionals over a 6-month period, translating the staff order to use Agendis into several deployment phases:

a/ test and adapt to the SDIS57's needs phase:

*"There was a big part of assimilating the existing software, configuring it and taking into account the latest regulations within the SDIS de la Moselle in the context of human resources." SDISEMIZ4*

b/ a deployment phase, itself divided into a

1) training phase :

*"And that involved identifying who was going to use the software, getting the supervisor, the centre manager generally, into the loop, getting them to come to headquarters, showing them, [...] explain to them that the new software is good, what it brings, and so on, responding to any obstacles that might come up in the field." SDISEMIZ4*

b) and a technical support phase :

*"There are always errors, and these have enabled us either to readjust the configuration of the software or to realise that there were errors in the working time regulations." SDISEMIZ4*

However, top-down introduction can go against already deployed tools and practices. In the case of Agendis, this new collaborative software faces already existing tools built by the users themselves, as this quote shows:

*"When you don't have a tool that had been proposed by headquarters for HR management or training, what did they do? They created their own tool. [...] [We went there to tell] them "well there you go, you were using your Excel sheet which was very very good, from tomorrow, you'll have to use this" SDISEMIZ4*

In this situation, the pre-existing EoA comes in conflict with the newly introduced tool, creating issues for the users.

#### *4) Horizontal introduction, from one service to another - **Crimson tactic**<sup>4</sup> case*

The fourth and last introduction of a new tool in civil security's EoA is a horizontal movement. As previously stated, the SDIS57 and its partner's EoA contain a large number of partially redundant collaborative digital tools, and this adds a new level of complexity to inter-service collaboration. For example, these population have a large number of mapping software such as TacMap, Géoplan, Géoconcept, Gopserv NG, Crimson and IDIC-SI, all of which serve geolocating and/or enhancing monitoring of live interventions. In practice, Crimson Tactic is SDIS57's main mapping tool to monitor large operations, and in theory, by their partners too. During the inter-service training we observed that the other departments have not adopted it, despite the SDIS are pushing to use it:

*"There's a push to use Crimson, but right now, the SAMU, for example, [...] they have access, but they don't use it. The police forces are a little more reticent too. [...] For us, it's become one of the major, primordial functional software applications." SDISEMIZ5*

However, we noticed a lot of information sharing has been achieved with Crimson tactic during the training (*i.e.* number of victims, cartographic representation of the incident) in an ad hoc way, through photos and screenshots shared by email or smartphone.

#### *5) Realigning EoA by redirecting already available tools (COVID-19 intervention screening case)*

Civil security's EoA also evolve through the recycling of already deployed tools. Professionals can rely on those tools to avoid using a tool deemed too complex, as illustrated by the following quote, telling how complex tools can be pushed aside for the benefit of a good old pen and paper:

*"Quite often, when they know that they haven't necessarily mastered the software and that they're wasting time, doing it on a whiteboard with a felt-tip pen [...] And a piece of paper, a door, a wall can be used to make these tools [...] You have to keep the basics." SDISEMIZ4*

Civil security workers specifically mention the creation of Excel spreadsheets, a collaborative spreadsheet software shared via Google Drive and email, as a set of tools that is widely used for various purposes other than accounting. Excel spreadsheets can be combined with other artifacts to meet a temporary need, developing a clear case of aligned ecology of artifacts. For instance, during the COVID-19 period, professionals were tasked with monitoring all COVID interventions and keep a list of all professionals who have been in contact with confirmed victims at an inter-organizational level. That's why the local professionals set up an Excel spreadsheet for ad hoc monitoring. By using already established artifacts, in this case combining Excel spreadsheets and GLPI tickets, the professionals have put in place an aligned EoA and a new collaborative practice for reporting suspected COVID-19's cases, as highlighted by this quote:

*"So we set up a [...] questionnaire that we put together in conjunction with one of the staff departments to create a GLPI ticket. [...] they would ask us [...] to send directly the Excel spreadsheet that we had been able to complete as we went along and to be able to guarantee the traceability of all the people involved in this type of intervention" SDISEMIZ4*

#### *6) Replacing tools on organizational request -**Artémis/Smartémis**<sup>5</sup> case*

Finally, evolution in civil security's EoA can manifest in a bidirectional way, combining one tool's introduction and another tool's decommission. Some of the new collaborative digital tools introduced in the SDIS57's EoA are deliberately redundant, as their purpose is to replace previous tools. Especially the operational management system (SGO), the tool used for day-to-day crisis management. The CODIS operators handling the urgency calls use those SGO to indicate the location of the crisis, write a summary of the situation and send professionals on site, all while still talking on the phone with the witness.

It is regularly replaced on the instructions of the Ministry of the Interior in a planned process. Before 2010, the SDIS57 used Gipsis (Gestion informatisée des plannings des services d'incendie et de secours), a tool to help draw up schedules. The SDIS57 then switched to a couple of software Artémis (PC version) to manage on-call duties and Smartememis (smartphone version) to record professional's real-time availability, which are still in use today. Finally, in 2030, SDIS57 plans to switch to NexSIS, an SGO based on a nationally shared information feedback system which will be usable on computers, smartphones and tablets. Its features will include geolocation, radio

transmissions, a messaging system, pooling of calls to the emergency lines and activity reporting. The differences between the software packages boil down to graphical UX changes, feature additions and technological upgrades, as the following quote illustrates:

*"Before that, we also had an operational management system that was another model. It also worked, but perhaps it didn't have the same capabilities. Now we were moving on to something else. And in 10 years' time, we'll be moving on to something else." SDIS2*

Therefore, the planned decommission of the previous SGO happens for upgrading reasons during the transitional time corresponding to the new tool's introduction.

## DISCUSSION

The next section is dedicated to the discussion of our results.

First, we aimed to better understand the real collection of collaborative tools within civil security by presenting an initial section of results on the density, redundancy, and interconnections within the SDIS57's EoA, prior to the introduction of any new tool. This approach facilitates a deeper understanding of the environment in which the new tool will be introduced, thereby enabling more accurate predictions regarding its use. It also contributes valuable knowledge to the scientific literature on civil security's EoA.

Second, we sought to better understand the influence of a newly introduced digital collaborative tool or a new function for an existing tool within the existing technological environment. This was accomplished by identifying six types of dynamic evolutions in the EoA, which we refer to as *movements*. In this ongoing work, we primarily focus on the *introductory movements*, which involve bringing a new tool into the EoA or repurposing an existing tool for new functions. This provides a clearer understanding of the consequences of introducing a new artifact into civil security's EoA, allowing for more accurate predictions regarding the tool's use and adoption. It also contributes to the knowledge of the dynamic characteristics of EoAs.

The broader implications of these findings have transversal applications to crisis management challenges, especially concerning the use of collaborative digital tools, beyond their development. For example, in the context of emergency preparedness, our results inform the selection and introduction of emergency software by providing feedback from actual users to policymakers and/or IT departments. In terms of response effectiveness, our findings offer insights into the appropriate or failed use through the accounts of our informants who are used to deal with crisis situations. Furthermore, our results highlight that EoAs do not operate around a single solution for managing communication, strategic management, HR, and other functions. Instead, they rely on a combination of multiple heterogeneous tools. This diversity enables the adaptation of tools to users at different levels, ensuring job coherence (*e.g.*, fingerprint reading tools for police, but not for the fire department), while the fluidity of the EoAs allows them to meet the evolving needs of each service (*e.g.*, operational management software regularly updated with new hardware).

### Civil security's EoA characteristics

Our research points out the dense and, therefore complex, civil security's EoA, which echoes Robinson et al. (2015), Potter (2016) and Munkvold (2023) findings. Especially, the diversity of civil security's communicational tools highlights the importance of informational exchanges in their everyday collaborative work. But we also observe that digital collaborative tools can be associated with other tools, inter-connecting themselves inside their EoA. In the manner of Bødker and Klokmoose (2012), one artifact influences the use of other artifacts in their commune ecology. This confirms the relevance of using the ecology of artifacts' perspective for sorting out between personal, collective and organizational aligned sets of tools in our understanding of SDIS57's technological environment. Our study highlights that not considering the EoA when working on a new tool's introduction amounts to pushing a big part of environmental considerations apart, while finding a way to mend them might reduce the effort needed to articulate those multiple partially bounded artifacts.

### Civil security EoA's evolution dynamics

Our main result revolve around the identification of multiple movements in the SDIS57 EoA and with its partners EoA. We identified 6 of these movements: the introduction of new tools (1.personal-to-organizational, 2.bottom-up, 3.top-down and 4.horizontal), the 5.realignment ways, and the 6.tools replacement. This variety of movements shows that civil security's EoAs are full of evolutive dynamics that should be considered when introducing a new tool. One approach we suggest for future crisis management support system consists in working with and not against or despite the existing EoAs, as recommended by Schmidt (2018).

### *Relevance of previously adopted artifacts in new tool's introduction process*

Our first set of results regarding 5.realignment showed a case example (COVID-19 intervention screening case) of already existing, integrated and mastered tools that are realigned (Larsen-Ledet et al., 2020) to fulfil a new purpose. By choosing to use artifacts that are already part of their ecology, users avoid the time and the effort that are necessary to master a new tool. Therefore, the pre-existing environment is to be considered because it may already provide accessible solutions. This also raises the question of an existing link between users and their artifacts, leading them to realign rather than reintegrate. But it also shows incomplete knowledge from users of the civil security's organizational EoA, showing that they may not be aware of the newly available tools. The realignment aspect does not seem to be a concern of the IT department and software providers either. In addition, we showed that old and new artifacts can be combined and used together in order to complete a specific task, illustrating the integration-in-practice concept of Rossitto et al. (2014). By showing that already implemented artifacts impact the new tool's use, our results reinforce Bødker and Klokmoose (2012) and Cormi et al. (2022) conclusions that considering EoA's is relevant when trying to deploy a new tool in organizations.

### *Integration-in-practice for new tools*

Our second set of results displayed situations when a new tool is introduced. We talked about the introduction of a new digital collaborative tool coming from a 1.personal EoA going to an organizational EoA and about the 2.bottom-up way of expanding one professional tool to the rest of the organization. This echoes Bødker et al. (2016) work with volunteer-based communities because they also see their organizational EoA progressively shaped by multiple personal EoA's imported by their local members, as observed in collaborative-writing work (Larsen-Ledet et al., 2020). We see similar processes at play in the 4.horizontal introduction and the sharing of Crimson map pictures through smartphone. An artifact expands from one service to another following the first service's decision to use the said tool. Therefore, the integration of a new tool into an organizational EoA can have consequences for all collaborating partners. Therefore, our analysis points to the need of improving integration between personal and organizational tools.

### *Gradual introduction of new tools*

In the introduction set, we also presented the case of 3.top-down vertical new tool's introduction. We identified specific introduction steps: a) test and adapt to the needs ; b) deployment containing b.1) training phase and b.2) support phase. We found similar steps in the 2.bottom-up configuration, but the individual who introduced the tool also had to do preliminary prospecting and tool validation by its managers. This process is close to the 2-dimensions sociotechnical alignment work described by Rossitto et al. (2014) to allow integration-in-practice: 1) choose the artifact that the organization wishes to integrate, generally with negotiations when talking about collaborative tools, which could be assimilated to the prospecting, tool validation and test-and-adapt steps, and 2) circulate information about the artifact, which could be assimilated to the deployment phase. Islind et al. (2019) work also suggests that interoperability between already implemented and new tools (Iroju et al., 2013) might add a consequent phase of manual work to finish integration-in-practice, implying a last phase that has not yet been identified in our cases.

## **Generalizability of the results**

Our findings are contextually bound to the French SDIS57 firefighting service. However, we believe our conclusions for French populations may be generalized to other countries and diverse services. For example, Munkvold (2023) conducted research in Norway on inter-agency collaboration (i.e., police, fire, health services, civil defense, municipal crisis teams, etc.) and similarly found that each agency uses its own map system. They suggested that this could apply to various other natural or man-made hazards beyond forest fires. Additionally, Robinson et al. (2015) studied emergency response in the USA and highlighted that technical infrastructures are rapidly changing due to the introduction of new tools, with emergency workers frequently using familiar "off-the-shelf" tools in their professional settings. Our results may therefore also be applicable to services beyond the SDIS57 firefighting service.

However, the generalizability of our findings has certain limitations. First, one must consider the variation in management styles and scales across civil security services. For instance, in France, firefighters operate at the SDIS level, where each SDIS is locally managed, and the selection of collaborative technological tools is determined by their computer department. In contrast, police and military police forces rely on a national service to select their collaborative technological tools, as their services are nationally managed. As a result, findings related to firefighters' EoA may not be applicable to the EoA of police forces.

Second, it is important to recognize that there is no common international organization overseeing civil security; each country has its own system. For example, in France, international partnerships are applied across all departments,

while in Germany, civil security-related partnerships must be established individually with each state (Länder). Therefore, conclusions drawn about French firefighters may not be applicable to firefighters in other countries. This aligns with the statements made by Dilekli and Rashed (2007), who emphasized that a well-operational information system in one context may not be as well-adapted or adopted in different geographical and/or economic contexts, as demonstrated by the fact that HAZUS only works with U.S. data.

## CONCLUSION

In order to address the gap between the theoretical and practical aspects of tools' introduction, our study aims to provide a deeper understanding of the existing collection of collaborative tools in civil security, and a deeper understanding of how the introduction of a new digital collaborative tool impacts or is influenced by the other tools already in use. By applying the artifact ecologies theories and methods to understand and describe past emergencies' digital collaborative tools, our work characterizes civil security's EoA as complex and full of diverse digital collaborative tools. These are often redundant and sometimes interconnected. We also identify multiple evolutive movements related to the introduction of a new digital collaborative tool and/or a new function for a known tool inside this EoA. We categorized them in 3 sets: the new tools introduction movement with 1) personal-to-professional configuration 2) bottom-up configuration 3) top-down configuration and 4) horizontal configuration; the realignment movement with 5) the integration of already available tools; and lastly, the replacement movement with 6) the organizational request for tool replacement. The consequences of these movements include a discussion around the relevance of considering previously adopted tools when introducing a new tool into one's EoA, but also observing the integration-in-practice (Rossitto et al., 2014) taking place when gradually introducing new tools as a gradual process and finally about its generalizability.

Our empirical work highlights the existing civil security's artifacts ecology wealth, showcasing the many strengths and established stability in the current technological, social and organizational toolbox. Therefore, future digital collaborative tools design for crisis management should go along with existing systems instead of wiping the slate clean and replacing them with a unique new collaborative tool that may be rejected and not merge easily into the existing ecology. Our work also suggests rethinking deployment approaches and adopting a practice based lens for informing planned introduction processes and the design of future digital collaborative tools. The broader implications of our results transversal extend to multiple sectors within civil security (e.g., emergency preparedness, IT departments, policymakers) and encourage a shift away from the "one-tool-fits-all" perception of digital collaborative tools.

Our future work perspectives revolve around identifying existing movements inside civil security's EoA through our field research on French firefighters. Therefore, future results should display new evolutive movements such as tools decommission or digital tools upgrading. We suppose that a better understanding of those dynamics would have the practical effect of enhancing, slowing down and/or interrupting projects that may not fit with existing EoAs, or even better, help policy makers have better control over their consequences.

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