

Perspectives on the Use of UAVs Within Swedish Emergency Response: Future Prospects and Challenges

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ABSTRACT

Unmanned aerial vehicles (UAVs) are important resources in Swedish fire and rescue service organizations (FRS). This study aims to review the current use of UAVs in FRS by gathering insights from end users. This will provide a basis for modeling and evaluation of future systems.

Five representatives from different parts of Swedish FRS were interviewed so far, and the material was evaluated based on a framework analysis method, resulting in perspectives on operational, organizational, and societal levels on current use, future use, and challenges.

The results show that UAVs are common for improving situational awareness through camera footage. Challenges exist in that there is no joint methodology of usage, which may hinder collaboration between organizations. Further, the analytical skills of the pilot and the incident commander are important for effective use. Automating tasks such as visual analysis could reduce the workload and relieve resources for other tasks.

Keywords

Unmanned Aerial Vehicles (UAV), Emergency Response Operations, Situational Awareness, Autonomy and Remote Sensing, UAS Organization and Training.

INTRODUCTION

Emergency response organizations face challenges such as forest fires, floodings, and landslides – natural disasters that are expected to happen with an increased frequency due to climate change. The response to such disasters, as well as everyday operations such as housefires, traffic accidents, drowning incidents, and search-and-rescue, may benefit from better and more available flight resources within emergency response. Due to these current and potential future challenges, emergency response could benefit largely from more effective use of existing technology. Unmanned aerial vehicles (UAVs) can and are used in many different emergency contexts and are relevant for reducing risks for emergency response personnel as well as specific tasks in future response scenarios.

The use of UAVs, as well as other unmanned platforms, for rescue operations falls within the field known as rescue robotics. Since 2001, rescue robots have played an important role in augmenting traditional rescue efforts in both major disasters and smaller, more frequent everyday accidents. These robots have, among other things, been used in response to the September 11 attacks, Hurricane Katrina, the Fukushima disaster, the fire at Notre-Dame Cathedral, and the floods in Germany 2021 (see, for example, Murphy, 2012; Nardi, 2019; Surmann et al., 2022). Today, various types of robots are used regularly by emergency services around the world (Colin et al., 2014; Delmerico et al., 2019) and are therefore neither new nor unfamiliar technologies within rescue operations.

Recent examples are the delivery of automatic external defibrillators (AEDs) to cardiac arrest patients (Jakobsen et al., 2025) and providing footage before arrival of first responders to an incident site (Kristiansson et al., 2024).

One common research topic on UAV usage is combining machine learning models for image classification with the use of a UAV (Katkuri et al., 2024). Autonomous robots within search and rescue are another topic studied by, for example, Kareem et al. (2026). They reviewed the use of different types of unmanned robots in search-and-rescue, and the use of machine learning within this field, finding that the need for further research on human-robot interaction is needed, especially in realistic settings where humans may be under stress. O'Neill et al. (2022) discussed the autonomy of an agent depending on the level of automation, going from low-level (only human decisions) to high level (agent decisions, no human input). The level of automation is also discussed as part of considerations of flying beyond visual line of sight (BVLOS) with UAVs (Matalonga et al., 2022).

Lattimer et al. (2023) reviewed and summarized current state-of-the-art of technological advancements for UAVs used for firefighting purposes, as well as explained current regulations and challenges related to air traffic regulations and the use of UAVs. Our research resembles Lattimer et al.'s in that we want to explore the use of UAVs in fire and rescue service organizations (FRS). However, we add to the ongoing discussion by accounting for the perspective of the experts and users of the technology within FRS, and the future they perceive based on the current technological advancements.

The Swedish FRS are responsible for not just firefighting, but also drowning incidents, traffic accident assistance and rescue, chemical and oil spills, among other tasks. They are organized and funded by the municipalities (Lag om skydd mot olyckor, [2003:778]), of which there are 290 in Sweden. However, the municipal FRS organizations can choose to form federations (often based on geography) and share resources. Collaborations between formal FRS organizations also occur, for example, by providing resources to a close-by municipality that is not part of a federation. The use of unmanned aerial systems (UAS, which includes the infrastructure and pilots needed to operate UAVs, as well as the UAV itself) is widespread. However, there is a lack of a common methodology for designing an organization for using UAVs, including how to best use this resource and how to assess their effectiveness. This makes it challenging for an FRS organization when deciding which UAVs to procure, how to select and train operators, and in other ways design a UAS organization that can provide efficient support for their own operations well as collaborate effectively with other organizations.

The goals of this study are to:

1. review the current use of UAS in Swedish FRS,
2. conceptualize different types of existing or plausible UAS organization designs for FRS,
3. evaluate advantages and disadvantages, including costs and benefits, with these designs, and
4. investigate how the level of autonomy in the UAS will affect the design.

As this is a work in progress, in this paper, we present initial results related to Goal 1, based on a set of interviews aiming to assess the current state of UAV use in FRS, future outlook, and potential challenges. The aim is to create a basis for the remaining goals, including quantitative assessments of benefits and costs of different types of UAS designs for FRS. We emphasize the combination of autonomous features with future use, as this is an emerging topic that must be addressed before being implemented.

The rest of this paper is organized as follows. In the next section, we provide a description of methodology used in this study. Then, we present empirical findings, classified using a thematic approach, and finally, in the last section, we present conclusions and future research directions.

METHOD

The results presented in this paper are based on five exploratory, semi-structured interviews with experts from FRS organizations in Sweden, see Table 1. The interviewees are all active in Swedish FRS, with roles ranging from operational to development, and representing some of the larger federations in Sweden. Participants were selected to represent different regions of Sweden, ensuring both geographical coverage and different organization sizes. Recruitment was based on recommendations from existing contacts, through direct request to the organization for a person with some managerial role and experience with UAS, and through snow-ball sampling, getting recommendations from the interviewees. This gave a sample suitable to the goals of the study, where existing and plausible organization designs are evaluated, while also reviewing the current use. Participants all have some managerial role in the sense of project management, command, or flight system responsibility. Insights into all these types of roles have been considered for inclusion, as to receive a wider perspective on different aspects of UAV use, related to study goals 1 and 2. Not all participants are operational UAV pilots, which was another aspect considered to broaden the view of UAV use. A slight bias towards positive descriptions and larger organizations/federations is present and therefore including the experiences of smaller FRS organizations or even organizations without use of UAV is considered for the continuation of the project, if possible.

Table 1 – Interviewee data

Interviewee	Role	UAS experience
1	Responsible for a national FRS development center.	Project manager for development of new methods including UAVs
2	Flight system responsible within federation.	Pilot and instructor of UAV usage
3	Regional operation commander.	Commanding role with no pilot experience, but requesting UAV resource
4	Flight system responsible within federation, and operational role.	Firefighter and UAS pilot within organization
5	Flight system responsible within federation, and operational role.	Firefighter and UAS pilot within organization

With the aim of better understanding the relevance and utilization of UAS in practice within FRS organizations in Sweden, we asked the interviewees about the level of utilization and type of activities and tasks that UAS are currently used for as well as their impact on the response to incidents they have been used in. Other questions during the interviews concerned organizational requirements, which include the rules and regulations of having and operating UAS, the needed competences and required training for UAS operators, pros and cons of in-house UAS, collaboration among different FRS organizations concerning their UAS, and the need for a national UAS center especially in case of big and rare events such as disasters. Another part of UAS use that was investigated is the future use of these systems, such as functions that currently do not exist, other tasks and activities that today they are not used in, and relevance and benefits of autonomous functions.

The questions in the interview guide, as summarized above, were classified according to the following themes related to the goals of the study: current use of UAS; competence and training; rules and regulations; future use; organization; autonomy.

Each interview was held online using Microsoft Teams and was recorded and automatically transcribed by the software. Two or three researchers participated in each interview, with one researcher being the main investigator, and the other supporting with additional questions and note-taking. Each interview lasted on average 60 minutes.

The interview material, that is, the transcripts and interview notes, was analyzed based on the framework analysis method (Ritchie & Spencer, 1994), and to better understand the methodology an example case by Goldsmith (2021) was also used.

We used framework analysis to analyze the interview material (Goldsmith, 2021; Ritchie & Spencer, 1994). Framework analysis is a useful tool to summarize perspectives from different actors (e.g., public policy makers on different organizational levels) and includes the steps data familiarization, defining the thematic framework, indexing, charting, and mapping and interpretation (Goldsmith, 2021; Ritchie & Spencer, 1994).

Data familiarization is used to understand the data (for both primary and secondary data), and select what to include (Goldsmith, 2021; Ritchie & Spencer, 1994). In this step, all the interview material was regarded as relevant for the study purpose and was thus included in the next steps. The thematic framework was, as previously mentioned, decided a priori, by categorizing the interview questions in the interview guide to specific themes related to the study's goals. This is a possible starting point, according to Ritchie and Spencer (1994). However, during the analysis, additional themes—like societal benefits—emerged, and some themes were combined, resulting in the themes presented in *Empirical Findings*. This is in line with Ritchie and Spencer (1994) suggestion: to iteratively decide on the thematic framework based on the initial familiarization of data step. Apart from the changes mentioned to the thematic framework, no further iterations were made for this paper. One can consider the themes to be of low resolution, but for the purpose of this study, these were considered sufficient.

The indexing and charting of the interview material was done by one of the researchers in the research group, who was present at all interviews. During this step, some answers, or parts of answers were allocated to other themes than the question they belonged to as respondents would sometimes address themes unrelated to the original question, varying in their level of detail. The semi-structured form of the interview, which allows for follow-up questions and reformulations of questions that were being covered in other answers, also led to the answers needing to be indexed to each theme. Interviewees were only informed of the overall purpose of the interview, and not of specific themes for the questions. The indexed answers were then charted (a table summary) by each theme and respondent.

The last stage of mapping and interpreting the data was done by summarizing each theme across all interviewees (as presented *Empirical Findings*) and finally also mapping the answers across our analysis topics of interest: current use, future use and challenges to implement more advanced functionalities.

These results were finalized into a matrix (see Table 2), dividing the results into categories on different levels in rescue services: operational, organizational, and the impact on society. We also present a table mapping system requirements in Table 3.

As the interview study is still ongoing with more participants to be included, the goal of this paper is to summarize and discern potential emerging patterns. The interview data is later planned to be the basis for scenario creation for future quantitative analysis.

EMPIRICAL FINDINGS

In this section, we present main findings from the interviews, a summary of the themes from the framework analysis.

Current use of UAVs

The use of UAV within the FRS is widespread, and according to one of the interviewees, every FRS organization has some type of UAV.

The role of the UAV is mainly to improve situational awareness by giving a birds-eye view to the ongoing operation. The information provided by UAVs is described by Interviewee 1 as a “*game changer*”, comparing it to what the infrared camera brought for FRS operations when first introduced. Examples of incidents where UAV is used include fires (forest, residential buildings, industrial), leaks (e.g., chemical spills, oil leaks, etc.), railway incidents, drownings, and search and rescue. Interviewee 1 also mentioned that dynamic events, where there is a need for continuous monitoring, are important use cases. Interviewee 2 indicated that there are always benefits with a better view of the situation since this will give the commander the information needed to make better decisions, “*When should we not use an UAV?*”. The UAV itself is identified as a tool with the main task of providing video footage, and potentially other types of sensor data in the future. However, today, it is not considered a “*lifesaving*” resource, due to the current inability for damage mitigation.

The organizational structure for the UAV-resource within most of the federations was usually such that a UAV could be dispatched at specific types of incidents or summoned by the incident commander on site. Interviewee 3 mentioned that once organizations start to use UAVs to improve situational awareness for fires, they realize that it might be used for other operations and purposes as well, such as for chemical leaks in water.

All FRS organizations that the interviewees belonged to have a dedicated UAV-resource with advanced specifications that included an infrared camera besides the ordinary camera. Some kept the UAV on regular firetrucks, while others had a dedicated vehicle for the UAV team. Flying beyond visual line of sight (BVLOS) is possible under special circumstances, when there is risk for loss of lives or substantial damage. Then, the FRS have the legal possibility of closing the airspace to fly themselves. However, none of the interviewees mentioned any case where this had been done.

Organization, education, and regulations

Even though UAV use is widespread within FRS, there is no national education or framework guiding their use within FRS organizations. The Swedish Civil Defense and Resilience Agency (MCF) provide a guide for setting up a flight organization in the context of the FRS (Myndigheten för samhällsnydd och beredskap, 2020), but the work has not been updated since its publication in 2020. The lack of a national standard has its disadvantages, as noted by Interviewee 2: “*in the worst case, each organization will have its own UAS workflow, making collaborations with other first responders, such as the Police, harder to achieve*”.

To tackle this shortage, one of the larger FRS federations has developed its own course for initiation and use of UAS within FRS. One of the main goals in developing the course was to promote collaboration and shared use of airspace; by ensuring that everyone understands the same practices and rules, and potential conflicts can be minimized. Many other FRS organizations have sent personnel to complete this course. Finishing it makes them able to instruct other personnel within their own organizations, following a train-the-trainer concept.

Organizationally, the dedicated UAV, as mentioned, could be dispatched at specific incidents or at the call of the commander of the incident. Some federations also had smaller UAVs on board their fire trucks, available for quick assessment of an incident. For more advanced technology, such as infrared cameras, they had to call on a dedicated resource, which is a more technically advanced UAV, including pilots. One FRS federation did not consider the

UAVs as resources with a similar turnout time of 90 seconds as a team of firefighters has. However, in practice, they had so many pilots in the organization, located at different stations, that there would always be someone available to fly the UAV if needed. Interviewee 4 noted that the resource could be utilized even more, if all stations knew how much the resource could help. Interviewee 2 highlighted the need to educate the incident commanders, who are the primary decision makers at the incident site, on what information that can be expected from the UAV, as well as some interpretation of data.

All interviewees had some experience where the incident commander directly interpreted data from the UAV and made decisions based on the information. However, the common methodology was to have one (the pilot) or possibly two people responsible for the flight, where the second person would forward interesting information to the incident commander. The interviews clearly demonstrated the necessity of analytical skills for efficiently assessing data collected from the UAV, and Interviewee 3 mentioned the risk of the commander being tied to the screen to analyze the data and make decisions. This had led to delegating specific tasks of footage analysis to the pilot, who would then report to the commander. They explained it in the following way: *“/.../ I used to feel like the drone and the drone pilots like, they took a lot of my attention. They wanted me to look at this screen continuously and show me from all angles /.../ and I didn't have time for that so I, for those I work with the most, I explain to them that I will instead give you a task, something I want you to find out. And then you find that out, and then I don't want to stand there and watch some long film, but you should, it should be enough that you come and tell me what the answer is /.../”*. But to be able to do this, the pilot had to be experienced, as it was a difficult task to both fly the UAV and analyze data at the same time, something mentioned by, for example, Interviewee 5.

As previously mentioned, several FRS organizations had dedicated UAV resources, which would solve the problem of overloading the incident commander. However, Interviewee 3 noted that in many cases, even if the UAV resource was dispatched, it was not utilized or did not reach the site before the end of the operation, possibly due to long response times.

Suggestions from many of the interviewees were to have a central command and control center, specialized in live interpretation of camera and sensor data collected by a UAV. This would free up one resource at the incident site. If the UAV could be piloted remotely from the command center, then yet another resource would be freed to manage other tasks at the incident.

The organization, funding, and training responsibilities for the data interpretation resource at a command-and-control center were briefly discussed. For example, it could be regionally financed by geographically connected federations. It could also be organized on a national level. However, Interviewee 2 indicated that regional funding can be challenging to manage; therefore, they could cover a large part of the cost themselves, with other nearby organizations contributing in smaller parts. Yet, even in such a format, charges for other specific services are sometimes hard to calculate.

We further explored the relationship between current airspace regulations and the use of UAV for FRS. A common opinion among interviewees was the need for special regulations for emergency response. Interviewee 2 highlighted that the approach by many FRS is to first buy a small, cheap UAV to fly with, and later they start to think about airspace regulations. However, flying with small UAVs was associated with the same type of risk as when using larger UAVs.

Societal benefits

The benefits of using UAVs to get better information concerning an ongoing incident were highlighted by all interviewees. One federation had plans of quantifying the benefits in terms of total reduced operation time when using UAVs versus not using them; such quantification does not exist today. Interviewee 4, however, said that there is a clear benefit in use of UAVs for operations that last over a day or more. Specific examples mentioned were forest fires and fires in wood chip piles at heating plants. Reducing the operation time frees up resources to be able to respond to other incidents. Other examples mentioned by the interviewees were incidents close to railways, for instance searching for suicidal people or gas leaks from industrial cargo, where the train traffic needs to be suspended until the ongoing problem has been resolved. As UAVs could help with searching for a person, or identifying dangerous substances from a distance, their use could substantially shorten the operation time. According to the interviewees, the cost for society as a whole in case of suspended train traffic is large, and the benefits of using UAVs are obvious, illustrated by Interviewee 1 with *“Then we have effects on the society, that is the big winner to get things going again. I mean, there is a stop in the train traffic for one day. I don't know the cost of that, but there are immense costs to society with all the logistics going on roads and railway.”*, which was something that interviewee 4 also expressed: *“If you have a total stop in the [train] traffic so that nothing moves. But it is also easier to get everything going, so that they don't need to stand still, because it costs an enormous amount of money when the train traffic stops.”*

One other main benefit of using UAVs is reducing the risk for personnel, where Interviewee 1 said *“We talk a lot about how the human should become the second responder /.../ Doing things as to not expose our firefighters to unnecessary risks.”* and Interviewee 5 also brought this up, for example *“It has been a close call many times and every time it’s close you feel like this, that this doesn’t feel really well in the gut, and what if we could have had a machine instead of a human standing there in the front.”*

Autonomy and future use

When asked about increasing the autonomy level of the UAS, the views differed between the interviewees. Freeing up a human resource for other tasks is mainly considered positive; yet many interviewees did not believe this would happen in the near future. However, other types of robotics were mentioned for such uses, for example ground robots (e.g., a robot capable of fighting fires) that one of the federations had recently invested in.

Streaming footage to a command center that has a specific task of interpreting data and giving decision support to commanders on site is envisioned by multiple respondents. The required technology exists for this, and the inspiration comes from other first response organizations as well as from society. Interviewee 1 compared it to the video assisted referee (VAR) system used in soccer, where they said that *“I have this idea that we should have one, like in soccer, we should have our own VAR-room in Sweden, where this [video from incident] is sent and from there gives suggestions to those out there, as for the soccer judges: ‘We think this was penalty, so now you go check it’.”* This to reduce the load of the incident commander on sight. Similar thoughts were expressed by Interviewee 5: *“/.../ a dedicated special resource with personnel that only works with, and not only drones, but we look at other robotics also. /.../ And who become really good at the image analysis and sensor data. /.../ And come with qualified decision support to the incident commander.”*

The possibility of retrospective analysis of an incident with the help of footage was considered, and some experiences were described further by Interviewee 1. By looking at video material from an incident, details that could have been helpful for decisions on site were discovered, which was an indicator that live footage interpretation might be an important step towards more effective utilization of the UAS.

Classification models for video footage, using machine learning, were available at one federation. However, the model was not specifically trained in emergency response tasks and could therefore only recognize objects on a general level, such as humans. No other use of such technology was mentioned during the interviews, but it was discussed as potentially helpful for a remote analysis resource.

Using larger and more powerful UAVs for logistic purposes, such as transporting materiel or personnel to remote locations was considered a possible future use. Using UAVs for tasks currently managed with stairs, such as evacuating people from high buildings or reaching high fires with a fire hose carried by the UAVs were also discussed.

Flying inside buildings with smaller UAVs is currently being tested by some federations but has yet to become regularly used. The possibility of having a special resource trained for indoor flights could be an option depending on the type of incident and the response time.

Other aspects of UAV use

The war in Ukraine was mentioned as driving the technological development of how and when a UAV can be used in emergency response. Several interviewees mentioned that there were lessons to be learned from this. Interviewee 5 mentioned that even though national and total defense was a political topic of high interest today, the military defense organizations were receiving much larger budget portions, while civil defense seemed to be expected to train without increased resources. Regarding the difference in funding for defense and rescue services, they said *“I mean, give us at least the rounding of those billions. We would be able to do so much.”*

The main takeaways from the interviews are summarized in Table 2, focusing on current and future use as well as challenges, and further divided into an operational, organizational, and whole-of-society perspective.

Table 2 - Summary of main points from interviews

	Operational	Organizational	Whole-of-society
Current use	<p>Bird's eye perspective for improved situational awareness</p> <p>Specific information tasks</p>	<p>A common practice is a special unit within the organization that can be dispatched either by the command-and-control center, or the operation commander</p> <p>An educational framework developed by one of the firefighting organizations is often used for pilot training</p>	<p>Reducing risk for rescue personnel</p> <p>Perception of reducing total time for handling incident</p> <p>Reduced disruptive time (such as stopping/re-routing traffic) in potentially dangerous situations such as industrial leaks</p>
Future needs	<p>Supported live data interpretation, possibly by a central command-and-control center resource</p> <p>Alleviate risks for fire fighters; can potentially be achieved by larger UAV</p> <p>Transportation of resources</p> <p>Unloading the pilot, possibly by higher level of autonomy</p> <p>Support with data processing; machine learning models can potentially be useful</p> <p>Other types of unmanned vehicles</p>	<p>A common best practice and the same response to all citizens; can be achieved by standardized methodology across all municipal FRS and other first response organizations</p>	<p>Societal acceptance of flying beyond visual line of sight</p>
Challenges	<p>Cultural skepticism toward introducing new technologies</p> <p>Perceived resource underuse</p>	<p>Budget restrictions</p> <p>140 different fire fighter organizations across the country – a unitary and common development is lacking today</p> <p>Sharing airspace with multiple responding organizations, commercial air traffic, and military</p>	<p>Political focus on military defense</p> <p>Ensuring flight safety – finding the right risk level</p>

To address the distinction between user needs, system requirements, and technical solutions for the use of UAVs (both current and future use), Table 3 presents a structured mapping of key insights, as a complement to Table 2. These are findings and suggestions interpreted from the interviews, with the current use and future challenges to be further explored when constructing conceptual designs of potential organization and resource use of UAVs within FRS in the continuation of the study.

Table 3. Mapping of user needs to system requirements and technical solutions

Use type	User need	System requirement	Technical solution
Current use	Improve situational awareness for incident commanders	Real-time aerial imaging and data streaming	UAVs with visual/thermal cameras; live feed to on-site devices
	Reduce responder exposure to hazardous environments	Remote reconnaissance capabilities	UAVs for pre-entry surveys; thermal imaging; UAVs mounted on firetrucks
	Support real-time data interpretation without overloading staff	Delegation of data analysis to trained personnel	Pilots assist with footage interpretation; dual-operator roles (pilot + analyst)
Future use	Decrease response times and minimize damages	Rapid deployment and BVLOS capabilities	Emergency BVLOS protocols; pre-positioned UAV teams; faster deployment logistics
	Standardize UAV practices across FRS organizations	National training and operational guidelines	Updated MCF guidance; shared training programs; train-the-trainer models
	Enhance data interpretation and decision support	Remote or automated data analysis and decision support	Remote command centers; ML-based object/hazard detection in UAV footage
	Reduce UAV operator workload through increased autonomy	Automated flight and remote piloting capabilities	Autopilot, obstacle avoidance, remote piloting from command centers
	Expand UAV roles beyond observation	UAVs capable of logistics and intervention tasks	Larger UAVs for transport; UAVs for fire suppression; indoor flight capabilities

CONCLUSIONS AND FUTURE WORK

It is evident from the results that UAVs has become an indispensable tool for Swedish FRS, and that there is a huge potential for increased utilization of this technology in the future, which could improve response efficiency and reduce risk for FRS personnel. While the most frequent use today is to improve situational awareness through video footage, the range of applications is expanding rapidly. Of particular interest is to use UAVs in situations where the risk for personnel can be reduced, for example when there are chemical spills, explosion risk or active threat scenarios. However, using UAVs today at an incident site requires one or two people to operate the system, so there is a trade-off between the benefits of the UAVs and what those individuals might accomplish elsewhere. Increased automation might help free up human resources, but it needs to be balanced against the (perceived) loss of control.

In the continuation of this study, we will complement the current set of interviews with talking to smaller FRS organizations, which may have other administrative and operational challenges than the larger federations that we have interviewed already. We will also interview representatives from the Drone Squad at the Swedish Police, who are regarded as more advanced UAS users than most FRS organizations.

Based on the interviews, we will create a limited set of different UAV organization designs for FRS, where one design might be to have one UAV operator on each unit (typically consisting of 4-5 fire fighters), with a fairly simple and cheap UAV. Another design might be a specialized UAV unit with dedicated personnel and advanced UAVs that is available for multiple FRS organizations, or even nationally. Next, we will assign monetary values to the costs and benefits of each design, allowing FRS organizations to assess them effectively. This will include advanced modeling of the benefits. As for most emergency response resources, the value of having a UAV at the incident site depends on how quickly it can be deployed, but the relationship between UAV response time and the outcome is not clear, and depends on the incident, the UAS capability and many other factors. It is a challenging task for future research to estimate the benefits, trying to quantify saved values or improved survival chances for victims, reduced risk for personnel, or decreased mission time for other resources.

In parallel, we will also investigate how the level of autonomy for the UAS might affect these costs and benefits. Increased autonomy may have many advantages, including relieving the UAV operator, or helping interpreting camera images and other sensor data. An idea from the interviews in this study, is to outsource this data interpretation to a remote unit. With numerous sensors generating substantial amounts of data, the cognitive load on an operator would be high, and the possibility of using machine learning models to alleviate the load is evident. This is a topic interesting to explore further within the human-AI teaming realm, developing methodologies and guidelines for practical use.

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Interview transcriptions were manually coded by theme, with generative AI providing summaries for each. All text, analysis, and ideas are those of the authors.

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