Enhancing Team Situational Awareness in Crime Scene Investigation through the Use of Head Cameras

Kristine Steen-Tveit[1], Bjørn Erik Munkvold[1] and Bente Skattør[2]

[1] Centre for Integrated Emergency Management, University of Agder, Norway
[2] Oslo Police District, Norway

Abstract. Modern society is undergoing a revolutionary shift in the digital realm, compelling law enforcement and other public sector agencies to stay up to date and explore the potential of new technologies for enhancing team situational awareness and overall performance. However, the integration of new technological tools does not consistently translate into increased effectiveness in police work. Also, the technology must be customized for officers' benefit, and its acceptance depends on multiple factors. This paper outlines the background, intent, and early results of an ongoing Norwegian project examining the possibilities of using head cameras during crime scene investigation (CSI) for live streaming and video recording. The results from field trials and a survey of participants indicate considerable promise in enhancing team situational awareness within CSI through the use of this technology.

Keywords: Crime Scene Investigation (CSI), Team Situational Awareness, Technology Acceptance, Live Video Streaming, Head Cameras.

1 Introduction

Gathering evidence at crime scenes is essential for identifying perpetrators and understanding motives. Evidence such as DNA and surveillance recordings aids in prosecution. The volume of data collected at crime scenes is rapidly increasing, encompassing investigative interviews, video recordings, photography, and dictated notes, primarily processed manually at the office. This study explores how leveraging new technology can enhance efficiency within the current forensic team sizes, despite growing demands. It emphasizes the potential of modern technology to improve efficiency and quality both at the crime scene and back at the office and further highlights the critical role of innovation in exploring and enhancing new technology within law enforcement.

The pace of digital changes in modern society is revolutionary, and the police must keep up and explore new technologies to improve their team situational awareness (TSA, refers to shared understanding among team members) and performance. However, the impact and effects of new technologies used in police work are not self-evident, and innovative tools do not automatically increase the effectiveness and efficiency of police work or positively affect crime control (Ernst et al., 2021). The technology

needs to be shaped to the officers' advantage, and the acceptance depends on several factors such as availability of technology, convenience, needs, and security (Lai, 2017). Research shows that stakeholders are more inclined to adopt new technology when they recognize its potential to enhance their work or understand the benefits it can provide them (Ernst et al., 2021). An appropriate design requires prior knowledge of the expected frequent use of the technology as well as any potential drawbacks (ibid).

This study is part of a Norwegian research project named AI4Interviews (NRC, 2022). It focuses on the police force's use of head cameras equipped with recording and live streaming features for consultations with remote experts. This technology represents a significant innovation in law enforcement. The AI4Interviews project is in the early development phase, testing head cameras and Speech-to-Text technology designed for forensic teams. This study investigates how participants accept and adopt video tools to enhance TSA in Crime Scene Investigation (CSI). We explore the results of four scenario-based field trials, followed by a qualitative survey, conducted with experienced forensic investigators utilizing a head camera for both video and audio recording, along with team-based CSI. The field trials focused on the usability of the system and its effect on TSA, collaboration quality, and the investigators` acceptance of this technological innovation by assessing their perceptions of the ease of use and perceived usefulness.

The research question investigated in this paper is thus: *How does the use of head cameras (for video and audio recording) in CSI work impact TSA and collaboration quality among forensic investigators?*

The following sections present key literature on CSI, the theoretical basis for our research, the methodological approach, and the results and discussion of their implications.

2 Crime Scene Investigation (CSI)

Law enforcement uses various methods and techniques for crime-solving (Bjerknes and Fahsing, 2018), chosen based on the unique crime scene. A crime scene, any location or item potentially holding evidence, requires careful investigation and evidence collection, involving multiple professional roles (Hamremoen, 2017; Ragde and Teige, 2021). Effective communication among these organizations is essential to develop a TSA of the crime scene and facilitate thorough analysis (Baber et al., 2006). CSIs are complex and stressful, with the risk of overlooking critical evidence, which can hinder case resolution. Forensic evidence is crucial for proving a crime, linking suspects to scenes or victims, identifying involved parties, exonerating the innocent, supporting victim testimonies, and clarifying the events of the crime (Fisher, 2004, cited in McEwen, 2010).

Forensic investigators need to make good decisions at an early stage to get an effective start on the investigation, i.e. the “golden hour” (Rose, 2021). Research in cognitive and social psychology shows that there are several limitations to human attention and decision-making abilities that have the potential to negatively influence the criminal investigation process (Meterko and Cooper, 2021). As an example, confirmation biases

can make a police officer have “a preexisting belief that affects the subsequent interpretation of the evidence” (Charman et al., 2015, p. 214) and overestimate the validity of partial information and thus shift the burden of proof to the suspect (Didrich, 2015). Charman et al. (2017) found that the initial beliefs of police officers regarding the innocence or guilt of a suspect in a fictional criminal case were indicative of their assessment of subsequent ambiguous evidence. This assessment, in turn, influenced their ultimate conclusions about the suspect's innocence or guilt. This study is one of several that highlights how police officers, like the general population, can be influenced by confirmation bias. Other factors like emphasizing efficiency over thoroughness can lead to more superficial processing among police participants, potentially impairing the accurate evaluation of evidence discovered later in an investigation (Ask et al., 2011).

Building upon the previous discussions, this study explores the use of head cameras by forensic teams during CSI. This includes leveraging live streaming for real-time consultation with specialists from the crime scene and capturing comprehensive audio-visual documentation, such as dictations while navigating and cataloging the crime scene.

3 Theoretical Basis

This chapter presents the theoretical basis for this paper and the research conducted in the AI4Interviews project. This includes theories concerning team situational awareness and technology acceptance.

3.1 Team Situational Awareness (TSA)

Situational Awareness (SA) is important for supporting decision-making and responding to different situations. Endsley (1995) defines SA as “the perception of elements in the environment within a volume of time and space; comprehension of their meaning; and projection of their status in the near future” and more informally as “knowing what is going on. “ (p. 287). Endsley's definition involves three hierarchical levels of SA comprising (1) the perceptual level: the detection, recognition, and identification of the elements in a specific situation; (2) the comprehension level: an understanding of the current state based on the information from the perceptual level in terms of what the different elements mean concerning the agent’s professional goals; and (3) the projection level: where the actor makes interpretations concerning the direction of the situation based on the prior levels and professional knowledge (Endsley, 1995).

Within a team, each member possesses a subgoal aligned with their specific role, contributing to the overarching team objective. Linked to each member's subgoal are specific SA elements that concern them. Since team members are fundamentally interdependent in achieving the overarching team goal, there is an inevitable overlap between each member's subgoal and SA requirements. This shared subset of information forms a significant part of team coordination. Coordination can manifest through verbal exchanges, replicating displayed information, or other means (Endsley and Jones, 1997).

TSA is defined as "the degree to which every team member possesses the SA

required for his or her responsibilities" (Endsley and Jones, 2001, p. 3). In Endsley`s model of TSA, she elucidates how teams cultivate elevated levels of SA across their members. The model comprises the following elements:

- *Requirements*: SA requirements of team members fundamentally depend on their objectives and can be defined accordingly.
- *Mechanisms*: Strategies and tools employed by a team to collectively understand and respond to the dynamic and evolving context of their environment. These mechanisms help team members stay informed, coordinate actions, and achieve their goals effectively.
- *Devices*: The methods to establish TSA employ various means such as direct communication, shared displays, or a common environment.
- *Processes*: Processes that characterize effective teams are that they are coordinated, prioritized, and self-checking (Endsley and Jones, 2001).

TSA requirements encompass information across the three levels of SA: the perception of data, comprehension of its relevance to individual and team goals, and the projection of actions by team members. Endsley highlights that TSA mechanisms rely on the shared mental models among team members. If two or more members lack a shared mental model they may interpret data differently, impeding the achievement of TSA (Stout et al., 2017).

A significant aspect of teamwork revolves around the domain where TSA requirements intersect, which stems from the fundamental interdependence among team members. For example, in a crime scene investigation, forensic investigators, experts, and managers each have distinct roles with specific SA requirements. However, they must work with a shared dataset, and the evaluations and interventions of one team member can profoundly affect those of the other. This interdependence generates a considerable demand for TSA. The ultimate objective is for all team members to have accurate SA. Effective communication and supportive technologies can help uncover different perceptions of the same situation, enabling the team to gather more information or address discrepancies (Endsley and Robertson, 2000).

3.2 Technology Acceptance

The ongoing evolution of technology poses challenges to existing work processes while also opening avenues for innovative solutions (Lai, 2016). Organizations often strive to influence the trajectory of technological advancements to their benefit (Lai, 2007). The rapid and dynamic expansion of technologies influences how stakeholders embrace these innovations, with organizational culture, support structures, and internal policies playing a crucial role in their adoption, alongside factors like technology accessibility, convenience, needs, and security. Various theories, including the Technology Acceptance Model (TAM) (Davis, Bogozzi and Warshaw, 1989) and its further developments (Venkatesh and Bala, 2008; Venkatesh and Davis, 2000) provide a framework for understanding stakeholders' acceptance of innovative technologies and their intention to use them. This study specifically draws on key concepts adapted from TAM; usability, equipment quality, and utilization, to guide data collection and analysis. Usability refers to how easily the technology can be used, equipment quality pertains to

the reliability and performance of the tools, and utilization focuses on the extent to which technology is integrated into work practices.

While quantitative studies based on these theoretical concepts can be valuable for predicting and quantifying factors influencing technology acceptance, qualitative research offers a more nuanced and context-specific approach. In this research, these concepts are applied as a framework for exploring factors influencing technology acceptance in the domain of CSI. The chosen concepts—usability, equipment quality, and utilization—collectively form a framework for evaluating participants' perceptions and behaviors related to technology adoption. The utilization category specifically explores perspectives from both SA and TSA.

4 Method

Qualitative research focuses on in-depth exploration, understanding, and interpretation of human experiences and behaviors. Instead of relying on predefined constructs, we can uncover unanticipated factors that may influence technology acceptance. For example, by observations we may discover unique contextual elements that shape users' perceptions, going beyond the predetermined factors outlined in quantitative models.

There is limited research on the current practice of using live video streaming in CSI teams. In the AI4Interviews project, we aim to capture the nuances of factors that may play a significant role in shaping technology acceptance and learn how using head cameras affects the TSA aspects (i.e., requirements, mechanisms, devices, and processes) which again play an important role in achieving the team`s shared goals. Further, we aim to determine what factors can influence the acceptance and use of a new system designed to facilitate TSA, and whether the system improves the processes associated with TSA.

4.1 Technological Solution

Fig. 1. IT head camera

The head cameras used in the project (provided by Jodapro.no) facilitate the transmission of live video streams from crime scenes to operation centers and/or remote specialists (conference function). Users can effortlessly issue commands through voice interaction, such as "Take a photo," "Zoom," or "Call CSI specialists." These commands are integrated into the design of the solution, prominently displayed on the small screen positioned in front or below the user's eye (see Figure 1). This user-centric design is intended to enhance operational capabilities to ensure a user-friendly experience, enabling efficient, precise, and hands-free communication in critical scenarios. The system records both audio and video for documentation and further analysis.

The head cameras include four microphones with active noise reduction, and an internal 94 dBA loudspeaker. It is waterproof, can withstand falls from up to 2 meters, and offers complete protection against dust penetration (IP66 certification).

4.2 Field Trials

Since its inception, the project has conducted a series of field trials with various timeframes (see Table 1 and Figure 2). The field trials consist of different scenarios for exploring the capabilities of the head camera solution. These studies were meticulously planned in collaboration with forensic experts to ensure realism and recorded in full for further analysis.

Echoing Bødker (2000), this study emphasizes the importance of crafting realistic scenarios. Throughout the research, we endeavored to construct scenarios that were open-ended, encouraging broad and conceptual responses. Simultaneously, we employed detailed scenario elements, such as 'blood spatters', where specifics were crucial. These scenarios were not only designed to engage participants actively but also to facilitate 'body storming' sessions (Oulasvirta, 2003), a technique where participants physically act out situations to explore ideas and solutions, thereby enhancing memory retention and inspiring the practical application of head cameras. During the trial, participants engaged in roles that involved exploration, communication, and hands-on testing with these realistic cases (Iacucci et al., 2002).

The first field trial utilized internal police resources, including live streaming to a control room. The second and third field trials expanded on this by live streaming to stakeholders within the project's network, including a university hospital and a bone expert in Cyprus. The third trial took place in Denmark, featuring live streaming with an expert from Australia. These experts are integral members of the project's network. The fourth field trial was conducted during the "11th European Meeting on Forensic Archaeology" in Madrid, where a workshop was conducted. The workshop was fully booked with 25 forensic specialists from around the world, all experiencing live streaming from a crime scene and serving as experts receiving the call from the incident scene.

Table 1. Overview of Field Trials

Field Trials	Scenarios
June 19, 2023, in Oslo	**Murder:** Apartment containing evidence of a killing and a struggle. The main tasks included verbally describing the crime scene, recording it, and live streaming information to a control room using the conferencing function. These activities were conducted with three different forensic investigators, and one forensic investigator was present in the Control Room. **Blood splatter:** The main tasks included documentation of the crime scene through recording and verbal description, conducting a conversation with a remote blood expert using the conference function, capture of fingerprint photos (90° angle, ruler, etc.). These tasks were performed by three different forensic investigators, along with a remote expert. **Sexual offense**: crime scene (outside). The main tasks included documentation of the crime scene through recording and verbal description, and conference function to a Control Room. There was significant noise at the crime scene, and the activities were carried out by two different forensic investigators. Additionally, several people were present in the

	Control Room.
Sep 8, 2023, in Bergen	**Bones**: A crime scene investigator found a bag of bone fragments and used the conference function to communicate with a remote expert from Cyprus to assist in identifying them, supporting decision-making, and providing advice for further actions.
Oct 25-26, 2023, in Denmark	**Two missing persons:** Discovery of two graves - one per day. Conducting test excavations of shallow graves with expert assistance from Australia via video and voice communication. A total of three stakeholders were connected simultaneously - two Australian forensic technicians and one Danish forensic technician.
Sep 29, 2023, in Madrid	**Murders:** Three different murders, bodies found outside. Transmission of information between crime scene and experts.

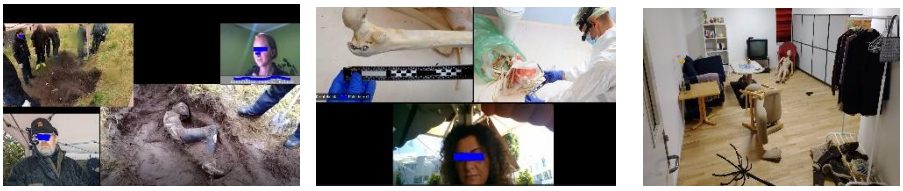

Fig. 2. Communication between the crime scene and the remote experts using the head camera. The pictures mainly show images captured by the head camera. (Photo: Bente Skattør)

4.3 Data Collection and Analysis

The data collection for this paper includes observation of the field trials, with at least one of the authors present at every trial, ensuring thorough and firsthand insight. In addition, video recordings were made in the first three field trials, with length 33 minutes, 17 minutes and 28 minutes. Further, we conducted a qualitative survey with the participants in all four field trials. Respondents were various professional crime scene investigators. The questionnaire invited the participants to provide their subjective experiences, practices, and positioning by answering with their own words and thus captured the sensemaking of the participants.

We have analyzed the observation notes and recordings of the four field trials, using the following categories: (1) TSA between the crime scene and remote expert/s, (2) networking and learning, and (3) technology usage. The categories were chosen to evaluate the effectiveness of remote collaboration, the impact of networking and knowledge exchange, and the practical application of technology.

The videos from the scenarios have been extensively analyzed by transcribing the audio and describing the images related to them. Subsequently, the content has been categorized according to the four elements of TSA; Requirements, Mechanisms, Devices, and Processes.

The survey was divided into various themes associated with TSA and incorporated elements derived from different theories of technology acceptance and consisted of both open and closed questions. By integrating the key dimensions (Usability,

Equipment Quality, and Utilization), the questionnaire aimed to capture a view of participants' experiences and attitudes towards the head camera and further contribute valuable insights to the establishment of TSA. Altogether 25 people responded to the survey, distributed across the various field trials.

5 Results

This section presents the results from the analysis of the field trials. We begin by presenting findings from the observations and video analysis, and then summarize key findings from the survey.

5.1 Observation of the Field Trials

The field trials incorporating live streaming into forensic tasks have provided valuable insights for further research in the project. After completing the test scenarios, the participants conducted debriefing sessions to review the outcomes. The participants reported the scenarios to be relevant and instructive, and effectively executed. In the following we summarize the analysis of the observation notes and recordings, using the categories defined in Section 4.

TSA Between the Crime Scene and Remote Expert. The live video streaming enabled the forensic investigators and remote experts to have effective communication concerning the important elements at the crime scene. In all four scenarios, the common SA requirements were thoroughly discussed based on the objects that all participants observed live, both on-site and via live video. During the sexual offense scenario in field trial 1, the communication was not disrupted by the area around and heavy traffic. The experts and investigators in the control room easily discussed with the on-scene investigator how the area appeared without any disturbances.

In one instance (field trial 2, the bone scenario), the expert stated, *"It's as if I was there myself*." Here, s/he could identify what were human bones among the remains and provide further advice to the on-site forensic investigator on how to proceed with analysing the bones. The experts and on-site investigators continuously discussed the elements on-site during all the scenarios.

Networking and Learning. The participants expressed that the field studies provided a unique opportunity for networking and collaboration. Participants had the chance to learn from each other and collaborate across different disciplines and geographical boundaries because of the conference function in the system. Distance becomes less relevant as long as network coverage is stable.

Technology Usage. The participants expressed that the head camera is easy to use and performs well in various environments, both indoors and outdoors, and almost independently of weather conditions. It also has excellent noise reduction, improving the quality of communication during live video streaming. Due to the hands-free functionality, the forensic investigators indicated that they could work more efficiently. An

example from a participant in Madrid highlights the system's capability to add notes, annotations, or markings at a crime scene: "*An annotation system—almost a virtual reality—in crime scenes where we use markers; having some sort of capability such as this would be great*."

Further, participants underpinned that such live video streaming in addition to being useful operationally, could also contribute to reducing travel costs. Resources can be saved because crime scenes can be processed and cleared more quickly without having to transport experts to the actual location.

5.2 Video Analysis

In this section, we present the findings from the video analysis related to the components of TSA presented in Section 3.1.

Results Related to SA Requirements. When analyzing the videos, critical SA requirements are expressed both visually and verbally, often in tandem as the forensic technicians articulate their observations. For example, in field trial 1 (murder scenario), SA requirements such as time, date, signs of break-in, furnishings, body location, clothing, injuries, weapons, unusual items, and clothing are described verbally. Specific weapon details were described and photographed using the head camera photo function. However, there are also cases where certain elements seen in the video are not commented verbally, such as blood on the door frame and an overturned lamp. Nonetheless, these non-verbally expressed details are still visible in the video, ensuring that technicians have the opportunity to capture all relevant information.

In some instances, various elements are adjusted to gain better insight. An example of this is during field trial 3 where the forensic technician examines the head where the fabric resembles a hood but upon closer inspection appears wrapped around the entire head. In field trial 2, the forensic technicians require more information to achieve SA and therefore call an expert: *"It's difficult to determine if these are human bones; I need assistance from an expert."*

Results Related to Mechanisms. The use of strategies in the test cases is premature, as this tool has not been implemented before in this context. However, the tool itself provides a real-time overview of the situation's development, supporting the team's ability to stay informed and coordinate effectively. As in the abovementioned example in field trial 3, the expert from Australia describes a good overview of the grave and expresses a desire to examine the head of the body, demonstrating how the tool aids in aligning team actions. The goals in these cases are to conduct the most thorough investigation possible, obtain early and accurate information, and initiate actions as early as possible. These mechanisms enable the team to collectively understand the situation and respond effectively, ensuring that their strategies and tools are utilized to achieve their objectives.

Results Related to Devices. Despite rain and shadows, the expert's view during the excavation in field trial 3 is good, though raindrops on the display affect the device somewhat. For example, communication with the Australian expert shows excellent image and sound quality. The participants in Denmark received good video and audio

from Australia, and vice versa. Internet connection via mobile network is utilized due to mobile router issues. On-site technicians can view the expert's screen in Australia, allowing for real-time annotations and discussions, and minimizing misunderstandings.

In field trial 2 (bone scenario), the remote expert efficiently identifies non-human bones and directs the technician to move items for better viewing, leading to the discovery of human bones. Precise descriptions foster a common understanding of the findings, enabling informed decisions for the investigation.

Results Related to Processes. The forensic technician outlines the process for transporting the body in field trial 3, with the expert confirming their decisions. Similarly, discussions about the body and a missing arm prompt the remote expert to request specific information. In the blood splatter case (field trial 1), there is a discussion about where to send fingerprint evidence, both to the National Criminal Investigation Service and the internal investigators. In the sexual offense scenario (field trial 1), discussions cover condom packaging, angles, markings, and item numbers. For dress discovery on scene, details include colors, item numbers, and distances to surrounding structures and vegetation.

5.3 Survey

The analysis of the survey responses followed the selected categories and is summarized as follows:

Usability. The usability assessment indicated that participants found the head cameras intuitive and user-friendly. Minimal training was required, underscoring the device's accessibility for a diverse range of forensic experts such as bone experts and blood splatter experts.

Equipment Quality. Participants commended the quality of both audio and visual components of the head cameras, provided that the network coverage remained stable. The conference function facilitated effective communication with remote experts, demonstrating the equipment's capability to maintain high-quality interactions during live streaming.

Utilization. The integration of head cameras positively impacted overall TSA, as users could stream real-time video to remote experts, fostering collaborative decision-making. Enhanced efficiency was noted by the respondents due to the streamlined communication between on-site and off-site team members. Participants reported an improvement in work quality, particularly in the documentation of crime scenes. The impact on the role of forensic investigators was evident, as the technology empowered them to share their perspectives with experts in different locations. Additionally, the incorporation of head cameras influenced work processes by expediting the exchange of information and promoting a more dynamic and responsive forensic analysis environment.

6 Discussion

The data collected so far in this project mainly relied on observation of field trials, and

video and audio recordings, supported by the survey. The incorporation of relevant scenarios appears to be crucial in discerning the genuine needs of forensic investigators and associated experts (Bødker, 2000).

The findings of this study unequivocally underscore the important role of early expert communication in investigations, particularly concerning its implications for time management—a critical aspect highlighted during the golden hour (Rose, 2021). By engaging with experts at the outset, investigative teams stand to expedite their processes, potentially enhancing overall efficacy. Also, the possibility for a remote expert to guide and advise the forensic investigators during their work process on-site might support informed decision-making processes and avoid the possibility of overestimating the validity of partial information (Didrich, 2015).

The collaborative nature of expert communication also addresses the challenge of overlooking critical SA requirements—a phenomenon not uncommon in high-pressure scenarios. Bringing together observations from different viewpoints, along with the ability to store video footage, helps prevent these oversights. For instance, in field trial 1 (blood splatter scenario), although bloodstains on the door frame were visually detected, their omission from the verbal report underscores the potential pitfalls.

Both the observation of the field studies and the survey support the results from the video analysis related to the live-streaming technology, which improved the communication between forensic investigators and remote experts and further enabled a comprehensive discussion on critical elements at the crime scene. This aligns with previous research that recognizes the importance of visual awareness, as opposed to relying solely on verbal communication, which is integral for establishing and maintaining TSA across distances (Jones et al., 2022).

The findings underscore the potential benefits of enabling real-time and recorded video or image access across organizations involved in the investigative process. This collaborative approach not only overcomes challenges related to compromised SA but also ensures a unified and well-informed response. By enhancing communication and sharing visual information in real-time, the live streaming technology appears to contribute significantly to improving the TSA and connects to the model of TSA, i.e., SA requirements, mechanisms, devices, and processes (Endsley and Jones, 2001).

Drawing a parallel to recent research conducted in Norway by Platou (2023), which explored the use of video calls in emergency medical communication centers (EMCCs), similar benefits of remote expert communication are evident. In these medical settings, video calls are primarily employed in cases of injury, decreased consciousness/stroke, and pediatric emergencies, serving purposes such as medical assessment, intervention evaluation, and enhancing situational awareness. The integration of video calls in healthcare delivery has been shown to increase accuracy and improve resource allocation efficiency, reducing the need for extensive resources like ambulances and air ambulances.

However, despite the clear benefits of communicating with experts early on, there are still difficulties in developing TSA systems in practice. One major problem is the lack of technology that supports this kind of teamwork (Steen-Tveit et al., 2020). The suggested head camera system looks like a good way to overcome this issue, although it comes with its own challenges in being put into action, especially in law enforcement

where procedures are complex. Nevertheless, the proactive involvement of police personnel in the testing and refinement of such systems could catalyze acceptance and adoption within the law enforcement community. Encouragingly, the dissemination of field trial findings through dedicated publication forums, such as police-authored blogs, holds promise in fostering a culture of knowledge sharing and collective learning within the profession.

In conclusion, the results show that the integration of live streaming technology proves beneficial for communication between on-site investigators and remote experts, aligning with the model of TSA. Additionally, the study indicates the potential for remote experts to guide on-site forensic investigators, contributing to informed decision-making and potentially minimizing the risk of cognitive biases (Meterko and Cooper, 2022). This can again lead to increased legal security in the investigation.

While the benefits of early expert communication in enhancing investigative processes are evident, the realization of comprehensive TSA systems requires overcoming technological and organizational barriers. The collaborative efforts of stakeholders, coupled with strategic dissemination of findings, offer a promising pathway towards advancing investigative practices and enhancing operational effectiveness within law enforcement contexts.

The approach in this study can facilitate the identification of critical SA requirements in diverse scenarios and thus provide a foundation for developing future functionalities. Given that the head camera system records both audio and video, further research will focus on leveraging artificial intelligence (AI) for computer vision and text analysis, and generative AI both during CSI and further into the crime investigation and crime prevention processes. Integrating AI into the content analysis could enhance the investigative process and hence significantly advance forensic capabilities.

References

.

1. Ask, K., Granhag, P.A., and Rebelius, A. (2011). Investigators under influence: How social norms activate goal-directed processing of criminal evidence. *Applied Cognitive Psychology*, 25(4), 548-553.
2. Baber, C., Smith, P., Cross, J., Hunter, J.E., and McMaster, R. (2006). Crime scene investigation as distributed cognition. *Pragmatics & Cognition*, 14(2), 357-385.
3. Bjerknes, O. T. and Fahsing, I. A. (2018) «Etterforskning - Prinsipper, metoder og praksis» Fagbokforlaget, 2018, ISBN 978-82-450-2335-0.
4. Bødker, S. (2000). Scenarios in user-centred design - setting the stage for reflection and action. *Interacting With Computers*, 13(1), 61-75.
5. Charman, S.D., Carbone, J., Kekessie, S. and Villalba, D.K. (2015). Evidence evaluation and evidence integration in legal decision-making: order of evidence presentation as a moderator of context effects. *Applied Cognitive Psychology*, 30(2), 214–225.
6. Charman, S.D., Kavetski M, and Mueller, D.H. (2017). Cognitive bias in the legal system: police officers evaluate ambiguous evidence in a belief-consistent manner. *Journal of Applied Research in Memory and Cognition*, 6(2), 193–202.
7. Cobb, C., McCarthy, T., Perkins, A., Bharadwaj, A., Comis, J., Do, B., and Starbird, K. (2014, February). Designing for the deluge: understanding & supporting the distributed,

collaborative work of crisis volunteers. In Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing (pp. 888-899)
8. Ditrich, H. (2015). Cognitive fallacies and criminal investigations. *Science & Justice* 55:155–159
9. Davis, F. D., Bogozzi, R., P., and Warshaw, P., R. (1989). User acceptance of computer technology: A comparison of two theoretical models. Management Science, 35, 982-1003.
10. Endsley, M. (1995). Toward a theory of situation awareness in dynamic systems. *Human Factors*, 37, 32-64.
11. Endsley, M. and Jones, W.M. (2001) A Model of Inter and Intra Team Situation Awareness: Implications for Design, Training and Measurement. *New Trends in Cooperative Activities: Understanding System Dynamics in Complex Environments.* CA, 46-67.
12. Endsley, M.R. and Robertson, M.M. (2000) Situation awareness in aircraft maintenance teams. *International Journal of Industrial Ergonomics*, 26, 2, 301-325.
13. Ernst, S., ter Veen, H., and Kop, N. (2021). Technological innovation in a police organization: Lessons learned from the National Police of the Netherlands. *Policing: A Journal of Policy and Practice*, 15(3), 1818-1831.
14. Fisher, B.A.J. (2004). *Techniques of crime scene investigation*. New York, NY, CRC Press.
15. Hamremoen, E (2017). *Kriminalteknikk, Første enhet på åstedet* (2. utgave), Gyldendal, ISBN-978-82-05-49659-9.
16. Iacucci, G., Iacucci, C., and Kuutti, K. (2002, October). *Imagining and experiencing in design, the role of performances.* In Proceedings of the second Nordic conference on Human-computer interaction (pp. 167-176).
17. Jones, B., Tang, A., and Neustaedter, C. (2022). RescueCASTR: Exploring Photos and Live Streaming to Support Contextual Awareness in the Wilderness Search and Rescue Command Post. Proceedings of the ACM Conference on Human-Computer Interaction, Vol. 6, CSCW1, Article 113.
18. Koper, C.S., Lum, C., Willis, J.J., Woods, D.J., and Hibdon, J. (2015). Realizing the Potential of Technology in Policing. A Multisite Study of the Social, Organizational and Behavioural Aspects of Implementing Policing Technologies. Retrieved from: https://bja.ojp.gov/sites/g/files/xyckuh186/files/media/document/2015_koperetal.realizing-potentialoftech.pdf
19. Lai, P.C. (2016). Design and Security impact on consumers' intention to use single platform E-payment. *Interdisciplinary Information Sciences*, 22(1), 111-122.
20. Lai, P.C. (2017). The Literature Review of Technology Adoption Models and Theories for the Novelty Technology. *Journal of Information Systems and Technology Management* Vol. 14, No. 1, 21-38
21. McEwen, T. (2010). The role and impact of forensic evidence in the criminal justice system. National Institute of Justice. Retrieved from: https://www.ojp.gov/pdffiles1/nij/grants/236474.pdf
22. Meterko, V., and Cooper, G. (2022). Cognitive biases in criminal case evaluation: a review of the research. *Journal of Police and Criminal Psychology*, 37(1), 101-122.
23. NRC (2022). Artificial Intelligence in Innovation of Investigative Interviews Speech-To-Text and Text Analysis Using Machine Learning, https://prosjektbanken.forskningsradet.no/en/, Norwegian Research Council.
24. Oulasvirta, A., Kurvinen, E., and Kankainen, T. (2003). Understanding contexts by being there: case studies in bodystorming. *Personal and Ubiquitous Computing*, 7, 125-134.
25. Platou, H.C.S. (2023). Videosamtale på AMK/Video calls on emergency medical dispatch center [Master`s Thesis]. University of Oslo.
26. Ragde, E.B, and Teige, T. (2021). *På åstedet*. H Aschehoug & Co, Oslo, Norway

27. Riebe, T., Kaufhold, M.A., and Reuter, C. (2021). The impact of organizational structure and technology use on collaborative practices in computer emergency response teams: An empirical study. Proceedings of the ACM on Human-Computer Interaction, 5, CSCW2, Article 478.
28. Rose, A. (2021). "*Forensics: The Golden Hour*", Springer Nature Switzerland, In Modern Police Leadership.
29. Saurabh, K., Arora, R., Rani, N., Mishra, D., and Ramkumar, M. (2022). AI led ethical digital transformation: Framework, research and managerial implications. *Journal of Information, Communication and Ethics in Society*, 20(2), 229-256.
30. Steen-Tveit, K., Radianti, J., and Munkvold, B.E. (2020). *Using Audio-Logs for Analyzing the Development of a Common Operational Picture in Multi-agency Emergency Response*. In Proceedings of the 53rd Hawaii International Conference on System Sciences, Maui, HI (USA).
31. Stout, R.J. Cannon-Bowers, J.A., and Salas, E. (2017) *The Role of Shared Mental Models in Developing Team Situational Awareness: Implications for Training*. In Salas, E. (ed.), Situational Awareness (pp. 287-318): Routledge
32. Venkatesh, V., and Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, 46 (2), 186-204.
33. Venkatesh, V., and Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decision Science*, 39 (2), 273-312.