Extension of the Usability Model of Digital Forensics in Criminal Proceedings to Include Digital Investigations

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Abstract

Usability in digital forensics is not merely a matter of user convenience; it directly affects the quality, efficiency, and transparency of digital investigations. Digital investigations not only motivated the development of digital forensic methods and tools, but also remain one of their primary application domains. Consequently, understanding usability in digital forensics within criminal proceedings requires explicitly considering digital investigations, particularly the interactions and collaborative workflows among involved stakeholders. The proposed extension of the digital forensics usability model demonstrates how digital investigations can be integrated into this broader context and reveals substantial intersections between human, technological, and organizational factors. By incorporating investigative processes into the model, the approach enables a more differentiated perspective on usability and highlights new research opportunities at the intersection of digital forensics, human-centered security, and organizational practice. As ongoing conceptual work[1], the proposed model extension opens new avenues for investigating usability challenges in digital forensic and investigative practice.

1 Introduction

Digital forensics (DF) faces numerous challenges, including its growing importance within criminal proceedings, continuously increasing data volumes, and the rapid evolution and diversification of information technologies [1, 2, 3]. From the perspective of DF, criminal proceedings furthermore constitute complex socio-technical systems involving a wide range of requirements, stakeholders, and interactions related to digital evidence. However, DF tools often prioritize technological capabilities over usability considerations. Usability in DF is not merely a matter of user convenience; rather, the usability of forensic tools, interfaces, and investigative processes can directly influence investigative efficiency, transparency, decision-making, and the interpretation of digital evidence. This becomes particularly relevant in collaborative investigative environments involving investigators, forensic analysts, prosecutors, and other stakeholders.

Despite the practical importance of digital investigations, existing discussions in DF frequently focus on isolated tools and forensic soundness rather than the broader investigative and socio-technical context. As a result, the intersections between investigative workflows and human, technological, and organizational usability aspects remain insufficiently conceptualized.

In this ongoing work, we extend our existing usability model for DF in criminal proceedings by explicitly integrating digital investigations as an additional component. The proposed extension highlights intersections between investigative processes and human, technological, and organizational factors, thereby enabling a more differentiated perspective on usability in digital forensic practice.

2 Previous Work

Previously, we proposed a definition of usability in DF within criminal proceedings [5], which is based on the definition of usability [6], the definition of DF **(author?)** [7], and the overarching purpose of criminal proceedings:

"The extent to which DF principles, methods, tools, and the presentation of their results can be used by the parties involved to contribute to the overarching goal of establishing the truth in criminal proceedings as comprehensively as possible, considering effectiveness, efficiency, and satisfaction."

[1] This work is conceptual and does not involve human participants, personal data, or user studies. Therefore, no formal ethics approval was required.

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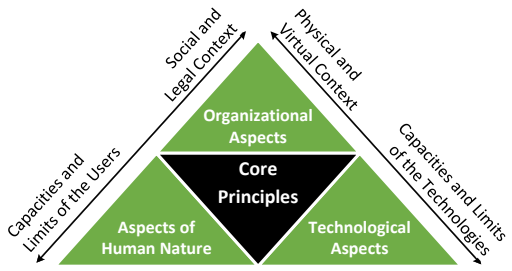

Figure 1: The original model of usability of digital forensics in criminal proceedings [5].

Furthermore, in the above work we present a model for the usability of digital forensics in criminal proceedings (UDFCP model), illustrated in Figure 1. The model structures the problem space of usability in this context into human, technological, and organizational aspects, which are equally emphasized and closely aligned with the four design criteria of usable security [8]. These dimensions are unified by core principles of the usability model, which highlight the importance of explicitly identifying the respective users, their goals and tasks, as well as considering the usability criteria of effectiveness, efficiency, and satisfaction.

In a further work [4], we further elaborate on the application of the human, technological, and organizational aspects as a framework for structuring usability-related challenges in DF. This work highlighted the close relationship between digital forensic usability and broader investigative processes, motivating the extension of the model toward collaborative socio-technical digital investigations.

As our approach to usability in digital forensics focuses more on the socio-technical system of digital evidence within criminal proceedings rather than on individual tools, and as digital investigations constitute a fundamental component of this system, we argue that DF usability cannot be understood without considering digital investigations as collaborative socio-technical processes.

3 Proposed Model Extension

In the extension of the model, visualized in Figure 2, maintaining the original visual language—such as aspects of equal size as well as the intersections and overlaps between these aspects and the core principles—represents a major challenge.

Although digital investigations constitute a distinct direction within the usability problem space of DF, they are not represented as an independent aspect. Instead, we conceptualize digital investigations as the interplay between technologically structured methodologies, human interpretation, and organizational influences. Consequently, the technological, organizational, and human aspects converge within the extended model.

The extended model preserves the balanced representation and overlaps of the aspects of the original model while allowing a more detailed differentiation of organizational subdomains aligned with human and technological perspectives.

The base of the model further incorporates the scientific and practical pillars of DF (computer science, forensic science, and digital investigations) as a foundational layer. For example, questions of cognition and bias can be associated more closely with forensic science, whereas tool-related concerns relate more strongly to computer science.

Finally, an octahedral core preserves the symmetric representation of the core principles of the original model while structuring the complexity of the research field through interconnected sub-parts representing forensic science, computer science, digital investigations and organizational aspects.

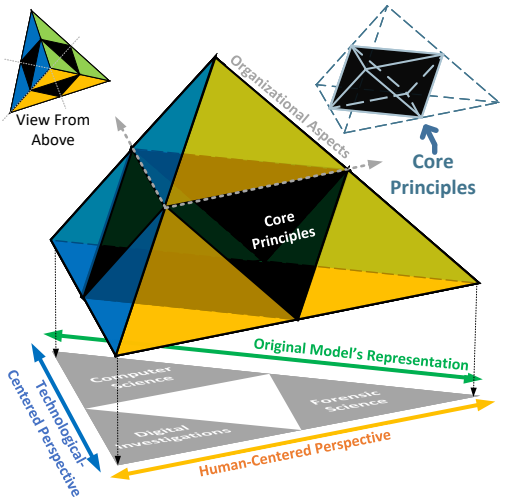

Figure 2: Conceptual representation of the extended, three-dimensional model which integrates the original model on the reverse side of the illustration.

4 Examples of (Future) Applications

Among other things, the expanded model can be used to examine emerging and complex socio-technical developments such as Digital Forensics-as-a-Service (DFaaS) or the important issue of the well-being of investigators and experts in DF. Both examples involve significant overlaps with human-centered, technological, and organizational aspects, as well as digital investigations.

5 Ongoing and Future Work

Further research must be incorporated into the specific design of the model's new technological and human-centered perspectives in order to make the model itself usable for research. In addition, the applicability of the model has yet to be demonstrated. For this purpose, one of the two scenarios described in Section 4 could be suitable.

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