Factors Affecting the Willingness to Use Decision Support Systems in a Military Context

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ABSTRACT

Due to their potential to enhance decision-making processes and manage the complexity of military decision making, the use of Decision Support Systems (DSS) is gaining increasing relevance in the military context. The current debate on integrating AI support in the military largely focuses on technical implementation, while the human factor receives less attention. It is crucial to consider the human factor early in the conceptualization and implementation of intelligent support-systems.

Our research paper specifically investigates how human needs and expectations shape the relevance criteria for a successful DSS utilization. Trust in and acceptance of DSS by military staff can facilitate their integration into decision-making processes and unlock their full potential. Trust and acceptance reduce the security-oriented need for additional information-gathering steps, decreasing resource usage for information acquisition and thus decision-making time.

DSS utilization will impact users' mindsets, work processes, and decision-making processes. Thereby, a positive attitude towards DSS helps users embracing changes to established workflows. This raises the question of prerequisites leading to trust and acceptance among users. To explore these prerequisites, a qualitative study was conducted by the Bundeswehr Office for Defence planning in collaboration with Helmut Schmidt University, involving G2 staff officers at the brigade level as Subject Matter Experts.

In the interviews, the experts were asked about criteria for DSS deductively derived from the literature. Further criteria for DSS were obtained inductively on the basis of the interviews with the experts. In addition, based on the interviews, hypotheses were developed on how both deductive and inductive criteria affect trust in and acceptance of DSS. The contributions of the interviewed experts show that acceptance and trust in this context can be generated, for instance, through positive experiences with the systems, transparency regarding the processing of information, and the explainability of decision support.

Keywords: Decision support system, Acceptance criteria, Qualitative user study, Willingness to use decision support system, Acceptance, Trust

1.0 INTRODUCTION

The term Decision Support Systems (DSS) has different meanings in literature for different groups of people. Often, the term is used for a specific tool in the context of decision support, but sometimes it is also used as an umbrella term to describe different types of computerized systems that support the decision-making process in organizations [1]. DSS support the decision maker in decision making by providing information such as optimized models, representation models, analysis, predictions and suggestions [2] Decisions that individuals make with the help of DSS are algorithm-based, but not algorithm-driven or algorithm-determined according to the Data Ethics Commission [3].

The benefits of DSS are used in various areas. DSS can help to accelerate decision-making and planning processes [4], [5], they assist in mastering complexity [6], [7] and can also help to save physical [8], [9] and human [10] resources. DSS can help to improve the quality of decisions or the basis for decisions [11], [12]. They also allow more resilient decision-making and planning processes [13]. Moreover, DSS increase the agility of decision-making and planning processes, as they are capable of taking into account short-term incoming information [14]. Big Data offers new approaches to algorithm-based decision making to deal with complexity and provide the decision maker with comprehensive data analysis. Here, the brute force method can be used as a helpful tool for retrieving and analyzing large amounts of data and can thus help to master complexity [6].

Due to the listed benefits, DSS are gaining increasing relevance in military applications. For the military, the use of DSS is particularly interesting in the area of "Command & Control", i.e. in the planning, directing, coordinating, and controlling of units and operations [15]. While the technical implementation of these systems in the military receives much attention, the question of what factors influence people's willingness to use DSS receives little attention. However, in order to optimally integrate DSS into work processes, it is essential to consider the needs and expectations of potential users of DSS when conceptualizing and implementing these systems. In order to prepare future armed forces in the many areas of application for DSS mentioned above, the question arises how DSS can be integrated into leadership organizations. This leading question is accompanied by the questions of when and under what conditions the integration of DSS is reasonably possible. We understand DSS in general terms as intelligent systems for decision support. We consider DSS in an abstract manner and thus do not refer to specific products or systems in order not to influence the investigation through possibly existing positive and negative associations. To investigate the prerequisites for the utilization of DSS, we believe it is important, in addition to technical aspects, to also focus on the human aspect in research. In the literature, there are initial studies on how criteria such as explainability affect trust in DS [16], or how explainability and transparency affect personalized AI systems [17]. To the best of our knowledge, however, the existing literature does not yet contain a study that attempts to holistically capture which criteria affect trust in and acceptance of DSS, and thus the willingness to use DSS.

Identifying human needs and expectations, as well as the exploration of criteria that lead to acceptance of and trust in DSS, are therefore part of a research project being conducted by the Bundeswehr Office for Defence planning and the Helmut Schmidt University. To this end, criteria that have an impact on acceptance of and trust in DSS were first identified deductively as part of a literature review. Subsequently, interviews were conducted with subject matter experts to obtain expert assessments of the deductively identified criteria, and to additionally collect inductively relevant criteria for the use of DSS. The interviewed experts are G2 officers at brigade level, i.e., officers who already have initial experience with DSS, and who therefore have the potential to generate valuable contributions in the semi-structured interviews.

Considering human needs already in the conception phase of DSS as well as in the early implementation phase is decisive for ensuring the later willingness of military staff to use DSS. The creation of a useful catalog of criteria for the purposeful selection and development of DSS is one aspect of the research project, but not part of this paper.

The introductory part of this paper is followed by a theory section defining the criteria that were deduced from the literature or inductively generated through the contributions in the interviews. The subsequent methods section provides details regarding the procedure and evaluation of the expert interviews. In the results section, the knowledge gathered from the discussions about the individual criteria is summarized, and the most important aspects of these criteria are presented. Also, initial hypotheses about the relationships between these constructs are made. The following section, limitations and future research, discusses limitations and presents potential research building on the results. At the end, the conclusions section summarizes the results and their possible applications.

3.0 DEFINITIONS AND TERMINOLOGY

3.1 Criteria

Criteria identified deductively through literature research, as well as criteria collected inductively through the expert interviews, play a crucial role within this paper. Therefore, it is essential that the reader understands how the authors define and differentiate these criteria. Table 1 provides an overview regarding both points. Figure 1 also illustrates in detail the difference between explainability and traceability.

Table 1: Definition of criteria used in the report.

Criteria	Derivation	Definition
Resilience	deductive	Laprie and Simoncini define resilience as the persistence of service provision that is reliable in the light of changes. Resilience deals with conditions that lie outside of a system's design frame, while other reliability metrics deal with conditions within the design frame [18]. In the context of DSS, resilience primarily refers to changing framework conditions of a conflict.
Speed	deductive	Due to the lack of suitable definitions of speed in the context of DSS in the literature, speed is defined in this paper as the time advantage generated in decision-making through the utilization of DSS.
Explainability	deductive	Explainability is a prerequisite to grasp and communicate the system's decision-making proposals and is sometimes associated with comprehensibility. It is about "enabling a stakeholder to understand the reasoning of model results and, if necessary, to challenge them" [19].
Traceability	inductive	Traceability allows the functionality of the DSS to be reviewed. If traceability is present, understanding how the DSS's evaluations and conclusions came about is possible.
Transparency	deductive	Transparency is the basis for a system's validation and verification. It means complete disclosure of the system. The entire system can still be so complex that it cannot be understood in its entirety. However, insight into all areas of the system and its functioning is provided. A transparent system has the characteristics of a white box, or at least a grey box, and is thus much different from a black box.
Controllability	inductive	Controllability is the ability to influence the system so that it operates in the desired manner.
Experience	inductive	The perception of a DSS through acquired knowledge about the system shapes the experience with DSS. The perception is shaped both by individual experiences of the user and by the transmission of collective experiences of the user community.
Usefulness	inductive	The criterion of usefulness refers to DSS users deriving added value in decision situations through the utilization of DSS. Usefulness refers to the DSS providing beneficial services. Usefulness should not be confused with user-friendliness, although a close connection exists.

While explainability is primarily a criterion for being able to present the work results to the decision-maker, traceability is a criterion for the analyst to understand and assess the result of the DSS. Explainability influences the communication process between the decision-maker and the analyst. Traceability influences the understanding process in the analyst's work with the DSS.

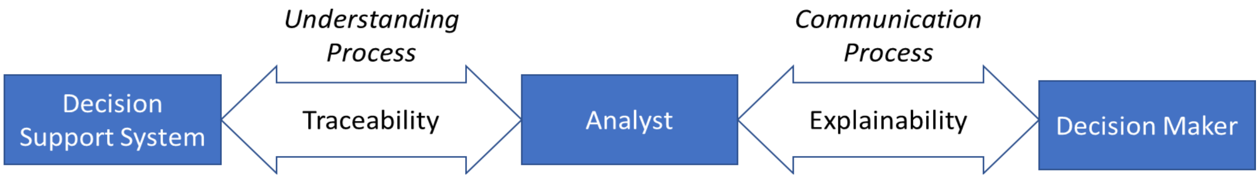

Figure 1: Difference between traceability and explainability.

3.2 Mediators and Dependent Variable

In addition to the deductive and inductive factors we want to introduce two additional factors. Those two factors are acceptance of as well as trust in DSS. Those two factors do not, in contrast to the eight factors defined above, stand on their own. In fact, we assume they are influenced by the deductive and inductive criteria of this research project. The literature provides evidence to support this assumption. According to Naisheh, explainability has an effect on trust in DSS [16], and according to Shin, explainability and transparency have a significant positive effect on trust in personalized AI systems [17]. Further we assume acceptance of and trust in DSS influences the willingness to use DSS. In this way, acceptance and trust mediate the influence of the criteria of Table 1 on the willingness to use DSS.

In our view, trust and acceptance are not identical. It would be conceivable that users trust DSS but still do not accept them because, in their view, they are too inconvenient to use or too difficult to be integrated into workflows.

In summary, acceptance of and trust in act as Mediators. "Mediation occurs when a mediator construct intervenes between two other directly related constructs." [20]. Mediators mediate the influence of influencing variables on a dependent variable and explain why this relationship exists. They help to explain causal effects [21]. Mediation is an important concept in the context of structural equation modelling. In our context the deductive and inductive factors are the influencing variables and the willingness to use DSS is the dependent variable. In chapter 5.3 we formulate hypotheses about these causal effects based on our research. In our further research we are going to test these hypotheses with a qualitative study using the method of partial least squared structural equation modeling.

4.0 ANALYTICAL METHODS

The information provided in this article is based on an evaluation of five SMEs in the period from September 23rd, 2022, to December 13th, 2022. The five SMEs are all G2 staff officers from brigades, a division, and a corps. The survey was conducted by a research project team consisting of representatives from the Bundeswehr Office for Defence Planning and the Helmut Schmidt University. During the semi-structured interviews, the experts were confronted with DSS. Scenarios and vignettes, which take into account the deductive criteria, were used to operationalise the question "When and under what conditions does the use/integration of DSS make sense? It was also asked which other criteria DSS have to fulfil in order to be used. In this way, the SMEs interviewed were not only able to provide input on the relevance of deductive criteria in the above-mentioned context, but also to inductively collect further criteria that are relevant from the user's point of view so that DSS can be used. The interviews were conducted until saturation was reached regarding new aspects to the interview questions. The interviews were transcribed and subsequently coded with the MAXQDA[1] software.

5.0 RESULTS

5.1 Deductive Criteria

5.1.1 Resilience

For experts, DSS must prove themselves to be resilient, since in a military context you always have to reckon with unpredictably changing conditions. These could be, for example, deviations from the enemy's doctrine. There must also be a resilience of the DSS towards shortcomings in situational awareness. As a derivation from this, experts demand the ability of DSS to learn and adapt.

5.1.2 Speed

Speed is a significant expectation of experts for a DSS, which they must meet to provide added value. For this, it is essential that DSS agilely integrate into work processes and structures to deliver this advantage. In their opinion, a DSS cannot be a standalone system, but should be integrated into the existing Battle Management System. However, it is assumed that there will always be a tradeoff between speed and accuracy. This conflict of objectives exists even without the use of DSS anyway. Consequently, it is important that the time savings through the use of DSS overcompensates for restrictions in accuracy, so that the quality of the decision as a product of accuracy and speed is improved overall.

5.1.3 Explainability

According to expert opinion, an important aspect of an advanced system is to be able to explain how the output results are derived. This aspect is of high relevance for DSS, especially because the rationale of the decision proposal must be explainable to the decision-maker. The relationship between the output of the DSS, such as a situation assessment, and the underlying input, such as situation reports, must be explainable.

5.2 Inductive Criteria

5.2.1 Traceability

Several experts point out that the reasons how a DSS decides should be traceable. Since in their opinion, the human assessment must stand above the DSS, they demand a possibility to check the DSS. For this, the work of the DSS must be understood and thus can be traced. This requires visibility into the completed process steps as well as into the underlying sources and sensor data.

5.2.2 Transparency

Several experts demand transparent DSS. Transparency is expected in three different aspects.

- Transparency of the causal relationships in information processing in a DSS.
- Transparency about the abstraction steps that have been carried out by the system to simplify the information.
- Transparency about the input information of the DSS and how it is processed by the DSS.

[1] MAXQDA is a software program designed for computer-assisted qualitative and mixed methods data, text and multimedia analysis in academic, scientific, and business institutions. The product name "MAXQDA" begins with a tribute to the German sociologist Max Weber and ends with the abbreviation QDA - which stands for Qualitative Data Analysis

5.2.3 Controllability

The experts demand systems that work according to their specifications and ideas and can thus be trained and guided in a similar way to a human analyst. To do this, DSS must also offer the user the opportunity to execute this control, so that it works individually for each user and provides its products in the desired way. Furthermore, it is expected to be able to execute control over the system via feedback.

5.2.4 Experience

According to many interviewed experts, the experiences made with the DSS is an important criterion that influences their use. Consequently, it is essential that these experiences can be made by the users and are made available to them. The DSS can also actively shape these experiences by providing the user with reliability indicators for the given evaluations and recommendations. The exchange in the user community should also be actively promoted to enable collective experience with the system.

5.2.5 Usefulness

Great value can be added by the use of a DSS in that the DSS highlights what would be unpredictable or easily missed without the use of DSS. To do this, the DSS must first and foremost assist in managing complexity. The DSS must also produce results that are a usable product for the analyst. An embedding into existing systems is to be strived for here. In order to actually provide benefits, the DSS must also fulfill aspects of user-friendliness. In this regard, the experts highlight scalability as an important aspect, which is of great importance in order to avoid information overload. It is necessary to define and establish levels of aggregation. According to the experts, data visualization should be situationally appropriate and tailored to the needs of the users.

5.3 Hypothesis Formation and Mediators

5.3.1 Acceptance

The acceptance of a system is a basic requirement for the willingness to use a DSS. The DSS should not be used merely due to an obligation to use it, but users should embrace its use out of their own conviction of the added value of a DSS. There should also be no compulsion to use the system, instead the user should always have the opportunity to overdrive the system or use alternatives.

For acceptance, the experts require usefulness, controllability, speed, explainability, the positive individual experiences of the user, and the positive collective experiences of the user community, as well as transparency.

Furthermore, trust, the second mediator listed in this paper, is also an essential prerequisite for the mediator acceptance.

Therefore, from the interview contributions, we hypothesize the following by induction inference regarding the mediator acceptance:

H1(+): The usefulness of DSS has a positive effect on the acceptance of DSS.

H2(+): The controllability of DSS has a positive effect on the acceptance of DSS.

H3(+): The speed of DSS has a positive effect on the acceptance of DSS.

H4(+): The explainability of DSS has a positive effect on the acceptance of DSS.

H5(+): Direct individual positive experiences with DSS have a positive effect on the acceptance of DSS.

H6(+): Indirect collective positive experiences with DSS have a positive effect on the acceptance of DSS.

H7(+): The transparency of DSS has a positive effect on the acceptance of DSS.

H8(+): The trust in DSS has a positive effect on the acceptance of DSS.

5.3.2 Trust

Trust in a system is also a basic prerequisite for the willingness to use a DSS. It became apparent that the experts interviewed would not trust any system directly, but that trust in DSS must first be earned after its introduction. The trust in the DSS itself, and thus in its output, is closely intertwined with trust in the quality of the input. To this end, the analyst must critically engage with the DSS's input. In doing so, the DSS should provide ways to inspect the input underlying the result.

There is always a trade-off between trusting the system, and relying on an experienced team of analysts. In principle, according to the experts, human evaluation should always take precedence.

It was also pointed out, that in the case where the DSS issues critical guidance (e.g., it issues a warning of a major impending threat), and where the consequences of not acting are very serious, there may be a compulsion to act based solely on the information provided by the DSS unless the timeframe to act allows for an alternative assessment, using other sources of information.

For trust, the experts require resilience, explainability, controllability, traceability, transparency, and the positive individual experiences of the user, as well as the positive collective experiences of the user community.

Therefore, from the interview contributions, we hypothesize the following by induction inference regarding the mediator acceptance:

H9(+): The resilience of DSS has a positive effect on the trust in DSS.

H10(+): The explainability of DSS has a positive effect on the trust in DSS.

H11(+): The controllability of DSS has a positive effect on the trust in DSS.

H12(+): The traceability of DSS has a positive effect on the trust in DSS.

H13(+): The transparency of DSS has a positive effect on the trust in DSS.

H14(+): Direct individual positive experiences with DSS have a positive effect on the trust in DSS.

H15(+): Indirect collective positive experiences with DSS have a positive effect on the trust in DSS.

6.0 LIMITATIONS AND FUTURE RESEARCH

One of the limitations of this paper is that the sample size, with 5 interviewed experts, is rather small. However, a saturation of content regarding new aspects was observed in the course of the expert interviews, so that conducting additional interviews would probably have only provided little additional insights. Another limitation is that all interviewed experts are G2 staff officers. This could potentially bias the results. However, G2 staff officers are also generally trained officers who could potentially serve as G3 staff officers and commanders in the future. For this reason, a one-sided G2 officer perspective should not have influenced the results. A study of the hypotheses formulated in Chapter 5.3 using partial least squares structural equation modeling is planned for the further course of the research project. This would correspond to a mixed-methods approach to investigating the impact of potential criteria on the readiness to use DSS.

7.0 CONCLUSION

This paper provides a summary of the insights gained from the current interim analysis of the expert interviews already conducted. The experts have essentially three expectations for DSS. First, they expect an acceleration in decision-making and thus a temporal advantage. Second, it is expected that the use of DSS will make complexity in decision-making and military leadership more manageable. Third, they expect more safety and robustness in decision-making, by providing a better overview of what is easily overlooked and unpredictable in planning through the use of DSS. Overall, a great openness to the use of DSS in these areas was detected in the interviews. DSS must meet these expectations in the future in order to foster a willingness for their use.

In addition to the criteria for DSS deductively derived from the literature, further criteria for DSS were inductively identified in the interviews, such as traceability, controllability and usefulness. Furthermore, based on the interviews, hypotheses were formulated that describe the relationships between the criteria for DSS on the one hand, and trust in and acceptance of DSS on the other. Trust and acceptance in turn are mediators which mediate the influence of criteria for DSS on the willingness to use DSS. However, the collected statements of the experts suggest that they always want to have the final say when it comes to the final assessment of the situation and decision-making. This is demonstrated by the repeated demand to be able to influence the system, or to override it. The experts demand systems that work according to their specifications and ideas, and are thus trainable and leadable like a human analyst.

One of the key takeaways from the study is that user trust in a DSS is cultivated through positive experiences and system transparency, particularly concerning the details of its information consideration and processing. The acceptance of action recommendations by DSS is increased if there is the possibility to compare them with other information sources, which provide indicators supporting the DSS recommendations. Furthermore, user-friendly and customizable DSS interface design can foster acceptance among users. The future of DSS lies in their ability to meet user expectations for time saving, complexity control, and enhanced security in decision-making situations. In addition, the system's statements or evaluations do not absolve the analyst of the duty to question them. Considering the constant evolution of warfare tactics and the necessity for risk management, the resilience of a DSS becomes critical.

To enhance the resilience of DSS, they must be adaptable, taking into account user feedback and flexibly responding to changing situations, such as deviations in enemy doctrine. The experts' expectations also indicate that the ability of a DSS to explain its rationale and provide traceability significantly impacts its acceptance. Hence, DSS should prioritize usefulness and the capacity to present information clearly at different levels of detail. This study thereby emphasizes the need for DSS to balance their technological sophistication with user-centric design and functionality.

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