Determinants that Are Believed to Influence the Acceptance and Adoption of Mission Critical Autonomous Systems

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Determinants that Are Believed to Influence the Acceptance and Adoption of Mission Critical Autonomous Systems

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Extensive research and technological advances have led to the evolution of autonomous systems. The world offers various autonomous systems while there seems to only be a trace of literature evaluating possible mission critical determinants that would affect one's willingness to accept and adopt said autonomous systems. Developing SE approaches and requirements for mission critical autonomous systems requires a better understanding of the challenges for pre- and post-system acceptance and adoption. Through a literature review, this study examines four main determinants in relation to operator acceptance and adoption: *system effectiveness*, *system transparency*, *risk-based criticality*, and *mental workload*. A semi-structured interview and theoretical model was created and reviewed to evaluate how the preferences, beliefs held by stakeholders, and factors compared to each other.

I. Introduction

In recent years a paradigm shift has occurred towards a growing emphasis on system autonomy, especially in mission critical environments. The Schloer Consulting Group described the different levels of autonomy found in these environments as simple, complex, and very complex [1]. Because today's mission critical environments (that are ever changing) have become increasingly complicated, with interactions and their consequences becoming more and more difficult to isolate and understand, the increasing capacity and ubiquity of autonomous systems has made the operator-automation relationship an important part of effectiveness [2]. This has further led designers to study the acceptance and usability of these systems as well as viability of future systems in development [3]. However, with the dependence on various systems and levels of their own autonomy used in missions, issues regarding the interaction between the operators of such systems and the limitations of these systems have emerged. Autonomous systems often make the system performance progressively dependent on the integrity of this relationship [2]. For example, an autonomous system may change the operator's role. Instead of controlling the operation, autonomous systems may require operators to allocate control of mission operation to the system. While the introduction of autonomous systems follows certain technology acceptance models that can predict operator acceptance and adoption, the evaluation of possible mission critical factors has been somewhat ignored in the literature. The analysis of possible mission critical

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determinants that may affect acceptance and adoption begins with an extant review of the literature as well as with the development and deployment of a questionnaire.

II. Contributions

This paper will explore and examine the factors that are believed to affect the acceptance and adoption of mission critical autonomous systems. An overview of the research method including a semi-structured interview, transcription, coding, and analysis is described. The most commonly identified factors from the interviews are discussed and briefly compared with the Technology Acceptance Model (TAM). This will improve the understanding of mission critical autonomous systems acceptance and adoption, which has not been studied before. Stakeholders including DOD professionals, warfighters, and engineers may be able to utilize the findings to achieve quicker and more effective acceptance and adoption of autonomous systems.

III. Background

A. Theories of Human Behavior on Technology Acceptance and Adoption

For many years, researchers have applied theories of human behavior to study technology adoption and acceptance [4]-[7]. It is important to draw a distinction between adoption and acceptance of autonomous systems. Adoption is described as a process that starts with the operator becoming aware of the technology and ending with the operator embracing the autonomous system and making full use of it [6][8]. According to Rodgers [7], autonomous systems can be adopted or rejected by either individual operators or by the entire social system, which is dependent on the level of decision making given to the operator for adopting an autonomous system. The decision for adoption ranges on a continuum from 1) optional decisions (the adopting operator has almost complete responsibility for the decision); 2) through collective decisions (the operator has some influence in the decision); 3) to authority decisions (the adopting operator has no influence in the decision).

Acceptance, opposed to adoption, has been defined as an attitude towards the autonomous system, and is influenced by various factors [6]. Indeed, an operator who has a new automated system available for use has not yet adopted it – there are additional stages beyond the availability of a system where acceptance plays an important role. For instance, experienced warfighters may believe that in combat, the less-capable system that works 100% of the time is preferred over the new, but unreliable autonomous system. Thus, even if an operator has a new autonomous system available to them but then does not accept it, adoption is unlikely to occur [9]. Hence, the acceptance of a technology begins long before the operator has first contact with the system under consideration [10]. That is the reason why it is of importance to understand the various factors that influence operator acceptance.

The use of models to estimate technology acceptance is not novel and past models have presented a good way to investigate usage cases and nuisance criteria for system development purposes [3]. One widely used model for technology acceptance is the Technology Acceptance Model (TAM), which was developed by Fred Davis [11]. TAM was developed on the concept that people accept or reject technology based on the perceived usefulness and perceived ease of use of that technology. The goal of TAM is to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified. TAM is grounded in the Theories of Reasoned Action (TRA) and Planned Behavior (TPB) to study attitudes toward new information technologies [12][13]. According to the TRA, human behavior is affected by behavioral intention, attitude, and subjective norm [12]. The TPB was developed as an extension of the TRA to explain actions caused by a situation beyond one's control [14].

Besides TAM, more complex models of acceptance such as Technology Acceptance Model 2 (TAM2), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Safety-Critical Technology Acceptance Model (SCTAM) have been released with the intent of improving the models used in gaining more accurate information on acceptance of technology in different disciplines. The UTAUT suggests differently than the TAM, that variables such as effort expectancy, performance expectancy, and social influence all influence behavior intention, or the intention of accepting a system [15]. However, the major limitation of current technology acceptance models is the basis of design, predicting the usage of technology that impacts users in a different way [2]. The current technology acceptance models are based on user-focused technology such as information systems/computers. These types of systems are inherently safer than the autonomous systems used during missions (like an autonomous weapon system). Thus, the technology acceptance models may not be encompassing the context of technology use in complex and mission critical environments, such as use in battlefields. This poses the opportunity to evaluate possible mission critical determinants and extend the model with such attributes.

There have been some previous surveys and questionnaires that have been utilized to understand autonomous systems in the military. One example is the survey for Royal Navy Personnel [16]. Their survey consisted of qualitative questions that asked the user for their experience with autonomous systems. Researchers followed up with additional questions to further understand the participant's initial answers.

Our current study follows this example, consisting of a semi-structured interview to gain a deeper understanding of what factors operators find essential to the acceptance and adoption of autonomous systems. Operators and current active duty military personnel were the target participants because they are considered subject matter experts (SMEs) in the field of military autonomous systems. It is customary practice for research with SMEs to gain the support of individuals within the same organization who act as facilitators to the SME [16].

B. Proposed Determinants Influencing Acceptance and Adoption

Context-dependent characteristics of the operator as well as the external and internal environment have been shown to determine the degree of influence on willingness to use automation [3]. While many factors impact acceptance and adoption in different operator contexts and levels of automation, the objective of this study was to examine the determinants for the acceptance and adoption of autonomous systems in the context of mission operations. A true evaluation of these mission critical determinants and their influence on the willingness for operators to accept and adopt autonomous systems began with qualitative and quantitative research methodology through the development and deployment of a semi-structured interview, discussed below.

IV. Methodology

This work will gather evidence on the preferences and beliefs held by stakeholder's pre- and post-autonomous system acceptance and adoption. The primary stakeholders of this study were DOD engineers, DOD contractor engineers, and warfighters that fall into the defense acquisition phases of "Engineering and Manufacturing" and "Production and Deployment". Three main steps were followed: literature review, development of semi-structured interview, and the interview and analysis procedure. Each step is detailed in sections A-C below.

A. Literature review

A literature review of technological models, acceptance, adoption, and autonomous systems was conducted to identify key determinants that may affect acceptance and adoption of autonomous systems. Various articles were gathered from DOD sources as well as academic journals. A total of 31 sources were identified by specific key terms utilized in *Google Scholar*, EBSCOhost, as well as PsychInfo targeting autonomous systems in the military domain. Several of the key terms used to identify factors that affect acceptance and adoption of autonomous systems were, *autonomous system, adoption, technology,* and *acceptance of technology,* among others. Additionally, sources were not limited by publication date, and no print sources were used for information unless they were digitized. The literature review resulted in our choosing four determinants to investigate in this study that were identified and translated into questions.

While many factors impacting acceptance and adoption appeared in literature, the research team conducted an expert review workshop to narrow down the list of determinants of interest to this study to better understand their importance to the acceptance and adoption of autonomous systems in the context of mission operations. Specifically, four determinants were identified: *system effectiveness, system transparency, risk-based criticality,* and *mental workload*. The four determinants are described below.

1. System Effectiveness

Recent imperatives have shifted the emphasis from system performance (i.e., characterized by such attributes as speed, payload capacity, etc.) to overall system effectiveness that focuses on its ability to satisfactorily complete its mission, against a wide variety of situations and threats, at an affordable life cycle cost [17]. Hence, system effectiveness can be defined as the probability that the system can successfully meet an operational demand within a given time when operated under specified conditions [18]. System effectiveness is thus also seen as a measure to which the autonomous system can be expected to achieve a set of specific mission requirements that is shown to the operator through its availability, dependability and capability [19].

2. System Transparency

Transparency refers to the degree where the inner workings or logic used by the automated systems are known to human operators to assist their understanding about the system [16]. The concept of transparency emerged from the trust in automation literature as a way to reduce uncertainty regarding the performance and or behavior of an automated system. Numerous studies have shown that designing system interfaces that provide operators with accurate feedback about the system's reliability or how the system operates better facilitates operator-automation task performance [4].

The design of a transparent system that provides accurate, useful feedback can reduce the frequency of automation misuse, and disuse, thus ultimately reducing adoption challenges [20-21].

3. Risk-based Criticality

Criticality has most commonly been defined as the impact level an autonomous system may have in the presence of security related threats [22]. The operator task is linked with a criticality value to express which consequences are related to a specific error/failure. Thus, the criticality of an autonomous system depends on its relative importance and impact on performance of the operator-automation system that it is part of. While criticality is based on the consequences of the error/failure, risk focuses on the probability of a given error/failure and the severity of its effects. Mission environments have been found important in defining potential risks and criticality associated with the use of automation [5]. Individuals in high-risk decision making situations show an inclination to use automation.

4. Mental Workload

Workload has a variety of definitions; for the purpose of this study, workload is defined as the portion of the operator information processing capacity or resources that are required to meet system demands [23]. An operator's workload most likely determines the amount of time and cognitive effort that can be spent monitoring the autonomous system. For that reason, workload has been identified as a significant variable that can alter the dynamics of the operator-automation interaction that might influence overall acceptance and adoption. For instance, higher mental workload appears to moderate a positive relationship between trust and system reliance [4], suggesting that operators often must use automation to maintain pace with task demands, regardless of how much they trust the system.

B. Development of semi-structured interview

Several steps including a literature review, conceptualization of the semi-structured interview, and approval from the UA System Institutional Review Board (IRB), provided information to create a validated semi-structured interview for mission critical operators (e.g., warfighters). The semi-structured interview consisted of open-ended questions to capture encountered challenges and preferences that stakeholders may have for autonomous systems.

The development of the semi-structured interview was based on previous research completed by the Royal Navy Personnel [16]. Additionally, the semi-structured interview consisted of open-ended questions, such as, "*What challenges did you face while operating the system?",* "*What factors are essential to acceptance and adoption of autonomous systems?"*, and similar questions. The semi-structured interview consisted of 14 questions total. While these questions did not specify mission critical systems, the interviewees were most familiar with mission critical autonomous systems due to their employment.

C. Procedure

The procedure began with interviews, which were then transcribed, coded, and analyzed. The detailed procedure is described below.

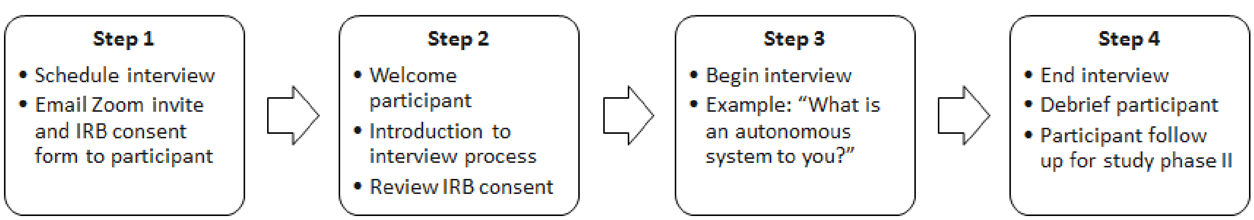

Fig. 1 Interview Process

1. Interview

The interview process is shown in Fig. 1. Participants were emailed the consent form and asked to read it before the day of the interview. The Interview took place via the online video conferencing platform *Zoom* and participants received a link for joining their *Zoom* session online. The interviewer welcomed participants and would then begin the interview by asking if the participant read and agreed with the consent form. If the participant had not read the consent form, the interviewer read the consent form aloud to the participant. Afterwards, the participant was verbally asked if they were comfortable with audio recording for transcription purposes. Once the participants consented to both the consent form and audio recording, the interviewer began recording the session on zoom. Each interview varied in time, with most taking between 10-20 min. After the interview ended, the participants were debriefed and released.

2. Transcription

Transcription process of the interviews began after a total of 47 participants were interviewed. Undergraduate research assistants transcribed each interview manually, with the help of the transcription software, *Dragon.* The transcription process can be defined as when research assistants listened to each interview individually, then transcribed or typed the entire interview in a document. In addition to writing down every spoken word in the interview (not including speech disfluencies), each question asked was time stamped. On average, the total time for transcription for one interview session was approximately 60 min (1 hour).

3. Coding

Each interview was then manually coded [24-27] by question type. Coding allows for qualitative data to be grouped and analyzed in a scientific way. The coding process began with the two coders familiarizing themselves with the coding scheme and then independently coding each of the free responses in the interview. There were a total of 12 open-ended questions that were coded individually. Each question was coded with at least 3 codes, with the maximum amount of codes per one question being 14. Two of the 12 questions are examined in this paper, regarding the factors impacting acceptance and adoption and challenges in autonomous systems. Inter-rater reliability [28], [29] between the two coders for all questions was determined using Cohen's Kappa [26], [27], resulting in moderate inter-rater reliability (κ=.387).

Table 1 Coding Factors and Definitions

Determinants	**Coding Factor**	**Coding Definition**
System Transparency	Transparency	Knowledge of the system's capabilities and why it was needed
	Perceived Usefulness	How useful the operator believes the system is
	Perceived Ease of Use	Easiness for an operator to use the system
	Human Override	The ability to have an operator or human in the loop to override system decisions
System Effectiveness	Reliability	A consistent accurate and dependable system
	Technical Issues	Array of technical problems with the system while in use
	Outdated software	Software that is outdated or needs consistent maintenance
	Physical Aspect of System	Weight, bulkiness, resilience of the system when in use
Criticality	Improved Capabilities	A system that may offer better capabilities and performance to complete a mission than previous ones
Mental Workload	Human Error	Incorrect input due to user error

Topics of discussion were manually analyzed for content and coded according to a defined coding scheme [26]. The transcriptions of the interviews were coded to represent factors believed to affect acceptance and adoption of autonomous systems [23]. Researchers identified key words within the transcriptions to generate a consistent coding scheme. For example, *transparency* was coded as a factor when participants mentioned understanding capabilities of an autonomous system, as well as why the system was assigned to them and/or needed for a mission. All codes were defined and developed by researchers after the transcription process, and added as needed during the coding processes. A total of 119 codes were developed and used across 12 questions. Examples of the codes and definitions can be found in Table 1. As shown in Table 1, each coding factor can be grouped under the four determinants identified in the literature review.

4. Analysis

The coding was analyzed with SPSS 26 [30] to determine the most frequent factors believed to affect acceptance and adoption of autonomous systems. Excel was also used to discover the most commonly used autonomous systems, and the frequency of participants per military branch. Bar graphs and pie charts were created to visualize the descriptive statistics.

V. Results and Discussion

A. Participants

A total of 47 Naval Postgraduate School (NPS) active duty military students voluntarily participated in the interviews. Participants were required to be over the age of 18. All of the participants were officers in the military with the majority of them being in the Marine Corps. The breakdown of participants per military branch can be seen in Fig. 2. The most participants were in the Marine Corps (48%), while 25% were in the Navy, 14% in the Army, 8% in the Air Force, and 2% in the Coast Guard. All but 2 participants were male.

In addition to identifying the top five factors most essential for accepting and adopting an autonomous system, we also examined which systems were most commonly used by these operators. Figure 2 shows the participants had the most interaction with radar/alert systems (45%), then computer/software/maintenance systems (40%), and then weapons/drones (15%).

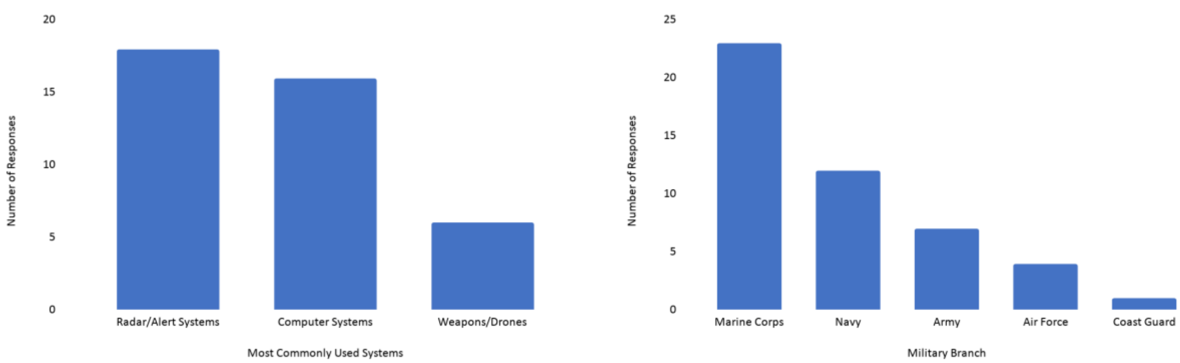

Fig. 2 Most Commonly Used Systems and Participants per Military Branch

B. Commonly Identified Factors for Acceptance and Adoption of Mission Critical Autonomous Systems

The top 5 factors essential for operators to accept and adopt a mission critical autonomous system are shown in Fig. 3, as determined by how often codes appeared in the interview transcripts for the question "*What factors are essential to acceptance and adoption of autonomous systems?".* A chi-square goodness of fit was computed to find a significant difference between the frequency of factors identified, $\chi^2(8) = 48.5$, $p <. 001$. Codes were allowed as many times as needed in interviews, meaning an interview could be coded one or more times with the same code. Figure 3 shows that *transparency* was the most identified factor in the acceptance and adoption process of an autonomous system in these interviews. *Transparency* was defined by participants as understanding the capabilities of the autonomous system in addition to understanding why they may need the system. *Perceived usefulness* was defined by participants as how useful an autonomous system would be to themselves/operators. *Perceived ease of use* was defined by participants as how easy it was to use the system, *human override* was defined as the ability for the operator to override the system if need be, and lastly, *reliability* was defined as how accurately and consistently the system performed.

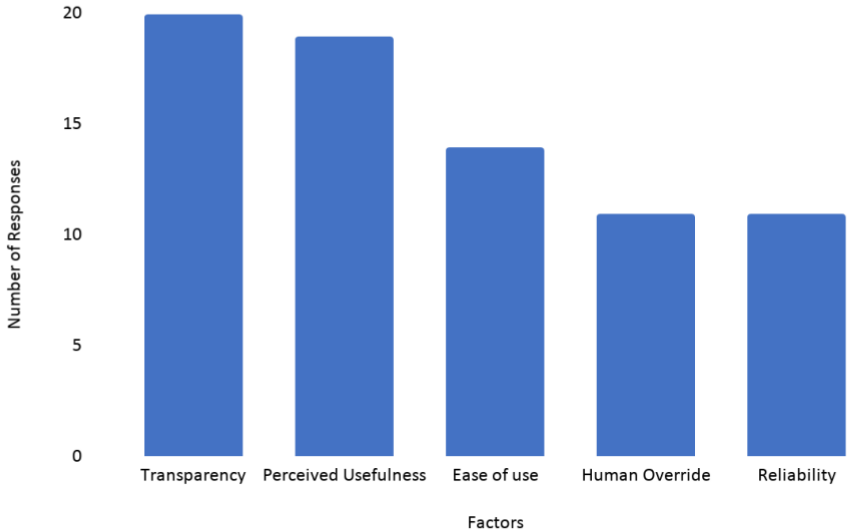

Fig. 3 Five Most Essential Factors to Accept and Adopt an Autonomous System

Table 2 shows direct quotes from participants regarding the aforementioned factors. The question asked was, "What are essential factors for you to accept and adopt an autonomous system more readily?". We used direct quotes from participants to code for all other factors as well. The examples that follow are imperative to future research and organizations because these operators are telling us directly where the gaps need to be filled.

Table 2 Example Quotes from Participants Regarding Essential Factors

Factor	Examples
Transparency	*"Transparency..being able to follow my inputs to outputs. If I push the controller on the joy stick, how many tanks move?"*
Perceived Usefulness	*"Is it relevant, or does it support or add to what our mission is or our tactics..."*
Perceived Ease of Use	*"I would say ease of use is a big one."*
Human Override	*"I have to have trust that I can intervene in whatever process I need to if something is not going the way it's supposed to."*
Reliability	*"I'd want to see [...] reliability based on tests that account for a wide variety of conditions and inputs."*

The factors coded in the interview transcripts relate to the determinants, as shown previously in Table 1. Each determinant, and the related factors are discussed. First, a need for *system effectiveness* to accept and adopt autonomous systems can be seen by several of the factors mentioned by participants. Some participants plainly stated that a system must be effective, and other participants wanted system effectiveness in the ways of *reliability, lack of technical issues, software,* and *convenience*. These factors can have an impact on system effectiveness because an increase in technical issues would decrease the effectiveness, while a newer, more efficient software or maintenance system could make a system more effective than an older system. *Convenience* is also critical as it can be assumed that a system that is not convenient to use would not be chosen as an effective system.

Secondly, a need for *system transparency* is also shown by participants stating that it is an essential factor to understanding the use of a system. Other factors, such as an option for *human override, knowledge of capabilities*, and *perceived usefulness* can be categorized as system transparency as well. The option for a *human override* can be categorized as *transparency* because operators must know the capabilities of a system for it to be truly transparent, and having a human in the loop is one of many possible capabilities of a system.

Third, the determinant of *risk-based criticality* can be seen in a handful of factors mentioned by participants. *Criticality*, as mentioned before, has been defined as the impact level an autonomous system may have in the presence of security-related threats [18]. Factors that can fit under criticality are *increased capabilities of the system, physical aspects of the system,* and *reliability*. Improved or increased capabilities of a system would make a system more critical to an operator's specific situation. Physical aspects of the system, like weight and bulkiness could cause operators to not deem the system as critical because it is too heavy to pack for a long period of time.

Lastly, *mental workload* is also shown to be an essential determinant to the acceptance and adoption of autonomous systems. *Mental workload* can be encapsulated by various factors such as *reliability, perceived ease of use, human error*, and *technical issues*. The presence of increased possible human error and technical issues would increase the mental workload on the operators as they would have to consistently monitor the system. On the other hand, a reliable system that is easy to use would decrease mental workload, as there would be less necessary monitoring, and more intuitive motion and use of the system.

It can be concluded that the initial determinants believed to affect the acceptance and adoption of autonomous systems positively correlates with the responses of the 47 NPS participants.

C. Challenges with Mission Critical Autonomous Systems

Lastly, we identified the most common challenges operators face with current autonomous systems, asking the question "*What challenges did you face while operating the system?*" in regards to an autonomous system the participants had interacted with. Figure 4 shows the top 5 challenges. By far the top challenge that warfighters identified was a lack of *perceived ease of use* while using their current autonomous systems. Four additional challenges were identified: o*utdated software, technical issues, physical aspect of the system*, and *user error. Outdated software* was classified as software that was too old and difficult to work with, in addition to constantly needing maintenance. *Technical issues* were defined as an array of technological problems regarding soft and or hardware. *Physical aspect of the system* often referred to weight or bulkiness of the systems/batteries operators had to carry at all times. Lastly, *user error* was a challenge that participants also identified as when operators or end-users would input the wrong data, causing the system to produce wrong information.

These factors can provide direction for improving autonomous systems. Given that the *lack of perceived ease of use* was by far the most identified challenge for autonomous systems by participants, further investigation for a given system should be performed. For example, a system may be actually difficult to use, the operators may have not had sufficient training or use of the system. Likewise, the system may seem difficult to use in comparison to its benefits. Different approaches may impact the *lack of perceived ease of use*. For example, using the system more often could reduce the negative perception. Further study should focus on these questions.

D. Differences Based on Military Branches

Five of the six military branches were represented by participants: Coast Guard (2%), Air Force (8%), Army (14%), Navy (25%), and Marine Corps (48%). The newly instated Space Force was not represented by participants. Further statistical analysis was conducted to examine whether differences between military branches and common challenges as well as preferences for acceptance and adoption factors exist. A Chi-square test of independence was computed and found no significance between military branches and challenges ($p > .05$) as well as factors for acceptance and adoption ($p > .05$ meaning statistical non-significance). These results suggest that, regardless of military branches, operators seem to agree on the most common challenges and essential factors to accepting and adopting current autonomous systems. Although military personnel of each branch may have very distinct and different occupations, this research suggests that there may be a general agreement across branches about the challenges and factors for acceptance and adoption of autonomous systems. However, as discussed in more detail in the limitations section, there was an uneven distribution of military branches in the participants, which may impact these findings**.**

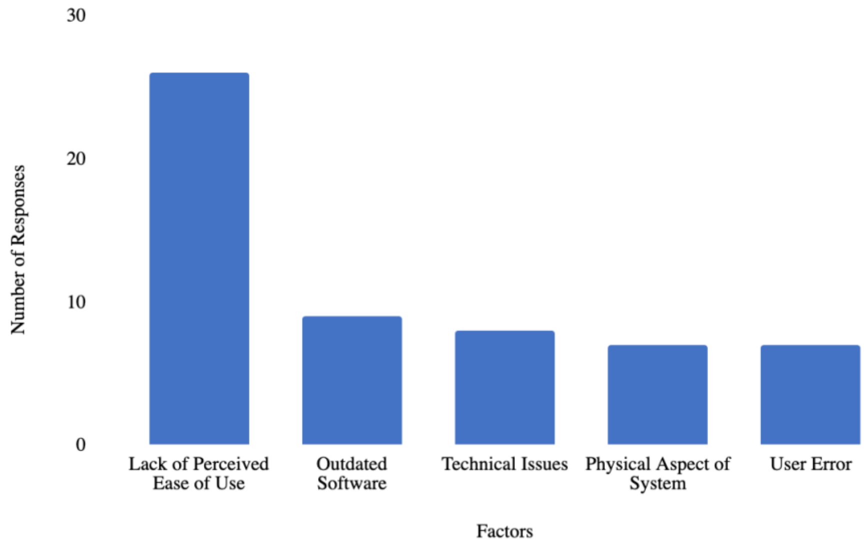

Fig. 4 Most Common Challenges Operators Face

E. Comparison with TAM

While there were some differences between our findings from the semi-structured interview for mission critical autonomous systems and the TAM, there was corroboration. As shown in Fig. 5, the TAM identifies *perceived usefulness* and *perceived ease of use* as impacting the attitude towards use and the intention to use (acceptance), which in turn impact the actual usage (adoption) of the system

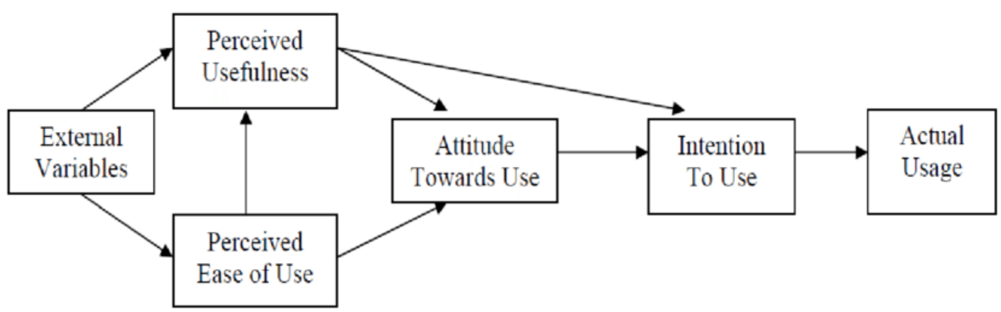

Fig. 5 Technology Acceptance Model (Davis, 1989)

Perceived usefulness and *perceived ease of use* were the second and third most important factors in our study. The TAM likewise suggests that *perceived ease of use* and *perceived usefulness* would lead to acceptance then adoption of technologies [3]. The findings corroborate that *perceived ease of use* and *perceived usefulness* are critical factors regarding the acceptance and adoption of autonomous systems, for both user-focused systems (as investigated in the TAM) and mission critical systems (as investigated in our study). Although *transparency* was the most important factor regarding acceptance and adoption of autonomous systems, it is not directly considered a factor (external variable) in the TAM. This difference could be due to the focus on mission critical systems or due to differences in our coding and the TAM terminology. The TAM external variables include *organizational job category*, *system experience*, and *computer experience* [2][3]. Transparency may have some confounding effect on these external variables. As discussed above, the factors we identified were grouped hierarchically into determinants. The factors and determinants identified in our study may be also grouped or intertwined further with the TAM external variables. Further study should be done to compare the preliminary findings of our study on mission critical autonomous systems and TAM. However, perceived usefulness and perceived ease of use are important to both.

VI. Conclusion

The literature review, creation and implementation of the semi-structured interview, transcribing, coding and analyzing aforementioned transcriptions led to preliminary results partially supporting the TAM for mission critical systems. Our findings suggest that regardless of military branch, operators may experience the same challenges and show the similar preferences to accepting and adopting current autonomous systems. This universality may prove useful when considering autonomous system adoption for cross-branch systems. These preliminary results are significant because they corroborate previous models and can possibly be used by organizations in the near future.

These findings can be utilized in various ways to increase acceptance and adoption of autonomous systems. Since *transparency* was the most often identified factor by participants, it can be assumed that an introduction of an autonomous system must include its capabilities as well as why the system is being used to begin with. Additionally, *perceived usefulness* is intertwined with transparency because if operators completely understand the need for the system, then their perceived usefulness for that system will increase. *Perceived ease of use* can be addressed in the sense of what may be intuitive to operators. Participants were asked if organizations should consult end-users during the research and design (R&D) phase of new autonomous systems, and most participants (93%) agreed that it was absolutely necessary to include end-user opinions in the beginning of the R&D process. The human override factor is related to operators' trust in autonomous systems, as acceptance is not only intertwined with perceived ease of use and usefulness, but trust as well [31]. Participants noted that having an override option was imperative as systems may not always be reliable, and operators prefer having some sort of control over the system. Lastly, *reliability* could be addressed by frequent and diverse testing to ensure the system is accurate and dependable in real world situations rather than strictly simulations.

A. Limitations and Future Work

As with all research, there are limitations. It is important to note that the semi-structured interviews were conducted with strictly active duty military NPS students. All NPS students are higher ranking military personnel, therefore possibly leading to skewed results. Enlisted active duty personnel may have different opinions as enlisted personnel are usually the operators of such systems according to our NPS participants. Additionally, the questions were not focused on mission-critical systems, as we wanted participants to not be primed by certain words/systems. Although this is qualitative research, 47 participants is still a small pool of participants that could have also led to skewed results. Although chi-square conducted ($p > .01$) showed that there were no significant differences between the branches and common challenges as well as no significant differences between the branches and the essential factors; a much larger sample size per each branch may lead to different results.

Future research should focus on the aforementioned limitations such as the small sample size. The semi-structured interviews could be conducted with enlisted military personnel rather than only NPS students. Additionally, the sample could be extended to veterans and/or civilians. Expanding the sample size could also fix the issue of skewed results because of an uneven distribution of participants per military branch. These preliminary results from the semi-structured interview could also help us ask more targeted questions in a questionnaire for a second phase of the study. A questionnaire based on the semi-structured interview could also help expand our sample. Additional data through the dispersion of a questionnaire will be gathered to allow for further analysis. The data will be analyzed to determine challenges and factors for acceptance and adoption through various military branches. More in-depth coding and analysis will be conducted to further examine the factors that contribute to the acceptance and adoption of autonomous systems. In addition to expanding our sample size and adding to our study in the form of a questionnaire; we could also expand on additional factors that may contribute to acceptance and adoption of autonomous systems as well as further explanation behind those factors.

Various organizations could utilize the extended model or system engineering approaches to predict whether people will accept and adopt an autonomous system. Being able to predict how willing operators are to accept and adopt mission critical autonomous systems could assist in an easier transition with new technology. Additionally, more efficient introduction and training could be created to assist towards a quicker and more seamless acceptance and adoption process of autonomous systems.

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