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# An Exploration of Methodologies Used to Measure Technology Maturity in Department of Defense Non-ACAT 1 Programs

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# An Exploration of Methodologies Used to Measure Technology Maturity in Department of Defense Non-ACAT 1 Programs

**Jeff Legg—**is an active-duty Commander in the U.S. Navy Supply Corps. He holds a doctorate in business administration from Marymount University, an MS in information systems management from Florida State University, and an MBA in acquisition management from the Naval Postgraduate School. He is currently stationed at Fleet Readiness Center Southwest and lives with his family in San Diego, CA.

## Abstract

In response to the lack of a codified or standardized methodology for assessing technology maturity during an Analysis of Alternatives for potential material solutions in Department of Defense (DoD) programs under the Acquisition Category (ACAT) 1 threshold, the purpose of this explorative qualitative study was to identify, analyze, and compare different methodologies currently used by acquisition professionals in non-ACAT 1 programs. Typically valued at over $3 billion, ACAT 1 programs experience heavy service and congressional oversight and have mandated Technology Readiness Assessments (TRAs) to determine technology maturity but account for less than 40% of the total DoD program budget. Technology maturity is an imperative metric required for conducting a comparative analysis of potential material solutions. Since neither a formal Analysis of Alternatives (AoA) nor a TRA is statutorily required for programs under the ACAT 1 threshold, the omission of any standardized AoA or TRA on the majority of acquisition programs allows for increased risk in cost, schedule, and performance overruns, all potentially resulting in increased taxpayer costs and decreased readiness for the DoD.

This study aimed to identify commonalities among methodologies and ultimately provide a set of best practices for measuring technology maturity for future alternative analysis by collecting and analyzing interview responses from DoD acquisition professionals responsible for conducting AoA in non-ACAT 1 programs.

## Background

As new threats emerge in the global landscape, facing competition with peer and near-peer competitors emphasizes the need for the United States to modernize its forces and infrastructure while simultaneously facing a decrease in its domestic industrial capacity (Wostenberg, 2021). The modernization of forces requires an unprecedented reliance on technological innovation and adoption that currently outpaces the DoD acquisition framework (Blank, 2024; Clark, 2024). Despite numerous recommendations on acquisition reform from both government and private organizations, the DoD continuously finds its major defense acquisition programs (MDAPs) on the Government Accountability Office's High-Risk List, signaling to Congress "programs and operations that are vulnerable to waste, fraud, abuse or mismanagement, or in need of transformation" (Government Accountability Office [GAO], 2024, header). Following numerous reform efforts over the past 50 years, the Government Accountability Office (GAO) consistently reports that most MDAPs experience cost increases and schedule delays due to numerous issues, including inaccurate and inconsistent assessment of technological components of the overall program (GAO, 2021a, 2021b).

Individual military departments manage those programs falling under the ACAT 1 threshold, identified as ACAT 2 or ACAT 3. While significant research has been conducted studying the performance of ACAT 1 programs, both the GAO and DoD Inspector General's Office (DoDIG) have identified similar issues with ACAT 2 and 3 programs within each department, finding a lack of oversight and control for cost, schedule, and accountability (U.S. Department of Defense Inspector General [DoD IG], 2019). Many, if not all, of these programs possess an element of technology as part of the overall acquisition. However, determining

technological readiness is at the individual department's discretion. With a lack of guidance at the DoD level, each department is left to determine its own best practices and adopt methodologies to assess technological readiness.

## Problem Statement

The United States Department of Defense (DoD) is the nation's largest federal agency, whose annual budget is larger than all other federal agencies combined (Congressional Budget Office [CBO], 2024). Despite having an annual budget of $816.7 billion in 2023, almost 47% of the federal government's discretionary spending outlays (DoD, 2022), the DoD has consistently remained on the GAO High-Risk List, indicating program vulnerability to waste, fraud, abuse, or mismanagement (GAO, 2024). Over 60% of the DoD's programs fall under the Major Defense Acquisition Program (MDAP) threshold of a total cost of $3 billion and do not require the same level of oversight or adherence to codified assessment procedures as MDAPs (DoD, 2020). As new threats in the global landscape emerge and evolve, the DoD's programs will become increasingly reliant on technology, and accurate readiness assessments of that technology will be critical. The lack of any standardized or codified technology readiness assessment on most acquisition programs allows for increased risk in cost, schedule, and performance overruns, potentially resulting in increased taxpayer costs and decreased readiness for the DoD (GAO, 2019).

## Research Question

What current methodologies are used by personnel to assess technology maturity in DoD non-ACAT 1 programs?

## Methodology

Technology maturity can be ambiguous, often defined by the organization conducting a technology maturity assessment. Technology maturity assessments can be loosely defined and executed, ranging from simple observations to complex calculations. DoD acquisitions, whose execution is heavily regulated by organizational guidance, are often also complex and enduring processes. The lack of available accurate consolidated execution data for DoD ACAT 2 and 3 programs prohibits the efficient evaluation of any technology maturity assessment methodology and a comparison of methodologies. As such, the goal of this research was to utilize interviews to identify methodologies used in these programs as the first step in a greater effort in research to ultimately evaluate their use, similar to the significant efforts taken regarding ACAT 1 programs. The methods identified were compared, and the frequency of the total and frequency of use by individual services was calculated. Additionally, each identified methodology was compared to existing DoD regulations, and academic research focused on that methodology, if any exists, to conduct triangulation.

### Population

The population for this research consisted of personnel who currently or previously participated in the technology maturity assessment process as part of DoD ACAT 2 and 3 programs. Due to organizational limitations of researching personnel actively participating in these programs within the DoD, the researcher excluded any personnel actively participating within programs in the DoD and sought individuals with previous acquisition program experience. From previous experience as a student at DAU and researching the organization, the researcher identified DAU as a significant single source of potential sample participants due to their mission faculty composition. DAU faculty would satisfactorily represent the population as it provides training and consists of faculty from all military branches.

The researcher identified interviewees based on the eligibility criteria below via a pre-interview questionnaire:

1. Currently or previously assigned to a DoD acquisition position or involved in a DoD acquisition program.
2. Assigned to a DoD non-ACAT 1 program.
3. Wholly or partially responsible for assessing the technological maturity of a potential solution for a non-ACAT 1 program.

**Sampling and Sampling Procedures**

With an initial sample set identified, the researcher used a purposive sampling strategy to identify those he would contact with interview offers. As Campbell et al. (2020) described, purposive sampling can improve the study's rigor and the trustworthiness of the data and results since the sample is more closely matched to the research objectives. By examining the accompanying demographic data collected via the pre-interview questionnaire, the researcher ensured a broad representation of participants based on experience, branch of service, and acquisition program roles. For example, the data may be biased if only participants who served in U.S. Navy acquisition programs were selected.

Qualitative case study research typically involves three to ten participants, but there is no specific requirement for the number of participants so long as research findings reach saturation (Creswell & Creswell, 2023). However, with over 170 technology maturity assessment methods identified (Parolin et al., 2024), it would be impossible to account for every potential use of these methods on ACAT 2 and 3 programs, given the research design and scope. The research applied judgment in selecting the best representative candidates to ensure sufficient representation and maximum possible saturation. The pre-interview questionnaire also allowed the researcher to calculate the frequency of listed assessment methodologies without interviewing participants; this data could be presented external to the interview analysis.

**Instrumentation**

This study used three instruments and three data collection methods. The first instrument was the researcher, who aggregated the data from the second and third instruments and conducted triangulation of that data with other sources, including DoD acquisition regulations and academic research. The researcher analyzed each case independently and cross-analyzed the collective cases based on the responses from the second and third instruments.

The second instrument used in this research effort was a pre-interview questionnaire to determine which DAU faculty personnel qualified for follow-up interviews. In addition to the three previously stated questions, the instrument included questions on DoD acquisition experience, acquisition training, and current employment status. Additionally, if applicable, the instrument presented preliminary questions on the participants' experience with technology maturity assessments and Analysis of Alternatives processes. These questions intend to facilitate purposive sampling and ensure adequate participant representation of the population. The questionnaire was delivered via Qualtrics, and answers would be parsed using Qualtrics filters.

The questions on the pre-interview questionnaire included the following:

1. Are you currently or have you previously been in a DoD acquisition position or involved in a DoD acquisition program?
2. How many years of DoD acquisition experience do you currently have?
3. In which DoD service were you primarily involved?

4. Have you received formal DoD acquisition training?
5. Have you received formal DoD training to conduct an Analysis of Alternatives?
6. Have you received formal DoD training in assessing technology maturity?
7. Are you currently a DoD civilian or uniformed military personnel (active or reserve)?
8. What is your current DoD grade level?
9. What is your current military rank?
10. Within your acquisition experience, have you ever been assigned to a DoD non-ACAT 1 program?
11. Within your acquisition experience, have you ever been partially or wholly responsible for assessing the technological maturity of a potential solution?
12. For the specific experience in #14, did the program prescribe a method or process for assessing the technology maturity of the solution alternatives?

Not all questions in the questionnaire required answers to submit, but only those participants who fully completed the questionnaire were considered for follow-up interviews.

The third instrument selected for this research effort was a semi-structured interview to collect greater details on the responses from the chosen participants' pre-interview questionnaires. In addition to gathering background information, interviews can be used to tap into an individual's expert knowledge. These interviews aimed to gather factual material and data, such as descriptions of processes, specifically technology maturity assessments. Researchers often use semi-structured interviews in policy research to delve deeply into a topic and understand the answers provided (Harrell & Bradley, 2009). Interviews were primarily conducted over virtual meeting applications like Microsoft Teams or Zoom. Recordings of the meetings were saved and sanitized to remove participants' names. Participants were notified before recording that their identities would remain anonymous, and each was assigned a number for reference and coding purposes. Each participant was offered a copy of their transcript to confirm accurate transcription. The semi-structured interview questions focused on the overall research effort question and included the following:

1. What methods were used to assess the technological maturity of the solution alternatives?
2. Was the outcome of the program considered successful?
3. Was the solution alternative with the highest assessed technological maturity selected?
4. What reason/rationale was provided for selecting a solution alternative with a comparatively lower maturity level?
5. What methodologies would you recommend for assessing the technological maturity of potential solutions during an Analysis of Alternatives for DoD non-ACAT 1 programs?

**Data Collection**

To accurately understand the research question proposed in this study, the researcher sought to locate themes from acquisition personnel with experience assessing technology maturity for DoD ACAT 2 and 3 programs. Lester et al. (2020) outline a seven-step plan for preparing, coding, and analyzing data for a qualitative approach utilizing thematic analysis.

Each of the three instruments used in this research effort had a different initial medium for collection. The pre-interview questionnaire data was managed and stored utilizing the

Qualtrics online application. Participant responses were manipulated and parsed within this application based on researcher needs. Various export report formats are available for incorporation into the larger data corpus stored in ATLAS.ti, a qualitative data analysis software application. The virtual interview sessions were recorded via virtual meeting applications like Microsoft Teams or Zoom. These applications provided an audio file and a verbatim transcription of the recording in text format, also stored in ATLAS.ti. For analysis, the text file was incorporated into the larger corpus. The applicable DoD regulations and academic research were available as various text files from online sources and available to the researcher at any time. The researcher created initial codes with the data collected and began coding and categorizing utilizing the ATLAS.ti application.

## Limitations and Protocols

Three major limitations in this study could be addressed in future research efforts. First, this qualitative study collected data via interviews with DAU employees. While not confirmed, it was assumed that none of these individuals were active participants in DoD acquisition programs. The relevancy of the data the individuals provided could be considered; DoD personnel actively involved in DoD acquisition programs could provide more relevant data on current technology maturity assessment methodology. Future research could collect data from DoD personnel active in acquisition programs pending DoD approval. Second, the interviewees' ACAT 2 and 3 program data was purposefully omitted to protect the anonymity of the participants. As such, this data was not validated within service-specific acquisition systems or the DoD Defense Acquisition Visibility Environment (DAVE) information system. Pending DoD approval, future research could collect and/or validate ACAT 2 and 3 program data within these systems. Lastly, the lack of previous government and academic research on ACAT 2 and 3 program performance prohibited further analysis of the effectiveness and comparison of technology maturity assessments. Further research, both qualitative and quantitative, would serve as the foundation of this body of knowledge.

The interviews aimed to gather factual material and data, such as descriptions of processes, specifically technology maturity assessments. An Institutional Review Board (IRB) approved the interview questions. Participants were notified before recording that their identities would remain anonymous, and each was assigned a number for reference and coding purposes. Each participant was offered a copy of their transcript to confirm accurate transcription. Additionally, no DoD acquisition programs were listed by name in the data collection to maintain program performance and participant anonymity.

## Results

From the initial solicitation email, 61 individuals completed the pre-interview questionnaire. Of those 61, 14 met the eligibility criteria and provided their contact information. One participant met the eligibility criteria but declined to be contacted. With the 14 individuals identified, the researcher emailed each willing participant individually to schedule the virtual interview. Of the 14, eight individuals provided replies to schedule the interviews. Inductive qualitative research usually uses theoretical sampling based on the researchers' perspectives and interpretations (Jain, 2021). However, Leedy and Ormond (2019) point to an iterative data collection and analysis process, sometimes called the *constant comparative model*. As the researcher analyzed the original content of the recorded interview sessions, new concepts were introduced and required further research via the document analysis effort. As more data was collected on these new concepts, new connections began to form with existing concepts and themes. As Leedy and Ormrod (2019) recommended, several initial, broad categories were identified to assist in coding. With the iterative process adopted, these categories were refined to themes and subsequently coded to smaller and more distinct units within the themes,

allowing the researcher to focus on target document analysis and associating repeated units within the theme. Identifying these themes and units provided the foundational data needed to answer the research question of this study. With the interview transcripts loaded into ATLAS.ti, four initial categories became prevalent for coding.

The initial coding categories are identified in Table 1.

**Table 1. *Initial Coding Categories***

| Theme | Code | Description |
|---|---|---|
| Types of Technology Assessment Methods | TYP | Referenced types of assessments used in DoD acquisition programs |
| Constraints on Technology Assessments | CON | Factors affecting execution of assessments |
| Technology Assessment Influences | INF | Organizations, factors, and/or elements that influence assessments |
| Third Party Assessments | 3PA | Organizations conductings/factors affecting third party assessments |

Based on the interview questions, all eight interviewees provided data on the methods of technology maturity assessment, as this was a direct question. This was the only question that resulted in a 100% response, and as such, *Types of Technology Assessment Methods* was identified as the first initial coding category. Specific methods identified were nominated as subsequent themes and units.

Following the initial analysis, while not a direct question, interviewees provided data on the factors that influence technology maturity assessments within DoD acquisition programs. These factors were attributed to why an assessment may or may not be conducted and the factors that influence its results. As such, *Constraints on Technology Assessments* and *Technology Assessment Influences* were identified as the second and third initial coding categories. Specific factors identified were nominated as subsequent themes and units.

Interviewees provided data on third parties or organizations external to the acquisition program members conducting technology maturity assessments. *Third-Party Assessments* were identified as the fourth and final initial coding category, and specific organizations and the factors affecting the execution of the third-party assessments were nominated as subsequent themes and units.

With the initial categories identified, subsequent subordinate themes and units within the transcripts could be coded and assigned to the initial categories. With the use of ATLAS.ti, these themes and units were identified and supplemented with data obtained from the document analysis performed by the researcher. This data was added to ATLAS.ti and coded accordingly. The interviewees' extensive knowledge and experience provided enough data to explore the primary themes further. They revealed commonality regarding the significance of incorporating customer input into assessments and the factors that prohibit or influence executing assessments, including cost, time, and lack of knowledge. Additional connections between these themes and subthemes were explored, constructing a basis and foundational level of knowledge for further research.

The final coding and relationship structure is shown in Figure 1.

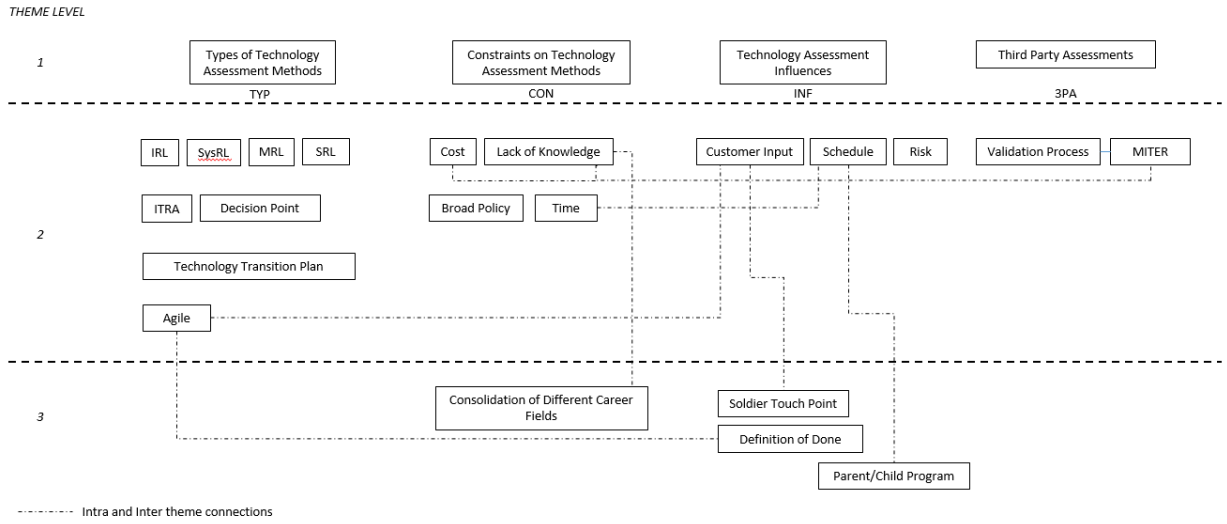


**Figure 1. Coding and Relationship Structure**

Figure 2 depicts the frequency of sub-themes within each initial theme category.

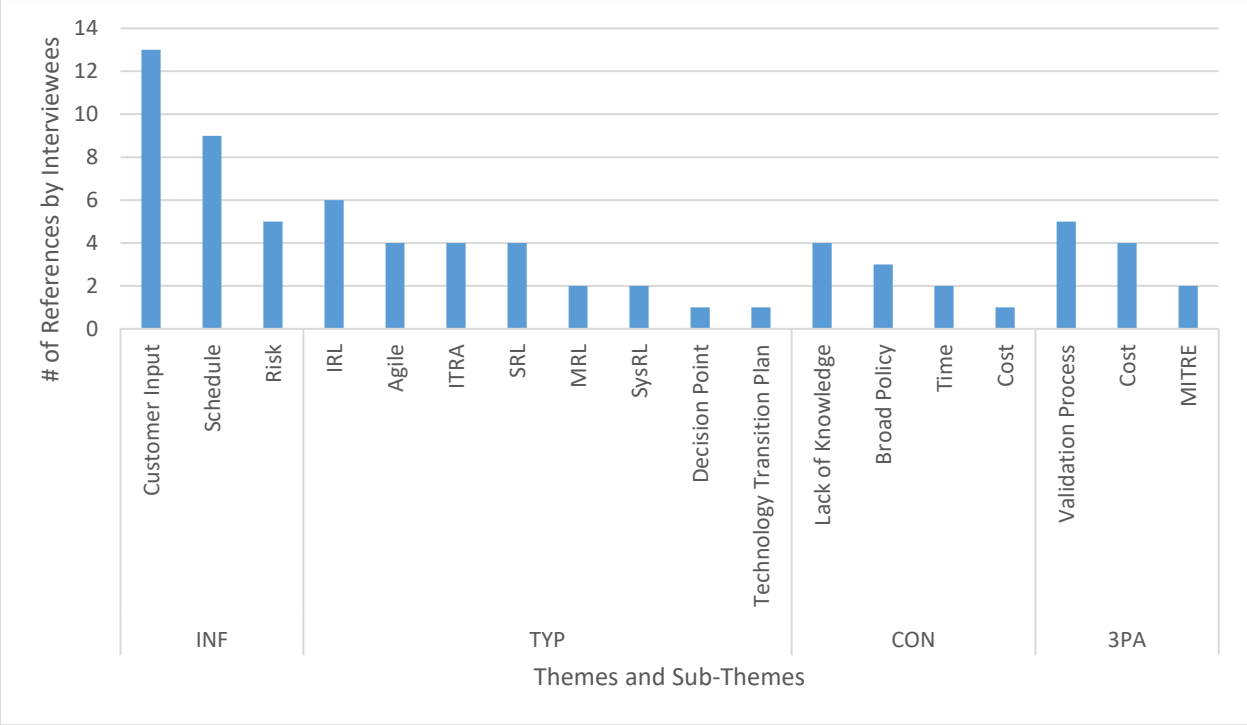


**Figure 2. Theme and Sub-Theme Frequency**

## Discussion and Conclusion

The Literature Review revealed many assessment methodologies, specifically citing Parolin et al. (2024), whose research identified and compared 170 distinct assessment tools. Many of these methods, as noted by other researchers (Cauthen et al., 2022; Rea, 2022; Silberer et al., 2023), currently only provide theoretical frameworks for assessments and have

yet to be applied to real-world situations such as DoD acquisition programs. The Literature Review also revealed repeated recommendations by the GAO (2022b, 2023b) for the DoD to adopt more comprehensive and encompassing assessment methods in acquisition programs. While the Literature Review yielded numerous methods, the interview data supporting the research question revealed eight distinct methods, only one recounted as used in a DoD non-ACAT 1 program. The Agile method, codified in 2001 (Beck et al., 2001), was emphasized by the DoD, specifically in software development, via the Adaptive Acquisition Framework (DoD, 2022a). While the DoD has no policy mandating Agile, the GAO has recommended that the DoD adopt Agile practices across all of its acquisition pathways (GAO, 2023a). A central tenet of the Agile method is iterative input and feedback from the end user. The interview data revealed the emphasis placed on *Customer Input* to satisfy User Acceptance and Definition of Done, both principles within the Agile process. While this method is potentially more resource-intensive and only feasible in some acquisition program types, it showcases the DoD's transition to a greater focus on incorporating user input into maturity assessments. The high frequency of *Agile* and *Customer Input* themes within the data reflects this organizational transition.

The lack of experiential data for actual usage of technology maturity assessment methodology in DoD non-ACAT 1 programs suggests constraints in executing assessments in these programs. This theme is further supported by the interviewee data, which provides specific instances of constraints affecting assessment execution. There is an evident literature and research gap on how these constraints affect non-ACAT 1 programs despite these programs being affected by the same constraints. The interviewee data suggests an inability of the DoD to create a policy broad enough to cover the range of acquisition programs at the non-ACAT 1 level, and a lack of policy potentially suggests a lack of priority for these assessments at both the DoD and individual service levels. This theme is supported by the repeated recommendations from the GAO to the DoD to account for the cost and time of conducting accurate and thorough assessments (GAO, 2020). The lack of a DoD mandate requiring these assessments could account for the lack of research and analysis of their subsequent constraints.

Although each interviewee's service affiliation, tenure, and acquisition experience differ, the four common themes provided relevance regarding assessing technological maturity in DoD non-ACAT 1 programs; as shown in Figure 2, the interconnectedness of these themes signifies the relationships these factors play in executing these assessments. Despite the wide range of acquisition programs within the DoD and the variety of methodologies available for implementation, many of these factors are present regardless of that diversity.

This research suggests little to no framework for conducting technology maturity assessments at the DoD level for non-ACAT 1 programs. The existence of any framework for conducting assessments at the service level within the DoD was not prevalent within the Literature Review; subsequent frameworks and/or policies may exist within lower functional levels of individual services but could not be verified within this research effort. The benefits of executing accurate and relevant technology maturity assessments and assessments whose scope extends beyond strict technology maturity are supported by government and academic research. Likewise, the results of inaccurate and irrelevant assessments are cited by interviewee data, supported by government and academic research, but still need to be aggregated in a manner suitable for further analysis.

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Acquisition Research Program
Department of Defense Management
Naval Postgraduate School
555 Dyer Road, Ingersoll Hall
Monterey, CA 93943

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