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Integration of Production Management Into Software Development

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Integration of Production Management Into Software Development

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Abstract

The application of the five production management levers addresses software projects as production systems, allowing for the application of well-established operations science techniques to improve throughput and predictability throughout the project life cycle. Traditional project management triple constraints of cost, schedule, and performance have long been the cornerstone of Department of Defense (DoD) software project management. Often, these constraints are managed independently, using past performance data to assess and predict future project performance, leading to highly variable outcomes. Traditional waterfall models for software project delivery exacerbate this variability and limit the ability to delivery capability at the speed of relevance. By treating projects as a production system, a deeper understanding of planning variables (product design, process design) and execution variables (capacity planning, limiting work in process, and variability) can be achieved and close the gap on project delivery performance. Further, the study connects industry best practices across software, manufacturing, and construction to improve DoD software project delivery. Operations science and production management principles and techniques are foundational to the agile and lean movement. The software industry has already adopted many of the operations science and production management techniques (such as limiting work in process, capacity-based sprint planning, software factories, etc.). A succinct process to apply, monitor, control, and report out on the five levers can encourage adoption and clarify execution of the Adaptive Acquisition Framework, DoD Instruction 5000.02, Software Acquisition Pathway.

Keywords: agile, production management, software

Introduction

The application of the five production management levers addresses software projects as production systems, allowing for the application of well-established operations science techniques to improve throughput and predictability throughout the project life cycle. Traditional project management triple constraints of cost, schedule, and performance have long been the cornerstone of Department of Defense (DoD) software project management. Often, these constraints are managed independently, using past performance data to assess and predict future project performance, leading to highly variable outcomes. Traditional waterfall models for software project delivery exacerbate this variability and limit the ability to delivery capability at the speed of relevance. By treating projects as a production system, a deeper understanding of planning variables (product design, process design) and execution variables (capacity planning, limiting work in process [WIP], and variability) can be achieved and close the gap on project delivery performance.

Further, the study connects industry best practices across software, manufacturing, and construction to improve DoD software project delivery. Operations science and production management principles and techniques are foundational to the agile and lean movement. The software industry has already adopted many of the operations science and production management techniques (such as limiting WIP, capacity-based sprint planning, software factories, etc.), while large capital construction projects are adopting production management to improve delivery on billion-dollar projects (Project Production Institute [PPI], n.d.). With a plethora of data both within the DoD and industry, a succinct process to apply, monitor, control, and report out on the five levers can encourage adoption and clarify execution of the Adaptive Acquisition Framework, DoD Instruction (DoDI) 5000.02, Software Acquisition Pathway.

Agile frameworks have been around for more than 20 years in software development. Providing a link between the operations science community in the manufacturing and construction industry and the software development communities is another step on the path of continuous improvement and delivery. It has been widely recognized that disconnected planning and execution affects project performance and acquisition throughout the DoD and beyond. This study helps the DoD take the lead within industry and revolutionize the way software projects are developed and delivered.

Research Issue Statement

This proposed study aimed to apply the five levers of production management—product design, process design, capacity, WIP, and variability (PPI, n.d.)—to the Adaptive Acquisition Framework, DoDI 5000.02, Software Acquisition Pathway to achieve increased control and monitoring within agile software development projects. Research questions included, Do current agile projects within the DoD (i.e., Agile Pilot Programs) currently employ any of the production management levers to manage and control software delivery? How can the production management five levers be applied to support agile software projects? How can the five levers be applied to the Office of the Under Secretary of Defense for Acquisition and Sustainment (OUSD[A&S]) agile metrics?

Research Results Statement

While this research is the subject of the author's PhD studies at the University of Maryland, the study is ongoing. However, expected results are (1) processes to apply the five levers to improve cost, schedule, and performance monitoring and control, and (2) guidelines to apply production management levers to achieve OUSD(A&S) software metrics reporting requirements. This paper will share the progress made to date toward these objectives.

Technical Concept

The DoDI 5000.02, *Operation of the Adaptive Acquisition Framework*, published on January 23, 2020, led to incorporating Change 8 of the DoDI 5000.02T, *Operation of the Defense Acquisition System*," on September 15, 2020. The practices and standards within the DoDI 5000.02T are being updated incrementally to apply the adaptive framework, specifically for the software acquisition pathway. Major changes for the pathway were the elimination of the traditional waterfall Systems Engineering Technical Review (SETR) milestone decisions for an iterative, incremental delivery approach focused on minimum viable product (MVP) and minimum viable capability release (MVCR) deliveries (DAU, n.d.).

Within the updated DoDI 5000.02, there is a lack of detail related to how agile, lean, and DevSecOps approaches can be leveraged to improve monitoring and control of software project delivery, specifically during planning and execution. While a preliminary approach and concept for acquisition and project management documentation has been identified, a detailed approach to agile project management to support agile software development is needed. Agile software development is the application of the agile manifesto values and principles within development frameworks (i.e., Scrum, XP, etc.) and practices (i.e., pair programming, test driven development, etc.) to produce a software product. Agile project management is the application of the agile manifesto values and principles to project delivery (i.e., focusing on delivering value early and iteratively to customers; Agile Alliance, n.d.).

Application of Production Management

The proposed research develops processes to apply the production management five levers to improve cost, schedule, and performance monitoring and control during planning and execution, supporting an agile project management approach to software development. This effort will also establish guidelines to apply production management levers to achieve OUSD(A&S) software metrics reporting requirements by identifying how the five levers can be used to monitor and control software project planning and execution. The Adaptive Acquisition Framework software development and acquisition processes in the current DoDI 5000.02 are conceptual and do not fully address how agile, DevSecOps, and lean can be applied to a software development acquisition. Detailed processes to address how programs can tailor a software acquisition to adopt an agile framework, DevSecOps best practices, and lean techniques to achieve rapid development and deployment of software with cybersecurity built in are still needed. Specifically, the incorporation of combined planning and execution through the adoption of production management techniques, wherein planning occurs iteratively through the life cycle by the “doers” of the work; requirements are only defined as a need (what a user needs and why, not how); and schedule is timeboxed. Contrary to waterfall, in agile projects, time is fixed (timeboxed), cost and resources are fixed (capacity-based planning), and scope is flexible.

By framing the software project as a production system and applying agile frameworks and processes, project managers can achieve improved integrated planning and execution. The five levers to adopt agile project management include product design, process design, capacity, WIP, and variability (PPI, n.d.). Product design relates to what the product or project requires; in agile software development projects, these requirements are developed iteratively throughout the life cycle of the project. Process design is focused on the actual process and procedures to accomplish the work. Too often, the detailed processes required to accomplish individual tasks within a project are not well understood. Capacity-based planning is focused on planning work based on resources (personnel, materials, information, etc.) available versus planning to a hard date or milestone. This allows for more detailed work estimation and execution, reducing cost and schedule variability over time. WIP is the work that is in flight, meaning that work has started but is not yet finished. WIP represents tied up resources and capital; until WIP is released, it does not result in a direct outcome or value to the stakeholder. Finally, variability relates to anything that affects the overall outcome and performance of a project. Variability is largely driven and affected by the other levers previously mentioned. Controlling project variability, especially when it relates to cost and schedule, is a challenge on all projects, software or otherwise. Understanding the five production management levers forces project managers to look beyond the traditional “iron triangle” of cost, schedule, and performance. Instead, project managers need to understand the detailed level planning, design, and execution to control variability and improve overall project monitoring and controls.

Implications on OUSD(A&S) Software Metrics

The second expected result of this study is to provide guidelines for software project managers to apply production management levers to achieve OUSD(A&S) software metrics reporting requirements. OUSD(A&S) Software Policy Guidance identifies the following as a minimal set of metrics for software projects: process efficiency metrics, software quality metrics, software development progress, cost metrics, and capability delivery/value metrics (Brady & Rice, 2020). This study will provide guidelines on how the production management levers can be controlled to achieve the OUSD(A&S) metrics. For example, workforce capacity planning can be achieved using feature/story points. Variability can be controlled by tracking team velocity—adjusting story point commitments during a sprint as the team capacity flexes.

The proposed research is directly tied to the DoD National Defense Strategy 2018 goals and objectives to deliver performance at the speed of relevance, prioritizing the speed of delivery, continuous adaptation, and frequent modular upgrades to pace the threat (DoD, 2018). There have been multiple efforts within the DoD to support agile DevSecOps acquisitions, including the establishment of the Defense Innovation Board (DIB) and Office of the Secretary of Defense (OSD) guidance for the Agile Pilot Programs: *Software Acquisition Strategy: Agile Guidance* (OUSD[A&S], 2019e); *Contracting Considerations for Agile Solutions* (OUSD[A&S], 2019d); *Agile 101: An Agile Primer* (OUSD[A&S], 2019c); *Agile Software Acquisition Guidebook* (OUSD[A&S], 2020); *Minimum Viable Product (MVP) and Product Roadmap* (OUSD[A&S], 2019a); *Agile Metrics Guide* (OUSD[A&S], 2019b); and *DevSecOps Best Practices Guide* (Brady & Rice, 2020; DoD, 2020). The rewrite of the DoDI 5000.02 to reflect all of the lessons learned and to reflect an adaptive acquisition framework to support software projects is needed to ensure programs can adopt and execute agile principles and practices within the DoD acquisition environment. The application of production management levers through process and guidelines will further strengthen the agile initiatives within the DoD and transform not only software development but agile project management. The inclusion of production management levers and processes is aligned with the agile and lean movements seen within industry and provides the foundation needed within the acquisition community to understand and adopt agile principles and values for software delivery.

Research Questions and Objectives

Table 1. Research Questions and Objectives

Research Question	**Objectives**
Do current agile projects within the DoD (i.e., Agile Pilot Programs) currently employ any of the production management levers to manage and control software delivery?	Identify production management levers in use by Agile Pilot Programs and determine level of maturity
	Compare impacts to cost, schedule, and performance by assessing the throughput (delivery cycle time) of software deliveries
How can the production management five levers be applied to support agile software projects?	Determine how product and process design works in an iterative, agile approach
	Determine how fixed capacity planning results in increase control and throughput
	Identify how limiting WIP increases throughput
	Identify how variability can be controlled, not just monitored, by treating software projects as production systems
	Create a guideline for understanding software projects as a production system

How can the five levers be applied to the OUSD(A&S) agile metrics?	Identify how OUSD(A&S) metrics for agile software projects can be met using the production management levers
	Map the production management levers to the OUSD(A&S) metrics

Research Methodology

The initial phase of this research is focused on conducting a literature review of the Agile Pilot Program publicly available data. Since the introduction of the Agile Pilot Programs in the Fiscal Year (FY) 2018 National Defense Authorization Act (NDAA), multiple DoD projects have adopted agile principles and values with varying levels of maturity and success. Phase 1 will focus on a detailed literature review of the current state of agile adoption within the pilot programs, as well as interviews with the Agile Pilot Program offices to collect information related to application of production management levers.

There are multiple resources to review related to the Adaptive Acquisition Framework, the application of agile to DoD software projects, and the current state of agile adoption within the DoD. Additionally, there are potential data points from the Department of Homeland Security (DHS) that could provide additional lessons learned. The objective is to identify how the DoD has started adopting an adaptive framework for agile software projects; lessons learned regarding adoption; how production management levers are being used today; and their impact on OUSD(A&S) software metrics/success criteria.

The following is a list of materials that will be the basis for the literature review. Additional resources will be reviewed as identified during Phase 1 of the proposed research.

- DoDI 5000.02: *Operation of Adaptive Acquisition Framework*
- *Software Acquisition Strategy: Agile Guidance* (OUSD[A&S], 2019e)
- *Contracting Considerations for Agile Solutions* (OUSD[A&S], 2019d)
- *Agile 101: An Agile Primer* (OUSD[A&S], 2019c)
- *Agile Software Acquisitions Guidebook* (OUSD[A&S], 2020)
- *Minimum Viable Product (MVP) and Product Roadmap* (OUSD[A&S], 2019a)
- *OSD DevSecOps Best Practices Guide* (DoD, 2020)
- *AiDA: Acquisitions in the Digital Age* (MITRE, n.d.)
- Project Production Institute research (Arbulu et al., 2016; Shenoy, 2017; Shenoy & Zabelle, 2016)
- GAO reports on agile within the DoD and the DHS (GAO, 2020a, 2020b)
- Defense Innovation Board SWAP report (Defense Innovation Board, 2019)

Research Results

This research is the focus of the author's PhD studies at the University of Maryland, the results of which are ongoing. The goal of this paper is to share the preliminary results of the literature review using publicly available data and well-established production management and operations science techniques.

Importance of Flow

Production management is the application of operations management and science to production systems (PPI, n.d.). Traditional project delivery is focused on productivity measures. However, productivity does not equate to throughput or outcomes. Projects can have very high productivity measures and still fail to deliver (Shenoy & Zabelle, 2016). This is the result of poor flow through a system, failure to address and exploit bottlenecks, and failure to control WIP.

To improve project cost, schedule, and performance, a deeper understanding of what happens throughout the life cycle of a project is needed. The current approaches to project management largely adopted by the DoD and supported by organizations such as the Project Management Institute (PMI) have broken project management into siloed areas of responsibility, often creating large communication gaps that lead to project failures (Zabelle et al., 2018). The approach used today, even in some projects that have adopted agile, still often reflects the results of Conway's Law, which states that organizations' design systems mirror their communication structures. In other words, if the organization is not cross-functional, then the system or products will not be cross-functional, likely resulting in more changes late in the development process (Skelton & Pais, 2019).

To understand how this is all related to project performance, it is important to understand what is happening when projects are not delivering within cost and schedule. Little's Law explains how WIP impacts overall throughput and project performance. Limiting WIP (not eliminating) can provide more consistent results for throughput over time, as variability in cycle time (humans in the loop) can impact the flow (Choo, 2016).

$$\mathrm{TH} = \frac{\mathrm{WIP}}{CT}$$

Where,

TH = throughput (items/unit time)

WIP = work in process (# of items)

CT = cycle time (time units/item)

Production Management Levers

Production management is the application of operations science techniques to the management of the project or production process as a system. The idea is to look at project execution as a whole system, not as individual phases (Shenoy, 2017). It is a well-established concept that has been in practice within the manufacturing industry for decades (PPI, n.d.). It is also foundational to agile project management, which focuses on cross-functional, collaborative approaches to achieve a desired outcome or product. Too often projects are focused on productivity; however, productivity is not indicative of throughput or outcomes. An example of this would be classic project management monitoring and control tools used by the DoD today, such as Earned Value Management (EVM). Like any monitoring and control system, it is based on data, including estimations of work, cost, and value. The trouble is that these estimations are often made years in advance without the input of the people who will actually perform the work. The further the estimation is made, in both time and resources, the greater the variability in the measurement will be. At a certain point the data become nothing more than a point for contractors and government to argue over performance, providing little actual value or control.

One possible solution to these challenges is to leverage the five levers of production management throughout the life cycle of a project and to adopt a more agile framework to project management and execution. The five levers of production management include product design, process design, capacity, WIP, and variability (PPI, n.d.).

Product Design

Product design focuses on controlling the scope of a project through product requirements (PPI, n.d.). Specifically, product design focuses on developing the busines case, including the potential use cases and value it will deliver to the end user. Traditional project requirements are well defined and detailed up front as part of the planning phase. However, in agile software projects, the requirements start as a business case and user needs and are detailed and defined through iterative and incremental development cycles, improving over time based on user feedback (Agile Alliance, n.d.). Establishing processes to apply agile to the product design will lead to improved innovation and earlier user feedback, reducing the cycle time for software product delivery. Further, a set of guidelines on how to identify and define MVP from a DoD perspective would assist with software project planning.

Use Within the DoD Today

A full study of the applications in use within the DoD today is ongoing and currently limited to the results of publicly available data. However, based on the preliminary literature reviews, the following was found to support and demonstrate the use of the product design lever, specific iterative development of software requirements within DoD agile projects.

Many existing projects that have adopted agile practices still follow waterfall development practices when it comes to requirements, spending time and resources up front to develop and define detailed requirements a year in advance of when they will be developed. This is evidenced by the *Defense Acquisitions Annual Assessment*, published in June 2020, which stated that while many programs stated they were following agile practices, it was often more like a hybrid waterfall-agile approach (GAO, 2020b). In addition, while the statutory regulations have been modified and relaxed for certain types of programs, not all have made the transition and are still bound by contractual limitations, such as stage gate reviews, forcing less agile cadences and delayed releases. However, not all programs are experiencing these limitations to their agile approach, with many taking advantage of policy changes that allow for early prototyping (GAO, 2020b).

Application to OUSD(A&S) Agile Metrics

The OUSD(A&S) metrics include process efficiency metrics, software quality metrics, software development progress, cost metrics, and capability delivery/value metrics (Brady & Rice, 2020). Product design supports software quality metrics and agile product metrics. It also influences cost metrics and capability delivery/value metrics.

Product design supports software quality metrics by incorporating the user and stakeholders early and often throughout the product design and development activities. Recidivism, first-time pass rate, defect count, test coverage, and number of blockers all are informed or result from product design decisions. Capturing the rate of rejection or return on developed work provides project managers with the ability to monitor product design performance. Repeat issues, such as poor test coverage, can then be swarmed by the team to identify the root cause and make a change to the design approach to fix the gap (OUSD[A&S], 2019).

Process Design

Process design is key to understanding communication channels, flows, queues, and sequencing of work. There are many well-established agile frameworks that support this concept as a way to control and monitor throughput. Agile process design and practice adoption is a stepping stone to achieving DevSecOps continuous integration and continuous delivery of software. It is critical to establish processes and guidelines from a software acquisition adaptive framework standpoint. In the future, this study aims to provide a framework for process mapping within software projects to understand how technology, automation, and people can deliver software capability incrementally and iteratively.

Use Within the DoD Today

A full study of the applications in use within the DoD today is ongoing and currently limited to the results of publicly available data. However, based on the preliminary literature reviews, the following was found to support and demonstrate the use of the process design lever within DoD agile projects.

A study published in the DAU's *Defense Acquisition Research Journal* looked at five successful agile adoptions with the DoD. A common theme across the projects was the investment in agile coaches and process development. Understanding the flow of information and identifying bottlenecks and non–value-added activities within existing processes was critical to the success of the project's agile transformation (Kramer & Wagner, 2019). Further, according to the *14th Annual State of Agile Report*, which surveyed over 40,000 agile projects across industry and government, over half of respondents are implementing some form of value stream management as projects are adopting agile beyond software development, applying agile to their core business operations and project management as well (Digital.ai Software Inc., 2020).

Application to OUSD(A&S) Agile Metrics

OUSD(A&S) agile metrics identify a number of agile process metrics that aim to support the estimation, measurement, monitoring, and control of tasking at the lowest level possible. Metrics include story point estimation to support velocity calculation within small agile teams. Story points measure the estimate time and complexity of a task, taking into account dependencies, risks and unknowns, and skills required of a resource. The monitoring and control of theses metrics allows for greater predictability, as teams are responsible for estimating their own work, are accountable for documenting their progress, and are continuously reviewing and iterating to improve overall processes to support delivery (OUSD[A&S], 2019).

Capacity

Understanding capacity of not only the technologies employed but also the people assigned to do work is critical to creating an integrated approach to software development. Technology capacities related to software development and DevSecOps tools are well established and have been documented in the *DoD Enterprise DevSecOps Reference Design Version 1.0*, published August 12, 2019. However, workforce planning capacities are less understood within the current workforce. Years of waterfall development have created long workforce cycle times. Resources are often split between projects and efforts; throughput is stalled as people switch from task to task; the cycle time and takt time to deliver capability is measured in years, not hours. This study will focus on how software project managers can use agile thinking and processes to increase throughput and deliver quality software more frequently and reliably. Workforce planning, when done at the worker level, results in increased throughput and less variability of product outcomes, making it easier for project managers to track performance, cost, and schedule (actual vs. estimated).

Use Within the DoD Today

A full study of the applications in use within the DoD today is ongoing and currently limited to the results of publicly available data. However, based on the preliminary literature reviews, the following was found to support and demonstrate the use of the capacity lever within DoD agile projects.

The Reserve Component Automation System (RCAS) Army project tracks the capacity of their teams across the enterprise through story point analysis. Further, they have implemented a quarterly review to track overall performance using story points to estimate their team velocity. Velocity is then used to adjust their planning for the next increment (Kramer & Wagner, 2019). Capacity planning is a well-established method to support project monitoring and controls within agile projects. However, it is a major shift from the waterfall approach of surging resources to achieve scheduled dates. Further, while there are many policy guidelines across the government that have been modified in the last 5 years to recommend or encourage capacity-based planning, it is unclear how many programs are actually utilizing it today.

Application to OUSD(A&S) Agile Metrics

Capacity based planning most directly relates to velocity predictability and the cost metrics from the OUSD(A&S) metrics (OUSD[A&S], 2019). Planning work within the limitations of capacity allows for greater predictability when it comes to project cost and schedule. Individual team velocity normalizes over time, reducing variability and uncertainty and providing greater predictability of project performance. This supports the shift from traditional scheduling, which is often done separately by those independent of execution. With increased predictability, cost impacts and estimates become better over time.

Work in Process

WIP is a major driver of variability within any project, not just software. WIP ties up resources, slows down progress, and decreases throughput. It creates unnecessary dependences within a production system that can hinder delivery. However, WIP isn’t all bad. Understanding how WIP can be used to drive results is key to software delivery (PPI, n.d.). Using agile and lean tools, such as Kanban boards, sprint planning, and so on, software project managers can improve project predictability for delivering a capability.

Use Within the DoD Today

A full study of the applications in use within the DoD today is ongoing and currently limited to the results of publicly available data. However, based on the preliminary literature reviews, the following was found to support and demonstrate the use of the work in process lever within DoD agile projects.

While there are few data available on how programs are managing or governing WIP within their projects, there are some data available on the use of Kanban boards to control flow. The RCAS Army project used Kanbans for their program management office–related work (Kramer & Wagner, 2019). Kanban boards alone do not make a project agile. However, they are often used when there are continuous flow or continuous delivery releases (Rehkopf, 2021). In DoD projects, Kanbans can provide a way for programmatic and support activities outside of traditional developer teams to support an agile culture and approach for delivery.

Application to OUSD(A&S) Agile Metrics

There is overlap with many of the recommended OUSD(A&S) agile metrics, as WIP is a fundamental concept for supporting flow throughout the project. The guide specifically calls out WIP, cycle time, and throughput as flow metrics related to Kanban. However, WIP is a shared production management lever and agile concept that can be used in scrum and other agile applications as well. Controlling WIP will have a direct impact on the DevSecOps metrics related to deployment frequency and lead time. Further, WIP is also directly related to the Agile Product Metrics of delivered features/capabilities, as increased WIP will delay overall throughput and delivery of the desired features/capabilities. This is especially true if developer teams are constantly being re-tasked throughout the sprint due to emergent stakeholder needs. Careful planning and adherence to agile cultural changes is needed to ensure teams can limit WIP (OUSD[A&S], 2019).

Variability

Variability comes in many forms for software projects. The largest source of variability on any project is humans. No matter how standard or common processes, procedures, requirements, and so on are made, there is always variability during execution. The goal of using variability as a lever is to understand, monitor, and control variability at the source.

Traditionally, variability was monitored (not controlled) using tools such as EVM. However, there are limitations to this commonly used tool when it comes to software projects. EVM assumes that a project has a detailed list of established requirements up front, a detailed integrated master schedule (IMS) for the life cycle of the project, and detailed cost estimates. The issue with these assumptions and trying to apply tools such as EVM to software projects is that interactive and incremental development does not start with all this information up front. So, unless the project manager re-baselines every increment, there will be large variability in the EVM metrics. Further, the planning and execution resources are often independent of one another, making the cost estimates, schedules, and work breakdown structure disconnected from the people doing the work. If project managers want to truly control projects (not just monitor), then the estimates for the schedule and resources need to come from the lowest delegated level possible ("the doers").

Similar to how the DoD has adopted risk, issues, and opportunity management as a way to account for the good and bad of variability, production management treats variability as a way to address detrimental and beneficial variability within projects (Morrow, 2017). Sources of project variability include process variation/quality, time variations, and product variation. A common example of detrimental variation within a software project is rework of a product due to quality and testing issues; a common example of beneficial variability is completing work early or being able to pull work forward from the backlog (PPI, n.d.).

Use Within the DoD Today

A full study of the applications in use within the DoD today is ongoing and currently limited to the results of publicly available data. However, based on the preliminary literature reviews, the following was found to support and demonstrate the use of the variability lever within DoD agile projects.

There are multiple projects that are leveraging scrum and Kanban approaches. However, it is unknown how many are leveraging agile metrics, such as recidivism to track rework and impacts on quality. Additional surveys and data will need to be collected to understand how mature the agile applications within the DoD actually are, as many projects that reference agile as their approach also reported following traditional waterfall project management monitoring and control techniques, which is not aligned (GAO, 2020; Kramer & Wagner, 2019).

Application to OUSD(A&S) Agile Metrics

The OUSD(A&S) quality metrics are most closely related to the variability production lever. Specifically, recidivism (i.e., work returned to a team for rework), first-time pass rate, defect count, and test coverage are all examples of metrics that track detrimental variability. Beneficial variability will be captured via story completion rate, cumulative flow diagrams, and release burnup charts within the agile process metrics (OUSD[A&S], 2019). There are opportunities to add additional beneficial variability metrics. However, these will be heavily dependent on the agile approach and individual project applications.

Next Steps and Future Work

This paper represents the initial research and results to apply production management to agile projects within the DoD, as well as their adoption to support the application of the OUSD(A&S) software project metrics. Further research includes data collection related to the specific applications of agile within the DoD and related government projects. While guidelines and policy are being updated, there is little reporting available to demonstrate how programs are being held accountable for implementing agile. As evidenced by the latest Defense Acquisitions Annual Assessment, there are many programs (22) that claim to be practicing agile but are not delivering anywhere near the industry standard for iterative and incremental releases (GAO, 2020b).

Agile Pilot Program Interviews

A review of the DoD Agile Pilot Programs, their successes and lessons learned with agile frameworks, will be necessary to understand the level of maturity and success adopting agile. While there are some data available on programs that have adopted an agile approach or tools, there are few data published on the agile metrics being captured. Measures of agile performance and health are needed to understand where agile adoptions are failing within government projects. One-on-one interviews with project management, government product owners, scrum masters, and development teams are needed to understand the current application of production management levers in DoD project, including agile processes and metrics.

To support this objective, this study will create a standard set of questions to be shared with the Agile Pilot Programs to identify how production management levers and agile principles and values have impacted project cost, schedule, and performance. Challenges related to the delivery cycle time and throughput of software to the end user will be captured and used to identify processes for product and process design. Further, information related to agile software metrics for process efficiency, software quality, development progress, cost, and value will be assessed to identify enablers and challenges to agile adoption in the adaptive framework.

Process Development to Apply Production Management to Agile Software Projects

After Phase 1 has been completed and all data have been collected, a process to integrate production management levers for software project monitoring and control will be identified. The process will address how to apply product and process design, how to control WIP to increase throughput, and how to manage process, product, and resource variability to achieve throughput objectives for software incremental delivery. Additional guidelines to apply production management levers to deliver on the OUSD(A&S) software project metrics will be created, establishing a clear framework to achieve the full benefits of agile software delivery. There is no one-size-fits-all approach for metrics. However, it is important that they are well understood and applied properly within the acquisition community, especially within contracts.

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