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**HOW CAN THE DOD ADOPT COMMERCIAL-STYLE
ARTIFICIAL INTELLIGENCE FOR PROCUREMENT?**

June 2020

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**HOW CAN THE DOD ADOPT COMMERCIAL-STYLE ARTIFICIAL
INTELLIGENCE FOR PROCUREMENT?**

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

The U.S. Department of Defense has issued a policy directing agencies to adopt artificial-intelligence capabilities to increase the speed and agility of operations. Despite this, there are no current initiatives to adopt artificial intelligence technologies into the Defense Acquisition System. This thesis examines the potential impact of artificial intelligence on DoD procurement. It studies organizations that have incorporated the technology in business practices, and on the basis of interviews with key personnel analyzes how well businesses have improved speed and agility. While the interviewees were not always clear about what artificial intelligence is, the technology could be helpful for procurement in market research, negotiations, insight, and contract management, among other ways.

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LIST OF ACRONYMS AND ABBREVIATIONS

AI	artificial intelligence
CPO	chief procurement officers
DARPA	Defense Advanced Research Projects Agency
DAS	Defense Acquisition System
DIB	Defense Innovation Board
DL	deep learning
DOD	Department of Defense
DoDIG	DOD inspector general
FY	Fiscal Year
GAO	Government Accountability Office
GSA	General Services Administration
HHS	Health and Human Services
JAIC	Joint Artificial Intelligence Center
JCF	Joint Common Foundation
ML	machine learning
NDAA	National Defense Authorization Act
NDS	National Defense Strategy
NLP	natural language processing
NSCAI	National Security Commission on Artificial Intelligence
NSS	National Security Strategy
OSTP	Office of Science and Technology Policy
OUSD(A&S)	Office of the Under Secretary of Defense for Acquisition & Sustainment
R&D	research and development
RPA	robotic process automation

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I. INTRODUCTION

Michael Brown, director of the Defense Innovation Unit, has said,

Artificial Intelligence is fundamentally redefining how we live, work, and fight wars. Within the Department of Defense, AI has the potential to transform how the Department operates at all levels, from business to the battlefield. In the face of competition from China and Russia, DOD aims to maintain its technological edge through establishing a more decentralized, experimental procurement approach: cultivating a leading AI workforce, engaging academic, commercial, and international allies and partners, and developing ethical and lawful guidelines for AI use. (*Statement by Michael Brown, 2019*)

Businesses are investing billions of dollars in artificial intelligence (AI), transforming their products and services. The government has begun to realize the potential of artificial intelligence, making it a priority in national strategic guidance in recent years. Many organizations are spending considerable time and resources on artificial-intelligence research and development. However, its potential application to the Defense Acquisition System (DAS) has yet to be examined. This thesis examines this issue. Procurement is full of highly manual, laborious, and data-centric tasks. Artificial intelligence could automate these tasks, delivering procurement professionals relevant real-time data. It can pre-populate required forms, streamline market research, and help procurement personnel manage contracts. It can provide management with better governance by giving them better insight into spending, among other things. It can aid procurement professionals, saving them time to focus on more strategic tasks such as negotiations or network management.

To better appreciate why artificial intelligence could be important for U.S. procurement, we can look at the current national-security picture. The United States is entering a new era characterized by emerging technologies, great-power competitions, and new battlespaces. Future conflicts will likely differ from past conflicts in that adapting and moving quickly will be vital to victory. America's military effectiveness in the new environment is unclear. Great powers like China and Russia are growing their military capabilities and looking to take advantage of new technologies. China has

detailed a strategy to become the world leader in artificial intelligence by 2030 (China's State Council, 2017). Russia is also investing heavily in artificial intelligence capabilities and believes that "whoever becomes the leader in this sphere will rule the world" (Simonite, 2017, para. 2).

The National Security Strategy (NSS) directs agencies to prioritize emerging technologies such as artificial intelligence (Office of the President of the United States, 2017). The National Defense Strategy (NDS) calls for delivering performance at the speed of relevance and to modernize key capabilities (Department of Defense [DOD], 2018). In 2018, the Department of Defense (DOD) established a Joint Artificial Intelligence Center (JAIC) and then released a Defense Artificial Intelligence Strategy directing agencies to adopt artificial-intelligence capabilities to increase the speed and agility of operations (DOD, 2019b). The Fiscal Year 2019 National Defense Authorization Act (NDAA) established the National Security Commission on Artificial Intelligence (The John S. McCain National Defense Authorization Act for Fiscal Year 2019 [NDAA], 2018), and the Defense Innovation Board (DIB) and Defense Advanced Research Projects Agency (DARPA) have studied the implications of it for the DOD for many years.

Meanwhile, Congress frequently calls for the reform of the DAS (Barnett, 2019). Since the 1990s, the DOD Weapons Systems Acquisition and DOD Contract Management have both been categorized as high-risk programs by the Government Accountability Office (GAO, 2019). Additionally, the DOD Inspector General (DoDIG) has identified Acquisition and Contract Management as a top-10 management challenge for Fiscal Year (FY) 2020, stating that "DOD programs still fall short of cost, schedule, and performance expectations" with "395 open recommendations [for improvement] related to acquisition and contracting" (DOD OIG, 2019, pp. 111–112). Recently DOD Instruction 5000.02 established a new Adaptive Acquisition Framework with the objective of "delivering effective, suitable, survivable, sustainable, and affordable solutions to the end user in a timely manner" (Office of the Under Secretary of Defense for Acquisition and Sustainment [OUSD(A&S)], 2020, p. 3). A rewrite of DOD Directive 5000.01, the Defense Acquisition System, is expected before the end of this year (Lord,

2019). These are being touted as “the most transformational change to acquisition policy in decades” (Lord, 2019, para. 27).

Time will tell if these reforms will satisfy decades of criticism; however, historically the initiatives of the OUSD(A&S) have been unable to remove the GAO’s categorization of high risk from DOD Acquisition and Contract Management and to satisfy DoDIG’s assessment. These current reforms do not mention artificial intelligence or any new technology. To the best of my knowledge, there are no initiatives within OUSD(A&S) to implement any new technologies in the acquisition process. Moreover, recent reports from the DIB and RAND Corporation suggest that the DAS must be reorganized to support artificial-intelligence systems.

This thesis describes the potential impact artificial intelligence could have on DOD acquisition and contracting. Information was collected through interviews, online forums, and reports. Organizations that have integrated artificial intelligence into their procurement processes were examined to identify successes and failures. This thesis closes by providing a potential pathway for the DOD to adopt commercial-style artificial intelligence for procurement. More specifically, this thesis addresses the following questions:

- How can the DOD adopt commercial-style artificial intelligence for procurement?
- Why did organizations adopt artificial intelligence into their procurement processes?
- What were the expected benefits of artificial intelligence for procurement?
- How well did the artificial intelligence improve speed and agility?
- What are the obstacles and risks?
- What are the lessons learned?

II. BACKGROUND

Artificial intelligence is all around us, integrated and woven into our daily lives in more ways than you are probably aware. It is in our homes, our cars, our phones, and our workplaces. It flies planes and drones. It drives cars and trucks. Artificial intelligence recommends what music we should listen to or what movie we should watch next. It suggests products, and it personalizes our news and social media feeds. It organizes email inboxes and provides smart replies. Artificial intelligence determines the most efficient routes when you are driving, arranges economic matches for us to share rides, and determines the rate charged when you use applications like Uber or Lyft. Artificial intelligence helps decide whether you should receive a loan, detects fraud, and manages stock portfolios. It translates languages, provides customer service, and prepares taxes. Virtual assistants like Alexa and Siri answer general questions and allow you to check the weather, send text or call someone, set up meetings, and order products online with only the sound of your voice. Artificial intelligence has won Jeopardy and beaten the world's best at chess, go, and poker, tasks previously thought to be impossible. It even helped tennis player Novak Djokovic win Wimbledon by helping him to not only improve his own game but to strategize on how to play specific opponents (Loudin, 2019). Artificial intelligence powers websites, applications, and search engines. The list goes on and on, and it will only continue to grow since we are still in the early stages of harnessing its power.

Artificial intelligence can fundamentally transform businesses. It is already changing healthcare by helping professionals detect and manage diseases, monitor health, perform surgery, personalize cancer treatments, and identify people at risk of suicide (National Academy of Medicine & GAO, 2019). But more than this, it will change business strategy. For example, right now Amazon's artificial intelligence suggests items you may want to buy. It does an adequate job at this task. In the future, however, after it has collected more data, it could become sufficiently accurate to change Amazon's business model. It will become "more profitable for Amazon to ship you goods that it predicts you will want rather than wait for you to order them" (Agrawal et al., 2018, p.

24). It will save the consumer from having to shop—giving them items they want and need—and change “Amazon’s business model from shopping-then-shipping to shipping-then-shopping” (Agrawal et al., 2018, p. 24).

Artificial intelligence is starting to be adequate in preparing nontrivial legal documents. A study compared it to 20 human attorneys in examining nondisclosure agreements and identifying risks within them. Artificial intelligence had an average accuracy of 94%, while the lawyers had 85%, as judged by independent auditors. More importantly, the lawyers took about 92 minutes on average for a contract while the artificial-intelligence program needed only 26 seconds (Chaffin, 2018).

A. WHY IS ARTIFICIAL INTELLIGENCE RELEVANT TODAY?

In this thesis, I use the term “artificial intelligence” broadly, as a term for computers, software, or algorithms that can perform intelligent tasks traditionally performed by human beings. This includes robotic process automation, machine learning, natural language processing, and deep learning among others.

Such artificial intelligence has been around for over 60 years. It has experienced a few booms and busts. However, today’s boom is very strong for several reasons. The first reason is the amount of available data; data are essential and the fuel for artificial intelligence. In the past, it was costly and challenging to acquire data. Today we have oceans of data. Cloud services allow for a massive amount of storage and sharing. Second, the required computing power needed for important artificial-intelligence applications is here. Third, mobile connectivity improvements like the fifth generation give artificial intelligence the necessary bandwidth and processing speed required to work remotely. Fourth, both industry and government support the current boom by having made significant investments in artificial intelligence. Last, advanced algorithms are now possible due to improvements in computer hardware (Torres, 2018).

An example of the impact of artificial intelligence occurred in 2016 when AlphaGo, an artificial intelligence algorithm, defeated the world champion grandmaster in the ancient game of go. The grandmaster has since retired, convinced that machines “cannot be defeated” (Webb, 2019, para. 3). More impressive is the recent defeat of

professional poker players at six-player poker by the program Pluribus. Poker presents incomplete information, unlike chess and go, and involves multiple opponents who sometimes bluff. Yet Pluribus defeated them convincingly by mixing strategies and betting in ways the humans did not. These milestones are noteworthy for two reasons. First is how the programs learned to play the games, by learning from experience. Only 13 days were needed to master go and eight days to master poker (Carnegie Mellon University, 2019). Second, the programs made moves never before considered. In the second go game's 37th move, AlphaGo made a move never seen in thousands of years of gameplay; it was initially thought to be a mistake, but it turned out to be brilliant (Docherty & Fanning, 2019).

Given these feats, one can see the potential utility for the military. "While the current rules of wargaming are complex and the tactical moves subtle, it is not hard to imagine a version of [AlphaGo] that could learn to play and win a war game in a few days. The implications for future battle management could prove enormous" (Arquilla & Denning, 2019, p. 35). These examples illustrate the potential utility of artificial intelligence and its relevance today: Artificial intelligence will not only improve business processes, but it will win the future battlespace. Application of artificial intelligence to procurement could not only automate and streamline business processes but could think of "moves" never before considered. It can merge and interpret a vast amount of data to predict an outcome. "The ability to fuse enormous amounts of data from across disparate data sets and provide meaningful answers are exactly what artificial intelligence and machine learning were designed to do" (Weinbaum & Shanahan, 2018, p. 5).

B. GOVERNMENT AND ARTIFICIAL INTELLIGENCE

Artificial intelligence is a major strategic concern for the DOD and the U.S. government as a key to maintaining a competitive advantage over other countries. In February 2019, an executive order established the American Artificial Intelligence Initiative, titled "Maintaining American Leadership on Artificial Intelligence." It directed federal agencies to act to support several related objectives (Executive Order No. 13859, 2019). Recently, the Office of Science and Technology Policy released the first annual

report on the Initiative (Office of Science and Technology Policy [OSTP], 2020). It concluded that significant progress has been made. Figure 1 was taken from that report and represents a timeline of U.S. government actions to advance the initiative.

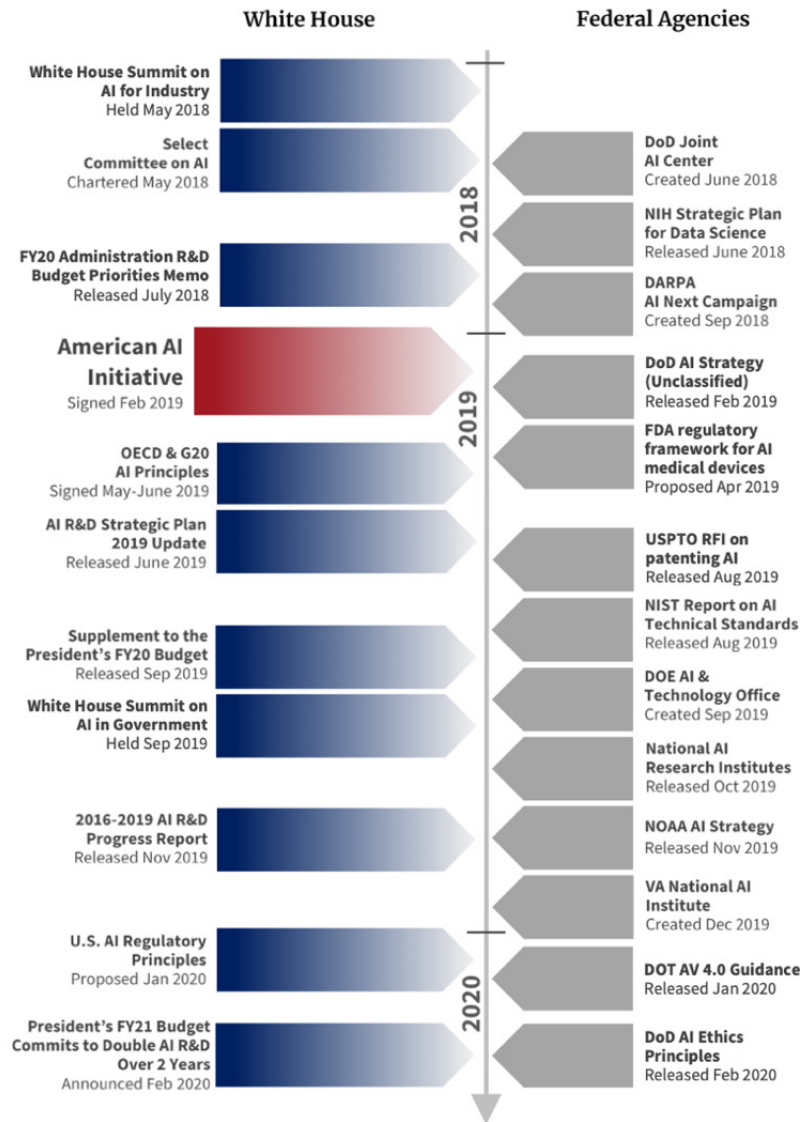


Figure 1. Timeline of U.S. Government Actions to Advance the American Artificial Intelligence Initiative. Source: OSTP (2020).

Figure 1 shows some products produced in recent years as a result of the initiative, but the U.S. government does have a long history with artificial intelligence.

For example, for nearly six decades, the Defense Advanced Research Projects Agency (DARPA) has supported artificial-intelligence research (DARPA, 2018b). Other parts of the U.S. government also have a long history with artificial intelligence.

More specific to the DOD is the National Security Strategy (NSS), which states that “to maintain our competitive advantage, the United States will prioritize emerging technologies critical to economic growth and security,” such as artificial intelligence (Office of the President of the United States, 2017, p. 20). Modernization was identified as a critical objective, and specifically lists acquisition as a priority.

The United States will pursue new approaches to acquisition to make better deals on behalf of the American people that avoid cost overruns, eliminate bloated bureaucracies, and stop unnecessary delays so that we can put the right equipment into the hands of our forces. We must harness innovative technologies outside of the traditional defense industrial base. (Office of the President of the United States, 2017, p. 29)

The 2018 NDS was framed in the same manner as the NSS and the American Artificial Intelligence Initiative. The guidance acknowledges our eroding military competitive advantage, and it states that new technologies such as artificial intelligence are “the very technologies that ensure we will be able to fight and win the wars of the future” (DOD, 2018, p. 3). It recommends that we “must modernize our military or the result would be a Joint Force that has legacy systems irrelevant to the defense of our people” (DOD, 2018, p. 1). A specific defense objective included is “continuously delivering performance with affordability and speed as we change the departmental mindset, culture, and management systems” (DOD, 2018, p. 4). The NDS also stipulates that the United States must “organize for innovation” (DOD, 2018, p. 10) and “modernize key capabilities” (DOD, 2018, p. 6). Furthermore, it recognizes that the “backlog of ... procurement ... has grown in the last decade and a half and can no longer be ignored” and that “the department will invest broadly in military application of autonomy, artificial intelligence, and machine learning, including rapid application of commercial breakthroughs, to gain competitive military advantages” (DOD, 2018, pp. 6–7). While the guidance did not call out the DAS by name, it calls for “reform [ing] the department for

greater performance and affordability” to be able to “deliver performance at the speed of relevance” (DOD, 2018, p. 10). Business processes in general were mentioned.

Current processes are not responsive to need; the Department is over-optimized for exceptional performance at the expense of providing timely decisions, policies, and capabilities to the warfighter. Our response will be to prioritize speed of delivery, continuous adaptation, and frequent modular upgrades. We must not accept cumbersome approval chains, wasteful applications of resources in uncompetitive space, or overly risk-averse thinking that impedes change. Delivering performance means we will shed outdated management practices and structures while integrating insights from business innovation. (DOD, 2018, p. 10)

In 2018, the DOD Artificial Intelligence Strategy was released, directing the adoption of artificial intelligence within the DOD (DOD, 2019b). The Joint Artificial Intelligence Center (JAIC), established earlier in the year, would serve as the principal agency to implement the strategy and “to accelerate the delivery of artificial intelligence-enabled capabilities, scale the Department-wide impact of artificial intelligence, and synchronize DOD artificial intelligence activities to expand Joint Force advantages” (DOD, 2019b, p. 9). The strategy reiterates much of the NSS and NDS, but it is more specific on the artificial-intelligence tasks. One focus area called for streamlining business processes or tasks that are “highly manual, repetitive, and frequent” (DOD, 2019b, p. 11). It also stipulates that “the ability of AI to reduce inefficiencies from manual, laborious, data-centric tasks will be harnessed across the Department with the objective of simplifying workflows and improving the speed and accuracy of repetitive tasks” (DOD, 2019b, p. 6). The strategy goes on to say that the DOD “will prioritize the fielding of artificial intelligence systems that augment the capabilities of our personnel by offloading tedious cognitive or physical tasks and introducing new ways of working” (DOD, 2019b, p. 7) and that “there are numerous artificial intelligence applications that could improve our day-to-day operations” (DOD, 2019b, p. 11). The strategy also offers a much blunter assessment of what the cost would be if implementation fails. “The costs of not implementing this strategy are clear. Failure to adopt artificial intelligence will result in legacy systems irrelevant to the defense of our people” (DOD, 2019b, p. 5). New technologies like artificial intelligence not only present a unique opportunity to help the

DOD overcome challenges in acquisition and contracting; they are essential to remaining relevant.

Another significant artificial-intelligence strategy was the 2019 DOD Digital Modernization Strategy, which “provides a roadmap to support implementation of the National Defense Strategy lines of effort through (the priorities) of cloud, artificial intelligence, command, control and communications and cybersecurity” (DOD, 2019a, p. 3). An important event occurred in 2018 when DARPA invested \$2 billion over several years in over 80 programs and called it the “AI Next” campaign, building on DARPA’s decades of research (DARPA, 2018a). Also, the Defense Innovation Unit was established in 2015 in Silicon Valley to leverage better partnerships with the most innovative American companies. *AI.gov* was established recently and is a governmental portal for artificial-intelligence activities. In 2020, \$1 billion was allocated for DOD artificial-intelligence projects, and \$208 million of this was allocated to the JAIC (Breaking Defense, 2019).

So just how is the DOD spending its budget and implementing this guidance? Most initiatives are focusing on the battlefield. Weapons systems like Tomahawk missiles and the Phalanx close-in weapons system are fully autonomous and have been in service for decades. The DOD uses a fleet of drones for a variety of missions; prominent in recent years are the Sea Hunter and Project Maven. DARPA developed Sea Hunter as an autonomous surface ship that tracks submarines. Project Maven was a collaboration with Silicon Valley to develop computer-vision algorithms that could process and analyze video footage from drones. Other artificial-intelligence warfighting projects include M1-tank engine analysis, summarizing sensor data during warfare, automated pilots for combat simulation, detecting changes to buildings in aerial photographs, cyberattack warning, predictive maintenance, battlefield management and autonomy, and sensor-based target identification. A central project in 2020 for the JAIC is artificial intelligence for maneuver and fires. It focuses on the warfighting operations like operations-intelligence fusion, accelerated sensor-to-shooter timelines, autonomous and swarming systems, target development, and operation-center workflows (Shanahan,

2019). Other projects help with decision-making and risk analysis and help with joint command and control.

While most of the artificial-intelligence initiatives focus on the battlefield, many others focus elsewhere. AI Next includes initiatives such as human-language technologies, biomedical advances, space-based imagery analysis, analysis of microbiologic systems, and control of prosthetic limbs (DARPA, 2018a). There are DOD initiatives for humanitarian assistance and disaster relief. Intelligent business automation for critical DOD processes such as background investigations and accrediting software systems is underway. Another recent major effort for the JAIC is the Joint Common Foundation (JCF), which “will be a platform that will provide access to data, tools, environments, and other certified platforms to enable software/artificial intelligence engineers to rapidly develop, evaluate, test and deploy artificial intelligence-enhanced solutions to warfighters” (Shanahan, 2019, para. 16). However, the National Security Commission on Artificial Intelligence (NSCAI) interim report observed,

The United States is not translating broad national artificial intelligence strengths and artificial intelligence strategy statements into specific national security advantages. Key departments and agencies have not yet fully embraced high-level strategy pronouncements and therefore critical national security missions have not incorporated artificial intelligence. (NSCAI, 2019, p. 22)

C. GOVERNMENT PROCUREMENT AND ARTIFICIAL INTELLIGENCE

Within the U.S. government, the Department of Health and Human Services (HHS) and the General Services Administration (GSA) are putting artificial intelligence into their procurement processes. HHS developed and recently deployed Accelerate, which “uses a neural network [to perform] cluster analysis of 10 years of HHS contracts and provide visibility into price discrepancies across its portfolio” (Malone, 2020, para. 2). They claim it will save \$30 million over five years. This will help procurement professionals get relevant pricing data when they perform market research. It also pre-populates the forms with applicable terms and conditions in real time, saving personnel time.

Meanwhile, the GSA is implementing the use of robots and other related technologies within their agency to streamline processes and “establish a foundation for greater data-driven decision-making through artificial intelligence” (*Statement of Keith Nakasone*, 2018, p. 2). It is also helping other government agencies adopt artificial intelligence into their operations in three ways. First, GSA has created an artificial-intelligence “community of practice,” which they hope will become the largest repository of use cases in the government. Second, GSA created the Center for Excellence for artificial intelligence, performing consultant work with other government agencies and bringing academic expertise to solve business problems. Third, their Federal Acquisition Service lets government agencies buy new artificial-intelligence services quickly (K. Nakasone, PowerPoint presentation, March 25, 2020).

Other agencies like DARPA and the Department of Homeland Security are considering process automation tools to increase efficiencies in procurement. Last year, both agencies solicited information on robotic and intelligent machines but have not reported any results.

D. INDUSTRY AND ARTIFICIAL INTELLIGENCE

Businesses realize the potential of artificial intelligence and are using it to transform their products and services. Investment in artificial intelligence is accelerating with projections that it will reach \$97.9 billion in 2023 (Daquila, 2019). American companies are competing for artificial intelligence talent by acquiring relevant startups at an increasing rate. Since 2010, there have been 635 artificial intelligence acquisitions that span every industry (CB Insights, 2019). In 2019, the job most recruited was an artificial-intelligence specialist (Hill, 2019). It is the third year in a row that artificial intelligence has claimed the top position, growing 74% annually. Another study found that 62% of North American companies have one or more artificial-intelligence systems in operation, and 87% plan to adopt some artificial intelligence in the next two years (Cognilytica, 2020).

Despite these trends, businesses are still trying to understand what artificial intelligence means for their future business. A study by PricewaterhouseCoopers

concluded that “global GDP will be up to 14% higher in 2030 as a result of the accelerating development and take-up of artificial intelligence—the equivalent of an additional \$15.7 trillion” (PricewaterhouseCoopers [PwC], 2017, p. 4). They claim that three factors will drive the impact:

- Productivity gains from businesses automating processes (including use of robots and autonomous vehicles).
- Productivity gains from businesses augmenting their existing labor force with AI technologies (assisted and augmented intelligence).
- Increased consumer demand resulting from the availability of personalized and/or higher-quality AI-enhanced products and services. (PwC, 2017, p. 4)

Productivity gains will come mostly from automation of labor-intensive manual tasks. It will free up time for employees to perform more valuable or strategic missions. Businesses will have better insight into their customer’s preferences. Shell’s chief technology officer stated, “Artificial intelligence enables us to process the vast quantity of data across our businesses to generate new insights which can keep us ahead of the competition” (Castellanos, 2020, para. 4). While most companies are applying artificial intelligence for narrow and well-defined tasks, the most progressive enterprises want to use artificial intelligence to do things never done before. Their goal is to disrupt markets by creating entirely new services, products, or businesses by harnessing the power of artificial intelligence.

E. INDUSTRY PROCUREMENT AND ARTIFICIAL INTELLIGENCE

Many companies are adopting new technologies for procurement. A recent survey found that 58% of businesses are automating procurement (Umbenhauer et al., 2019). Another survey of chief procurement officers (CPO) from Fortune Global 500 companies found that 67% of ranked artificial intelligence was one of their top three priorities for the next ten years (Marlinghaus, 2018). Large technology companies are developing that capability in-house; others are looking for contracts. Figure 2 lists artificial-intelligence and procurement startups that could help companies apply artificial intelligence to procurement. For instance, Prevedere helps a company forecast future business from global data from hundreds of sources (Prevedere, n.d.); one can then correlate that with

internal data for insights. Rapid RPA automates a customer’s business processes to enhance productivity (Echelon | RPA, n.d.). Other companies like Icertis, Sievo, and Seal are specific to procurement. Icertis is a bigger startup with a valuation of \$1 billion (D’Onfro, 2019). It is a platform to manage the life cycle of contracting, from offers to negotiation, acceptance, and management. More specifically, it automates contract tasks and analyzes past negotiations (D’Onfro, 2019). Seal helps with contract management by helping their customers find the contracts quickly, extract critical data, and perform analytics (Seal Software, n.d.). Sievo provides contract management, spending analysis, and forecasting (Sievo, n.d.). Similar startups for artificial intelligence and procurement are growing.



Figure 2. List of Artificial Intelligence and Procurement Startups

F. PRIOR RESEARCH

An early study examined artificial intelligence's utility in assisting claims analysts within the Differing Site Condition Analysis System (Kruppenbacher, 1984). The study found that a rule-based expert system can apply successfully to contract management and can do accurate analysis. Another study examined how artificial intelligence can take over daily tasks in the future workplace (Subramanian et al., 1999). It concluded that the technology can be helpful for sophisticated real-time negotiations and that machines could be programmed to do business tasks "so that decisions can be made in a faster and accurate way" (Subramanian et al., 1999, p. 111).

Another study focused on aiding complex negotiation scenarios with artificial intelligence (Rodriguez-Aguilar et al., 2003). It concluded their decision-support agent could help in the real world and that it was time to deploy such agents. Additionally, their agent could cooperatively solve complex problems with other intelligent programs. Another paper proposed a formal reputation model to evaluate bids from suppliers and manage the trade-off between price and a firm's reputation (Klabi et al., 2013). This provides the tools a government needed to evaluate bids and guarantee that the most trusted supplier was identified while minimizing the total cost.

A more recent thesis considered the problems that artificial-intelligence systems would encounter within the Joint Capabilities Integration and Development System and how well warfighter requirements would be addressed through the DAS through the software-acquisition pathway (Ehn, 2017). It concluded that such systems face problems becoming an executable DOD program. Lack of knowledge about artificial intelligence within the DOD could mean poorly defined requirements, causing cost, schedule, and performance issues. This issue was recently studied (Defense Innovation Board, 2019; Tarraf et al., 2019), and refactoring the DAS to support the development of artificial-intelligence systems was suggested.

One study examined artificial intelligence in procurement and concluded it "will change the face of procurement" (Chopra, 2019, p. 315). Automation and robots could

help automate some tasks so people can focus on higher-priority tasks, and new startups will offer cost-effective procurement solutions within the next five years:

Bottom line, procurement leaders must become AI-conversant so they can onboard and direct professionals who possess the skills to leverage the tools. Without competent staff, it's widely believed it will be nearly impossible for companies to build next-generation strategic sourcing and procurement organizations. (Chopra, 2019, p. 315)

III. BASIC INFORMATION GATHERING

To better answer the research questions, I sought people with experience integrating artificial intelligence into procurement. I sent out 95 requests but received only 10 responses. Some respondents could not discuss their knowledge due to restrictions on sharing work-related information. However, I did connect with and interview five people from government and industry. Some respondents invited me to webinars where I could gather more information. Additionally, I gathered some data through podcasts and online interviews. I focused on why each organization implemented artificial intelligence in their procurement processes, how it improved speed and agility, the benefits and risks of artificial intelligence, the challenges overcome, and the lessons learned.

A. WHY DID THE COMPANY ADOPT ARTIFICIAL INTELLIGENCE INTO PROCUREMENT?

The organizations of the interviewees implemented artificial intelligence for different reasons. One organization was exploring how “digitization” could help their procurement, since there is always pressure to deliver savings and value. They had already implemented some automation to help save time and deliver value. However, they lacked a digital strategy and wanted to

leverage technology to help us with capacity and to get us from transactional to more strategic, high-impact activities, like using data to make smarter decisions, or to gain insights to negotiate better deals. We also started to see a lot of companies providing AI and digital products and services, so these capabilities were maturing and improving the user experience. (J. Thong, PowerPoint presentation, March 31, 2020)

They also hoped artificial intelligence would help with spending analytics. They wanted to know, for a given category, how much money they spend with each supplier. For example, if they were spending \$10 million in one category with four suppliers, they might achieve a better cost by using only two suppliers. Finding these opportunities is difficult for employees alone. Artificial intelligence could provide this insight and analysis automatically.

One company hoped to improve insight and accessibility for their contracts. Because it was a global company, it had difficulty comparing the contracts in different regions. It was difficult and time-consuming to compare and reconcile differences in the terms they were agreeing to. They hoped to solve this problem by creating a database to maintain all of their contracts and to use artificial intelligence to help them identify significant terms and conditions.

HHS was one of the first U.S. agencies to exploit artificial intelligence. HHS had three main problems to address. One was that they had no insight into the data at the headquarters level and had little ability to see what people were buying. Another was that the procurement process itself was too convoluted and taking too long to buy something because of the regulations and clauses. Another was that HHS has much old technology and systems and wanted to see if there was overlap or redundancy so some systems could be retired (O. Mek, interview with author, March 24, 2020).

The GSA wanted to use machine learning to improve enterprise-user licensing agreements, which usually contain 30 to 50 pages of terms and conditions. They thought they could use software to help them perform preliminary analysis and then have humans look at the details (K. Nakasone, interview with author, March 23, 2020). They also wanted to automate repetitive low-level tasks that are well-defined, such as determining a contractor's financial responsibility (Walch & Schmelzer, 2019). The U.S. Department of Veteran Affairs (VA) believes tasks should be automated when possible, saying that we should:

Automat [e] things that computers should be doing. So, there's a lot of things that computers are good at that we don't really need people to be doing. And so, whenever those situations arise, it's best to automate them, if we can, so that people can focus on the things that only people can do. So, one type of use for this type of technology is just to automate business processes. (Fedscoop, 2019c)

B. WHAT WERE THE EXPECTED BENEFITS OF ARTIFICIAL INTELLIGENCE FOR PROCUREMENT?

Most interviewees hoped that streamlined processes and the automated routine work would be the primary benefits of artificial intelligence. "We're doing a lot of

robotic tasks. It's the same thing over and over again. Now, we're seeing some processes improve. [Something] that could take four hours is really now down to maybe less than an hour or even minutes. So there's an efficiency in terms of time" (J. Thong, PowerPoint presentation, March 31, 2020). Another interviewee made a similar comment.

It gives us the ability to access the terms and conditions in contracts that we need much more quickly. Also, we no longer have to spend a week to review hundreds or thousands of pages in the contract. We can now find what we need within a day. So it's a time saver. It's automatic. And it can be customized and tailored to the terms that we focus on for our industry. So, that alone is already a major deal for us. (S. Negrete, interview with author, March 26, 2020)

Another anticipated benefit of artificial intelligence is the gathering of information about a supplier to better a negotiating position. Software tools can continuously gather and analyze millions of data indicators, then use machine learning and predictive analytics to tell whether a specific company is doing well based on positive or negative views. They can use that data to analyze how external data correlates to a company's internal data. When an external data value changes, it affects their internal data. For example, one could then predict future sales based on past performance or a demographic change, saving money in a negotiation (J. Thong, interview with author, April 9, 2020). The company found that artificial intelligence helped for spend analytics, predictive analysis, strategy development, forecasting, digital assistants, requests for proposals, supply-demand matching, contract management, supplier management, and robotic process automation (J. Thong, email to author, April 9, 2020).

Another company found that artificial intelligence improved communication and transparency between regions around the world in a product line. It let them quickly run reports to give them better insight into how many contracts were in a region. Machine learning models quickly integrated data from enterprise systems, operational networks, and external sources to generate predictive insights and find critical issues like start dates, end dates, renewal dates, force majeure, escalation clause dates, and third-party charges like storage or standby fees. Their contracts are now readable and extractable, letting them see the status of the contract and find opportunities for better pricing or terms while negotiating (S. Negrete, interview with author, March 26, 2020).

HHS also hopes to realize significant savings in money, obtain insight for negotiations, and optimize processes. They believe they will save \$2 billion over five years due to these benefits. For example, better data access allowed their neural network to perform cluster analysis of over 10 years of contracts, allowing them to find price differences. This information will let them buy in bulk and negotiate prices. Better data also lets them manage contracts better since they can better measure performance. For instance, to ensure compliance with a requirement, they can pull the data from headquarters, rather than having to ask for a report from each agency. Artificial intelligence alerts them when the terms and conditions of a contract are violated. Last, a centralized database helps them find steps that can be combined or eliminated and enables them to identify and retire overlapping technology and systems (O. Mek, interview with author, March 24, 2020).

HHS found that artificial intelligence improved both processes and quality. They use a chatbot, a virtual customer service agent, to answer questions about relevant regulations and clauses and help guide their employees through the acquisition process. This improves the quality of an acquisition plan before it gets to a contracting officer. It also shortens the process since it helps to eliminate many questions and discussions between the requirements generator and procurement organization. Faster and better insight was also cited by multiple interviewees.

The other [benefit] is just good insights, to help us go source and save money on some things. Often, it would take us days to complete an analysis that a robot could do in a mere two minutes now, providing the same conclusion. So, it gives you more opportunity, more insight to then generate savings. (J. Thong, interview with author, April 9, 2020)

Combining machine learning with linear regression helped HHS predict which types of contracts would have problems by looking at past performance. Software then gave them recommendations, such as updating a policy or changing personnel (O. Mek, interview with author, March 24, 2020).

Prediction could be an additional benefit of artificial intelligence. The software could alert the organization that an event may occur in the future, such as a demographic change in their future customers, which gives them time to react and be proactive about it

rather than reactive (J. Thong, interview with author, April 9, 2020). It also can provide more relevant data to help humans make better decisions.

The other, probably more interesting, use of artificial intelligence is sort of expanding the boundaries of what a computer can actually help with. And so, especially in the VA, we have a lot of decisions that are made all the time by really talented professionals, and if we are able to increase the amount of support that computers can give to those professionals as they make these critical decisions--whether it's a doctor, you know, treating a patient or somebody processing a disability claim--we see a lot of potential to help provide those professionals the exact right information they need to make the right decision. (Fedscoop, 2019c)

Last, interviewees mentioned how artificial intelligence allowed them to focus more on strategy. It helped them complete transactions more quickly, with relevant insight and data that forced them to be more strategic (J. Thong, interview with author, April 9, 2020). "Humans can then focus on human to human connections" (Fedscoop, 2019b).

C. HOW WELL DID ARTIFICIAL INTELLIGENCE IMPROVE SPEED AND AGILITY?

Streamlining processes and providing better insights should save both time and money and let employees work on higher-level tasks. HHS found that once it had better data and insights, it could optimize and even eliminate steps, improving speed and agility. HHS realized that data were just being cut and pasted from one form to another. Using machine learning, a 10-step process was simplified into three steps, greatly improving the process (O. Mek, interview with author, March 24, 2020). Another interviewee said:

I would say proactive and faster decision-making ... at the end of the day, we're looking to make decisions fast and confidently. And that's where the speed and agility comes, too, is quicker decision-making. Because we have data that's telling us to do certain things, and then we're confident with it, then we can ... become more proactive than reactive, helping us make decisions quicker that are fact based, so that when we look at it, we can all agree that, hey, this is what it's saying and here's the data backing it up, so let's do it. (J. Thong, interview with author, March 31, 2020)

GSA is seeing immediate benefits from being able to pull data from an enterprise data lake and put into the acquisition forms they build. "We are already starting to see

results where you can save a whole lot of time that used to be done by humans, all the extraction and the import of data, importing it again into another document” (K. Nakasone, interview with author, March 23, 2020). He also said that instead of “spending weeks and weeks and churn over determining financial responsibility, we know we can use AI and ML to help us with that” (K. Nakasone, interview with author, March 23, 2020).

An organization from industry is seeing a similar benefit. “For us, it’s the ability to review and organize documents. Something that used to take a week can be done in one day. We can find and extract the applicable clauses, terms, and conditions quickly. So, that alone is gold” (S. Negrete, interview with author, March 26, 2020).

Lastly, some interviewees noted that artificial intelligence works well with an agile methodology for implementation, the idea of starting small and developing specific processes side by side with users. Agile methods often use microservices, which allow for continuous delivery and improvement during deployment. Microservices can be built to represent each of the planning aspects of the acquisition life cycle (GovernmentCIO Media & Research, 2020). Microservices can be designed with artificial-intelligence methods to make them smarter.

D. WHAT ARE THE CHALLENGES AND RISKS?

Every interviewee said change management is one of the biggest challenges with artificial intelligence, just as much as with other innovations. “There’s no innovation without adoption--if the workforce doesn’t adopt it, you don’t have anything” (O. Mek, interview with author, March 24, 2020). Building and proving that a solution works is not really the hard part. Rather, the biggest challenge is getting people to use it and change the way they conduct business. Another interviewee said:

It’s the change management, because here’s the deal. You’re finding out that these companies are really good at implementing for you and getting it up and running. The robot is a robot. But the change management really is--it’s not worth anything if the everyday user is not going in there and interacting with it and using it for its power. People still want to do their own thing and may not want to believe that the robot is returning the right insights. (J. Thong, interview with author, April 9, 2020)

To overcome this challenge, HHS identified human-centered design as critical. Users identify bottlenecks or manual processes that can be automated. Developers then build a proof of concept and bring it back to the user for feedback. This feedback loop occurs every two or three weeks, refining the solution each time. Human-centered design gets the user to support the automation since they were a part of the process throughout. “If you win the hearts and minds of the people, you could change, you could lead change, you could influence others to come aboard--because in modernization and innovation, it’s not the technology challenge. It’s the culture change” (O. Mek, interview with author, March 24, 2020). Most people do not yet understand artificial intelligence and what it can do. Explaining how artificial intelligence can help them will not convince them until you can prove it. It’s essential to give users tangible results with improvements every few weeks. Just explaining it won’t mean anything. That’s why “human-centered design is so critical. That’s probably the biggest part” (O. Mek, interview with author, March 24, 2020).

This is consistent with an industry practice identified by one of the interviewees called “design thinking.” The company uses design thinking to creatively solve problems and sell the innovative mindset concurrently. This not only creates solutions and improves processes but helps the change management problem. Moreover, it helped change people’s mindsets, improving ideation, creativity, and collaboration (J. Thong, PowerPoint presentation, March 31, 2020). Another industry organization observed that support from leadership is key for adoption.

Nobody wants to change, right? People don’t like new programs or new ways of doing things. You have to have support from above to push it to more people. When they see that the boss’s boss and everybody is pushing for it, they’ll start to make the effort. It’s a slow process to get people to jump on board at first, but if you have the support from above to help push it and be part of the process to improve and customize the program, they start to see the benefit. (S. Negrete, interview with author, March 26, 2020)

Another key practice worth noting is to use training as a tool for change management. One interviewee found that tailoring the training to very specific user groups and teams helped improve feedback and responses. They also incorporated their

artificial intelligence platform into review processes and meetings, making it a requirement for managers to display specific information and read their spend analysis (J. Thong, PowerPoint presentation, March 31, 2020).

The director of the Joint Artificial Intelligence Center believes the three biggest challenges the DOD faces are culture, talent, and data management. He noted the importance of having experienced people in the DOD who have worked with artificial intelligence and “have the breadth and depth of understanding of what AI can do and, more importantly, [know] how you move it from research and development or pilots, prototypes, into true operational production that is scaled across the Department of Defense” (Fedscoop, 2019e). He said that the DOD must have “a culture that begins to understand the art of the possible in artificial intelligence” (Fedscoop, 2019e).

Most of the interviewees cited data acquisition as another big challenge to using artificial intelligence. This includes access to the data, assuring quality of the data, labeling the data, and classifying the data (M. Arendt, interview with author, March 12, 2020). Acquiring the data and getting it into a usable format for artificial intelligence will take time. One interviewee said the following about data management:

If you accept, as almost everybody that I’ve talked to does, that data is that strategic asset, that fuel that really allows you to do AI ... we have a lot of work to do on the data management. [For instance, for] Project Maven, we found we were working much longer and much harder on the data management side of the AI delivery cycle or life cycle than we ever expected when we first started. No surprise to anybody in industry, who warned us that’s where you’re going to spend more time than you would ever expect. ... One of the impediments we face is that, often, to create these new types of models requires a lot of training data, and the data to train these models is in a lot of disparate systems. And so trying to figure out how do we get the data into a place where it can be easily analyzed and then used to train models is a big challenge. You know, we’ve got databases that are operational databases. We have different databases that are more sort of focused on analytic use cases, and that’s spread across a lot of different systems, so we need to find ways to get that data in a place where the people building these models can actually use it. (Fedscoop, 2019e)

Often, organizations want to start using artificial intelligence or robots without solving the data problem first. “If you want to do [artificial intelligence], 80% of the

work will be cleaning the data, ingesting the data, normalizing the data, and trying to structure and format the data” (O. Mek, interview with author, March 24, 2020).

Artificial intelligence can then help organizations understand and organize the data. Machine learning, supervised and unsupervised, can look at and interpret the data. A model or algorithm is selected and subsequently trained. Subject matter experts, like acquisition experts, look at the outcome and help refine it, which teaches the model or algorithm. The reinforcement process occurs over and over, allowing it to become smarter and smarter, which ultimately normalizes the data.

Several interviewees noted that the success of artificial-intelligence software depended on the quality of the data. “If you don’t have the right data in, then you won’t have the right data out--trash in, trash out” (S. Negrete, interview with author, March 26, 2020). Therefore, it is important to have the right processes in the beginning to capture and structure the data. A data standard and data governance strategy will save time. Several interviewees said they did not have a good process to capture the important data and had to spend significant time cleaning the data to correct the problem. Also, a good governance framework for the data is needed that addresses other considerations like data privacy and data rights (Walch & Schmelzer, 2018).

Security concerns were brought up by one interviewee, in the form of adversaries manipulating artificial-intelligence software or training data. This challenge could be addressed in part by the right language written into the acquisition (K. Nakasone, interview with author, March 23, 2020). Another interviewee noted also that machine learning could help dissect and label sensitive data. Other technologies like blockchains could encrypt the data and maintain immutable transactional records so that there is a full record of who did what (O. Mek, interview with author, March 24, 2020).

Another challenge in using artificial intelligence is finding a contracting process with the necessary flexibility and speed to develop software that uses artificial intelligence. Traditional Federal Acquisition Regulation–based procurement processes do not have these characteristics. However, industry can write, test, and deploy software within a few weeks, so we need to use its methods. A second contracting problem is that the companies that are best at developing artificial intelligence do not want to work with

the government. Alternative contracting methods like other transaction authorities or indefinite-delivery/indefinite-quantity contracts offer a solution, but incentivizing and lowering the barriers to entry for new companies to do business with the government must be considered (M. Arendt, interview with author, March 12, 2020). Third-party contract-management software could incorporate necessary artificial-intelligence methods, but it usually needs to be tailored to that industry. It has taken one company nearly a year to create a dashboard that is easy to read (S. Negrete, interview with author, March 26, 2020). Another potential risk is developer bias in the program. A governance program must have good rigor and transparency to certify ethical behavior without exposing their intellectual property (K. Nakasone, PowerPoint presentation, March 25, 2020).

E. LESSONS LEARNED AND OTHER KEY INSIGHTS

Two interviewees thought it was important to start with innovative and technology-oriented people within the organization to help improve adoption of artificial intelligence.

The first people we brought in were people excited about doing it. Lessons learned is that when you implement something, you always want to tag certain people that you know that will be good proponents of it. Train them first, the super-users--get them excited, and then they can train others. (J. Thong, interview with author, April 9, 2020)

Another interviewee found that providing the artificial-intelligence assistant to innovative workers allowed them to individually train the robot and find new ways to perform their work more efficiently (Fedscoop, 2019a). This helped encourage adoption and led to more successful outcomes. Another interviewee noted that focused training that is specific and relevant to that group's procurement function made group members feel like they were being catered to and encouraged their adoption (J. Thong, interview with author, April 9, 2020).

Another important insight is the importance of the change agent: "Find someone who's willing to disrupt the system, that is not willing to take no for an answer" (Fedscoop, 2019e). The change agent must have support from above and be empowered

to make decisions and move things forward very quickly. Again, an innovator mindset was cited as critically important. They need to be able to see and do things differently. They have to be “excited and curious about innovation, technology, and digitization, and not comfortable with the status quo, but very comfortable with the unknown, working in a loose, chaotic environment” (J. Thong, PowerPoint presentation, March 31, 2020). Additionally, the makeup of the team and rules they operate by was cited as critically important.

We treated this special project like a startup. We wanted to be small, nimble, and fast ... different years of experience and skill sets, a blend of millennials and more seasoned members. However, what was common among them was that innovator mindset. Also ... none of them had straight-up technical skills. They represented the “user community,” with a strong desire to simplify things via technology. ... [We] wanted to model and exercise one tenet, which is move fast, make decisions fast, like a startup. So I want to stress that this was probably the most important key to our success: choosing the team and to model it like a startup. ... We called the team the Digital Lab. So, why so important? I mean what’s in a name? The importance is the perception that is conveyed. We wanted to convey a picture of a team experimenting and producing new and great products for the rest of team to use. (J. Thong, PowerPoint presentation, March 31, 2020)

One interviewee discussed the makeup of the acquisition team and thought it important to include subject-matter experts on the team, such as a data scientist, a business analyst, and an information-technology specialist. He believed that having technical people was key to managing the project and determining whether and where the process needs artificial intelligence (K. Nakasone, PowerPoint presentation, March 25, 2020). A related issue is that the skills required to use some of the artificial intelligence techniques are relatively new skills that the traditional information-technology staff in government does not have. The government has to make sure that they hire some people with those skills (Fedscoop, 2019d).

Several interviewees suggested starting with the problem and not necessarily the artificial intelligence:

You don’t want to start out with artificial intelligence or blockchain or robotic process automation. You want to start out with the business need.

What problem are you trying to solve? Is it aligning with the mission of the agency? You have to look at the mission. You have to start with what are you trying to solve before you just start looking at the technology. (O. Mek, interview with author, March 24, 2020)

One interviewee said to work with the users in their workplace and not develop solutions in a vacuum. Start by asking users what their pain points are, develop a solution quickly, and iterate. The work cannot be done separately from the users (O. Mek, interview with author, March 24, 2020).

A big lesson learned, noted by one interviewee, was to start small. It is important not to chase every single idea that the organization has. In fact, it may be better to only try and improve one idea. Additionally, the organization has to determine whether the process being improved is feasible, sustainable, and scalable. Important questions include: Will the budget allow for this in five years, and is it marketable? Again, if people cannot be convinced that this is a good idea and to buy in, then the organization should stop development (O. Mek, interview with author, March 24, 2020).

Multiple interviewees stated that the best way to start is simply to start. One interviewee made the following observation.

There is no time better than the present to just dive into AI and get a project started. Admiring a problem from afar won't do anything to accelerate the adoption and integration of AI to achieve mission impact at scale, and that's our mission statement. So you just have to get your sleeves rolled up, your hands dirty, and just dive into it. And you'll quickly find it's quite hard to get going, but that starting point is let's just figure out how to do this. (Fedscoop, 2019e)

Additionally, the solution does not need to be perfect. Rather, it needs to be in the hands of the warfighter or user as soon as possible. What is more important is the feedback loop. It has to be easy for the user to tell you what they need and how they think it could be better. The solution must have a continuous development and feedback loop to improve it. The interviewee identified this as “deployment, adoption, and refinement” (M. Arendt, interview with author, March 12, 2020).

Several interviewees noted that artificial intelligence takes time to set up and time to refine: “AI is neither a silver bullet nor an easy button ready to be pushed. So, in

looking at whatever problem a supported unit, or customer, wants us to help them with, the question is ... is AI the best solution. If it is, then we dive down deep in the details” (Fedscoop, 2019e). Table 1 summarizes the findings from this chapter.

Table 1. Summary of Secondary Questions and Findings

Questions	Findings
Why Companies Adopted Artificial Intelligence	<ul style="list-style-type: none"> • Improve employee work experience • Develop smarter strategic decision-making • Make better deals through insights and analysis • Uncover insights and inconsistencies in contracting • Eliminate inconsistencies in contracting • Better disseminate information • Speed procurement process • Retire old systems and upgrade technology • Automate low-level tasks
Benefits	<ul style="list-style-type: none"> • Streamline processes and automate routine work • Save staff time and eliminate tedious work • Create transparency between regions, customers, and product lines • Ensure compliance with contract terms and conditions • Improve negotiating position • Save money through better negotiation, process, insight, etc. • Improve procurement processes • Identify and predict contract problems and suggest improvements • Support professionals to allow their focus on important decisions • Allow for strategic focus
Speed and Agility	<ul style="list-style-type: none"> • Faster and improved decision-making • Employees able to focus on higher-level tasks • Greater speed and agility in multiple applications • Flexible and independent implementation
Risks and Challenges	<ul style="list-style-type: none"> • Change management • Data acquisition and quality • Premature rollout before data are ready • Government workforce culture and skills • Cybersecurity • Contracting pathway for artificial intelligence • Resistance of companies to contract with government • Tailoring third-party software • Developer bias in software • Lack of buy-in
Lessons Learned	<ul style="list-style-type: none"> • Choose best change agent and like-minded team to lead artificial intelligence implementation • Provide specific and relevant training to encourage artificial intelligence implementation • Include users throughout development • Properly sequence implementation--data first • Start with the mission and “pain points” first • Start small, nimble, and fast • Accept “good enough” in the beginning • Encourage a robust feedback loop • Start now

IV. ANALYSIS

In this chapter, I briefly discuss the results of the interviews, explore areas for potential applications of artificial intelligence in procurement for the DOD, and provide a potential pathway for implementation.

A. KEY INSIGHTS FROM THE INTERVIEWS

Each interviewee's definition of artificial intelligence varied and was poorly defined. Rather, each spoke more about a complex of ideas including databases, distributed processing, statistical analysis, and artificial intelligence. For the purposes of this discussion, the following definitions are referenced. Databases are "a formally structured collection of data" (Hargrave, 2001, p. 140). Distributed processing is "an approach that allows one application program to execute on multiple computers linked together by a network. The networked computers share the work between them" (Hargrave, 2001, p. 165). Statistical analysis is "the science of uncovering patterns and trends in data, using statistics" (Glen, 2020, para. 6). Each of these items by themselves are insufficient; rather, they are all essential and must work together to create intelligent behavior in digital systems. I refer to this as the "artificial-intelligence complex."

The benefits of artificial intelligence anticipated by interviewees were significant. They thought that it could save significant time and money, improve speed and agility, streamline processes, and automate tasks. It could provide new insights from a large amount of data, improving decision-making and policies. It could save time to allow procurement professionals to work on tasks not adequately addressed today—like contract management, which is often improperly performed due to time and capacity constraints. Similar tasks that could be improved are network management and proactively planning for emergencies; more time could permit identifying contingency contractors and putting advanced contracts in place. Lastly, these improvements could save significant money and improve the likelihood that programs meet schedule and performance expectations, allowing the DAS to address some long-standing challenges and criticisms.

Table 2 lists potential opportunities for artificial intelligence and related software concepts in procurement. It is organized by procurement phase or competency along with a corresponding procurement activity. It was developed by analyzing each interviewee's responses and learnings throughout the development of this thesis, then applying that analysis to procurement activities within the DAS. While the list is fairly long, improving just one of these activities could save the DOD substantial time and money. For instance, if artificial intelligence could analyze large amounts of data about a company's contracts, the DOD could negotiate better prices. And if cost analytics could organize and classify cost data to increase transparency and compatibility of spending across an organization, that could lead to significant savings.

Table 2. Potential Applications of the Artificial-Intelligence Complex to Procurement

PROCUREMENT LIFE CYCLE PHASE OR COMPETENCY	PROCUREMENT ACTIVITY	POTENTIAL APPLICATIONS
MANAGEMENT COMPETENCY	<ul style="list-style-type: none"> • Governance • Planning and Strategy • Cost Analytics • Requirement Compliance • Risk Management • Root Cause Analysis • Federal Acquisition Regulation and Regulatory Compliance 	<ul style="list-style-type: none"> • Provide data insight across the enterprise • Identify opportunities for new policy • Automate classification by cost categories • Streamline or eliminate reporting requirements • Examine contracts and identify risks • Identify redundancies to be eliminated • Generate applicable clauses automatically
PRE-AWARD LIFE CYCLE	<ul style="list-style-type: none"> • Acquisition Planning • Market Research • Contracting Strategy • Offer Validation and Evaluation • Communication • Risk and Fraud Analysis • Terms and Conditions Preparation • Solicitation Documents Preparation 	<ul style="list-style-type: none"> • Allow focus on strategic tasks • Analyze pricing of potential sources • Provide insight to develop strategy • Determine if a bid meets the minimum criteria • Allow time for network management • Determine contractor’s financial responsibility • Pre-populate applicable terms and conditions • Pre-populate forms with applicable language
AWARD LIFE CYCLE	<ul style="list-style-type: none"> • Cost or Pricing Analysis • Negotiation Preparation & Strategy • Negotiation Terms and Conditions • Negotiations • Proposal Evaluation • Evaluation Criteria Application • Invoice Automation • Spend Classification • Contract Analytics 	<ul style="list-style-type: none"> • Identify opportunities to negotiate better rates • Gather and analyze data, e.g. future sales • Provide insight into past performance • Solve complex negotiation problems • Evaluate bids and manage trade-offs • Perform more accurate analysis without bias • Automate payment if a certain condition is met • Automate classification by cost category • Improve insight and analysis
POST AWARD LIFE CYCLE	<ul style="list-style-type: none"> • Contract Administration • Contract Management • Terms & Conditions Compliance 	<ul style="list-style-type: none"> • Track and measure contractor performance • Alert management if a condition/price change • Alert management of fee and renewal dates

B. CONDITIONS FOR SUCCESSFUL IMPLEMENTATION OF THE ARTIFICIAL-INTELLIGENCE COMPLEX

Implementing artificial intelligence into procurement activities depends on access to quality data that are structured and labeled well. Additionally, successful implementation of artificial intelligence requires solving the change management problem. The technology to do this is not difficult; as discussed earlier, a growing number of organizations can support these tasks. However, artificial intelligence will not

provide sufficient utility if the database problem is not solved too; the more data, the better artificial intelligence works. The DOD possesses oceans of data, but it is fragmented on legacy systems, local computer drives, and file cabinets. The key is to collect the data, clean it, label it, and put it into distributed database systems for the future. Artificial intelligence solutions should not begin development until the data problem is solved. A data governance plan will ensure this is ongoing to bring in the right data in a timely way. The artificial-intelligence complex is only possible with good networking software and good analytic tools. There are plenty of the latter; however, the former are not always reliable because of the many complexities of network routing.

Even with the right technologies, another challenge will be getting people to adopt the new solution. “Human-centered design” or “design thinking” should be used to ensure that users participate in the development of the solution from the outset. This concept is similar to expert-systems development, which focuses on user requirements and utilizes constant interactions between the development team and the user. The user must help identify the tasks that need to be improved. Prototypes should be built quickly and taken back to the user for their feedback. Prototypes should be improved based on their input. This feedback loop is critical for development and adoption.

The issue of whether artificial intelligence will replace people often discourages adoption of artificial intelligence by the workforce. However, often artificial intelligence is a tool or a virtual coworker that can help employees complete their work more efficiently. This could certainly be true for procurement. At this time, full procurement process automation without human input is impossible. Communicating this to the workforce, early and often, will ease fears associated with emerging technologies.

Interviewees identified other risks and challenges to implementing the artificial-intelligence complex—like cybersecurity, developer biases, and data rights; other problems, like the Procurement Integrity Act, remain. These challenges can be solved because Health and Human Services has solved similar problems. HHS is like the DOD in many ways; they have many of the same rules and face the same challenges, and they have successfully awarded contracts using artificial intelligence. For instance, access to data is complicated by laws like the Health Insurance Portability and Accountability Act

(1996), which controls how private health information and personally identifiable information can be used. Also, HHS uses five different contract-writing systems—much like the DOD. However, they were able to obtain the data they needed without interrupting current work or violating the rules that are obligated to follow. One final problem worth noting is that organizations that are best at developing artificial intelligence do not want to work with the DOD. The DOD must lower the barriers to entry and properly incentivize industry with these technologies.

C. POTENTIAL PATHWAY

To implement new technologies like artificial intelligence in the DOD, the DAS should treat AI differently from other software. Traditional procurement pathways, including the software acquisition pathway released in the new Adaptive Acquisition Framework, cannot address the speed at which new technologies like artificial intelligence need to be implemented and refined since algorithms and software can be programmed and improved within weeks, if not days or hours. New technologies like artificial intelligence typically require a “spiral path” development involving constant refinement of the solution with a continuous feedback loop.

Figure 3 illustrates my ideas. It addresses two significant challenges facing the DOD: change management and data. The pathway for AI implementation is not a typical pathway. It is not linear. The champion identified should not simply be a program manager, and the team identified should not merely be an acquisition team.

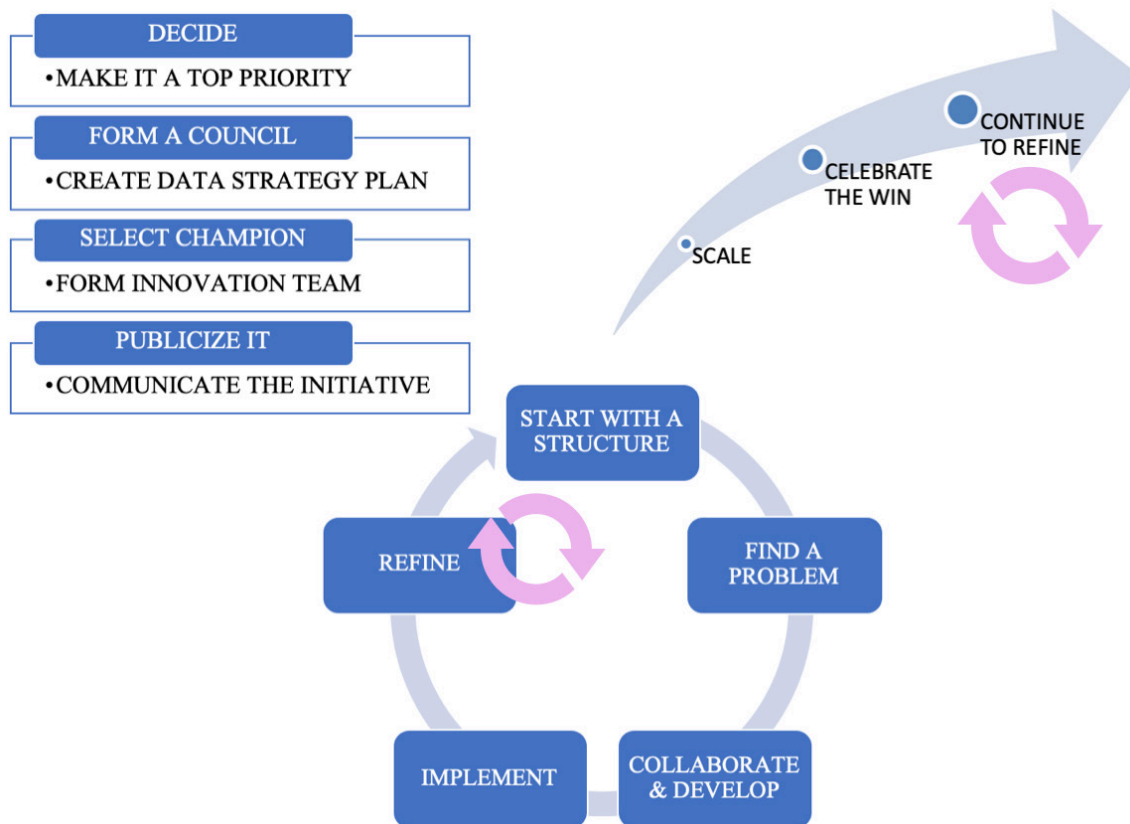


Figure 3. Potential Pathway for Implementing Artificial Intelligence within the DOD

First, leadership must make the artificial-intelligence complex a top priority. They must allocate the necessary resources now to avoid delays. Emerging technologies like artificial intelligence are becoming more commonplace and essential to organizations, and the government is falling behind. Moreover, starting small can work well; HHS began with a proof of concept that cost them \$175,000 and took them four weeks to build (Nyczepir, 2019).

Next, a senior leaders council should develop a data strategy. The strategy should standardize capturing and labeling data across the enterprise so it can be used by emerging technologies like artificial intelligence. The council should then designate a champion to lead the initiative. The champion must be innovation-minded and think differently. They must be empowered to make decisions and allocate resources. They should select a team of people who have the same mindset and have a strong desire to

simplify processes with technology. Members of the team should have varying backgrounds; most should be users, but some should have some technical ability to monitor the performance of contractors. They should prioritize speed and nimble decision-making over failure, which will allow them to better learn and adapt. This is a crucial element to the success of this pathway. Last, the team should communicate their initiatives to their organization to ease the fears associated with emerging technology and communicate that an innovative team is creating exciting and new quality products for the sponsoring organization to use.

The team should begin with a procurement framework that is commonly used by the sponsoring organization to make it easier and familiar when solutions are piloted, tested, and ultimately scaled. Next, they should identify problems that are time-consuming manual processes that procurement professionals struggle to complete. The team should work with the artificial-intelligence and software experts and bring companies in to show their platforms and products. If a platform or product looks promising, let the team create a proof of concept with test data. If it works, scale it with actual data and keep testing and refining it; if it doesn't work, try something else. The idea is to allow people to see immediate benefits and applications. Then celebrate the win. Publicize and communicate the new product the team has developed. Find another problem and repeat.

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V. CONCLUSIONS

This thesis discussed applying artificial intelligence to procurement within the DAS. My interviews suggested that artificial intelligence, properly implemented, could help the acquisition process in ways large and small. It could help people complete their work more quickly and accurately, improve market research, assist in negotiations, give insights, and aid contract management. It could change the DOD's business strategies and thinking.

My primary research question was how the DOD could adopt commercial-style artificial intelligence for procurement. The previous chapter outlined a pathway incorporating industry practices. It included elements that are different and missing from traditional acquisition. It addressed the two biggest DOD challenges when implementing emerging technologies: data integrity and change management. It emphasized the importance of a quick feedback loop during software development and continuous refinement.

I make the following recommendations for implementation of the artificial-intelligence complex in procurement:

- *Make it a priority.* Procurement is full of manual and repetitive tasks that can be helped by technologies like artificial intelligence. Further research is not needed; a team can learn as they work through each issue. Rather, organizational commitment and the will to innovate are more important.
- *Start with data.* Data are the fuel for artificial intelligence, but working out processes to get the data will take the most time. Do not start implementation until the data problem is solved, because otherwise cleaning and labeling the data will take much more time.
- *Treat it differently than traditional software.* Artificial intelligence requires procedures that the DAS has yet to develop. The artificial intelligence implementation pathway must be fast and agile, it must be spiral and not linear, and the user must be at the center of development and improvement.

- *Start small.* First identify small problems and develop small solutions at the organizational level. If successful, scale it.
- *Monitor similar projects at other government agencies.* Study and follow the progress of Health and Human Services. Closely monitor the Accelerate platform, since it is a potential model the DOD could follow. Also, use the General Services Administration as a consultant.

There is no better time to begin implementing the artificial-intelligence complex into the DAS. Agencies have been directed to begin adoption, and industry investment and support for procurement is growing. Organizations that do not adopt these methods soon will face increased competition for resources and talent, and intelligence will not achieve the speed necessary to maintain their competitive advantage and relevance. This means that the DAS must modernize if it is to achieve its top priority of “enabl [ing] innovative acquisition approaches that deliver warfighting capability at the speed of relevance” (OUSD[A&S], n.d.).

Former Secretary of Defense Jim Mattis captured the essence of why action today is essential:

We will modernize key capabilities, recognizing we cannot expect success fighting tomorrow’s conflicts with yesterday’s weapons or equipment. ... To keep pace with our times, the department will transition to a culture of performance and affordability that operates at the speed of relevance. Success does not go to the country that develops a new technology first, but rather, to the one that better integrates it and more swiftly adapts its way of fighting. Our current bureaucratic processes are insufficiently responsive to the department’s needs for new equipment. We will prioritize speed of delivery, continuous adaptation and frequent modular upgrades. We must shed outdated management and acquisition practices, while adopting American industry’s best practices. Our management structure and process are not engraved in stone. They are a means to an end, empowering our warfighters with the knowledge, equipment and support needed to fight and win. Failure to modernize our military risks leaving us with a force that could dominate the last war, but be irrelevant to tomorrow’s security. (Mattis, 2018)

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