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The DoD's Application of Data Analytics in Financial Management: How to Achieve Competitive Advantage through Data Integration

June 2024

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ABSTRACT

This study examines the current use of data analytics within the Department of Defense (DOD) financial management by identifying enhancement opportunities through analyzing the DOD policies and strategic documents that govern data analytics and evaluating Advana, the principal platform for advanced analytics. The research reveals that the DOD has made significant strides in leveraging data analytics for financial management, resulting in optimized resource allocation and prevention of wastage through expiration or cancellation. However, there is still ample room for improvement to enhance the effectiveness of data analytics to meet the DOD's objectives. While strategic documents outline objectives, they lack clear guidance on implementation mechanisms and oversight frameworks. The enhancement of financial reporting compilation through Advana stands as a notable opportunity; however, the pace of integrating authoritative data systems into the platform remains slow. Moreover, there is a need for additional highly skilled employees proficient in using Advana for financial management purposes. Based on these findings, the thesis provides recommendations for optimizing Advana implementation and utilization, enhancing data integrity and monitoring, and improving workforce development and talent management.

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LIST OF ACRONYMS AND ABBREVIATIONS

AI	Artificial Intelligence
AWG	Analysis Working Group
Amazon EKS	Amazon Elastic Kubernetes Service
API	Application Programming Interface
AWS	Amazon Web Services
BEV	Budget Execution Validation
CDAO	Chief Digital and Artificial Intelligence Office
CDO	Chief Data Officer
DAU	Defense Acquisition University
DACoE	Data Analytics Center of Excellence
DAR-Q	Dormant Account Review Quarterly
DFAS	Defense Finance and Accounting Service
DJMS-AC	Defense Joint Military Pay System – Active Component
DOD	Department of Defense
DU	Digital University
ERP	Enterprise Resource Planning
eUCFR	Enhanced Unit Commander's Financial Report
ETL	Extract Transform Load
FBWT	Fund Balance with Treasury
FFMIA	Federal Financial Management Improvement Act
FM	Financial Management
FISCAM	Federal Information System Controls Audit Manual
GA	General Availability
GAO	Government Accountability Office
GFEBS	General Fund Enterprise Business System
GPU	Graphics Processing Unit
GT&C	General Terms and Conditions
G-Invoicing	Government Invoicing
HUnT	Humanless Unmatched Transactions
IGT	Intragovernmental Transaction

IT	Information Technology
JAIC	Joint Artificial Intelligence Center
ML	Machine Learning
MIT	Massachusetts Institute of Technology
NIPRNet	Non-classified Internet Protocol Router Network
OMB	Office of Management and Budget
OUSD(C)	Office of the Under Secretary of Defense (Comptroller)
PCS	Permanent Change of Status
P2P	Procure-to-Pay
PPBE	Planning Programming Budgeting Execution
RPA	Robotic Process Automation
SFIS	Standard Financial Information Structure
SIPRNet	Secret Internet Protocol Router Network
SLOA	Standard Line of Accounting
SQL	Structured Query Language
U.S.	United States
UMT	Unmatched Transaction
USMC	United States Marine Corps
USN	United States Navy

I.   INTRODUCTION

A.   PROBLEM STATEMENT

In the modern complex and dynamic security environment, the Department of Defense faces numerous challenges and opportunities in ensuring national security and fulfilling its mission (Department of Defense [DOD], 2022b). To navigate these complexities and effectively address both challenges and opportunities, the Department of Defense should leverage data analytics as a critical tool for making informed decisions, optimizing resource allocation, and staying ahead of emerging threats. According to Chaudhary et al. (2021), organizations that harness the power of data can gain competitive advantage, better drive strategic decision-making, and achieve operational excellence. Therefore, the Department of Defense should prioritize integrating data analytics into its operations to effectively navigate the complex security environment and enhance overall efficiency.

This thesis focuses on the challenges related to data analytics within financial management, aiming to analyze the gaps encountered in applying data analytics to financial management and propose recommendations to enhance performance outcomes. For example, in fiscal year 2021, the Department of Defense Office of Inspector General underscored issues concerning the reconciliation of the DOD transactions in the data analytics platform, Advana, with Treasury transactions and financial statements (Department of Defense Office of Inspector General, 2022). The DOD manages nearly 300 feeder systems, many of which lack standardized data capture methods or integration with other systems. Despite the potential benefits of data analytics, challenges persist due to inadequate implementation. According to the Department of Defense Office of Inspector General (2022) report, data-sharing issues have revealed shortcomings in data completeness, accuracy, and interoperability. This thesis explores the reasons behind these challenges despite the existence of strategies governing the utilization of data analytics within the DOD's financial management sphere.

The significance of this study lies in revealing the potential of data analytics in financial management to transform how the Department of Defense manages its resources and to ensure accountability. By leveraging data analytics, financial reporting, compilation, and intergovernmental transactions can be significantly improved, leading to greater transparency and accountability. Data analytics can enhance audit processes, ensuring compliance with financial management standards, and assist in financial statement audits. Additionally, data analytics can optimize the budgeting process, resulting in cost efficiency improvements and robust risk assessments. Automation of processes through advanced analytics platforms can reduce labor expenses, allowing more focus on decision-making. By improving the usage of data analytics in financial management, the Department of Defense can maximize the value of its data to enhance its financial management and overall efficiency.

B.   RESEARCH QUESTIONS

This thesis explores the following research questions:

1. How are data analytics used in the DOD's financial management?

2. How can the DOD better leverage data analytics in its financial management?

3. How can the DOD's data analytics for financial management be improved?

C.   RESEARCH DESIGN

This study investigates the potential for improving data analytics practices for financial management in the Department of Defense and proposes actions to improve the Department of Defense's data analytics capabilities. The scope of this study covers the data analytics within the Department of Defense, including current status, challenges, and possible solutions, with primary emphasis on the application of data analytics related to financial management within the DOD. Additionally, focus is placed on the data analytics platform Advana, which is used for this purpose.

The research in this thesis is designed to provide a thorough understanding of the effectiveness of data analytics in enhancing financial management within the DOD,

identify areas for improvement, and offer actionable recommendations for optimizing data-driven decision-making processes.

Furthermore, this thesis employed document and system analysis as its core approaches. For this research, in terms of document analysis, I reviewed a combination of primary and secondary sources, including policies, strategic documents, previous publicly available interviews with DOD officials, academic articles, Government Accountability Office (GAO) reports, and research papers. These sources were instrumental in investigating research topics such as data analytics, financial management, and Advana, which formed the focus of the study. The topic of financial management included such variables as reconciliations, financial reporting compilation, intragovernmental transactions, audit, and financial management standards. The data analytics topic encompassed variables such as data acquisition, data governance, data quality, data access, data utilization, and data literacy. The Advana topic embraced variables such as Databricks, DataRobots, Tableau, Qlik, Spark, the Medallion system, and datasets.

In the system analysis chapter dedicated to Advana, the focus is on examining the technical components and tools of the platform, providing insights into its development and implementation within the DOD to show how the platform can facilitate data analytics in the DOD.

I employed a qualitative approach to bridge the existing gap in empirical research and delve into the research questions. Furthermore, I chose the exploratory nature of the research method due to the novelty of the topic and the limited availability of scientific literature.

D.   STRUCTURE

This thesis consists of seven chapters. The first chapter is the introduction, which provides a general background, describes my motivation, states the research questions, provides a short synopsis of methodology, and presents the organization of the thesis.

The second chapter explores the critical role of data generally and financial data strategy in modern organizational frameworks. It emphasizes the significance of

leveraging data-driven decision-making practices to enhance operational effectiveness and achieve finance transformation objectives. Additionally, it highlights the importance of innovative practices in federal financial management.

The third chapter examines the policies and strategic documents of the U.S. government and the Department of Defense related to data analytics in financial management. It highlights the alignment of these documents with key principles of data strategy and financial data management, emphasizing the significance of data governance, accessibility, quality, and analytics in supporting organizational objectives. However, it also identifies areas for improvement, such as the need for clearer guidance on implementation mechanisms and protocols for monitoring and evaluating initiatives to enhance their effectiveness.

The fourth chapter assesses Advana's pivotal role in driving digital transformation within the DOD through democratizing analytics, enhancing financial management accuracy, and improving compliance and risk management. It emphasizes Advana's robust technological infrastructure, which integrates business systems to provide real-time data access and analytics capabilities, particularly in financial management. Additionally, the chapter highlights Advana's training initiatives, showcasing the DOD's efforts to equip its workforce with the necessary skills to leverage technologies effectively.

The fifth chapter thoroughly examines the impact of Advana on various aspects of financial management within the DOD. It highlights Advana's role in improving financial accountability, bolstering audit readiness, optimizing the Program, Planning, Budgeting, and Execution (PPBE) process, and integrating with Robotic Process Automation (RPA) initiatives. While Advana demonstrates transformative potential in enhancing financial management practices, challenges such as data-sharing with Congress and swift analysis necessitate ongoing improvement efforts to maximize its effectiveness.

The sixth chapter analyzes the challenges and opportunities surrounding data management and the adoption of data-driven approaches within the DOD. It examines persistent issues such as outdated systems, access controls, and governance policies

hindering data accessibility and utilization. Additionally, it explores the potential solutions offered by federated data governance approaches and emphasizes the importance of cultivating a culture conducive to digital tools adoption and skill development to enhance data-driven decision-making within the DOD.

The seventh chapter contains findings that reveal the alignment of DOD policies with modern practices but highlight gaps in implementation plans and oversight mechanisms. Practical application shows significant usefulness of Advana, but challenges with data quality and cultural barriers persist. Due to outdated systems and access controls, efforts to democratize data face hurdles. Cultivating a culture of transparency and investing in talent can enhance the DOD's data-driven capabilities for strategic advantage. The seventh chapter also provides recommendations and suggests areas of future research that could be pursued, given the vast potential of data analytics application in financial management. As technologies and software continue to develop, more opportunities in this sphere will arise.

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II. THE ROLE OF DATA IN SHAPING FINANCIAL DECISION-MAKING: EVOLVING LANDSCAPE OF FINANCIAL DATA MANAGEMENT

This chapter thoroughly explores the significance of data, data strategy, and financial data strategy in today's financial and business landscape by delving into the fundamental components essential for a successful data strategy, including acquisition, governance, quality, access, literacy, extraction, reporting, and analytics. It further elaborates on the significance of financial data strategies in optimizing organizational performance and decision-making processes. Data-driven decision-making is essential for addressing and controlling potential threats and uncertainties, optimizing outcomes, and strengthening operational effectiveness within organizations. The analysis of research studies reveals a clear correlation between the adoption of practices that rely on data analytics and increased productivity, underscoring the strategic advantages associated with leveraging data-driven approaches.

In the financial sector, a well-defined financial data strategy is essential for effectively navigating the challenges and opportunities presented by digital transformation, enabling organizations to leverage data to achieve financial transformation objectives. Additionally, the chapter highlights the indispensable role of data in federal financial management, emphasizing the importance of innovative practices and the emergence of Chief Data Officers (CDO) to overhaul data utilization within government agencies, particularly the DOD.

Overall, these findings underscore the vital interconnectedness between data strategy and financial strategies within modern organizational frameworks, emphasizing the indispensable role of data in driving business success and maintaining competitive advantage.

A. THE POWER OF DATA IN DRIVING ORGANIZATIONAL GROWTH AND EFFICIENCY

Numerous enterprises have embraced data analytics[1] as a critical element for success in today's marketplace. Key players in the market use data-driven strategies to mitigate risks, optimize outcomes, improve operational effectiveness, and advance continuous process enhancements. According to Pykes (2022), market leaders like Amazon, Google, and Netflix have successfully utilized data to inform their business plans and operations. As the cornerstone of well-informed decision-making, data furnishes executives with instantaneous insights, empowering them to confidently steer their companies' directions, thereby minimizing risks and maximizing results through reliance on empirical evidence rather than suggestions or assumptions (Pykes, 2022). Also, Pykes (2022) argues that decisions, grounded in actual statistics, are substantiated by data, which emerges as a powerful problem-solving tool, enabling firms to navigate both future projections and historical experiences via retrospective analysis. This proactive approach, coupled with system and process monitoring, enhances operational efficiency and resilience, allowing businesses to preempt potential interruptions. Pykes (2022) suggests that data facilitates a deeper understanding of operations and performance metrics, simplifying resource allocation and strategic planning, while also driving process improvement efforts to maximize resource efficiency and streamline operations. Through data analytics and business process analytics, leaders gain insights to uncover bottlenecks, inefficiencies, and areas ripe for improvement within their workflows, fostering a comprehensive understanding of organizational processes and user behavior. Pham (2022) also underscores the significance of data analytics and highlights its crucial role in contemporary business landscapes. Specifically, the integration of data analytics, leveraging Big Data and machine learning technologies, has revolutionized decision-making processes, marking a significant advancement in business analytics methodologies (Pham, 2022). He states that by uncovering hidden patterns within vast data sets, organizations can make more effective decisions, leading to optimized business

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[1] "Data analytics converts raw data into actionable insights. It includes a range of tools, technologies, and processes used to find trends and solve problems by using data" (Amazon Web Services [AWS], 2024b, para. 1).

development processes and accelerated growth. According to Pham (2022), this shift from traditional decision-making methods to agile analytics-based approaches enables faster progress toward business objectives.

The advantages of making decisions based on data have been demonstrated through studies carried out by economist Erik Brynjolfsson, along with his colleagues from the Massachusetts Institute of Technology and the Wharton School at the University of Pennsylvania, who explore the ways in which such decisions impact business success (Brynjolfsson et al., 2011). They establish a metric to gauge the extent to which organizations rely on data for decision-making throughout their operations. Even after taking into consideration a number of potential factors, their findings show that companies that prioritize data-driven initiatives typically have higher productivity levels. The differences are substantial; for example, the findings indicate that an increase of one standard deviation on the data-driven decision-making scale corresponds to a four to six percent increase in productivity. Another research conducted by Brynjolfsson and McElheran (2019) states that the adoption of data-driven decision-making practices in American firms management has notable impacts. In partnership with the federal Census Bureau, researchers have created metrics to evaluate the extent to which production companies integrate data into their processes of making decisions. Their findings indicate a strong correlation between data-driven decision-making practices and increased operational efficiency, bringing attention to the distinct benefits of data-driven decision-making practices compared to other management practices or information technology (IT) investments. Moreover, evidence from instrumental variables and timing falsification tests suggests a causal relationship (Brynjolfsson & McElheran, 2019). Importantly, early adopters of data-driven decision-making practices appear to gain significant strategic advantages. These results underscore the importance of embracing data-driven methodologies to inform and guide decision-making processes as a cornerstone of modern management strategies, offering potential for enhanced productivity and competitive advantage (Brynjolfsson & McElheran, 2019).

Economist Prasanna Tambe (2014) studied how much big data technologies help businesses. This study examined how labor market dynamics influence early returns on

investment in big data technologies, specifically focusing on the utilization of Hadoop—one of the key infrastructure technologies for big data—as well as technical skills such as Map/Reduce and Apache Pig. He discovered that there is a strong correlation between the leveraging of big data technology and improved productivity even after correcting for a number of possible confounding factors. To be more precise, compared to the average firm, a one standard deviation rise in the use of deep data technology is linked to a one to three percent improvement in productivity. On the other hand, a reduction in big data use of one standard deviation is linked to a one to three percent decline in productivity. So, Tambe (2014) shows a link: adopting big data tech boosts productivity, and decreases have the opposite effect.

The book chapter "From Business Intelligence to Big Data: The Power of Analytics" suggests that traditional business intelligence has limitations in handling the vast volume and variety of data generated by modern technologies (Alnoukari, 2022). In this context, it highlights the influence of cloud computing, Internet of Things, machine learning, and artificial intelligence on enterprises' analytics initiatives. It outlines the technological advancements and shifts in computing paradigms that have enabled the management and analysis of immense quantities of data, particularly highlighting the transition to cloud-based environments and the necessity for real-time processing. Furthermore, it underscores the transformative power of analytics as a key organizational capability, shaping decision-making processes and driving competitive advantage in the digital era. That is why it is essential for organizations to have a data strategy amidst the vast volume and variety of data generated by modern technologies.

The abundance of data available nowadays can result in the presence of irrelevant or low-quality data in data analysis processes, which can impede accuracy, validity, and reliability, leading to increased resource consumption and potential misinterpretation of insights and ultimately obstructing effective decision-making and analysis outcomes. Pykes (2022) states that organizations should not only gather data, but they also need to separate the important from the irrelevant—a process that has become harder with the profusion of available information. According to White (2023), relying on low-quality data for decision-making purposes can lead to significant and expensive errors, which

may far exceed the initial investment required to acquire and maintain high-quality data. Processing and cleansing raw data are essential for removing fraudulent or duplicate signals and ensuring data integrity, though doing so adds to the overall cost. White (2023) states that to ensure data integrity, organizations should define their use case, use reliable data sources, cleanse and validate data, and regularly monitor data quality. Ultimately, relevant and high-quality data is essential for making accurate decisions, driving improved outcomes, and maintaining the organization's competitiveness.

B. EFFECTIVE DATA STRATEGY: KEY ELEMENTS AND CONSIDERATIONS

In recent decades, the management of information technology has undergone a significant transformation, recognizing the importance of managing data alongside systems and software applications (Fleckenstein & Fellows, 2018). To ensure seamless integration and effective interconnection across various spheres of IT, organizations require a comprehensive data strategy that guides their work with data management and utilization.

A data strategy is defined as a comprehensive plan detailing the people, procedures, technology, and guidelines necessary for efficiently managing a business's data assets (Amazon Web Services [AWS], 2024c). It encompasses activities such as gathering, storing, sharing, and applying data to support the advancement of groundbreaking technologies such as machine learning and artificial intelligence, as well as facilitating informed decision-making processes. According to AWS (2024c), organizations should implement a data strategy to remain innovative and competitive in a rapidly changing market. Key benefits include improved decision-making, operational efficiency, cost optimization, support for new business models, and the development of future-proof applications. Additionally, AWS (2024c) claims that a data strategy assists in resolving issues with data administration, achieving analytical maturity, fostering an organization-wide data-driven culture, and ensuring regulatory compliance.

There are seven key elements of a data strategy: data acquisition, data governance, data quality, data access, data literacy and usage, data extraction and

reporting, and data analytics (Hosch, 2019). Figure 1 illustrates these key elements along with concise descriptions outlining their role.

Data Acquisition	Data Governance
How the institution obtains its data Build an inventory of data assets. For each one, establish a written plan for: Identification Prioritization Capture Storage Linkage Curation	How people make decisions and behave with respect to how data will be defined, produced, used, stored, and destroyed Establish: Decision-making body and rules Data dictionaries Data stewards

Data Quality	Data Access
How data will be maintained to be complete, valid, consistent, timely, and accurate to make them appropriate for a specific use	How authorized individuals can obtain and use data while maintaining privacy and security Establish written plans for: Accessibility Security

Data Usage & Literacy	Data Extraction & Reporting	Data Analytics
How data users understand and use data Establish: Data user responsibilities Training/education protocols Usage metrics	How data will be queried and retrieved from storage and delivered to users Establish protocols for: Extraction Reporting	How data will be used through dynamic and visual deployment for benchmarking, exploratory and causal analysis, and prediction and forecasting

Figure 1.   The Key Elements of a Data Strategy. Source: Hosch (2019).

Despite their importance, the development and application of these components may differ depending on the maturity and organizational setting. Hosch (2019) suggests that not every piece in an organization's data strategy needs to be equally developed. Nevertheless, to guarantee the availability of high-quality data to support the organization's goals, each component must be taken into account and modified (Hosch, 2019). These components might vary in terms of maturity and sophistication among different data warehouses or systems, and Hosch (2019) states that prioritizing according

to scope is often necessary due to practical reasons; however, a well-developed data strategy requires that the organization's plan includes all data.

According to Hosch (2019), a data acquisition element involves six key activities: identifying and cataloging data sources, prioritizing based on institutional objectives, determining data capture methods, addressing storage considerations, integrating data across systems, and implementing data curation practices. These activities ensure the availability of high-quality data to support organizational goals and informed decision-making.

The Data Management Body of Knowledge defines data governance as "the exercise of authority and control (planning, monitoring, and enforcement) over the management of data assets" (DAMA International, 2017, p. 67). Data governance underscores the importance of people and business processes in managing data, with core elements including connection to organizational goals, decision-making rights, and defined roles (Hosch, 2019). Data stewards oversee data assets and enforce governance decisions, supported by clear job descriptions and performance expectations. In his research, Hosch (2019) indicates that maintaining data dictionaries ensures a shared understanding of data meaning, with options like master data management protocols or data asset managers to streamline operations. Well-defined data governance maximizes the value of data assets and supports strategic objectives.

Effective data management depends on data quality, as errors and inefficiencies can impede analysis and decision-making (Hosch, 2019). Poor data quality, in his opinion, necessitates laborious manual cleaning and hampers analytical work, underscoring the need for strict data quality control procedures. Mishandling data can lead to inaccurate information and flawed conclusions, negatively impacting organizational effectiveness.

Hosch's (2019) research indicates that organizations must prioritize robust data quality management to ensure accurate decision-making in today's data-driven environment. Mature systems feature automatic quality assurance and proactive error reporting, with improvement strategies including cost evaluation, error identification,

control implementation, and progress monitoring. Also, the research shows that assigning data stewards and leveraging automation are crucial for quality control. Strategic planning, proactive measures, and ongoing evaluation are essential for maintaining data integrity and reliability.

As Olson (2003) describes, the accuracy of data can be enhanced through the utilization of data profiling techniques. The increasing significance of data underscores the importance of ensuring its accuracy, as it directly impacts organizations' financial performance. Olson (2003) introduces data profiling as a technology that plays a crucial role in improving database accuracy within large IT environments. His research provides insights into the concept of data profiling and its integration into broader data quality initiatives, shedding light on its relevance in contemporary information systems management.

According to Hosch (2019), an effective data strategy ensures both accessibility and security of data assets by providing authorized access while implementing robust security measures. This involves tailoring protocols to each data asset and complying with relevant federal laws. The study suggests that prioritizing data literacy, establishing competencies, providing professional development, formalizing the data extraction and reporting process, and establishing user roles are crucial.

Prioritizing integration and strategic planning for every data asset within an organization is essential for a robust data strategy (Hosch, 2019). This strategy should encompass aspects such as data quality, accessibility, governance, and the maturity of data-gathering processes to ensure comprehensive management of data resources.

Formulating an effective data strategy for the organization necessitates delineating the different types of data analytics, including prescriptive, predictive, descriptive, and diagnostic, each utilizing unique algorithms and techniques for analysis. Erl et al. (2016) explain that descriptive analytics offers insights into past events, while diagnostic analytics delves deep to ascertain the reasons behind occurrences. Prescriptive analytics aids in determining optimal decision options based on available data, and predictive analytics utilizes past data patterns and trends to forecast future events.

According to Rustagi and Goel (2022), predictive analytics offers organizations a glimpse into the future with greater reliability and accuracy compared to traditional tools. This iterative modeling process applies various techniques to datasets based on specific requirements. By leveraging predictive analytics, organizations can assess risks, identify opportunities, discern trends, and formulate strategies proactively. Accurate predictions, drawn from both structured and unstructured data, enable informed decision-making and strategic planning to drive business success. Erl et al. (2016) state that data analysis involves two primary processing methods: batch processing, which occurs post data collection, and stream processing, facilitating real-time analysis of continuous data streams. These methods, integral to the data strategy, serve to optimize organizational strategies and outcomes.

C. FINANCE IN THE ERA OF DIGITAL TRANSFORMATION: THE ROLE OF FINANCIAL DATA STRATEGY

The financial sector has historically been at the forefront of data processing, leveraging computing devices and digital applications to enhance operations (Boyanov, 2021). In recent decades, the relationship between finance and IT has become increasingly intertwined, and global digitalization has opened up unprecedented opportunities to collect, store, and process financial information in real-time from anywhere in the world. Boyanov (2021) explains that the transition from managing some digital data to handling Big Data has occurred, characterized by massive volumes of data arriving in diverse forms and at high speeds.

According to Khandare (2019), in today's dynamic business landscape, organizations that demonstrate agility and responsiveness gain a competitive edge, particularly as the finance sector undergoes significant transformation. Amidst a challenging environment with limited growth opportunities, finance functions are tasked with providing strategic advantages to their organizations. Khandare (2019) emphasizes that the ongoing shift to the digital age has fundamentally altered work dynamics, necessitating adaptation and transformation from finance professionals to remain relevant and effective.

With the world becoming more interconnected and business environments evolving rapidly, finance departments must enhance their responsiveness to meet challenges posed by the digital revolution, changing customer expectations, and global market volatility (Khandare, 2019). He discusses that while traditional financial skills such as planning, budgeting, and forecasting remain essential, there is a growing need for finance professionals to acquire new skills to adapt to the evolving landscape. Also, organizations now prioritize connectivity and collaboration across business units, leveraging data analytics and strategic projections to inform decision-making processes, necessitating the active involvement of finance personnel in these tasks.

The Association of International Certified Professional Accountants conducted a comprehensive global analysis to assess the evolving nature of the finance function and its impact on organizations worldwide (Farrar & Simons, 2017). Through interviews, roundtables, and surveys, the project addressed key questions surrounding the future of finance, including the drivers of change, implications for finance departments, and strategies for adaptation. Based on over 300 interviews, the Association identified four primary themes: the shifting role and mandate of finance, the influence of technology on finance operations, the evolving structure of finance departments, and the changing skill sets and attitudes required in finance professionals.

In a blog post published by Apptio (2017), strategies were outlined for finance teams to enhance agility. One of the strategies focuses on minimizing complexity by streamlining decision-making processes and leveraging automation tools. Another strategy emphasizes the establishment of stringent standards for data management, ensuring that all approved data is housed within a single system. This approach streamlines decision-making processes by eliminating debates over conflicting data sets, directs discussions toward insights that support evolving business requirements, facilitates quicker budget decisions, and encourages collaboration between corporate finance and IT teams. The blog post states that by centralizing data management in this way, organizations can enhance efficiency, alignment, and agility in their decision-making processes. Also, as Apptio (2017) states, these methodologies strive to empower finance teams to navigate dynamic business landscapes, facilitating agile decision-

making and optimal resource allocation to propel organizational growth. Consequently, they must seamlessly align with the organization's overarching data strategy, given the pivotal role of data in financial operations. This interconnectedness underscores the integration of data strategy and financial strategies within contemporary organizational frameworks.

A well-defined financial data strategy is essential for navigating the challenges and opportunities presented by the global digital transformation. The financial data strategy outlines what the organization should do to "leverage data to achieve the desired outcomes of finance transformation while accommodating the unique challenges and constraints of existing business environment" (Rewal et al., 2021, p. 3). A financial data strategy also provides a framework for making design decisions and outlines plans for handling important aspects of the process, involving relevant stakeholders, and establishing standards. However, Rewal et al. (2021) indicate that "finance data strategy should not be considered set in stone after completing initial development sessions" (p. 3) as ongoing education and design workshops will reveal new requirements and insights, requiring continuous refinement. Throughout the transformation, a purposeful financial data strategy acts as a guiding light, ensuring alignment, facilitating team acclimation, and resolving challenges. Additionally, Rewal et al. (2021) suggest that the enterprise information model plays a crucial role in shaping reporting and business processes, transforming a "generic ERP package into a specific structure to fit the needs of the organization" (p. 4), enabling flexible reporting and unified transaction processing. Also, Rewal et al. (2021) state that developing a flexible finance data model involves "conducting multiple design cycles to align with business process requirements, rationalize master data values, visualize design decisions, and assess impact on internal and external reporting" (p. 4) ultimately refining the model to better reflect business realities.

Financial data analytics is one of the elements of a financial data strategy that provides various benefits for the organization. For example, it may be used to improve the performance of the entire organization in a number of ways, including creating dynamic profit and loss statements, assisting in determining the strategic direction for

achieving the company's goals and objectives, accelerating month-end close, and simplifying budgeting and forecasting (Walter, 2021). To handle the expanding responsibilities of the chief financial officer (CFO) and finance team, contemporary business planning and analytical solutions are emerging. Walter (2021) identifies that the CFO and finance team may access a complete set of financial and operational data through all-in-one platforms, and they can rely on big data processing to provide updates and scenario planning to help numerous organization stakeholders. Walter (2021) further reveals that it is becoming increasingly important for a business to have a single source of data truth when creating reports more frequently and for more locations, and within this context, all-in-one platforms allow all stakeholders to create reports from one location, ensuring that decisions are made consistently and accurately.

D.   FEDERAL DATA MANAGEMENT

The Federal Data Strategy outlines a comprehensive 10-year vision aimed at accelerating the use of data within the federal government to provide services to the public community, advance missions, and manage assets effectively concurrently with ensuring security, maintenance of privacy, and assurance of confidentiality (Office of Management and Budget, 2019). This strategy encompasses a mission statement, ten operating principles, and 40 practices to direct federal organizations in maximizing the worth of data assets. It emphasizes the importance of data governance, access, security, and promoting efficient and appropriate data use both within and across agencies, ultimately aiming to drive innovation, economic growth, and informed decision-making.

Financial management in the federal government relies heavily on effective data practices to ensure proper spending and financial health (Management Concepts, 2022). While some aspects of federal financial management resemble those of businesses, others, such as appropriations, are unique to the government. The study notes that to navigate these complexities, financial managers must embrace innovative data practices. CDOs have become increasingly vital since the passage of the Evidence-Based Policymaking Act of 2018 (Evidence-Based Policymaking Act, 2018, sec. 202). They are responsible for modernizing data usage within their agencies. As CDOs work toward a

more data-driven government, financial managers should familiarize themselves with emerging data best practices and guidelines to support their efforts in reforming financial data management (Management Concepts, 2022).

However, when analyzing federal data management, it is important to highlight that federal organizations may encounter challenges in managing data. For example, to maximize the utility of data, the organization should not merely accumulate vast quantities of data without structure, storing it in a haphazard manner for potential future use (Fleckenstein & Fellows, 2018). What lies beneath the surface of data analytics encompasses both the meticulous preparation necessary to derive valuable insights from data and the responsible management of the data that facilitated the generation of the insights. Fleckenstein and Fellows (2018) observe that within the scope of a U.S. federal agency, data is often not given the same level of consideration. While data storage costs may be perceived as low, the reality is that storing large volumes of data can incur significant expenses. Furthermore, Fleckenstein and Fellows (2018) emphasize that organizing and interpreting data without adequate context can be time-consuming and challenging, despite the critical importance of quality data to support operational requirements. They further explain that federal agency personnel regularly make decisions based on data, such as targeting services, adhering to specific regulations and guidelines, and managing resources based on budgetary constraints. Therefore, just as with any strategic asset, federal agencies must assign personnel to manage data effectively, ensuring that data is handled thoughtfully and strategically to support the agency's mission and objectives.

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III.   REVIEW OF POLICIES AND DOD STRATEGIC DOCUMENTS

The DOD has developed strategic guidance governing data usage and the integration of data analytics into financial management. This chapter analyses the U.S. government's and DOD's policies and strategic documents in this domain, demonstrating a robust foundation for applying data analytics in financial management. These policies and strategic documents provide a framework for achieving the DOD's data-driven financial management environment and set goals for the DOD-wide financial management community. Overall, the U.S. government's and DOD's policies and strategic documents demonstrate a strong alignment with key principles of data strategy and financial data management. They emphasize the importance of data governance, accessibility, quality, and analytics in supporting organizational objectives, including financial management goals. While the documents outline strategic objectives and goals, clearer guidance on implementation mechanisms, and specific protocols for monitoring and evaluating initiatives could enhance their effectiveness.

A.   MANAGING DATA AS A STRATEGIC RESOURCE

In the 2016 update of Circular A-130, the U.S. government mandated more uniform and consistent information resources management policies to optimize the quality and security of federal information systems and enhance agency programs across federal agencies including the DOD. Circular A-130, issued by the Office of Management and Budget (OMB), is a policy document that guided management of federal information resources and asserted that federal information serves as both a strategic asset and a valuable national resource, allowing the government to effectively execute missions (U.S. Chief Information Officers Council, 2016). Circular A-130 has been revised several times, and the most recent revision of Circular A-130, "Managing Federal Information as a Strategic Resource," was issued in 2016 (U.S. Chief Information Officers Council, 2016). This revision modernized and updated the guidance to reflect changes in technology, legislation, and best practices since the previous revision in 2000. In particular, the revision aimed to align Circular A-130 with "executive orders,

presidential directives, recent OMB policy, and National Institute of Standards and Technology standards and guidelines" (U.S. Chief Information Officers Council, 2016, para. 1). The Circular laid out guidelines for "information governance, acquisitions, records management, open data, workforce, security, and privacy" (U.S. Chief Information Officers Council, 2016, para. 2).

According to Circular A-130 (OMB, 2016), with IT integrated deeply into all agency missions and business processes, and the emergence of the digital economy, there has been a shift in how information is shared and technology is utilized by federal agencies and non-federal parties. The government must adapt to the digital revolution by cultivating a skilled workforce and delivering secure, high-quality digital services. Given IT's central role in government operations, agencies must continually explore new technologies to enhance service delivery in a cost-effective manner. Delivering top-tier digital services requires the government to transform its approach to IT procurement, development, and delivery. The Circular A-130 (OMB, 2016) drives this transformation by institutionalizing agile approaches that enable the swift adoption of evolving technologies while prioritizing information security, privacy, and effective management of information resources across all federal programs and services.

Data governance, as outlined in Circular A-130 (OMB, 2016), plays a crucial role in ensuring that an organization's data and information needs are met effectively. It achieves this by defining clear roles, responsibilities, and processes for managing data throughout its life cycle. This includes establishing accountability among data stewards and owners, as well as standardizing procedures for data acquisition, storage, and usage. Furthermore, according to Circular A-130, by aligning data management practices with technology, agency programs, and strategic objectives, data governance ensures that data initiatives support the organization's mission.

B.   DATA STRATEGY

Before the DOD Data Strategy was published in 2020, the DOD had a less formalized approach to data management. The first DOD AI Strategy, published in 2018, laid some groundwork for maturing the DOD's data-centric structures (Blackburn, 2019).

However, the focus on treating data as a strategic asset and using it for operational benefit and enhanced effectiveness was significantly amplified with the DOD Data Strategy (Norquist, 2020).

The DOD Data Strategy envisioned the Department as "a data-centric organization that uses data at speed and scale for operational advantage and increased efficiency" (Norquist, 2020, p. 1). It emphasized the importance of enterprise data management activities to support this goal. Central to this strategy are guiding principles that emphasize the strategic importance of data, collective data stewardship, ethics in data practices, and ensuring data is fit for purpose while maintaining compliance with regulations. The strategy highlights the necessity for enterprise-wide data access and availability, recognizing data as a critical resource that must be accessible to all authorized individuals and entities. It underscores the importance of collecting data electronically. Moreover, the Data Strategy emphasizes the significance of data for artificial intelligence training, acknowledging that data sets and algorithmic models are invaluable assets that require careful management. To enable the realization of its goals, the strategy identifies four essential capabilities: architecture, standards, governance, and talent and culture. These capabilities are essential for effectively managing data, ensuring interoperability, and empowering the workforce to make data-informed decisions.

The strategy also outlines seven goals, capsulated by the acronym VAULTIS, which the DOD aims to achieve to become a data-centric organization (Norquist, 2020, p. 2). These goals include making data visible, accessible, understandable, linked, trustworthy, interoperable, and secure. By focusing on these objectives, the DOD will enhance data utilization, facilitate informed decision-making, and strengthen overall data management practices across the organization.

C.   DATA DECREES

In the memorandum addressed to senior Pentagon leadership, commanders of the combatant commands, defense agency directors, and DOD field activity directors, the DOD implemented five "data decrees" aimed at fostering transformative efficiency gains throughout the focus areas outlined in the DOD Data Strategy (Hicks, 2021). The

memorandum stresses that "transforming the DOD to a data-centric organization is critical to improving performance and creating decision advantage at all echelons from the battlespace to the board room, ensuring U.S. competitive advantage" (Hicks, 2021, p. 1). To expedite this transformation, the DOD sets five "DOD Data Decrees":

1. Maximize data sharing and rights for data use: all DOD data is an enterprise resource.
2. Publish data assets in the DOD federated data catalog along with common interface specifications.
3. Use automated data interfaces that are externally accessible and machine-readable; ensure interfaces use industry-standard, non-proprietary, preferably open-source, technologies, protocols, and payloads.
4. Store data in a manner that is platform and environment-agnostic, uncoupled from hardware or software dependencies.
5. Implement industry best practices for secure authentication, access management, encryption, monitoring, and protection of data at rest, in transit, and in use. (Hicks, 2021, p. 1)

By enforcing these decrees, the DOD aims to streamline data management practices, fostering enhanced accessibility, interoperability, flexibility, and security to promote informed decision-making and operational efficacy.

The memorandum underscores that "the DOD Chief Data Officer is responsible for issuing policy and guidance regarding DOD's data ecosystem (e.g., people, technology, and culture), data sharing, data architecture, data life-cycle management, and a data ready workforce" (Hicks, 2021, p. 1). The CDO is granted access to all DOD data and oversees the implementation of the DOD Data Strategy, facilitating the resolution of data-sharing disputes. DOD components are instructed to appoint data leaders and participate in the DOD Data Council to coordinate data activities effectively. The memorandum emphasizes the importance of common access to authoritative data for informed decision-making, with the Advana platform (see Chapter IV) serving as the central platform for managing and analyzing data for senior leaders. Any other data platforms require approval from the DOD CDO to ensure compliance with open data standards. Moreover, the memorandum highlights the reliance of senior leader forums on the Advana platform for decision support and directs DOD components to "coordinate with the Executive Analytics Cell to develop appropriate metrics, visualizations, and

insights regarding the strategic priorities, business health, and operations of the Department" (Hicks, 2021, p. 2).

D. FINANCIAL MANAGEMENT FUNCTIONAL STRATEGY 2020–2024

The DOD (2020) Financial Management Functional Strategy for Fiscal Years 2020–2024 creates the framework for delivering financial management strategic outcomes crucial for fulfilling the DOD's overarching national security mission. It states that the Office of the Under Secretary of Defense (Comptroller) (OUSD[C]) is the principal organization responsible for the comprehensive reform initiative aimed at establishing a simplified, uniform, and analytics-based financial management environment within the DOD. This Financial Management Functional Strategy outlines financial management strategic outcomes that include fostering stewardship and bolstering public trust in taxpayer funds through enhanced transparency measures; ensuring sustainability in corrective actions identified through audit processes; augmenting mission capabilities; facilitating access to authoritative, accurate, and timely financial information to inform decision-making processes; cultivating a knowledgeable, skilled, and efficient workforce; maintaining an affordable and secure financial management infrastructure; and establishing a robust internal control environment conducive to sustaining an unqualified audit opinion (DOD, 2020). These strategic outcomes collectively underpin the DOD's commitment to achieving fiscal integrity, operational resilience, and organizational excellence within its financial management domain.

The Financial Management (FM) Functional Strategy (DOD, 2020) outlines five key goals aimed at driving strategic outcomes within the Department of Defense's financial management domain:

Goal 1 focuses on the continual enhancement and implementation of financial policies and processes. This goal aims to streamline and harmonize the FM operations and business systems, thereby improving efficiency and effectiveness across financial operations.

Goal 2 is geared toward the development and strengthening of a well-trained financial workforce. By equipping personnel with the necessary expertise, skills, and competencies, the DOD seeks to bolster business transformation initiatives and enhance audit readiness within its financial management practices.

Goal 3 aims to establish a uniform planning, programming, budgeting, and execution process. This process is designed to facilitate end-to-end funds traceability, reduce reliance on feeder systems, and enhance data linkage between various stages of financial planning and execution.

Goal 4 focuses on achieving "a sustainable unmodified audit opinion by improving financial processes, controls, and information via audit remediation" (DOD, 2020, p. 6).

Goal 5 emphasizes the optimization of the Department's Defense Business Systems (DBS) capabilities. This involves maximizing the use and performance of DBS while minimizing system redundancies and resource requirements. "Increased cooperation and coordination among business system owners" are also prioritized to "facilitate timely and effective transformation" within the FM community (DOD, 2020, p. 6).

The FM Functional Strategy aims to establish a target financial management environment characterized by being "data-driven, standards-based, technology-enabled, affordable, secure, and auditable" (DOD, 2020, p. 5). The Department of Defense conducted its first-ever full financial statement audit in FY 2018, followed by subsequent audits in FY 2019 (Fine, 2019). These audits identified findings across various functional areas, emphasizing the need for remediation as a component of the DOD's FM improvement strategy. Importantly, the approach to achieving the FM Functional Strategy goals aligns with the Department's audit remediation strategy, placing the FM community at the forefront of policy, financial reporting, operational, performance, and risk management efforts (DOD, 2020).

The FM Functional Strategy states that the FM community will transition into a data-driven organization, significantly enhancing the strategic value of DOD decision-

making through the attainment of FM Functional Strategy objectives. A data-driven culture, which emphasizes the usage of data, places considerable emphasis on acquiring and refining the analytics and prioritized data essential for managing the organizational business environment and achieving stated goals and objectives. According to the strategy, FM leaders possess the potential to improve their organization's capability to forecast results, strategize, and properly react by leveraging data effectively. This transformation not only promises to enhance corporate decision-making significantly but also to amplify the FM function's capability to provide strategic value to the DOD. Figure 2 shows how the data-first methodology is built on concepts of reporting and compliance; data and service provider; and value-added business partner.
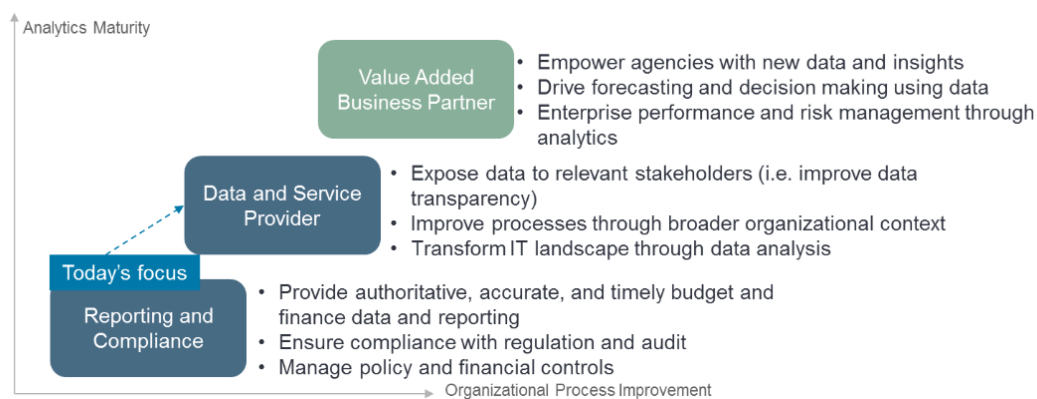
Figure 2.   Financial Management Data-First Approach. Source: DOD (2020).

Moreover, the FM Functional Strategy includes 12 essential FM Enterprise Initiatives formulated by the OUSD(C) to attain and maintain the desired outcome outlined in the strategy.[2]

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[2] The FM Enterprise Initiatives include Advana; USSGL/SLOA/SFIS Compliance (Reform Initiative); FBWT – Cash Accountability and Traceability; Intragovernmental Transactions; Property; Journal Vouchers; Financial Management Information Technology Systems Environment; Funds Distribution; Cost Management; Planning, Programming, Budgeting and Execution Process Standards; DOD Financial Management Certification Program; and DATA Act. Source: DOD (2020).

Advana serves as a tool for streamlining processes, enhancing data quality, and facilitating decision-making within the financial management domain. It is one of the initiatives referenced as a related FM Enterprise Initiative for Objective 1.1, aiming to "improve and standardize business processes and data for decision-making" (DOD, 2020, p. 12). Additionally, Advana is associated with Objective 4.1, focusing on achieving an unmodified financial statement audit opinion. It is also linked to Objective 5.1, which involves defining the Accounting and Feeder System Target End State, and Objective 5.2, centered on the development of the Defense Business Systems Financial Management Roadmap.

The FM Functional Strategy defines the FM Target Equation, depicted in Figure 3, which serves as the blueprint for realizing the desired FM environment and guides the implementation of FM strategic initiatives. When business processes within the FM community are executed accurately, the result will be the realization of a business environment that is "information-driven, standards-based, technology-enabled, affordable, auditable, and secure" (DOD, 2020, p. 5).
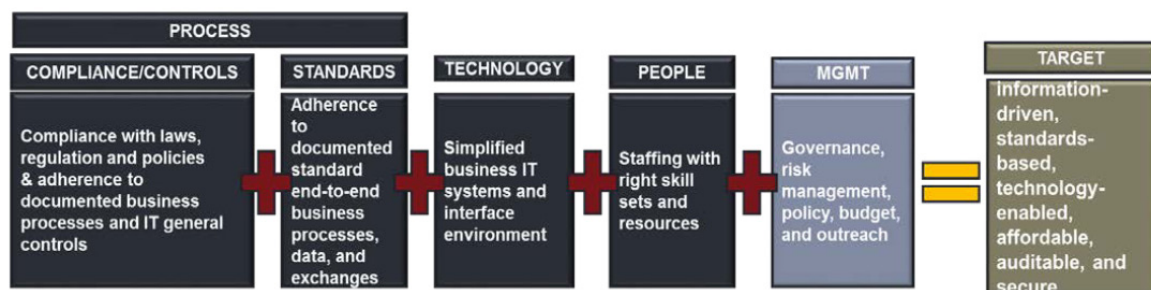
Figure 3.   Financial Management Target Equation. Source: DOD (2020).

The FM Functional Strategy underscores the important role of data analytics in financial management within the DOD. The strategy is guided by fundamental principles of efficiency, effectiveness, auditability, and security, which highlight the importance of leveraging data analytics to drive informed decision-making and optimize operational performance. Through the implementation of data-driven initiatives, the FM community seeks to enhance transparency, streamline processes, and improve resource allocation,

thereby ensuring that financial management practices align with the evolving needs of the DOD.

E.   FINANCIAL MANAGEMENT STRATEGY 2022–2026

The Financial Management Strategy for Fiscal Years 2022–2026 (DOD, 2022a) outlines that its main goal, to provide efficient and high-quality financial management services, is vital for maintaining the DOD's leading role as a global military force while ensuring responsible handling of funds. The strategy highlights the importance of being financially prepared to support mission readiness. It aims to ensure that every decision made within the DOD is informed by financial considerations, thereby strengthening U.S. global capabilities. The strategy details the steps needed to achieve these goals, including improving access to data for better decision-making across all levels.

The strategy outlines key goals, objectives, and success criteria. The first goal is to develop a skilled and motivated financial management workforce (DOD, 2022a, p. 8). This involves activities like improving training, fostering a sense of community, and ensuring compliance with regulations. The aim is to have a workforce that is dedicated, productive, and guided by strong leaders. The strategy states that financial managers will fulfill their responsibilities effectively and contribute to the success of military missions. They will also collaborate closely with operational teams, offering support and guidance. Continuous learning and development opportunities will be provided to ensure the workforce remains engaged and proficient.

The second goal aims to optimize the use of taxpayer funds to achieve the most valuable outcomes (DOD, 2022a, p. 10). Currently, the process of budgeting and execution involves manual tasks and outdated technology, making it labor-intensive and inefficient. Innovations like automation can greatly enhance this process, making it more efficient and reducing the burden on the workforce. According to the strategy, this will improve agility in delivering capabilities to the warfighter and other stakeholders. The goal is to simplify and automate the budgeting process by optimizing budget execution, managing costs and risks together, and fostering a strong funds control environment. Collaboration with Congress is crucial for transparency and addressing challenges,

including enhancing the budget execution process. The strategy states that DOD leaders should have access to real-time data to compare budgeted versus executed results, allowing for effective cost and performance management. A dynamic, agile operation driven by data analysis ensures continuous prioritization and decision-making throughout the year. Ultimately, responsible resource allocation is essential to meeting national defense objectives efficiently and effectively.

The third goal is centered on improving the accuracy and dependability of financial outcomes (DOD, 2022a, p. 12). One of the key metrics for achieving this goal is the consolidation of all Fund Balance with Treasury (FBWT) reconciliation tools in Advana. FBWT reconciliation poses a significant challenge for the DOD, impacting its ability to secure a favorable assessment of financial statements by auditors. According to the strategy, streamlining the reconciliation process through Advana will facilitate the identification and resolution of data quality issues stemming from feeder systems, ultimately expediting the journey toward achieving an unmodified audit opinion.

The fourth goal aims to simplify and optimize the entire business landscape (DOD, 2022a, p. 14). It involves optimizing system security, harnessing innovative digital solutions such as machine learning and artificial intelligence, and streamlining FM regulations and policies. According to the strategy, the goal's execution envisions highly automated FM operations characterized by clear segregation of duties and access controls, ensuring accountability across standard processes and modernized capabilities. Success will be gauged by the swift removal of systems from the environment and adherence to robust federal and DOD standards. The desired outcome is a lean, cost-effective, and highly productive environment that reallocates resources to support mission-critical activities. The strategy foresees that enhanced process execution will be validated through efficiency and effectiveness measures, bolstered by data integrity improvements driven by CDO and CFO standards, utilization of the Advana analytics platform, and adoption of reliable commercial off-the-shelf business solutions. FM leadership will collaborate with various stakeholders to bring this vision of a streamlined and secure business environment to fruition, making necessary adjustments to existing practices along the way.

The fifth strategic objective, defined in the strategy, focuses on fostering data-driven decision-making informed by fiscal insights (DOD, 2022a, p. 16). As every business event within the DOD generates financial transactions, standardized approaches to data management, quality, and governance are crucial. The Department is progressing toward adopting improved data management standards outlined in the DOD Data Strategy, with significant implications for the FM community. The strategy reveals that collaboration with the DOD CDO is essential for implementing these standards, enhancing data integrity for critical decision-making. Leveraging the visibility provided by financial audits, the FM community can understand various business data interactions and develop solutions that capitalize on this advantage. This involves consolidating FM and other business data into a unified platform like Advana, creating a reconcilable Universe of Transactions. This capability not only supports financial audits but also enhances analytics to inform business decisions. The strategy suggests that by leveraging Advana as a single source of truth, redundant data systems can be reduced, simplifying data management and bolstering confidence in FM data for decision-making. Strategic objectives include driving universal adoption of secure, single-source reporting through Advana and improving data quality and management standards to facilitate decision-making. As noted in the strategy, as Advana adoption increases, redundant data systems should naturally diminish, streamlining data management processes.

Overall, the Financial Management Strategy for Fiscal Years 2022–2026 emphasizes efficient financial management for sustaining the Department of Defense's global military leadership while ensuring responsible fund handling. It outlines five strategic goals: workforce development, fiscal optimization, financial accuracy, business simplification, and data-driven decision-making. Through initiatives like Advana and collaboration with the DOD CDO, the strategy aims to improve data integrity, streamline operations, and facilitate informed decision-making at all levels of the DOD.

F.   DATA, ANALYTICS AND AI ADOPTION STRATEGY 2023

The DOD Data, Analytics, and Artificial Intelligence Adoption Strategy emphasizes the necessity of standardizing and improving data quality and access to data

within the DOD as it is crucial for gaining a competitive advantage and ensuring the success of the warfighter's mission, especially in the advancement of technologies reliant on data, artificial intelligence, and machine learning (Hicks, 2023). The availability and utilization of data, analytics, and AI technologies within the DOD provide significant value to service members and enhance decision-making efficiency. This strategy outlines the path to responsibly harnessing these capabilities to strengthen organizational operations and ensure enduring decision advantage across DOD functions. The DOD Data, Analytics, and Artificial Intelligence Adoption Strategy is built upon strategic guidance developed in recent years, drawing from the DOD's initial AI Strategy (Blackburn, 2019) and the DOD Data Strategy (Norquist, 2020).

According to the strategy, the recent progressions in data, analytics, and artificial intelligence (AI) technologies offer a significant advantage by enabling quicker decision-making across various levels of the Department, spanning from strategic planning to tactical operations. Rapidly embracing these technologies "presents an unprecedented opportunity to equip leaders at all levels of the Department with the data they need," empowering them to leverage the full potential of the workforce's decision-making capabilities (Hicks, 2023, p. 3). This accelerated adoption should enhance decision advantage, enabling DOD leaders to allocate resources effectively to bolster deterrence efforts.

The DOD Data, Analytics, and Artificial Intelligence Adoption Strategy indicates that the DOD is committed to seizing opportunities presented by advancing technologies in a timely and relevant manner, aligned with the U.S. global mission. This underscores the need for a cohesive framework that encompasses data, analytics, and AI initiatives, supported by a skilled and empowered workforce utilizing commercial tools and partnerships.

The strategy asserts that the Department's strategic focus revolves around several interconnected goals aligned with the DOD AI Hierarchy of Needs, as shown in Figure 4. This hierarchy emphasizes the foundational importance of quality data, serving as the bedrock for all analytic and AI capabilities essential for informed decision-making. Building upon this foundation are insightful analytics and metrics, providing DOD

leaders with essential models and visualizations to comprehend the factors influencing outcomes within their respective spheres. At the apex of the hierarchy lie ethical artificial intelligence practices, embodying the DOD's commitment to ethical AI utilization, facilitating quicker insights and enhanced mission outcomes. The DOD Data, Analytics, and Artificial Intelligence Adoption Strategy identifies that supporting these layers are robust sets of processes, including effective data governance for improved data quality and analytics, as well as rigorous assurance processes ensuring responsible AI implementation (Hicks, 2023). Additionally, enablers such as digital talent management play a vital role in sustaining the AI Hierarchy of Needs.
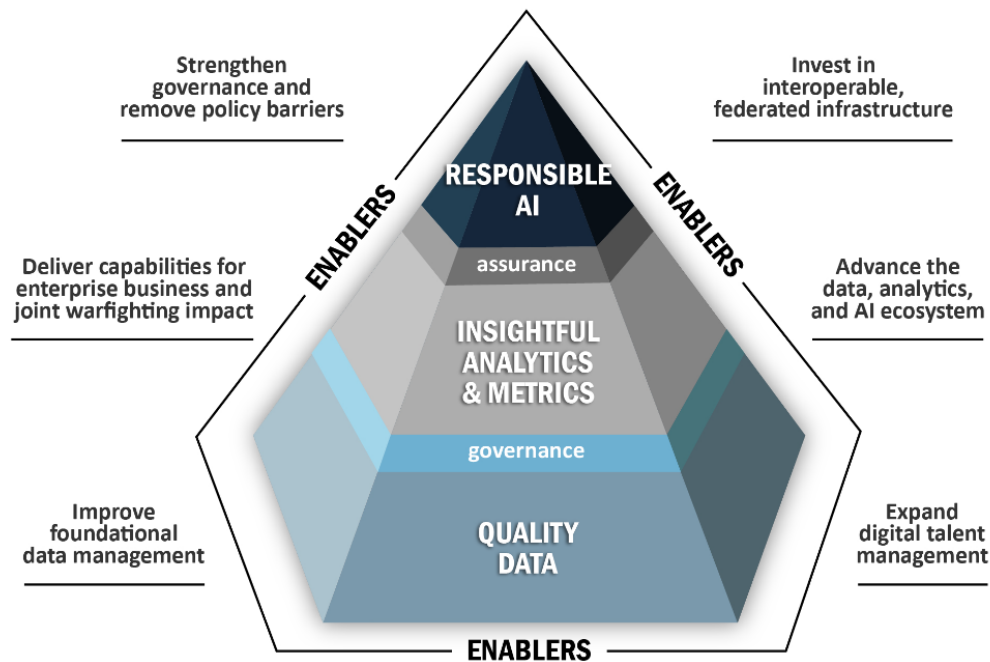
Figure 4.   Strategic Goals and the AI Hierarchy of Needs. Source: Hicks (2023).

The strategy describes that utilizing the Hierarchy as a framework aids in evaluating DOD AI preparedness and steering the DOD's objectives to expedite the integration of data, analytics, and AI technologies, thereby enhancing lasting decision-making superiority. These interconnected goals, along with their associated "activities

and investments, cut across technology, human capital, process, and culture areas" (Hicks, 2023, p. 7).

The DOD's initial focus on data management prioritizes enhancing quality of data and treating data as a product to align with the secretary of defense's key priorities. The DOD Data, Analytics, and Artificial Intelligence Adoption Strategy clarifies that instead of centralizing data management, a decentralized network will be established among data providers and users, distributing ownership across different data domains. This approach involves owners of data domains taking responsibility to oversee and control the data generated within their respective domains, treating it akin to a traditional product. The strategy suggests that by adopting this product-oriented approach, the DOD aims to foster a culture of data sharing and collaboration, breaking down silos and promoting cross-functional cooperation. This strategy ensures proper data governance, accountability, and access controls, ultimately leading to improved data quality, reduced backlogs, lower storage costs, and enhanced decision-making capabilities.

According to the strategy, implementing an inclusive and adaptable strategy and prioritizing data quality will enable the Department to deploy effective solutions tailored to organizational requirements. Governance over data, analytics, and AI will be flexible, emphasizing efficiency and data-driven decision-making, and fostering cooperative knowledge sharing.

G.   FINANCIAL MANAGEMENT REGULATION ON ADVANA

Volume 1, Chapter 10 of the Financial Management Regulation (DOD, 2023a), updated in June 2023, outlines the provisions regarding Advana, a common enterprise data repository mandated by the National Defense Authorization Act for Fiscal Year 2018. Advana serves as a centralized platform for data and analytics within the DOD, offering users access to standardized business data, decision-making tools, and analytics capabilities. Initially developed by the OUSD(C) and now managed by the Chief Digital and Artificial Intelligence Office, Advana aligns with the National Defense Strategy by facilitating access to comprehensible and actionable data across the Defense enterprise,

while enhancing analytic capabilities to address complex departmental challenges (DOD, 2022b).

The regulation identifies Advana's position as the designated DOD repository for common enterprise data and outlines the respective roles and duties of OUSD(C) and DOD components in its creation, maintenance, and utilization across supported business domains. According to the regulation, Advana's implementation guarantees that all performance metrics and data products utilizing DOD data are sourced from a reliable and comprehensive repository of transaction-level information.

The roles and responsibilities within the DOD's financial management framework are delineated to ensure effective utilization of Advana and its alignment with organizational goals. The Financial Management Regulation states that OUSD(C) is entrusted with leveraging Advana to enhance analytic capabilities by strategically integrating data with advancing technology, standardizing data integration, managing data sharing agreements, and maintaining system security. On the other hand, DOD components are responsible for providing Advana with authoritative transactional data, ensuring accurate data transmission, utilizing Advana for various reconciliations, and collaborating with the Advana program as needed.

As clarified in the regulation, the utilization of Advana within the DOD encompasses various critical functions aimed at enhancing data management and ensuring accuracy and efficiency in financial operations. Advana serves as the central repository for authoritative source-level transactional data obtained from all DOD business systems daily. This data, imported directly from the originating business systems, is crucial for maintaining data integrity and supporting informed decision-making across the DOD. Additionally, the regulation reveals that the DOD Components are responsible for adhering to agreements governing the accurate and timely transmission of data and for mapping source data elements to the Advana common data model.

The Financial Management Regulation indicates that Advana facilitates various reconciliation processes, including monthly reconciliations between financial

management systems and general ledger accounting systems, quarterly reconciliations within the Defense Departmental Reporting System, and the reconciliation of FBWT accounts (DOD, 2023a). Moreover, Advana supports audits and reviews, such as dormant account reviews, and DOD components are required to utilize Advana for these purposes unless otherwise approved. In addition, the regulation states that each business domain within the DOD represents a distinct line of business and encompasses relevant business events.

Overall, the regulation sets strategic guidance for comprehensive usage of Advana and underscores its pivotal role in promoting transparency, accountability, and efficiency in financial management within the DOD.

H.   ASSESSMENT OF POLICIES AND STRATEGIC DOCUMENTS ALIGNMENT

The U.S. government and DOD policies and strategic documents align with the core principles of data strategy and financial data management. These principles emphasize the significance of data governance, accessibility, quality, and analytics in advancing organizational objectives, including those related to financial management goals. This section offers a comprehensive overview of the analyzed policies, outlining the gaps they address.

Circular A-130 specifies comprehensive guidelines for information governance, acquisition, records management, and security (OMB, 2016). It emphasizes the importance of IT integration, skilled workforce, and agile approaches to IT procurement. While it addresses data governance and management broadly, it does not focus on financial data management.

The DOD Data Strategy demonstrates a strong alignment with key components of data strategy. It emphasizes data governance, accessibility, quality, and the importance of analytics (Norquist, 2020). It also recognizes data as a critical resource for financial decision-making, aligning well with financial data management objectives.

DOD Data Decrees focus on enhancing data management practices within the DOD, emphasizing data sharing, accessibility, security, and adherence to industry best

practices (Hicks, 2021). While they do not explicitly mention financial data management, they contribute to creating a conducive environment for effective financial data management.

The Financial Management Functional Strategy 2020–2024 (DOD, 2020) specifically targets financial management objectives, outlining goals for improving financial policies, workforce training, audit readiness, and system optimization. It aligns well with financial data management objectives but may benefit from further integration with broader data strategy principles.

Similar to the FM Functional Strategy, the Financial Management Strategy 2022–2026 focuses on financial management goals but also emphasizes the importance of data-driven decision-making (DOD, 2022a). It outlines steps to improve data access and quality, aligning with both financial and broader data strategy components.

The DOD Data, Analytics, and AI Adoption Strategy underscores the foundational importance of data quality and access for analytics and AI adoption within the DOD (Hicks, 2023). It aligns with principles of data strategy and emphasizes decentralized data management, which can contribute to improved data quality and accessibility.

In conclusion, the policies and documents evaluated generally align well with best practices in data strategy and financial management. They incorporate principles such as data governance, accessibility, quality, and analytics, which are considered fundamental in the field. While the documents outline strategic objectives and goals, they may benefit from clearer guidance on implementation mechanisms and oversight frameworks. Specific protocols for monitoring progress, evaluating initiatives, and ensuring accountability in data management practices could enhance the effectiveness of these policies.

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IV.   ADVANA: ENHANCING DOD CAPABILITIES THROUGH DATA ANALYTICS

Advana is attempting to drive digital transformation within the DOD by democratizing analytics, enhancing financial management accuracy, and improving compliance and risk management. Its robust technological infrastructure integrates over 3,000 business systems, providing real-time data access and analytics capabilities, particularly in financial management. Central to Advana's success is its sophisticated technological backbone, enabling seamless data aggregation, processing, and consumption. Leveraging tools like Databricks, Apache Spark, Qlik, Tableau, DataRobots, and others, Advana facilitates rapid analysis of large datasets and supports advanced analytics and machine learning applications while prioritizing infrastructure and security for compliance with data governance regulations. In addition to its technological prowess, Advana offers training opportunities, including webinars, office hours, and partnerships with organizations like Databricks Training and Databricks Academy, Management Concepts, Decision Lens University, Coursera, Digital University, and Massachusetts Institute of Technology Horizon. These initiatives underscore the DOD's commitment to equipping its workforce with the skills needed to leverage emerging technologies effectively.

A.   THE EVOLUTION OF ADVANA: FROM FINANCIAL SOLUTION TO COMPREHENSIVE ANALYTICS PLATFORM

Originally created as a solution to address the financial management challenges within the DOD, Advana underwent a transformative evolution into the data analytics platform servicing the entire department's needs. Since 1995, the GAO has classified the financial management of the Department of Defense as high risk (GAO, 2020). As a result of a GAO recommendation in the report *DOD Financial Management: Significant Efforts Still Needed for Remediating Audit Readiness Deficiencies* (GAO, 2017), the DOD began developing a consolidated repository of data utilizing data that is continuously updated to monitor results from audit examinations and their corresponding advancement toward resolution. In 2018, the DOD conducted the first comprehensive

financial statement audit encompassing all its departments (DOD, 2018a). The substantial quantity of audit discoveries emanating from the Department's comprehensive examinations of financial statements in 2018 underscored the significant number of necessary enhancements. These audits revealed numerous deficiencies in financial management and reporting, identifying a total of 20 material weaknesses along with over 2,400 notices of findings and recommendations (DOD, 2018b). Key areas of concern included insufficient controls over IT systems, insubstantial measures to guarantee the precision and entirety of property documentation, and fragmented sets of financial transactions. Also, certain data utilized for reporting on the Department's advancement was both inaccurate and incomplete (GAO, 2020). The creation of the Universe of Transactions in response to the results of the DOD's audit initiatives aimed to streamline internal control activities and bolster budget execution capabilities. The Advana platform initially served as the Universe of Transactions for financial statement audits and expanded its scope from that point onward (Little et al., 2022). In 2019, the introduction of Advana was formalized through the Memorandum on Quarterly Dormant Account Review, marking a pivotal moment in the Department's efforts to enhance its financial processes (Easton, 2019). Advana's integration into the Dormant Account Review Quarterly (DAR-Q) signaled a strategic shift, underscoring its role in driving operational efficiency. The memorandum emphasized Advana's significance in facilitating DAR-Q processes, reflecting the DOD's commitment to optimizing budget resource management and fiscal accountability (Easton, 2019). Developed collaboratively by the Chief Financial Officer Data Transformation Office and the Financial Improvement and Audit Remediation Directorate, Advana simplified DAR-Q processes for DOD components. The adoption of Advana underscored its role in enhancing the DOD's budgetary practices. According to the appendix of the memorandum, as components transitioned to DAR-Q, Advana provided support by offering both a framework for tool utilization and guidance for internal procedure implementation (Easton, 2019).

At the same time, the DOD acknowledged the need to modernize and consolidate its disparate and often outdated business systems into a unified platform, incorporating the establishment of a comprehensive financial management database and ensuring

compliance with the Department's auditability standards (GAO, 2018). As a result, the DOD has embarked on efforts to expand the capabilities of the Advana platform, recognizing its potential to drive value. In 2019, the Department of Defense and Booz Allen Hamilton finalized the development and implementation of Advana as a versatile platform tailored for mission stakeholders, analysts, and data scientists (Booz Allen, 2023). Later Advana integrated over 3,000 diverse business systems, ranging from finance and logistics to warfighter analytics, enabling streamlined decision-making processes. Figure 5 illustrates how Advana's data analytics domains encompass a wide range of activities within the DOD. However, this thesis, due to its scope, focuses specifically on financial management analytics.

Figure 5.   Advana's Data Analytics Domains. Source: Little et al. (2022).

Through standardized data models, natural language discovery, and analytics tools designed to enable users to independently work with data, Advana empowers users to make informed decisions efficiently and effectively across the organization. Moreover, Booz Allen Hamilton secured a substantial 5-year contract worth $674 million from the General Services Administration in 2021 (Booz Allen, 2021). The contract aims to bolster and maintain the DOD's Advana data analytics platform, which is crucial for enhancing decision-making processes across the organization.

Initially created under the leadership of the OUSD(C), Advana serves as an integrated platform that consolidates data from various business systems within the DOD (Booz Allen, 2021). Spanning numerous DOD organizations, Advana plays a pivotal role in addressing critical mission and business challenges by making data more accessible, understandable, and actionable (Booz Allen, 2021). Advana is crafted to incorporate state-of-the-art technologies, including cloud computing, data engineering, artificial intelligence, machine learning operations. According to Booz Allen Hamilton (2021, para. 2), Advana's architecture helps to support the platform's rapid development, thereby enabling the Department of Defense to achieve "information dominance by having access to real-time, high-quality, decision-grade data from across the enterprise." In 2022 DOD CDO David Spirk acknowledged that bringing the Department of Defense's data onto a unified analytics platform enables key personnel, ranging "from the undersecretary of defense for personnel and readiness, to the undersecretary of defense for intelligence and security, to use that data to shape strategic decisions" (Heckman, 2022, para. 22).

In the domain of financial management, the platform's goals include transforming the CFO function, democratizing analytics, improving financial management and data accuracy, strengthening compliance and risk management, and providing decision analytics on financial performance (Booz Allen, 2023). Advana achieves these goals by aligning disparate data sets into a common data model, facilitating advanced analytics and decision-making processes. Furthermore, according to Booz Allen (2023), Advana supports users across the Army, Navy, and Air Force, ingesting data from over 120 DOD systems. It automates processes, identifies high-risk funds, and enhances financial

management capabilities, positioning the DOD to manage business and financial information effectively.

B. THE CORE TECHNOLOGICAL COMPONENTS DRIVING ADVANA'S FUNCTIONALITY

This section provides an overview of data aggregation, consumption, and infrastructure in the Advana ecosystem. It discusses the tools and processes used to leverage data effectively, including automated ingestion pipelines and optimized storage layers. The section explains how Advana facilitates data consumption through analytics and visualization techniques, empowering users to make informed decisions. The section also emphasizes the importance of infrastructure and security, highlighting Advana's role in protecting sensitive information and ensuring compliance. Also, it reveals Advana's position as a catalyst for digital transformation within the DOD, enabling users to utilize data strategically to achieve the DOD's mission objectives. However, realizing Advana's full potential necessitates highly skilled professionals within the DOD and its components. Specifically, proficient data engineers, data scientists, and data analysts are indispensable for effectively navigating the complexities of Advana's tools and technical functionalities introduced in this section.

1. Data Aggregation

Data aggregation is a crucial process in transforming raw data into actionable insights. By combining datasets from diverse sources into a single format and summarizing them, an organization can gain a holistic view of its operations and make better-informed decisions (Qlik, 2023). The benefits of data aggregation include improved decision-making, reduced storage needs, enhanced performance, preserved privacy and security, smoother integration with business intelligence tools, and laying a foundation for AI analytics. In Advana, the initial stage of data aggregation is ingestion. This involves the automated ingestion of batch and streaming data from various sources through fully automated pipelines, minimizing human involvement (DOD, 2021). At the ingestion stage, tools and apps such as StreamSets, SFTP, Databricks, and Apigee are used.

StreamSets is a cloud-native platform for building, running, and monitoring data pipelines. These pipelines define the flow of data from various sources to destinations and include processing steps (StreamSets, 2023). The platform supports ingestion from different systems like cloud data lakes and warehouses, as well as on-premises databases. It consists of StreamSets Control Hub for pipeline management and StreamSets engines deployed within the corporate network. According to the StreamSets web page, the engines, including Data Collector and Transformer, handle data ingestion and processing tasks. When pipelines are started from the Control Hub, both engines interact with external systems, process data, and provide real-time updates and metrics for monitoring.

Within Advana, the secure file transfer protocol is used, which facilitates encrypted file transfers between clients and servers. It offers a secure alternative to traditional file transfer protocol. It incorporates secure shell for authentication and data encryption, ensuring data security during transmission (Kiteworks, 2023). Secure file transfer, including secure file transfer protocol, is crucial for protecting sensitive information from interception and potential breaches. By employing secure file transfer methods, data integrity, confidentiality, and authenticity are preserved in Advana, granting access only to authorized users.

Another component of data ingestion is Databricks. With Databricks, data ingestion into Delta Lake is streamlined and efficient, supporting hundreds of data sources (Databricks, 2023a). The Auto Loader feature simplifies ingestion by automatically processing new files from cloud storage directories. It ensures exactly-once semantics and offers capabilities for tracking, monitoring, and managing schema changes over time. Additionally, according to Databricks (2023a) the COPY INTO SQL command enables batch file ingestion with exactly-once semantics, ideal for scenarios with fewer files or when Structured Query Language (SQL) preference is preferred. Overall, these features facilitate seamless data ingestion for data science, machine learning, and business analytics, ensuring that Delta Lake is always updated with the latest data.

In Advana's data ingestion stage, Apigee Integration is utilized to seamlessly connect existing data and applications, presenting them as easily accessible Application

Programming Interface (API). Collaboration with Google Public Sector began in 2022 to integrate Apigee into Advana (Google Cloud, 2023). By September 2023, Apigee's API developer portal achieved General Availability (GA), allowing any DOD sector to establish its own instance and interface with Advana's data mesh (Google Cloud, 2023). This approach streamlines the integration process, allowing for quick configuration through a drag-and-drop interface (Google Cloud, 2024). Built-in monitoring ensures the health of integrations is continuously tracked, mitigating risks associated with data connectivity challenges. According to Google Cloud (2024), key features of Apigee include a unified solution for API management and integration, support for new connectivity patterns enabling complex integration scenarios, and scalability.

Following data aggregation in Advana, the next phase involves data storage. Advana's data storage capabilities seamlessly handle various data types and sources, providing cost-effective solutions (DOD, 2021). Whether data is structured or unstructured, Advana efficiently manages it.

At this stage the following tools are used: Parquet, Avro, Delta Lake, and Amazon S3. Apache Parquet serves as a columnar storage format universally available across all projects within the Hadoop ecosystem, ensuring seamless data storage "regardless of the choice of data processing framework, data model, or programming language" (Apache Parquet, 2024, para. 1).

Avro, an open-source project for Apache Hadoop, offers data serialization and exchange services (IBM, 2024). It enables seamless data exchange between programs written in any language, with efficient serialization of data into files or messages. Avro's storage format is compact and efficient, combining data definition and data within one message or file. According to IBM (2024), the data definition is stored in JSON format for easy interpretation, while the data itself is in binary format for compactness. Avro files include markers for splitting large datasets into subsets suitable for Apache MapReduce processing.

In Advana, Delta Lake serves as the optimized storage layer for tables within a lakehouse on Databricks, offering enhanced functionality for data management. It

"extends Parquet data files with a file-based transaction log for ACID transactions and scalable metadata handling," making it suitable for scalable operations (Databricks, 2024a, para. 1). Fully compatible with Apache Spark APIs, Delta Lake seamlessly integrates with Structured Streaming, enabling unified "batch and streaming operations and providing incremental processing at scale" (Databricks, 2024a, para. 1). As the default storage format on Databricks, all tables are Delta tables unless specified otherwise. Originally developed by Databricks (2024a), Delta Lake continues to receive active contributions to its open-source project. The platform leverages Delta Lake's guarantees to optimize various optimizations and products, emphasizing its importance within the Databricks ecosystem.

Amazon Simple Storage Service (Amazon S3) is a highly scalable object storage service renowned for its reliability, security, and performance (AWS Documentation, 2024). It offers the flexibility to store and safeguard data for diverse use cases, including data lakes. According to AWS Documentation (2024), featuring cost-effective storage classes and user-friendly management tools, Amazon S3 enables organization to optimize costs, organize data efficiently, and implement granular "access to data to meet specific business, organizational, and compliance requirements" (para. 1).

In the data aggregation phase in Advana, the subsequent step entails data processing. In Advana's data processing stage, parallel and distributed computing capabilities facilitate the rapid processing of terabytes of data within seconds, ensuring efficient and timely analysis (DOD, 2021).

The following tools are used for data processing: Databricks, StreamSets, Apache Spark, and Spark GraphFrames.

Databricks provides a flexible and scalable platform for managing data processing workflows. In Advana, Databricks orchestrates tasks through Databricks Jobs. These jobs support various workload types such as notebooks, scripts, and SQL queries, enabling seamless implementation of data processing workflows (Databricks, 2024c). Leveraging Python scripts and Delta Live Tables, users transform and analyze data, with support for data build tool transformations and integration of Python packages and Java Archive

files. Databricks (2024c) states that collaboration and version control are ensured through integration with repositories like GitHub, and Apache Airflow is offered for workflow orchestration.

StreamSets is used for handling streaming data, which refers to the continuous flow of information from various sources to a destination for real-time processing and analytics. Contrary to traditional batch processing, where data is handled as complete sets with a definite beginning and end, streaming data processing is an ongoing process (StreamSets, 2024). It involves processing data continuously over a rolling timeframe, allowing for endless permutations and real-time insights. Modern data engineering emphasizes the importance of handling both stream and batch processing. According to StreamSets documentation (StreamSets, 2024), stream processing frameworks provide developers with the necessary tools to build applications that handle streaming data. Apache Spark is one of the most popular frameworks due to its native language support, distributed processing capabilities, and efficient in-memory architecture. It processes data in micro-batches, making it well-suited for handling streaming data efficiently at scale. Spark accelerates data processing by minimizing the steps involved. With Spark, "data is read into memory, operations performed, and the results written back" in a single step, leading to faster execution (Amazon Web Services [AWS], 2024d, para. 4). Additionally, Spark enhances performance by reusing data through an in-memory cache. According to AWS (2024d), this data reusability is achieved through DataFrames, which stores objects in memory and can be reused across numerous Spark operations. GraphFrames, a package for Apache Spark, introduces DataFrame-based graphs and offers APIs in Java, Python, and Scala (Databricks, 2023b). It aims to combine the capabilities of GraphX with extended functionalities utilizing Spark DataFrames. These extensions include motif finding, DataFrame-based serialization, and powerful graph queries. According to Databricks (2023b), GraphFrames is an integral part of Databricks Runtime for Machine Learning.

2. Data Consumption

Data consumption involves the conversion of raw data into processed information that can be interpreted by business intelligence software, allowing for the extraction of meaningful analyses and patterns. The true value of data is unlocked through consumption, transforming it into insights that drive informed decision-making and create tangible business value (Finlay, 2021). In the Advana data consumption stage, the following groups can be identified: data access layer; exploratory environment; AI and machine learning application; reporting and business intelligence; and data governance.

The data access layer facilitates efficient data retrieval and querying through various methods to enable swift analytics. It offers tools that cater to both non-technical and technical users, allowing seamless interaction with data through fast and efficient interfaces, ensuring a fully integrated experience (DOD, 2021). Examples of tools used at this layer include Apache Solr and Magellan.

Apache Solr is a search server constructed upon the foundation of Apache Lucene, an open-source, Java-based information retrieval library. Solr is engineered to support robust retrieval of documents and analytical tools, accommodating unstructured data, semi-structured data, or a combination of both structured and unstructured data formats (Apache Guide, 2024). Solr provides versatile query syntax and parsers that support a wide range of search capabilities, from "the simplest keyword searching to complex queries on multiple fields and faceted search results" (Apache Guide, 2024, para. 2). According to Apache Guide, with streaming expressions, users can perform analytics on entire data sets, subsets matching specific queries, or random document samples. Solr also offers powerful math expressions to support advanced analysis and predictive analytics use cases.

Magellan Data Discovery by OpenText is an advanced analytics software appliance tailored for business analysts seeking swift access, blending, exploration, and analysis of their data (OpenText, 2024). Designed to empower users without relying on IT or data experts, Magellan enables efficient data handling and analysis for enhanced business insights.

In the exploratory environment of Advana, users can seamlessly explore and analyze data using a range of commonly used programming languages directly through their internet browser, eliminating the necessity for tool installation. This environment allows for version control of code, facilitates easy sharing and collaboration with colleagues, and enables code execution on a robust distributed computing platform, enhancing efficiency and productivity in data analysis tasks (DOD, 2021). R, Python, and Scala are the primary tools used in the exploratory environment.

R analytics refers to the application of the R programming language in data analytics, leveraging its capabilities in statistical computing and graphics. Widely used in statistical analysis and data mining, R aids in identifying patterns and constructing practical models (Spotfire, 2024). Beyond data analysis, R can also contribute to software application development for statistical analysis purposes. According to Spotfire (2024), equipped with a graphical user interface and supporting various "analytical modeling techniques such as classical statistical tests, clustering, time-series analysis, linear and nonlinear modeling, and more" (para. 2), R provides a comprehensive environment for analytics. Its interface includes windows for scripting, console, workspace, history, and tabs for help, packages, plots, and files. Spotfire (2024) states that R "allows for publication-ready plots and graphics and for storage of reusable analytics for future data" (para. 2).

Python serves as a crucial tool for data analysis due to its flexibility, ease of learning, open-source nature, and robust support ecosystem. With Python, analysts can handle massive quantities of data efficiently and effectively, extract meaningful insights, and perform complex analytical tasks (Terra, 2024). Its simplicity and readability make it accessible to beginners, while its extensive library ecosystem provides a wide range of functionalities for data manipulation, visualization, statistics, machine learning, and more. Additionally, Terra states that Python's popularity and community support ensure that analysts have access to ample resources and assistance when encountering challenges.

Scala proves efficient for data analytics and data science primarily due to its capabilities in distributed computing and parallel data processing. It facilitates interaction

with distributed databases, enabling seamless handling of large volumes of data and accelerating processing times (Turing, 2024). Scala's compatibility with Java, including support for Java's API and libraries, appeals to developers familiar with Java, enhancing productivity and ease of integration. Additionally, Scala's support for immutable data formats and higher-order functions streamlines data manipulation, akin to Python's functionality. According to Turing (2024), the language's constructs simplify interactions with wrapper classes and container types, further enhancing its suitability for data analysis tasks. Overall, Scala's combination of distributed computing capabilities, compatibility with Java, and streamlined data manipulation features makes it a valuable tool for data scientists and analysts.

AI and machine learning are pivotal features within Advana, supported by leading tools such as Databricks and DataRobot. These platforms empower the DOD to harness advanced analytics, predictive modeling, and automated decision-making capabilities. Databricks presents a comprehensive solution for AI and machine learning endeavors, seamlessly orchestrating the entire machine learning life cycle with comprehensive governance mechanisms (Databricks, 2024b).

The Unity Catalog ensures careful management, allowing users to find, keep track of versions, and control access to a variety of data, features, models, and functions. Additionally, the Unity Catalog provides centralized management of artificial intelligence application (Databricks, 2024b). Lakehouse Monitoring keeps a close eye on data, making sure it stays accurate and reliable. Furthermore, according to Databricks (2024b), MLflow helps track and organize the development of models, while Databricks AutoML makes model training easier with automation. Model Serving lets users deploy models quickly and efficiently, ensuring they're always available and respond quickly. Databricks Workflows automate tasks and prepare pipelines for real-world use. Also, Databricks Runtime for Machine Learning sets up ready-to-use clusters for machine learning, including popular libraries like TensorFlow, PyTorch, and Keras, with added support for Graphics Processing Unit (GPU) processing (Databricks, 2024b). With Databricks, users can smoothly manage AI and machine learning (ML) tasks, using advanced tools and libraries to boost efficiency and results.

In Advana, DataRobot offers a comprehensive platform for automated machine learning and AI, empowering users to accelerate their AI initiatives. DataRobot provides Advana users with the opportunity for automation, accuracy, and collaboration (Informatec, 2024). Key features include human-centric design for business users, built-in guardrails to ensure consistency, and unsupervised anomaly detection for uncovering insights in datasets. According to Informatec (2024), the DataRobot platform can be used for the automation of tasks like model evaluation, feature engineering, and model tuning, leveraging open-source libraries for advanced techniques. With DataRobot, Advana users can build predictive models, streamline workflows, and drive decision-making.

In Advana, the reporting and business intelligence layer is designed to streamline the creation of dynamic dashboards and reports, allowing users to construct visuals. For these purposes, Qlik and Tableau serve as tools of this layer.

Qlik offers Advana users a solution for analyzing the DOD's data. Through its comprehensive toolbox of visualizations and data preparation tools, Qlik enables both experts and non-experts to make sense of vast amounts of data, facilitating informed decision-making (HICO-Group, 2024). With Qlik, Advana users can integrate data from various sources, explore it visually, collaborate, and leverage machine learning for enhanced analysis. According to HICO-Group (2024), Qlik provides a scalable and secure platform that adapts to diverse business needs, making it a versatile tool for data analytics. The integration between Qlik Sense and DataRobot allows organizations to seamlessly combine their data analytics and machine learning capabilities (Informatec, 2024). Qlik Sense consolidates data from various sources, while DataRobot empowers business analytics professionals to develop accurate machine learning models without coding. According to Informatec (2024), with the two-way integration, predictive models created and deployed in DataRobot can be utilized within Qlik Sense applications, enabling DOD employees to generate predictions in real time.

Tableau is a business intelligence tool known for its ability to generate data visualizations, making information comprehensible for teams across various industries. Its interface allows non-technical users to create customized dashboards without IT expertise. With functionalities like real-time analysis, data visualization, and

collaboration, Tableau simplifies data analysis and facilitates the creation of visually appealing dashboards (DataScientest, 2023). Tableau offers a range of software and tools, including Tableau Desktop for developing dashboards, Tableau Server for sharing workbooks, and Tableau Online for online sharing. According to DataScientest (2023), the platform's seamless integration with various data sources, quick Extract, Transform, Load (ETL) operations, visualizations, and data analysis capabilities make it useful for reporting and business intelligence. Additionally, Tableau provides robust data governance features and benefits from a vibrant user community dedicated to continuous improvement.

At Advana's data governance component, the following tasks are performed: "managing every piece of data using data cataloging, data tagging, data lineage, data policy management, and managing data access approvals" (DOD, 2021). One of the tools used at this stage is Collibra. Collibra Data Governance provides an adaptive solution designed to scale with organization, offering a centralized platform for managing every aspect of data governance (Collibra, 2024a). It enables users to create a shared language around data by defining business terminology, rules, and regulations. With features like stewardship management, reference data management, and centralized policy management, Collibra facilitates assigning roles, reconciling data, and ensuring compliance across the organization. The platform also offers intuitive workflows, embedded privacy by design, a data dictionary, and a data helpdesk to streamline governance processes and increase trust in data. Collibra (2024a) states that by automating governance activities and providing a single location for data management, Collibra helps organizations quickly find, understand, and govern their data, ultimately driving better decision-making, collaboration, compliance, and risk mitigation.

3.   Infrastructure, Security and Data Platform

The Data Infrastructure and Security layer in Advana is designed to incorporate the best-of-breed combination of open-source and commercial off-the-shelf technologies (DOD, 2021). This approach ensures that the platform operates on a foundation that is not only secure but also scalable and high-performing. The examples of the tools that are

used at this layer are Immuta, Splunk, and Amazon Elastic Kubernetes Service (Amazon EKS).

Immuta offers a comprehensive Data Security Platform designed to tackle the obstacles of data governance and security, enabling organizations to unlock the full value of their data investments while ensuring compliance and mitigating risks. By simplifying operations, improving data security, and unlocking data's value, Immuta empowers organizations to streamline data access, enhance productivity, and maintain regulatory compliance (Immuta, 2024). Immuta's unique approach includes discovery of sensitive data, classification of sensitive data, attribute-based access control, and continuous data security monitoring. According to Immuta (2024), with features such as dynamic access control, policy management, and real-time data monitoring, Immuta enables organizations to automate governance activities and provide cross-functional teams with a single platform for securing and governing data at scale.

Splunk is a security information and event management software platform used in the field of cyber security. It enables organizations to collect, analyze, and visualize machine-generated data from various sources to detect and prevent security threats effectively (Sai, 2023). Splunk offers "real-time monitoring, analysis, security, and observability capabilities, allowing organizations to identify and respond to security incidents proactively" (Sai, 2023, para. 7). According to Sai (2023, para. 7), the core features of Splunk include the ability to "ingest and index large volumes of data," real-time monitoring, advanced search and query functionalities, and customizable dashboards and reports. It also provides security-specific applications and add-ons for "threat intelligence, incident response, compliance monitoring, and user behavior analytics" (Sai, 2023, para. 9). Splunk's architecture consists of various components such as forwarders, indexers, search heads, deployment modules, and monitoring consoles, working "together to enable data ingestion, indexing, searching, and visualization" (Sai, 2023, para. 12). Additionally, Sai (2023) acknowledges that in addition to its primary use case in cyber security, Splunk is also widely used for "IT operations monitoring, application performance monitoring, business analytics, and log management" (para. 11). Its

capabilities empower Advana users to derive insights from the data, ensuring a proactive cyber security strategy and compliance with cyber security regulations.

Amazon EKS by AWS streamlines the deployment, operation, and maintenance of Kubernetes clusters on AWS infrastructure. It enhances data infrastructure and security through features like integrated networking and authentication with AWS services, facilitating secure communication between containers and AWS resources (Amazon Web Services [AWS], 2024a). Amazon EKS offers a managed Kubernetes experience, eliminating the need for users to handle the control plane setup and management. It ensures high availability across multiple AWS Availability Zones and seamlessly integrates with various AWS services for enhanced observability and operational efficiency. According to AWS documentation (Amazon Web Services [AWS], 2024a), Amazon EKS simplifies Kubernetes cluster management, empowering the organization to establish secure, scalable, and resilient data infrastructure for containerized applications.

Advana data platform layer uses compute and storage resources that are both fast-performing and capable of horizontal scalability, seamlessly handling petabytes of data and hundreds of billions of records (DOD, 2021). For the DOD's Advana data platform layer, NIPRNet and SIPRNet serve as crucial components for facilitating secure communication and data exchange within the DOD. NIPRNet, the Non-classified Internet Protocol Router Network, supports the exchange of unclassified data, while SIPRNet, the Secret Internet Protocol Router Network, facilitates the transmission of classified information up to the secret level (SecureStrux, 2024). These networks are integral to ensuring the security and confidentiality of sensitive data and communications across various DOD agencies and organizations.

With a clear emphasis on enhancement, Advana is continuously expanding to incorporate new tools and applications, including those currently in testing or planning stages, to provide tailored robust IT, data engineering, and analytics support aligned with the evolving requirements of the DOD. With this growth, Advana will prioritize the introduction of high-quality tools and apps to streamline business operations and enhance mission effectiveness (Booz Allen, 2021). This underscores Advana's vital role in

transforming how the DOD utilizes data, enabling informed decision-making based on data insights.

C.   EXPANDING SKILLS WITH ADVANA: TRAINING OPPORTUNITIES

For the DOD personnel to successfully adopt and utilize Advana and data analytics, the DOD offers training programs. For example, Advana provides a range of training opportunities to support users in effectively utilizing its tools and resources. These training materials include both free resources provided by Advana and third-party training options. Advana conducts webinars and office hours to further assist users in understanding and maximizing the platform's capabilities (Acquisition Data and Analytics [ADA], 2024). Furthermore, Advana provides access to the Advana Access Request Guide, which offers guidance on how users can obtain access to the platform and its associated training resources. ADA states that in addition to Advana's own training materials, users with DOD network access can also benefit from specific training resources such as Databricks Training and Databricks Academy, which provide specialized training on utilizing Databricks, a key component of Advana's data platform. Also, training organizations such as Management Concepts, affiliated with the American Society of Military Comptrollers, deliver comprehensive courses tailored to specific training requirements (Martin, 2024). Industry partners develop platforms on Advana and also offer tailored training. Martin (2024) states that Decision Lens has introduced Decision Lens University, offering a range of online courses and in-person instruction sessions. These diverse training channels aim to equip Advana users with the necessary skills and expertise to leverage the platform effectively.

The Defense Acquisition University (DAU) is expanding its training offerings for Advana users by partnering with Coursera, the provider of online open courses. Through this collaboration, the DAU aims to enhance the skills of the DOD workforce with online DOD–Coursera programs (ADA, 2024). These programs include courses on Data Science, which cover essential topics such as Programming in R, Practical Machine Learning, Statistical Inference, and more. According to ADA, this partnership enables

Advana users to access a wide range of relevant courses to further develop their skills in data science and related fields.

In April 2023, Advana partnered with Digital University (DU) to introduce a Data Literacy Education Program. This collaboration aims to enhance learners' "understanding of data analysis, interpretation, and visualization techniques, culminating in the ability to effectively convey insights through storytelling with data" (Omni Federal, 2023, para. 2). Through this collaboration, individuals using Advana can access DU's online learning platform, allowing them to "take courses at their own pace and on their own schedule, from home, the office, or on their mobile devices" (Omni Federal, 2023, para. 3). DU's administrative portal offers powerful features for learners to customize their training plans by combining Advana's custom content with off-the-shelf courses from the online course provider Udemy. According to Omni Federal (2023), the administrative portal facilitates "management of users, training plans, and analytics, providing a comprehensive set of resources to boost data literacy across the DOD" (para. 3). Also, Omni Federal (2023) indicates that DU currently "serves over 80,000 learners across the DOD with a 32,000+ course catalog across Udemy, Pluralsight, Data Camp, Cloud Academy, Coursera, Workera, and Udacity" (para. 5).

In November 2023, as part of the DU endeavor, the DOD Chief Digital and Artificial Intelligence Office launched the "Digital On-Demand" initiative to educate the DOD enterprise on emerging technologies. Digital On-Demand offers accessibility to the Massachusetts Institute of Technology (MIT) Horizon's library, offering flexible and mobile-friendly options for DOD military and civilian personnel (DOD, 2023c). Digital On-Demand offers users access to best-in-class training content and serves as a foundational resource for understanding AI systems and other emerging technologies, fostering a common language and understanding across the DOD workforce. According to the DOD (2023c), the MIT Horizon online platform offers educational materials on various artificial intelligence capabilities and emerging technologies, such as the Internet of Things, 5G networking, edge computing, generative AI, cybersecurity, big data analytics, etc. By providing modules covering these technologies, including those relevant to Advana like data analytics, machine learning and AI, Digital On-Demand acts

as a valuable resource, empowering users to improve their proficiency and fully leverage the platform's capabilities.

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V. ANALYSIS OF USAGE OF DATA ANALYTICS IN FINANCIAL MANAGEMENT

This chapter analyzes the effectiveness of data analytics in enhancing various aspects of financial management. First, Advana shows promise in improving financial accountability by facilitating FBWT reconciliations, financial reporting compilation, and intragovernmental transactions. However, challenges persist in fully harnessing its capabilities, indicating the need for further collaboration, standardization, and enhanced oversight to achieve greater transparency and accountability.

Second, Advana plays a crucial role in bolstering audit readiness within the DOD. It aids in augmenting audit processes, ensuring compliance with financial management standards, and overcoming cross-functional barriers. This includes assisting in financial statement audits, compliance with the Federal Information System Controls Audit Manual (FISCAM), and addressing obstacles related to cross-functional business transformation.

Furthermore, Advana demonstrates its transformative potential in optimizing the Program, Planning, Budgeting, and Execution process. By emphasizing cost savings, efficiency improvements, and robust risk assessment, Advana enhances budgeting processes and data analytics within the DOD. However, challenges persist in areas such as swift analysis, data-sharing with Congress, and the implementation of Business Health Metrics, necessitating ongoing improvement efforts.

Lastly, Advana's integration with Robotic Process Automation initiatives within the Defense Finance and Accounting Service (DFAS) showcases significant efficiency gains, cost savings, and enhanced data analytics capabilities. By harnessing Advana's capabilities, DOD components can extract insights, streamline processes, and proactively monitor performance.

A.   ADVANA'S ROLE IN DOD'S FINANCIAL ACCOUNTABILITY

Advana serves as the official DOD repository for common enterprise data (DOD, 2023a). Its utilization should ensure that any performance measure or data product reliant

on DOD data stems from an authoritative source of transaction-level detail. According to the Financial Management Regulation (DOD, 2023a), DOD components, which include various organizational entities within the DOD such as the Office of the Secretary of Defense, the Military departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the combatant commands, the defense agencies and DOD field activities, are obligated to fulfill several obligations.

These include providing Advana with authoritative source-level transactional data extracted from all DOD business systems on a daily basis, using cost-effective and secure methods (DOD, 2023a). Additionally, DOD components must ensure the precise and punctual transmission of data by signing agreements and establishing business rules aligning source data elements with the Advana common data model (DOD, 2023a). This model encompasses standards such as the Standard Financial Information Structure and the Procurement Data Standard, along with ongoing development of domain-specific data models.

Furthermore, according to the Financial Management Regulation (DOD, 2023a), Advana is to be incorporated for transmitting the Universe of Transactions to any entity issuing an audit request, data call request, or other legitimate requirement for reconciled transaction details. This regulation also states that monthly reconciliations between disbursing, obligation, funding, and entitlement financial management systems to general ledger accounting systems are required, utilizing the Advana Feeder to General Ledger Reconciliations Audit Workbooks. Quarterly reconciliations between general ledger accounting systems and their unadjusted trial balance should also be conducted using General Ledger to Unadjusted Trial Balance Reconciliations Audit Workbooks (DOD, 2023a). Likewise, quarterly reconciliations between the unadjusted trial balance and the adjusted trial balance within the Defense Departmental Reporting System must be undertaken using Unadjusted Trial Balance to Adjusted Trial Balance Reconciliations Audit Workbooks (DOD, 2023a). Additionally, Advana must be employed to reconcile FBWT accounts and retire all legacy microapplications by December 2024.

Furthermore, the Financial Management Regulation states that the Advana Dormant Account Review – Quarterly tool must be utilized for all DOD dormant account

reviews unless otherwise approved by OUSD(C). Lastly, DOD components are tasked with providing functional support to the Advana program, as needed, to facilitate the reconciliation of their general ledger data with outputs from the Defense Departmental Reporting System and other essential data reconciliations (DOD, 2023a).

Despite the identified obligations, the DOD has yet to fully leverage the potential and existing capabilities of Advana, highlighting a need for closer attention to the spheres of financial management within the DOD that are discussed in the following subsections. Addressing existing gaps is imperative for optimizing Advana's functionalities and ensuring the DOD's financial management practices soon.

1.   Fund Balance with Treasury

Across the Department of Defense, Advana implementation remains incomplete, as although it gathers and stores data from various DOD financial management systems, it currently lacks the functionality to facilitate effective FBWT reconciliations. In fiscal year 2021, the DOD Office of Inspector General found that DOD component personnel were unable to reconcile defense agency transactions within Advana, including FBWT transactions, to their respective financial statements (Khan, 2023). Additionally, from fiscal years 2020 through 2022, Advana received consecutive service organization reports with modified opinions, primarily due to deficiencies in access controls and segregation of duties. Khan (2023) states that these opinions included adverse opinions in fiscal year 2020 and qualified opinions in fiscal years 2021 and 2022.

The DOD Agency Financial Report FY2023 (DOD, 2023b) states that the Office of Inspector General identified a material weakness regarding the Department's FBWT accounts. The weakness stems from ineffective processes and controls to reconcile transactions with the Department of the Treasury's records, promptly resolve discrepancies, and provide accurate documentation for FBWT transactions and reconciling items. To rectify this issue, a series of corrective actions have been proposed. According to the Financial Report FY2023 (DOD, 2023b), these actions include supporting beginning balances through comprehensive research and documentation or exploring alternative approaches, identifying and coordinating alternate methods to

address beginning balance discrepancies, implementing and standardizing Advana reconciliations, identifying key stakeholders, and establishing preventive processes to minimize variance inflow and aging. Despite ongoing efforts to improve internal controls, processes, and systems related to FBWT reporting, deficiencies persist, particularly in the oversight of the Advana reconciliation process. The correction target for these issues is set for FY2026.

2. Financial Reporting Compilation

According to the DOD Agency Financial Report FY2023 (DOD, 2023b) the Department of Defense's financial management displays several material weaknesses in terms of financial reporting compilation. First, concerns arise regarding the completeness and accuracy of the DOD components' and agency-wide Statement of Budgetary Resources, particularly due to insufficient maintenance of detailed transactions and supporting documentation, and a lack of effective financial reporting monitoring to detect and investigate abnormal balances. Additionally, offline adjustments made by DOD components are not properly reflected in the financial statements. The Department also faces challenges in providing historical data to support beginning balances and reconciling them to closing balances, with inadequate oversight and monitoring activities to address deficiencies. Furthermore, according to the DOD Agency Financial Report FY2023 (2023b), there are issues with the presentation of gross costs on the Statement of Net Cost and a lack of reliable controls implemented by service providers, impacting the accuracy of component-level financial statements. Compliance with financial reporting standards such as Statement of Federal Financial Accounting Standards 7 and OMB Circular A-136 is also lacking. Moreover, deficiencies in controlling the Legal Representation Letters and Management Schedules of Information process have been noted, affecting the calculation of contingent legal liabilities (DOD, 2023b). Lastly, inconsistencies in presentation styles across consolidation entities' financial statements further compound the challenges faced by the Department (DOD, 2023b). These weaknesses highlight the need for comprehensive reforms to strengthen financial management and reporting practices within the DOD.

The corrective actions outlined in the DOD Agency Financial Report FY2023 (2023b) emphasize a concerted effort to enhance data analytics capabilities, particularly through the utilization of Advana, within the DOD's financial management framework. Key initiatives include establishing a comprehensive transaction framework universe and ingesting all accounting and feeder systems into Advana by FY 2025 to ensure a complete population of transactional details impacting financial statements. Additionally, according to the DOD Agency Financial Report FY2023, there's a focus on developing applications within Advana for reconciling financial statements to accounting system transactional details, facilitating in-depth analysis of journal entry data, and prioritizing review of unsupported adjustments. Moreover, there's an emphasis on collaboration with the financial management community to build and reconcile transaction universes, standardizing statement formats with the Department of the Treasury, and establishing policies and procedures to confirm the completeness, accuracy, and compliance of financial statement disclosures (DOD, 2023b). These actions underscore the Department's commitment to leveraging advanced analytics tools like Advana to improve financial management practices, enhance data integrity, and achieve greater transparency and accountability in financial reporting processes.

While there is considerable room for future development, Advana is already demonstrating tangible results. A notable instance is the integration of the General Fund Enterprise Business System (GFEBS) into Advana's Improper Payment Detection tool during FY2023. This tool, aimed at preventing the DOD from making erroneous payments, has successfully identified $27 million in improper payments within GFEBS since October 2022 (Advana, 2024). Though the process takes time, Advana has proven to be useful in this area, and continued work is essential to further enhance its effectiveness.

Recognizing that the positive cases of Advana's usage, such as the integration of GFEBS into its Improper Payment Detection tool, demonstrate tangible results, there remains work ahead to further enhance its capabilities and effectiveness within the DOD's financial management framework.

3. Intragovernmental Transactions

The DOD has identified significant material weaknesses in its handling of intragovernmental transactions, a concern ongoing since FY 2011 with a correction target set for FY 2026 (OUSD[C], 2022). Key challenges include the inability to furnish adequate evidence supporting the performance of work, receipt of goods and services exchanged between government agencies, and verification and confirmation of outstanding obligations. Additionally, there are issues with verifying the timely and accurate collection of disbursements, as well as validating recorded reimbursable agreements to ensure they meet prescribed criteria regarding time, purpose, and amount. Furthermore, according to OUSD(C) (2022), an ineffective process for collecting, exchanging, and reconciling buyer and seller intragovernmental transactions exacerbates these deficiencies. Overall, the DOD's failure to manage transactions between government agencies well causes financial errors and accountability problems, hurting resource management and trust in government operations.

In response to identified material weaknesses in intragovernmental transactions, the DOD is implementing a series of corrective actions (OUSD[C], 2022). This includes ongoing component-level gap analyses, the development and entry of general terms and conditions agreements into the Department of the Treasury's Invoicing system, and participation in G-Invoicing training to align with federal and DOD data standards. Additionally, efforts are directed toward designing and implementing financial system connections in alignment with the release timeline specified by the guidelines set forth by the Treasury for G-Invoicing. Crucially, the Department is prioritizing the development and documentation of authorization procedures and controls over obligations. This involves establishing compensating controls to ensure obligations are properly authorized in cases where system authorizations are unreliable. Moreover, according to OUSD(C) (2022) the Department continues to leverage Advana's enterprise-wide tools and guidance for intragovernmental transaction (IGT) reconciliation. Of particular importance is the utilization of Advana's dashboard feature, which offers a comprehensive view of intragovernmental transactions, facilitating monthly IGT reconciliations.

The GAO (2021b) suggested that the OUSD(C) use the General Terms and Conditions (GT&C) of G-Invoicing to guarantee conformity with DOD's standards across all DOD components. In response, the OUSD(C) took actions, including the introduction of the Advana platform's GT&C Executive Dashboard tool for monitoring GT&C usage (GAO, 2021b). Additionally, OUSD(C) oversees GT&C operations within the G-Invoicing system administered by the Treasury Department, examining metrics and offering monthly briefings to DOD executives and component leaders (GAO, 2021b). These initiatives have strengthened oversight and enforcement of GT&C module usage policy, facilitating the integration of G-Invoicing and rectifying deficiencies in transactions involving the elimination of balances or entries between different government agencies.

B. LEVERAGING ADVANA FOR AUDIT READINESS

Advana was initially designed with audit purposes in mind. Acknowledging the imperative to bolster financial management, the OSD team pinpointed Advana as pivotal in monitoring expenditures and facilitating auditing tasks (Collibra, 2024b). By systematically cataloging pertinent data sources, Advana offers a centralized hub of information. This section focuses on strategic endeavors aimed at tackling audit readiness, including the annual evaluations of Financial Management systems, which monitor compliance and the retirement of outdated systems. Additionally, this section contains an analysis of initiatives to rectify Federal Information System Controls Audit Manual compliance deficiencies within the DOD's IT framework. Finally, the section investigates cross-functional barriers impeding business transformation within the DOD, underscoring the pivotal role of effective governance and tools like Advana in augmenting audit processes and ensuring compliance.

1. Data Analytics Tools for Auditing

Advana is addressing challenges in financial statement audits by developing tailored tools. These tools are based on the principle that achieving an unmodified opinion requires each reporting entity to accurately identify and record transactions, and show their flow to financial statements (Harker, 2020). Advana's tools aggregate and

reconcile audit populations, allowing reporting entities to delve from financial statements to general ledger details. According to Harker (2020), who was acting under secretary of defense (comptroller)/chief financial officer (OUSD[C]/CFO), this helps in tracking and resolving auditor findings, enhancing funds management, and minimizing cash reconciliation discrepancies between DOD's accounting systems and the Department of the Treasury.

The successful outcome achieved by the United States Marine Corps (USMC) in obtaining a positive audit opinion for its FY 2023 financial statements exemplifies how the implementation of Advana's financial management tools, overseen by the OUSD(C), Enterprise Financial Transformation, can yield favorable results (Advana, 2024). The Advana Team (2024) states that the contributions from Advana included aiding in the resolution of USMC's Intra-governmental Transactions Material Weakness through the platform's Seller Elimination Workbooks and introducing a Qlik feature to address obligation interface errors within the USMC's general ledger system.

2. Financial Management Systems Assessments

Annually, the Department conducts Financial Management systems reviews, which include evaluations of Federal Financial Management Improvement Act (FFMIA) implementation, system security, and the advancement in addressing IT Non-Financial Reportable Items (DOD, 2023b). These assessments serve as vital tools for tracking compliance with both federal and the DOD standards. Moreover, they inform the investment review process for business systems and act as catalysts for influencing system improvements, migrations, and retirements, ultimately enhancing the DOD's overall auditability. According to the DOD (2023b), central to these efforts is the use of an automated Enterprise FM IT Roadmap within the DOD's Advana platform. This Advana FM IT Roadmap facilitates continuous monitoring of compliance reporting, enabling more concise identification of improvement areas, and overseeing the retirement of outdated, non-compliant systems. The DOD Financial Report (2023b) states that in FY 2023, the Department retired 10 systems relevant to internal controls over financial reporting, streamlining the portfolio of systems and bolstering efficiency. Under the

oversight of the Defense Business Council and the Financial Improvement and Audit Readiness Governance Board, the Department remains committed to improving its financial auditability posture. According to the DOD (2023b), this involves establishing consistent assessment and reporting criteria for systems impacting financial reporting and maintaining disciplined oversight over system retirements. Through annual Financial Management systems reviews and the implementation of the Advana platform, the DOD follows the goal of enhancing auditability, ensuring compliance with federal standards, and driving efficiency through the retirement of outdated systems.

3. FISCAM Compliance

FISCAM offers a framework for evaluating how well information system controls are designed, implemented, and operating (GAO, 2009). This methodology is intended primarily for assessing financial audits, performance audits, and attestation engagements in alignment with widely accepted government auditing standards.

The DOD has acknowledged issues regarding FISCAM compliance within its IT systems environment, a problem that has persisted since FY 2001 and that is targeted for correction by FY 2026. Within the DOD's IT landscape, various vulnerable systems and core enterprise systems are supporting crucial end-to-end processes and ERP systems (OUSD(C), 2022). These systems were primarily designed for functional tasks like human resources, property, and logistics management, rather than prioritizing auditable financial statement reporting. Consequently, they fall short of full compliance with FISCAM requirements, particularly in entity-level technology controls, application-level general controls, and automated application controls. According to OUSD(C) (2022), these deficiencies encompass security management access, segregation of duties, configuration management, system interfaces, master data, and audit trails. To address the non-conformance issues related to FISCAM compliance, the DOD has outlined corrective actions. These include the ongoing implementation of an enterprise Identity, Credential, and Access Management solution. OUSD(C) (2022) states that this solution aims to manage user identity attributes, validate user access rights to protected systems, and facilitate the provision, revocation, and management of user access rights.

Additionally, the Department will continue to utilize the Non-Financial Reportable database and leverage technology such as Advana, along with the IT Functional Council, to track remediation status and identify common solutions to material weaknesses and Department-wide issues.

4. Cross-Functional Business Transformation Obstacles within the DOD

The challenge of cross-functional business transformation within the DOD highlights the necessity for effective governance to facilitate cooperation between various functional areas, particularly in financial management processes. Despite efforts by the OUSD(C) to dictate policy and drive change, there have been struggles in gaining support from other functional owners across the Office of the Secretary of Defense (OSD) to achieve interoperability for a successful audit (Commission on PPBE Reform, 2024).

An example of such limitations is seen in the migration to U.S. Treasury Direct Disbursing, intended to streamline payment processes and improve audit readiness. According to the report of the Commission on PPBE Reform (2024), while progress has been made in this transformation, conflicts arise due to the Procure-to-Pay (P2P) process, where only a fraction of transactions can utilize the Treasury Direct model. The Financial Management Systems Tiger Team proposed streamlining the P2P process to enable Treasury Direct disbursing, but progress has been slow due to ongoing debates between the FM and acquisition communities.

The report of the Commission on PPBE Reform (2024) states that the FM community believes that the majority of P2P transactions can be accommodated by enterprise resource planning (ERP) systems, with adjustments to policy and practice. However, concerns from the procurement community have hindered progress, with no viable governance forum to assess cross-functional proposals and mandate change (Commission on PPBE Reform, 2024).

In this context, the role of Advana, as a tool for reconciling financial data and facilitating cross-functional cooperation, becomes crucial. Figure 6 shows the Proposed Change to P2P to Accommodate Treasury Direct Disbursement, contrasting Legacy DOD Processes/Systems with the envisioned Federal Processes/Systems. This figure illustrates

the potential for Advana to streamline and optimize the system landscape by minimizing the number of systems involved in the process.
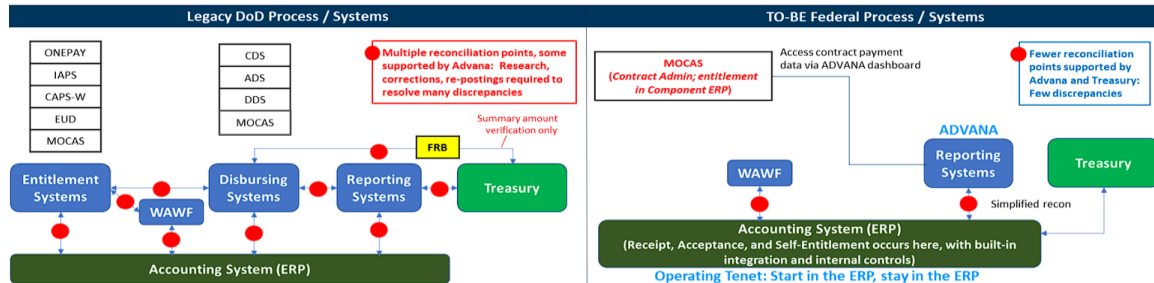
Figure 6.   Proposed Change to P2P to Accommodate Treasury Direct Disbursement. Source: Commission on PPBE Reform (2024)

Advana can provide a platform for transparent data exchange and decision-making, helping to bridge gaps between disparate systems and stakeholders. With effective utilization of Advana and empowered cross-functional governance, the DOD can overcome challenges and improve outcomes in its business processes and audit readiness efforts.

C.   MODERNIZING PPBE AND BUDGETING PROCESSES THROUGH DATA ANALYTICS

The integration of data analytics holds immense potential for optimizing the Program, Planning, Budgeting, and Execution process within the DOD. By assembling a proficient team to deploy and interpret data analytic tools, the PPBE process can be revolutionized, expediting decision-making and resource allocation (Rhode, 2023). Implementing data analytics within the DOD holds the potential for cost savings and efficiency improvements. By leveraging data analytics, the DOD has the capability to pinpoint inefficiencies within current operational processes, optimize resource allocation, and streamline operations, ensuring that financial resources are distributed and allocated to areas where they are deemed most essential and critical (Rhode, 2023). Also, according to Rhode (2023), data analytics facilitates robust risk assessment, enabling the DOD to make informed choices aimed at minimizing possible adverse effects on

budgetary allocations and expenditures. Moreover, analyzing data to evaluate performance enables the DOD to assess the effectiveness of budget programs and initiatives, making adjustments or reallocations as necessary. Ultimately, effective data analytics can identify opportunities for cost reduction without compromising mission effectiveness, proving invaluable in times of budget constraints (Rhode, 2023). This transformation can streamline outdated procedures, enabling analysts to dedicate their expertise to data analysis and providing actionable insights for swifter, more informed decision-making.

Thus, the USD(C) has introduced a dashboard supported by Advana, offering tailored reports for monitoring budget data throughout the budget process, from preparation to execution. This dashboard allows for trend analysis at both appropriation and Budget Line Item levels (Commission on PPBE Reform, 2024). Additionally, the Advana platform incorporates a Spend Plan Module, enabling the identification of spend plan variances, and facilitates a mid-year review process that is automated.

As an example of Advana's transformative potential in reshaping financial management practices within the DOD and leveraging data analytics to achieve cost savings, Deputy Secretary of Defense David L. Norquist referenced evidence spanning from the inception of Advana to his speech. Speaking before the Senate Armed Services Subcommittee on Readiness and Management Support on November 20, 2019, he highlighted the transformative impact of Advana (Norquist, 2019). By streamlining processes and eliminating inefficiencies, Advana afforded analysts invaluable time and insights. As a result, the DOD was able "to identify a cumulative $316 million in high-risk funds," optimizing resource allocation and preventing wastage through expiration or cancellation (Norquist, 2019, p. 7).

Furthermore, the DOD recognized the need for enhanced data analytics and adopted the Analysis Working Group (AWG) and Advana platform to improve its planning and budgeting processes (Commission on PPBE Reform, 2024). The AWG, established in response to strategic directives, aims to reform analytical expertise, ensure robust decision-making foundations, and foster transparency and collaboration. It

emphasizes principles of transparency, robustness, and analysis, promoting joint perspectives and comprehensive briefings for senior leaders.

A practical demonstration of the application of analytics in budget execution can be showcased through an example within the Navy. For Budget Execution Validation (BEV), the Navy leverages the Jupiter[3] and Advana platforms, integrating analytical tools to monitor and validate budgetary processes while optimizing execution. According to the User Guide for the Enhanced Unit Commander's Financial Report (eUCFR) (Assistant Secretary of the Navy, 2022) users can access and navigate the United States Navy (USN) MILPAY Monitoring Dashboard within Jupiter Analytics, powered by Advana. The USN MILPAY application serves as a centralized tool for analyzing and monitoring various aspects of Sailor Pay, including debt management, pending payments, and Permanent Change of Status (PCS) gains. Through the integration of data from sources such as Defense Joint Military Pay System – Active Component (DJMS-AC), users can generate insights to support budget execution validation and ensure the accuracy and integrity of financial data within the Navy's enterprise (Assistant Secretary of the Navy, 2022). This product is intended to provide commanding officers and their designees with valuable insights to monitor pay and entitlements for assigned personnel, track trends over time, and automate the generation of insights related to the Navy's Military Pay priority areas. The Navy's example demonstrates the utilization of data analytics to monitor financial processes, ensuring accuracy and providing insights for the management of budget funds.

D.   FOSTERING TRANSPARENCY: DOD–CONGRESS DATA EXCHANGE

Efficient congressional oversight demands a steady flow of pertinent, secure, and timely data from the DOD. However, existing barriers hinder the seamless transmission of data between the DOD and Congress, impacting effective decision-making and oversight processes. Outdated methods for data sharing between the DOD and Congress

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[3] Jupiter serves as the enterprise data hub for the Navy, facilitating Information Domain integration and providing metadata on Naval data, both within the Advana technical ecosystem and beyond, to ensure data quality, stewardship, and stakeholder collaboration (Office of the DON Chief Data Officer, 2020).

hinder efficient communication and transparency. Manual and labor-intensive processes, such as sharing spreadsheets and PDF files, result in slow response times, errors, and difficulties in extracting needed information for analysis (Commission on PPBE Reform, 2024). These antiquated methods strain resources and impede effective collaboration between the DOD and Congress, potentially impacting their resourcing-related relationships.

The report of the Commission on PPBE Reform (2024) emphasizes the need for streamlined, searchable, and sortable data sharing between the DOD and Congress to foster transparency and partnership. The report proposes leveraging digital collaborative environments like Advana to facilitate efficient data sharing, enabling timely submissions and feedback exchange. Advana's capability to ingest investment data and support internal analytics presents a promising solution for expediting this recommendation.

However, the imperative of sharing data between the DOD and Congress via Advana is not a recent development. Despite ongoing efforts to bolster this data exchange, limited progress has been achieved in this area. Analysis conducted by the Government Accountability Office (GAO, 2022) on Section 830(b) of the National Defense Authorization Act for Fiscal Year 2020, coupled with the DOD documentation, underscores this persistent challenge. Notably, as early as 2020, the DOD proposed leveraging Advana to streamline data transfer and reporting to Congress. However, despite these initial proposals, substantive strides have yet to be achieved in the past four years, leaving the issue unresolved. This stagnation underscores the enduring challenges associated with optimizing data-sharing practices between government entities. The lack of progress stems from various factors, such as technical complexities and bureaucratic hurdles. Additionally, concerns about data security and data compliance have contributed to the slow pace of implementation. Addressing these issues requires collaboration across different levels of government to overcome the challenges and achieve effective data-sharing mechanisms.

E. EXECUTIVE ANALYTICS "PULSE" AND BUSINESS HEALTH METRICS

The DOD's leadership decision-making depends on the integration of data across various platforms and strategic documents, such as the National Defense Strategy, to ensure timely and informed resource allocation and capability delivery. By linking the annual budget request to strategic documents or guidance documents, leadership can make informed decisions faster. Integration and synchronization of acquisition, requirements, resource allocation, and financial management systems are vital for the timely delivery of capabilities (Commission on PPBE Reform, 2024). Furthermore, standardized data and analytical tools at all leadership levels can enable real-time trade-offs for resourcing decisions, while automation and informed workflows can free personnel from mundane tasks.

The DOD is prioritizing the utilization of data and analytics to monitor progress on strategic initiatives in a metrics-based approach aimed at enhancing performance. Collaborating with key stakeholders such as the CDAO, Advana has been instrumental in designing an executive analytics capability called "Pulse." Integrated within Advana, Pulse offers senior leaders comprehensive insights derived from authoritative data, enabling them to assess the Department's performance against its top priorities (GAO, 2023). Pulse utilizes performance data and additional analytics from Business Health Metrics. This initiative underscores Advana's role in driving the Department's transformation into a data-driven organization, aligning performance improvement efforts with key priorities, and facilitating informed decision-making.

For instance, Nicolas Lanham, deputy program manager for the Advana Program, provided a description of Pulse's functionality and operational framework, outlining the Advana office's strategies for enhancing its data-driven decision-making capabilities in 2023. The overarching goal outlined by Lanham is to transform data utilization for senior leaders by ensuring scalability and automation within applications, facilitating real-time decision-making processes (Degges, 2023). This involves making Advana-hosted data dynamic and easily accessible, allowing leaders to engage with evolving information during discussions, rather than relying on static briefing materials. Lanham emphasizes

the importance of not just presenting data but enabling meaningful connections and insights. The vision for the platform is to empower users to seamlessly explore new integrations and make informed decisions collaboratively. According to Lanham, this methodology is being implemented across departments, with Advana already proving its value in use cases. The platform's partnership environment and the incorporation of an application programming interface layer aim to enhance its versatility and support the development of applications tailored to leaders' needs. Ultimately, Lanham mentioned that the objective is to leverage data to establish key performance metrics and drive performance assessment across various information-based functions.

Advana has made significant strides in transforming data analysis processes within the DOD, drastically reducing the time required for analysis while improving data quality and reliability (Defense Business Board [DBB], 2022b). Despite these advancements, challenges in timeliness and reliability persist. According to the Defense Business Board (2022b), moving forward, there is an opportunity for Advana to provide decision-makers with the necessary dashboard and data through Business Health Metrics, enhance the use of data-driven performance measures in the Department's Annual Performance Plan and Report, ensure continuity and accountability by utilizing standardized core metrics, and foster greater alignment across the federated enterprise by standardizing metrics.

However, the ongoing challenges related to the utilization of Business Health Metrics indicate that the DOD components are not effectively incorporating them into their operations. This lack of widespread adoption is exemplified by research conducted by the Defense Business Board. The Request for Information was distributed to 16 Defense Agencies/Field Activities and all three Military Departments aimed to gather insights on the primary metrics senior leaders use to assess business health (DBB, 2022b). However, only four respondents reported using Advana metrics for this purpose, highlighting the challenge of consistently and objectively measuring enterprise health.

Also, the GAO (2023) identified gaps in the DOD/Advana's implementation of Business Health Metrics. Specifically, the GAO states that the DOD lacks a monitoring plan to assess the sustainability and effectiveness of corrective actions taken in response

to business reform initiatives, and there is a lack of guidance on effectively leveraging Business Health Metrics within Advana for managing and reforming the DOD's business operations. According to the GAO (2023), to address these gaps, the DOD should develop a comprehensive monitoring plan and provide guidance on effectively utilizing Business Health Metrics to support department-wide reform efforts, ensuring that data collected through Advana is optimally utilized for informed decision-making and performance improvement.

F.   DFAS DATA ANALYTICS INITIATIVES IN FINANCIAL REPORTING

Efforts to enhance financial reporting within the DOD are underway, prompted by a recommendation from the Government Accountability Office (GAO, 2021). The GAO advises establishing a process to compile a comprehensive set of transactions at the consolidated level and ensuring consistent data collection across all Defense Finance and Accounting Service sites for suspense account transactions. In response, the DOD has expressed agreement and is actively pursuing the integration of Advana to streamline the compilation of suspense account transaction data. Additionally, the DOD acknowledges the importance of standardizing file formats and fields to facilitate the preparation of transaction universes for suspense accounts across all Treasury Indices (GAO, 2021). This initiative underscores Advana's potential to revolutionize financial management practices and bolster reporting accuracy within the DOD.

The DFAS Data Analytics initiative strategically aligns personnel skillsets with job functions to optimize the application of technology solutions, thereby enhancing insight from extensive data sources. This advancement has led to increased data integrity and facilitated multifaceted analysis. Notably, DFAS has progressed from descriptive to predictive analytics, enabling real-time, forward-looking data for decision-making (Defense Finance and Accounting Service [DFAS], 2019). For instance, predictive analytics tools like the Mechanization of Contract Administrative Services (MOCAS) dashboard can forecast invoice surges, aiding in resource realignment. Furthermore, initiatives such as the General Fund Enterprise Business System (GFEBS) Unmatched Transactions Reduction Initiative demonstrate DFAS's commitment to leveraging data

analytics to streamline processes and improve efficiency. According to DFAS (2019), standardization efforts, exemplified by the Standard Financial Information Structure (SFIS) initiative, ensure consistency and integrity in financial reporting, surpassing regulatory requirements. Additionally, initiatives like the end-to-end review of costing for financial management showcase DFAS's ability to provide cost-effective services while maintaining quality.

Looking ahead, DFAS established in 2020 a Data Analytics Center of Excellence (DACoE) to further cultivate a data-driven culture and generate greater business insights. The DACoE's priorities encompass refining data management practices, establishing governance structures, enhancing training programs, and delivering value through applied analytics (DFAS, 2020). With the recruitment of data scientists and engineers, the DACoE is poised to support high-impact projects by providing advanced analytics expertise. Moreover, according to DFAS (2020), the DACoE aims to enhance project teams' data analysis proficiency through standardized resources and training materials.

Furthermore, the Defense Agencies Initiative has implemented Oracle Analytics Server to support DFAS with a powerful querying tool (DFAS, 2023). This tool enables the generation of real-time data reports, crucial for enhancing the accuracy of reconciliations, managing the universe of transactions, and facilitating comprehensive variance analysis.

In FY 2023, DFAS successfully met strategic objectives, maintaining alignment with its mission and vision while advancing the Department toward long-term goals (DFAS, 2023). A notable achievement was the collaboration with Advana to introduce the Data Integrity Dashboard, a project of personal pride. As DFAS (2023) states, this dashboard facilitates the identification of data enhancement opportunities by data owners, directly impacting the accuracy and integrity of financial statements. The anticipated outcome includes improved audit performance and greater confidence in financial results due to enhanced data quality.

G. IMPROVING FINANCIAL COMPLIANCE: ROBOTIC PROCESS AUTOMATION AND MACHINE LEARNING INTEGRATION

The evolution of IT management initially stemmed from the need to automate manual processes and has since advanced to the integration of independently automated tasks, now widely implemented through Robotic Process Automation. The RPA initiative within DFAS aims to revolutionize operational efficiency through innovative digital solutions. By partnering across DFAS, the Office of the Under Secretary of Defense, and various Military Services and Agencies, the mission of DFAS is to develop and implement RPA technologies that deliver measurable productivity benefits (DFAS, 2022).

DFAS employs RPA to address cost-effective risk management challenges. By leveraging RPA, DFAS aims to enhance internal controls, expedite processes with increased accuracy, standardize operations, and reduce reliance on manual labor (Davis & Reed, 2021). The focus is primarily on optimizing low-analysis, highly manual tasks prone to errors, repetitive processes, and tasks involving large audit samples. According to Davis and Reed (2021), DFAS utilizes available bots to minimize redundancy, facilitating collaboration within the DOD, leveraging tools like Advana and an Enterprise SharePoint site, and aligning operations with enterprise use cases. This strategic integration of RPA enables DFAS to streamline operations, mitigate risks, and achieve greater efficiency in financial management processes.

Through strategic implementation, DFAS has already achieved significant time savings. For instance, in the Accounts Receivable Public Invoices process, the time required to generate invoices in the Defense Enterprise Accounting Management System has been reduced by 2,930 hours annually (DFAS, 2022). Similarly, the Defense Cash Accountability System Query Document Pull process has seen a reduction of 132 hours annually, streamlining FBWT reconciliations. Additionally, as DFAS (2022) states, in the General Fund Enterprise Business System Tie Point Reconciliation #2 Reverse & Repost process, the time required to handle debt collections in GFEBS has been reduced by 1,285 hours annually.

The DFAS RPA program's achievements extend beyond mere time savings. It aims to simplify and optimize the entire business environment by leveraging digital and automation solutions. According to DFAS (2022), this involves supporting and deploying bots, enhancing the Advana QLIK RPA dashboard for DFAS, and maintaining a pipeline of high-value use cases to address various operational challenges.

The RPA program represents a strategic shift toward harnessing software to emulate human actions within digital systems, thereby optimizing business processes. With numerous bots operational and already deployed within DFAS (2022), the vision is to cultivate a mature robotics program that complements employee efforts, driving even greater efficiencies across the organization.

The DOD has long grappled with the significant labor hours spent annually on manual tracking and resolution of discrepancies within enterprise resource management systems. While RPA tools are instrumental in automating rules-based financial transactions, many processes still require manual intervention due to their less-defined nature (Defense Innovation Unit [DIU], 2022). The average time spent on resolving these Unmatched Transactions (UMTs) manually stands at 2 hours, highlighting the need for more efficient solutions.

In response to this challenge, the DIU and the Joint Artificial Intelligence Center (JAIC) conducted separate pilots utilizing machine learning (ML) technology, hosted on the secure cloud environment of Advana (DIU, 2022). The pilots aimed to leverage ML platforms to streamline UMT resolution processes within various DOD agencies. Through a selection process facilitated by DIU, contracts were awarded to two vendors, Vertosoft and Summit2Sea, to collaborate on the Humanless Unmatched Transactions (HUnT) program (DIU, 2022).

According to DIU (2022), one pilot, led by Summit2Sea, employed Amazon Web Services' Sagemaker ML platform within the DOD Comptroller's Office, focusing on six Defense Agencies. The second pilot, conducted in collaboration with the Army Financial Management and Control team, tested the Vertosoft/DataRobot AI platform. These

initiatives marked a significant advancement in the DOD's automation capabilities, transitioning from rule-based RPA functions to predictive analytics.

As DIU (2022) states, Erica Thomas, from OUSD(C)'s Enterprise Data & Business Performance directorate, emphasized the transformative impact of combining RPA with ML in the Humanless Unmatched Transaction solution. By predicting corrective actions for UMT resolution using ML and executing them with RPA, significant labor cost savings are expected, with projections exceeding $1.3 million annually across multiple agencies (DIU, 2022).

The Summit2Sea pilot, employing separate ML models for each defense agency, achieved remarkable efficiency gains, reducing UMT resolution time from hours to mere minutes (DIU, 2022). Similarly, the Vertosoft/DataRobot pilot with the U.S. Army demonstrated a 99% accuracy rate in error detection across four use cases, significantly enhancing operational effectiveness.

Eric Dorsey, the DIU program manager, underscored the potential for substantial savings and improved efficiency across the DOD, particularly within the Army Financial Management and Comptroller, which handles a substantial volume of UMTs annually (DIU, 2022). Both pilots have successfully transitioned into production, with discussions underway for broader implementation across additional DOD entities.

The automated processes within the DOD and its associated agencies, such as the Navy, Air Force, and Defense Logistics Agency, aim to enhance financial management by improving efficiency in data handling, compliance reporting, and logistics (Federal Robotic Process Automation Community of Practice, 2020). These automations help in reducing manual workloads, ensuring timely updates and validations of data, and enhancing overall operational efficiency. By leveraging RPA, these organizations streamline financial workflows, minimize human errors, and reallocate human resources to more strategic tasks.

In conclusion, the integration of machine learning with robotic process automation presents a transformative solution for the DOD, offering significant efficiency gains, cost savings, and enhanced data analytics capabilities.

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VI. ANALYSIS OF THE ADOPTION OF THE DATA-DRIVEN APPROACHES IN THE DOD

This chapter analyzes the cultivation of data-driven approaches within the DOD. Challenges in accessing and utilizing available data persist due to outdated systems, access controls, and governance policies. The analysis highlights the need to streamline access controls and governance policies while maintaining security standards, ensuring data is more readily available to personnel across the organization. However, the adoption of federated data governance approaches shows promise in surmounting this challenge while integrating emerging technologies.

Based on the DOD analysis, to maximize platform utility and derive accurate insights, the organization needs to collect high-quality data. Moreover, the DOD could use the medallion architecture more efficiently within a lakehouse framework to iteratively refine data and progressively enhance data structure and quality. Nevertheless, shortages of incentives and skills among personnel complicate these efforts. Cultural change within the DOD is one of the obstacles that hinder digital tools adoption. Addressing these challenges related to data management, cultural change, and skills development is pivotal for enhancing data-driven decision-making within the DOD.

A. DATA DEMOCRATIZATION

The DOD confronts the challenge of responsible and effective data democratization, "an ongoing effort to make data accessible, usable, and comprehensible to stakeholders throughout the organization" (Rinderer, 2023, para. 7). This initiative involves eliminating barriers that impede data access and facilitating smarter, quicker, data-driven decision-making processes. Within the DOD, data accessibility presents a notable challenge, impacting operational efficiency. In order to improve data accessibility, as the Defense Innovation Board states, "DOD must first address its lack of seamless data extensibility and interoperability through a unified, scalable data access approach" (DIB, 2024, p. 5). While there is an abundance of data available, not all personnel have access to the information necessary for their tasks. Bill Streilein, chief

technology officer for the DOD's Chief Digital and Artificial Intelligence Office, explained during a webinar event hosted by GovExec that this incomplete utilization of available data resources stems from factors such as outdated systems, access controls, and governance policies, ultimately hindering the Department's ability to fully leverage its data assets (Streilein, 2023). To address this issue, one proposed solution is to centralize data through an authoritative source like Advana. Advana has proven effective in consolidating data, enabling comprehensive analytics and insights. However, according to Streilein (2023), there are concerns about the scalability of this approach to encompass all of the DOD's diverse data sources. He stated that the DOD is investigating a federated model to tackle incomplete data accessibility, enabling data to be utilized at its origin while facilitating self-service access. Also, according to Streilein (2023), operating on role- or attribute-based mechanisms, this approach empowers users to create customized analytics suited to their requirements.

The implementation of classified data and analytics environments within Advana has faced challenges. According to the Defense Innovation Board report "Building a DOD Data Economy," feedback from users indicates frustration with the delayed progress in establishing classified data and analytics environments within Advana (Defense Innovation Board [DIB], 2024). The majority of data products remain at the Unclassified level, with restricted access at higher classification levels such as Secret and Top Secret. Presently, there are around 475 business systems accessible at the Unclassified level and 50 at the Secret level (DIB, 2024). The report states that the stakeholders have raised concerns regarding the availability and accessibility of Advana environments at the Top Secret level, citing their absence or the complexity associated with accessing them. Overall, as Bohra et al. (2023) stated, the DOD should extend access to its extensive data resources across its workforce, and enhance data technologies to unlock their full potential.

B.   DATA STANDARDS, DATA QUALITY, DATA DUPLICATION

The Commission on PPBE Reform in its 2024 report highlights the integration of Advana, which has directed the focus of the senior leaders toward making decisions

based on data within the DOD (Commission on PPBE Reform, 2024). At the same time, as this report states, the efficacy of this platform relies heavily on the quality of data input from the systems they integrate with. Therefore, ensuring high data quality is imperative for the effective utilization of Advana, as subpar data quality could undermine the impact of these efforts.

According to an interview with the CDAO Craig Martell (Vincent, 2022), the main focus of the CDAO office is not on developing new AI models and programs; rather, it is dedicated to facilitating the utilization and dissemination of clean and dependable data throughout the expansive enterprise of the DOD, extending from the OSD to the warfighter. "I would say that's our hardest challenge right now. [It's] how do we figure out how to get quality data across the department," Martell explained (Vincent, 2022, para. 4). Martell observed that the majority of the growing attention and call for AI does not truly stem from a necessity for AI itself. Instead, he noted that it predominantly arises from a requirement for high-quality data and an effective dashboard that enables individuals to comprehend the significance of their data. This perspective underscores the fundamental importance of data quality, data literacy, and visualization tools in meeting organizational needs and extracting value from data assets.

The challenge of data duplication poses an obstacle for the DOD and for the departments within the DOD. The example of the Navy illustrates that akin to other departments within the DOD, it faces a substantial issue of data duplication across its various data systems. As Navy CDO Tom Sasala (Nyczepir, 2021) pointed out, challenges in inventorying data and establishing department-wide data policies are magnified by the extensive size and scope of the Navy's data landscape. He also mentioned that despite efforts to implement authoritative datasets and appoint deputy data officers, rampant data duplication persists, hindering data quality and usability. Addressing this issue is paramount for the Navy and reflects broader challenges within the DOD in managing and leveraging data effectively.

Effective decision-making and technology utilization across all DOD levels and functions necessitate data that is reliable, accessible in various formats, and secure. As data volumes increase, infrastructure enhancements and cultural shifts are vital to

facilitate data curation and adherence to data standards (Bohra et al., 2023). However, the DOD lacks standardized protocols for comprehensively recognizing and managing its data assets, with limited capabilities for data storage and sharing (DBB, 2024). While the deployment of Advana marked a significant step toward advanced analytics, its adoption has been gradual. As the Defense Business Board (2024) states, the absence of uniform data standards and definitions remains a significant obstacle, impeding the realization of data's full potential for integration, analytics, and informed decision-making within the DOD.

Data owners within the DOD currently lack incentives to share, interconnect, or manage their data, often due to concerns about trust and proper utilization. Fragmentation and lack of integration further hinder data sharing and interoperability, exacerbated by outdated security and IT infrastructure (DBB, 2024). Additionally, the absence of mechanisms for moving data across classification levels or programs poses challenges for achieving end-to-end visibility (DBB, 2024). Also, the report of the Defense Business Board (2024) states that while the DOD expresses the ambition to leverage data strategically, the absence of standardized taxonomy, integration, and intellectual property rights impedes the execution of this vision.

Existing legacy systems and processes within the DOD hinder a fully digital workflow, leading to data flow disruptions and instances of duplication and inaccuracies. Discrepancies across systems were identified by the Commission on PPBE Reform (2024), indicating potential issues arising from reliance on flat files, like Word or Excel documents, and manual data entry methods. These methods necessitate data updates across multiple systems, contributing to errors and outdated information (Commission on PPBE Reform, 2024). Furthermore, flat files pose additional challenges such as limited searchability and error propagation across formats. Also, unique security needs for DOD programs may impede the adoption of standardized digital solutions, complicating efforts to streamline processes.

One potential solution to assist the DOD in monitoring its progress toward becoming a data-driven organization is to develop roadmaps. Private sector organizations have developed roadmaps, such as Data Maturity Models and Data Analytics Maturity

Models (DBB, 2022). These models enable organizations to assess their level of data and analytics capability more effectively compared to those undergoing similar transformations without such frameworks. According to the report of the Defense Business Board (2022a), maturity models offer systematic steps for progression, facilitating organizations in visualizing the path toward achieving full capability. Key considerations for implementation include defining future-state objectives and taking responsibility for progress. These models serve as benchmarks for organizations, allowing them to evaluate their proficiency levels and plan strategies to bridge any identified gaps (DBB, 2022a). According to the Defense Business Board (2022a), the leaders within the DOD, who work with data, are acquainted with and have applied data maturity models in developing and executing Advana. Despite applying this model, there is still no implementation plan that would facilitate progress monitoring.

In Advana, a medallion architecture serves as a data design pattern implemented within a lakehouse framework, aiming to systematically enhance the organization and quality of data across different layers, namely Bronze, Silver, and Gold tables. Figure 7 illustrates the progression of data from batch and streaming stages to the application of business intelligence and machine learning tools, depicting the data quality associated with each layer. According to Databricks (2022), medallion architecture facilitates iterative refinement of data within a lakehouse environment, enabling gradual improvements in data structure and quality across each layer of the architecture.
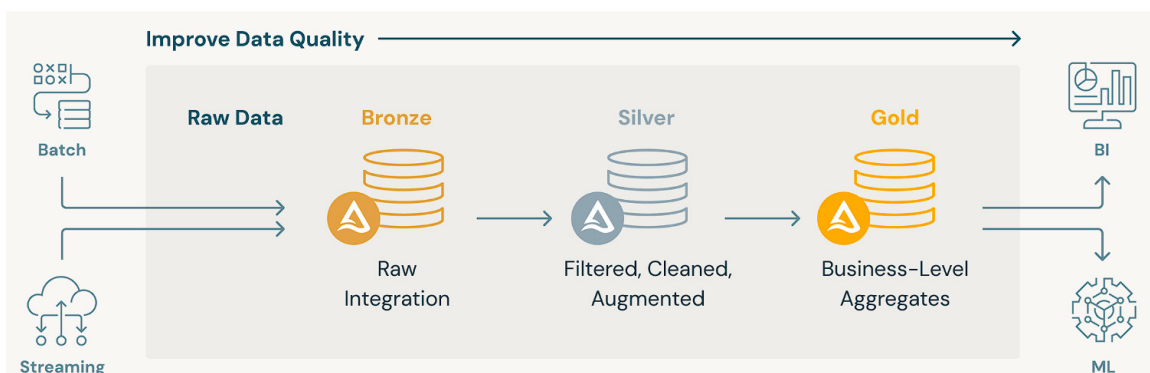

Figure 7.   Medallion Architecture. Source: Databricks (2022).

In the Bronze layer, incoming data from external source systems is initially deposited. At this layer, table structures mirror those of the source systems in their original state, augmented by supplementary metadata columns such as load date/time and process identifier (Databricks, 2022). This layer prioritizes swift Change Data Capture and facilitates historical archiving of the source data for cold storage purposes. As Databricks (2022, para. 3) mentions, the Bronze layer also ensures "data lineage, auditability, [and] reprocessing if needed without rereading the data from the source system."

Data from the Bronze layer is then processed in the Silver layer. At this layer, data undergoes matching, merging, conformation, and cleansing, which is performed by users, aiming for a consolidated "Enterprise view" of business units and their interactions (Databricks, 2022). This layer integrates data from various sources to facilitate "self-service analytics for ad-hoc reporting, advanced analytics, and ML" (Databricks, 2022, para. 4), supporting the work of analysts, engineers, and scientists. According to Databricks (2022), the ELT methodology is typically employed, emphasizing minimal transformations and cleansing during Silver layer loading to prioritize speed and agility in data delivery to the lake. As Databricks (2022, para. 6) states, more "complex transformations and business rules are applied while loading the data from the Silver to Gold layer."

The Gold layer of the lakehouse serves as a consumption-ready database for project-specific purposes, housing denormalized and read-optimized data models with minimal efforts for efficient reporting (Databricks, 2022). This layer applies final data transformations and quality rules, hosting projects like "Customer Analytics, Product Quality Analytics, Inventory Analytics, etc." (Databricks, 2022, para. 7). It often incorporates "Kimball-style star schema-based models or Inmon-style Data marts" (Databricks, 2022, para. 7). This integration enables comprehensive advanced analytics and machine learning across diverse data sources.

The Gold layer in the lakehouse data architecture is renowned for its exceptional data quality and usability, providing denormalized, read-optimized data models for efficient reporting and analysis. Because of these advantages, users of Advana tend to

gravitate toward datasets categorized as gold, which are readily usable. This poses a challenge as users are often unwilling or lack the necessary skills to work with data at the bronze or silver layers, where users must perform data cleaning and preparation. This limitation hampers the full utilization of Advana's capabilities. Despite Advana's technological prowess and integration of various tools and technologies, users opt for the easiest route by selecting pre-existing and pre-cleaned datasets. The reluctance of users to engage with the Bronze and Silver layers may be attributed to a lack of proficiency in data-related skills, such as SQL and programming languages, necessary for conducting data preparation tasks. Additionally, it is also related to concerns over the readiness of data and the magnitude of the cleaning task; sometimes, it is simply beyond the scope of time users have, even if they have the skills to transform the datasets. These challenges underscore the importance of addressing the mentioned workforce's issues to maximize Advana's potential and promote effective data utilization across the DOD.

C.   CULTURAL CHANGE

The research conducted by Ernst & Young indicates that the DOD has developed strategic guidelines for transitioning into a data-centric organization, supported by the robust technological infrastructure of the Advana platform, which is described in Chapter IV (Bohra et al., 2023). However, the research also highlights persisting gaps in the DOD's approaches, which impede the pace of this transition (Bohra et al., 2023). Moving forward, the focus should shift toward effectively communicating the availability and location of assets, fostering consensus on the importance of data-driven efficiencies, and identifying and retaining individuals capable of promoting a data-driven culture. Data-first organizations establish robust frameworks for high-level data-driven decision-making (Bohra et al., 2023). However, achieving this goal necessitates the use of various digital tools and software licenses. Chapter IV delineates the key technological components integrated into Advana. Moreover, developing the technologically sophisticated data analytics platform entails a substantial budgetary commitment. Hence, it is imperative to prioritize training and workforce proficiency to optimize the platform's utilization and enable employees to effectively harness its capabilities. Above all, fostering a culture within the organization that values and understands the importance of

data analytics is crucial for encouraging employee involvement and ensuring the successful adoption of sophisticated data analytics platforms developed by the DOD.

Currently, the DOD encounters challenges in nurturing a culture that fosters data-driven decision-making. The DOD exhibits data-driven leadership at the upper echelons of each service or agency, as affirmed by the Defense Business Board (2022a). However, the commitment to data-driven decision-making diminishes as it descends from the highest levels of leadership. The "frozen middle" phenomenon within the DOD refers to stagnation at middle management levels, where reluctance to change obstructs the usage of new tools and technologies (DBB, 2024). This reluctance to embrace innovation stems from a risk-averse culture, perpetuated by bureaucratic processes. Interviews conducted by the Defense Business Board (2024) revealed that this "frozen middle" hinders progress and stifles innovative ideas, ultimately preventing the DOD from achieving its goals of innovation and modernization. To overcome this obstacle, it is imperative to empower middle management to take prudent risks and challenge the status quo, fostering a culture that rewards bold initiatives.

In the DOD, blending the expertise of data professionals from the business world with the complexities of organizational structures poses a challenge. The DOD has recruited numerous skilled individuals accustomed to significant autonomy in utilizing data for business results, primarily from commercial sectors (Bohra et al., 2023). However, within the DOD's complex organizational framework, data governance structures introduce constraints and friction, restricting data accessibility and usage in applications. According to Bohra et al. (2023), achieving data literacy necessitates a concerted, collaborative effort between different parts of the organization to effectively leverage the growing knowledge base within the workforce.

The DOD also inadequately incentivizes its personnel to adapt their skills and practices to keep pace with a rapidly evolving digital environment. According to the Defense Business Board (2024), senior executives have voiced concerns over this issue, highlighting its impact on the DOD's capability to adequately address the growing threat posed by China. This lack of incentive, coupled with organizational inertia, impedes the adoption of new technologies and tools essential for enhancing the agility and capabilities

of the digital workforce. DBB (2024) states that program managers, in particular, tend to prioritize short-term risk reduction and cost savings over the integration of new tools and processes.

At the same time, it is important to mention that the gaps associated with cultural resistance within the DOD are not unique but are prevalent in many large organizations. As indicated by research conducted by McKinsey & Company (Bucy et al., 2016), many organizations, including those in the private sector, are facing similar challenges posed by disruptive technologies, necessitating organizational transformation. Despite the urgency, most transformation efforts fall short of their objectives, with research indicating that "70 percent of complex, large-scale change programs don't reach their stated goals" (Bucy et al., 2016, para. 2). The authors of the research state that common challenges include employee disengagement, lack of management support, and insufficient cross-functional collaboration.

D.   DATA TALENT MANAGEMENT

The core of a data-centric organization lies in its people. According to Bohra et al. (2023), employee learning and involvement play pivotal roles in guaranteeing that all members are aligned with the organization's overarching goals in measurable ways, with transparent connections to decision-making processes and essential data. The DOD currently faces a deficiency in the comprehensive skill set required to expedite the transition to widespread application of data analytics. This highlights a need for substantial upskilling of the workforce.

The DOD faces a significant demand for data scientists, engineers, and migration specialists to support the expansion of Advana and the transfer of data from various systems (DBB, 2022a). However, competing with the private sector for talent proves challenging due to factors like superior pay, benefits, and hiring efficiency. According to the Defense Business Board (DBB, 2022a), one potential solution lies in upskilling existing DOD employees, providing incentives and opportunities for them to transition into data science careers. While the DOD already offers some training and certification programs in data-related fields, as mentioned in Chapter IV, expanding these initiatives is

crucial to ensure a sufficient pool of skilled personnel in the future. By investing in training and certification programs for in-house talent, the DOD can strengthen its data capabilities and reduce reliance on external recruitment (DBB, 2022a).

Moreover, recruiting new talent remains crucial but poses a challenge within the DOD due to the highly competitive landscape for skilled data professionals. Both the DOD and the private industry vie for the same pool of specialized talent, facing competition not only with each other but also with the broader marketplace (DBB, 2024). The DOD lacks a clear pathway to effectively acquire talent in data analytics and data science domains. Moreover, even after they acquire such talent, as DBB (2024) states, then the DOD lacks precise career paths and clear competency frameworks for these employees. Without such pathways, employees with data skills don't clearly understand their career perspectives within the DOD; at the same time, employees without data skills may struggle to adapt to new tools, hindering the timely and effective development of new systems. According to DBB (2024), this gap contributes to prolonged fielding timelines and suboptimal results of new digital tools and systems.

The report provided by the Commission on PPBE Reform also highlights a concern regarding the recruitment and retention of personnel within the DOD, underscored by an increase in the vacancy rate (Commission on PPBE Reform, 2023). As the Commission on PPBE Reform states, this trend is partly attributed to the substantial workload that leads to extensive overtime commitments. Furthermore, the report states that the absence of full-time telework options within the DOD places the organization at a disadvantage when competing for talent against private companies that offer such flexibility (Commission on PPBE Reform, 2023). The DOD Financial Management Strategy 2022–2026 is expected to play a significant role in these endeavors (DOD, 2022a). As discussed in Chapter III, the strategy aims to cultivate a skilled and motivated financial management workforce within the DOD by enhancing training, fostering community, ensuring compliance, and providing continuous learning opportunities. However, the actual work environment within the DOD may not always align precisely with the strategies outlined on paper.

For example, recruiting and retaining skilled talent within the DOD pose considerable challenges, particularly given the evolving nature of roles within the organization. This is exemplified by the transition of numerous employees, initially serving in finance capacities, to undertaking intricate data-related responsibilities. During the Data AI Summit organized by Databricks, Cody Ferguson, who holds a position in the Chief Digital and Artificial Intelligence Office at the DOD, overseeing the Data and AI Division,[4] emphasized the significant challenge of digital talent management within the government sector, particularly in recruitment and retention efforts for top-tier professionals (Ferguson, 2023). According to Ferguson (2023), despite being government employees, many individuals, originally stationed in the comptroller's office, now find themselves engaged in roles spanning data engineering, data operations, artificial intelligence, and database management. However, he mentioned that their official job titles often fail to capture the breadth of their responsibilities accurately. Consequently, the prioritization of talent management emerges as a crucial initiative to address this disparity and optimize workforce capabilities.

The DOD should bolster the analytical capacity of its personnel, given the frequent confusion between reporting and analysis. During the Current 2022 Summit Little (Little, 2022), who worked at CDAO in 2022, mentioned that while reporting involves simply presenting data, analysis requires actionable steps based on that data. Little (2022) stressed that the objective is to empower analysis by recruiting top-tier talent attracted to the formidable challenges the DOD faces. This empowerment is essential because, without it, there is a risk of misunderstanding the true scope of the DOD's problems.

Presently, many components within the DOD face a shortage of dedicated data scientists who possess the expertise to extract optimal insights from available data. This scarcity presents a significant challenge for the DOD. Addressing this challenge warrants the establishment of accessible support mechanisms. One of the options of such support mechanisms comes from Dr. Tim Grayson, formerly affiliated with DARPA (Weber,

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[4] This role encompasses management of four key portfolios: data source connectivity, data governance, support for data scientists and engineers organization-wide, and management of the data operations layer.

2022). He advocates for establishing a specialized unit of data scientists. This unit of experts would be tasked with resolving internal data-related challenges encountered by various DOD entities, thereby helping data owners to understand how they can use their data to get maximum value from it (Weber, 2022). At the same time, those proficient data scientists would gain invaluable familiarity with a diverse array of DOD systems (Weber, 2022). This experience would not only hone their existing skills but also equip them with the adaptability requisite for swiftly navigating data connections and translators between various systems of the DOD. Also, establishing such units within all DOD components would foster agility, particularly in response to the evolving environment, which consistently introduces new challenges to the DOD.

Another area that warrants attention is the upskilling of employees who already possess technological skills. These individuals may also require additional data training and development initiatives. It's not uncommon for individuals to have technology skills but at the same time face difficulties with unfamiliar tools or syntax of programming languages like R or Python that are widely used for data analytics tasks. Bohra et al. (2023) emphasize the crucial necessity of offering thorough training and support, particularly prioritizing these aspects within the DOD, while also advocating for the cultivation of a culture centered on continuous learning to equip personnel with proficiency in data literacy and adaptability.

In conclusion, the challenges outlined in this chapter underscore the complexity of achieving data democratization, ensuring data quality, and effectively managing data talent within the DOD. These challenges are interconnected and require a comprehensive approach that addresses technical, cultural, and organizational barriers. Initiatives like Advana demonstrate potential but must be complemented by efforts to improve data accessibility, enhance data standards, and cultivate a data-driven culture. Additionally, investing in workforce training and development, incentivizing innovation, and empowering middle management are essential steps toward overcoming these challenges. By prioritizing these initiatives, the DOD can unlock the full potential of its data resources, enhance decision-making processes, and maintain competitiveness in an increasingly data-driven environment.

VII. SUMMARY, FINDINGS AND RECOMMENDATIONS, CONCLUSION

A. SUMMARY

The thesis analyzed the intersection of data analytics and financial management within the DOD, exploring the significance of data strategy, financial data strategy, and their interconnectedness in today's business landscape. It highlights the role of data-driven decision-making in optimizing organizational performance and mitigating risks, emphasizing the strategic advantages associated with leveraging data-driven approaches. Additionally, the thesis analyzes the effectiveness of Advana, a digital transformation initiative, in driving financial management accuracy, compliance, and risk management within the DOD. It discusses Advana's role in enhancing financial accountability, bolstering audit readiness, optimizing budgeting processes, and integrating with Robotic Process Automation initiatives. Furthermore, the thesis examines data management challenges within the DOD, emphasizing the importance of accessing high-quality data and overcoming obstacles related to outdated systems, access controls, governance policies, and cultural change. Overall, the thesis provides a comprehensive exploration of how data analytics and financial management intersect in the context of the DOD, offering insights into improving data-driven decision-making processes and enhancing organizational effectiveness.

This thesis tackled three primary research questions. The first question, "How are data analytics used in the DOD's financial management?" was thoroughly examined throughout the thesis, with the subsequent section of this chapter presenting the findings to address this inquiry. For each group of findings, the thesis offers either a practical recommendation or a recommendation for future research. These recommendations are aimed at addressing the second and third research questions, "How can the DOD better leverage data analytics in its financial management?" and "How can the DOD's data analytics for financial management be improved?."

B. FINDINGS AND RECOMMENDATIONS

In this section, the findings and recommendations are structured into three groups. The first group delves into the policies and strategic documents, offering insights and recommendations pertinent to this aspect. The second group centers on the practical application of data analytics within the domain of financial management, providing recommendations for this focus area. Lastly, the third group articulates findings and recommendations aimed at facilitating the transformation of the DOD into an organization driven by data.

1. Findings and Recommendations on the Implementation of Policies and Strategic Documents

- Progress in Policy Development

The analysis reveals significant progress in the development of policies and strategic documents concerning data analytics within the DOD. These documents, as outlined in Chapter III, demonstrate a comprehensive understanding of modern practices adopted by leading private companies, reflecting a commitment to enhancing performance and fostering innovation through effective data utilization.

- Strengthening Policy Implementation and Oversight

While the evaluated policies and documents exhibit alignment with fundamental principles such as data governance, accessibility, quality, and analytics, the absence of implementation plans underscores the need for enhanced management practices and oversight controls within the DOD. Specifically, there is a pressing need to refine the approach to policy implementation by establishing specific protocols for tracking progress, assessing the impact of initiatives, and maintaining accountability throughout the data management life cycle. This refinement will enhance the DOD's capacity to leverage data analytics for informed decision-making and operational excellence.

Recommendations

- Prioritize the implementation of data-related strategies concerning financial management and the widespread adoption of data analytics to

maximize their impact across the DOD. It would be beneficial for the DOD to consider developing comprehensive implementation plans aimed at tracking progress, assessing initiatives, and maintaining accountability throughout the data management life cycle. By following such implementation plans, the DOD can effectively monitor performance and establish metrics to evaluate the implementation process. Additionally, these implementation plans would enable the organization to measure its overall performance and assess the effectiveness of different units within the DOD.

2. Findings and Recommendations on the Application of Data Analytics in Financial Management

- Fund Balance with Treasury Reconciliation

Advana lacks functionality for effective FBWT reconciliations, leading to material weaknesses identified by the DOD Office of Inspector General. Ongoing corrective actions aim to address deficiencies in processes and controls related to FBWT reporting, with a correction target set for FY 2026.

- Financial Reporting Compilation

Material weaknesses exist in financial reporting compilation, including concerns about completeness, accuracy, and compliance with financial reporting standards. Corrective actions to be performed by the DOD involve enhancing data analytics capabilities through Advana and standardizing statement formats with the Department of the Treasury.

- Intragovernmental Transactions

Significant material weaknesses persist in handling intragovernmental transactions, with corrective actions focusing on gap analyses, system enhancements, and Advana utilization for reconciliation. G-Invoicing aims to centralize intradepartmental transactions but faces challenges in policy compliance and implementation. Corrective

actions include the introduction of a GT&C Executive Dashboard tool within Advana to monitor usage and ensure compliance with DOD policy.

- Data Analytics Tools for Auditing

Advana's tailored tools aid in financial statement audits by aggregating and reconciling audit populations, aiding in tracking and resolving auditor findings, and enhancing funds management.

- Financial Management Systems Assessments

The DOD conducts annual reviews to monitor compliance with federal standards, utilizing Advana's platform for continuous monitoring, identifying improvement areas, and overseeing the retirement of outdated systems.

- FISCAM Compliance

The DOD addresses FISCAM compliance deficiencies through corrective actions, including the implementation of an enterprise Identity, Credential, and Access Management solution and leveraging Advana for tracking remediation status.

- Cross-Functional Business Transformation Obstacles

Challenges in cross-functional cooperation within the DOD underscore the necessity of effective governance. Advana serves as a tool to reconcile financial data and facilitate collaboration, particularly in initiatives like migrating to U.S. Treasury Direct Disbursing.

- Modernizing PPBE and Budgeting Processes Through Data Analytics

Integration of data analytics in DOD's PPBE processes enhances efficiency and effectiveness. Data analytics expedite decision-making, identify inefficiencies, and enable robust risk assessment. Continuous performance measurement facilitates budget program evaluation and alignment with strategic objectives. Leveraging Advana enhances budget monitoring and management, ensuring transparency and efficiency.

- DOD–Congress Data Exchange

Outdated data sharing methods hinder efficient communication between DOD and Congress. Digital collaborative platforms like Advana offer opportunities for expedited data sharing and enhanced transparency. Limited progress in improving data exchange highlights persistent challenges in modernizing communication channels. Overcoming these obstacles is crucial for fostering a culture of transparency and partnership, enhancing decision-making processes.

- Executive Analytics "Pulse" and Business Health Metrics

Integration of data analytics through the initiative "Pulse" enables informed resource allocation and performance assessment. Pulse provides senior leaders with real-time insights, enhancing data utilization and decision-making. Challenges persist in ensuring the timeliness and reliability of analytics, hindering the effective incorporation of Business Health Metrics. Overcoming these challenges is essential for maximizing the potential of data analytics in driving performance improvement efforts.

- DFAS Data Analytics Initiatives in Financial Reporting

DFAS leverages data analytics to enhance financial reporting and analysis within DOD. Initiatives like the Data Analytics Center of Excellence and the adoption of the platform Oracle Analytics Server enhance data-driven decision-making. Challenges remain in ensuring the widespread adoption and effective utilization of data analytics tools. Ongoing efforts are required to maximize the impact of data analytics in financial management within DOD.

- Robotic Process Automation and Machine Learning Integration

The integration of RPA and ML within the DOD is an advancement in enhancing operational efficiency and financial compliance. Through strategic initiatives such as the RPA program within the DFAS, the DOD aims to revolutionize processes, mitigate risks, and achieve greater efficiency in financial management. RPA is leveraged to address cost-effective risk management challenges, streamline operations, and reduce reliance on manual labor, resulting in significant time savings across key areas. Additionally, ML technology, hosted on the secure cloud environment of Advana, is utilized to streamline

the resolution of Unmatched Transactions within various DOD agencies. Efficiency gains and cost savings are demonstrated through the predictive analytics capabilities of ML integrated with RPA. These initiatives mark a transformative shift toward automation and predictive analytics, offering substantial benefits in terms of operational effectiveness and financial compliance within the DOD.

Recommendations

- Enhance Advana's functionality to incorporate robust FBWT reconciliation features, addressing identified material weaknesses effectively.

- Engage with industry-leading experts or organizations to benchmark financial reporting practices and identify areas for improvement within Advana.

- Conduct thorough gap analyses of intragovernmental transaction processes, leveraging Advana's analytical tools to identify areas for improvement and streamline reconciliation efforts.

- Enhance Advana's capabilities to integrate with the G-Invoicing system seamlessly, facilitating centralized tracking and monitoring of intradepartmental transactions.

- Expand Advana's suite of tailored tools for financial statement audits, incorporating additional features to enhance data aggregation, reconciliation, and funds management.

- Regularly update and refine Advana's data analytics tools based on feedback and insights gathered from audit teams and users, ensuring continuous improvement and relevance.

- Implement a feedback mechanism within Advana to gather insights from users on areas for improvement in financial management systems assessments, ensuring continuous refinement of assessment processes.

- Conduct regular reviews and audits of FISCAM compliance processes utilizing Advana's monitoring and reporting capabilities, identifying areas for improvement and implementing corrective actions promptly.

- Establish performance metrics and accountability mechanisms within Advana to track progress and outcomes of cross-functional business transformation initiatives, fostering transparency and accountability.

- Establish clear performance metrics and benchmarks within Advana to measure the effectiveness and impact of data analytics initiatives on PPBE processes, facilitating continuous improvement and optimization.

- Resolve the technical issues associated with merging data and ensuring seamless compatibility between systems to enable the incorporation of Business Health Metrics into decision-making processes.

- Foster collaboration and knowledge sharing among different departments and agencies within the DOD to leverage lessons learned and best practices in implementing RPA and ML technologies, maximizing efficiency and effectiveness.

3. **Findings and Recommendations on the Adoption of the Data-Driven Approaches in the DOD**

- Data Democratization and Accessibility

The DOD encounters significant hurdles in democratizing data, impeding its accessibility and effective utilization. These obstacles primarily stem from outdated systems, stringent access controls, and governance policies that restrict the flow of data within the organization. To mitigate these challenges, the DOD has turned to Advana, a centralized data platform, as a potential solution. However, apprehensions persist

regarding the scalability of Advana to accommodate the diverse data sources within the DOD ecosystem. In response, a federated model has been proposed, aiming to tackle incomplete data accessibility by granting users self-service access to data. This shift toward enhanced data technologies and access is deemed essential for unlocking the full potential of the DOD's data assets and fostering a culture of data-driven decision-making across the organization.

- Data Standards, Quality, and Duplication

Usage of Advana is seen as pivotal for leveraging data in decision-making processes. However, the success of Advana hinges on the quality of the underlying data. Ensuring high data quality is essential not only for Advana's effectiveness but also for fostering data-driven decision-making within the DOD. Challenges in this endeavor include issues like data duplication, the absence of standardized protocols, and fragmentation across different departments and units within the DOD. To address these challenges, Advana's medallion architecture, operating within a lakehouse framework, aims to enhance data structure and quality iteratively. This approach facilitates ongoing improvements in data quality and organization, laying the foundation for more robust data analytics and decision-making capabilities. Despite these advancements, challenges persist in data utilization. Users often gravitate toward pre-cleaned datasets, reflecting a preference for convenience and a lack of skills for data preparation tasks. Overcoming these challenges requires comprehensive training and support to equip users with the necessary skills and promote the effective utilization of data analytics tools like Advana within the DOD.

- Cultural Change

The DOD encounters significant hurdles in effectively integrating data expertise with its existing organizational structures. Among these challenges is a notable resistance to change, particularly entrenched within middle management tiers. This resistance poses a considerable barrier to the adoption of digital tools and technologies essential for modernizing processes and enhancing efficiency within the DOD. Furthermore, a lack of incentives and skills among personnel further complicates efforts to adapt to the rapidly

evolving digital landscape. These challenges underscore the broader issues associated with cultural change within large organizations like the DOD. Addressing these cultural barriers necessitates concerted and sustained efforts aimed at fostering a more adaptive and forward-thinking mindset across all levels of the organization.

- Talent Management, Education, and Skills

Upskilling the workforce and recruiting skilled digital talent emerge as paramount priorities for the DOD to navigate the complexities of the digital age. However, the DOD faces formidable challenges in this endeavor, including intense competition for talent, the absence of clear technical career paths, and prevalent skills gaps within its ranks. Effective talent management strategies are imperative, alongside a concerted effort to prioritize the development of data skills among personnel. To optimize workforce capabilities, the DOD must invest in thorough training programs, provide robust support mechanisms, and foster a culture of continuous learning throughout the organization. By cultivating data literacy and adaptability among its workforce, the DOD can position itself to address internal challenges effectively while enhancing its overall organizational capabilities. Moreover, providing access to comprehensive data analysis training and expertise represents a critical step toward empowering personnel and bolstering the DOD's capacity to leverage data for informed decision-making and strategic advantage.

Recommendations

- Explore avenues to streamline access controls and governance policies while maintaining security standards, ensuring that data is more readily available to personnel across the organization.

- Establish clear guidelines and standards for data quality across all departments and units within the DOD to ensure consistency and reliability in data usage, thus maximizing the effectiveness of tools like Advana in decision-making processes.

- Encourage open communication and collaboration between different departments and units within the DOD to facilitate knowledge sharing and cross-functional teamwork. Create platforms for employees to exchange ideas, share their success stories, and learn from each other's experiences and challenges in implementing data initiatives and driving cultural change.

- Lead by example by promoting a culture of transparency, accountability, and agility at the highest levels of leadership within the DOD. Demonstrate a commitment to embracing digital transformation and encourage all personnel to actively participate in driving organizational change toward a more data-driven and digitally enabled future.

- Establish clear and attractive career pathways for personnel with digital skills, providing opportunities for advancement and recognition within the DOD. Create specialized roles and positions that align with emerging data trends and technologies, incentivizing talented individuals to pursue careers in data analytics, data science, data engineering, and other data-related domains.

C.   AREAS OF FUTURE RESEARCH

An avenue for future research lies in exploring opportunities for partnerships with external stakeholders such as industry, academia, and institutions to remain abreast of emerging trends and technologies in financial management. For instance, robotic process automation and machine learning have demonstrated notable efficacy in financial management applications. Future research could focus on identifying and analyzing best data analytics practices utilized by commercial entities in the private sector. This research endeavor can aim to ascertain the leading data analytics tools employed in financial management by prominent private companies and to develop strategies for implementing these tools within the financial management framework of the DOD.

Another potential area for future research, stemming from this thesis, pertains to enhancing talent management through the establishment of clear initiatives and

recognition programs aimed at motivating personnel to acquire and develop essential data skills. This research endeavor proposes to identify strategies for recognizing and rewarding individuals and teams that demonstrate initiative and proficiency in leveraging data tools to enhance organizational efficiency and effectiveness. The overarching objective of this future research area is to develop comprehensive and detailed guidelines and frameworks clarifying how to incentivize individuals to acquire data skills effectively.

D.   CONCLUSION

This thesis has explored various facets of data analytics within the DOD, particularly focusing on its application in financial management and the broader organizational transformation toward becoming data-driven. Through an exhaustive examination of policies, strategic documents, and practical applications, several key findings have emerged, shedding light on both the progress made and the challenges encountered. The analysis revealed a significant alignment of DOD policies and strategic documents with modern practices adopted by leading private companies, reflecting a commitment to leveraging data for enhanced performance and innovation. However, notable gaps were identified in terms of implementation plans and oversight mechanisms, highlighting the need for enhanced management practices and accountability frameworks to ensure the successful execution of data-related initiatives. Moreover, while fundamental principles such as data governance and accessibility were well incorporated, there remains room for improvement in terms of clarity and guidance on implementation mechanisms. Clearer protocols for tracking progress, assessing initiatives, and maintaining accountability throughout the data management life cycle are essential for optimizing the effectiveness of these policies.

Furthermore, the practical application of data analytics within financial management showcased both successes and challenges. While tools like Advana have demonstrated significant potential in streamlining processes and enhancing decision-making, issues such as data quality, duplication, and cultural barriers pose significant hurdles. In terms of data management, efforts to democratize data and enhance

accessibility have been hindered by outdated systems and stringent access controls. Initiatives like the federated model aim to address these challenges, but concerns regarding scalability persist. Moreover, ensuring high data quality remains a priority, necessitating standardized protocols and ongoing improvements in data structure and organization. While cultural resistance within the DOD presents challenges, it is important to note that similar issues are widespread across many large organizations, indicating that these hurdles are not unique to the DOD. Cultivating a culture of transparency, accountability, and collaboration is essential for driving organizational change and overcoming resistance to digital transformation. By implementing targeted recruitment strategies, investing in training programs, and establishing clear career pathways, the DOD can attract and retain skilled digital talent, paving the way for a more data-driven and digitally enabled future.

The DOD stands to gain substantial advantages from the strategic implementation of data analytics, particularly within its financial management domain. The broader adoption of advanced data analytics throughout the organization will offer a significant competitive edge in the contemporary fast-paced and dynamic security environment.

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