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Aligning DoD Cost Analysis Competencies to Third Party Standards

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ALIGNING DOD COST ANALYSIS COMPETENCIES TO THIRD PARTY CERTIFICATION STANDARDS

THESIS

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Abstract

In an attempt to improve certification training programs, the National Defense Authorization Act (NDAA) of 2020 mandated changes to certification requirements for all acquisition related career fields directing the implementation of certification programs based on nationally or internationally accredited third-party standards (NDAA, 2019). This research focused on DoD's Defense Acquisition University's (DAU) Business Cost Estimating (BUS-CE) Program's compliance with the NDAA. The study has one major research question that focuses on determining how well aligned the Defense Acquisition University's (DAU) BUS-CE certification program's competency model is to its relevant third-party standard, the International Cost Estimating and Analysis Association's (ICEAA) Cost Estimating Body of Knowledge (CEBoK) competency model. A second review further addresses the research question by looking at the comprehensiveness of DAU's BUS-CE competency model when compared to CEBoK's competency model. The research found that of the 223 learning objectives in the DAU BUS-CE competency model, 67% were aligned with ICEAA's CEBoK competency model and of the 398 objectives in the ICEAA CEBoK competency model, 42% aligned with DAU's competency model. The research identified significant knowledge areas lacking in the DAU BUS-CE competency model that were covered in the CEBoK competency model.

Acknowledgments

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Helga D. Leite Evora, Capt

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ALIGNING DOD COST ANALYSIS COMPETENCIES TO THIRD PARTY CERTIFICATION STANDARDS

I. Introduction

General Issue

The Department of Defense (DoD)'s acquisition workforce is responsible for the acquisition of major programs and weapons systems. There has been a long history of Congress distrusting the DoD's ability to effectively manage its acquisition programs. Prior to the 1980s, the acquisition process was "perceived as being plagued by cost overruns, inefficiencies, and burdensome government specifications (Madsen, et al., 2007, p. 47)." Following the DoD's $435 hammer and $600 toilet seat scandals, President Reagan was forced to enact The President's Blue Ribbon Commission on Defense Management (Mothershed, 2011). Informally known as the Packard Commission, the board was tasked to study and prescribe recommendations regarding Defense Management. In their final report to the President, the board described the acquisition workforce as compared to industry counterparts as "undertrained, underpaid, and inexperienced" and recommended improvements to training to enhance the quality of DoD acquisition personnel (Packard, 1986, p. 66). In response to concerns that DoD reform efforts did not focus enough on the qualification and professionalism of the acquisition workforce, Congress enacted the Defense Acquisition Workforce Improvement Act (DAWIA) (GAO, 1992). The act established the Defense Acquisition

University as well as experience, training, education, and other qualification requirements for acquisition workforce employees (Layton, 2007, p. 12).

Defense Acquisition University is the primary source of training for defense acquisition professionals. A "Back-to-Basics" certification framework was implemented in 2020, which was the most significant update to DAU Acquisition certification standards since 1990. Using this initiative, 14 acquisition career fields were streamlined into six functional areas: Program Management, Contracting, Life Cycle Logistics, Engineering and Technical Management, Test and Evaluation, and Business – Financial (BUS-FM) and Business – Cost Estimating (BUS-FM) (USDAS, 2020). Business Functional Area professional certification programs were reduced from a three-level model to a two-level model under the Back-to-Basics framework. In addition, a model that focuses on required training relevant to the position held replaced the frontloaded training model (Woolsey J. , 2021).

Problem Statement

In fiscal year 2020, the National Defense Authorization Act (NDAA) mandated the implementation of professional certification programs and certification requirements for all acquisition personnel. The professional certification programs were to be based on standards developed by a third-party nationally or internationally accredited program unless the Secretary of Defense (SECDEF) determined that no such third-party exists for a particular acquisition career field (NDAA, 2019).

Because the Back-to-Basics initiative was announced prior to the 2020 NDAA, it is reasonable to address whether it includes changes relevant to the 2020 NDAA's

mandates. Back-to-Basics was implemented for all acquisition functional areas with some of these areas responding accordingly, addressing the NDAA mandate. For example, the contracting community implemented the DoD Contracting Competency Model based on the National Contract Management Association's Contract Management Standard (DAU, 2020). The Program Management (PM) community incorporated a comprehensive exam to the Back-to-Basics curriculum referencing the alignment of PM certification standards to Program Management Institute's (PMI) third-party standards as mandated by the NDAA (O'Donnell, 2022). Regarding BUS-CE, it is unclear if the FY 2020 mandates have been addressed and if they have been, what changes were implemented to ensure compliance.

This study will determine whether the BUS-CE curriculum is compliant with the FY 2020 NDAA by mapping the sub-competencies under the BUS-CE competency model in DAU with the International Cost Estimating and Analysis Association's (ICEAA) Cost Estimating Body of Knowledge (CEBoK).

Research Objectives/Questions/Hypotheses

The results of this study will enable decision makers within DoD to draw informed conclusions related to Cost Estimating certification requirements as mandated by the FY 2020 NDAA. Specifically, this study pertains to the alignment of DAU's BUS-CE functional area competencies to ICEAA's 16 knowledge areas that comprise the CEBoK as shown in Table 1. This study addresses the following research question:

To what extent are the DAU's BUS-CE competency elements aligned with ICEAA's CEBoK competency elements?

Table 1: ICEAA Cost Estimating Body of Knowledge (CEBoK)

Module	Title
1.	Cost Estimating Basics
2.	Costing Techniques
3.	Parametric Estimating
4.	Data Collection & Normalization
5.	Inflation & Index Numbers
6.	Basic Data Analysis
7.	Learning Curve Analysis
8.	Regression Analysis
9.	Cost & Schedule Risk Analysis
10.	Probability & Statistics
11.	Manufacturing Cost Estimating
12.	Software Cost Estimating
13.	Economic Analysis
14.	Contract Pricing
15.	Earned Value Management
16.	Cost Management

Methodology

This study involved a qualitative lexicon analysis of descriptions of the DOD's BUS-CE competencies and the descriptions of ICEAA's knowledge areas and domains in the CEBoK Guide, the NDAA for Fiscal Year 2020 (NDAA, 2019), DAU BUS-CE iCatalog (DAU iCatalog Home, 2022) and other key resources. In this analysis, we highlighted key words, phrases, and meaning from the description of each knowledge area, domain, and competency enabling mapping between DAU and ICEAA's competency models.

The DAU BUS-CE Competency Model, consisting of 223 learning objectives, served as the primary DoD source used in analyzing the alignment between DoD's BUS-CE competencies and ICEAA's competencies. ICEAA did not have a formal competency model established so two sets of student created learning objectives, obtained from Air Force Institute of Technology (AFIT), was used to create a comparable competency model from ICEAA's CEBoK knowledge areas (modules). We referenced ICEAA's list of testable topics for the certification exams to ensure the student created objectives covered the CEBoK knowledge areas (modules) adequately. Additional objectives were created to fill any gaps the two sets of student created objectives did not fill. The mapping of each objective resulted in the following coding: Aligned (Green), Somewhat Aligned (Yellow), Completely Unaligned (Red) and Not Applicable "N/A" (Black). An inter-rater reliability (IRR) procedure was then conducted with a sample of 30 DAU objectives that ultimately resulted in an IRR of 88%.

Assumptions/Limitations

This research is limited to the accuracy and completeness of the data set created for ICEAA's CEBoK. The competency model is made up of Air Force Institute (AFIT) student created objectives and researcher created objectives. We assume this model accurately depicts the content reflected in the CEBoK knowledge areas (Modules). An analysis of these objectives was completed, cross-referencing each objective and the CEBoK content.

Preview

Chapter I covered a brief history of acquisition issues and workforce reform, as well as the research objectives of this study. Chapter II presents research on previous acquisition workforce issues and reform efforts; and discusses education, training and certification requirements for the Defense Acquisition Workforce. Chapter III describes the methodology used to analyze DAU BUS-CE and ICEAA CEBoK competency models. Chapter IV presents the analysis and results, while Chapter V discusses key findings and recommendations.

II. Literature Review

Chapter Overview

This chapter highlights how education and training standards for the acquisition workforce have evolved with various reform efforts since the implementation of DAWIA and the FY 2020 National Defense Authorization Act (NDAA). There are significant gaps in the literature in terms of the implementation of third-party based certification standards as directed by the NDAA for the Cost Analysis community. Cost analysts are aware of what education and training standards are required of them. They are also aware of where they must turn to fulfill these requirements. Whether these requirements are compliant with recent acquisition reform legislation that has been issued to higher echelons is unknown. Specifically, it is uncertain whether the Business Cost Estimating (BUS-CE) course in Defense Acquisition University (DAU) has been aligned with a third-party certification program. Policy letters for other acquisition areas reflect the implementation of third-party standards in their respective programs. Cost Analysis Policy does not reflect that the Cost Analysis community has followed suit.

History of Acquisition Workforce Issues

As noted earlier, DoD has long been the subject of criticism when it comes to acquisition efforts. Cost overruns, schedule delays, and improper payments to contractors have all been reported (Fairhall, 1987). The House Armed Services Committee's report of Fiscal Year (FY) 2007 defense authorization bill stated:

> Simply put, the Department of Defense (DoD) acquisition process is broken. The ability of the Department to conduct the large-scale acquisitions required to ensure our future national security is a concern of the committee. The rising costs and lengthening schedules of major defense acquisition programs lead to more expensive platforms fielded in fewer numbers. The committee's concerns extend to all three key components of the Acquisition process including requirements generation, acquisition and contracting, and financial management. (Congress, 2007, p. 350)

Two specific areas have been of high concern in the defense acquisition procurement process: Major Defense Acquisition Programs (MDAP) and contracting efforts in contingency locations (Gates, 2009). As such, defense contract management and defense weapon system acquisition were designated high risk areas by the Government Accountability Office (GAO) (GAO, 2007). There are a number of reasons for the criticism surrounding acquisition efforts, but the size, quality, and effectiveness of the acquisition workforce has been at the forefront (Gates, 2009). In 2007, The Defense Acquisition Structures and Capabilities Review (DASCR), also known as the Section 814 Study, conducted a review of structures and capabilities by each military department, defense agency, and other elements of the DoD with an acquisition function (Lumb, 2008). This study showed that "almost every acquisition improvement study…concludes in some fashion or another that more attention needs to be paid to acquisition workforce quality and quantity."(p. 20)

Central to the acquisition workforce related issues include the claim that the workforce lacks the skills to accomplish the workload (Gates, 2009). In a survey, Vernez and Massey (2009) found that organic cost estimators (government civilian and military) lacked adequate training and that the DAU cost estimating courses were too general to provide the necessary skills required. In contrast, the AFIT graduate program was praised for providing cost analysts who were better trained to provide the analytical capabilities required for the job. The overall consensus of respondents in this study was that organic cost estimators were not adequately trained. Moreover, certification standards were thought to be outdated and training standards did not reflect current skill needs (Gates, 2009).

The Defense Acquisition Improvement (Act)

The Department of Defense (DoD) has implemented multiple acquisition reform initiatives to improve its acquisition processes, highlighted in Table 2, along with frequent modifications to training and education requirements to improve its acquisition professionals (Karnes, Aligning Program Managment Competencies to Industry Standards, 2021). President Reagan's Blue Ribbon Commission on Defense Management was a blueprint for acquisition reform and prefaced the passage of the DAWIA in 1990. The commission called for business-related education experience criteria for civilian contracting personnel and expanded opportunities for the education and training of all civilian acquisition personnel (Packard, 1986, p. 11). Following a lack of implementation of Packard's recommendations, President George W. Bush directed the Secretary of Defense develop a plan to fully implement Packard's recommendations. Two studies

followed that would radically transform education and training for the acquisition workforce. The first, the Defense Management Report (DMR), was published with the intent of fully implementing Packard's recommendations, improving the performance of the Defense Acquisition System, and more effectively managing DoD and its resources (Cheney, 1989). John Betti, the third USD(A), believed that acquisition reform prior to 1990 was unsuccessful due to Congress' implementation of recommendations by commissions outside of DoD (Layton, DAU, 2007). He believed the DMR would be successful because a DoD commission would be involved in the process implementing its own recommendations. Pertinent to the acquisition workforce, DMR would pursue professionalism of procurement personnel making them more competitive than their private industry counterparts. Military Officers lacked the skills to deal with a complex acquisition environment and the task of creating an equally competent officer in both acquisitions and the operational environment would be impossible. A different direction would need to be taken to provide the needed acquisition skills as well as develop weapons capabilities reflecting operational realities. Among several recommendations and directives, DoD services would need to develop specialized education and training for the acquisition workforce and advanced management education encompassing programs in universities and opportunities in industry.

Table 2: Acquisition Reform Previous to DAWIA

DoD Policy	Year Issued	Description
4000.8 establishment of Basic military supply system regulations	1952	Called for a definitive program for recruitment and training of military and civilian contracting workforce personnel
1430.6 armed services Procurement training Program	1961	set forth training requirements for both civilian and military contracting personnel and identified 13 different contracting courses that would be provided
1430.7 armed services Procurement training register	1961	established requirements for the training of military and civilian contracting personnel listing all joint general and specialized contracting courses as well as service-unique contracting courses
1430.10-m-1 DoD Civilian Career Program for Contracting and acquisition Personnel	1966	Prescribed the minimum skill level and knowledge to be attained by procurement personnel through mandatory courses, passing an equivalent test, or demonstrating requisite skills and knowledge through qualifying experience
5000.23 systems acquisition management Careers	1974	Changed the minimum experience for Program managers and required completion of the Program management Course or the executive refresher Course at the Defense systems management College. it placed program management on equal footing with operational, line, and command positions
	revised 1987	Public law 99-145, November 8, 1985, required Program managers of major programs to complete the Program management Course at the Defense systems management College, effective July 1, 1987
5000.1 major/non-major Defense systems	1971*	Cornerstone of DoD's efforts to improve acquisition management raising the stature and authority of Program managers
	revised 1987	established streamlined acquisition organization (3-tiered management structure) of service acquisition executive, Program executive officers, and Program managers
5000.48 experience, education, and training requirements for Personnel assigned to acquisition	1986	established experience, education, and training requirements for military and civilian personnel assigned to contracting, quality assurance, and business and financial management positions in DoD. Prior to this Directive, there had been no DoD mandatory training for military contracting personnel since the early sixties. instead, each service was allowed to train its military personnel within service guidelines
5160.55 Defense Weapons systems management Center	1964	Chartered the Defense Weapons systems management Center as the first school for Program managers
5160.55 Defense systems management school	1971	Chartered the Defense systems management school (Dsms)
5160.55 Defense systems management College	1977	Chartered the Defense systems management College, which replaced the Defense systems management school
	1988*	expanded the role of the Defense systems management College to manage career training for the acquisition workforce
5000.52 Defense acquisition education and training Program	1988*	eliminated DoD 5000.23, 5000.48, 5100.58, DoD 1430.10-m-1. the UsD(a) was responsible for establishing education, training, and experience standards for each acquisition position and establishing functional boards
5000.52m Career Development Program for acquisition Personnel	1989*	the manual complemented DoD 5000.52 and established the mandatory career development program for military and civilian personnel establishing experience, education, and training standards at entry, intermediate, and senior levels for certification in: general business; contracting; industrial property administrator; purchasing; procurement clerk; manufacturing and production function; quality and reliability assurance; business and financial manager; program management; logisticians; and systems engineers

*Directives in effect when DaWia passed in 1990

A second study, The Quality and Professionalism of the Acquisition Workforce, was conducted by Congress and ran concurrently with the DMR. The report determined that DoD was not compliant with providing a high quality, professional acquisition work force. Acquisition personnel did not complete the mandatory training and education requirements pushed in previous legislation. DoD also lacked the resources to effectively provide education and training requirements. The House Committee concluded that a comprehensive program passed by statue would be required. Thus, the Defense Acquisition Workforce Improvement Act (DAWIA) was introduced and passed via the FY 1991 Defense Authorization Act (Layton, DAU, 2007). DAWIA established the Defense Acquisition University (DAU), outlined elevated requirements for personnel assigned to critical positions, and established educational and training requirements for the entire acquisition workforce (Karnes, 2021).

Defense Acquisition University

As noted earlier, DAU is the primary source of training for defense acquisition professionals, providing formal courses as well as continuous learning modules to promote continuing education and professional growth for thousands of students every year (Woolsey J. , 2019). DAU is comprised of five main regional campus locations and two colleges supporting approximately 180,000 members of the Defense Acquisition Workforce (DAU Media Kit 2020 Edition, 2020). DAU (with the approval of the USD(AT&L)) establishes the curriculum and requirements for education, experience, and core training for certification in each acquisition career field for all defense agencies (Rendon, 2010). Upon completion of certification requirements, students are awarded

DAWIA Certification (Certifications & Related Programs, 2022). In addition to DAU, DoD graduate schools such as the Air Force Institute of Technology (AFIT) and the Naval Postgraduate School (NPS) have provided acquisition graduate degrees since the 1900s (Stewart, 2019; NPS, 2009). Moreover, DAU has established partnerships with civilian institutions to provide courses that meet the requirements for many DoD career fields. Professional associations such as National Contract Management Association (NCMA), National Institute for Government Purchasing (NIGP), American Society of Military Comptrollers (ASMC) and the Project Management Institute (PMI) have also played a significant role in professionalizing the acquisition workforce.

Certification Standards

Under DAU, the functional areas are divided into seven categories each with different certification levels (DAWIA Certification & Development Guides, 2022):

- Business-Cost Estimating: Practitioner and Advanced
- Business-Financial Management: Practitioner and Advanced
- Contracting: Professional
- Engineering and Technical Management: Foundational and Practitioner
- Life Cycle Logistics: Foundational and Advanced
- Program Management: Practitioner and Advanced
- Test and Evaluation: Foundational and Practitioner

The official source for publication of certification standards is found on the online iCatalog in DAU. The iCatalog provides a description of the education, experience and training required for all certification levels in each functional area. Certification

requirements are based on the position held and must be met within a certain period in accordance with DoDI 5000.66 (HCI, 2022). The courses required for DAWIA certification along with experience requirements for cost estimators are shown in Figure 1.

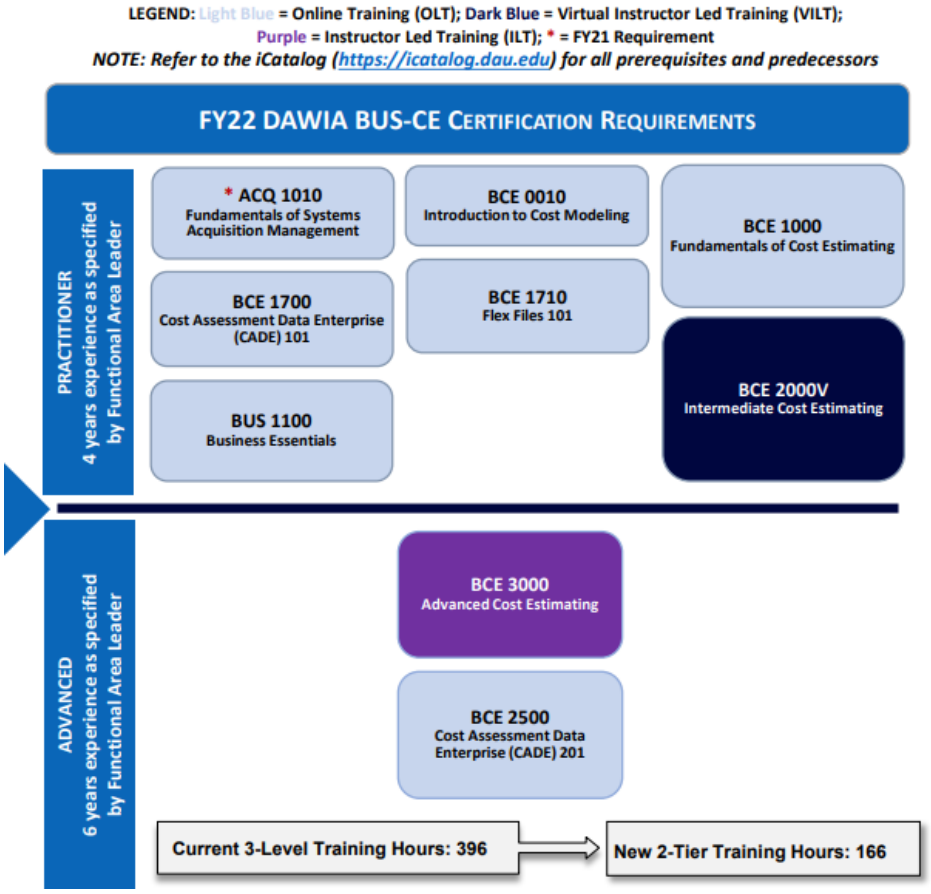

Figure 1: DAWIA BUS-CE Certification Requirements

Adaptive Acquisition Framework

In January 2020, DoD modernized the acquisition framework with the implementation of the Adaptive Acquisition Framework (AAF). The AAF framework project met the 2018 National Defense Strategy objective of developing a "lethal and effective force based on U.S. technological innovation and a culture of performance that yields decisive and sustained U.S. military advantage" (USD(A&S), 2022, p. 4). AAF condensed acquisition guidance that had grown to 200 pages into smaller chunks known as acquisition pathways. The AAF pathways, shown in Figure 2, simplify the process for Program Managers. By starting at the pathway relevant to the capability being acquired and tailoring for additional requirements, the tedious task of filtering out which regulatory requirements applies to the capability being acquired is removed from the process.

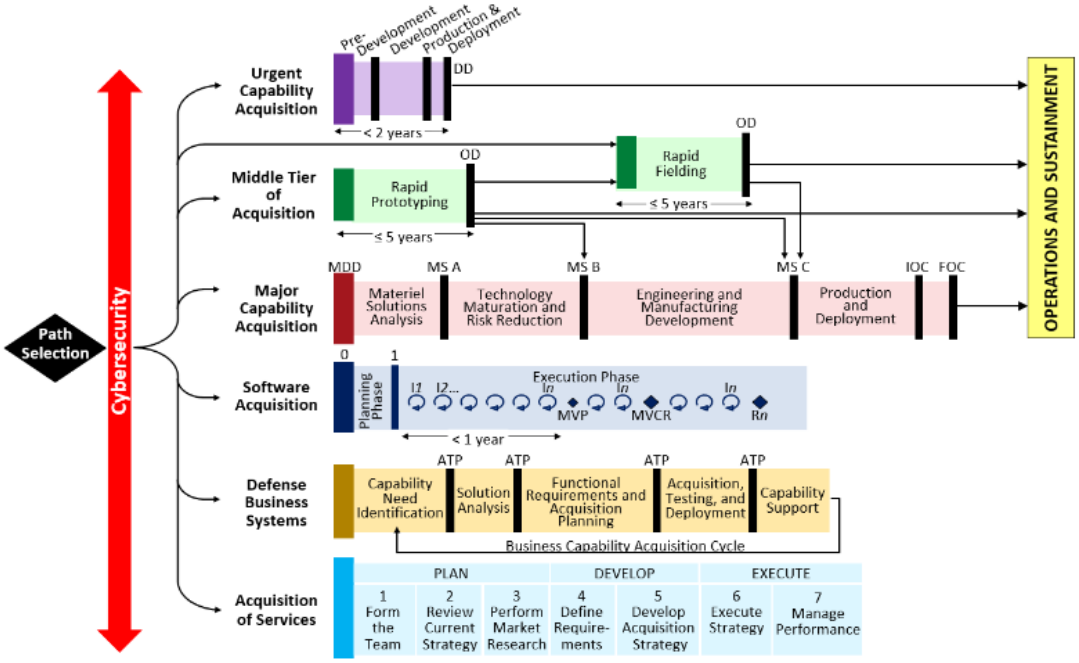

Figure 2: Adaptive Acquisition Framework (AAF)

Additionally, AAF decreased the bureaucratic powers previously required in acquiring certain capabilities, adding more flexibility in the decision-making process and speeding up acquisition processes. (Woolsey J. , DAU, 2020). AAF increased flexibility, reduced OSD requirements, and enabled Program Managers (PM) to choose relevant pathways to fit their specific program requirements. Shaffer (2020) found that training requirements had become excessive and inflexible for DoD acquisition professionals.

Back-to-Basics Initiative

In September 2020, the Under Secretary of Defense for Acquisition and Sustainment, Ms. Ellen Lord, announced the Back-to-Basics initiative. This initiative focused on pivoting away from the 30-year-old framework implemented by DAU with the enactment of DAWIA. “This reform initiative shifts our focus from how we have

equipped the workforce in the past to getting back to the basics of acquisition with a sharpened focus on workforce readiness and how we equip Department of Defense (DoD) component acquisition professionals for the future" (Shaffer, et al., 2020, p. 1). They highlighted a few reasons prompting this change, one of them being the drastic 50% budget reduction in the DAU and Defense Acquisition Workforce Development Account that occurred during the Defense Wide Review (DWR) conducted in 2020. With reduced resources, the Back-to-Basics initiative was viewed as imperative to "equip the workforce with the basics to best empower them to achieve acquisition success" (Shaffer, et al., 2020, p. 4).

Before The-Back-to-Basics initiative, DoD acquisition positions were grouped into 14 acquisition career fields. Each career field was divided into three certification levels for purposes of establishing standards and qualifications (DAU, 2022):

Level I – Basic or Entry Level

Level II – Intermediate or Journeyman Level

Level III – Advanced or Senior Level

The Back-to-Basics initiative reduced training requirements for all acquisition functional areas and ultimately restructured the training requirements for all acquisition career fields into six functional areas. With the assistance of the Business-Cost Estimating (BUS-CE) Tiger Team, which included senior leaders from all services and Missile Defense Agency (MDA) the following training structure was developed: a new BUS-CE certification framework, two levels of BUS-CE certification, a competency model based on the DoD Cost Estimating Guide (signed December 2020) and a revised

Position Category Description (PCD) (ASD(A), 2021). The complete updates to BUS-CE and certification requirements are highlighted in Table 3.

Table 3: BUS-CE Certification Comparison and Updates

	Outgoing	New (effective 1 Feb 2022)
Structure	Three Levels	Practitioner and Advanced
Education	Baccalaureate degree	Ops Research degree required or 24 semester hours in a combination of operations research, mathematics, probability, statistics, mathematical logic, science, or subject-matter courses requiring substantial competency in college-level mathematics or statistics. At least 3 of the 24 semester hours must have been in calculus
Training	Based on the Acquisition Cost Estimating and Financial Management Competencies published in 2015	Acquisition Common Competencies, Business Common Competencies, Cost Estimating Competencies
Experience	2 years (Level I), 4 years (Level II), 6 years (Level III)	Practitioner: At least 4 years of acquisition experience in cost estimating supporting a program office, PEO, Service/Defense agencies, or supporting program(s) that report to a Service Acquisition Executive (SAE) Advanced: At least 6 years of acquisition experience in cost estimating and serving a program office, PEO, Service/Defense agency level, or supporting a program that reports to a Service Acquisition Executive (SAE)
Assessment	No comprehensive exam	No change
Validation	Services/Components process to validate completion of above requirements	No change
Currency	80 hours Continuous Learning/2 years-ref DoDi 5000.66	80 hours Continuous Learning every 2 years - with an acquisition and/or leadership focus. CL guidelines: >50 hours of course work pertaining to Acquisition, >20 hours of leadership training

Under the Back-to-Basics framework, the Business Functional area transformed into two paths – Business-Cost Estimating (BUS-CE) and Business-Financial Management (BUS-FM). Each of these paths were condensed from the three certification levels to two levels – Practitioner and Advanced (DAU, 2021):

- **Practitioner:** At least four years of acquisition experience in cost estimating supporting a program office, PEO, Service/Defense agencies, or

supporting program(s) that report to a Service Acquisition Executive (SAE)

- **Advanced:** At least six years of acquisition experience in cost estimating and serving a program office, PEO, Service/Defense agency level, or supporting a program that reports to a Service Acquisition Executive (SAE)

These two levels incorporate courses shown in Figure 3 FY22 Cost Estimating Course Training Requirements for certification requirements (ASD(A), 2021):

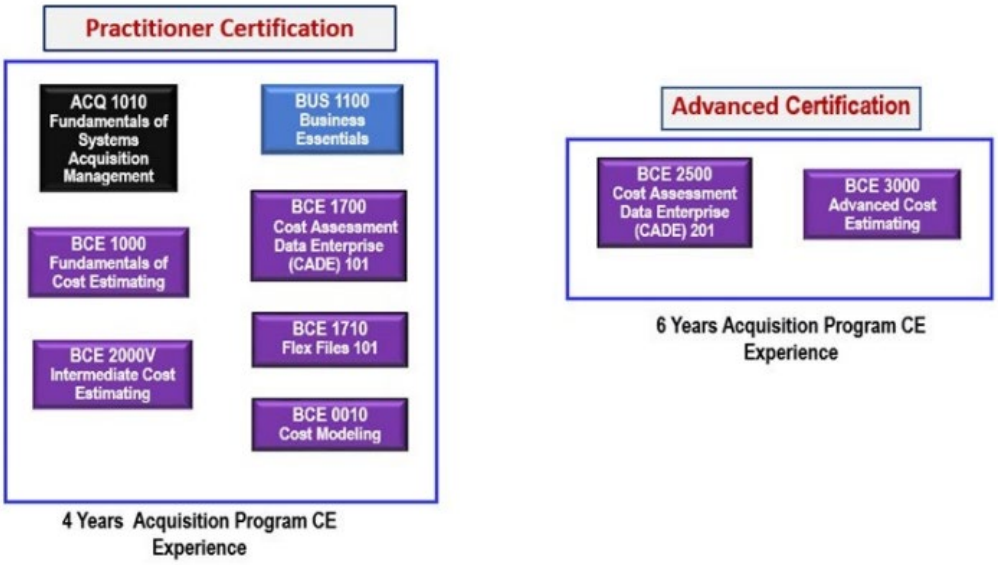

Figure 3: FY22 Cost Estimating Course Training Requirements

The competencies within the BUS-CE path were separated into three units of competency with 18 overall competency categories (Placeholder4):

- Business Common Core
- Cost Estimating Practitioner
- Cost Estimating Advanced

DAU deployed the Back-to-Basics revised framework in fiscal year 2022.

National Defense Authorization Act (NDAA)

Congress and DOD have used multiple mechanisms to reform the acquisition field, one of the primary methods Congress has used in recent years has been through Title VIII, entitled *Acquisition Policy, Acquisition Management, and Related Matters*, of the National Defense Authorization Act (Schwartz & Peters, 2018). These reforms have included authorizing the use of rapid acquisition processes for certain military

organizations (FY 2016 NDAA) and calling on the DoD to collaborate with the national technology and security base to boost defense technology innovation (FY 2017 NDAA).

The FY 2020 NDAA mandated changes to certification requirements for all acquisition related career fields by directing that certification programs should be based on nationally or internationally accredited third-party standards (NDAA, 2019). This shift from DoD-centric competencies to the widely accepted standards of the private sector is an attempt to improve the quality of the Defense Acquisition Workforce by recruiting and growing an experienced and knowledgeable personnel base, thoroughly capable of working with defense industry throughout the acquisition process (Karnes, Aligning Program Managment Competencies to Industry Standards, 2021). The announcement of the Back-to-Basics a few months before the release of the NDAA prompted this analysis on whether the FY2020 NDAA requirements are fulfilled by the current BUS-CE certification program.

International Cost Estimating & Analysis Association (ICEAA)

The most relevant third-party standard suitable for informing training curriculum for the cost estimating workforce is the Cost Estimating Body of Knowledge (CEBoK) developed by the International Cost Estimating & Analysis Association (ICEAA). ICEAA and its predecessor organizations have been collaborating with DoD acquisition professionals for decades, including the establishment of a memorandum of understanding between DAU and ICEAA (MOU) (DAU Partners with International Cost Estimating Analysis Association, 2020). ICEAA is a nonprofit organization that establishes internationally recognized standards for cost estimating and analysis. The

Certified Cost Estimator/Analyst (CCEA) designation is ICEAA's primary professional certification that requires five years of relevant cost-related experience and passing a rigorous two-part exam to qualify. The Professional Cost Estimator/Analyst (PCEA) is ICEEA's apprentice level certification for those new to the cost estimating profession. Applicants must pass an exam to obtain this certification. Both these certifications validate a professional's knowledge and understanding of math and statistics principles with engineering, program management, procurement, budgeting, and accounting disciplines. Achieving either one of ICEAA's certifications demonstrates that one has mastered the elements that form a successful cost estimate.

The Cost Estimating Body of Knowledge (CEBoK) is ICEEA's official training course material and consists of sixteen modules within five general subject areas designed to cover all topics representing the body of knowledge ICEAA promotes and tests for in the certification exams.

Summary

Chapter two discussed broad research related to defense acquisition workforce issues impacting the overall defense acquisition system. The chapter provided insight into how various acquisition reform efforts failed in implementation within DoD. Next, the chapter highlighted how the defense acquisition workforce obtains education, training, and certification requirements, followed by a discussion on the most recent updates to these requirements. Finally, the chapter concluded with recent legislation and the third-party certification standard this research will focus on.

III. Methodology

Chapter Overview

This chapter provides an explanation regarding the data and methodology used to analyze the data. The data source and criteria for inclusion and exclusion in the data set will be discussed. Then, the qualitative process used to perform the analysis will be described along with the quantitative method used to summarize the results. Finally, the chapter will summarize the key points of the methodological components of the research.

Data Source Overview

The data gathered in this research is from Defense Acquisition University's (DAU) ICatalog and International Cost Estimating & Analysis Association's (ICEAA) CEBoK Modules. In the ICatalog in DAU, Business Cost Estimating's (BUS-CE) competency model encompassing competencies and sub-competencies are accessible via the main page. An excerpt is shown in Table 4, the entire BUS-CE's competency model includes a total of 223 learning objectives.

Table 4: BUS-CE Competency Model Excerpt

Unit of Competency	Competency	Competency Description	Sub Competency Statement/Task
Cost Estimating Practitioner	Cost Estimating Process	Define DoD Cost Estimating Process	Analyze DoD cost estimating process flow chart
Cost Estimating Practitioner	Program Definition	Summarize program definition using relevant documents.	Review technical baseline description documents to ID the program's purpose and its system and performance characteristics and all system configurations.
Cost Estimating Practitioner	Program Definition	Summarize program definition using relevant documents.	Review program requirements (ICD, CDD, CPD, CONOPS) to understand timeline for delivering capability being estimated.

ICEAA's CEBoK is available via the CEBoK 2.0 Wiki page with member enrollment. As noted in Chapter 1, ICEAA's CEBoK does not have a formal competency model. Student Learning Objectives obtained from the Air Force Institute of Technology's Cost Master's Degree Program were used to create a data set comparable to that of DAU's BUS-CE competency model. Cost 674, Seminar in Cost Analysis, is a required course where students review ICEAA's CEBoK modules in preparation for potential ICEAA certification post AFIT graduation. As part of the course requirements, students created learning objectives to facilitate ease of learning. Two sets of these learning objectives were used to help create the ICEAA CEBoK competency model.

ICEAA CEBoK Data

While the first set of student-created learning objectives resulted in 278 learning objectives, only 256 fit the criteria for inclusion in the final data set. An additional 97 objectives from the second set of student objectives and 45 newly created learning objectives were also included in the final data set, culminating in 398 total learning objectives. The exclusion criteria entailed removing objectives that were either too broad or not written in complete sentences to form actual objectives, in total 20 objectives were excluded from the initial data set.

Within the CEBoK 2.0 modules, a list of Testable Topics for each module is available for the certification exams. This list of Testable Topics was compared with the first set of student-created learning objectives to ensure that all testable topics were covered. The second set of student objectives was used to fill in where testable topics were not covered or where objectives lacked completeness. For example, some of the student objectives were not written appropriately, these objectives were either revised to follow an objective format or replaced by objectives from the second set of student objectives. The second set of student objectives filled in most of the gaps missing from the first set, where gaps still existed objectives were created. Tables 5 and 6 provide an overview of the characteristics of the final dataset for this research.

Table 5: ICEAA CEBoK Dataset Characteristics

Unit of Competency	Competency	Total Learning Objectives
PCEA/CCEA	1. Cost Estimating Basics	41
PCEA/CCEA	2. Costing Techniques	26
PCEA/CCEA	3. Parametric Estimating	22
PCEA/CCEA	4. Data Collection & Normalization	19
PCEA/CCEA	5. Inflation & Index Numbers	29
PCEA/CCEA	6. Basic Data Principles	21
PCEA/CCEA	7. Learning Curve Analysis	23
PCEA/CCEA	8. Regression Analysis	37
PCEA/CCEA	9. Cost & Risk Analysis	38
PCEA/CCEA	10. Probability	24
PCEA/CCEA	11. Manufacturing	16
PCEA/CCEA	12. Software Cost Estimating	20
PCEA/CCEA	13. Economic Analysis	28
PCEA/CCEA	14. Contract Pricing	28
PCEA/CCEA	15. Earned Value Management (EVM)	13
PCEA/CCEA	16. Cost Management	13

Table 6: DAU Dataset Characteristics

Unit of Competency	Competency	Total Learning Objectives
Business Common Core	1. Requirements	3
Business Common Core	2. Financial Management	26
Business Common Core	3. Cost Estimating	18
Business Common Core	4. Earned Value Management Overview	8
Business Common Core	5. Ethics	5
Business Common Core	6. Contracting	7
Cost Estimating Practitioner	7. Purpose, Policy, Properties & Definitions	36
Cost Estimating Practitioner	8. Cost Estimating Process	1
Cost Estimating Practitioner	9. Program Definition	7
Cost Estimating Practitioner	10. Cost Estimate Basis	3
Cost Estimating Practitioner	11. Identify, Collect, Normalize & Analyze Data	24
Cost Estimating Practitioner	12. Schedule Cost/Schedule Estimating Methods	27
Cost Estimating Practitioner	13. Build Cost Model	9
Cost Estimating Practitioner	14. Final Results & Documentation	2
Cost Estimating Advanced	15. Purpose, Policy, Properties and Definitions	6
Cost Estimating Advanced	16. Program Definition	2
Cost Estimating Advanced	17. Cost Estimate Basis	28
Cost Estimating Advanced	18. Build Cost Estimate Model	12

The structure of the competency alignment map for ICEAA's CEBoK competencies was constructed to mirror DAU's competency model for organization and continuity purposes. The headings of both competency models are explained in the following list:

- Unit of Competency: This heading consists of the certification level applicable to the learning objectives. DAU's certification levels for BUS-CE consist of Business Common Core, Practitioner and Advanced certification levels. While ICEAA's CEBoK certification levels are Professional Cost Estimator Analyst (PCEA) and Certified Cost Estimator/Analyst (CCEA).
- Competency: This heading consists of the names of the 18 DAU BUS-CE competencies and the 16 ICEAA CEBoK modules which for the purposes of this research were transformed into competencies.
- Element #: This heading consists of the lowest level both DAU BUS-CE competencies and ICEAA CEBoK are broken down. Each element contains a sub competency (learning objective). The 398 ICEAA CEBoK sub competency elements were mapped to each of the 223 DAU BUS-CE elements for a clear picture of the overall alignment. Element #'s are the coding for each element
- Sub Competency Statement/Task Descriptions: This heading consists of the description for the sub competency (learning objective).

This research required the qualitative analysis of data – the data being both DAU's BUS-CE and ICEAA's CEBoK sub competency elements (learning objectives) descriptions. ICEAA's CEBoK sub competencies within the two certification paths, Professional Cost Estimator/Analyst (PCEA) and Certified Cost Estimator/Analyst (CCEA), overlapped for most of the competencies. In other words, most of the sub competencies were included in both certification levels, resulting in these competencies falling under both certification levels. Because of this, one lexicographic comparison was performed combining certification levels into one for each institution:

- DAU's Practitioner and Advanced BUS-CE competency elements
  ICEAA's PCEA and CCEA competency elements

The analysis resulted in the mapping of 223 DAU BUS-CE sub competency elements to ICEAA CEBoK's 16 knowledge areas (Modules). A quantitative analysis was applied by transforming the qualitative results into numeric coding using the COUNTIF function in excel and plotting the data. Karnes and Mortlocks' alignment classification table was used similarly in this research (Karnes & Mortlock, 2021, p. 392). Each element was classified as either aligned, somewhat aligned, completely unaligned, or not applicable. These classifications are explained below and a sample mapping of the sub-competencies from DAU and CEBoK are shown in Tables 7 and 8.

- Aligned (Green/ "G"): The description of the DAU BUS-CE competency element clearly aligned with one or more ICEAA CEBoK competencies. Indicators included exact or synonymous lexicon and application.

- Somewhat Aligned (Yellow/ “Y”): The description of the DAU BUS-CE competency element was partially aligned with the processes of one or more ICEAA CEBoK competencies. Indicators included similar or related lexicon but dissimilar application of the concepts.
- Completely Unaligned (Red/ “RR”): The description of the DAU BUS-CE competency element was not aligned with any of the ICEAA CEBoK competencies. The only indicator was the absence of similar content and descriptors.
- Not Applicable (Black/ “N/A”): Competencies were designated as not applicable if they are largely focused on information not exclusive to the cost estimation, for example financial or budgetary management practices.

Table 7: Sample Sub Competency Mapping Between DAU BUS-CE and ICEAA CEBoK Models

DAU Element #	Sub Competency (Learning Objective)	CEBoK Element #	Sub Competency (Learning Objective)
01.02S	Recognize how 1002 & WAWF data as a data source for analysis in financial management		
02.10	Explain the purpose and structure of Analysis of Alternatives (AoA) and the requirement for AoAs within DoD.	01.21	Cost estimator should be able to define and describe an Analysis of Alternatives (AoA)
02.35	Describe cost estimator support to non-JCIDS programs		
05.01	Identify elements applicable to the development of a cost estimate plan	01.35	Cost estimator should be able to list and describe the four basic costing techniques or methodologies available when developing a cost estimate
06.14	Identify the applicability of data to a given estimating task	04.03 04.15 04.16 04.17	-Recognize the types of data - Cost Estimators should be able to explain the difference between Primary and Secondary Data. - Cost Estimators should be able to differentiate the differences between Quantitative vs Qualitative. - Cost Estimators should be able to identify the difference between Objective vs Subjective.
06.19	Recognize value of cost data for other acquisition functions (e.g., engineering, logistics and contracting)		

Table 8: Additional Sub Competency Mapping Between DAU BUS-CE & ICEAA CEBoK Models

DAU Element #	Sub Competency (Learning Objective)	CEBoK Element #	Sub Competency (Learning Objective)
07.05	Estimate each element using the appropriate methodology for the data collected	01.35	- Cost estimator should be able to list and describe the four basic costing techniques or methodologies available when developing a cost estimate
		02.01	- Cost estimator should be able to define the purpose and nature of cost estimating techniques
		02.09	- Cost estimator should be able to describe the Parametric cost estimating technique.
		02.10	- Cost estimator should be able to identify when to use the Parametric method and describe the strengths and weaknesses of the method.
08.08	Capture program risk drivers in estimate (e.g., risk register, risk cube, etc.)	09.03	- Cost estimator should be able to describe the different types of cost risk models
		09.20	- Cost estimator should be able to describe the Risk Cube Method
		09.21	- Cost estimator should be able to discuss the Risk Cube Method Assessment Process
		09.33	- Cost estimators should understand how to apply uncertainty and risk to cost elements
		09.34	- Cost estimators should know how to apply the decision process and how to model risk uncertainty
12.23	Critique how Earned Value Management is performed, and the main contributions that CES provide to EVM	15.01	- Cost estimators should be able to define EVM and understand how it is applied

Inter-rater Reliability Test

Due to the subjective nature of this research, an inter-rater reliability (IRR) conducted by an additional rater was required to measure the level of agreement in alignment of the objectives. “Inter-rater reliability is a measure of consistency used to evaluate the extent to which different judges agree in their assessment decisions (American Psychological Association, 2010). A random sample of 30 DAU objectives, selected using the RAND function in Excel, were analyzed, and aligned using the full set of CEBoK objectives by the additional rater. In general, an inter-rater agreement of at least 80% is required for a test to be considered reliable (McHugh, 2012). Two rounds were conducted, the first round resulted in an IRR of 57%. Following a discussion between raters, a second round resulted in an IRR of 89% meeting the reliability threshold requirement.

Chapter Summary

Chapter III outlined the methodology and data sets involved in this study. The discussion into data sets provided insight into data creation and normalization between both data sets for effective analysis in Chapter IV. Furthermore, specific categories and subcategories were provided to capture the intent of this research. Next, a qualitative analysis process was introduced to identify similarities between data sets. Finally, a quantitative method was provided to summarize results.

IV. Analysis and Results

Chapter Overview

This chapter presents the results from applying the methodology in chapter III. Recall from chapter III, a lexicographic method mapping phrases and wording from each Defense Acquisition University (DAU) Business Cost Estimating (BUS-CE) objective to each ICEAA CEBoK learning objective was used in this analysis; each learning objective were classified as aligned, somewhat aligned, completely unaligned or N/A. An inter-rater reliability was conducted using a sample of 30 DAU objectives. The learning objectives for ICEAA's certification levels (PCEA and CCEA) tended to overlap between both levels so an analysis of each certification level between ICEAA and DAU would not be beneficial. Instead, the objectives between the certification levels for both institutions were combined and compared as whole.

Figure 4 and Table 9 answer the question, *to what extent are the DAU's BUS-CE competency elements aligned with ICEAA's CEBoK competency elements?* Based on the findings, DAU's competency model is 42% aligned with ICEAA's competency model (Figure 4). Figure 5 shows the alignment (Green) of the CEBoK objectives to DAU objectives by Module and Figure 6 shows the percentage of completely unaligned (RED) objectives per module. Analyzing the alignment from this direction shows how comprehensive DAU's Competency model is when compared to the CEBoK and allows DoD leadership to adjust DAU's competency model to include those objectives from the CEBoK to fully implement the NDAA requirements.

Table 9: Quantity of ICEAA Objectives in Alignment with DAU Objectives

Alignment Category	# Aligned with ICEAA CEBOK
Aligned	166
Somewhat Aligned	8
Completely Unaligned	224
Not Applicable "N/A"	0
Total	398

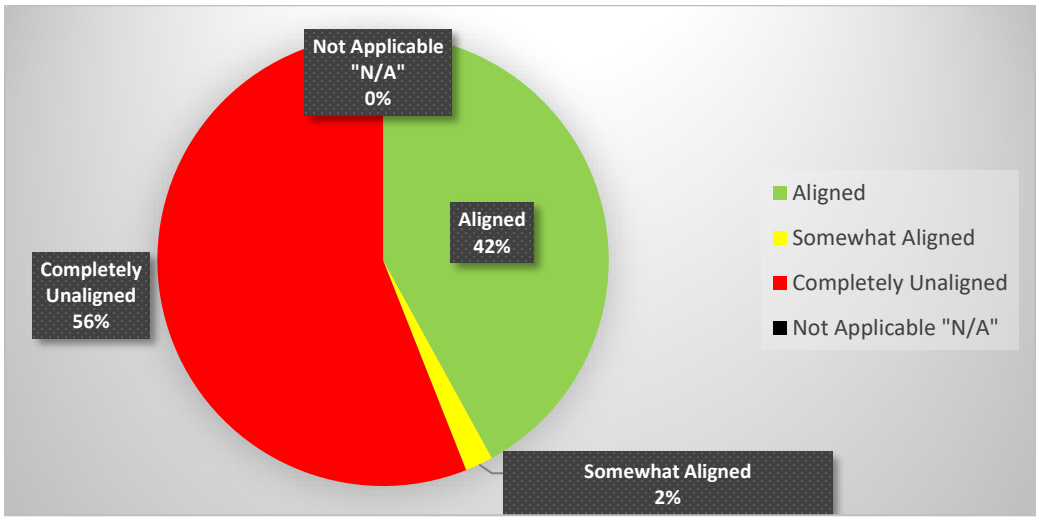

Figure 4: ICEAA Competency Alignment to DAU Competencies

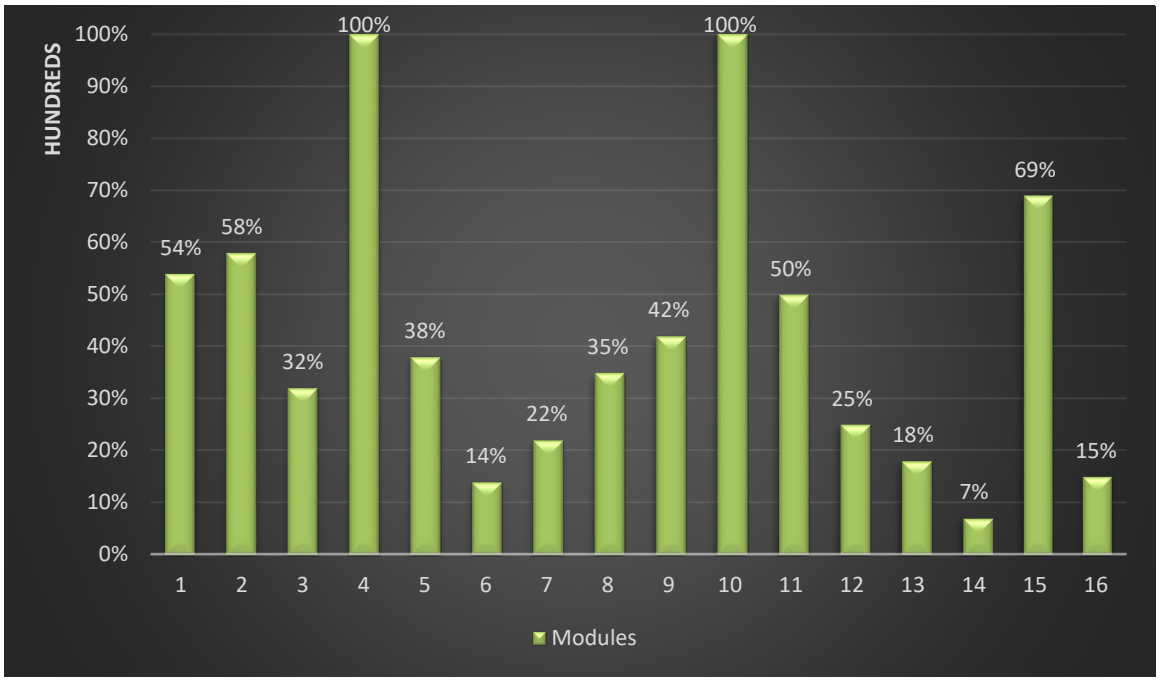

Figure 5: Sub Competency Alignment (GREEN) by CEBoK Module

The knowledge areas that were most in alignment with DAU objectives were Module 4 – Data Collection and Normalization, Module 10 – Probability and Statistics, and Module 15 – Earned Value Management:

- Module 4 – Data Collection and Normalization: This knowledge area contained objectives that were 100% aligned with DAU objectives. Data collection and normalization is extremely important in the cost estimating process. Data is the cornerstone of an estimate and cost analysts must understand how to collect appropriate data, analyze it, and adjust it to create useful estimates.

- Module 10 – Probability and Statistics: This knowledge area contained objectives that were 100% aligned with DAU objectives. This section provides the cost

estimator with a math foundation crucial to providing robust cost estimates. This section covers items such as measures of central tendency, dispersion, hypothesis testing and statistical testing.

- Module 15 – Earned Value Management (EVM) –This section provides the cost estimator tools to determine if their programs are progressing as planned within cost, schedule, and work parameters. This knowledge area contained objectives that were 69% aligned with DAU objectives.

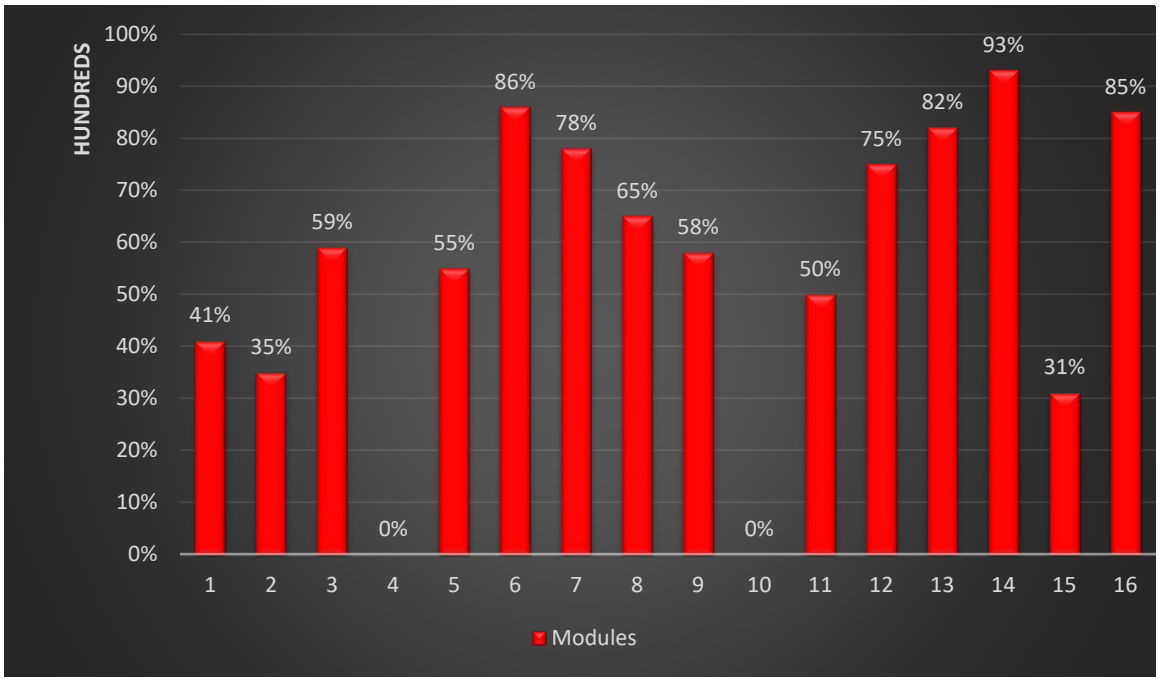

Figure 6: Sub Competencies Completely Unaligned (RED) by CEBoK Module

The knowledge areas that were least in alignment with DAU objectives (Figure XX) were Module 14 – Contract Pricing, Module 6 – Basic Data Analysis Principles, Module 16 – Cost Management and Module 13 – Economic Analysis:

- Module 6 – Basic Data Analysis Principles: This section is part of Unit III – Analytical Methods and provides cost estimators with basic mathematical techniques to analyze their data; a vital step in the cost estimating process. Although this knowledge area is aligned at only 14% with DAU objectives, the other Modules in this Unit (Module 7 – Learning Curve Analysis, Module 8 – Regression Analysis, and Module 9 – Cost and Schedule Risk Analysis) contain information overlapping with Module 6 so objectives from these modules are similar to that of Module 6.

- Module 13 – Economic Analysis (EA): This section discusses the application of the Economic Analysis process, a process designed to facilitate decision making when resources are particularly scarce. This knowledge area was in alignment with DAU objectives by only 14% which is concerning given that EA concepts are commonly used in DoD, as such DAU should implement additional objectives to fully capture this concept.
- Module 14 – Contract Pricing: This knowledge area had the lowest level of alignment with DAU objectives by 7%. This section covers the contracting process and the cost estimator's role as well as the methodologies involved in developing contracts. The misalignment in this area is concerning because cost estimators are largely involved in every stage of the acquisition process to include the development of the Request for Proposal (RFP) and conducting cost and price analysis on received proposals to determine an appropriate cost for contractor services.
- Module 16 – Cost Management: This knowledge area aligned by 15% with DAU objectives. This section covers concepts such as performance analysis used by both government and industry in overseeing their program's performance. The misalignment in this area should be corrected by DAU by implementing additional objectives covering this knowledge area in more detail. Analyzing program performance is extremely important to ensure a program is operating at optimal levels. Management can then make the any required adjustments to improve performance, potentially avoiding cost increases and realizing potential savings.

Tables 24-43 in the Appendix further elaborate on the specific alignment of each ICEAA objective annotated by the element and alignment column. Table 10 shows an excerpt of the alignment with sub competency element descriptions and element numbers.

Table 10: Alignment of CEBoK Competencies to DAU By Element

CEBoK Element #	Sub Competency (Learning Objective)	DAU Element #	Sub Competency (Learning Objective)
01.14	Cost estimator should be able to define and describe a Life Cycle Cost Estimate (LCCE).	01.03E	Recognize why key components of a LCCE are important.
03.14	Cost estimator should be able to define calibration and list reasons to calibrate a CER		
04.10	Cost estimator should be familiar with the data collection process	06.12	Collect additional technical information (and underlying basis) from Subject Matter Experts (SMEs).
		06.13	Recognize, collect and analyze alternate data sources (e.g. DCMA, DCAA, contractor accounting systems, etc.)
		06.18	Identify (and/or include) the auditable and traceable data sources for each elements and document how the data were normalized.
		12.05	Develop a data collection plan that documents the data collection methods, the types and quality of needed data, and the required data collection resources.
05.23	Cost estimator should understand the Budget Year Multiplier concept and when it is used.		
		06.14	Describe the different data collection methods (data queries, data mining, interviews, focus groups, and document reviews).
		06.15	Identify the applicability of data to a given estimating task.
09.03	Cost estimator should be able to describe the different types of cost risk models.		
09.36	Cost estimators should be able to distinguish between cost growth vs. cost risk and risk vs. uncertainty vs. opportunities		
14.03	Cost estimator should know what costs to include in an Economic Analysis.		

This section shows the alignment from the DAU perspective, aligning DAU objectives to ICEAA objectives (Figures 7-8 and Table 31). Based on the findings, when the Not Applicable "N/A" category is removed, DAU's competency model is 67% aligned with ICEAA's competency model (Figure 5). The addition of the Not Applicable "N/A" category reduces the alignment to 55% (Figure 4). Some of the learning objectives that were characterized as Not Applicable "N/A" include general training requirements primarily in the DAU Business Core competency. These objectives would not apply to the ICEAA organization but are necessary to DAU's competency model. Other items under this category include objectives that were not otherwise aligned but could reasonably have been included in ICEAA's competency model but were not. As such, these objectives did not count against DAU's alignment and were placed in the Not Applicable "N/A" category.

Table 11: Quantity of DAU Objectives in Alignment with ICEAA CEBok Objectives

Alignment Category	# Aligned with ICEAA CEBoK
Aligned	123
Somewhat Aligned	25
Completely Unaligned	36
Not Applicable "N/A"	39
Total	223

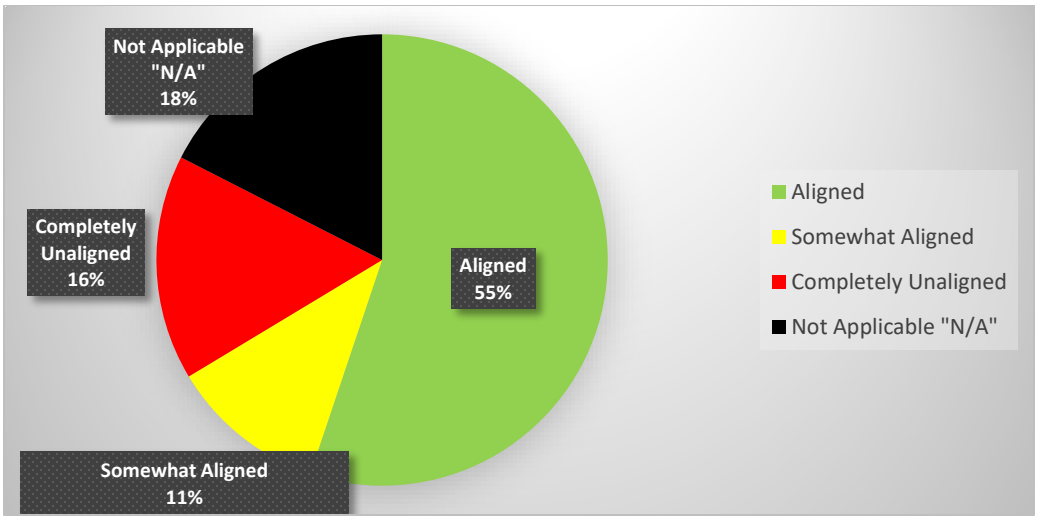

Figure 7: DAU Competency Alignment to ICEAA CEBoK Competencies (All Alignment Categories)

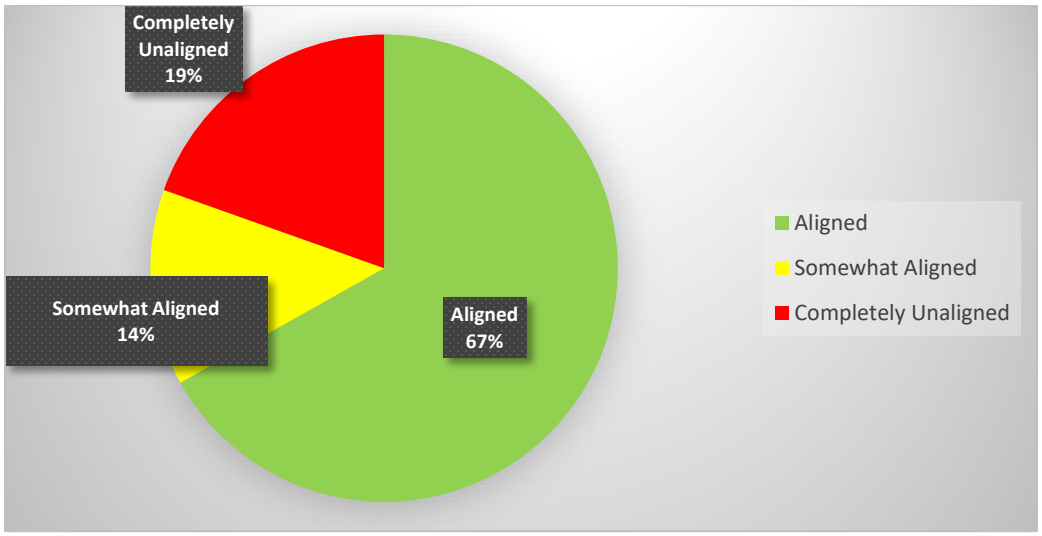

Figure 8: DAU Competency Alignment to ICEAA CEBoK Competencies (Excluding "N/A" Category)

Tables 32-38 further elaborate on the specific alignment of each DAU objective annotated by the element and alignment column. Tables 17-18 show an excerpt of the alignment with sub competency element descriptions and element numbers. The 39 learning objectives in the Not Applicable "N/A" category were excluded from these

tables. As expected, a majority of these elements fall under the Business Core unit of competency. A clear picture of each element and each competency level's alignment between the DAU BUS-CE model and the CEBoK is provided. Objectives in this section are largely focused on information not exclusive to cost estimation, for example financial or budgetary management practices.

Table 12: Alignment of DAU Competencies to CEBoK By Elements (Elements 01.02F-01.04H)

Unit of Competency	Competency	Element #	Alignment
1.0 Business Common Core	**1.2 Financial Management**	01.02F	
1.0 Business Common Core	**1.2 Financial Management**	01.02G	
1.0 Business Common Core	**1.2 Financial Management**	01.02K	
1.0 Business Common Core	**1.2 Financial Management**	01.02X	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03B	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03D	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03E	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03F	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03G	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03H	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03I	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03J	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03K	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03L	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03M	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03N	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03O	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03P	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03Q	
1.0 Business Common Core	**1.3 Cost Estimating**	01.03R	
1.0 Business Common Core	**1.4 Earned Value Management Overview**	01.04A	
1.0 Business Common Core	**1.4 Earned Value Management Overview**	01.04B	
1.0 Business Common Core	**1.4 Earned Value Management Overview**	01.04C	
1.0 Business Common Core	**1.4 Earned Value Management Overview**	01.04D	
1.0 Business Common Core	**1.4 Earned Value Management Overview**	01.04E	
1.0 Business Common Core	**1.4 Earned Value Management Overview**	01.04F	
1.0 Business Common Core	**1.4 Earned Value Management Overview**	01.04G	
1.0 Business Common Core	**1.4 Earned Value Management Overview**	01.04H	

Table 13: Alignment of DAU Competencies to CEBoK By Element (Elements 01.06D-02.32)

Unit of Competency	Competency	Element #	Alignment
1.0 Business Common Core	**1.6 Contracting**	01.06D	
1.0 Business Common Core	**1.6 Contracting**	01.06E	
1.0 Business Common Core	**1.6 Contracting**	01.06F	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.02	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.03	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.05	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.06	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.07	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.08	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.09	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.10	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.11	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.12	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.13	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.14	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.15	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.16	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.17	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.18	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.19	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.20	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.21	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.22	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.23	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.24	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.25	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.26	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.27	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.28	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.29	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.30	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.31	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.32	

Table 14: Alignment of DAU Competencies to CEBoK By Element (Elements 02.35-06.15)

Unit of Competency	Competency	Element #	Alignment
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.35	
Cost Estimating Practitioner	**Purpose, Policy, Properties and Definitions**	02.36	
Cost Estimating Practitioner	Cost Estimating Process	03.01	
Cost Estimating Practitioner	Program Definition	04.01	
Cost Estimating Practitioner	Program Definition	04.02	
Cost Estimating Practitioner	Program Definition	04.03	
Cost Estimating Practitioner	Program Definition	04.04	
Cost Estimating Practitioner	Program Definition	04.05	
Cost Estimating Practitioner	Program Definition	04.06	
Cost Estimating Practitioner	Program Definition	04.07	
Cost Estimating Practitioner	Cost Estimate Basis	05.01	
Cost Estimating Practitioner	Cost Estimate Basis	05.02	
Cost Estimating Practitioner	Cost Estimate Basis	05.03	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.01	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.02	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.03	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.04	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.05	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.06	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.07	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.08	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.09	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.10	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.11	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.12	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.13	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.14	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.15	

Table 15: Alignment of DAU Competencies to CEBoK By Element (Elements 06.16-07.16)

Unit of Competency	Competency	Element #	Alignment
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.16	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.17	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.18	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.19	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.20	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.21	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.22	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.23	
Cost Estimating Practitioner	Identify, Collect, Validate, Normalize and Analyze Data	06.24	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.01	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.02	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.03	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.04	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.05	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.06	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.07	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.08	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.09	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.10	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.11	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.12	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.13	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.14	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.15	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.16	

Table 16: Alignment of DAU Competencies to CEBoK By Element (Elements 07.17-11.02)

Unit of Competency	Competency	Element #	Alignment
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.17	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.18	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.19	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.20	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.21	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.22	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.23	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.24	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.25	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.26	
Cost Estimating Practitioner	Schedule Cost/Schedule Estimating Methods	07.27	
Cost Estimating Practitioner	Build Cost Estimate Model	08.01	
Cost Estimating Practitioner	Build Cost Estimate Model	08.02	
Cost Estimating Practitioner	Build Cost Estimate Model	08.03	
Cost Estimating Practitioner	Build Cost Estimate Model	08.04	
Cost Estimating Practitioner	Build Cost Estimate Model	08.05	
Cost Estimating Practitioner	Build Cost Estimate Model	08.06	
Cost Estimating Practitioner	Build Cost Estimate Model	08.07	
Cost Estimating Practitioner	Build Cost Estimate Model	08.08	
Cost Estimating Practitioner	Build Cost Estimate Model	08.09	
Cost Estimating Practitioner	Final Results and Documentation	09.01	
Cost Estimating Practitioner	Final Results and Documentation	09.02	
Cost Estimating Advanced	Purpose, Policy, Properties and Definitions	10.01	
Cost Estimating Advanced	Purpose, Policy, Properties and Definitions	10.02	
Cost Estimating Advanced	Purpose, Policy, Properties and Definitions	10.03	
Cost Estimating Advanced	Purpose, Policy, Properties and Definitions	10.04	
Cost Estimating Advanced	Purpose, Policy, Properties and Definitions	10.05	
Cost Estimating Advanced	Purpose, Policy, Properties and Definitions	10.06	
Cost Estimating Advanced	Program Definition	11.01	
Cost Estimating Advanced	Program Definition	11.02	

Table 17: Alignment of DAU Competencies to CEBoK By Element (Elements 12.01-12.28)

Unit of Competency	Competency	Element #	Alignment
Cost Estimating Advanced	Cost Estimate Basis	12.01	
Cost Estimating Advanced	Cost Estimate Basis	12.02	
Cost Estimating Advanced	Cost Estimate Basis	12.03	
Cost Estimating Advanced	Cost Estimate Basis	12.04	
Cost Estimating Advanced	Cost Estimate Basis	12.05	
Cost Estimating Advanced	Cost Estimate Basis	12.06	
Cost Estimating Advanced	Cost Estimate Basis	12.07	
Cost Estimating Advanced	Cost Estimate Basis	12.08	
Cost Estimating Advanced	Cost Estimate Basis	12.09	
Cost Estimating Advanced	Cost Estimate Basis	12.10	
Cost Estimating Advanced	Cost Estimate Basis	12.11	
Cost Estimating Advanced	Cost Estimate Basis	12.12	
Cost Estimating Advanced	Cost Estimate Basis	12.13	
Cost Estimating Advanced	Cost Estimate Basis	12.14	
Cost Estimating Advanced	Cost Estimate Basis	12.15	
Cost Estimating Advanced	Cost Estimate Basis	12.16	
Cost Estimating Advanced	Cost Estimate Basis	12.17	
Cost Estimating Advanced	Cost Estimate Basis	12.18	
Cost Estimating Advanced	Cost Estimate Basis	12.19	
Cost Estimating Advanced	Cost Estimate Basis	12.20	
Cost Estimating Advanced	Cost Estimate Basis	12.21	
Cost Estimating Advanced	Cost Estimate Basis	12.22	
Cost Estimating Advanced	Cost Estimate Basis	12.23	
Cost Estimating Advanced	Cost Estimate Basis	12.24	
Cost Estimating Advanced	Cost Estimate Basis	12.25	
Cost Estimating Advanced	Cost Estimate Basis	12.26	
Cost Estimating Advanced	Cost Estimate Basis	12.27	
Cost Estimating Advanced	Cost Estimate Basis	12.28	

Table 18: Alignment of DAU Competencies to CEBoK By Element (Elements 13.01-13.12)

Unit of Competency	Competency	Element #	Alignment
Cost Estimating Advanced	Build Cost Estimate Model	13.01	
Cost Estimating Advanced	Build Cost Estimate Model	13.02	
Cost Estimating Advanced	Build Cost Estimate Model	13.03	
Cost Estimating Advanced	Build Cost Estimate Model	13.04	
Cost Estimating Advanced	Build Cost Estimate Model	13.05	
Cost Estimating Advanced	Build Cost Estimate Model	13.06	
Cost Estimating Advanced	Build Cost Estimate Model	13.07	
Cost Estimating Advanced	Build Cost Estimate Model	13.08	
Cost Estimating Advanced	Build Cost Estimate Model	13.09	
Cost Estimating Advanced	Build Cost Estimate Model	13.10	
Cost Estimating Advanced	Build Cost Estimate Model	13.11	
Cost Estimating Advanced	Build Cost Estimate Model	13.12	

Table 19: Additional Sample Sub Competency Mapping

DAU Element #	Sub Competency (Learning Objective)	CEBoK Element #	Sub Competency (Learning Objective)
01.02Q 01.03C	Recognize the problems that may arise during the funds execution process and best way to satisfy objectives and fiscal constraints. Recognize the purpose of the 5000.73.		
02.31	Analyze the data to determine cost drivers, trends and outliers. Distinguish between cost drivers and cost contributors (aka cost passengers).	03.01 03.12	-Cost estimators should be familiar with the use of parametric estimating. -Cost estimator should be able to distinguish between cost drivers and cost passengers
06.05	Interpret schedule/program data and appraise the different sources for reliable schedule/program data.	04.02 04.03 04.10	-Cost estimators should be able to identify key data principles - Recognize the types of data - Cost estimator should be familiar with the data collection process
06.11	Define and apply EVM data elements	15.06	Cost estimators should be able to understand EVM Data Elements
07.07	Apply basic and advanced Statistics (e.g. regression analysis, queuing theory, optimization methods, hypothesis testing, variance analysis) to support cost analysis.	03.15 03.19 08.01	- Cost estimator should be able to identify basic outputs of a regression - Cost estimator should be able to list and describe the steps in deriving CERs by regression analysis - Cost estimators should be familiar with Regression Analysis
07.24 08.05	Describe step-down functions and apply where appropriate. Determine the amount of contingency funding required to fund the program at a specified confidence level (i.e. the uncertainty-adjusted cost estimate).		
12.06	Develop a data collection plan for implementing CSDRs. Identify the CWIPT and responsibilities for recommendation of the CCDR and SRDR plans.	04.10	Cost estimator should be familiar with the data collection process

Summary

This chapter detailed the lexicographic qualitative analysis conducted for this research and prepares the reader for the results to be discussed in Chapter V. A brief overview of the methodology and dataset was provided to revisit key points of the analysis. Next, the lexicon mapping results for DAU objectives were presented along with a discussion of the objectives most in alignment with ICEAA CEBoK objectives. Following, the lexicon mapping results from the CEBoK perspective along with a discussion of the most aligned and least aligned knowledge areas was discussed. Chapter V will address these results as they apply to the application of the 2020 NDAA requirements.

V. Conclusions and Recommendations

Chapter Overview

This research's major objective was to determine whether DoD's cost estimating certification program was aligned with ICEAA's CEBoK, as required by the 2020 National Defense Authorization Act (NDAA). Recall that the NDAA mandated that all acquisition workforce professional certification programs be based on standards developed by a third-party nationally or internationally accredited program (NDAA, 2019). The findings for this research question are provided in this chapter and then discussed in the context of the NDAA requirement.

Research Questions Answered

The research question addressed to what extent are the DAU's BUS-CE competency elements aligned with ICEAA's CEBoK competency elements? The two certification levels in each institution were combined and compared for one comparison between the two institutions. DAU's BUS-CE competency model resulted in a 42% alignment with CEBoK's competency model mapping the elements from ICEAA to DAU. Analyzing the alignment from DAU's perspective, mapping the elements from DAU to ICEAA, resulted in a 67% alignment with CEBoK's competency model. Of note, there are several misalignments in the DAU model shown in Table 40. These topics aren't covered sufficiently as compared to the coverage in the ICEAA competency model. A summary of the alignment between DAU and ICEAA's competency model is provided in Tables 40-42.

Table 20: DAU BUS-CE Alignment to ICEAA CEBoK Competency Model

To what extent are the DAU's BUS-CE competency elements aligned with ICEAA's CEBoK competency elements?				
ICEAA CEBoK	67% Aligned	11% Somewhat Aligned	16% Completely Unaligned	18% Not Applicable "N/A"

Table 21: ICEAA CEBoK Alignment to DAU BUS-CE Competency Model

To what extent are the DAU's BUS-CE competency elements aligned with ICEAA's CEBoK competency elements?				
DAU BUS-CE	42% Aligned	2% Somewhat Aligned	56% Completely Unaligned	0% Not Applicable "N/A"

Table 22: ICEAA CEBoK Knowledge Areas Most in Alignment and Least in Alignment

Most Aligned	Least Aligned
100% Alignment Module 4 – Data Collection and Normalization	14% Alignment Module 6 – Basic Data Analysis Principles
100% Alignment Module 10 – Probability and Statistics	18% Alignment Module 13 – Economic Analysis
69% Alignment Module 15 – Earned Value Management	7% Alignment Module 14 – Contract Pricing
	15% Alignment Module 16 – Cost Management

Recommendations for Action

The following are recommendations based on the research conducted, although this research focused on providing answers for DoD stakeholders to better integrate the 2020 NDAA requirement, recommendations to ICEAA are also included.

1. DAU should base the BUS-CE certification program more closely on the ICEAA CEBoK.

ICEAA integrates many concepts applicable to DoD in each knowledge area (modules). Although this information requires updating with the release of new and updated DoD Acquisition policy, we believe the ICEAA competency model is more robust in cost estimating training requirements. DAU's learning objectives in terms of cost estimating concepts and skills are substantially covered in the ICEAA models. Where DAU lacks alignment, concepts that are broadly business related, but not specifically cost estimation related, are mostly the cause for this misalignment.

2. DAU should augment the BUS-CE certification training program focusing on areas where CEBoK knowledge areas are least in alignment.

Several CEBoK knowledge areas were not adequately covered in the DAU competency model. For example, The Contract Pricing knowledge area (Module 14) had the lowest alignment at 7% with DAU's competency model. Cost estimators should have a more detailed understanding of this area given they are largely involved in the contracting process and contracts are commonplace in the acquisition process. Augmenting the DAU competency model will provide cost estimators with a more robust training program as well as increase DAU's alignment with industry standards.

3. ICEAA should implement more consistent updates to CEBoK certification training materials

As mentioned earlier, the CEBoK is ICEAA's official resource to study for certification testing, although it recently migrated to an online format, the material itself has not been consistently updated. The major concepts in terms of knowledge, skills and application go largely unchanged. Some topics, such as Probability and Statistics, do not change frequently and do not need frequent updating. However, specific DoD policy changes frequently, and ICEAA should strive to reflect these changes in their knowledge areas (Modules). For example, the Acquisition Pathways concept discussed in Chapter 2 implemented by DoD in 2020, is an important concept simplifying the acquisition process in terms of applying regulations to capabilities. DAU's competency model included several objectives linked to this concept categorized under "Not Applicable" in terms of alignment.

Summary

The purpose of this research was to investigate DoD's Cost Estimating certification program and its compliance of the 2020 NDAA, mandating that all acquisition certification programs be based on third party certification standards. This research utilized available qualitative data from DAU and AFIT creating a data set of 223 DAU BUS-CE learning objectives and 398 ICEAA CEBoK learning objectives. Analysis conducted resulted in a 42% alignment, calling for significant improvement in the DAU Competency model to increase NDAA compliance.

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Appendix

Table 23: Alignment of CEBoK Competencies to DAU By Element (Elements 01.01-01.20)

Competency	Element #	Alignment
Module 1	01.01	
Module 1	01.02	
Module 1	01.03	
Module 1	01.04	
Module 1	01.05	
Module 1	01.06	
Module 1	01.07	
Module 1	01.08	
Module 1	01.09	
Module 1	01.10	
Module 1	01.11	
Module 1	01.12	
Module 1	01.13	
Module 1	01.14	
Module 1	01.15	
Module 1	01.16	
Module 1	01.17	
Module 1	01.18	
Module 1	01.19	
Module 1	01.20	

Table 24: Alignment of CEBoK Competencies to DAU By Element (Elements 01.21-01.40)

Competency	Element #	Alignment
Module 1	01.21	
Module 1	01.22	
Module 1	01.23	
Module 1	01.24	
Module 1	01.25	
Module 1	01.26	
Module 1	01.27	
Module 1	01.28	
Module 1	01.29	
Module 1	01.30	
Module 1	01.31	
Module 1	01.32	
Module 1	01.33	
Module 1	01.34	
Module 1	01.35	
Module 1	01.36	
Module 1	01.37	
Module 1	01.38	
Module 1	01.39	
Module 1	01.40	

Table 25: Alignment of CEBoK Competencies to DAU By Element (Elements 01.41-02.19)

Competency	Element #	Alignment
Module 1	01.41	
Module 2	02.01	
Module 2	02.02	
Module 2	02.03	
Module 2	02.04	
Module 2	02.05	
Module 2	02.06	
Module 2	02.07	
Module 2	02.08	
Module 2	02.09	
Module 2	02.10	
Module 2	02.11	
Module 2	02.12	
Module 2	02.13	
Module 2	02.14	
Module 2	02.15	
Module 2	02.16	
Module 2	02.17	
Module 2	02.18	
Module 2	02.19	

Table 26:Alignment of CEBoK Competencies to DAU By Element (Elements 02.20-02.25)

Competency	Element #	Alignment
Module 2	02.20	
Module 2	02.21	
Module 2	02.22	
Module 2	02.23	
Module 2	02.24	
Module 2	02.25	
Module 2	02.26	
Module 2	02.20	
Module 2	02.21	
Module 2	02.22	
Module 2	02.23	
Module 2	02.24	
Module 2	02.25	
Module 2	02.26	
Module 2	02.20	
Module 2	02.21	
Module 2	02.22	
Module 2	02.23	
Module 2	02.24	
Module 2	02.25	

Table 27: Alignment of CEBoK Competencies to DAU By Element (Elements 02.26-03.19)

Competency	Element #	Alignment
Module 2	02.26	
Module 3	03.01	
Module 3	03.02	
Module 3	03.03	
Module 3	03.04	
Module 3	03.05	
Module 3	03.06	
Module 3	03.07	
Module 3	03.08	
Module 3	03.09	
Module 3	03.10	
Module 3	03.11	
Module 3	03.12	
Module 3	03.13	
Module 3	03.14	
Module 3	03.15	
Module 3	03.16	
Module 3	03.17	
Module 3	03.18	
Module 3	03.19	

Table 28: Alignment of CEBoK Competencies to DAU By Element (Elements 03.20-04.17)

Competency	Element #	Alignment
Module 3	03.20	
Module 3	03.21	
Module 3	03.22	
Module 4	04.01	
Module 4	04.02	
Module 4	04.03	
Module 4	04.04	
Module 4	04.05	
Module 4	04.06	
Module 4	04.07	
Module 4	04.08	
Module 4	04.09	
Module 4	04.10	
Module 4	04.11	
Module 4	04.12	
Module 4	04.13	
Module 4	04.14	
Module 4	04.15	
Module 4	04.16	
Module 4	04.17	

Table 29: Alignment of CEBoK Competencies to DAU By Element (Elements 04.18-05.18)

Competency	Element #	Alignment
Module 4	04.18	
Module 4	04.19	
Module 5	05.01	
Module 5	05.02	
Module 5	05.03	
Module 5	05.04	
Module 5	05.05	
Module 5	05.06	
Module 5	05.07	
Module 5	05.08	
Module 5	05.09	
Module 5	05.10	
Module 5	05.11	
Module 5	05.12	
Module 5	05.13	
Module 5	05.14	
Module 5	05.15	
Module 5	05.16	
Module 5	05.17	
Module 5	05.18	

Table 30: Alignment of CEBoK Competencies to DAU By Element (Elements 05.19-06.09)

Competency	Element #	Alignment
Module 5	05.19	
Module 5	05.20	
Module 5	05.21	
Module 5	05.22	
Module 5	05.23	
Module 5	05.24	
Module 5	05.25	
Module 5	05.26	
Module 5	05.27	
Module 5	05.28	
Module 5	05.29	
Module 6	06.01	
Module 6	06.02	
Module 6	06.03	
Module 6	06.04	
Module 6	06.05	
Module 6	06.06	
Module 6	06.07	
Module 6	06.08	
Module 6	06.09	

Table 31: Alignment of CEBoK Competencies to DAU By Element (Elements 06.10-07.08)

Competency	Element #	Alignment
Module 6	06.10	
Module 6	06.11	
Module 6	06.12	
Module 6	06.13	
Module 6	06.14	
Module 6	06.15	
Module 6	06.16	
Module 6	06.17	
Module 6	06.18	
Module 6	06.19	
Module 6	06.20	
Module 6	06.21	
Module 7	07.01	
Module 7	07.02	
Module 7	07.03	
Module 7	07.04	
Module 7	07.05	
Module 7	07.06	
Module 7	07.07	
Module 7	07.08	

Table 32: Alignment of CEBoK Competencies to DAU By Element (Elements 07.09-08.05)

Competency	Element #	Alignment
Module 7	07.09	
Module 7	07.10	
Module 7	07.11	
Module 7	07.12	
Module 7	07.13	
Module 7	07.14	
Module 7	07.15	
Module 7	07.16	
Module 7	07.17	
Module 7	07.18	
Module 7	07.19	
Module 7	07.20	
Module 7	07.21	
Module 7	07.22	
Module 7	07.23	
Module 8	08.01	
Module 8	08.02	
Module 8	08.03	
Module 8	08.04	
Module 8	08.05	

Table 33: Alignment of CEBoK Competencies to DAU By Element (Elements 08.06-08.25)

Competency	Element #	Alignment
Module 8	08.06	
Module 8	08.07	
Module 8	08.08	
Module 8	08.09	
Module 8	08.10	
Module 8	08.11	
Module 8	08.12	
Module 8	08.13	
Module 8	08.14	
Module 8	08.15	
Module 8	08.16	
Module 8	08.17	
Module 8	08.18	
Module 8	08.19	
Module 8	08.20	
Module 8	08.21	
Module 8	08.22	
Module 8	08.23	
Module 8	08.24	
Module 8	08.25	

Table 34: Alignment of CEBoK Competencies to DAU By Element (Elements 08.26-09.08)

Competency	Element #	Alignment
Module 8	08.26	
Module 8	08.27	
Module 8	08.28	
Module 8	08.29	
Module 8	08.30	
Module 8	08.31	
Module 8	08.32	
Module 8	08.33	
Module 8	08.34	
Module 8	08.35	
Module 8	08.36	
Module 8	08.37	
Module 9	09.01	
Module 9	09.02	
Module 9	09.03	
Module 9	09.04	
Module 9	09.05	
Module 9	09.06	
Module 9	09.07	
Module 9	09.08	

Table 35: Alignment of CEBoK Competencies to DAU By Element (Elements 09.09-09.28)

Competency	Element #	Alignment
Module 9	09.09	
Module 9	09.10	
Module 9	09.11	
Module 9	09.12	
Module 9	09.13	
Module 9	09.14	
Module 9	09.15	
Module 9	09.16	
Module 9	09.17	
Module 9	09.18	
Module 9	09.19	
Module 9	09.20	
Module 9	09.21	
Module 9	09.22	
Module 9	09.23	
Module 9	09.24	
Module 9	09.25	
Module 9	09.26	
Module 9	09.27	
Module 9	09.28	

Table 36: Alignment of CEBoK Competencies to DAU By Element (Elements 09.29-10.10)

Competency	Element #	Alignment
Module 9	09.29	
Module 9	09.30	
Module 9	09.31	
Module 9	09.32	
Module 9	09.33	
Module 9	09.34	
Module 9	09.35	
Module 9	09.36	
Module 9	09.37	
Module 9	09.38	
Module 10	10.01	
Module 10	10.02	
Module 10	10.03	
Module 10	10.04	
Module 10	10.05	
Module 10	10.06	
Module 10	10.07	
Module 10	10.08	
Module 10	10.09	
Module 10	10.10	

Table 37: Alignment of CEBoK Competencies to DAU By Element (Elements 10.11-11.06)

Competency	Element #	Alignment
Module 10	10.11	
Module 10	10.12	
Module 10	10.13	
Module 10	10.14	
Module 10	10.15	
Module 10	10.16	
Module 10	10.17	
Module 10	10.18	
Module 10	10.19	
Module 10	10.20	
Module 10	10.21	
Module 10	10.22	
Module 10	10.23	
Module 10	10.24	
Module 11	11.01	
Module 11	11.02	
Module 11	11.03	
Module 11	11.04	
Module 11	11.05	
Module 11	11.06	

Table 38:Alignment of CEBoK Competencies to DAU By Element (Elements 11.07-1210)

Competency	Element #	Alignment
Module 11	11.07	
Module 11	11.08	
Module 11	11.09	
Module 11	11.10	
Module 11	11.11	
Module 11	11.12	
Module 11	11.13	
Module 11	11.14	
Module 11	11.15	
Module 11	11.16	
Module 12	12.01	
Module 12	12.02	
Module 12	12.03	
Module 12	12.04	
Module 12	12.05	
Module 12	12.06	
Module 12	12.07	
Module 12	12.08	
Module 12	12.09	
Module 12	12.10	

Table 39: Alignment of CEBoK Competencies to DAU By Element (Elements 12.11-1310)

Competency	Element #	Alignment
Module 12	12.11	
Module 12	12.12	
Module 12	12.13	
Module 12	12.14	
Module 12	12.15	
Module 12	12.16	
Module 12	12.17	
Module 12	12.18	
Module 12	12.19	
Module 12	12.20	
Module 13	13.01	
Module 13	13.02	
Module 13	13.03	
Module 13	13.04	
Module 13	13.05	
Module 13	13.06	
Module 13	13.07	
Module 13	13.08	
Module 13	13.09	
Module 13	13.10	

Table 40: Alignment of CEBoK Competencies to DAU By Element (Elements 13.11-14.02)

Competency	Element #	Alignment
Module 13	13.11	
Module 13	13.12	
Module 13	13.13	
Module 13	13.14	
Module 13	13.15	
Module 13	13.16	
Module 13	13.17	
Module 13	13.18	
Module 13	13.19	
Module 13	13.20	
Module 13	13.21	
Module 13	13.22	
Module 13	13.23	
Module 13	13.24	
Module 13	13.25	
Module 13	13.26	
Module 13	13.27	
Module 13	13.28	
Module 14	14.01	
Module 14	14.02	

Table 41:Alignment of CEBoK Competencies to DAU By Element (Elements14.03-14.22)

Competency	Element #	Alignment
Module 14	14.03	
Module 14	14.04	
Module 14	14.05	
Module 14	14.06	
Module 14	14.07	
Module 14	14.08	
Module 14	14.09	
Module 14	14.10	
Module 14	14.11	
Module 14	14.12	
Module 14	14.13	
Module 14	14.14	
Module 14	14.15	
Module 14	14.16	
Module 14	14.17	
Module 14	14.18	
Module 14	14.19	
Module 14	14.20	
Module 14	14.21	
Module 14	14.22	

Table 42:Alignment of CEBoK Competencies to DAU By Element (Elements 14.23-16.01)

Competency	Element #	Alignment
Module 14	14.23	
Module 14	14.24	
Module 14	14.25	
Module 14	14.26	
Module 14	14.27	
Module 14	14.28	
Module 15	15.01	
Module 15	15.02	
Module 15	15.03	
Module 15	15.04	
Module 15	15.05	
Module 15	15.06	
Module 15	15.07	
Module 15	15.08	
Module 15	15.09	
Module 15	15.10	
Module 15	15.11	
Module 15	15.12	
Module 15	15.13	
Module 16	16.01	

Table 43:Alignment of CEBoK Competencies to DAU By Element (Elements 16.02-16.13)

Competency	Element #	Alignment
Module 16	16.02	
Module 16	16.03	
Module 16	16.04	
Module 16	16.05	
Module 16	16.06	
Module 16	16.07	
Module 16	16.08	
Module 16	16.09	
Module 16	16.10	
Module 16	16.11	
Module 16	16.12	
Module 16	16.13	

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14. ABSTRACT

In an attempt to improve certification training programs, the National Defense Authorization Act (NDAA) of 2020 mandated changes to certification requirements for all acquisition related career fields directing the implementation of certification programs based on nationally or internationally accredited third-party standards (NDAA, 2019). This research focused on DoD's Defense Acquisition University's (DAU) Business Cost Estimating (BUS-CE) Program's compliance with the NDAA. The study has one major research question that focuses on determining how well aligned the Defense Acquisition University's (DAU) BUS-CE certification program's competency model is to its relevant third-party standard, the International Cost Estimating and Analysis Association's (ICEAA) Cost Estimating Body of Knowledge (CEBoK) competency model. A second review further addresses the research question by looking at the comprehensiveness of DAU's BUS-CE competency model when compared to CEBoK's competency model. The research found that of the 223 learning objectives in the DAU BUS-CE competency model, 67% were aligned with ICEAA's CEBoK competency model and of the 398 objectives in the ICEAA CEBoK competency model, 42% aligned with DAU's competency model. The research identified significant knowledge areas lacking in the DAU BUS-CE competency model that were covered in the CEBoK competency model.

15. SUBJECT TERMS

National Defense Authorization Act (NDAA), Defense Acquisition University (DAU), International Cost Estimating and Analysis Association (ICEAA), Cost Estimating Body of Knowledge (CEBoK), Competency Models

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