3-23-2018

An Analysis of Major Acquisition Reforms through Text Mining and Grounded Theory Design

Amanda L. McGowin

AN ANALYSIS OF MAJOR ACQUISITION REFORMS THROUGH TEXT MINING AND GROUNDED THEORY DESIGN

THESIS

Amanda L. McGowin, Captain, USAF

AFIT-ENV-MS-18-M-224

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT-ENV-MS-18-M-224

AN ANALYSIS OF MAJOR ACQUISITION REFORMS THROUGH TEXT MINING AND GROUNDED THEORY DESIGN

THESIS

Presented to the Faculty

Department of Systems Engineering and Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Cost Analysis

Amanda L. McGowin, BS

Captain, USAF

March 2018

AFIT-ENV-MS-18-M-224

AN ANALYSIS OF MAJOR ACQUISITION REFORMS THROUGH TEXT MINING AND GROUNDED THEORY DESIGN

Amanda L. McGowin, BS
Captain, USAF

Committee Membership:

Dr. Jonathan Daniel Ritschel
Chair

Dr. R. David Fass
Member

Dr. Bradley Boehmke
Member

Abstract

Cost growth is an established phenomenon within Defense Acquisition that the US Government has attempted to abolish for decades through seemingly endless cycles of reform. Dozens of experts and senior leaders within the acquisition community have published their notions on the reasons for cost growth, nevertheless, legislation has yet to eradicate this presumed conundrum. For this reason, this research is aimed at identifying existing trends within past major Defense Acquisition Reform legislation, as well as in a compendium of views from leaders within the Defense Acquisition community on the efficacy of acquisition reform, to determine the possible disconnect.

To accomplish this goal, this research takes a qualitative approach, utilizing various Text Mining methodologies (word frequency, word relationships, term frequency-inverse document frequency, sentiment analysis, and topic modeling), along with Grounded Theory Design, to analyze the major reforms and expert views. The results of this research corroborate the current literature's claim that past Defense Acquisition reforms have not been able to sufficiently address the root causes of cost growth, and identifies six potential root causes of cost growth: Strategy, the Industrial Base, Risk Management, the Requirements and Research, Development, Test, and Evaluation (RDT&E) Processes, the Workforce, and Cost Estimates and the Planning, Programming, Budget, and Execution (PPBE) Process.

To my husband and "the kids"

Acknowledgments

I would like to express my sincere appreciation to my research advisor, Dr. Dan Ritschel, for his guidance and support throughout the course of this thesis effort. His unique limbo status provided some interesting challenges, but not once did it deter him from being an awesome advisor. I would also like to thank my committee members, Dr. Dave Fass and Dr. Brad Boehmke, and my course director, Lt Col Brandon Lucas, for their leadership and advise throughout the program. Finally, I would like to thank the Graduate Cost Analysis class of 2018M, who's friendship I will never forget.

Amanda L. McGowin

Table of Contents

List of Tables

List of Figures

List of Equations

Page

AN ANALYSIS OF MAJOR ACQUISITION REFORMS THROUGH TEXT MINING AND GROUNDED THEORY DESIGN

I. Introduction

Background

It is not a revelation to state that the Department of Defense (DoD) Acquisition System is "broken." For over 50 years, the U.S. Government enacted multitudes of reforms in attempts to improve the system, focusing primarily on the military acquisition processes and organizational restructure (Jackson, 2011; Eide & Allen, 2012). In fact, acquisition reform has been so common a solution that nearly every year some form of legislation or policy has been enacted. Among these 50 plus reforms, five are considered major transformations (Ritschel, 2012):

1. The Nunn-McCurdy Provision of the 1983 Defense Authorization Act
2. The President's Blue Ribbon Commission on Defense Management of 1986, more informally known as the Packard Commission
3. The Defense Acquisition Workforce Improvement Act (DAWIA) of 1990
4. The Federal Acquisition Streamlining Act (FASA) of 1994
5. The Weapon Systems Acquisition Reform Act (WSARA) of 2009

While some reviews of reform show that at least minor improvement of program outcomes exists (Rich & Dews, 1987), there has not been a significant decrease in cost and schedule overruns within Major Defense Acquisition Programs (MDAPs) (Eide & Allen, 2012). Despite the numerous failed attempts, recent news has revealed Congress' intent to once again resort to reform as the answer, with Representative Mac Thornberry,

House Armed Services Committee (HASC) Chairman, 115th Congress, articulating plans to focus on innovation and organizational restructure (Mitchell, 2017). Conversely, Frank Kendall, the Undersecretary of Defense for Acquisition, heeds a warning to Congress stating that bureaucracy and regulation are not good tools to achieve results and in reality, burdens the system (Serbu, 2017).

Predictably, a plethora of previous research has examined the effectiveness of acquisition reform using common methods. This includes the impact of the Packard Commission on the reduction of cost overruns within MDAPs via statistical analysis by comparison of means (Searle, 1997), the effects of acquisition reform on cost and schedule growth using a panel regression model (Smirnoff, 2006; Giacomazzi, 2007), and the impact of acquisition reform on contract cost variance using a comparison of means and a timeline with intervention analysis (Holbrook, 2003). The U.S. Government Accountability Office, the RAND Corporation, and dozens of experts in the defense acquisition community have also reported on reform performance.

The methods typically used in past defense acquisition research have been predominantly quantitative. However, given that reforms are unstructured text-based documents, qualitative analysis is an appropriate alternative approach (Patten, 2009). Two popular qualitative research methods are grounded theory design and Text Mining (Yu, Jannasch-Pennell, & Digangi, 2011). Grounded theory is a strategy for systematically analyzing data in an exploratory manner for the development of theory (Glaser & Strauss, 1967). Similarly, Text Mining is a process that extracts useful information from data through the identification of patterns, which is also exploratory in

nature (Feldman & Sanger, 2006; Yu et al, 2011). "Both grounded theory and Text Mining utilize an iterative process [to investigate data]" (Yu et al, 2011).

While grounded theory has been used for decades successfully across many areas of research, especially in sociology (Glaser & Strauss, 1967; Yu et al, 2011), Text Mining is a fairly new analytic technique that emerged in the late 1990's which is becoming increasingly more prevalent (Witten, 2003). Text Mining has been used in pharmaceutical drug discovery, survey analysis, capability engineering framework, and within the government for counter-terrorism, scientific research, and problem detection in defense acquisition programs (Losiewicz, Oard, & Kostoff, 2003; Grimes, 2007; Kirk & Monarch, 2008; Miller, 2012). Although Text Mining has been employed within government research, it has not yet been applied to defense acquisition reform.

Research Objective and Questions

The purpose of this research is to identify and analyze trends within past major Defense Acquisition Reform legislation in comparison to a compendium of views from leaders within the Defense Acquisition community on the efficacy of acquisition reform. This analysis is designed to provide insight, not only on where the acquisition process and reforms have been, but on where they should be headed to effectively reduce cost and schedule overruns within MDAPs. As a result of this research we investigate answers to the following questions:

1. What are the commonalities and differences of the various major acquisition reforms?

2. What are the commonalities and differences between the reform legislation and the recommendations of the Defense Acquisition Leaders and Experts?
3. What unique insights does Text Mining reveal for new or different root causes of cost and schedule overruns?
4. Are incentives, or a lack of incentives, a problem? If so, do the reforms address incentives, and how?
5. How well do the results of Text Mining coincide with the results of grounded theory?

The goal of this research is to provide a historical understanding of the performance of the major acquisition reforms in relationship to the acquisition community's leading experts opinions on the root causes of cost and schedule growth. Additionally, this research will provide a theory grounded in data which could aide in the development of a plan or further research addressing the root causes of cost and schedule growth within MDAPs, while simultaneously providing ammunition to combat "band aide" fixes that generally focus on side-effects of the true cause.

Methodology

The intent of this research is to use Text Mining in combination with grounded theory design to analyze the major past acquisition reform legislation, including corresponding amendments, and a compendium of Leading Expert views to detect major trends. As mentioned previously, there are five major reforms: the Nunn-McCurdy Provision (1983), the Packard Commission (1986), DAWIA (1990), FASA (1994), and

WSARA (2009). The text of those five legislative documents comprise the reform data for this analysis. The Acquisition Expert data is a compendium of expert views compiled from several sources, and dozens of experts listed in Table 1.

Any trends identified from the major reforms and the compendium will be compared to measure how well the reforms reflect the opinions of the experts and reveal any potential shortfalls the reforms have yet to address. Furthermore, this research will analyze any major trends that were identified in an effort leading to the development of a theory explaining root causes of cost and schedule overruns.

Table 1: Acquisition Expert Data - A Compendium of Leading Expert Views

Year	**Document**	**Experts**
2008	Testimony of the Honorable James I. Finley, Deputy Under Secretary of Defense (Acquisition and Technology) Before the United States House of Representatives Committee on Oversight and Government Reform and Subcommittee on National Security and Foreign Affairs	The Honorable James I. Finley
2014	Defense Acquisition Reform: Where do we go from Here? A Compendium of Views by Leading Experts	Brig Gen Frank J. Anderson, USAF (Ret.) The Honorable Norman R. Augustine Mr. David J. Berteau Mr. Irv Blickstein, Gen James Cartwright, USMC (Ret.) The Honorable Thomas Christie Mr. Jonathan Etherton The Honorable Christine H. Fox Dr. J. Ronald, Fox Mr. Paul Francis The Honorable Jacques S. Gansler, PhD The Honorable Dr. J. Michael Gilmore The Honorable Daniel I. Gordon Mr. William C. Greenwalt Mr. Todd Harison The Honorable Tina W. Jonas

		Dr. Paul G. Kaminski The Honorable Frank Kendall III The Honorable Dr. John F. Lehman The Honorable Elizabeth McGrath Dr. David L. McNicol The Honorable Dr. Jamie Morin The Honorable David Oliver Admiral Gary Roughead, USN (Ret.) Ms. Katherine Schinasi Gen Norton A. Schwartz, USAF (Ret.) The Honorable Sean J. Stackley Mr. Michael J. Sullivan Vice Admiral David J. Venlet, USN (Ret.) Lt Col Daniel Ward, USAF The Honorable Dr. Dov Zakhrim
2017	Getting Defense Acquisition Right	The Honorable Frank Kendall III

Assumptions/Limitations

There are two essential assumptions leading into this research. The first is that leadership's opinions about the root cause(s) of cost and schedule growth have not changed significantly within the last fifty years. As a result, the analysis conducted on the documents and products containing leadership and expert opinion will not take into consideration the year they were produced; thus, trends will be generalized and applied throughout the research. Consequently, any comparison of leadership opinion to the major acquisition reforms will disregard the year of the reform. This assumption was determined based on a limitation on the availability of documented views of past acquisition leadership, or an entire nonexistence of those products.

While an ideal ambition of this research is to identify potential root causes of cost and schedule growth, it is not the main focus. We will not be analyzing cost and schedule data at the *individual program level* to measure the performance of the major

acquisition reforms. Additionally, we are led to a second assumption that the root causes of cost and schedule growth have not changed significantly over time, which allows us to make our prior assumption that the compendium of leading expert views can be applied across all major reform efforts regardless of year.

Organization of the Research

Chapter II presents a literature review describing the Defense Acquisition System, cost and schedule growth, a brief history of defense acquisition reform, related research, and a background on the methods used in this analysis. Chapter III will describe the dataset and methodology used for the research. Chapter IV will then present the analysis of the data and coinciding results. Finally, Chapter V will conclude with a discussion of the implications of the research and recommendations for further research.

II. Literature Review

"The definition of insanity is doing the same thing over and over and expecting different results."

- Anonymous

Cost growth is an established phenomenon within Defense Acquisition that the US Government has attempted to abolish for decades through seemingly endless cycles of reform (Cancian, 2010). Dozens of experts and senior leaders within the acquisition community have published their notions on the reasons for cost growth, nevertheless, legislation has yet to eradicate this presumed conundrum (Jackson, 2011; Eide & Allen, 2012). For this reason, this research is aimed at identifying existing trends within past major acquisition reforms, as well as in documented senior leader views, to determine the possible disconnect.

To thoroughly understand the context of this research, it is important to have an understanding of cost and schedule growth, the Defense Acquisition System, the history of acquisition reform, and the efficacy of Text Mining and Grounded Theory in related research fields. Thus, this chapter presents a review of related literature and research that results in an identification of the literature gaps this research intends to fill.

Cost and Schedule Growth

The Defense Acquisition University defines cost growth as "a term related to the net change of an estimated or actual amount over a base figure previously established" (DAU Acquisition Glossary, 2017). This term is frequently confused with "cost

overrun," which is used to express a "higher than expected cost on a particular contract" (Cancian, 2010). "Cost Growth" is a more general term used when describing overall escalation in DoD acquisition programs (Aaron, 1983). Analysis of cost growth, in most cases, excludes unit quantity and inflation because both are external factors not controlled by acquisition management. It is important to note that the Government Accountability Office (GAO), however, does typically include quantity in their cost growth analyses (Cancian, 2010). Thus, understanding who conducted the study and the methodology employed is important when interpreting study results.

The definition of schedule growth is less convoluted. As defined in a 2014 report published by the RAND Corporation, schedule growth is simply an "extension to the planned schedule" (Riposo, McKernan, &Kaihoi Duran, 2014). Despite the simple definition, the most effective measurement of schedule growth is debatable. One issue is whether or not to include programs that are still active (e.g., they have not reached Initial Operating Capability). While some level of insight can be gained from this method, it may also involve a maturity bias since the results do not reflect the final realized schedule. Another issue is whether to measure schedule growth in years or by percentage deviation, but a consensus has not yet been reached (USD[AT&L], 2016). For these reasons, awareness of how schedule growth was measured is crucial to fully understanding and interpreting analyses.

Today's concerns about DoD program cost growth are not new and have garnered Congress' attention since the 1960s (O'Neil, 2011) when they mandated reporting of Major Defense Acquisition Program (MDAP) performance via the Selected Acquisition Report (SAR) (Cancian, 2010; O'Neil, 2011; Fox, 2011). Since then, multitudes of

reforms have been implemented, and while some reviews show at least minor improvement of program outcomes (Rich & Dews, 1987), most analyses find that over time no significant change in cost growth has occurred (O'Neil, 2011; Eide & Allen, 2012).

Since the 1990s, cost growth has remained stable and consistent (Cancian, 2010; USD(AT&L), 2016). The Government Accountability Office (GAO) and Institute for Defense Analysis (IDA) have reported average growth between 25 and 45 percent, but in the *Performance of the Defense Acquisition System: 2016 Annual Report*, the Office Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]) proclaims the 31-year average is seven percent for MDAPs, after adjusting for inflation and effects of budgetary constraints on programs (Cancian, 2010; USD[AT&L], 2016). These disparate results highlight the necessity of understanding the data being used for cost growth calculations and the inclusion/exclusion criterion applied by the researchers. While cost growth has remained consistent over time, USD(AT&L) reports that schedule growth has a statistically significant downward trend since 1985 (USD[AT&L], 2016). These results can be seen in Figure 1.

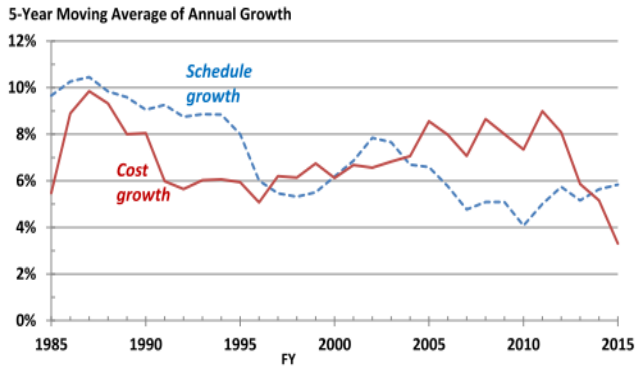

Figure 1: Growth in Schedule and Cost on Major Contracts (USD[AT&L], 2016)

USD(AT&L) provided two pertinent notes in the *Performance of the Defense Acquisition System: 2016 Annual Report* which are associated with Figure 1:

> **NOTE 1:** The 5-year moving average of annual growth in contracted total costs is relative to negotiated cost targets on major contracts of MDAPs (including MAIS that are large enough to also be MDAPs) in EMD and early production that reported EV data (i.e., including almost no firm-fixed-price or full-production contracts). This is different than statutory measures of program-level cost growth measures such as PAUC and APUC relative to Milestone B baselines. These data summarize 18,470 earned-value reports on 1,123 major contracts for 239 MDAPs.
>
> **NOTE 2:** Spearman's correlation test showed that schedule growth and cost growth are independent (not correlated) over this period. In the BBP era (since 2012), schedule growth is essentially flat, while cost growth has dropped dramatically.

Despite the consistency of cost growth over the last few decades, media outlets have given extensive coverage of defense acquisition that portrays cost growth as both an increasing problem and a problem unique to the DoD (O'Neil, 2011). In reality, complex programs often result in cost or schedule growth in the public sector outside of the DoD, and within private sector programs (Merrow, Phillips, & Myers, 1981; Merrow, 1983; Biery, 1992; O'Neil, 2011). Most defense programs, roughly three-quarters, perform at around the original baseline with only a few experiencing excessive cost growth above 30 percent, which drives the total cost growth for defense programs (O'Neil, 2011). These results can be seen in Figure 2. The next section provides an overview of the Defense Acquisition System and discusses how cost and schedule growth relate.

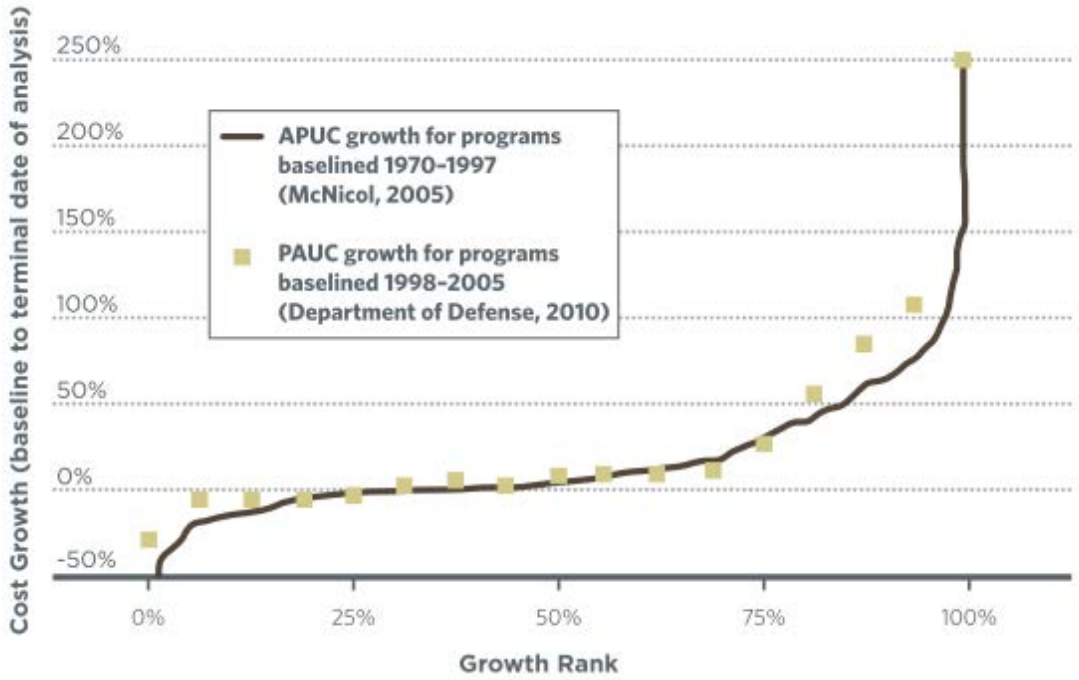

Figure 2: Procurement Unit Cost Growth of MDAPs Initially Approved Between 1970 and 1997, and Program Unit Cost Growth of Those Approved Between 1998 and 2006 (O,Neil, 2011)

Cost and Schedule Growth Within the Defense Acquisition System

DoD Directive 5000.01 states that the "Defense Acquisition System exists to manage the nation's investment in technologies, programs, and product support necessary to achieve the National Security Strategy and support the United States Armed Forces…[supporting] not only today's force, but also the next force, and future forces" (DoDD 5000.01, 2007). The DoD Directive goes on to state that the "primary objective of Defense acquisition is to acquire quality products that satisfy user needs with measurable improvements to mission capability and operational support, in a timely manner, and at a fair and reasonable price" (DoDD 5000.01, 2007).

The Defense Acquisition System accomplishes its mission and objective through the integration of three processes: the Acquisition Process, the Capability Requirements

Process (also known as the Joint Capabilities Integration and Development System [JCIDS]), and the Planning, Programming, Budget, and Execution (PPBE) Process (DODI 5000.02, 2017; DAG, 2017). The Acquisition Process allows the DoD oversight of the management of an acquisition program throughout that program's total life-cycle (DAG, 2017). The Acquisition life-cycle is composed of five distinct phases: Material Solution Analysis, Technology Maturation & Risk Reduction, Engineering & Manufacturing Development, Production & Deployment, and Operations & Support.

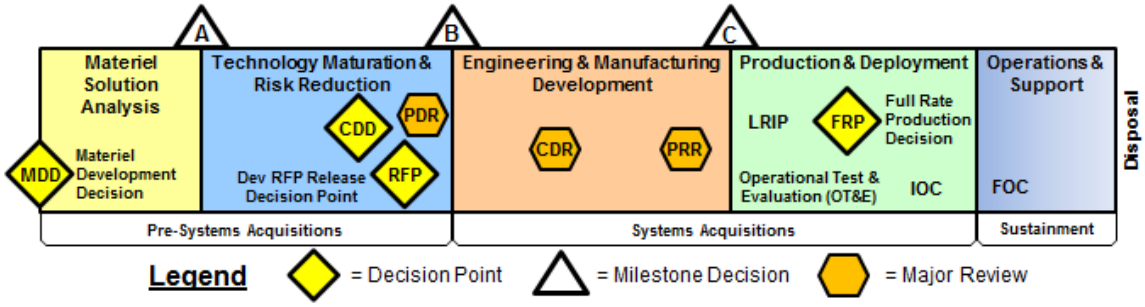

Figure 3: Defense Acquisition Life Cycle (AcqNotes.com)

Entrance into the Technology Maturation & Risk Reduction, Engineering & Manufacturing Development, and Production & Deployment phases, are considered milestone events which require Milestone Decision Authority (MDA) for program continuance. Milestone B, or the Development Decision, is a critical decision point which commits the DoD to a specific product, budget profile, contract terms, and schedule leading to entrance into the Engineering & Manufacturing Development phase of the life cycle. It ensures all risks have been considered and accounted for, a realistic and executable program plan, and affordability. Milestone B also requires validation of capability requirements, full funding in the Fiscal Year Development Plan, and

compliance with affordability goals through an independent cost estimate (DODI 5000.02, 2017).

Since DoD resources are officially committed at Milestone B, it is typically the formal initiation of an acquisition program after the MDA's approval of the Acquisition Program Baseline (APB). The APB is the service component's formal commitment to the MDA, and the original, or current APB (if the original has been updated) is the basis for future measurement of cost and schedule growth (DODI 5000.02, 2017).

DoD Instruction 5000.02 details the thresholds for reporting cost and schedule growth. A schedule growth of six months, or cost growth of ten percent must be immediately reported to the MDA. Furthermore, a six-month schedule growth or unit cost growth of 15 percent of the current APB (or 30 percent of the original APB), must be reported quarterly in the SAR. MDAPs and Major Automated Information Systems (MAIS) have additional reporting requirements at the congressional level for exceeding Nunn-McCurdy "significant" or "critical" unit cost thresholds (DODI 5000.02, 2017).

The Nunn-McCurdy Act thresholds are one of the acquisition reform attempts aimed at reducing cost growth, and it is considered to be one of the five major reform efforts (Ritschel, 2012). MDAP "significant" and "critical" thresholds for unit cost growth are defined in 10 USC 243, while MAIS definitions are found in 10 USC 2445c (DODI 5000.02, 2017). The next section in the chapter further explores the long history of defense acquisition reform efforts.

A History of Defense Acquisition Reform

The history of defense acquisition is extensive, literally composing entire books and a mountainous accumulation of research. The Office of the Secretary of Defense Historical Office has a collection of acquisition history volumes, providing a comprehensive review of the topic. This section, however, focuses on the reform efforts within acquisition history and provides a succinct review of the performance of major reforms.

McNamara Era (1961-1968).

In 1962, Merton Peck and Frederic Scherer of the Harvard Graduate School of Business Administration published *The Weapons Acquisition Process: An Economic Analysis*, which was one of the first comprehensive economic studies on the Defense Acquisition System (Fox, 2011). The research analyzed twelve weapons systems programs of the 1950's, and one of their conclusions was that "the average cost growth was found to be 220 percent beyond the original target cost" (Peck, 1962; Aaron, 1983). This result, along with Peck and Frederic's (1962) other findings listed in Table 2, illuminated some of the major imperfections of the acquisition system for the first time (Fox, 2011).

Table 2: Peck and Scherer's (1962) Identified Problems within the DAS

1	Schedule Slippage
2	Cost Growth
3	Lack of Qualified Government Personnel
4	High Frequency of Personnel Turnover
5	Inadequate Methods of Cost Estimation
6	Insufficient Training in the Measurement and Control of Contractor Performance

At the time of Peck and Scherer's report, Robert McNamara was Secretary of Defense (through 1968). His experience as an executive at the Ford Motor Company armed him with the skills to reform the management of defense acquisition programs. In response to the attention brought by Peck and Scherer's report, McNamara began centralizing authority at the Office of the Secretary of Defense (OSD) level and decentralizing operations to the military services. After these initial reform efforts, McNamara went on to produce further innovations in three acquisition areas: program planning and selection, source selection and contracting, and program management (Fox, 2011).

Program planning and selection innovations included McNamara's creation of the Planning, Programming, and Budgeting System (PPBS), providing organization to major program decisions and the allocation of resources. Source selection was improved with the additions of parametric cost estimating, formal procedures, contractor performance evaluations, total package procurement (which later proved unsuccessful), contract definition, and incentive contracting. Finally, program management was enhanced by embracing Program Management and Systems Engineering concepts, consolidation of contract administration across the services, Cost and Schedule Control System Criteria (now called Earned Value Management), and Technical Performance Measurement amongst other key techniques and reporting requirements (Fox, 2011).

Laird & Packard Era (1969-1971).

Although McNamara's reform efforts were deemed legendary, cost, schedule, and technical performance remained a problem. The six problem areas identified by Peck and

Scherer (see Table 2) remained unresolved, and Robert Benson, an OSD analyst, stated that "about 90 percent of major weapons systems…end up costing at least twice as much as was originally estimated" (U.S. Senate Congressional Records, 1969). Consequently, the Defense Acquisition process appeared to be "out of control" (Fox, 2011).

At the end of McNamara's term in 1969, Melvin Laird was appointed as the new Secretary of Defense. Upon appointment, Laird, with Deputy Secretary William Packard at his side, created the Blue Ribbon Defense Panel. The Panel's mission was to conduct a one-year study on:

1. DoD organization and management, mission performance, and decision-making process
2. Defense research and development efforts, and the impact on mission, cost, organization, time, and relations with the scientific and industrial communities
3. DoD's procurement policies and practices related to cost, time, and quality (Fox, 2011)

Simultaneously to the Blue Ribbon Panel's efforts, Packard implemented new acquisition management reform efforts, restructuring the defense acquisition system to resemble the approach found in free enterprise; a system which clearly states objectives, agrees upon them, and gives people flexibility to meet those objectives in a way that is appropriate for their area of responsibility. Packard also created the Defense Systems Acquisition Review Council (DSARC) as a means to report the status and readiness of each major weapons system prior to advancement to the next life-cycle milestone. Furthermore, he established "Panel A" with a mission to find ways to increase the effectiveness of the acquisition process (Fox, 2011).

As a result of Panel A's finding, in 1970 Packard instructed each of the services to focus on three areas to reduce cost growth. The first was to improve cost estimations of both the services and the contractors. The second was to better define the system in an effort to reduce change orders. Finally, the third area of focus was on earlier identification and analysis of risk. Packard also instructed each service to report on how they were implementing the changes (Fox, 2011).

Around the same time, the Blue Ribbon Panel published its report on DoD management and process. They concluded that the DoD's current policies contributed to weapon systems cost and schedule growth as well as the technical performance issues, and that reform was needed to foster improvement. In response, Packard directed the services to focus on reducing technical risk at the conceptual stage of a program and to provide proof that the risks had been adequately addressed before a program could transition to full-scale development. He also provided guidance to improve the training and authority of program managers and to reduce reporting requirements. Furthermore, he directed an update to existing regulations reflecting the policy reforms, essentially leading to the creation of the new *Directive on the Acquisition of Major Defense Systems*, DoD Directive 5000.1 in 1971 (Fox, 2011).

Post-Packard Era, Through the 1980s.

After Packard left office in 1971, implementation of initiatives to improve defense acquisitions continued based on his recommendations. Notably, the creation of the Cost Analysis Improvement Group (CAIG) which standardized cost estimating techniques and provided independent cost estimates. Additionally, Congress created the Commission on

Government Procurement, which focused research on cost growth in weapon system acquisition programs, amongst a variety of other procurement issues (Fox, 2011).

The Commission's final report in 1972 determined that the defense acquisition system required modernization and better management, as well as increased competition through early industry involvement in the development of weapon systems, allowing them to cultivate solutions that meet mission needs. In partial response to the Procurement Commission's recommendations, Congress passed the Budget act of 1974 and created the Office of Federal Procurement Policy under the Office of Management and Budget (OMB). The Office of Federal Procurement Policy subsequently published OMB Circular A-109 in 1976, which required the military services to identify a need for new weapon systems, validation and approval of that need by OSD, and open competition within industry (Fox, 2011).

Caspar Weinberger, Defense Secretary from 1981-1987, believed that cost overruns were a result of the previously centralized control and effects of political constraints. Thus, in the early 1980s, another round of decentralization of decision making power was applied to the acquisition process through the creation of the Acquisition Improvement Program (AIP). The AIP additionally focused on improvements to the PPBS, continued stressing the importance of competition to produce affordable weapon systems, and echoed the need for realistic cost estimates and budgets (Fox, 2011).

The concepts and policies enacted through the AIP were not new by any means. While they did address some serious problems in the acquisition process, cost growth was not affected. Accordingly, Congress introduced an amendment in the 1982 Defense

Authorization Act with intentions to directly influence the cost growth problem. The amendment, known as the Nunn-McCurdy Act, established cost growth thresholds that require Congressional reporting on programs that reach growth over 15 percent, and program termination for growth over 25 percent (unless OSD deemed the program essential to national security) (Fox, 2011). The Nunn-McCurdy Act is considered to be the first of the efforts considered today as a major reform (Ritschel, 2012).

In the mid-1980s, allegations of fraud, waste, and abuse plagued the DoD. To manage this issue, Defense Secretary William Taft (1984-1989) created the Assistant Secretary of Defense for Acquisition and Logistics (ASD[A&L]). Shortly after, President Regan revitalized the President's Blue Ribbon Commission on Defense Management, also known as the Packard Commission, by Executive Order. He also formally created the Office of the Under Secretary of Defense for Acquisition (USD[A]) which served as the nucleus for acquisition reform during the remainder of the 1980s (Fox, 2011).

The Packard commission of 1986 is famous for being the second of today's major reforms. It was responsible for the organization structure of Program Executive Officers (PEOs), Service Acquisition Executives (SAEs), USD(A) (currently USD for Acquisitions, Technology, and Logistics) serving as the Defense Acquisition Executive, and the Joint Requirements Management Board that is in place today. It also resulted in rigorous testing of prototypes prior to production, more frequent use of off-the-shelf products, the continuation of civilian management, and improved training for acquisition personnel (Fox, 2011).

The 1990s Through the 21st Century.

The Packard Commission laid the groundwork for improved training. It requires program managers to have specific qualifications to include workforce experience and training at the Defense Systems Management College (Fox, 2011). This foundation eventually prompted the implementation of the Defense Acquisition Workforce Improvement Act (DAWIA) in 1990, which focused on improving the quality of the acquisition workforce. DAWIA, considered today as the third major reform effort, created the Defense Acquisition University, formal education and training programs for acquisition personnel, certification requirement, and established career paths for program managers (Pope, 1997; Layton, 2007).

Despite the implementation of two major reforms in the 1980s and DAWIA in 1990, cost and schedule growth is still prevalent. William Perry (Deputy Secretary of Defense 1993-1994, Secretary of Defense 1994-1997) led several efforts throughout the 1990s which directed metrics based reform calling for the development of strategic plans identifying long- and short-term goals. Additional panels at the time encouraged off-the-shelf procurement, competition, and a strengthened bid protest process. In response, Congress passed the Federal Acquisition Streamlining Act (FASA) in 1994 (Fox, 2011).

FASA, the fourth of today's major reforms, promoted commercial purchases and simplified the contract award and management process. It also reduced requirements placed on commercial firms in the bidding process. Most importantly, FASA showed the acquisition workforce that Congress was committed to modernizing business practices, and allowed federal agencies enough freedom to begin making reform changes of their own. Throughout the remainder of the 1990s, reform efforts continued. These efforts

included a collection of acts serving as a more radical extension to FASA, collectively known as the Clinger-Cohen Act, which overhauled procurement laws and further promoted commercial purchases in conjunction with a new revision of the DoD 5000 Series (Fox, 2011).

Entering into the 2000s, the problems of cost and schedule growth remain persistent. Reform efforts shifted to focus on the early phases of weapon system development, stressing the importance of sound systems engineering principles. In 2009, Congress passed the Weapon Systems Acquisition Reform Act (WSARA), the fifth and latest of the major reform efforts, establishing offices for the Cost Assessment and Program Evaluation (CAPE), Developmental Test and Evaluation, and Systems Engineering. WSARA also implemented technological maturity reviews for major programs and integrated combatant commanders into the requirements generation process (Schwartz, 2013; Schwartz, 2014).

In addition to WSARA, another notable initiative includes several iterations of Better Buying Power (BBP). BBP sought to achieve greater efficiencies through affordability, cost control throughout a program's total lifecycle, elimination of unproductive processes, incentivization of productivity and innovation, and promotion of competition (USD[AT&L], 2015).

Acquisition History Summary.

As discussed in this section, cost and schedule growth have been persistent problems within the defense acquisition system. For decades, Congress and Department of Defense leadership have resorted to dozens of reform efforts in an attempt to abolish or mitigate the issue. Although there has not been a significant decrease in cost or

schedule growth, five reform efforts are considered to have had major impacts on the acquisition process. Table 3 displays a summary of the five major reforms and their main focus. While numerous researchers have studied the effects of major reforms in various ways (discussed later in this chapter), none have used the grounded theory or Text Mining methods.

Table 3: Summary of Major Reform Implementation and Focus

Major Reform	Year	Focus
Nunn-McCurdy	1983	• Establishment of cost growth thresholds o Significant: growth over 15% o Critical: growth over 25% • Requirement for MDAP Congressional reporting and potential program termination for threshold breaches
Packard Commission	1986	• Establishment of current acquisition organizational structure: PEOs, SAEs, DAE • Establishment of the Joint Requirements Management Board • Requirements for prototype testing prior to production, more frequent use of off-the-shelf products, continuation of civilian management, and improved training for acquisition personnel
DAWIA	1990	• Improvement of the quality of the acquisition workforce • Creation of the Defense Acquisition University • Requirements for formal education, training, and certification • Establishment of program manager career paths
FASA	1994	• Promoted commercial purchases • Simplified the contract award and management processes while reducing requirements placed on commercial firms • Modernized business practices
WSARA	2009	• Improvement of the early phases of weapon system development through use of systems engineering principles

		• Establishment of CAPE and the Office of Developmental Test and Evaluation • Implementation of technological maturity reviews • Integrated combatant commanders into the requirements generation process

Grounded Theory Design

Grounded theory is an inductive strategy for systematically analyzing data in an exploratory manner for the development of theory. The guiding principle is to let the data derive the theory, as opposed to fitting data to a predisposed assumption (Glaser & Strauss, 1967). It allows for the identification of a pattern within the data, and from that pattern, the discovery of the core category or foundation of the theory (Glaser et al., 1967; Glaser, 2010). As a result, the theory constructed is truly grounded in the data and thereby avoids bias. It is important to understand that grounded theory design is strictly the process of generating a sound, well rounded theory of substance. The process does not involve verification of the theory, which is a completely separate process (Glaser et al., 1967).

Classic grounded theory design utilizes the constant comparative analysis method. This process involved assigning codes, or categories, to each line of data, and constantly comparing those codes to related codes across the data (Glaser et al., 1967). Assigning codes to the data is accomplished either explicitly (using what was specifically written) or implicitly (by assigning meaning to what was written). These codes can be actions, ideas, objects, or subjects. The process of coding continues until a core category and related concepts emerge, and all possible categories are exhausted (Holton, 2010).

Grounded theory has been used for decades successfully across many areas of research, especially in sociology which is where the method originated (Glaser et al., 1967; Yu et al., 2011). It is also widely used in the health care profession, researching how general practitioners experience their medical careers (Piko, 2014), mother-infant communication dynamics (Waller, Bower, Spence, & Kavanagh, 2015), anorexia (Williams, King, & Fox, 2016), and countless others. Grounded theory has been less commonly used in other professions, and has never been applied to Defense Acquisitions, but has been used successfully in information technology (Wiesche, Jurich, Yetton, & Krcmar, 2017), sales and consumer behavior (Johnson, 2015; Goulding, 2000), and logistics and supply chain management (Manuj & Pohlen, 2012).

Text Mining

Text Mining is a fairly new analytic technique that emerged in the late 1990's which is becoming increasingly more prevalent (Witten, 2003; Grimes, 2007). Derived from data mining, it is a process that extracts useful information from unstructured text through the identification of patterns (Witten, 2003; Feldman & Sanger, 2006; Yu, Jannasch-Pennell, & Digangi, 2011). With the use of Text Mining, a researcher can siphon features such as characters, words, terms, concepts, and sentiments existing within a body of text (Feldman et al., 2006; Grimes, 2007). There are dozens of different Text Mining methods available, but some of the most common are word and term frequency analysis (Silge et al., 2017), word relationships (Losiewicz et al., 2003; Silge et al., 2017), sentiment analysis (Silge et al., 2017), and clustering or classification (Losiewicz et al., 2003; Feldman et al., 2006).

Analyzing word frequency can be applied in several ways and is used to quantify what a document is about. At the most basic level are word counts and percentage of word usage. Both of these techniques can be applied within a specific document, across the corpus, and to compare individual documents to each other or to the corpus as a whole. In conjunction with the frequency analysis, correlation tests can be applied to determine the relationship strength of individual document themes across the corpus (Silge et al., 2017).

Word relationship analysis examines which words tend to follow others, or that co-occur within documents or across the corpus. The analysis is conducted using a similar technique as the word frequency analysis by providing and analyzing a count of pairs or groups of words. Word relationships typically use a token called the n-gram, which is a sequence of n words that compose these pairs (bigrams) or word groupings. Typically, word frequency and word relationship analyses are used within the data exploration phase of research (Silge et al., 2017).

A more sophisticated Text Mining method is sentiment analysis. Sentiment analysis is designed to extract the meaning or emotional intent of a document. In the most basic case, the document text is categorized as either positive or negative. Text can further be categorized into several types of sentiment: anger, anticipation, disgust, fear, joy, sadness, surprise, and trust (Silge et al., 2017; Feldman, 2013). One challenge of this method is that it is difficult to apply to documents containing multiple paragraphs, since the positive or negative sentiment of the document may vary throughout, effectively averaging to zero or a neutral sentiment. For this reason, sentence- or paragraph-sized analyses work best (Silge et al., 2017).

The final Text Mining methods relevant to this research are clustering and classification, which are used to identify different categories, or concepts, within text. Clustering attempts to define these categories, while classification methods assign data to predefined categories (Losiewicz et al., 2003; Feldman et al., 2006). Silge et al. (2017) calls the clustering method "Topic Modeling," and specifically uses Latent Dirichlet Allocation (LDA) for fitting a topic to a document. LDA is driven by two principles:

1. Every document is a mixture of topics
2. Every topic is a mixture of words

The first LDA principle essentially states that a document is composed of a certain percentage of Topic A, and a certain percentage of Topic B (e.g., 70% Topic A, 20% Topic B, and 10% Topic C). The second principle is used to identify the most commonly used words within one of the document's topics. Said more simply, the LDA model shows "how words are associated with topics and how topics are associated with documents" (Silge et al., 2017).

While Text Mining is a fairly nascent analytic technique, it is widely used in the public and private sectors. Today, the millennial generation is entering into their prime working and spending years. This generation grew up with technological power at their disposal and use it in almost every aspect of their lives (Zeihan, 2016; McGee, 2017). As a result, there has been an increase in internet research, ecommerce, and the use of social media.

It is these areas on the internet where Text Mining prevails. Specifically, it is used to build internet search engines, analyze product and business reviews, and create marketing strategies based on social media feedback (Feldman, 2013; McGee, 2017). In

addition to the abundant internet applications, Text Mining is becoming more frequently used across a wide variety of professions. These include: pharmaceutical drug discovery, marketing, politics, financial markets, survey analysis, capability engineering framework, and within the government for counter-terrorism, scientific research, problem detection in defense acquisition programs, and cost estimator relevance (Losiewicz, Oard, & Kostoff, 2003; Grimes, 2007; Kirk & Monarch, 2008; Miller, 2012; Feldman, 2013; Brown, 2017). Despite its increasing usage within the defense acquisition field, it has not yet been used to analyze acquisition reform.

The Use of Text Mining in Conjunction with Grounded Theory Design

The classical grounded theory methodology is a manual approach where the researcher iterates through a document line-by-line, applying codes and making respective comparisons. This is an extremely time-consuming process and can reach infeasibility when dealing with a large corpus (Glaser et al., 1967; Yu et al., 2011). The automation of Text Mining has drastically decreased processing time allowing analysis of corpuses with increasingly substantial volume (Feldman & Sanger, 2009; Yu et al., 2011). Because both processes are used to analyze text data, Yu et al. (2011) discuss the similarities and compatibility of the two techniques.

Grounded theory and Text Mining techniques are both exploratory in nature and can be applied to qualitative data. In addition, both processes advocate that the researcher maintains an open mind and avoids preconceived expectations or conclusions. Maintaining an open mind and allowing the data to drive the results alleviates

unintentional bias. A third similarity is the process of coding or categorizing with the goal of extracting patterns or themes from the data (Yu et al., 2011).

In both techniques, the coding process is iterative and continuously compares new categories to those previously discovered. To be successful in both the grounded theory and Text Mining coding processes requires the researcher to remain interactive as themes begin to emerge, and continuously apply constraints and identify keywords to arrive at a core category. Despite the similarities of the two methods, and the efficiencies gained through Text Mining, their use in conjunction with each other is limited. However, with the classification capabilities of Text Mining, use in conjunction with Grounded Theory appears to be an ideal fit (Yu et al., 2011).

Related Research

This section discusses previous research and methods used to examine the effects of various factors and acquisition reforms on cost overruns and growth, as well as on schedule growth. Furthermore, this section discusses how Text Mining techniques have historically been applied within the defense acquisition arena.

Searle (1997): Impact of Packard Commission on Reducing Cost Overruns.

Searle's (1997) research evaluated the effectiveness of the Packard Commission's recommendations and respective policies on its intention to reduce cost overruns in DoD acquisition programs. The motivation for this research was hat the Packard Commission's recommendations were similar to prior reforms and initiatives which were historically ineffective at reducing or controlling cost overruns, and additionally, a prediction that the new policy would have different effects on contracts in the

development versus production phases. To accomplish this evaluation, Searle (1997) applied a statistical analysis methodology, comparing the means of final overrun percentage of contracts completed before and after the implementation of the Packard Commission's policies. Specifically, he analyzed the total mean overrun percentage of contracts between the two time periods, then added an additional layer, examining the means at the different program phases (development and production).

The results of this research indicate that there is in fact a statistical difference between the means before and after the implementation of the policy changes. Specifically, Searle found that in the latter time period, the total mean of final cost overrun percentage was worse than before the policy was implemented, by almost double (BEFORE: -5.56%, AFTER: -9.58%). Comparing the means of final overrun percentage of the two phases before and after policy implementation showed similar results. While the means of the production phase were not statistically different, the means of the development phase were drastically worse after the policy implementation, with the percentage nearly tripling (BEFORE: -4.14%, AFTER: -15.29%).

These results imply the policy changes made based on the Packard Commission's recommendations actually had a negative impact on cost performance. It was undetermined whether the impact was direct through bad policy or targeting incorrect causes of overruns, or indirect through the creation of an environment of ineffective management. Additionally, because of one of the Packard Commission's focuses, the requirement for increased testing and prototyping, Searle (1997) concludes that the difference in significance of results between the production and development phases was a reasonable result.

Holbrook (2003): Analysis of the Implementation of Acquisition Reform Initiatives and Contract Cost Variance.

Holbrook's research, published in 2003, focused on the impacts of acquisition reform initiated in the 1990s (primarily FASA in 1994, and Clinger-Cohen Act of 1996) on cost performance in weapon system contracts completed between 1994 and 2001. The goals of this research were to determine whether cost performance was improving and how any cost performance trends related to the acquisition reform implementation timeline, testing five hypotheses.

Consistent with Searle's (1997) research, Holbrook (2003) used a statistical analysis methodology, comparison of means, analyzing the mean of final overrun percentages of contracts completed before and after the implementation of the reforms of the 1990s. The means comparison test was completed on the total contract overrun percentages, percentages specific to the production and development phases, and based on contract type (either cost plus or fixed price). In addition, he conducted a time-phased approach with intervention analysis[1] on all active contracts, regardless of completion status, to identify if any trends or consistent time lags exist in comparison to the implementation timeline of the acquisition reforms.

The results of the means comparison test, using the original treatment date of December 31, 1997 to deliminate the pre- and post-reform periods, did not exhibit any statistical differences between the means of final overrun percentages before and after the reform initiatives for all five of the tested hypotheses. Conversely, the time-phased

[1] Intervention analysis is a forecasting concept used to identify how one-time events impact a result (PSU Department of Statistics Online Programs, 2017)

approach indicated that trends do in fact exist following the implementation of reform initiatives. Specifically, cost overruns tend to drop immediately following reform implementation years, however, these results are based on a visual analysis and are not statistically quantified.

Due to the inconsistencies in the results, Holbrook shifted the treatment date to December 31, 1994 based on several factors. However, even with this shift, each of the five hypothesis tests returned the same result: there is no statistical difference in cost performance before and after the reforms. While both of the means comparison tests failed to show statistical difference between contracts completed before and after reform implementation, the time-phased results of all active contracts do indicate a relationship between cost performance and reform initiatives.

Giacomazzi (2007): Impact of Defense Acquisition Reforms and External Factors on Schedule Growth.

Giacomazzi's (2007) research utilized the panel regression model described by Smirnoff (2008). The purpose was to determine the effects of defense budget changes, unexpected inflation, contingency operations, and acquisition reforms on MDAP schedule growth for programs in either the development or production phases. This research altered the dependent factors to include acquisition reforms and initiatives which were more related to the improvement of schedule growth, such as the National Performance Review (NPR), the Clinger-Cohen Act, and the revision of the DoD 5000 series in addition to the Packard Commission and FASA.

The results of the development phase regression model indicate that budget fluctuation has little to no effect on schedule growth, with the only statistically

significance finding being an increase in procurement budget leading to a very small increase in schedule growth. Unexpected inflation and the presence of major contingency operations had a slightly larger impact, increasing schedule. While the revision of the 5000 series was effective at reducing growth, the other reforms proved to not have any statistical significance.

The regression model for the production phase determined that budget and contingency operations were not statistically significant in predicting production schedule growth. Unexpected inflation was more significant in this model than for the development model, leading to an increase in schedule variance. Finally, similar to the development phase model, results indicate that the 5000 series revision was once again the only reform initiative to have a significant effect on the reduction of schedule growth.

Smirnoff and Hicks (2008): Impact of Economic Factors and Acquisition Reforms on Cost of Defense Weapon Systems.

While many researchers studied either the causes of cost overrun or the impact of acquisition reform, until Smirnoff's thesis in 2006, no one attempted to identify the aggregate effects of both areas. Thus, the purpose of his research was to build an empirical model explaining the causes of cost overruns within MDAPs, specifically related to the defense industry consolidation of the 1990s, defense budgets, major contingency operations, estimation error due to inflation, and major acquisition reforms (Nunn-McCurdy, Packard, DAWIA, and FASA). Contract type (fixed price or cost plus) and program phase (production or development) were also factored into the model.

To describe the relationships of the factors on cost overruns, Smirnoff and Hicks (2008) used a fixed-effects panel regression model. As modeled, this research

determined that defense industry consolidation and unexpected inflation rates did not have any statistically significant impact on cost overruns. The presence of major contingency operations and fluctuations in defense budget had various correlations to overruns depending on contract type and program phase. Taking into account the effects of budget and war, all four of the reforms were correlated with overruns in at least one of the contract types or program phases.

Smirnoff and Hicks (2008) found that the Nunn-McCurdy Act had a significant impact reducing cost overruns on fixed price contracts and within the production phase. The Packard Commission was correlated with a decrease in overruns for fixed price and cost plus contracts. FASA proved to have the greatest effect, with the reduction of cost overruns in every case, regardless of contract type or program phase. Finally, contrary to the researcher's expectation, results showed DAWIA correlating to an increase in cost overruns. An explanation of this relationship was unknown at the time of this research and it was suggested that, while correlated, this was not necessarily a result of any causal effect.

Miller (2012): Acquisition Program Problem Detection Using Text Mining Methods.

The first time a Text Mining method is utilized in defense acquisition analysis is in Miller's (2012) research. Up until this point, program managers and cost estimators relied on Earned Value Management (EVM) analysis applied to the cost and schedule data provided by the contractor in the Cost Performance Report (CPR) Format 5 data, to measure program performance. But sometimes, by the time an issue is identified through EVM, the problem is already too big to correct (Nicholas & Steyn, 2017). For that

reason, Miller's goal was to apply Text Mining methods to the written portion of the Format 5, a portion of the report rarely utilized but paid for by the US Government, to detect potential problems before they have a chance to escalate out of control.

This research applied the use of the Text Mining method Latent Dirichlet Allocation (LDA). LDA is a useful technique for analyzing documents that may contain multiple topics. Through the process, it creates a Dirichlet distribution of topics based on word frequency and relationships between words. In addition to the LDA technique, Miller used ordinary least squared (OLS) regression to build a model to predict a contractor's estimate at complete (EAC).

The Text Mining method produced 250 topics that were then used to build the regression model. A step-wise method was used to further narrow the topics down to those which are predictive of a contractor's EAC. The final model could predict potential problems up to six months in the future with an average error of about four percent, using eight variables, or topics, as the model inputs. Ultimately, the researcher recommended that the use of this model be applied in addition to EVM analysis to provide decision makers with additional information.

Freeman (2013): Multivariate and Naïve Bayes Text Classification Approach to Cost Growth Risk in DoD Acquisition Programs.

Following-on from Miller's (2012) research, Freeman (2013) attempted to improve on prior methods used to identify programs at risk of cost growth. This research combined the use of multivariate classification techniques and the Text Mining method, multinomial Naïve Bayes classification to analyze EVM data and the contractor's CPR

Format 5 data, with the goal of producing a new program risk detection model forecasting out six and twelve months.

The efforts of this research resulted in the creation of models that were able to predict which programs were at high risk of cost growth. Freeman (2013) determined that the Naïve Bayes classification of Format 5 data was best to use for predictions within six months, predicting 70 percent of the high-risk programs with a 60% chance of predicting correctly. For predictions forecasted out to twelve months, the multivariate classifier of EVM data proved to be the most accurate, predicting 92 percent of the high-risk programs with a 73 percent chance of correct identification.

Ritschel, Lucas, White, and Mrla (Pending Publication 2019): Impact of WSARA on the Cost of Air Force Weapon Systems.

WSARA was the most recent major reform that attempted to control cost overruns. Research on WSARA's effectiveness was limited until Ritschel, Lucas, White, and Mrla's (2017) research. They conducted a comprehensive investigation into WSARA's impact on MDAP cost overruns within the Air Force. To accomplish this, they conducted a means comparison test, OLS regression, and a case study.

The means comparison test was conducted to detect differences in programs completed before and after WSARA implementation. Four tests were accomplished by program phase (development and production), and contract type (fixed price and cost plus) which is consistent with the method used by Holbrook (2003) and Smirnoff and Hicks (2008). The OLS regression was applied to all Air Force programs, regardless of completion status. Similar to the means comparison test, four models were built by program phase and contract type. The regression models attempted to predict annual cost

overrun percentage based on four main categories of cost drivers: economic, internal (major reforms), political, and time of war. Finally, the case study utilized OLS regression to examine the impacts of WSARA on the operations and support program phase of four aircraft platforms, building models to predict cost per flying hour.

The results of the means comparison test indicated that WSARA only had a statistically significant effect on contracts in the development phase, lowering the average cost overrun after WSARA implementation. There were not statistically significant results for programs in the production phase, nor by contract type. Two of the four regression models indicated that WSARA was correlated with cost overruns: cost plus contracts and contracts in the production phase. After WSARA implementation cost overruns on cost plus contracts and contracts in the production phase were higher than before WSARA's implementation. Finally, the case study produced two models that were able to predict cost per flying hour for two airframes in the operations and support phase of their lifecycle. The first model determined that program costs increased approximately 24 percent, and 10 percent for the second model.

Brown (2017): Measuring the Increasing Relevance of Cost Estimating Through Text Analytics.

Brown's (2017) article was brief, but discussed the emerging application of text analytics within defense cost estimating research. Although the employment of text analytics, or Text Mining, to defense research is in its infancy, Brown alluded to its possible contribution to cost estimates in the future. To demonstrate the technique, Brown analyzed text within the National Defense Authorization Act utilizing a word frequency analysis and linear regression. His simple analysis showed that the usage of

cost estimating terminology has been steadily increasing each fiscal year since 2005, supporting claims that cost estimating relevance in the DoD is growing.

Related Research Summary.

A plethora of previous research has examined the effectiveness of defense acquisition reforms using a variety of methods. Most results indicate that the major reforms had little to no significant effect on reducing cost and schedule growth, or overruns. While these methods have been predominantly quantitative, given that reforms are unstructured text-based documents, qualitative analysis is an appropriate alternative approach (Patten, 2009). Although Text Mining has been employed within government research, it has not yet been applied to defense acquisition reform. Furthermore, despite its wide usage in other fields, the employment of grounded theory is also absent from acquisition reform research. The absence of these two methods identifies a gap that this research intends to fill.

Chapter Summary

This chapter provided a review of related literature and research focused on cost and schedule growth, the Defense Acquisition System, the history of acquisition reform, and the efficacy of Text Mining and Grounded Theory in related research fields. The next chapter discusses Text Mining and grounded theory methodologies, and their use in conjunction with each other.

III. Methodology

The purpose of this research is to identify and analyze trends within past major Defense Acquisition Reform legislation in comparison to a compendium of views from leaders within the Defense Acquisition community on the efficacy of acquisition reform. This analysis is designed to provide insight, not only on where the acquisition process and reforms have been, but on where they should be headed to effectively reduce cost and schedule overruns within MDAPs. The intent is to use Text Mining in combination with grounded theory design to analyze the major past acquisition reforms, including corresponding amendments, and the compendium of expert views to detect major trends. This chapter provides detailed explanations of the Text Mining and grounded theory methods used, as well as a description of the data set, data sources, and data preparation process.

Text Mining

Text Mining is a fairly new analytic technique that emerged in the late 1990's which is becoming increasingly more prevalent (Witten, 2003; Grimes, 2007). Derived from data mining, it is a process that extracts useful information from unstructured text through the identification of patterns (Witten, 2003; Feldman & Sanger, 2006; Yu, Jannasch-Pennell, & Digangi, 2011). With the use of Text Mining, a researcher can siphon features such as characters, words, terms, concepts, and sentiments existing within a body of text (Feldman et al., 2006; Grimes, 2007).

Most documents, including the data for this research, are classified as "unstructured text." While structured text, such as a hypertext markup language (HTML) webpage, uses various codes and tags to deliminate portions of the document (e.g., titles, headers, paragraphs, lists, etc.), unstructured text only has semantic and syntactical structure (e.g. white space, punctuation, special characters, etc.) (Feldman et al., 2006; Losiewicz, Oard, & Kostoff, 2003). To extract useful information from unstructured text, this research will use a six-step process categorized by three main functions as discussed by Losiewicz et al. (2003), which are listed in Table 4. In addition to the six-step process, this research will implement a preprocessing phase prior to the application of Text Mining models in accordance with Feldman et al.'s (2006) recommendation. This preprocessing phase is also known as "Tidy Text" (Silge & Robinson, 2017).

Table 4: Losiewicz et al. (2003) Text Mining Functional Categories and Six-Step Process

Step	**Function**
1. Source Selection	Data Collection
2. Text Retrieval	
3. Information Extraction	Data Warehousing
4. Data Storage	
5. Text Data Mining	Data Exploration
6. Presentation	

The first step, source selection, is the process of identifying where to retrieve possible documents for use as your data set. This process requires a knowledge of the specific subject area(s) that are relevant to your area of study. This process is especially important when you do not have a predefined set of documents to analyze. Similarly, the text retrieval step is the process of discovering and selecting individual texts from the

source(s) that were selected (Losiewicz et al., 2003). For the purposes of this research on major acquisition reforms, and a compendium of leader views, the text selection step occurred first, followed by source selection.

Once the corpus is compiled, the information extraction and data storage phases can begin. This process involves collecting the metadata of the specific documents, such as the title, author, and actual text of the document, then organizing and storing that data in a format usable for analysis (Losiewicz et al., 2003). In the R programming language, the object that will collect the metadata of the corpus is called a data frame (Silge et al., 2017), which is similar to a spreadsheet in Microsoft Excel.

Prior to any Text Mining analysis, preprocessing, also known as Tidy Text, needs to be performed on the data frame (Feldman et al., 2006; Silge et al., 2017). This process makes the handling of text data "easier and more effective" (Silge et al., 2017). Tidy Text follows the R programming language Tidy Data principle which conforms to a specific structure; each variable is in its own column in the data frame, each observation is in its own row, and each value is in its own cell (Silge et al., 2017; Grolemund & Wickham, 2017). The original data frame containing the corpus is created following the Tidy Data structure. This translates to each document residing in one row in the data frame, and the metadata as variables (e.g., title, date, author, document text, etc.), where all of the document text resides in one single cell of the data frame.

The next step is to transform the tidy data frame to a Tidy Text structure, which further breaks down each row (each document) into tokens. A token is a feature of the document text such as individual words, terms, or sentences (Losiewicz, 2003; Feldman et al., 2006; Grimes, 2007; Silge et al., 2017). In the resulting data frame, each token

becomes the observation stored in each row. For example, if tokenized by individual word, our data frame would transform from each document residing in its own row, to each document being spread across multiple rows where individual words of that document's text reside in a single cell (Silge et al., 2017). An example is provided in Tables 5 and 6.

Table 5: Tidy Data Frame

Document	**Author**	**Text**
Little Bunny Foo Foo	Unknown	Little bunny foo foo went hopping through the forest scooping up the field mice and bopping them on the head…
Sick	Shel Silverstein	I cannot go to school today, said little Peggy Ann McKay. I have the measles and the mumps, a gash, a rash and purple bumps…

Table 6: Tidy Text Data Frame Tokenized by Individual Words

Document	**Author**	**token (Word)**
Little Bunny Foo Foo	Unknown	little
Little Bunny Foo Foo	Unknown	bunny
Little Bunny Foo Foo	Unknown	foo
Little Bunny Foo Foo	Unknown	foo
Little Bunny Foo Foo	Unknown	went
Little Bunny Foo Foo	Unknown	hopping
//Break in table. *Little Bunny Foo Foo* word tokenization continues		
Sick	Shel Silverstein	i
Sick	Shel Silverstein	cannot
Sick	Shel Silverstein	go
Sick	Shel Silverstein	to
Sick	Shel Silverstein	school
Sick	Shel Silverstein	today
//Break in table. *Sick* word tokenization continues		

The tokenization process strips all punctuation from the text and converts all characters to lowercase, which makes them easier to analyze (Silge et al., 2017). However, this process does not remove special characters ($, @, #, etc), which means that an additional cleansing process may need to be applied to the data frame before it is ready for analysis. The cleansing process typically utilizes regular expressions, which are sequences of characters that form some pattern, applied to a string of text (AFIT Data Science Lab, 2017).

After tidying and cleansing the data frame, analysis of the major reforms and the compendium of leader views can be completed using Text Mining methods. While there are dozens of different Text Mining methods available, some of the most common are used in this research: word and term frequency analysis (Silge et al., 2017), word relationships (Losiewicz et al., 2003; Silge et al., 2017), term frequency-inverse document frequency (Silge et al., 2017; AFIT Data Science Lab, 2017), sentiment analysis (Silge et al., 2017), and clustering (Losiewicz et al., 2003; Feldman et al., 2006).

Analyzing word frequency can be applied in several ways and is used to quantify what a document is about. At the most basic level are word counts and percentage of word usage. Both of these techniques are applied within the individual documents (either a reform or expert view), across the corpus, and to compare individual documents to each other or the corpus as a whole. In conjunction with the frequency analysis, correlation tests are applied to determine the relationship strength of individual document themes across the corpus (Silge et al., 2017).

Word relationship analysis examines which words tend to follow others, or that co-occur within documents or across the corpus. The analysis is conducted using a

technique similar to the word frequency analysis, by providing and analyzing a count of pairs or groups of words. Word relationships use a token called the n-gram, which is a sequence of n words that compose these pairs (bigrams) or word groupings. Typically, word frequency and word relationship analyses are used within the data exploration phase of research (Silge et al., 2017).

The term frequency-inverse document frequency (tf-idf) is a statistic used to measure the importance of a word to a document within a corpus. This statistic is comprised of two measures: a term's frequency and a term's inverse document frequency. While term frequency by itself can be useful to identify potentially important words, it does not account for words with high usage that are not important, such as stop words ("the," "and," "but," etc.). A term's inverse document frequency (Equation 1) is a weight assigned to a term in which the weight is decreased for commonly used words and increased for words unique to a specific document within the collection. When the inverse document frequency is multiplied to the term frequency, the resulting tf-idf (Equation 2) is the frequency of the term adjusted for how rarely it is used (Silge et al., 2017; AFIT Data Science Lab, 2017).

$$idf_{(t,D)} = \ln\left(\frac{n_D}{n_t}\right) \qquad \text{Equation 1}$$

$$tf\text{-}idf_{(t,d,D)} = tf_{(t,d)} \times idf_{(t,D)} \qquad \text{Equation 2}$$

Where: t = given term, D = set of documents, n_D = number of documents in the set, n_t = number of documents where t appears

One of the more sophisticated Text Mining methods is sentiment analysis, which attempts to extract the meaning or emotional intent of a document. In the R programming language, there are prebuilt sentiment datasets which utilize three of the most popular lexicons for single words (Silge et al., 2017):

1. AFINN created by Finn Årup Nielsen
2. BING by Bing Liu and collaborators
3. NRC by Saif Mohammad and Peter Turney

Each of the three available lexicons assign positive and negative scores to each individual word within the dataset. One challenge of this method is that it is difficult to apply to documents containing multiple paragraphs, since the positive or negative sentiment of the document may vary throughout, effectively averaging to zero. For this reason, sentence- and paragraph-sized analysis is used throughout this research (Silge et al., 2017).

The final Text Mining methods this research employs are clustering and classification, which are used to identify different categories, or concepts, within text. Clustering attempts to define these categories, while classification assigns data to predefined categories (Losiewicz et al., 2003; Feldman et al., 2006). Clustering coincides with the guiding principle of the grounded theory method, let the data drive the theory, which is also being utilized in this research. To provide a comparison of grounded theory to Text Mining, this research strictly uses the clustering method opposed to classification (which requires a predetermined set of topics). Silge et al. (2017) calls the clustering method "Topic Modeling," and specifically uses Latent Dirichlet Allocation (LDA) for fitting a topic to a document. LDA is driven by two principles:

1. Every document is a mixture of topics
2. Every topic is a mixture of words

The first LDA principle essentially states that a document is composed of a certain percentage of Topic A, and a certain percentage of Topic B (e.g., 70% Topic A, 20% Topic B, and 10% Topic C). The second principle is used to identify the most commonly used words within one of the document's topics. Said more simply, the LDA model shows "how words are associated with topics and how topics are associated with documents" (Silge et al., 2017).

The final step in Losiewicz et al.'s (2003) six-step process is the presentation of results of the Text Mining methods. This visualization step helps researchers understand the results, determine whether the chosen model is appropriate, and assess whether the quality of the data is adequate to support the desired analysis (Losiewicz et al., 2003). Feldman et al. (2006) discusses various approaches that are useful:

1. *Concision*: displays large amounts of different types of data all at once
2. *Relativity and Proximity*: display clusters and groupings relative to size or similarity
3. *Focus with Context*: provides the ability to interact with a highlighted feature
4. *Zoomability*: provides the ability to move from micro to macro

The application of these approaches can be implemented through the graphing of concepts, associations, and frequencies (Feldman et al., 2006). Within the R programming language, several packages exist to aid in data visualization (Silge et al., 2017; Grolemund et al., 2017). Two primary packages that will be used throughout this research are *wordcloud* (Fellows, 2015) and *ggplot2* (Wickham, Chang, & RStudio,

2016). The *wordcloud* package can be used with the frequency analysis to display a count of the most commonly used words, which displays words with the highest frequencies larger in the word cloud than those with lower frequency (Fellows, 2015). *ggplot2* is the standard when it comes to graphing in R, and provides about 30 chart types, and an abundance of formatting and display options (Grolemund et al., 2017; Wickham et al., 2016).

The Text Mining methods described in this section are used to analyze the entire data set for this research, including the five major reforms and the compendium of views from 32 leading experts. However, prior to applying the Text Mining methods, this research utilizes grounded theory design to analyze a subset of the data. This process is described in detail in the following section.

Grounded Theory

Grounded theory is an inductive strategy for systematically analyzing data in an exploratory manner for the development of theory. The guiding principle is to let the data derive the theory, as opposed to fitting data to a predisposed assumption (Glaser & Strauss, 1967). It allows for the identification of a pattern within the data, and from that pattern, the discovery of the core category or foundation of the theory (Glaser et al., 1967; Glaser, 2010). For this reason, grounded theory will be conducted prior to any of the Text Mining methods described in the previous section to avoid unintentional researcher bias through illumination of possible categories from the Text Mining results.

Classic grounded theory design, the method being applied to this research, utilizes the constant comparative analysis method. This process involves assigning codes or

categories, to each line of data, and constantly comparing those codes to related codes across the document (Glaser et al., 1967). The process of coding continues until a core category and related concepts emerge, and all possible categories are exhausted (Holton, 2010). The constant comparative method is systematically accomplished through four stages:

1. *Comparing incidents applicable to each category*: this stage involves examining each incident, or sentence, and assigning them codes or categories. Codes are not predefined, but are assigned to each sentence as the code emerges. The emergence of codes can be either explicitly extracted from the text, or implicitly extracted through deducing meaning from the text. Typically, the codes are either actions, ideas, objects, subjects, or properties of the sentence (Glaser et al., 1967).
2. *Integrating categories and their properties*: by this point in the analysis many categories have emerged, and the researcher should have an accumulated knowledge on those categories and the properties of the text. In this stage, instead of the researcher comparing emerging categories to prior categories, there is a transition to comparing categories to the text properties. This stage is crucial to identifying the circumstances under which categories are emerging, and allows the researcher to progress into the next stage (Glaser et al., 1967).
3. *Delimiting the theory*: this stage involves aggregating the codes into a smaller set of higher level categories. The aggregation process continues until the level reaches a set of core categories, which should be generalized and applicable in a wide range of situations. At this point the researcher should aim to reach

theoretical saturation ensuring all of his or her coding is aggregated into one of the core categories. Then the researcher can move into the final stage of the constant comparative method (Glaser et al., 1967). An example of the coding process is depicted in Table 7.

4. *Writing the theory*: the final stage in the comparative method entails utilization of the core categories that were identified in stage three to compose a theory (Glaser et al., 1967).

Table 7: Grounded Theory Coding Example

Document	Text	Code	Level 1	Level 2	Level 3 (Core)
WSARA	(1) determine the root cause or causes of the critical cost growth in accordance with applicable statutory requirements and Department of Defense policies, procedures, and guidance; and ''(2) in consultation with the Director of Cost Assessment and Program Evaluation, carry out an assessment of— ''(A) the projected cost of completing the program if current requirements are not modified; ''(B) the projected cost of completing the program based on reasonable modification of such requirements; ''(C) the rough order of magnitude of the costs of any reasonable alternative system or capability; and ''(D) the need to reduce funding for other programs due to the growth in cost of the program.	JROC Duties - MDAP Critical Cost Growth - projected cost of program completion - funding reduction in program or other programs	Cost Growth	--	Affordability
			EAC	Cost Estimate	Analytical Technique
			Funding Reductions	Funding	External Factors
Gansler	Clearly, today there is widespread recognition of the need for changes in the way the DOD does its business; but the leadership (with a clear vision; a desirable and achievable strategy; and a set of actions (that can achieve widespread alignment and motivation); is not visible - - and the leadership team must be aligned at all levels (Congress, the Administration, key DOD appointees, the military, and industry)	Widespread recognition of the need for change	Recognized need for change	Need for Change	Modernization

While the Text Mining methods are being applied to the entire data set of this research, grounded theory is only applied to a subset due to the manual nature of the process and time commitment required to perform the analysis. The subset consists of a

portion of the most recent major reform legislation, WSARA, Title II—Acquisition Policy, and the one of the most recent directors (of the available experts within the compendium) for the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]), Jacques S. Gansler (1997-2001). Considering the epistemological compatibility of Text Mining and the constant comparative method (Yu et al., 2011), the grounded theory analysis is used as a validation set for Text Mining performance.

Data Collection and Preparation

The data for this research originates from various sources (see Appendix A) and are originally in either portable document format (.pdf) or HTML. Each source document was copied into individual text (.txt) files which were imported and analyzed through RStudio Version 1.0.143. RStudio is open source software which includes a code editor and other tools which makes programming with R easier to use. Upon importing each file using RStudio, the data was preprocessed and prepared in accordance to the Tidy Data and Tidy Text principles described in the Text Mining section of this chapter. The source documents are of two main types: Acquisition Reform Legislation, listed in Table 8, and a Compendium of views from leading experts in the Acquisition field, listed in Table 9.

Each text file was built using a standard format to store various document metadata, such as the document title, document date, and source. The metadata were used as variables during the data analysis. A full listing of the metadata, along with descriptions, can be found in the Data Dictionary presented in Appendix B.

Table 8: Acquisition Reform Data

Year	Document	Common Name
1982	Defense Authorization Act and Amendments	Nunn-McCurdy
1986	President's Blue Ribbon Commission on Defense Management	Packard Commission
1990	Defense Acquisition Workforce Improvement Act	DAWIA
1994	Federal Acquisition Streamlining Act	FASA
2009	Weapon Systems Acquisition Reform Act and Amendments	WSARA

Table 9: Acquisition Expert Data - A Compendium of Leading Expert Views

Year	Document	Experts
2008	Testimony of the Honorable James I. Finley, Deputy Under Secretary of Defense (Acquisition and Technology) Before the United States House of Representatives Committee on Oversight and Government Reform and Subcommittee on National Security and Foreign Affairs	The Honorable James I. Finley
2014	Defense Acquisition Reform: Where do we go from Here? A Compendium of Views by Leading Experts	Brig Gen Frank J. Anderson, USAF (Ret.) The Honorable Norman R. Augustine Mr. David J. Berteau Mr. Irv Blickstein, Gen James Cartwright, USMC (Ret.) The Honorable Thomas P. Christie Mr. Jonathan Etherton The Honorable Christine H. Fox Dr. J. Ronald, Fox Mr. Paul Francis The Honorable Jacques S. Gansler, PhD The Honorable Dr. J. Michael Gilmore The Honorable Daniel I. Gordon Mr. William C. Greenwalt Mr. Todd Harison The Honorable Tina W. Jonas Dr. Paul G. Kaminski The Honorable Frank Kendall III The Honorable Dr. John F. Lehman The Honorable Elizabeth McGrath

		Dr. David L. McNicol The Honorable Dr. Jamie Morin The Honorable David Oliver Admiral Gary Roughead, USN (Ret.) Ms. Katherine Schinasi Gen Norton A. Schwartz, USAF (Ret.) The Honorable Sean J. Stackley Mr. Michael J. Sullivan Vice Admiral David J. Venlet, USN (Ret.) Lt Col Daniel Ward, USAF The Honorable Dr. Dov Zakhrim
2017	Getting Defense Acquisition Right	The Honorable Frank Kendall III

Summary

This chapter detailed the Text Mining and grounded theory methodologies used to conduct the analysis of this research. A description of the data set, sources, and preparation process was also presented. The results of the analysis are examined in the next chapter and further discussions, implications, and conclusions are presented in Chapter V.

IV. Analysis and Results

The purpose of this research is to identify and analyze trends within past major Defense Acquisition Reform legislation in comparison to a compendium of views from leaders within the Defense Acquisition community on the efficacy of acquisition reform. This analysis is designed to provide insight, not only on where the acquisition process and reforms have been, but on where they should be headed to effectively reduce cost and schedule overruns within MDAPs. To accomplish this goal, this research utilizes Text Mining methodologies, along with Grounded Theory Design for validation purposes, as described in the previous chapter, to analyze the major acquisition reforms and a compendium of views to investigate the following questions:

1. What are the commonalities and differences of the various major acquisition reforms?
2. What are the commonalities and differences between the reform legislation and the recommendations of the Defense Acquisition Leaders and Experts?
3. What unique insights does Text Mining reveal for new or different root causes of cost and schedule overrun?
4. Are incentives, or a lack of incentives, a problem? If so, do the reforms address incentives, and how?
5. How well do the results of Text Mining coincide with the results of grounded theory?

This chapter discusses the results from the Grounded Theory and Text Mining analyses and how they relate to the research questions discussed above.

Grounded Theory

In accordance with the process described in Chapter III, Grounded Theory Design is applied to a subset of the data, consisting of Title II of WSARA and Jacque S. Gansler's essay from the Compendium document. Due to the extent of involvement required by the researcher, Grounded Theory was conducted prior to any of the Text Mining methodologies to minimize the effects of unintentional researcher bias through illumination of possible categories. Therefore, the core categories that do appear through this method are derived from and grounded solely in the data. The intent is to use the results obtained through Grounded Theory Design to determine the validity of the Text Mining results.

The purpose of WSARA, Title II, is focused on Acquisition Policy. Applying the Grounded Theory Constant Comparative Method on the section results in 12 core categories. Given the focus on policy, the result contains some expected themes such as Policy, Strategy, and Management which constituted approximately 34% of the content. Looking further at the context of these topics reveals the more specific strategies that are required by the legislation, such as focus on the requirements process, Analysis of Alternatives, consideration of trade-offs, early identification of systematic problems, and determination of program affordability.

The remaining 66% of WSARA's core categories provide additional insight into the legislative content. The most frequent themes include Competition (20.3%), Affordability (16.5%), Program Certification (9.5%), and Modernization (7%). (A full list of WSARA's core categories are listed in Table 10). Again, diving further into the context of each topic, we see that text related to *affordability* largely concentrates on cost

estimates and their reasonability, monitoring cost, and root cause identification in the case of cost growth. This tied into *program certification* which focuses on reviews to identify whether to continue or terminate programs incurring critical cost growth. The text related to *modernization*, although appearing as a core category, did not have significant depth with regards to context. Within WSARA, *modernization* is strictly concerned with keeping regulations, especially the Federal Acquisition Regulation (FAR), up to date with the most current policies.

Table 10: WSARA Core Categories

Core Category	**Count**	**% of total Count**
Affordability	26	16.46%
Analytical Technique	9	5.70%
Competition	32	20.25%
Expenditures	1	0.63%
External Factors	2	1.27%
Integrity	4	2.53%
Management	22	13.92%
Modernization	11	6.96%
Policy	1	0.63%
Program Certification	15	9.49%
Strategy	31	19.62%
Waivers	4	2.53%

Competition is the most frequently used theme and contextually, the most interesting and possibly the most insightful. Here we see the introduction of several ideas such as competition through the program life-cycle, competitive prototyping, dual-sourcing, and modular/open architecture. While we do not see a strict policy for the implementation of these strategies, WSARA suggests their use in programs when

appropriate and practicable. Cumulatively, these ideas of competition form a means to improve contractor performance.

The Constant Comparative Method as applied to Gansler's essay resulted in nine core categories. The context of the core categories were further organized into five code families: problems, requirements, solutions, results, and other. The top four core categories discussed by Gansler are Bureaucracy (15.3%), External Factors (17.1%), Competition (20.7%), and Modernization (24.3%). (A full list of Gansler's core categories and classification by code family are listed in Table 11).

Table 11: Gansler Core Categories and Code Families

Core Category	**Count**	**% of total Count**	**Code Family**
Affordability	2	1.80%	Problem (1), Other (1)
Analytical Technique	2	1.80%	Problem (1), Requirement (1)
Bureaucracy	17	15.32%	Problem (9), Solution (8)
Competition	23	20.72%	Problem (6), Solution (4), Results (12), Other (1)
External Factors	19	17.12%	Problem (18), Other (1)
Incentives	1	0.90%	Other (1)
Modernization	27	24.32%	Problem (7), Requirement (7), Solution (9), Other (4)
Strategy	10	9.01%	Problem (2), Solution (5), Other (3)
Utilization of Human Capital	10	9.01%	Problem (5), Solution (5)

Gansler discusses *bureaucracy* in two forms; the problems with it and potential solutions. The largest problems are the barriers and restrictions that *bureaucracy* imposes on the acquisition system. Gansler recommends reducing barriers, especially relating to the industrial base and commercial purchases, as a means to promote

competition and innovation. While *bureaucracy* is a burden on the system, it is largely a part of the environment we work in, making it external to the system. Other *external factors* of today's environment which cause issues within the acquisition system are the continuously shrinking budgets and uncertainty associated with them, worldwide security concerns and the presence (or ending of) contingency operations, the size of the military force structure, and a rapidly-changing world with regards to geopolitics, economics, security, and technology, as well as a lack of U.S. investment in Research and Development resulting in potential missed opportunities.

The discussion about *competition* ranged from issues with how we currently use (or fail to use) certain strategies along with proposed solutions, to results of proper usage based on previous programs. The largest problem that Gansler discusses in this category is the wrong use of source selection strategies for complex programs. Typically, we utilize Lowest Price Technically Acceptable (LPTA) in this situation, which works well for simple, interchangeable commodities, however, with complex systems we should be taking more of the trade-off, or best value, approach. The second issue Gansler focuses on is a lack of competition throughout the life-cycle of the system. He recommends decision makers and program managers become more familiar with the various source selection and competition strategies and when they are most effective. Doing so results in higher system reliability, quality, and performance, with lower costs in general.

The *modernization* theme centered on a widespread recognition of the need for change, outdated accounting techniques, and outdated policies and regulations. The solutions revolved around an overall overhaul of the Defense Acquisition System; everything from updating regulation and policy, accounting techniques to account for

indirect costs of human capital and regulatory compliance, to the way we do business with the industrial base.

Throughout his essay, Mr. Gansler referenced the Joint Direct Attack Munition (JDAM) program, which basically converted all "dumb bombs" into "smart bombs." The JDAM program was very much aligned with his opinions and suggestions. The program implemented the best value source selection strategy, competition through production, and various other recommendations provided by Gansler, which illustrates their benefit given the success of the program.

Although we only applied the Grounded Theory method to a subset of the data, we still find overlaps in the results between the reform and expert opinion, and begin to notice their differences. It is of note that Mr. Gansler held the office of USD(AT&L) from 1997 to 2001, which is between two of the major reforms: FASA (1994) and WSARA (2009). Since Mr. Gansler's role in the DAS preceded WSARA, it is possible that some of his views were directly implemented in the legislation. For instance, we see overlap in six of the 15 total core categories between the two documents. The *Competition* core category comprises approximately 20% of the content in each document (they are utilized similarly about 97.7% of the time). We also see moderate overlap between the *Strategy* (9% vs. 19.6%, a 45.9% likeness), *Analytical Techniques* (1.8% vs. 5.7%, a 31.6% likeness), and *Modernization* (24% vs. 7%, a 28.6% likeness) categories. We also see minor overlap in the *Affordability* (1.8% vs. 16.5%, a 10.9% likeness) and *External Factors* (17.1% vs. 1.3%, a 7.4% likeness).

Even though there are some similarities between the two documents, the contrast is much greater. First, are the differences in content between the two documents; there is

no overlap present for nine of the 15 core categories. Six categories are unique to WSARA (Expenditures, Integrity, Management, Policy, Program Certification, and Waivers), and three are unique to Gansler's essay (Bureaucracy, Incentives, and Utilization of Human Capital). The unique themes found within WSARA are focused mainly on policy and procedures, while Gansler's themes focus on certain problems that exist within the DAS. Our second observation is the distinction in tone, or purpose of the documents. Again, WSARA implements policy and procedures, while Gansler identifies problems and requirements, recommends solutions, and exhibits results of his recommendations based on their use in prior programs.

These results are simply a snapshot of the possible comparisons between the major reforms and expert opinions. Further comparisons between the reforms and the entire compendium are made in the subsequent Text Mining sections. Furthermore, the following sections will present a comparison of each of the major reforms to each other, each of the experts to each other, as well as a comparison of the Grounded Theory results discussed above to the topic modeling results to determine their validity.

Text Mining

As discussed in Chapter III, various Text Mining methods are applied to the data set in an attempt to identify and analyze trends as they relate to the research questions identified above. The specific Text Mining methods utilized include word counts and frequencies, term frequency-inverse document frequency (tf-idf), word relationships, sentiment analysis, and topic modeling. This section discusses the results of these methods.

Exploratory Analysis.

The goal of the exploratory analysis phase of this research is to establish a top-level glimpse into the content and trends within the major reforms and a compendium of expert views. This includes word counts and frequencies, which provide insight into possible topics contained within each document, word relationships to establish context for word usage at a top-level, and tf-idf to identify the importance of words (or bigrams) to a document.

To begin, this research compares the most frequently used words from the compendium of experts to the major reforms. In the word clouds, Figures 4 and 5, the size of the words in the cloud indicate frequency, with the largest size the most frequent, while the bar charts, Figure 6, display the top ten most frequent words. The word count analysis removed stop words (i.e. and, the, for, etc.) as well as common acquisition words and legislative terminology (listed in the Data Dictionary in Appendix B) that, if included, would hide potential themes of importance within the data.

In the Compendium, we see that some of the most frequently used words are "program," "cost," "industry," and "risk," while the reforms have high usage of the words "contract," "federal," "agency," and "secretary." These differences might indicate that the experts view defense acquisition issues at the program level and/or with the DAS interactions with the industrial base, while the reforms tend to address issues at the contract level, or by management (or agency) responsibility.

Figure 4: Word Cloud - All Compendium

Figure 5: Word Cloud - All Reforms

Diving a little further, we applied the word count analysis to compare and contrast possible themes between reforms, and each of the experts (see the Exploratory Results at Appendix C). Given the variance in size of each document, this analysis did not prove to be extremely useful to compare across reforms or across the experts, but a few things did become apparent. The first is that across the results we see several pairs of words that are likely used together consistently (i.e. “federal” and “agency,” “military” and “service,” etc). Second, the word count results for the entire set of reforms (Figure 6) largely mimic the results of FASA, since the size of the FASA legislation greatly outweighed the size of the other reforms. Similarly, much of what Frank Kendall discusses is reflected in the compendium results, since he has produced a much larger document than the other experts. Another issue we find, that is not addressed in the scope of this research, is the

use of pluralities (i.e. “program” vs. “programs”). In future research, it is suggested that a stemming or lemmatization process be applied prior to analysis. To account for the first issue, we apply the use of bi-grams to capture various word relationships, and for the second issue, we a look at the percentage of frequency used.

Using bi-grams to account for the various word relationships within the documents proved more useful and provided slightly more context than examining individual word counts (see Figure 7). Within the compendium, the experts mention “weapon systems,” “program managers,” and “buying power” most frequently, while the major reforms utilize higher-level terminology such as “executive agency,” “federal procurement,” and “procurement policy.” But again, when looking at the major reforms or the entire compendium collectively, we encounter the document size issue.

Regardless of the document size issue when examining the documents collectively, the use of bi-grams allows us to gain insight into the contents of each of the major reforms when disaggregated into individual documents (Figure 8). For example, WSARA discusses “systems engineering,” “developmental tests,” and “cost assessments” which indicate themes related to ensuring that the weapon systems are both sound and affordable. Conversely, the Packard Commission uses terminology more related to preventing fraud and implementation of punitive actions such as “suspension debarment,” “voluntary disclosure,” and “false claims.”

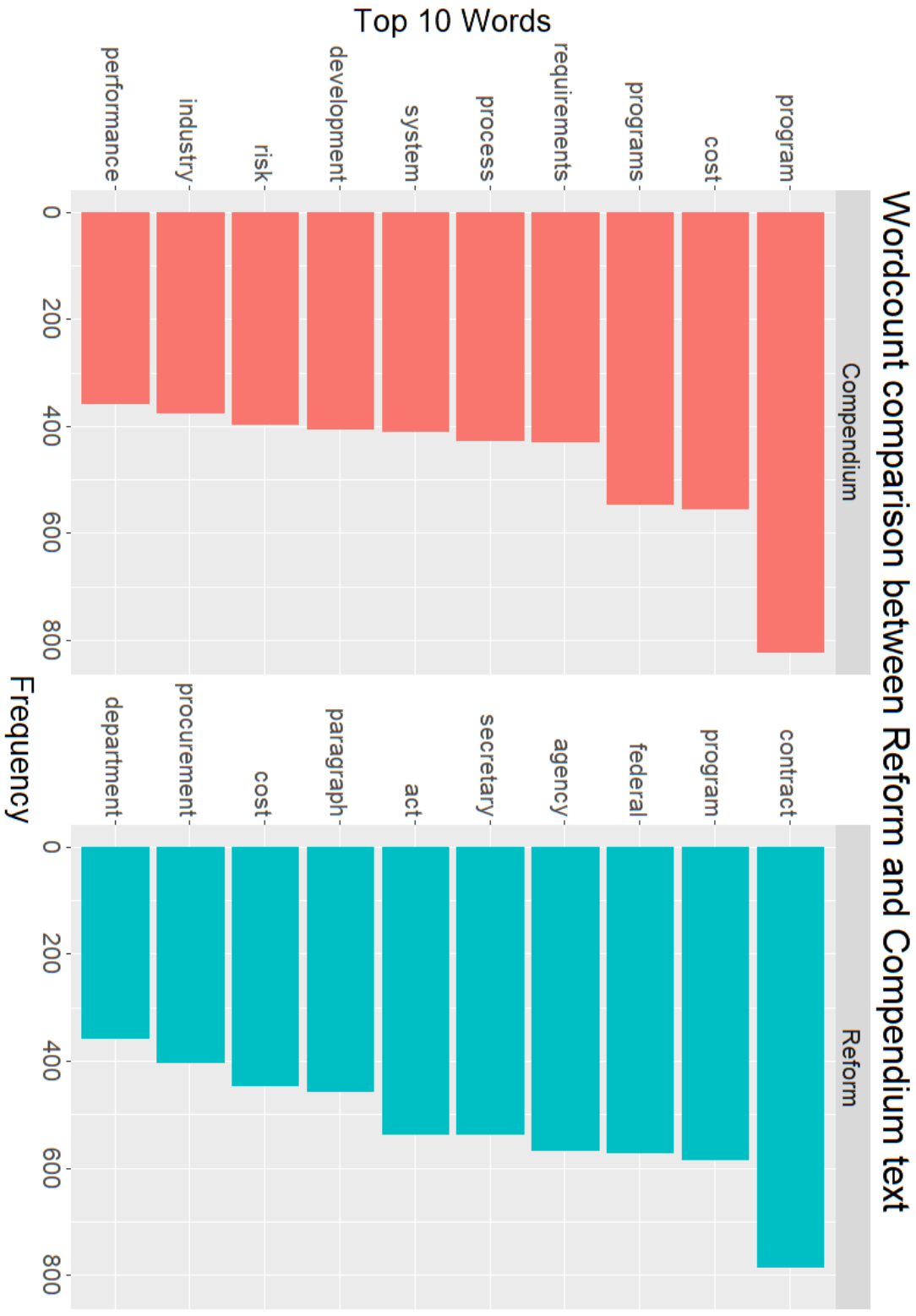

Figure 6: Word Count Comparison - Compendium vs. Reforms

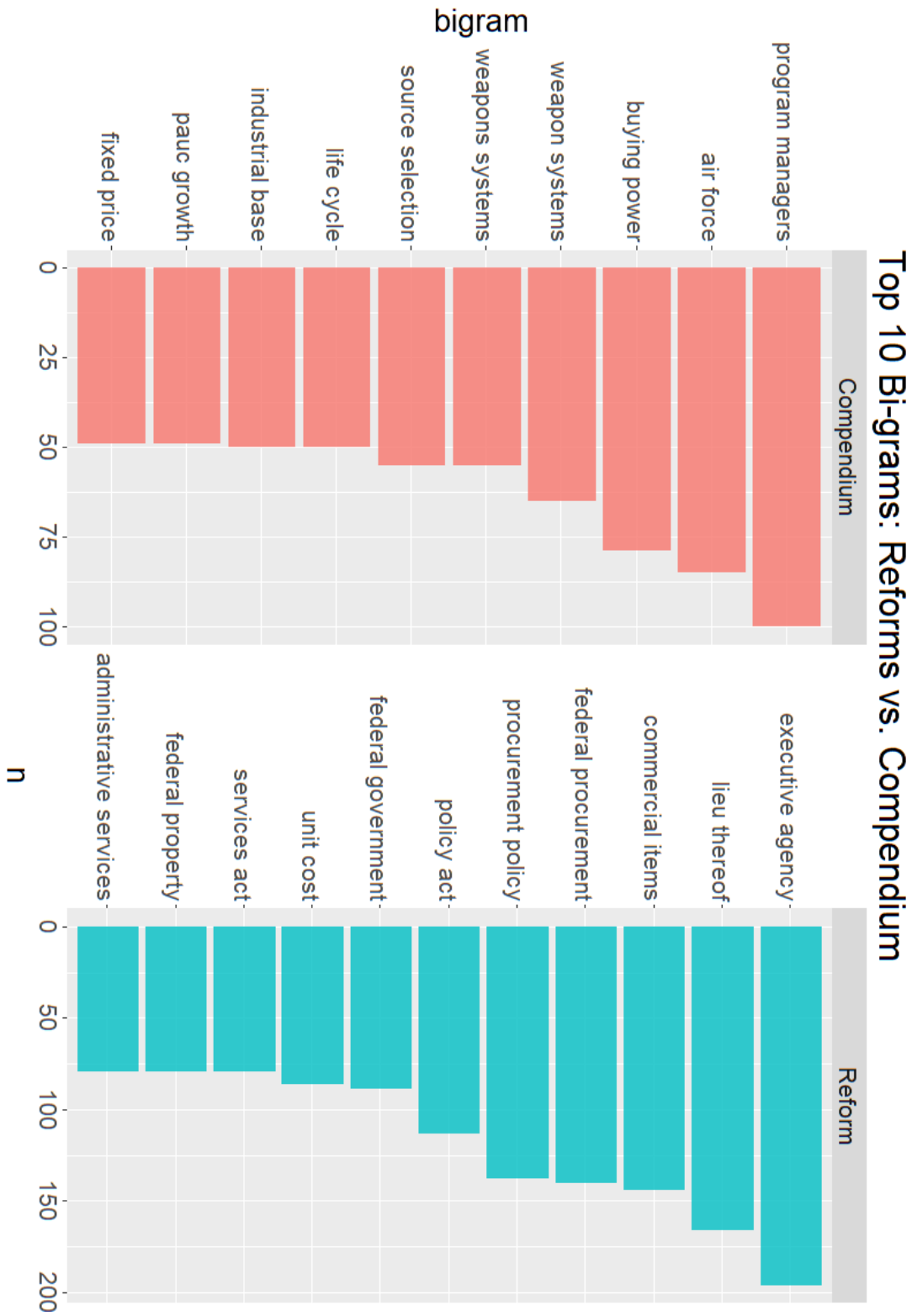

Figure 7: Bi-Gram Count Comparison - Reforms vs. Compendium

While insight was gained through this method for the major reforms, document size continues to be a challenge when examining the expert's opinions. For some of the experts, such as James Finley and Frank Anderson, their essays are just large enough to gain a glimpse into their views, but they have relatively low frequencies for their most frequently used terms (for example, Finley's highest term frequency was only two). However, other experts, such as Norman Augustine and David Berteau, did not have more than a few term frequencies above one, making their results difficult to interpret. These results can be seen in Figure 9. To solve this issue, the most frequently used terms for each expert (and each of the major reforms) were plotted in word maps which show a directional connection of the words that comprise each term. Furthermore, the bi-gram maps turned into more of a network map identifying some of the most used phrases (Figures 10 and 11).

Comparing Norman Augustine's (Figure 10) and David Berteau's (Figure 11) network maps to their term frequencies from Figure 9, we can more easily identify potential themes within their opinions. For example, Augustine's essay contains phrases such as "provide quality leadership" and "requirements definition process," while Berteau's essay contains "budget control act" and "Packard Commission requirements." Network maps for each of the experts and major reforms can be found in the Exploratory Analysis Results at Appendix C.

To address the second issue of the larger documents skewing the results of the word and term counts, we apply word frequencies as a percentage of their usage across each individual document and the corpus as a whole. Using this process allows us to

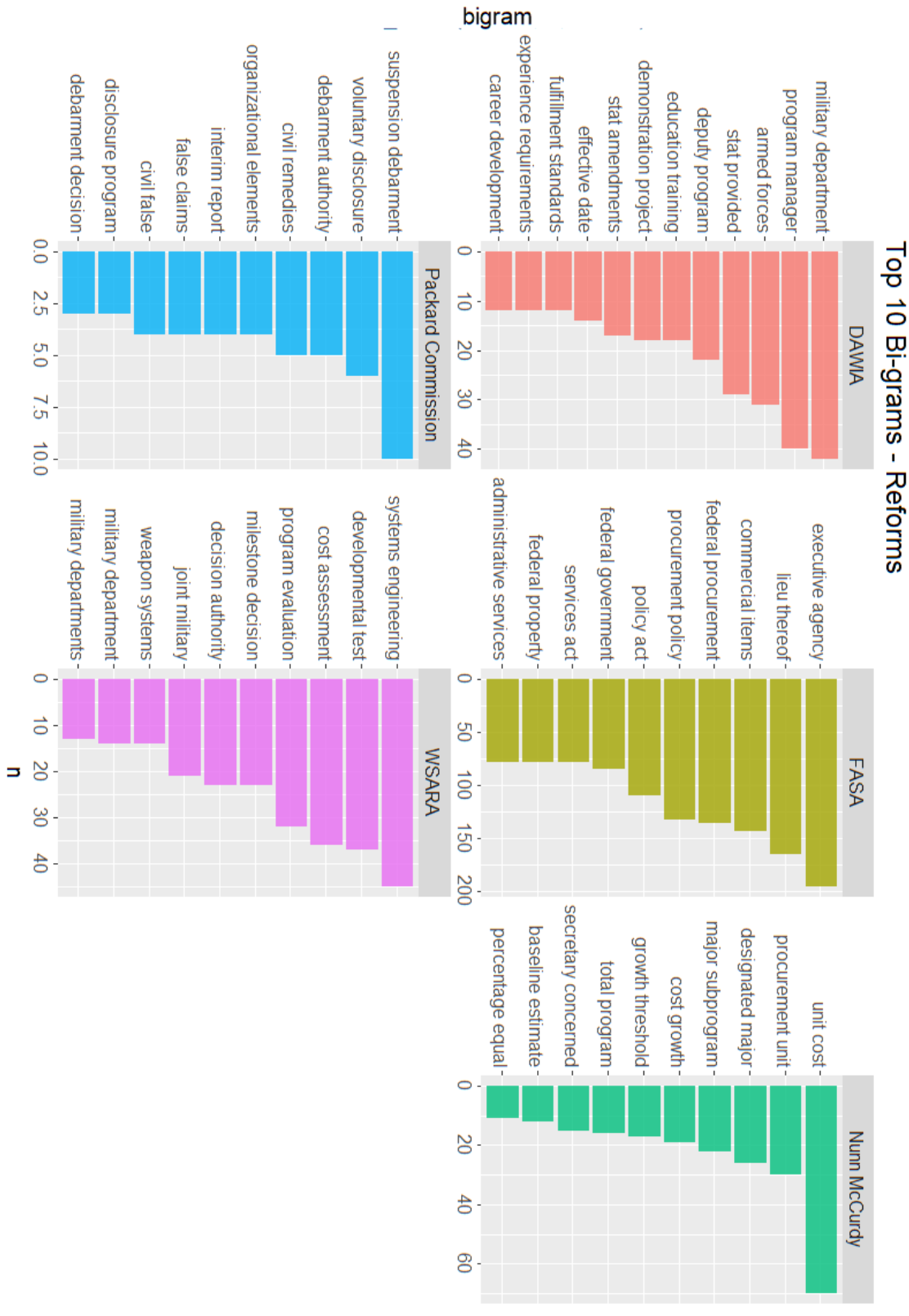

Figure 8: Bi-Gram Count Comparison - Reforms

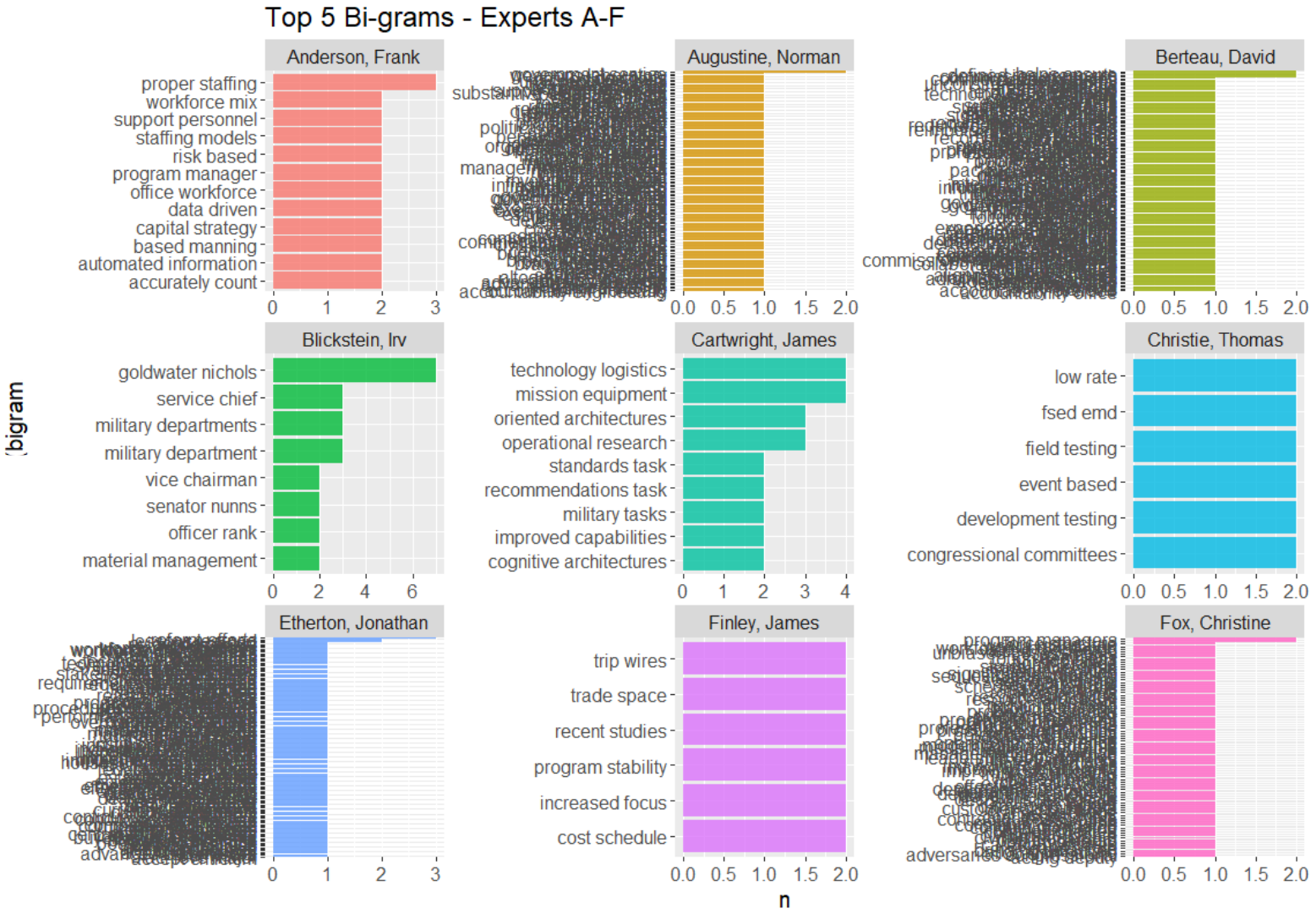

Figure 9: Bi-Gram Count Comparison - Experts A-F

Figure 10: Bi-Gram Network - Expert: Augustine

Figure 11: Bi-Gram Network - Expert: Berteau

normalize the data and uncover themes of potential importance within the smaller documents of the corpus without having the results masked by those of the larger documents. Figure 12 displays the frequency of word usage across each of the major reforms.

In the frequency percentage plots, words appearing close to the dotted line have similar frequencies between that individual document and the entire corpus, with words appearing in the top-right possessing the highest frequencies, and the bottom-left possessing the lowest. Additionally, words appearing above the line tend to be frequently used in the collection as a whole, but do not appear much in that individual document. Conversely, words below the line are more unique to that individual document.

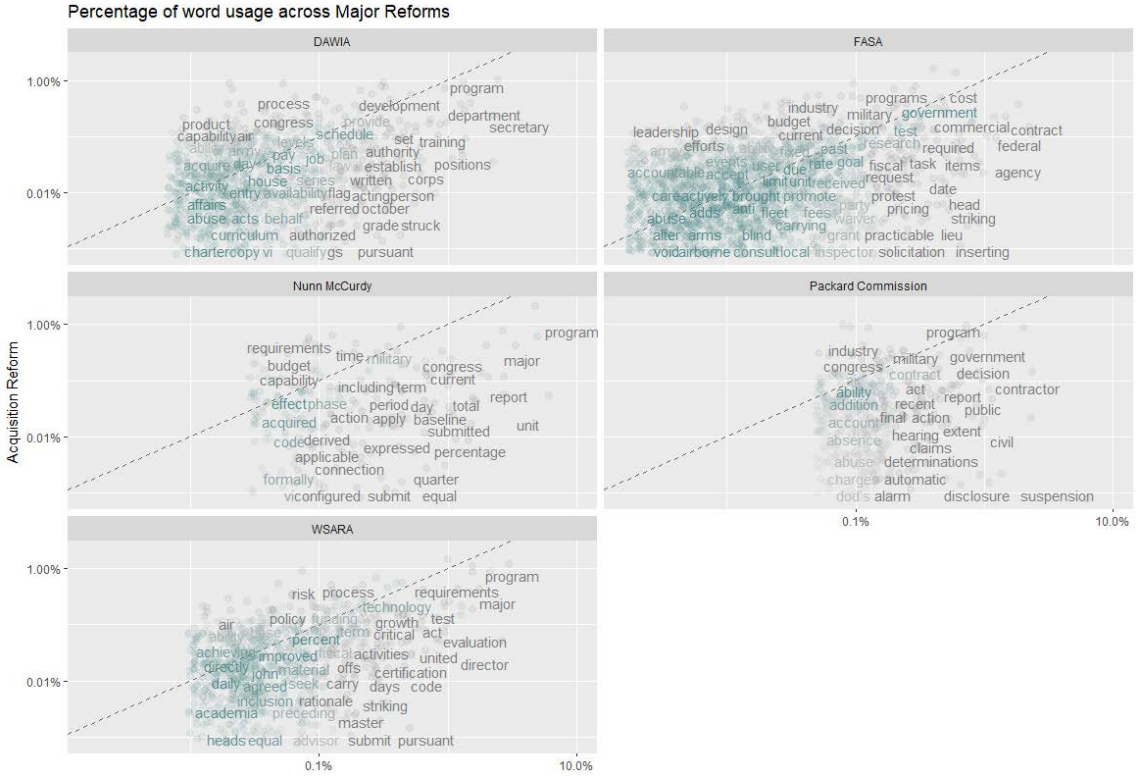

Figure 12: Word Frequency Percent - Reforms

Specific to the major reforms plotted in Figure 12, words appearing above the line are common across the entire collection of major reforms, but not within the individual document. For example, examining the frequency percentage for DAWIA indicates that there is not much discussion about "products" or "processes," which are frequently discussed across the other major reforms, but it does uniquely discuss "training" and "workforce." (Larger individual plots with more detail are located in the Exploratory Analysis Results at Appendix C.) Figure 13 displays similar frequency plots for some of the experts as compared to the entire compendium. Frank Anderson's plot show that while many of the experts talk about "performance" and "budget," he shares more of his views on topics such as the "workforce" and "lifecycle."

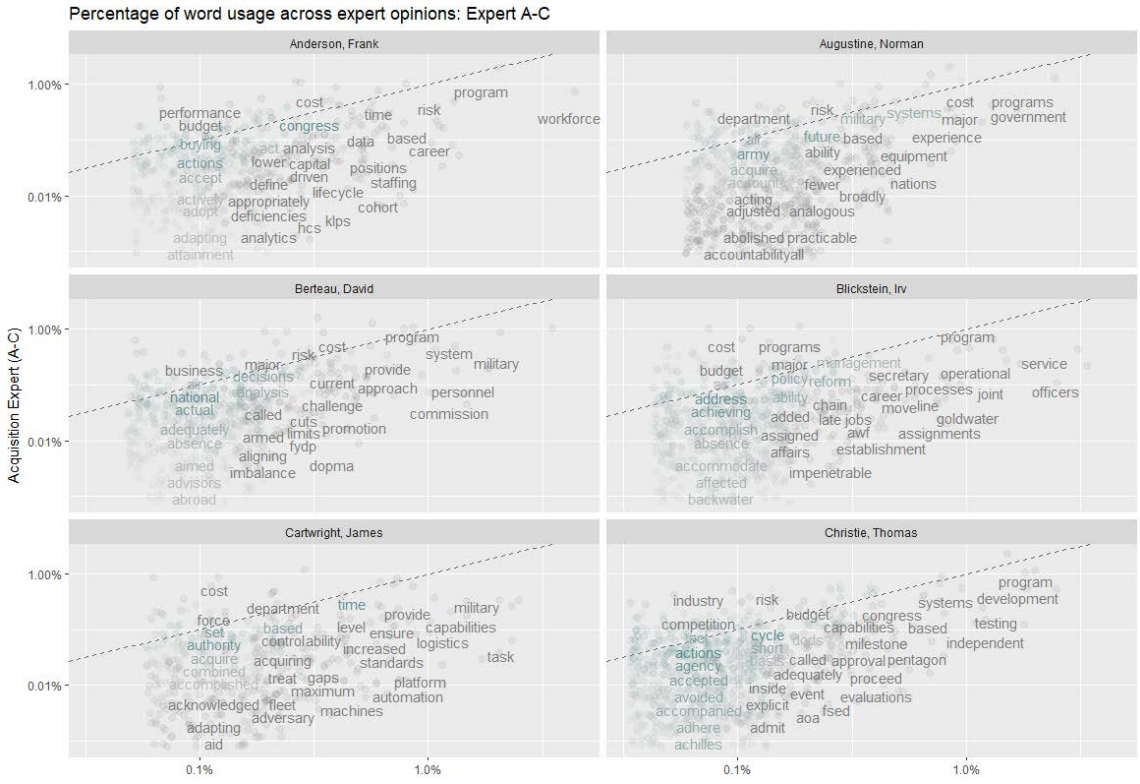

Figure 13: Word Frequency Percent - Experts A-C

Although we are beginning to gain insight into the content of each document, we can see that high word or term usage does not necessarily indicate importance. The incorporation of word and term frequencies as a percentage of their usage across documents helped to rectify this issue, but the term frequency-inverse document frequencies (tf-idf) goes even further and can verify the frequency percentage results while isolating the words and terms (bi-grams) of most importance. Figure 14 displays the tf-idf results for three of the major reforms (DAWIA, FASA, and Nunn-McCurdy). In DAWIA specifically, we can see that some of the terms of most importance are "experience requirements," "fulfillment standards," and "education training."

Figure 15 displays the tf-idf results for three of the experts. While the size of the documents remains an issue with the use of bi-grams in some instances (such as with Norman Augustine and David Berteau), we are still able to use the tf-idf of individual words to identify themes of importance, while gaining additional contextual insight for the experts who provided opinions large enough for use with the bi-gram analysis. For example, Frank Anderson's most important terms include "proper staffing," "automated information," and "workforce mix." For Norman Augustine and David Berteau, we may lose some context but we are still able to see themes of importance such as "government," "responsibility," and "production" (for Augustine), and "Packard" "commission," "spending," and "innovation" (for Berteau).

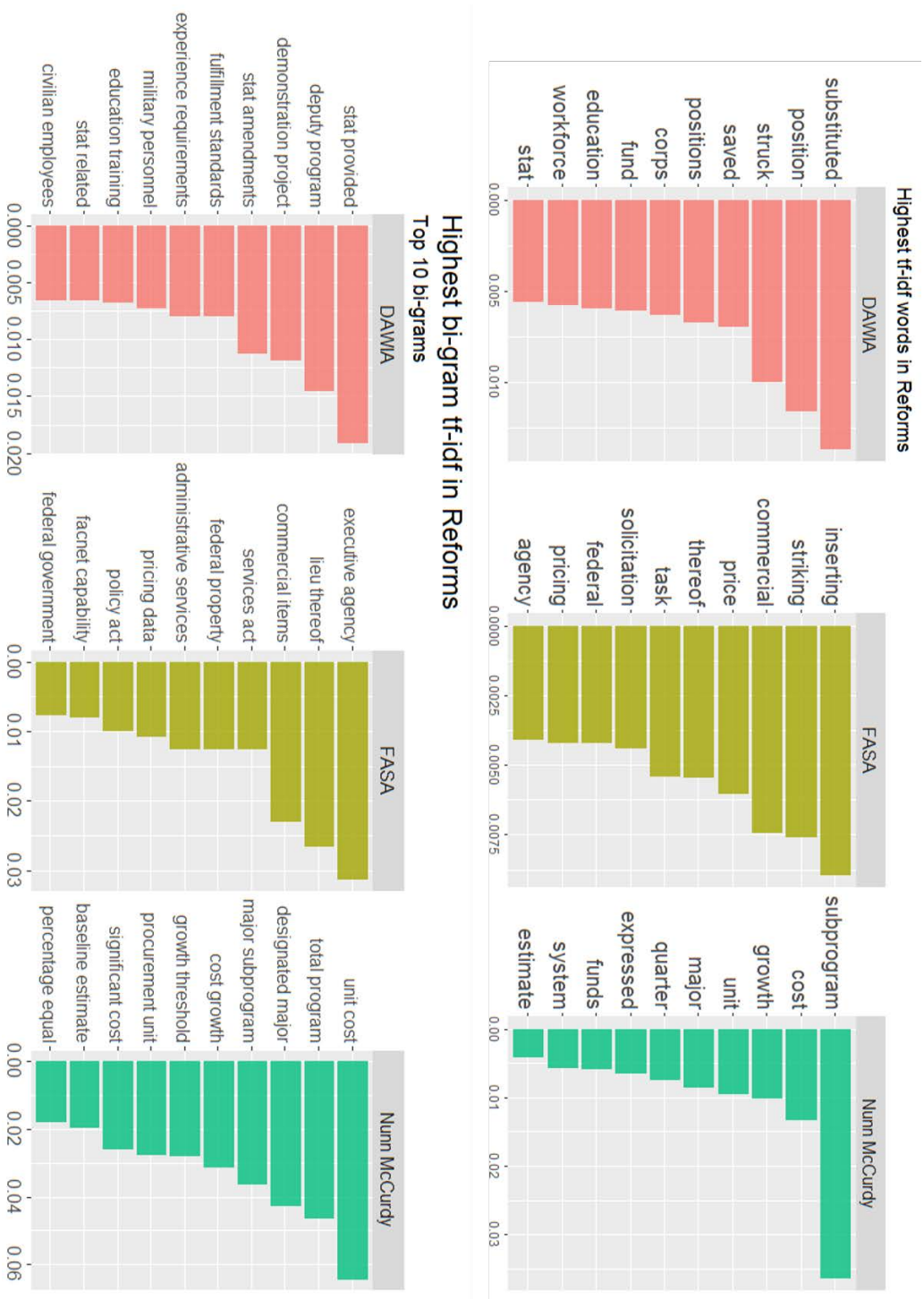

Figure 14: tf-idf (Words & Bi-Grams) Reforms: DAWIA, FASA, & Nunn-McCurdy

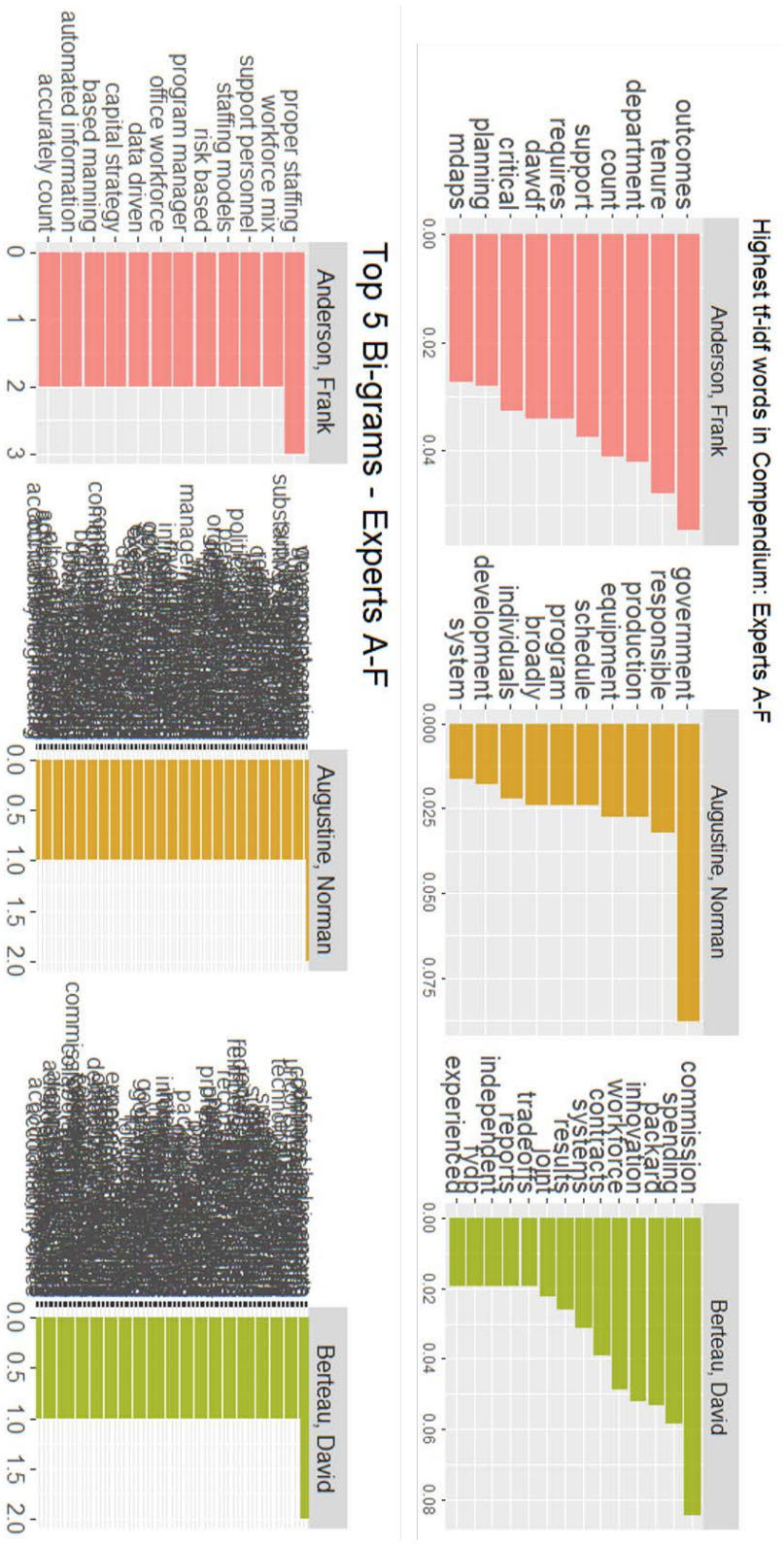

Figure 15: tf-idf (Words & Bi-Grams) Experts A-B

When comparing the tf-idf results to the frequency percentage plots (Figures 16 and 17), there is significant overlap in the results. The use of the two methods together reinforces the importance of certain words and terms within the individual documents. Words that are identified as important based on their tf-idf score are circled in blue on the frequency plot. Unmatched pairs from the bi-gram tf-idf are circled in grey, while matched pairs are circled in colors other than blue or grey. Absence of tf-idf words or terms on the frequency plot do not necessarily mean that they are truly absent; the plots are prone to overlapping words due to other words with similar or identical frequencies.

Sentiment Analysis.

While the use of bi-grams in the exploratory analysis gives us insight into the context of word usage, sentiment analysis provides us with feeling or emotion contained within each document. The emotion can simply be either positive or negative, and will fall into one of eight categories: anger, anticipation, disgust, fear, joy, sadness, surprise, or trust. Since the sentiment scores are based on word counts, document size will be an issue when examining the entire set of reforms or the compendium, but this does not affect documents at an individual level.

Each of the major reforms follow a similar sentiment categorization, with the exception of the Packard Commission. The majority of the reforms use largely positive vocabulary, with very little negativity, falling into the trust and anticipation categories. Conversely, the Packard Commission, while the positive vocabulary still outweighs the negative, uses much more negatively associated words than the other reforms. Also, its top sentiment categories are trust and fear. At the third level, all of the reforms had the categories of trust, anticipation, and fear as their top three emotions. Figure 18

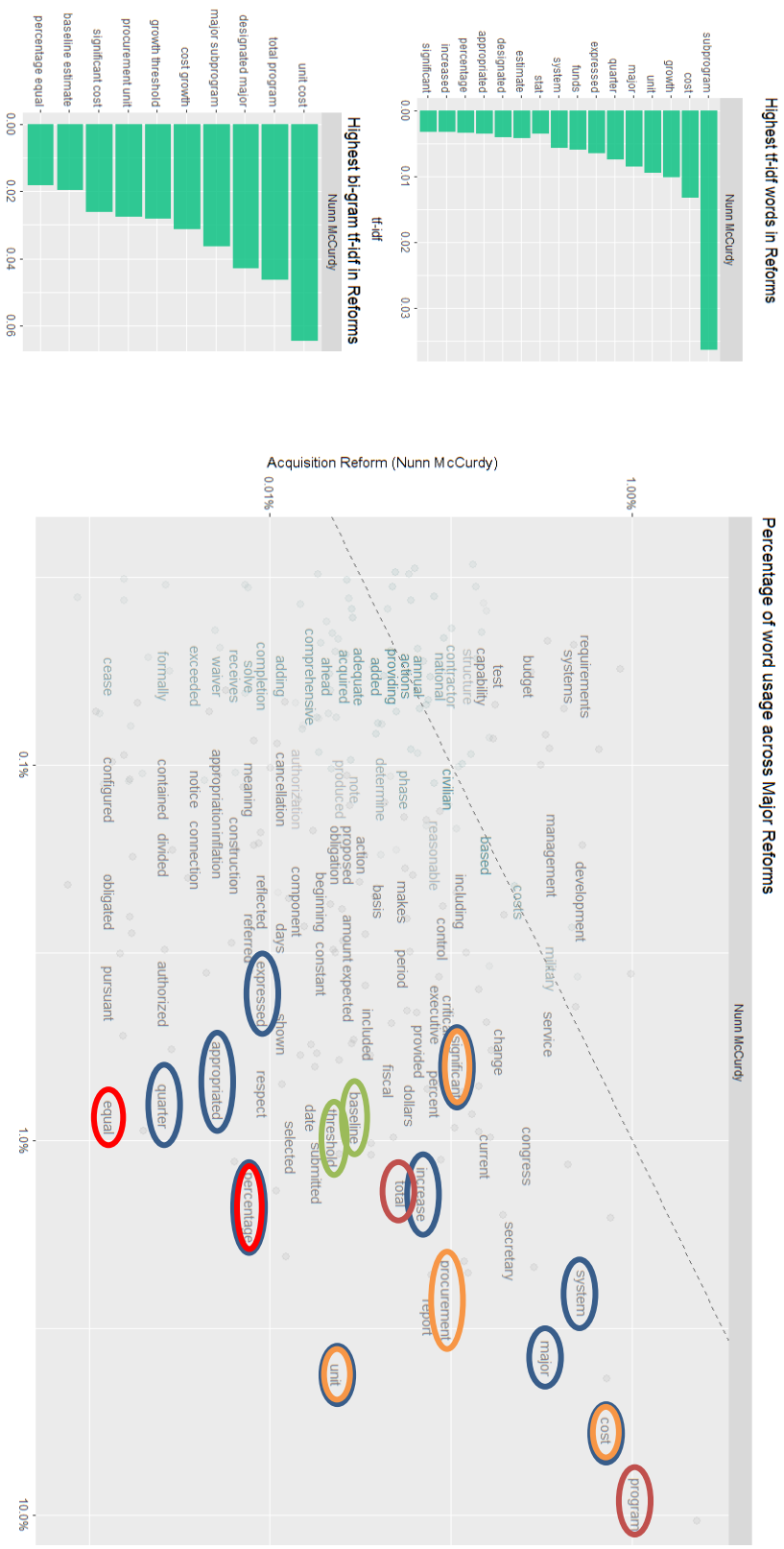

Figure 16: Frequency Percentage vs. tf-idf (Reform: Nunn-McCurdy)

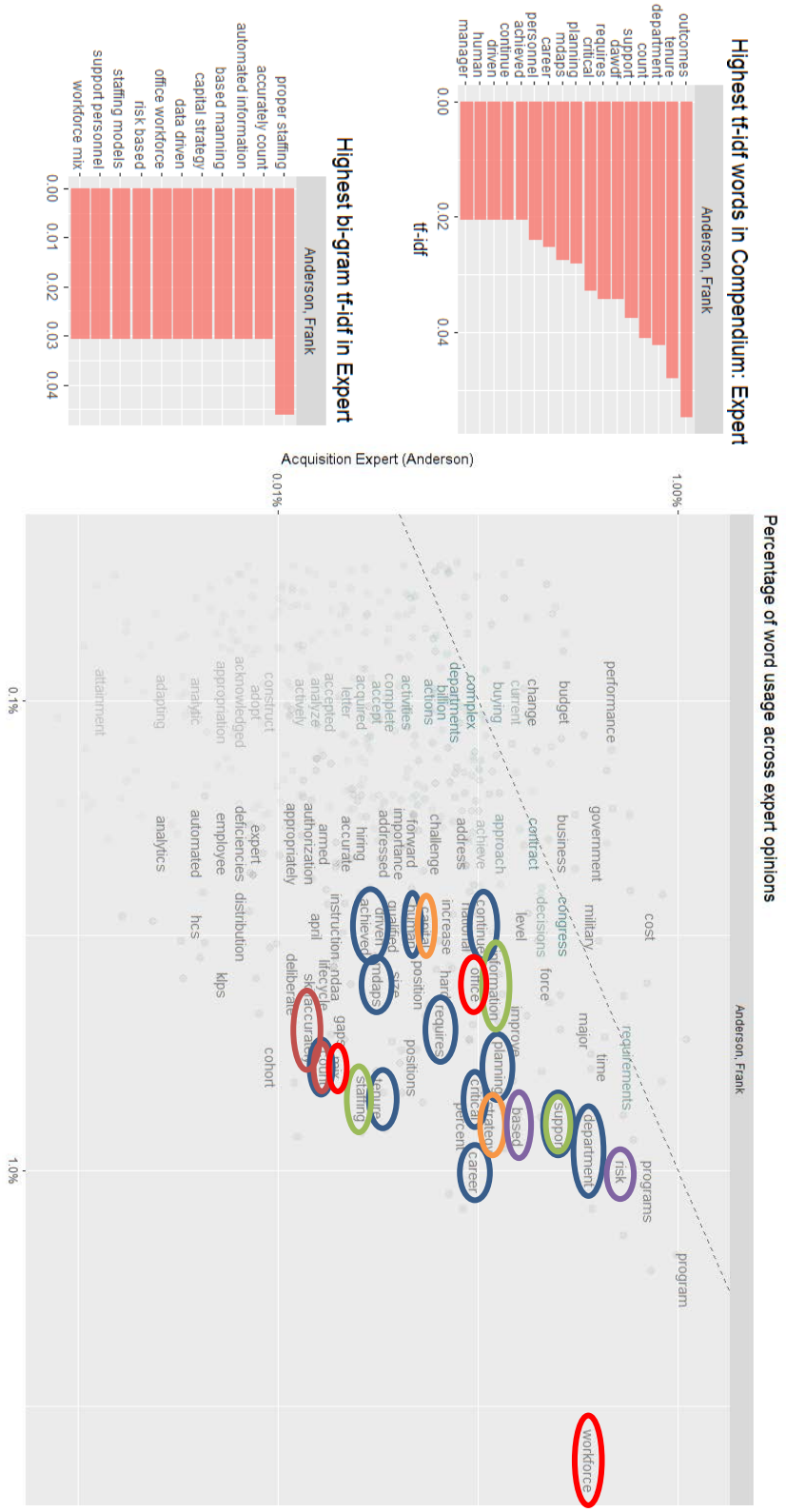

Figure 17: Frequency Percentage vs. tf-idf (Expert: Anderson)

displays the sentiment of the Packard Commission and FASA, which is similar to the remaining reforms (the full results are listed within the Sentiment Analysis Results at Appendix D).

The sentiment of a majority of the experts closely resembles the emotion found in the majority of the reforms. Most of the experts used approximately twice as much (or more) positive language than negative. There were only four exceptions: Gansler, Harrison, Lehman, and Morin, whose opinions were slightly more than half negative. While Gansler and Harrison both have experience within Research & Education fields, they do not appear to have much in common with Lehman or Morin who were both members of the Executive Service (see Table 15 in the Data Dictionary at Appendix B).

When examining the emotion within each of the opinions, we again see that for the majority of the experts (21 of 32), trust and anticipation were the top two categories, while the remaining experts top two emotions were trust and fear. For all of the experts, trust and anticipation were within the top three. Figure 19 displays the sentiment of Frank Anderson (similar to the majority of experts who fall into the largely positive, trust/anticipation category) and Jamie Morin (similar to those experts using more than average amounts of negative vocabulary and falling into the trust/fear category).

Currently, the sentiment analysis has been based off of a count of how many positive or negative words are contained within each document. But, one important item that has not been accounted for yet is the use of negation words (no, not, without, and never). When negation words precede a positive word (i.e. “not greater”), the term should be counted as negative, but has actually been counted as negative-positive,

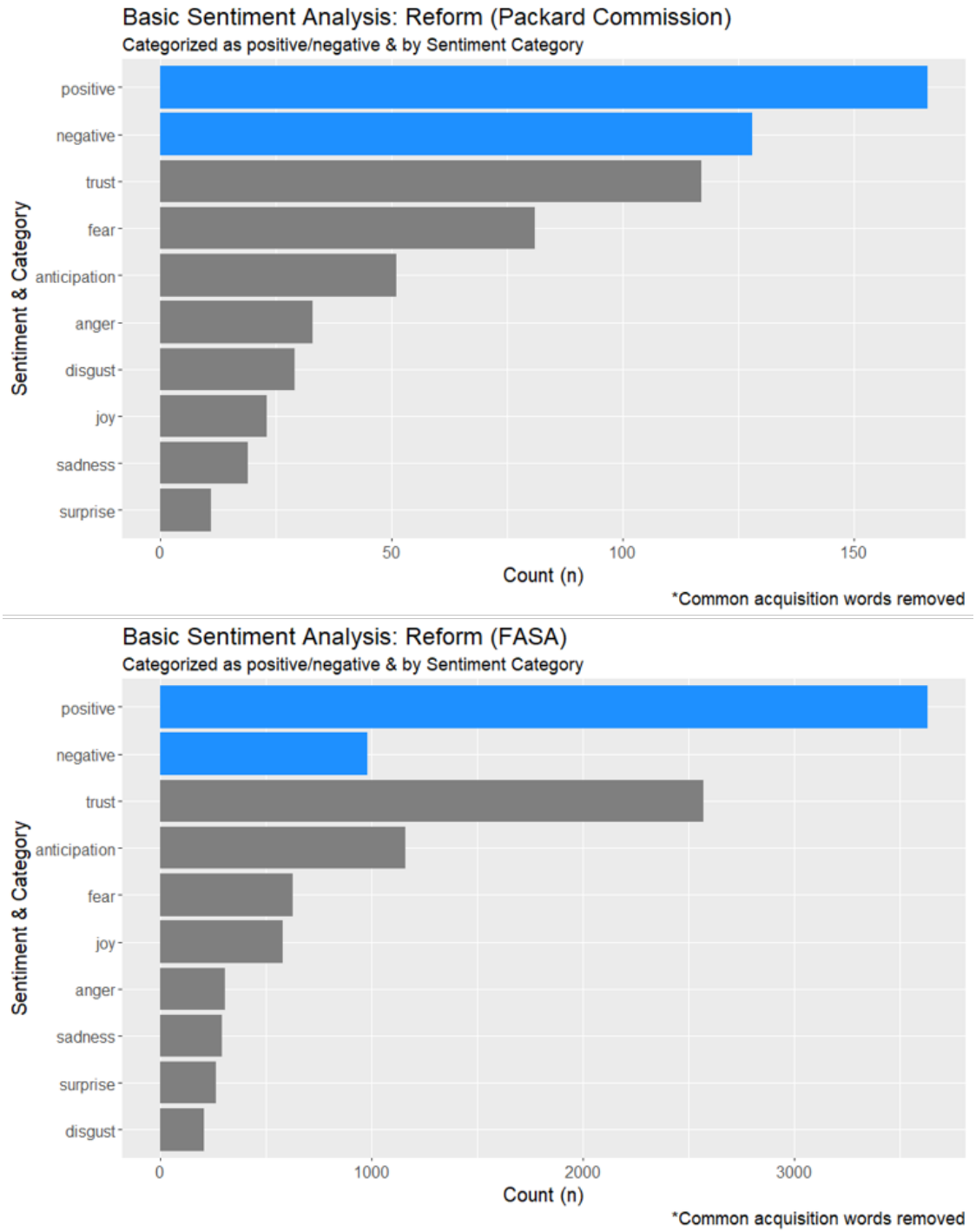

Figure 18: Basic Sentiment - Reforms: Packard Commission and FASA

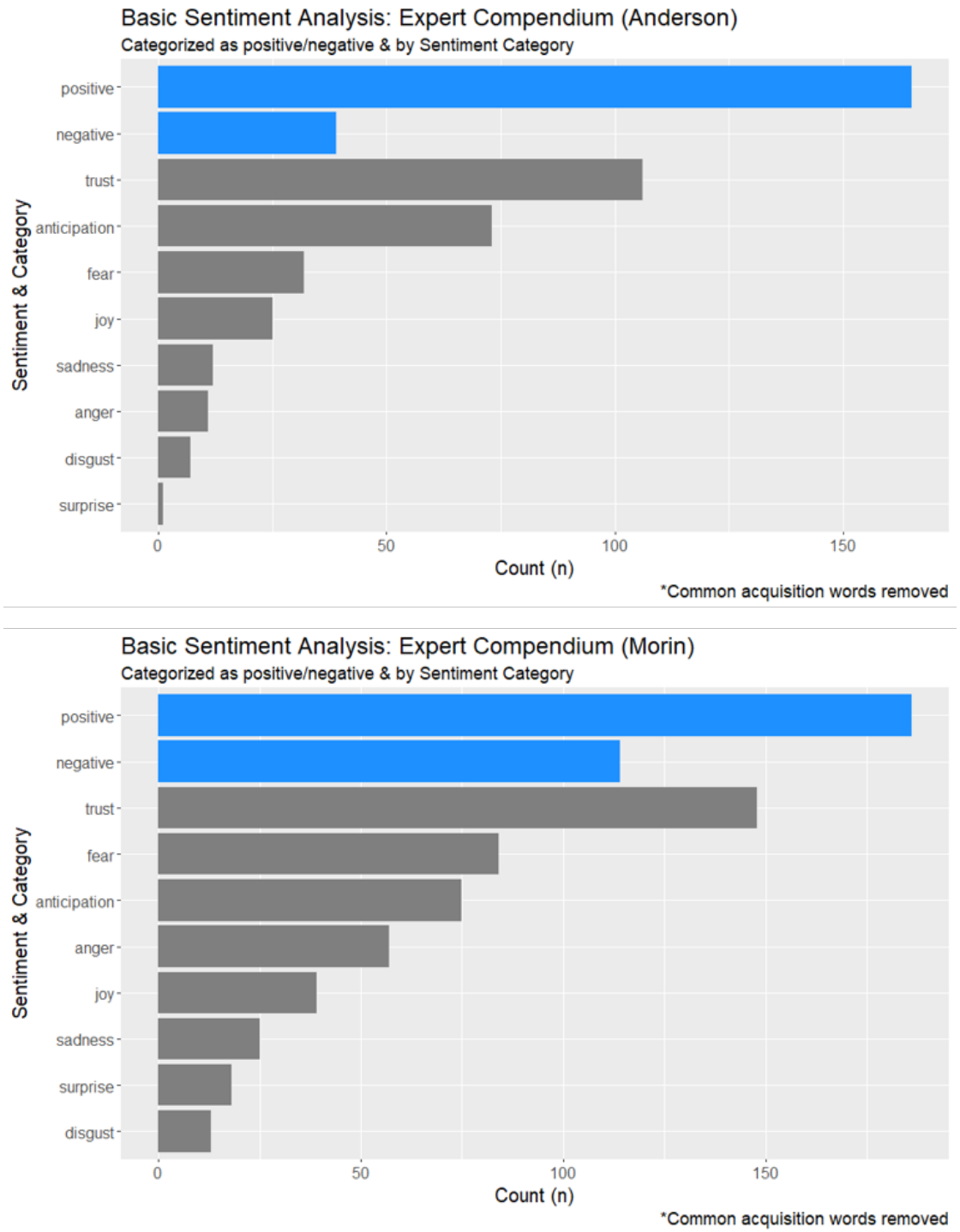

Figure 19 : Basic Sentiment – Experts: Anderson and Morin

equating to a neutral net sentiment score. For this reason, there is potential for the results of the basic sentiment analysis to be stated as more positive than it is in actuality.

After taking this into consideration for both the reforms and the compendium, FASA appears to be the only document with a significant positive overstatement (Figure 20) of approximately 200 sentiment points. In addition to the need to account for the overall overstatement of positivity within FASA, this research examined whether presence of negation words preceding positive words have an effect on the sentiment categories by either the total count contributing to that category or by the shifting of that category's position based on frequency. However, within the *NRC* lexicon utilized for this portion of the sentiment analysis, neither "not" nor "greater" were associated with a type of sentiment (i.e. fear, anger, trust., etc.). Therefore, the presence of negation words preceding positive words did not have an effect on the order of the sentiment type classifications.

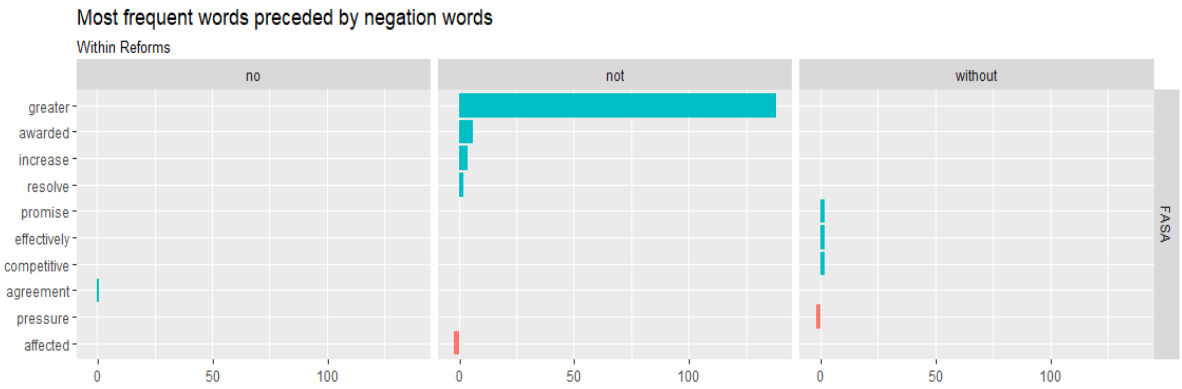

Figure 20: Negation Preceding Positive Words - Reform: FASA

Another way to view the sentiment of each document is to see how the emotion changes throughout while applying a sentiment score (utilizing the *AFINN* lexicon) to identify how positive or negative the document actually is. Figure 21 displays the progression through the reforms; red indicates a net negativity for that section in the document, blue indicates positivity, while the absence of color is an indication of neutrality. Additionally, the saturation of each bar represents how positive or negative that section of the document is. Considering the sentiment found in Figure 18, we see a considerable amount of red as the Packard Commission progresses, however, the red has a fairly light saturation indicating that it may not be as negative as we initially thought. Similarly, comparing FASA from Figure 21 to Figure 18, we see an abundant amount of dark blue which is an indication that FASA is actually a very positive document.

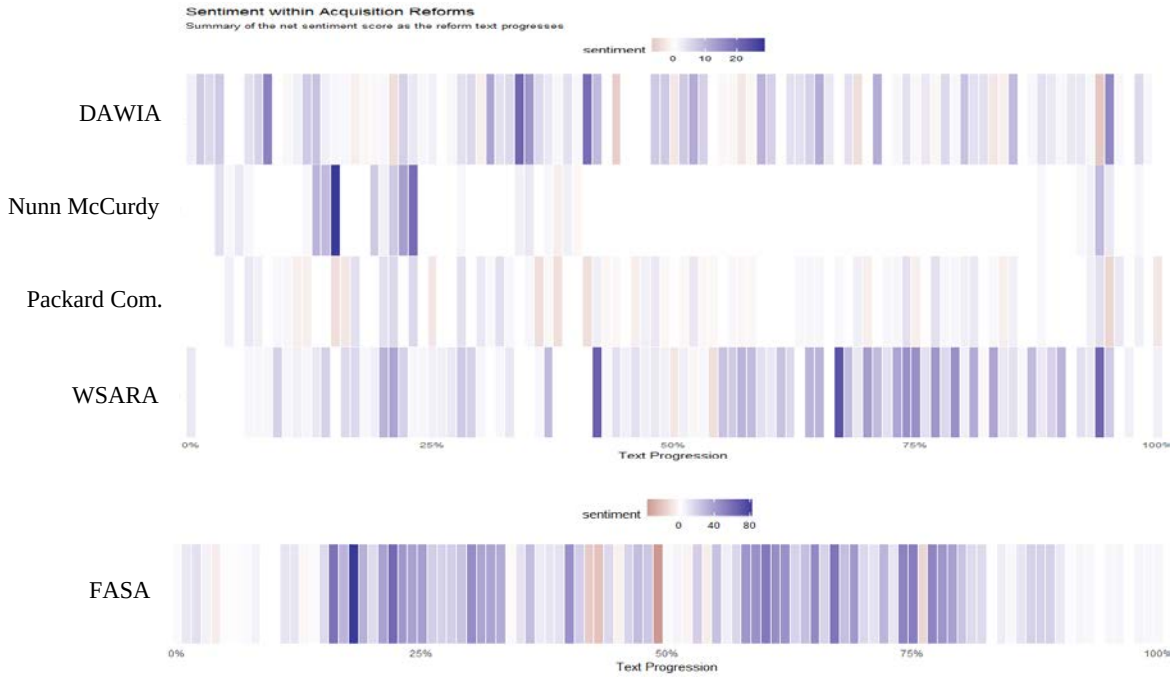

Figure 21: Sentiment Throughout the Progression of Each Reform

Figure 22 displays the sentiment progression through each of the expert's opinions. While Frank Kendall's opinion looks extremely positive, the remainder of the experts all look rather similar, including the four experts (Gansler, Harrison, Lehman, and Morin) who had higher negative sentiment counts than the rest. One interesting item of note is that each of the experts tend to end their opinions on a positive-negative-positive note; something that was lacking in the reform legislation which likely utilize more formal language than the experts.

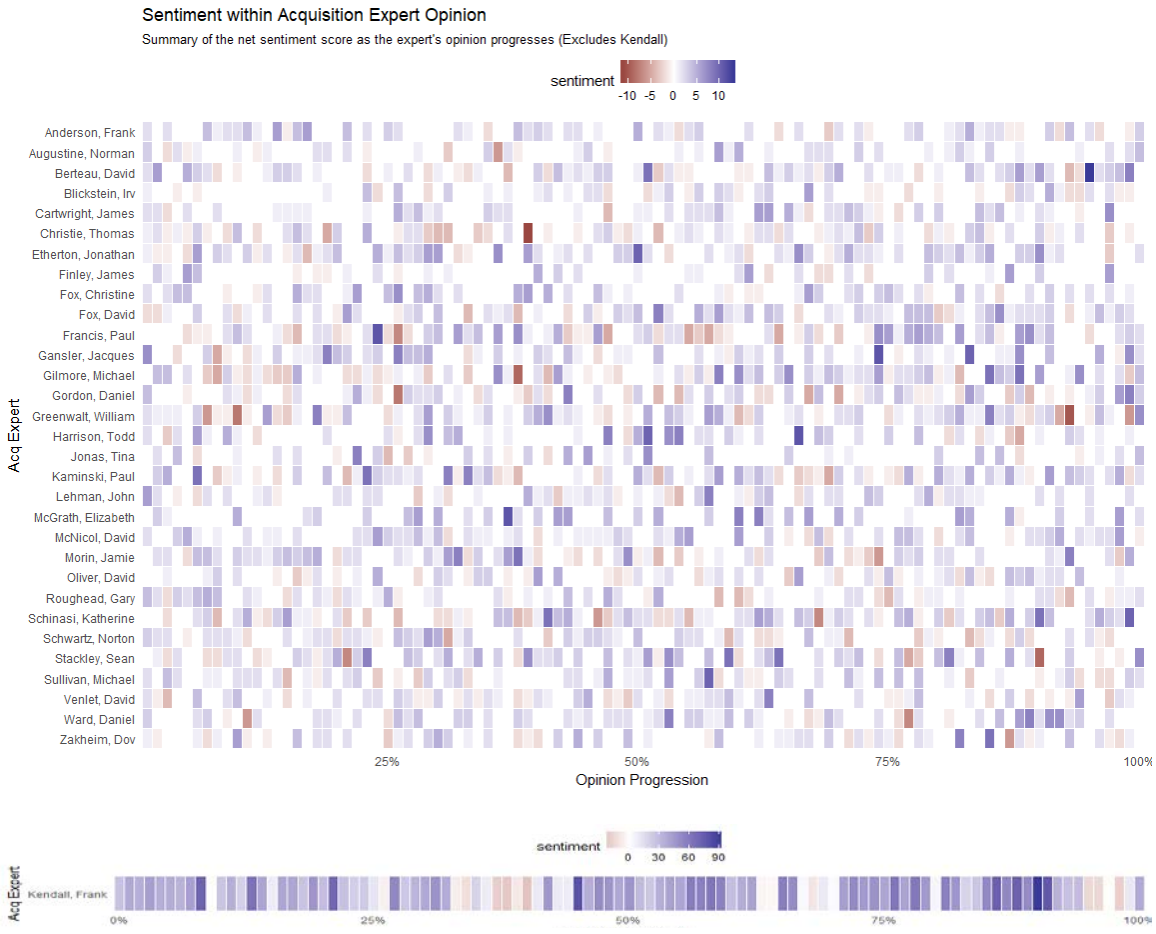

Figure 22: Sentiment Throughout the Progression of Each Expert's Opinion

Another interesting occurrence that we noticed was the presence of either very dark blue (positivity) or very dark red (negativity) segment saturation within several of the expert's opinions, which are identified in Figure 23. By extracting the text associated with each of the segments, we are able to identify what each expert is saying in each of those instances. The "Ultra Negative" or dark red segments, displayed in Table 12, come from four experts. Reading the actual text associated with each segment, it is clear that the experts have a truly negative tone at that time. The only possible exception would be Gilmore, who did use negative language, but was talking about the prevention of loss of life through proper system performance, which may be a positive message.

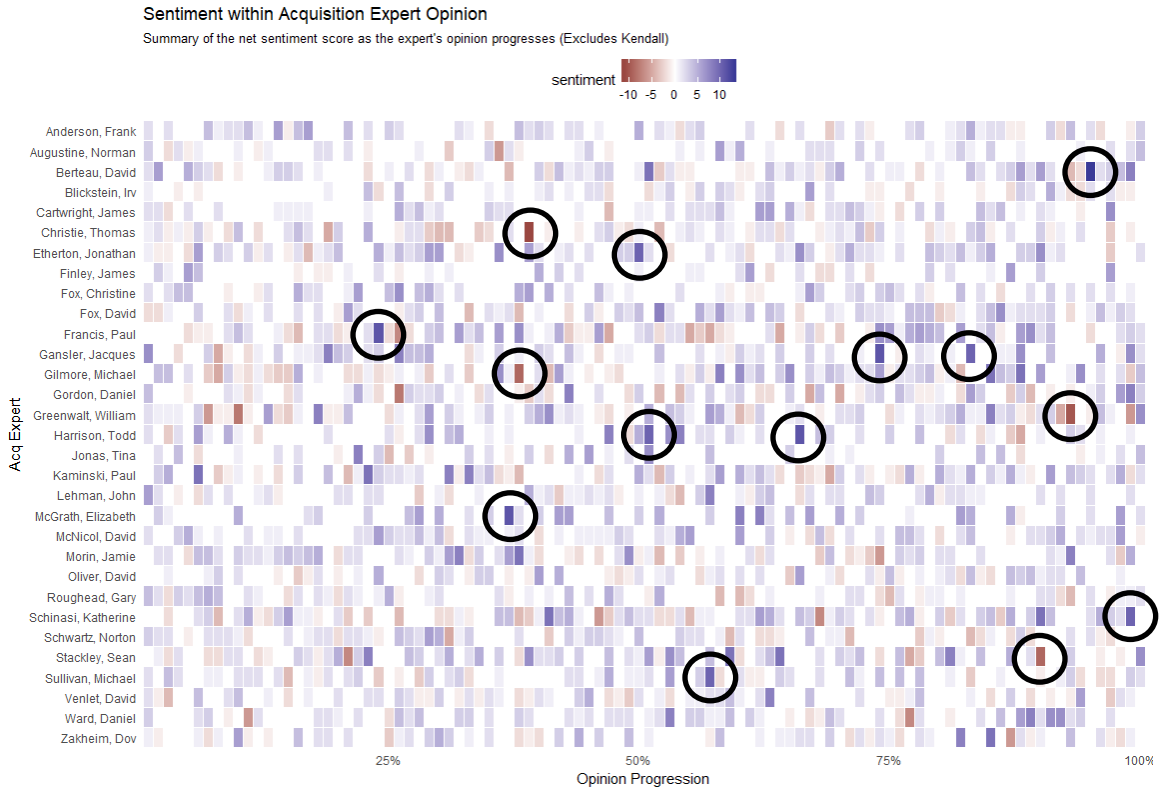

Figure 23: Sentiment Throughout the Progression of Each Expert's Opinion with Identification of Extremely Positive/Negative Sentiment

Table 12: "Ultra Negative" - Dark Red Segments from Sentiment Progression

Expert	Sentiment	Sentence	Text
Christie, Thomas	-11	38	by the time the technical and cost issues finally become known in the current system, few, if any, of those involved initially are still around, and those who are refuse to admit they had been wrong, to cut their losses before the problems worsen, or to discipline the system by making an example of program officials and their contractors who have sold the department and the taxpayers a bill of goods.
Gilmore, Michael	-9	37	the substantive purpose of a test and evaluation program is to characterize system capabilities across the intended operational conditions so that problems with system performance are not discovered at the worst possible time---in combat when lives will be lost if operational performance is not fully understood.
Greenwalt, William	-10	126-127	past reactions to failure and fraud have made success even unlikelier as risk-averse behavior and mind-numbing bureaucratic processes have increased waste and destroyed creativity and innovation. sometimes the best course of oversight action in reaction to the scandal of the day is to not legislate but to ensure that criminals are going to jail and that there is enough flexibility in the system to buy what the warfighter needs.
Stackley, Sean	-9	81	the penalty for too much oversight is ever-increasing costs and impediments to execution that have no ceiling; the penalty for too little oversight is the costs and risks of rework for unforced errors.

The “Ultra Positive” or dark blue segments are listed in Table 13. After examining the text, seven of the 10 segments are clearly positive messages. The first segment in question is from McGrath. The text was a restatement of the original question she was asked in the survey dispersed to each of the experts. The segment itself does utilize positive language, but did not actually include her opinion. The next couple of segments in question are from Harrison. In sentences 35 and 45 he talks about how split

awards can decrease competition later in the life-cycle if there was a considerable amount of learning that occurred, which felt like a mostly negative message. This was likely categorized as positive due to his use of words like “award,” “winner,” “advantage,” and “greater.”

Table 13: "Ultra Positive" - Dark Blue Segments from Sentiment Progression

Expert	Sentiment	Sentence	Text
Berteau, David	13	104-105	it is important to point out problems and to highlight possible corrective actions, but it equally important to highlight successes and progress. congress can do better in this regard, selecting successful programs and managers for constructive oversight attention in hearing, speeches, commentary, and reports.
Etherton, Jonathan	10	51-52	the department should improve requirements development by sustaining centers of expertise in requirements analysis and development, and agencies should ensure that all acquisitions of complex services (e.g., information technology or management) occur only with express advance approval of requirements by the program manager, user, and the contracting officer, regardless of the type of acquisition vehicle used. while some acquisition workforce and cultural reforms may not have enjoyed hoped-for success in the s, others were quite successful.
Francis, Paul	11	35-36	the answers to these questions will not necessarily be found in acquisition policy nor encourage good acquisition practices. while individual participants see their needs as rational and aligned with the national interest, collectively, these needs create incentives for pushing programs and encouraging undue optimism, parochialism, and other compromises of good judgment.
Gansler, Jacques	11	67	there are two required (industrial base) changes:) the removal of the barriers to the dod buying from commercial or foreign firms (when they offer the best value),) the removal of the barriers to firms integrating their commercial and defense operations in the same facilities (in order to gain the cost and performance benefits from the economics of scale of the higher

			volume; and, to gain the performance and cost benefits from the technology transfer between the sectors.
Gansler, Jacques	10	75	when the dod decided to harden their soldiers-carrying vehicles against road-side bombs (the largest killer and maimer of fighting men and women in iraq and afghanistan) they found that the best armor came from israel; the best shock absorbers came from germany; the best tires came from france; and the best design for the undercarriage (against mines) came from south africa.
Harrison, Todd	10	35	if the split in award is large enough (i.e. the winner gets a much larger share) and the learning curve steep enough (i.e. unit costs decline rapidly as more units are built), the company that loses in the first round may never be able to overcome the cost advantage of its competitor in subsequent rounds.
Harrison, Todd	11	45	a lower learning percent means learning happens faster, giving a greater advantage for the company that wins the first round of competition and potentially making competition less effective.
McGrath, Elizabeth	11	22	what steps would you recommend to help ensure that top performers within the acquisition workforce are rewarded for their performance and empowered to manage programs with success?
Schinasi, Katherine	10	178-179	supported by a robust technology process and talented individuals who are rewarded for success. micromanagement has not brought success and will not as long as advocacy is combined with the responsibility for execution.
Sullivan, Michael	10	41	improve program management by attracting, training, and retaining professionals and providing them more rewarding career tracks there have been many acquisition reform studies aimed at the need for improving the program management workforce to achieve improved acquisition outcomes.

Topic Modeling.

Utilizing topic modeling as a Text Mining tool first requires the researcher to know the number of topics that are contained within the data. Since we are using topic modeling with the intention of comparing the results to those of Grounded Theory

(whose guiding principle is let the data derive the theory (Glaser & Strauss, 1967)), for validation purposes, a predetermined knowledge of the topics or number of topics within the data did not exist. For that reason, before the data could be fit to an LDA topic model, the number of topics needed to first be estimated.

The R Programming package *ldatuning* (Nikita, 2016) provides a function to accomplish this. The function uses four metrics to estimate the number of topics, two (Arun2010 [Arun, Suresh, veni, & Murthy, 2010] and CaoJuan2009 [Cao, Xia, Li, Zhang, & Tang, 2009]) of which attempt to optimize by determining the minimum number of topics likely within the data, while the other two (Deveaud2014 [Deveaud, Saniuan, & Bellot, 2014] and Griffiths2004 [Griffiths & Steyyers, 2004]) use maximization. The *ldatuning* function is a time-intensive process, especially when combined with topic modeling, so it is only applied to the data in sets: all data (3+ hours), experts (~13 minutes), reforms (~10 minutes), and for the Grounded Theory subsets Gansler (~5 minute) and WSARA (~5 minute).

Figure 24 displays the *ldatuning* results for the compendium. While the Deveaud2014 metric was not useful in this instance, the remaining three metrics all converged to an optimal number of topics between five and eight. The remaining *ldatuning* results for each of the other subsets of data are located in the Topic Modeling Results at Appendix E, but Table 14 displays the range of expected number of topics for each.

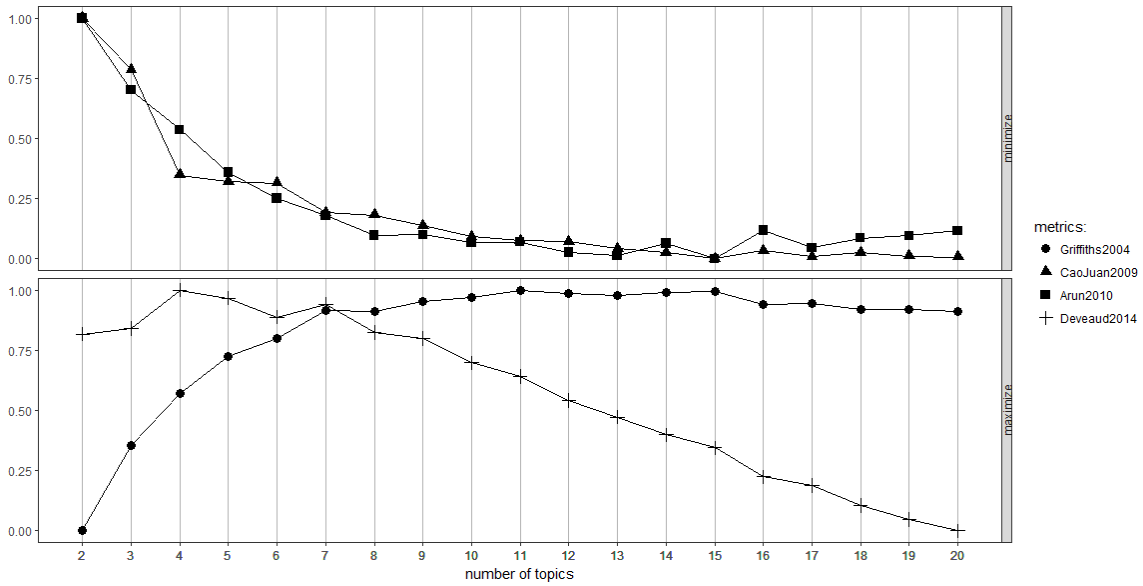

Figure 24: LDA Tuning - Experts (5-8 Topics)

Table 14: Expected Number of Topics Within Data Subsets as Estimated by LDATuning

Subset	**Expected Number of Topics**
All Data	6-10
Compendium	5-8
Reforms	7-9
Gansler	4-8
WSARA	4-6

The R Package *topicmodels* (Grün & Hornik, 2017) contains a function to fit data to an LDA model. As previously mentioned, that function requires prior knowledge about the number of topics that are contained within the data, parameter (k). The range of expected number of topics for each subset, as displayed in Table 14, is used as the input for parameter (k) when fitting the data to an LDA model. For the compendium and reforms, the model displaying the best results, based on the beta probability, happened to

be on the highest range of expected topics, where the beta probability is the likelihood of a word being generated from that topic (Silge et al., 2017).

Words were assigned to the topic buckets based on the probability (beta probability) of that word being contained within that topic. One challenge of this method was that the topic buckets did not contain an automatic classification or categorization, so topic names were subjectively applied retroactively based on the top ten words within each of the buckets. The selection of topic names were applied based on the collective knowledge of individuals currently or previously working in the defense cost analysis field, or currently within education and training arena focusing on defense cost analysis.

From the compendium subset, an eight-topic model was generated (Figure 25). Based on the top ten words within each topic, the following categorizations were assigned: The Defense Acquisition System (DAS), Source Selection as a means of Effective Competition, Cost Risk Analysis, the Requirements and Research, Development, Test and Evaluation (RDT&E) processes, various items that would be found on the Cost Analysis Requirement Document (CARD), MDAP Total Ownership Costs, Proper Use and Management of the Workforce, and Request for Proposals (RFP).

A nine-topic model was generated from the major reforms subset (Figure 26). The topic names retroactively assigned are as follows: Federal Actions and Legislative Terminology, Bureaucracy, the Workforce, Top-Level Management, Contracting Agency Law and Responsibilities, Federal Contracts, Punitive Actions, Program Structure or Work Breakdown Structure (WBS) elements, and MDAP Reporting. Based on these results, one tendency noticed was that some of the topics largely encompassed a single reform. For example, Topic 7 was categorized as “Punitive Actions” which is largely the

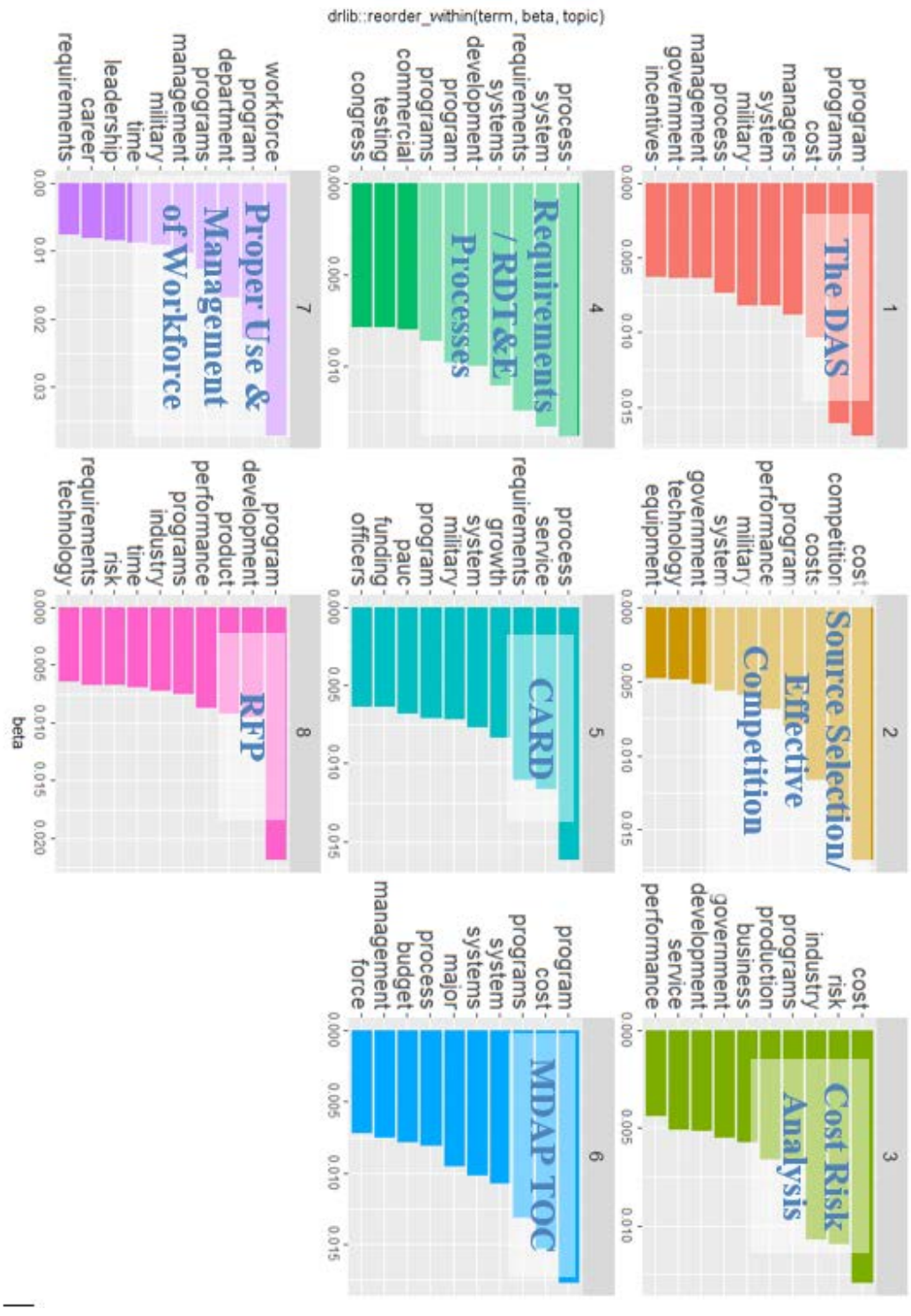

Figure 25: Topic Model Beta Probabilities - Experts (8 Topic)

Figure 26: Topic Model Beta Probabilities - Reforms (9 Topic)

main focus of the Packard Commission. Additionally, Topic 3, categorized at "Workforce" may have been predominantly modeled after DAWIA.

While we see some minor commonalities between the reforms and the compendium, such as talk of the workforce and management, the two subsets appear to be addressing completely different issues. The experts predominantly talk about strategies to improve defense acquisitions, such as source selection and effective competition, and provide areas to focus improvement, such as the requirements and RDT&E processes. Conversely, the reforms seem to address top-level oversight and impose bureaucracies. From this view, it does not appear as if the reforms address the concerns of the experts.

But how well does topic modeling actually represent the major themes of the two subsets? To examine this question, topic modeling is applied to Jacques Gansler's essay, as well as Title II of WSARA, which are the data sets analyzed with the Grounded Theory method. Gansler's opinion is fit to a five-topic model, as shown in Figure 27, and immediately we see variance in the number of topics that emerge (recall from Table 11 that nine topics emerge through the Grounded Theory method). Although, this in itself is not an indication that one method outperforms the other. For instance, several of the less frequently used core categories that emerge through Grounded Theory could potentially be aggregated further than they currently are, reducing the total number of core categories. For example, it may be appropriate to categorize "Analytical Technique," which accounts for only 1.8% of the content, under the "Strategy" category.

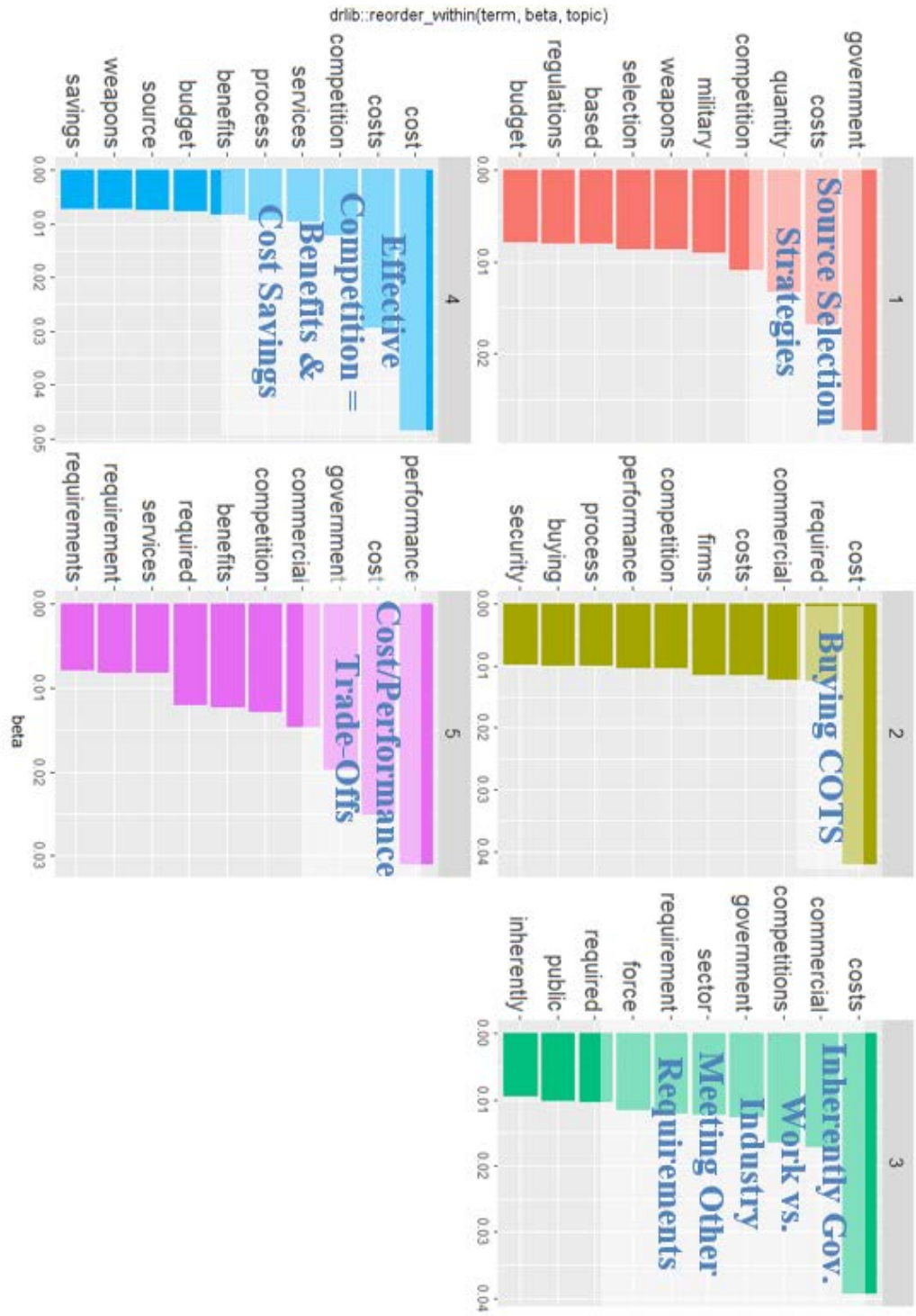

Figure 27: Topic Model Beta Probabilities - Grounded Theory Comparison (Gansler 5 Topic)

Although the topic names assigned to each of the topic model buckets do not necessarily match those derived from the Grounded Theory method, we do see similar content after examining the context of the Grounded Theory results. For example, the Grounded Theory core category "Strategy" encompasses source selection and the use of the best value trade-off approach, which both emerge as themes through topic modeling. In fact, each of the topic modeling categorizations are found within at least one of the Grounded Theory core categories, but the same does not appear evident in reverse, and we especially seem to lose sight of the code families.

Similar to the comparison of Gansler's essay, WSARA initially displays a disparity of topic numbers from the comparison of the topic modeling results to Grounded Theory. While 12 topics were derived through Grounded Theory (Table 10), topic modeling only generates six (Figure 28). Again, there is potential to further aggregate the Grounded Theory results, and the topic modeling results can all be found within the context of the Grounded Theory core categories. But the topic modeling results tend to be much more specific than what was produced through the Grounded Theory method.

In general, the topic models have much less detail and lack the level of context that is possible to achieve using Grounded Theory Design. This research built the topic models at the individual word level, so it may be possible to gain more insight by incorporating bi-gram analysis. Although, the short length of each of the essays in the compendium may skew those results, reflecting the themes more commonly found in the longest document.

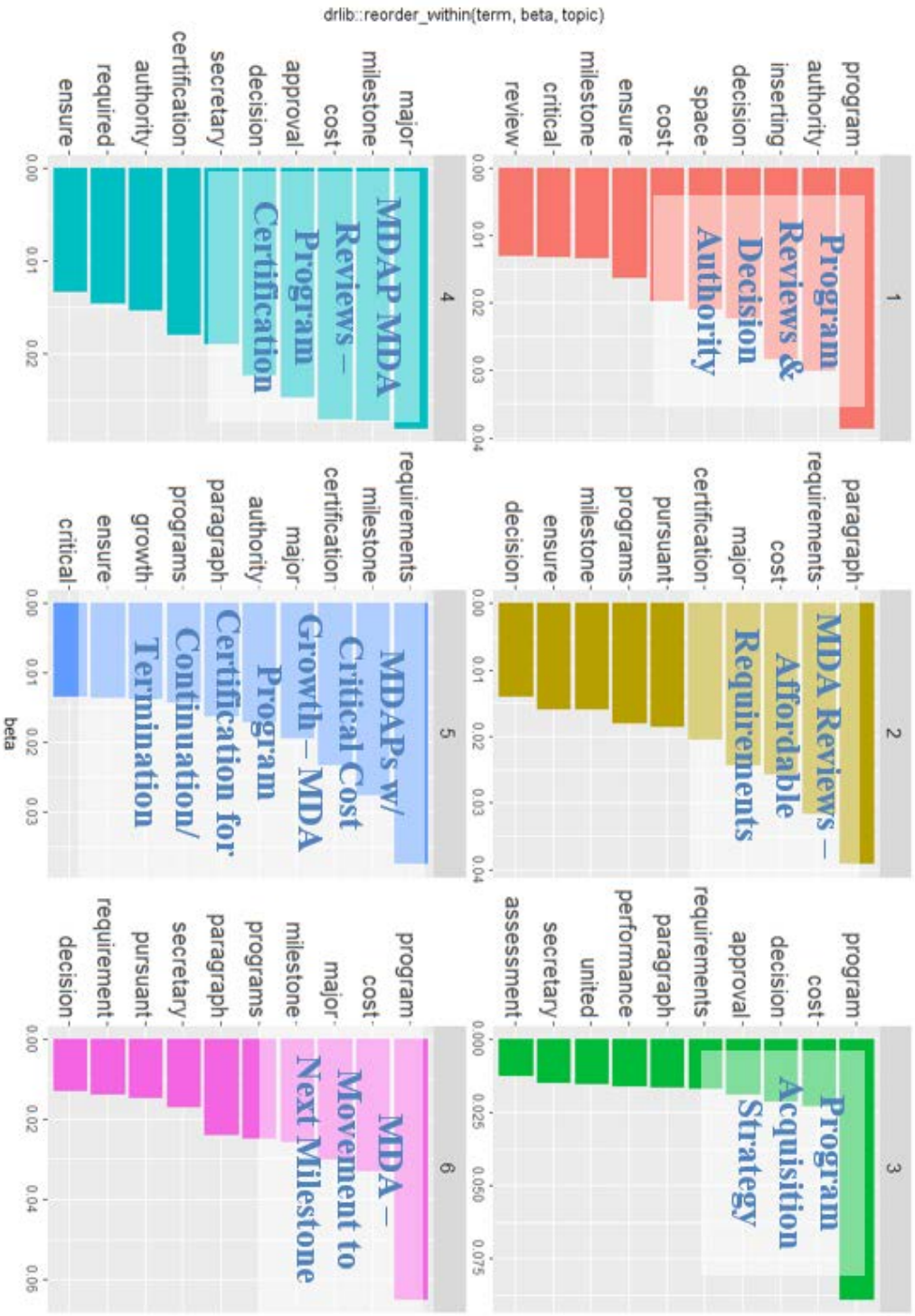

Figure 28: Topic Model Beta Probabilities - Grounded Theory Comparison (WSARA 6 Topic)

Despite the differences (number of emerging topics and level of context available) between the Grounded Theory and topic modeling results, the core topics that emerged from each were very much similar in content. The use of the single-word topic models in conjunction with the other Text Mining analysis, especially the bi-gram maps, do provide adequate insight into document content with much faster results than through Grounded Theory. These results suggest that Text Mining would be an appropriate and more practical alternative to Grounded Theory, especially in an operational environment. Due to the similarities in content, we conclude that the results obtained through the Grounded Theory method validate those of Text Mining.

Summary

This chapter presented the results obtained through the Grounded Theory and various Text Mining methodologies. It began to discuss some of the commonalities and differences between the major reforms in comparison to the expert opinions, between each of the major reforms, and amongst the experts. In Chapter V, the Research Questions are addressed and further discussions, implications, and conclusions are presented.

V. Conclusions and Recommendations

"Cows are exactly the same as they were a million years ago—in a field eating grass—whereas we think that we've improved. But have we?"

- Jeremy Clarkson
The Grand Tour, 2018

In previous chapters we have discussed the current problems with Defense Acquisition cost and schedule growth, a history of acquisition reform, and prior research related to acquisition reforms as well as cost and schedule growth. We have also provided an overview of the Grounded Theory and Text Mining methodologies utilized in this research and discussed the results of the analysis. This chapter addresses the research objective and questions, the significance of the results, and identifies opportunities for future research.

Research Objectives Addressed

The purpose of this research is to identify and analyze trends within past major Defense Acquisition Reform legislation in comparison to a compendium of views from leaders within the Defense Acquisition community on the efficacy of acquisition reform. This analysis is designed to provide insight, not only on where the acquisition process and reforms have been, but on where they should be headed to effectively reduce cost and schedule overruns within MDAPs. To address this objective, this research investigates the following research questions:

Question 1: What are the commonalities and differences of the various major acquisition reforms?

Although the purpose of each major reform is different, several commonalities exist. First, each reform addresses issues as they apply to the contract level, or by management (or agency) responsibility. The reforms also share similar sentiment; the verbiage utilized is largely positive or neutral with very little negativity. In addition, each of the reforms are categorized with the same top three sentiment categories: trust, anticipation, and fear. Considering the formal nature of reform legislation, these similarities are understandable.

They only major differences between the reforms were their intended purposes. Nunn-McCurdy implements thresholds and reporting requirements to limit cost growth. The Packard Commission invokes various punitive actions to combat fraud and abuse. DAWIA addresses improvement of the Defense Acquisition workforce by enforcing experience requirements and education and training standards. FASA attempts to streamline Defense Acquisition by implementing various processes, promoting competitive proposals, conducting market research, and purchasing commercial items. Finally, WSARA further aims to improve Defense Acquisitions by implementing sound systems engineering practices, employing prototype and developmental testing, requiring program evaluations and certification, and detailing the responsibilities of the MDA.

Question 2: What are the commonalities and differences between the reform legislation and the recommendations of the Defense Acquisition Leaders and Experts?

The sentiment of the compendium closely resembles the emotion found in the collection of major reforms. Both use verbiage that is largely positive with very little

negativity. In addition, both are categorized with the same top thee sentiment categories: trust, anticipation, and fear. Other than sentiment, the reforms and expert opinions do not share much in common.

The first noted difference between the two subsets is how they address issues. As indicated in the first research question, the reforms undertake issues at the contract level or by management (or agency) responsibility. This is indicative of a top-down approach when setting policies to solve problems, which often lacks effective implementation. Conversely, the experts tend to discuss the problems at the program level and/or with the DAS interactions with the industrial base; an indication that an intelligent, thoughtful, human-based solution (opposed to more bureaucracy) may be required.

Another considerable difference is the content of the reforms compared to the compendium. Broadly speaking, the major reforms set out to decrease or manage cost growth in one way or another, in addition to their more specific goals. Collectively, the nine themes within the major reforms are Federal Actions, Bureaucracy, Workforce, Top-Level Management, Contracting Agency Law and Responsibility, Federal Contracts, Punitive Actions, Program Structure or Work Breakdown Structure (WBS) Elements, and MDAP Reporting.

The experts, on the other hand, discuss more specifically how we, as personnel in the DAS, can improve the DAS as a whole, subsequently affecting the perpetual issue of cost growth. The eight themes predominant within the compendium are The DAS, Source Selection as a means of Effective Competition, Cost Risk Analysis, the Requirements and Research, Development, Test and Evaluation (RDT&E) processes, various items that would be found on the Cost Analysis Requirement Document (CARD),

MDAP Total Ownership Costs, Proper Use and Management of the Workforce, and Request for Proposals (RFP).

While we see some minor commonalities between the reforms and the compendium, such as discussion of the workforce and management, or even Packard, FASA, & WSASA all suggesting (although not enforcing) to buy commercial when possible, the two subsets do not appear to coincide and in fact address completely different issues. The experts predominantly talk about strategies to improve defense acquisitions, such as source selection and effective competition, and provide areas to focus improvement, such as the requirements and RDT&E processes. Conversely, the reforms seem to address top-level oversight and impose bureaucracies.

So why is it that, despite decades of reform efforts, cost growth continues to "plague" the DAS? Essentially, the reforms do not address the issues identified by the experts. A result which is not surprising and supported by subject matter literature (Eide et al., 2012; Fox, 2011; Jackson, 2011; O'Neil, 2011; Rich et al., 1987; Ritschel, 2012; Schwartz, 2013; and many others) and now backed by textual analysis.

Question 3: What unique insights does Text Mining reveal for new or different root causes of cost and schedule overrun?

Considering our research assumption that the expert's opinions have not changed over time, the identification of "new" root causes may not have been a practical question to ask. What this data is able to show was that the reforms do not address what the experts believe to be the problem. Therefore, looking further into the context of the themes present within the expert compendium, we can identify what the root causes may truly be and find some actionable suggestions.

Utilizing the results of the compendium topic model and the bi-gram network maps, the following problems with the DAS and potential root causes of cost growth are identified: Strategy, the Industrial Base, Risk Management, the Requirements and Research, Development, Test, and Evaluation (RDT&E) Processes, the Workforce, and Cost Estimates and the Planning, Programming, Budget, and Execution (PPBE) Process.

1. *Strategy*: In today's current environment, weapon systems continue to become more and more complex, which requires program managers and decision makers to take careful consideration of the acquisition strategies they use. Two goals that should be focused on are increasing competition and increasing our buying power. Accomplishment of these goals go hand-in-hand since effective competition will draw down costs.

   Most importantly, program managers should be focusing on source selection strategies to enforce competition. Initially beginning with a Request for Proposal (RFP), the DoD should focus more on clearly identifying *what* capabilities and technical parameters need to be met, and let the industrial base determine *how* to accomplish them. Additionally, we rarely require prototypes during the RFP process; the inclusion of prototypes will aid in creating a competitive environment as well as help in the source selection, and potentially result in fewer production issues later in the program.

   During consideration of the Source Selection, program managers have fallen into the habit of using the Lowest Price Technically Acceptable (LPTA) for almost every situation. While LPTA is especially useful for systems with low complexity, using a trade-off or best value approach works best when

more complexity is involved. Additionally, for low-to-no complexity programs, buying commercial off-the-shelf should be taken into consideration.

Other source selection strategies that should be considered are whether to utilize sole sourcing or dual sourcing (split awards), not only in the developmental phase of a program, but throughout the entire life-cycle (system upgrades and modernization). Consideration of dual or sole sourcing, along with the use of modular and open architectures, can help to ensure competition throughout the entire life-cycle of a program as well as ensure the DoD is getting the best price available.

Some final strategic considerations that can help to promote competition and draw down costs are the use of fixed-price contracts when practical, and the enforcement of affordability caps. The selection of effective acquisition strategies will demand a knowledgeable and experienced program manager; it will not likely be able to fit to a "rule-of-thumb." Each situation will require a human thinking about various aspects of the system, and above all, using common sense.

2. *Industrial Base*: The DoD's relationship with the industrial base is important and complicated. To ensure an effective relationship, we should continue to invest in Research and Development, while creating incentives to produce affordable weapon systems. To get a handle on affordability, program offices should be creating competitive source selection environments, evaluate contractor performance, ensure proper contract management, and provide

program stability through the limitation of Engineering Change Requests as well as changes in Rates of Production.

3. *Risk Management*: Risk management and mitigation should encompass all affairs within the control of a program office. To effectively manage risk, it is important to have sound business practices, continuous process improvement, and lessons learned. Program offices should be utilizing evidence-based approaches (i.e. source selection strategies and cost estimation methods), and any analytical tools available to them. Finally, program stability can be achieved through effective program and contract management as well as having accountability measures in place.
4. *Requirements and RDT&E Processes*: The Requirements Definition and RDT&E Processes are extremely important and currently, not conducted in the most effective manner. In the Requirements Definition Process, the DoD tends to put too much emphasis on *how* capabilities should be implemented. To successfully produce an affordable weapon system, we should instead be focusing on properly *defining* the required capabilities and performance parameters while letting the industrial base produce innovative solutions and prototypes. Subsequently, design reviews should be in place to ensure the proposed solution meet the requirements and deliver the necessary capabilities.

    The RDT&E process should follow suit with strong design reviews in place to ensure any required engineering change requests are administered early in the program. Development testing should be implemented on a

regular basis with realistic pass/fail criteria to ensure system reliability and performance. Low rate initial production should be taken advantage of, along with operational testing, to ensure the system can effectively deliver the required capabilities prior to full rate production, mitigating the need for large scale retrofitting.

5. *Workforce*: The Acquisition workforce is talented, intelligent, and well trained and educated, but that is not enough. We need to ensure that the right leaders and managers are in the right place, and that the workforce is utilized appropriately. In addition to proper staffing, our workforce and leaders need to have the ability to progress along defined career paths, are rewarded for excellence, and held accountable for the decisions that are made.
6. *Cost Estimates and PPBE*: Analysts and program managers should ensure to the best of their ability that realistic cost estimates are selected. Often, there is pressure to provide a "more affordable" estimate that will not "kill" a program before it even gets initiated. This usually involves selecting an estimate outside of the "most likely" range which in turn incorporates a significant amount of risk into the program resulting, almost certainly, with cost overruns.

Using a cost estimate that is known to be unrealistic is bad business for Defense Acquisitions and the U.S. Government at a whole. When bad estimates are budgeted for, that budget will ultimately need to be increased at some point in the program life-cycle as cost growth occurs. Funding and resources are scarce, so when one budget is increased, funding for another

program must be decreased, resulting in the loss of capability elsewhere. It is import to remember that it is not just our job to initiate programs, but to ensure that the programs we initiate are affordable.

Question 4: Are incentives, or a lack of incentives, a problem? If so, do the reforms address incentives, and how?

Incentives were not one of the resulting themes after topic modeling the compendium. Three of the experts did discuss incentives frequently enough to result in the top 10 word frequencies (D. Fox and Finley), percentage word frequencies (D. Fox, Finley, and Francis), or the bi-gram networks (D. Fox and Francis); see the Exploratory analysis Results at Appendix C. Francis, however, has the only expert essay to result in a high enough tf-idf score for incentives to be considered a word of importance. According to his bi-gram network, when Francis speaks on the subject it is in the context of "creating incentives." Additionally, Francis discusses the "industrial base" and "private firms," so there may be some compatibility in the usage of these terms with incentives. Since, collectively, incentives were not a topic of interest among the experts, it was not surprising to see that the major reforms did not appear to address the subject in any significant manner.

Question 5: How well do the results of Text Mining coincide with the results of grounded theory?

Text Mining was able to provide similar, although not identical, results in comparison to those of Grounded Theory. A researcher performing Grounded Theory analysis is able to establish groupings of information to identify the core themes present within a document or collection of documents; a well-established and trusted method

(Glaser et al., 1967). This process, however, is extremely time consuming and impractical when dealing with large data sets. Text Mining, although it did not provide identical results, did provide much faster (days compared to weeks) insight into the content of the data.

Topic modeling, in combination with the bi-gram and sentiment analyses, provides adequate contextual insight, proving Text Mining to be a useful substitute to Grounded Theory. The topic model results were much more specific than the general core categories identified through the Grounded Theory method. For example, we see results such as "Source Selection Strategies" and "Buying Commercial Off-the-Shelf," opposed to the core themes derived through Grounded Theory, such as "Modernization" or "Affordability." Considering the specificity of the topic modeling results, it is especially useful for distinguishing topics of interest from the data set, although it may be more difficult to identify the higher-level themes.

Another advantage of using topic modeling, other than its speed and ease of use, is that less bias goes in to identifying the topics contained within the data, since the topics are mathematically determined based on an LDA model. Although, some bias may be unavoidable when the researcher labels or categorizes the resulting topic model buckets. Considering the advantages of both methods, this research concludes that Text Mining may be more beneficial and more practical to use in daily operations, especially considering that in today's current environment, knowledge gained is invaluable and time saved can be utilized in much more crucial situations. In summary, due to the similarities in content, we conclude that the results obtained through the Grounded Theory method validate those of Text Mining.

Significance of Research

This research concludes two important points: first, the use of various Text Mining methods produces sufficient insight into the content of textual data at a speed that greatly outperforms the "old fashioned way," while also being relatively easy to implement. Second, this research provided additional evidence to verify the current literature's claim that past Defense Acquisition reforms have not been able to sufficiently address the root causes of cost growth, and at best address only the symptoms.

It is recommended that future legislative authors heed the advice of the Acquisition experts and leaders who have many years of experience, wisdom, and tales of program success and failure. We do not need additional bureaucracy, but rather program managers and decision makers to fully consider the nature and uniqueness of individual programs when selecting acquisition strategies. The response to our third research question, regarding the unique insights that Text Mining reveals about the root causes of cost growth, identifies a full range of the issues identified by the experts and provides relatively actionable suggestions.

Opportunities for Future Research

While the results of this research provided sufficient insight into the content of the major reforms and expert compendium, there are additional areas that may be worth examining in future research efforts. For instance:

1. What commonalities are found in the recommendations from leaders of a certain "type"?

2. Apply topic modeling to the individual reforms and individual expert essays to extract the themes relevant to the individual documents.
3. Apply stemming or lemmatization to the data to see if the results, especially the word and bi-gram counts, to see if any additional clarity within the results can be identified.
4. Provide a more in-depth comparison of the Grounded Theory method to the results of topic modeling.
5. Apply Text Mining methods more frequently within Defense Acquisition research.

Bibliography

Aaron, R. D. (1983). *The Cost Growth Problem: A Realistic Diagnosis and Solution.* Naval Postgraduate School. Retrieved from http://www.dtic.mil/docs/citations/ADA131082

Amestoy, P., Azzalini, A., Badic, T., Benison, G., Bowman, A., BÃ¶hm, W., … Yang, C. (2017). Package "igraph" - Network Analysis and Visualization. Retrieved from https://cran.r-project.org/web/packages/igraph/igraph.pdf

Arun, R., Suresh, V., Veni Madhavan, C. E., & Narasimha Murthy, M. N. (2010). On Finding the Natural Number of Topics with Latent Dirichlet Allocation: Some Observations (pp. 391–402). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-13657-3_43

AcqNotes, (). *Defense Acquisition Life Cycle*. Retrieved from http://www.acqnotes.com/wp-content/uploads/2014/09/Acquisition-System.png

AFIT Data Science Lab. (2017). Dealing with Regular Expressions. Retrieved August 9, 2017, from https://afit-r.github.io/regex

Bache, S. M., & Wickham, H. (2016). Package "magrittr" - A Forward-Pipe Operator for R. Retrieved from https://cran.r-project.org/web/packages/magrittr/magrittr.pdf

Brown, G. E. (2017). Measuring the Increasing Relevance of Cost Estimating Through Text Analytics. *ICEAA World Magazine*, (2), 32–33. Retrieved from http://www.iceaaonline.com/ready/wp-content/uploads/2017/08/IW2017-2web.pdf

Cancian, M. F. (2010). Cost Growth: Perception and Reality. *Defense Acquisition University*. Retrieved from http://www.dtic.mil/docs/citations/ADA523912

Cao, J., Xia, T., Li, J., Zhang, Y., & Tang, S. (2009). A density-based method for adaptive LDA model selection. *Neurocomputing*, *72*(7–9), 1775–1781. https://doi.org/10.1016/J.NEUCOM.2008.06.011

DAG. (2017). Chapter 1: Program Management. In *Defense Acquisition Guidebook*. Defense Acquisition University. Retrieved from https://www.dau.mil/guidebooks/Shared Documents/Chapter 1 Program Management.pdf

DAU. (n.d.). Cost Growth-Defense Acquisition Glossary. Retrieved August 4, 2017, from https://dap.dau.mil/glossary/pages/1684.aspx

Deveaud, R., Sanjuan, É., & Bellot, P. (2014). Accurate and effective latent concept modeling for ad hoc information retrieval. *Lavoisier*, *17*(1), 61–84. https://doi.org/10.3166

DoD Directive 5000.01. (2007). US Department of Defense. Retrieved from http://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/500001p.pdf

DoD Instruction 5000.02. (2017). US Department of Defense. Retrieved from http://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500002_dodi_2015.pdf

Dusa, Adrian. (2007). User manual for the QCA(GUI) package in R. *Journal of Business Research*, *60*(5), 576--586. Retrieved from https://cran.r-project.org/web/packages/QCA/QCA.pdf

Eide, P. K., & Allen, C. D. (2012). The More Things Change, Acquisition Reform Remains the Same. *ARJ*, *19*(1), 99–120. Retrieved from http://www.dau.mil

Feldman, R. (2013). Techniques and applications for sentiment analysis. *Communications of the ACM*, *56*(4), 82. https://doi.org/10.1145/2436256.2436274

Feldman, R., & Sanger, J. (2006). *The Text Mining Handbook*. Cambridge University Press. Retrieved from https://wtlab.um.ac.ir/images/e-library/text_mining/The Text Mining HandBook.pdf

Fellows, I. (2015). Package "wordcloud." Retrieved July 28, 2017, from https://cran.r-project.org/web/packages/wordcloud/wordcloud.pdf

Fox, J. R. (2011). Defense Acquisition Reform 1960-2009: An Elusive Goal. Center of Military History, U.S. Army. Retrieved from http://history.defense.gov/Portals/70/Documents/acquisition_pub/CMH_Pub_51-3-1.pdf

Freeman, C. E. (2013). *Multivariate and Naive Bayes Text Classification Approach to Cost Growth Risk in Department of Defense Acquisition Programs*. Air Force Institute of Technology. Retrieved from http://www.dtic.mil/docs/citations/ADA583708

Giacomazzi, III, M. P. (2007). *An Analysis of the Impact of Defense Acquisition Reforms and External Factors on Schedule Growth of Defense Weapon Systems*. Air Force Institute of Technology. Retrieved from http://www.dtic.mil/docs/citations/ADA467540

Glaser, B. (2010). Grounded Theory is the study of a concept! Retrieved August 24, 2017, from https://www.youtube.com/watch?v=OcpxaLQDnLk&t=196s

Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Hawthorn, NY: Aldine Publishing Company.

Griffiths, T. L., & Steyvers, M. (2004). Finding scientific topics. *Proceedings of the National Academy of Sciences of the United States of America*, *101 Suppl 1*(suppl 1), 5228–35. https://doi.org/10.1073/pnas.0307752101

Grimes, S. (2007). A Brief History of Text Analytics. Retrieved July 24, 2017, from http://www.b-eye-network.com/view/6311

Grün, B., & Hornik, K. (2017). Package "topicmodels." Retrieved from https://cran.r-project.org/web/packages/topicmodels/topicmodels.pdf

Grün, B., & Hornik, K. (2011). topicmodels : An R Package for Fitting Topic Models. *Journal of Statistical Software*, *40*(13), 1–30. https://doi.org/10.18637/jss.v040.i13

Goulding, C. (2000). Grounded Theory Methodology and Consumer Behaviour, Procedures, Practice and Pitfalls. *Advances in Consumer Research*, *27*(1), 261–266. Retrieved from http://eds.b.ebscohost.com.afit.idm.oclc.org/eds/detail/detail?vid=16&sid=b935f3f1-672a-4fab-a4ee-462c4829e3fa%40sessionmgr101&bdata=JnNpdGU9ZWRzLWxpdmU%3D#AN=6688096&db=bth

Grolemund, G., & Wickham, H. (2017). *R for Data Science* (First Edition). O'Reilly. Retrieved from http://r4ds.had.co.nz/index.html

Holbrook, M. A. (2003). *An Analysis of the Implementation of Acquisition Reform Initiatives and Contract Cost Variance*. Air Force Institute of Technology. Retrieved from http://www.dtic.mil/docs/citations/ADA414994

Holton, Judith A., P. (2010). The Coding Process and Its Challenges. *Grounded Theory Review*, *9*(1), 21–40. Retrieved from http://groundedtheoryreview.com/2010/04/02/the-coding-process-and-its-challenges/

Jackson, R. A. (2011). Acquisition Reform as Performance Art: Re-forming Acquisition Reform. *Defense AT&L*, *Nov-Dec*, 25–27. Retrieved from http://www.dtic.mil/docs/citations/AD1016048

Johnson, J. S. (2015). Qualitative sales research: an exposition of grounded theory. *Journal of Personal Selling & Sales Management*, *35*(3), 262–273. https://doi.org/10.1080/08853134.2014.954581

Kirk, J. Van, & Monarch, I. (2008). Mapping Acquisition Requirements from Capabilities in a Net-Centric Enterprise – Creating a Capabilities Engineering Framework. In *NDIA 11th Annual Systems Engineering Conference, 10/20-23* (pp. 8, 15). Carnegie Mellon University. Retrieved from http://www.dtic.mil/ndia/2008/systems/7444vankirk.pdf

Layton, E. (2007). *Training Professionals for the Acquisition Workforce, 1992-2003*. Ft Belvoir VA. Retrieved from http://www.dtic.mil/docs/citations/ADA483328

Losiewicz, P., Oard, D. W., & Kostoff, D. N. (2003). *Science and Technology Text Mining Basic Concepts*. Rome, NY. Retrieved from http://www.dtic.mil/docs/citations/ADA415886

Manuj, I., & Pohlen, T. L. (2012). A reviewer's guide to the grounded theory methodology in logistics and supply chain management research. *International Journal of Physical Distribution & Logistics Management*, *42*(8/9), 784–803. https://doi.org/10.1108/09600031211269758

McGee, T. (2017). How Millennials Are Changing Retail Patterns. Retrieved August 24, 2017, from https://www.forbes.com/sites/tommcgee/2017/01/23/the-rise-of-the-millennial/#4aef0cdb5f74

Merrow, E. W. (1983). *Cost Growth in New Process Facilities*. Retrieved from https://www.rand.org/content/dam/rand/pubs/papers/2005/P6869.pdf

Merrow, E. W., Phillips, K. E., & Myers, C. W. (1981). *Understanding Cost Growth and Performance Shortfalls in Pioneer Process Plants*. Retrieved from https://www.rand.org/content/dam/rand/pubs/reports/2006/R2569.pdf

Miller, T. P. (2012). *Acquisition Program Problem Detection Using Text Mining Methods*. Air Force Institute of Technology. Retrieved from http://www.dtic.mil/docs/citations/ADA557568

Mitchell, E. (2017). GOP chairman to unveil defense acquisition reforms in mid-May. *The Hill*. Retrieved from http://thehill.com/policy/defense/331590-gop-chairman-to-unveil-defense-acquisition-reforms-in-mid-may

Neuwirth, E. (2015). Package "RColorBrewer" - ColorBrewer Palettes. Retrieved from https://cran.r-project.org/web/packages/RColorBrewer/RColorBrewer.pdf

Nicholas, J. M., & Steyn, H. (2017). Project Execution, Monitoring, and Control. In *Project Management for Engineering, Business and Technology* (5th ed., p. 412). Routlegde.

Nikita, M. (2016). Package “ldatuning.” Retrieved from https://cran.r-project.org/web/packages/ldatuning/ldatuning.pdf

Nikita, M. (2016). Select number of topics for LDA model. Retrieved from https://cran.r-project.org/web/packages/ldatuning/vignettes/topics.html

O’Neil, W. D. (2011). Cost Growth in Major Defense Acquisition: Is there a Problem? Is there a Solution? *Defense Acquisition University*. Retrieved from http://www.dau.mil

Patten, M. L. (2009). Patten 2009 Qualitative.pdf. In *Understanding Research Methods* (Seventh, p. 19). Pyrczak Publishing.

Peck, M. J., & Scherer, F. M. (1962). *The Weapons Acquisition Process: An Economic Analysis*. Boston: Division of Research, Graduate School of Business Administration, Harvard University.

Pedersen, T. L. (2018). Package “ggraph” - An Implementation of Grammar of Graphics for Graphs and Networks. Retrieved from https://cran.r-project.org/web/packages/ggraph/ggraph.pdf

Piko, L. M. (2014). Discovering Glaser: My Experience of Doing Grounded Theory. *Grounded Theory Review, 13*(2), 47–55. Retrieved from http://eds.b.ebscohost.com.afit.idm.oclc.org/eds/detail/detail?vid=12&sid=b935f3f1-672a-4fab-a4ee-462c4829e3fa%40sessionmgr101&bdata=JnNpdGU9ZWRzLWxpdmU%3D#AN=102559399&db=bth

Pope, J. K. (1997). *Measuring the Effect of the Defense Acquisition Workforce Improvement Act.* Monterey CA. Retrieved from http://www.dtic.mil/docs/citations/ADA331749

PSU Department of Statistics Online Programs. (2017). Intervention Analysis. In *STAT 510 Applied Time Series Analysis*. The Pennsylvania State University, Eberly College of Science. Retrieved from https://onlinecourses.science.psu.edu/stat510/node/76

Rich, M. D., & Dews, E. (1987). *Thoughts on Reforming the Military Acquisition Process*. Santa Monica. Retrieved from https://www.rand.org/content/dam/rand/pubs/papers/2006/P7352.pdf

Ritschel**,** J.D. (2012). “Efficacy of U.S. Legislation in Military Acquisition Programs: Nunn-McCurdy Act Unveiled,” *Economic Papers: A journal of applied economics and policy*, 31: 491-500.

Ritschel, J. D., Lucas, B. M., White, E. D., & Mrla, D. (Pending Publication 2019). The Impact of WSARA on the Cost of Air Force Weapon Systems. *Journal of Public Procurement*.

Riposo, J., McKernan, M., & Kaihoi Duran, C. (2014). *Prolonged Cycle Times and Schedule Growth in Defense Acquisition: A Literature Review*. Retrieved from https://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR455/RAND_RR455.pdf

Robinson, D. (2017). Package "drlib." Retrieved February 26, 2018, from https://github.com/dgrtwo/drlib

Schwartz, M. (2013). *Twenty-five Years of Acquisition Reform: Where Do We Go From Here?* Retrieved from www.crs.gov

Schwartz, M. (2014). *Reform of the Defense Acquisition System*. Washington D.C. Retrieved from www.crs.gov

Searle, D. A. (1997). *The Impact of the Packard Commission's Recommendations on Reducing Cost Overruns in Major Defense Acquisition Programs*. Air Force Institute of Technology. Retrieved from http://www.dtic.mil/docs/citations/ADA329942

Serbu, J. (2017, January 18). In final speech, DoD acquisition chief knocks congressional reforms as unhelpful. *Federal News Radio*. Retrieved from https://federalnewsradio.com/defense/2017/01/final-speech-dod-acquisition-chief-knocks-congressional-reforms-unhelpful/

Silge, J., & Robinson, D. (2017). *Text Mining with R*. Retrieved from http://tidytextmining.com/index.html

Silge, J., Robinson, D., De Queiroz, G., & Keyes, O. (2018). Package "tidytext" - Text Mining using "dplyr", "ggplot2", and Other Tidy Tools. Retrieved from https://cran.r-project.org/web/packages/tidytext/tidytext.pdf

Smirnoff, J. P. (2006). *The Impact of Economic Factors and Acquisition Reforms on the Cost of Defense Weapon Systems*. Air Force Institute of Technology. Retrieved from http://www.dtic.mil/docs/citations/ADA450067

Smirnoff, J. P., & Hicks, M. J. (2008). The impact of economic factors and acquisition reforms on the cost of defense weapon systems. *Review of Financial Economics*, *17*(1), 3–13. https://doi.org/10.1016/J.RFE.2007.02.005

USD(AT&L). (2015). Better Buying Power. Retrieved September 13, 2017, from http://bbp.dau.mil/

USD(AT&L). (2016). *Performance of the Defense Acquisition System: 2016 Annual Report*. Washington, DC. Retrieved from http://www.acq.osd.mil/fo/docs/Performance-of-Defense-Acquisition-System-2016.pdf

U.S. Senate Congressional Records. (1969). *Blank Check for the Military*. Monday, March 10, 1969. Retrieved from https://www.gpo.gov/fdsys/pkg/GPO-CRECB-1969-pt5/pdf/GPO-CRECB-1969-pt5-2.pdf

Waller, J., Bower, K. M., Spence, M., & Kavanagh, K. F. (2015). Using grounded theory methodology to conceptualize the mother-infant communication dynamic: Potential application to compliance with infant feeding recommendations. *Maternal & Child Nutrition*, *11*(4), 749–760. https://doi.org/10.1111/mcn.12056

Wickham, H., Chang, W., & RStudio. (2016). Package "ggplot2." Retrieved from https://cran.r-project.org/web/packages/ggplot2/ggplot2.pdf

Wickham, H., Hester, J., Chang, W., RStudio, & R Core team. (2018). Package "devtools." Retrieved from https://cran.r-project.org/web/packages/devtools/devtools.pdf

Wickham, H., & RStudio. (2017). Package "stringr" - Simple, Consistent Wrappers for Common String Operations. Retrieved from https://cran.r-project.org/web/packages/stringr/stringr.pdf

Wickham, H., & RStudio. (2017). Package "tidyverse." Retrieved from https://cran.r-project.org/web/packages/tidyverse/tidyverse.pdf

Wiesche, M., Jurisch, M. C., Yetton, P. W., & Krcmar, H. (2017). Grounded Theory Methodology in Information Systems Research. *MIS Quarterly*, *41*(3), 685-A9. Retrieved from http://eds.b.ebscohost.com.afit.idm.oclc.org/eds/detail/detail?vid=3&sid=b935f3f1-672a-4fab-a4ee-462c4829e3fa%40sessionmgr101&bdata=JnNpdGU9ZWRzLWxpdmU%3D#AN=124643931&db=bth

Williams, K., King, J., & Fox, J. R. E. (2016). Sense of self and anorexia nervosa: A grounded theory. *Psychology and Psychotherapy: Theory, Research and Practice*, *89*(2), 211–228. https://doi.org/10.1111/papt.12068

Witten, I. H. (2003). *Text mining*. Hamilton, New Zealand. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.74.3588&rep=rep1&type=pdf

Yu, C. H., Jannasch-Pennell, A., & Digangi, S. (2011). *The Qualitative Report Compatibility between Text Mining and Qualitative Research in the Perspectives of Grounded Theory, Content Analysis, and Reliability Recommended, 16*(3), 730–744. Retrieved from http://nsuworks.nova.edu/tqr

Zeihan, P. (2014). *The Accidental Superpower: The Next Generation of American Preeminence and the Coming Global Disorder* (First Edition). New York, NY: Twelve Hachette Book Group.

Appendix A: Data Sources

Table 15: Sources of Major Reform Legislation

Name	**Nunn-McCurdy**
Document	95 Stat. 1099 - Department of Defense Authorization Act, 1982
Date	01 Dec 1981
Excerpt	Pages 31-35
Source	GPO
URL	https://www.gpo.gov/fdsys/granule/STATUTE-95/STATUTE-95-Pg1099/content-detail.html
Name	**Nunn-McCurdy Amendment**
Document	10 U.S. Code § 2433 - Unit cost reports
Date	
Excerpt	n/a
Source	Cornell Law
URL	https://www.law.cornell.edu/uscode/text/10/2433
Name	**Packard Commission**
Document	A Quest for Exellence - Final Report to the President by the President's Blue Ribbon Commission on Defense Management
Date	30 Jun 1986
Excerpt	Pages 41-111: CH 3 Acquisition Organization and Procedures & CH 4 Government-Industry Accountability
Source	DTIC
URL	http://www.dtic.mil/docs/citations/ADA170887
Name	**DAWIA**
Document	10 U.S. Code Ch. 87 - Defense Acquisition Workforce
Date	18 Sep 2013
Excerpt	n/a
Source	OSD AT&L
URL	http://www.acq.osd.mil/se/docs/dawia.pdf
Name	**FASA**
Document	Pub. L. 103-355 - Federal Acquisition Streamlining Act of 1994
Date	13 Oct 1994
Excerpt	n/a
Source	Congres.gov
URL	https://www.congress.gov/bill/103rd-congress/senate-bill/1587/text

Name	**WSARA**
Document	Public Law 111 - 23 - Weapon Systems Acquisition Reform Act of 2009
Date	22 May 2009
Excerpt	n/a
Source	GPO
URL	https://www.gpo.gov/fdsys/pkg/PLAW-111publ23/content-detail.html

Table 16: Sources of Compendium of Views

Document	**Testimony of the Honorable James I. Finley**
Date	29 April 2008
Excerpt	Pages 1-9
Source	House.gov
URL	https://democrats-oversight.house.gov/sites/democrats.oversight.house.gov/files/migrated/20080429104038.pdf
Document	**Defense Acquisition Reform: Where do we go from here?**
Date	02 Oct 2014
Excerpt	Pages 5-199
Source	GPO
URL	https://www.gpo.gov/fdsys/granule/CPRT-113SPRT90719/CPRT-113SPRT90719/content-detail.html
Document	**Getting Defense Acquisition Right**
Date	01 Jan 2017
Excerpt	Pages 1-216
Source	DTIC
URL	http://www.dtic.mil/docs/citations/AD1024390

Appendix B: Data Dictionary

This Data Dictionary describes aspects of the data used throughout this research. The following information is included:

1. Metadata associated with each observation, including the data type and a brief description with possible values (Table 17)
2. Descriptions of how each acquisition expert was classified by "Type" (Table 18)
3. Listing of each Acquisition Expert classified by "Type" (Table 19). NOTE: each expert may be assigned to one or more "Types"
4. Listing of the R Packages used to accomplish the Text Mining portion of the analysis (Table 20)
5. Common Acquisition Words and Legislative Terminology that were removed from various portions of the analysis (Table 21)
6. Negation Words for Sentiment Analysis (Table 22)

In addition, the full source code used to execute the textual analysis for research can be obtained at: https://github.com/AFIT-R/TextMining-Thesis

Table 17: Description of Metadata

Variable	Type	Description
DOCUMENT	factor	The title of the original document
DATE	date	The document's date of publication
CLASS1	factor	Indicated either a REFORM or Opinion COMPENDIUM
CLASS2	logical	Indicates TRUE if Reform Amendment or Appendix, FALSE otherwise

NAME	factor	The common name of the Acquisition Reform or the Name of the Expert giving opinion
SOURCE	factor	Original source of the document
URL	chr string	Source web address
EXCERPT	chr string	Portion of the original document to be analyzed, specified by either page or line numbers
BIO	chr string	Biography of the Expert providing an opinion, if available. Equals "n/a" if CLASS1 does not equal to COMPENDIUM
TYPE	Factor	The “type” of the Expert providing an opinion: JOINT CHIEFS, INDUSTRIAL BASE, RESEARCH & EDUCATION, USD(AT&L), or EXECUTIVE SERVICE. Equals "n/a" if CLASS1 does not equal to COMPENDIUM
NOTES	chr string	Any notes or comments that the researcher put into the document
TXT	chr string	The portion of the original document to be analyzed

Table 18: Acquisition Expert "Type" Descriptions

Type	Description
Joint Chiefs	Includes individuals who have served on the Joint Chiefs of Staff during their military career
Industrial Base	Includes the Defense Industry, Public Industry, and Private Acquisitions
Research & Education	Includes Defense Research, the GAO, RAND Corp., the IDA, Public Policy, Industrial Base Policy, Procurement Policy/Law, the Center for Strategic and Budgetary Assessments, the Center for Strategic Studies, and the Center for Strategic and International Studies
USD(AT&L)	Includes any position equivalent to the current USD(AT&L) structure: USD(AT&L), USD(Acquisition), USD(Acquisition & Technology)
Executive Service	Includes Service Secretaries, Service Assistant Secretaries, Members of Congress, DoD Operational Test & Evaluation (DOT&E), CAPE, CAIG, OSD(Comptroller), CFO FBI, Federal Strategy and Operations, DOD Chief Management Officer, OSD(PA&E), Secretary of the Air Force for Financial Management and Logistics, and the Deputy Secretary of Defense.

Table 19: Acquisition Expert "Type" Classifications

Expert	Type
Anderson, Frank J.	Executive Service, Research & Education
Augustine, Norman R.	Industrial Base
Berteau, David J.	Executive Service, Industrial Base, Research & Education
Blickstein, Irv	Research & Education
Cartwright, James	Joint Chiefs, Research & Education
Christie, Thomas P.	Executive Service, Research & Education
Etherton, Jonathan	Executive Service
Finley, James I.	USD-AT&L
Fox, Christine	Executive Service, Research & Education
Fox, J. Ronald	Executive Service, Research & Education
Francis, Paul	Research & Education
Gansler, Jacques S.	Research & Education, USD-AT&L
Gilmore, J. Michael	Executive Service
Gordon, Daniel I.	Industrial Base, Research & Education
Greenwalt, William C.	Executive Service, Industrial Base, Research & Education
Harrison, Todd	Research & Education
Jonas, Tina W.	Executive Service, Industrial Base
Kaminski, Paul G.	USD-AT&L
Kendall, Frank III	USD-AT&L
Lehman, John F.	Executive Service
McGrath, Elizabeth	Executive Service
McNicol, David L.	Executive Service, Research & Education
Morin, Jamie	Executive Service
Oliver, David	Industrial Base, USD-AT&L
Roughead, Gary	Joint Chiefs
Schinasi, Katherine	Research & Education
Schwartz, Norton A.	Joint Chiefs
Stackley, Sean J.	Executive Service
Sullivan, Michael J.	Executive Service
Venlet, David J.	Executive Service
Ward, Daniel	Executive Service
Zakhrim, Dov	Executive Service, Industrial Base, Research & Education

Table 20: Negation Words for Sentiment Analysis

Negation Words			
Not	No	Never	Without

Table 21: R Packages Used for Textual Analysis

Package	Usage
devtools	Collection of package development tools
Ggraph	Additional graphs for use with igraph
igraph	Network graphs for mapping word relationships
ldatuning	Estimation/tuning of LDA model parameter (k)
magrittr	Pipe Operator for efficient code
stringr	Text cleaning and regular expressions
tidyverse	Data manipulation & plotting INCLUDES: ggplot2, tibble, tidyr, readr, purrr, dplyr
tidytext	Provides additional Text Mining functions
topicmodels	Fitting data to LDA model (Gibbs)
RColorBrewer	Additional color palettes for graphs and charts
wordcloud	Plots word clouds using text data
drlib	From GitHub: dgrtwo/drlib. "Just a few utilities;" such as *'reorder_within()'*

Table 22: Common Acquisition Words and Legislative Terminology

Acquisition Words		
Acquisition	Defense	DoD
Legislative Terminology		
Title	Section	Shall
Amended	Pub	Subsec
Div	Chapter	Subtitle
u.s.c.	Subsection	Sec
e.g.	Req	Jan
Oct	Nov	Dec
II	III	Vii
Ve	Viii	Xii
htp://uscode.house.gov/view.xhtml?req=granuleid%3AUSC-prelimtitle10-chapter87&saved=%7CKHRpdGxlOjEwIH		

Appendix C: Text Mining - Exploratory Analysis Results

Appendix C Table of Contents

1. Word Clouds

Figure 1: Word Cloud - All Compendium

Figure 2: Word Cloud - All Reforms

2. Word Counts

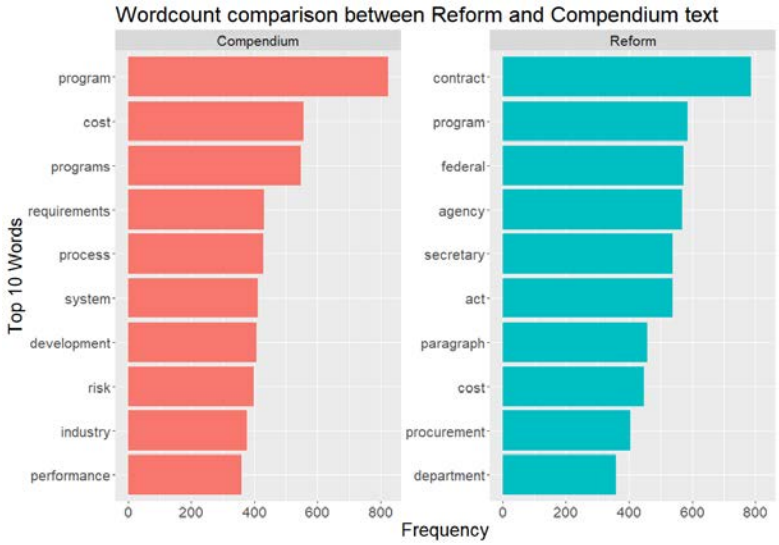

Figure 3: Word Count Comparison - Compendium vs. Reforms

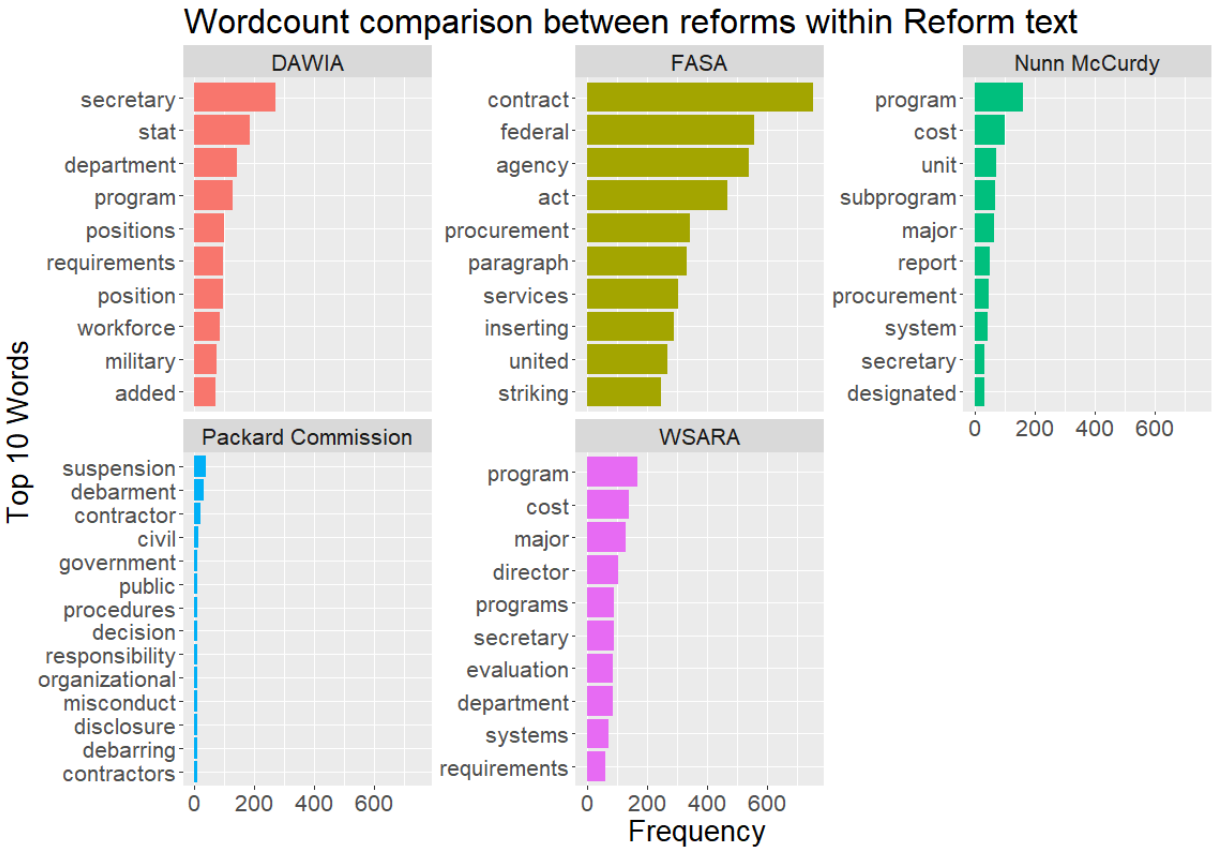

Figure 4: Wordcount Comparison - Between Reforms

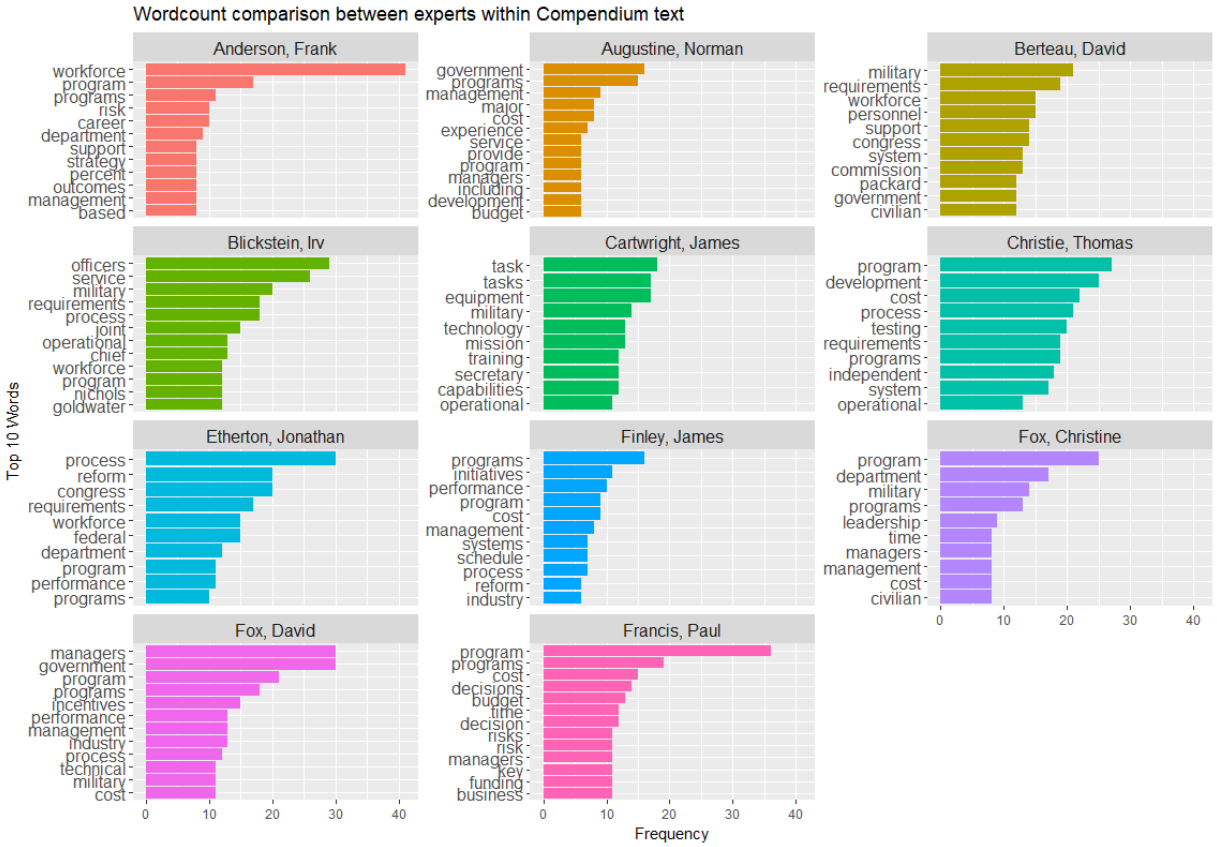

Figure 5: Wordcount Comparison - Experts A-F

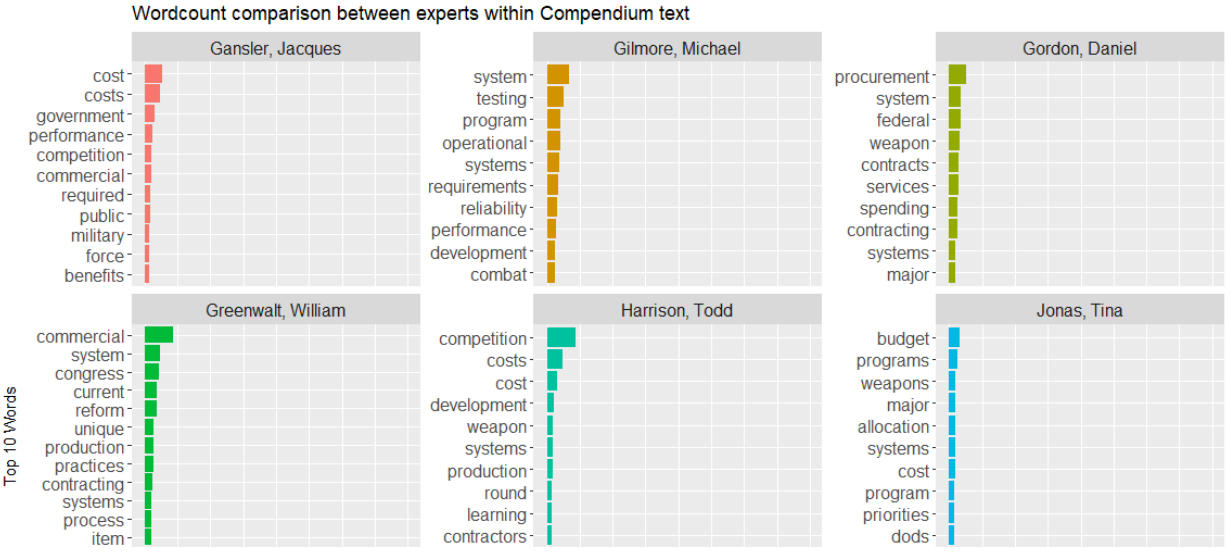

Figure 6: Wordcount Comparison - Experts G-J

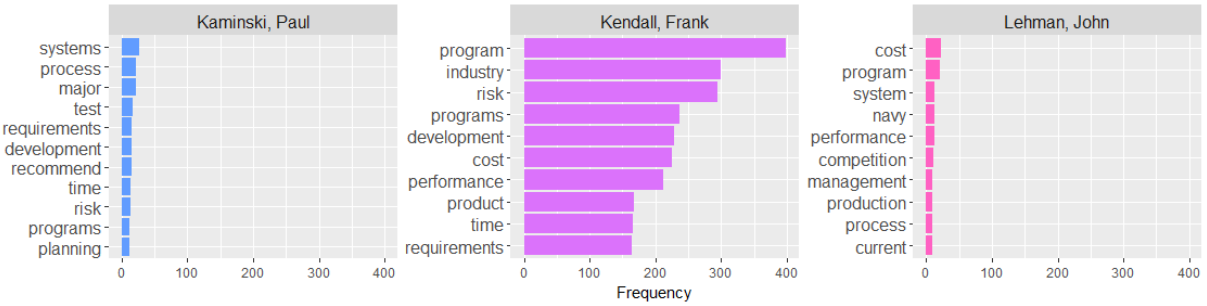

Figure 7: Wordcount Comparison - Experts K-L

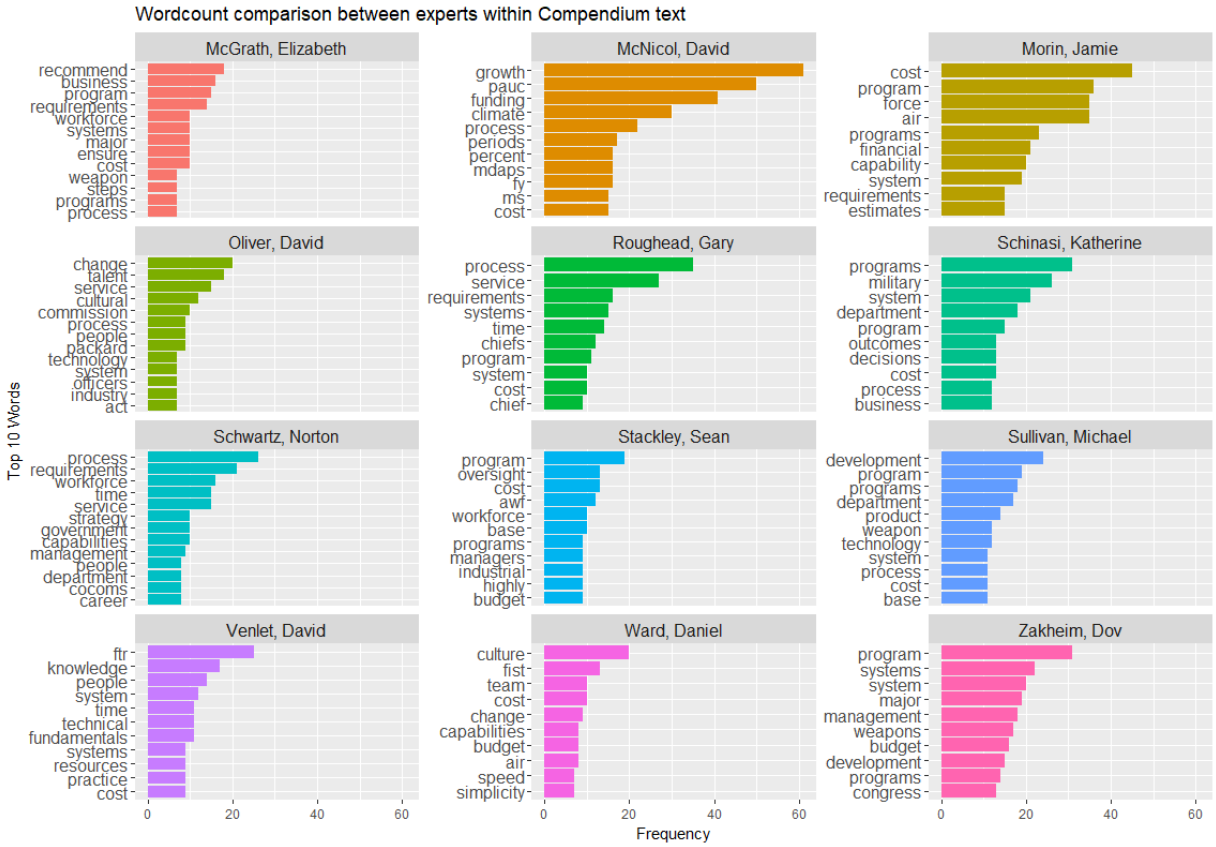

Figure 8: Wordcount Comparison - Experts M-Z

3. Word Relationships

a. Bigram Counts

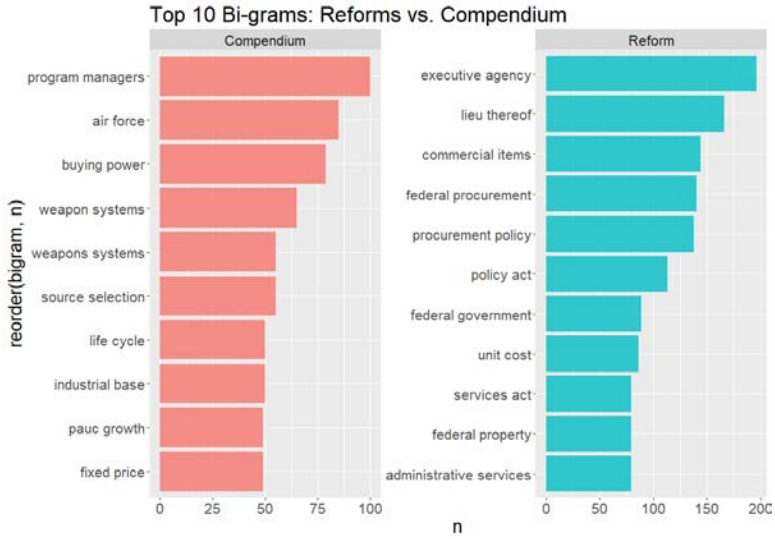

Figure 9: Bigram Count Comparison - Reforms vs. Compendium

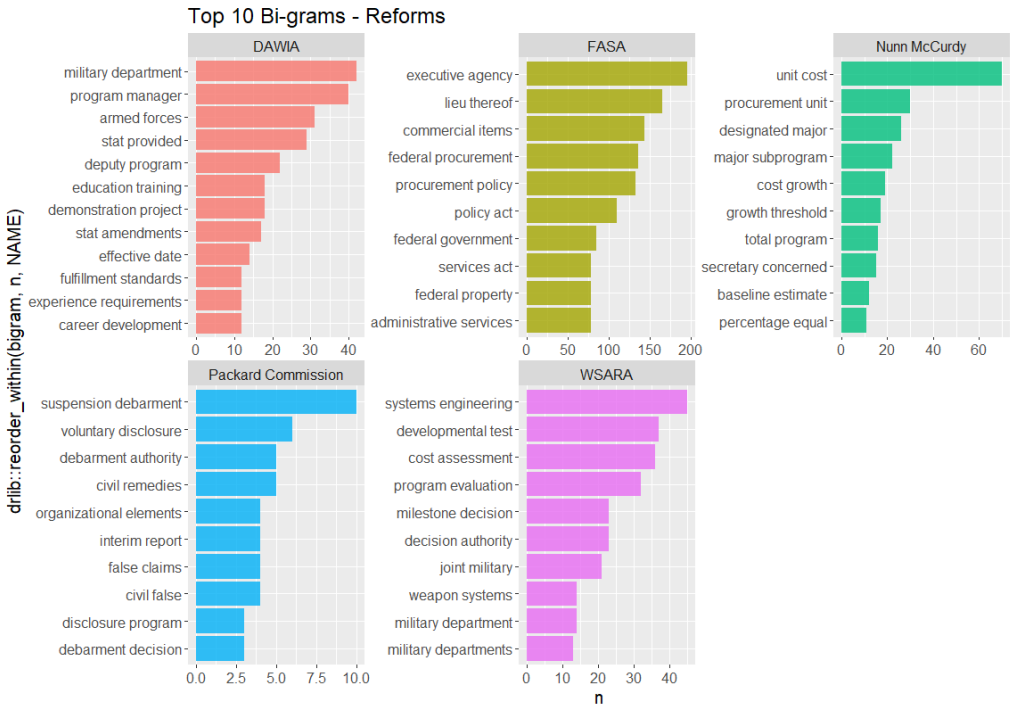

Figure 10: Bigram Count Comparison - Reforms

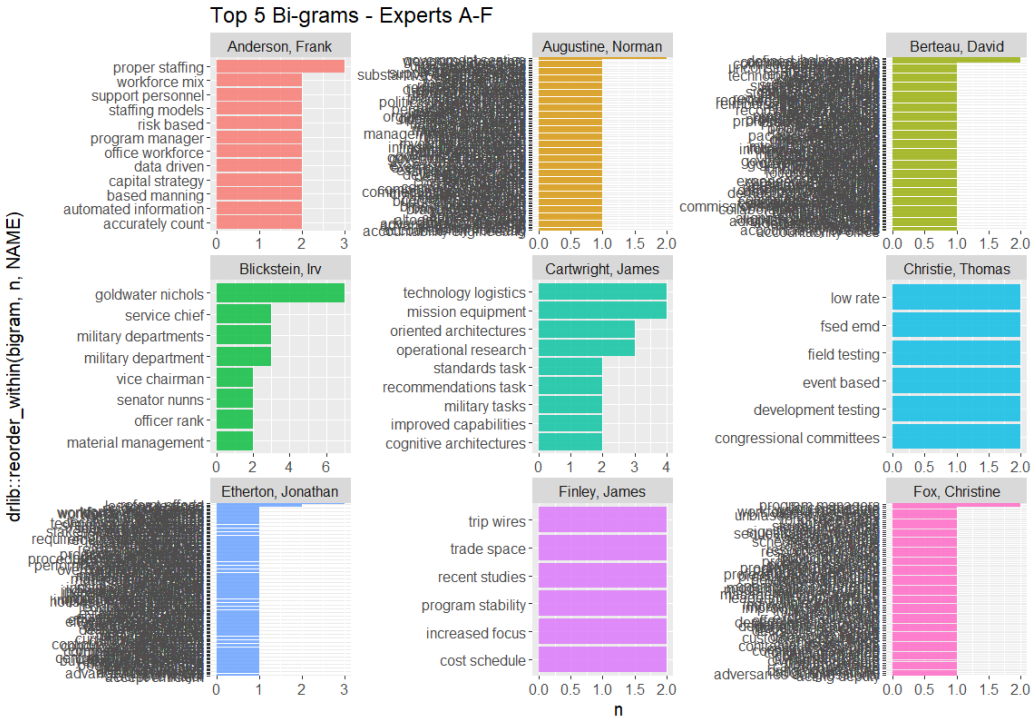

Figure 11: Bigram Count Comparison - Experts A-F

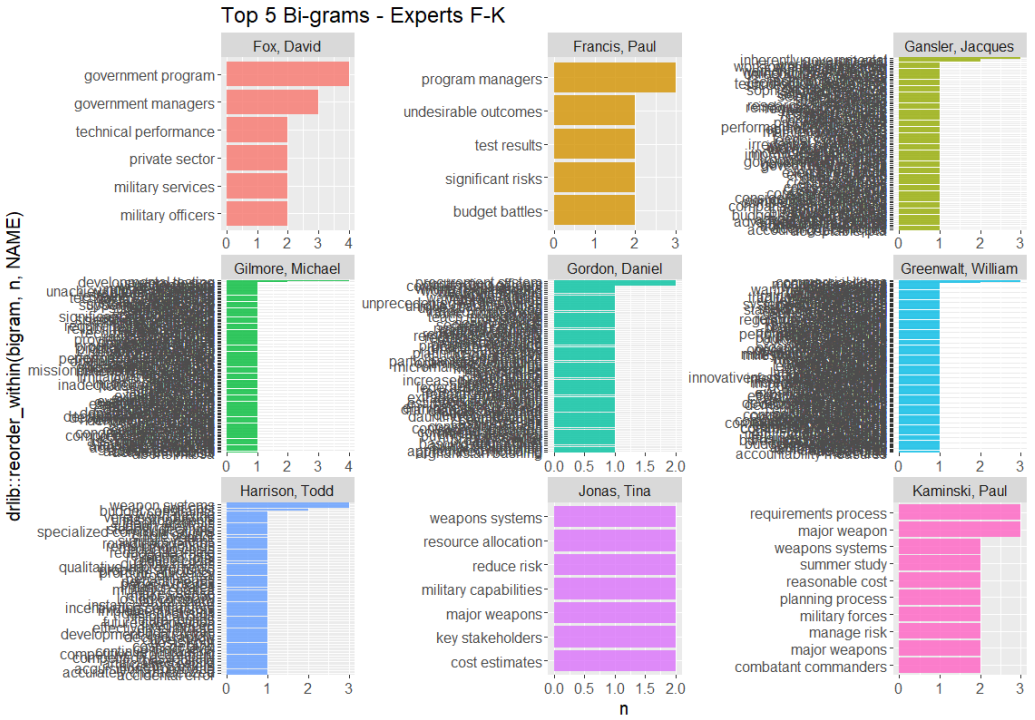

Figure 12: Bigram Count Comparison - Experts F-K

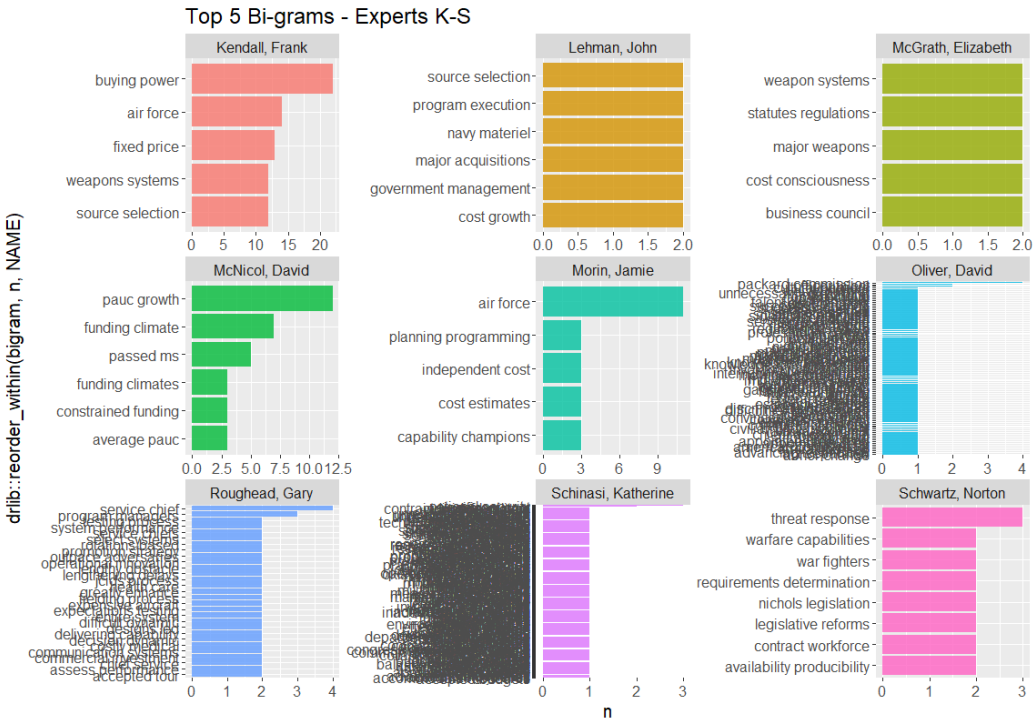

Figure 13: Bigram Count Comparison - Experts K-S

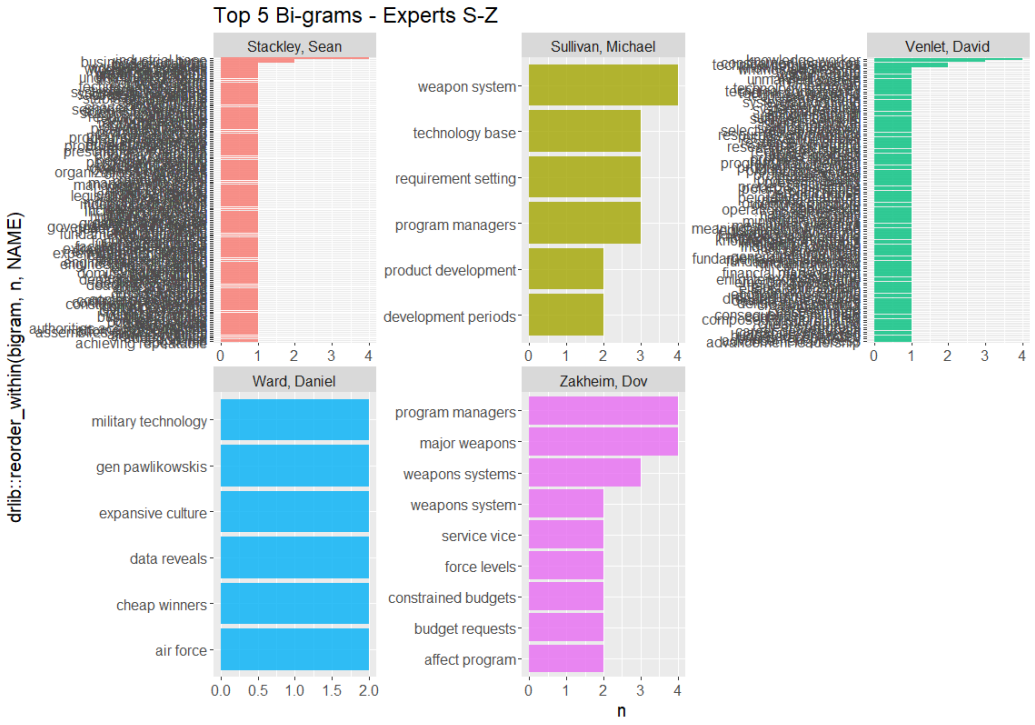

Figure 14: Bigram Count Comparison - Experts S-Z

b. Bigram Networks

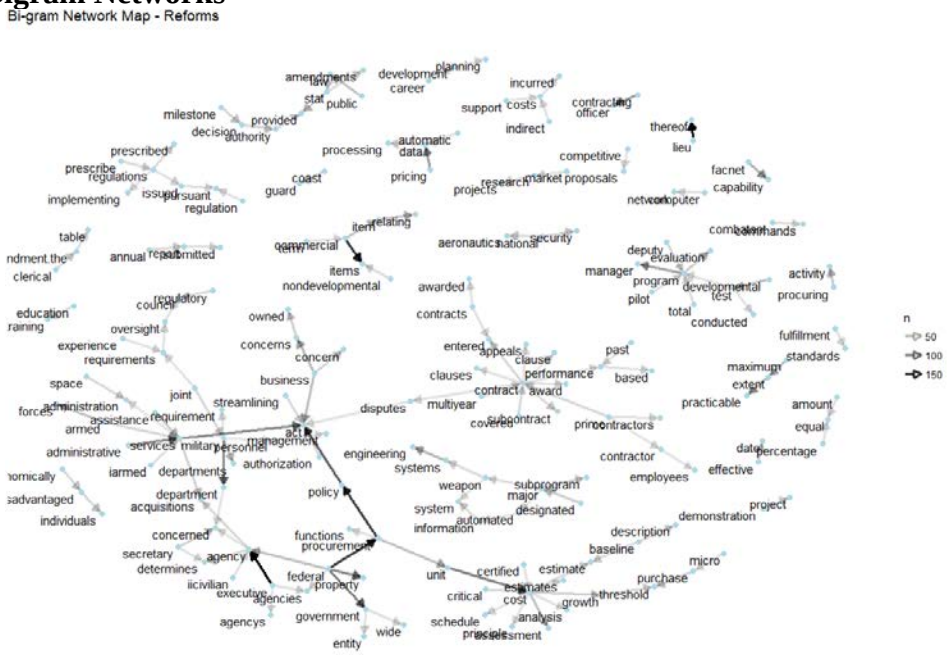

Figure 15: Bi-Gram Network - All Reforms

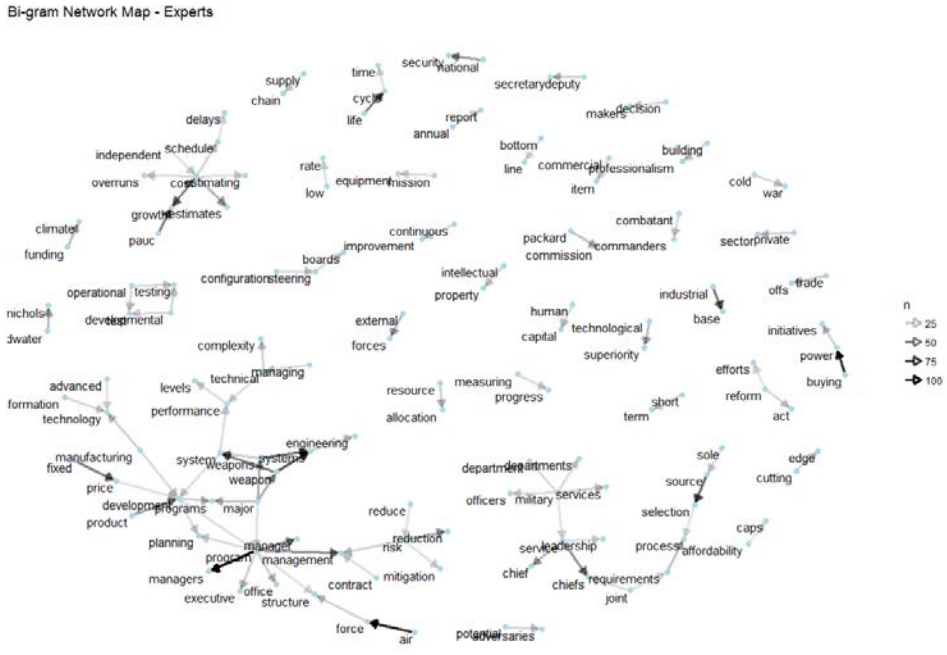

Figure 16 Bi-Gram Network - All Compendium

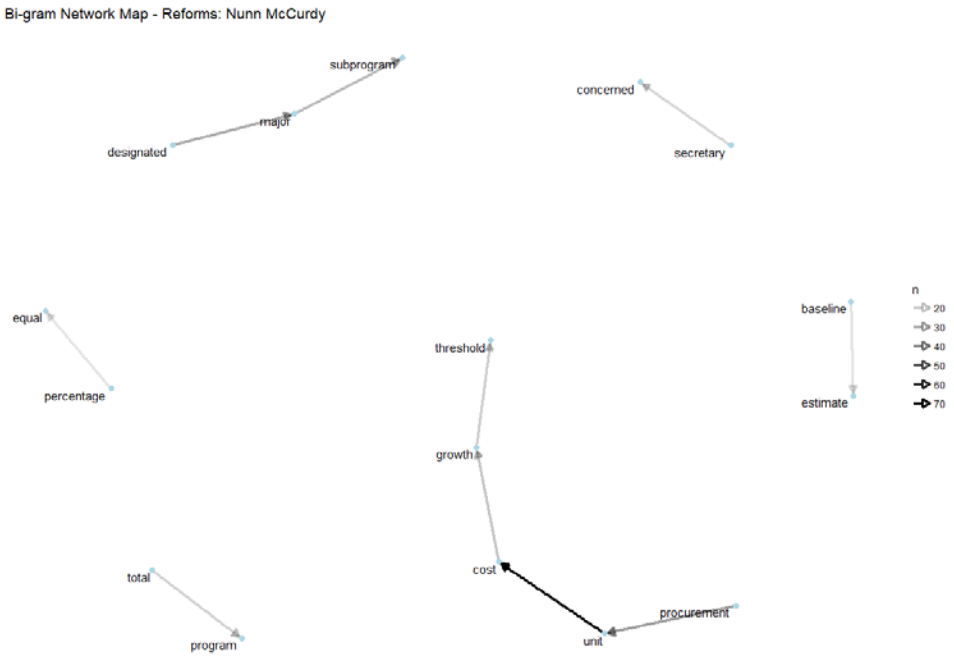

Figure 17: Bi-Gram Network - Reform: Nunn McCurdy

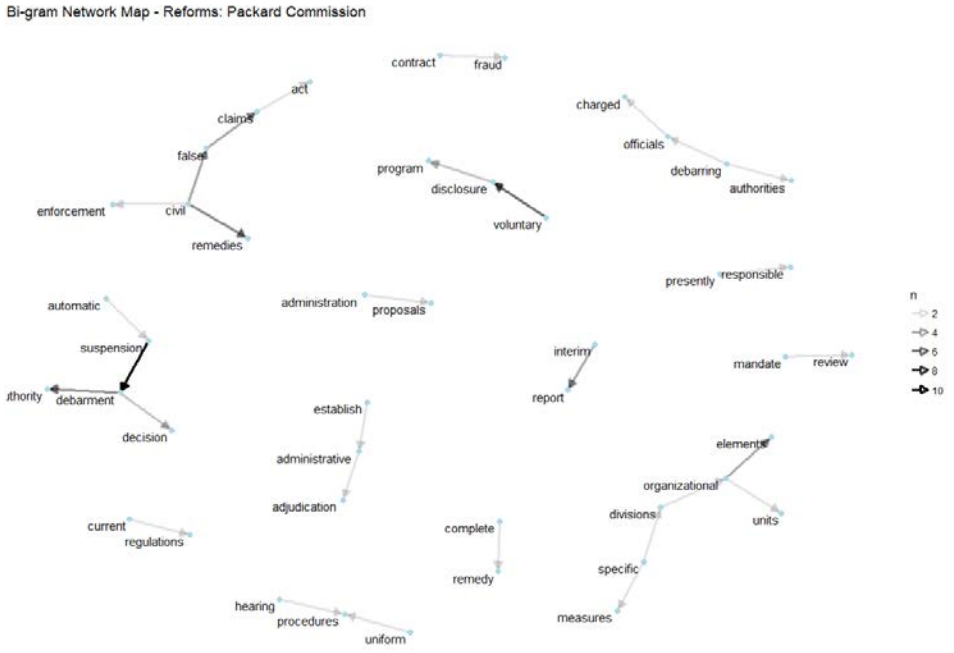

Figure 18: Bi-Gram Network - Reform: Packard Commission

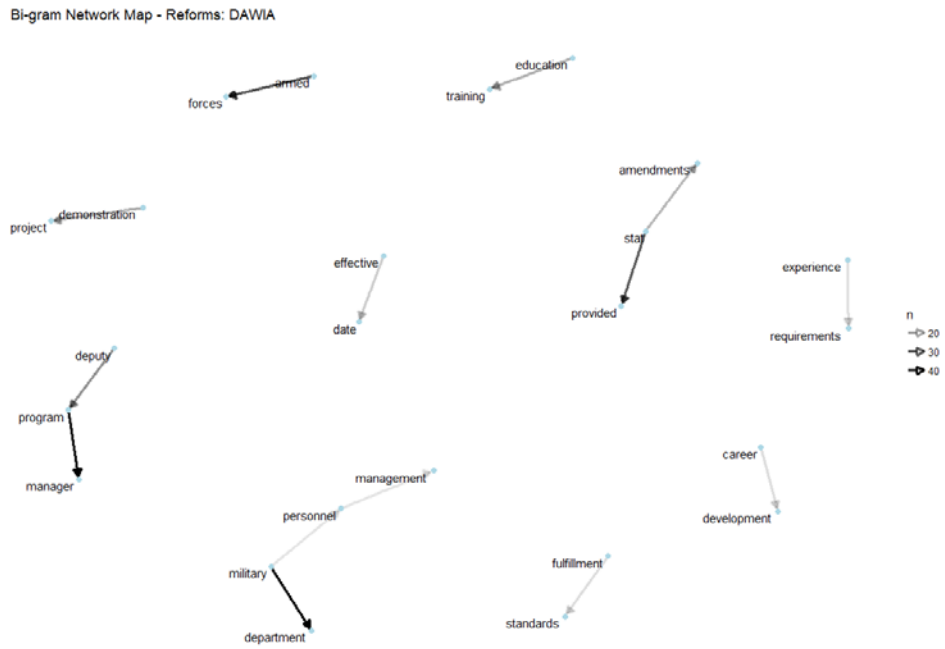

Figure 19: Bi-Gram Network - Reform: DAWIA

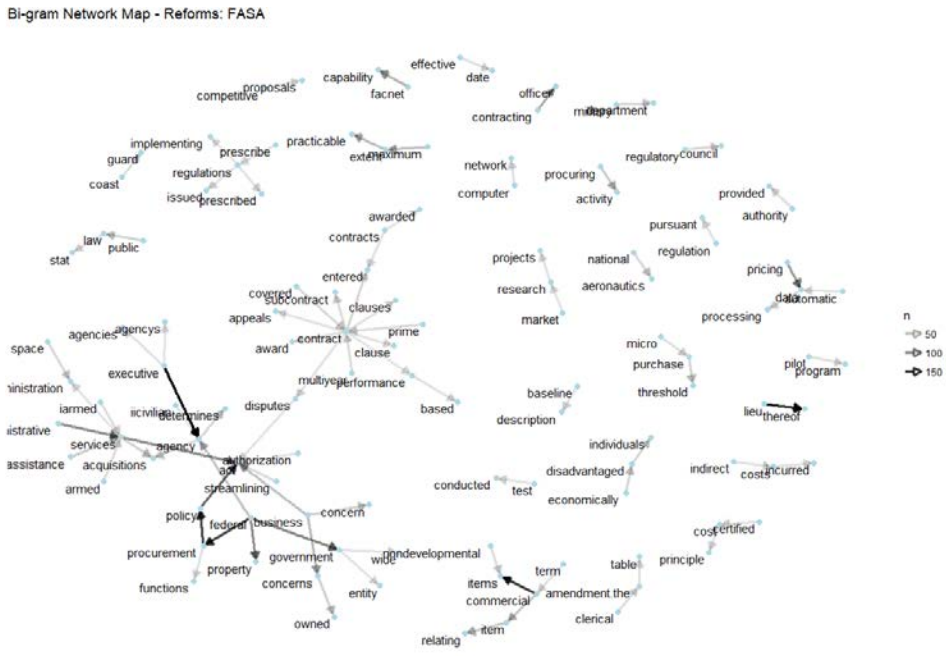

Figure 20: Bi-Gram Network - Reform: FASA

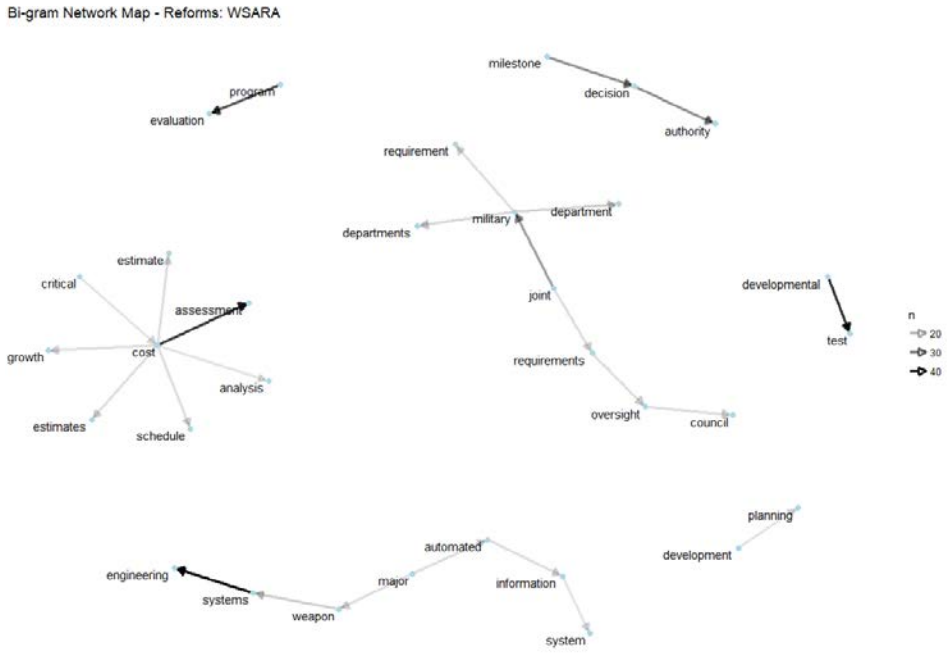

Figure 21: Bi-Gram Network - Reform: WSARA

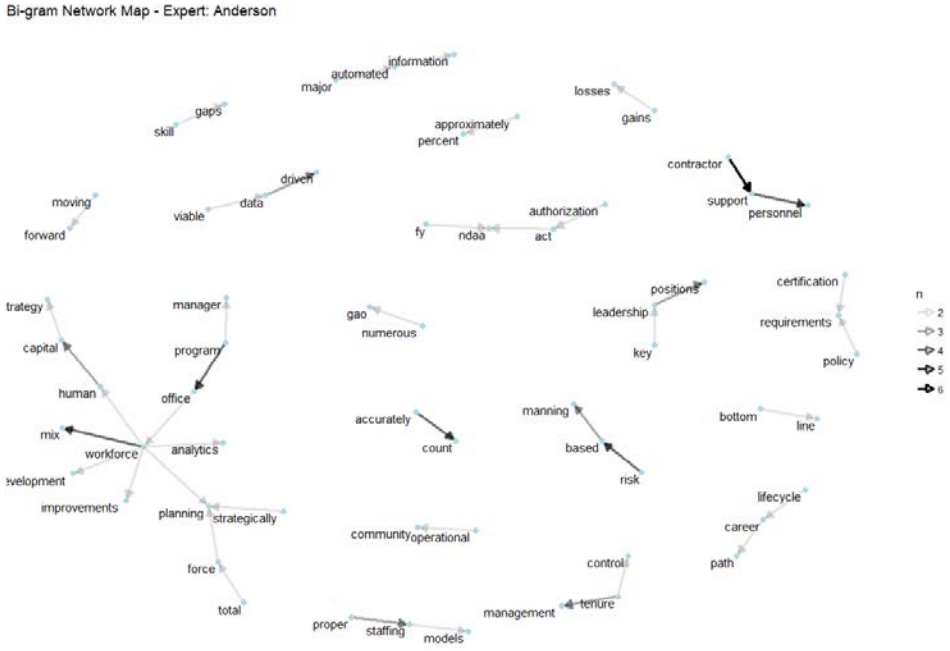

Figure 22: Bi-Gram Network - Expert: Anderson

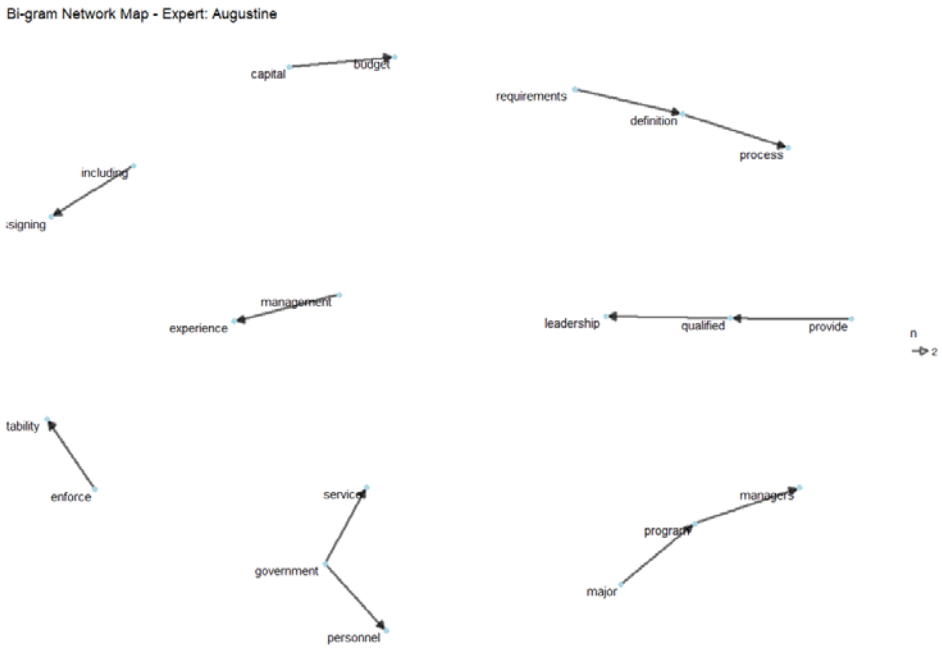

Figure 23: Bi-Gram Network - Expert: Augustine

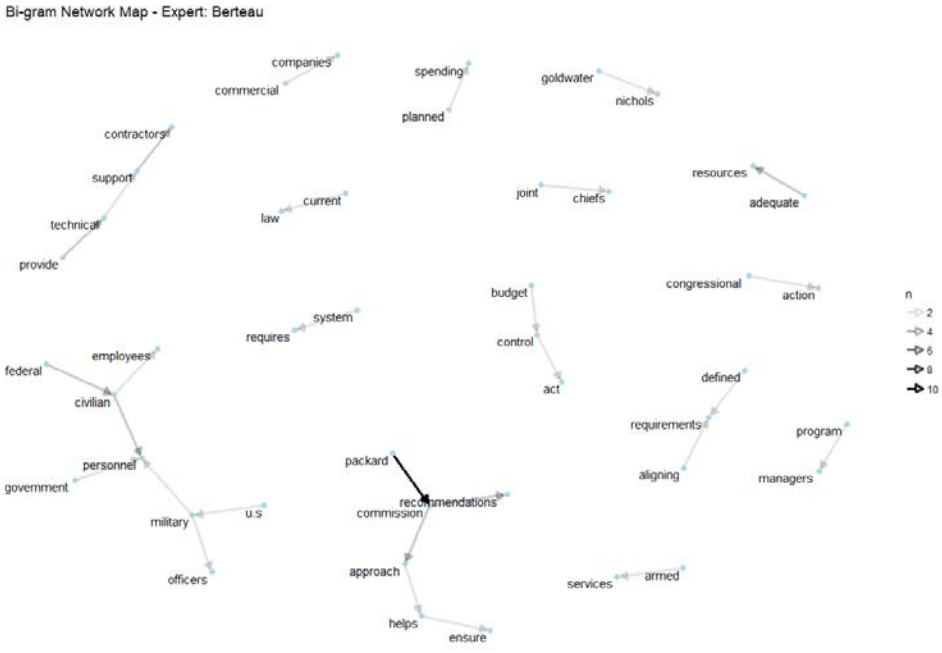

Figure 24: Bi-Gram Network - Expert: Berteau

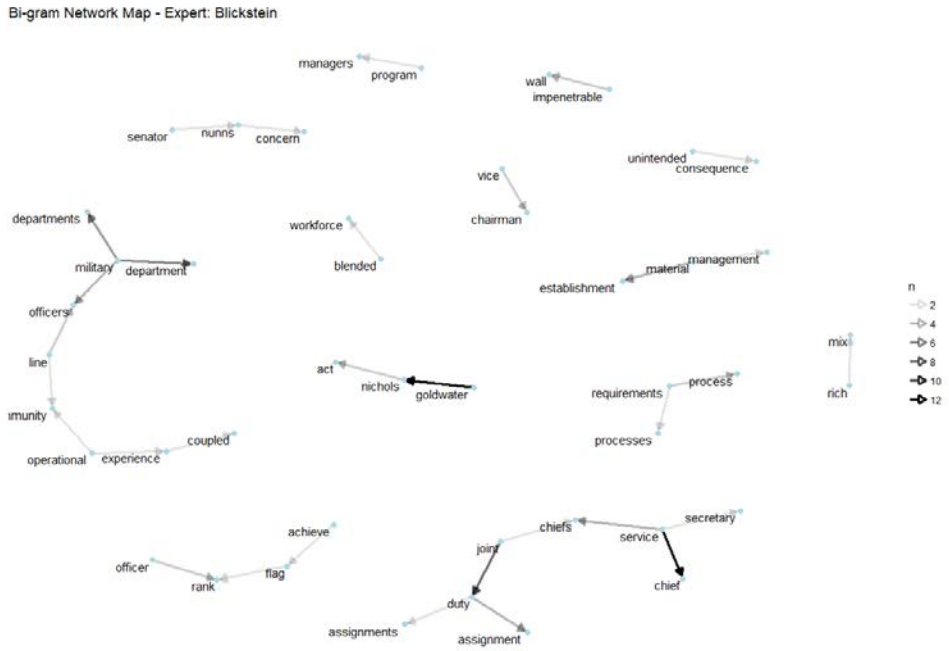

Figure 25: Bi-Gram Network - Expert: Blickstein

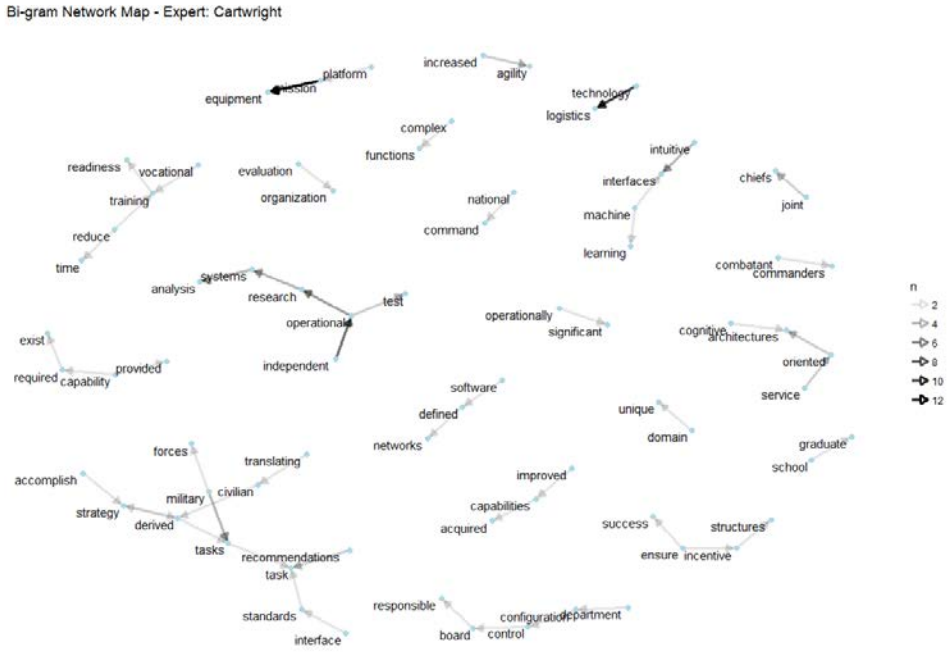

Figure 26: Bi-Gram Network - Expert: Cartwright

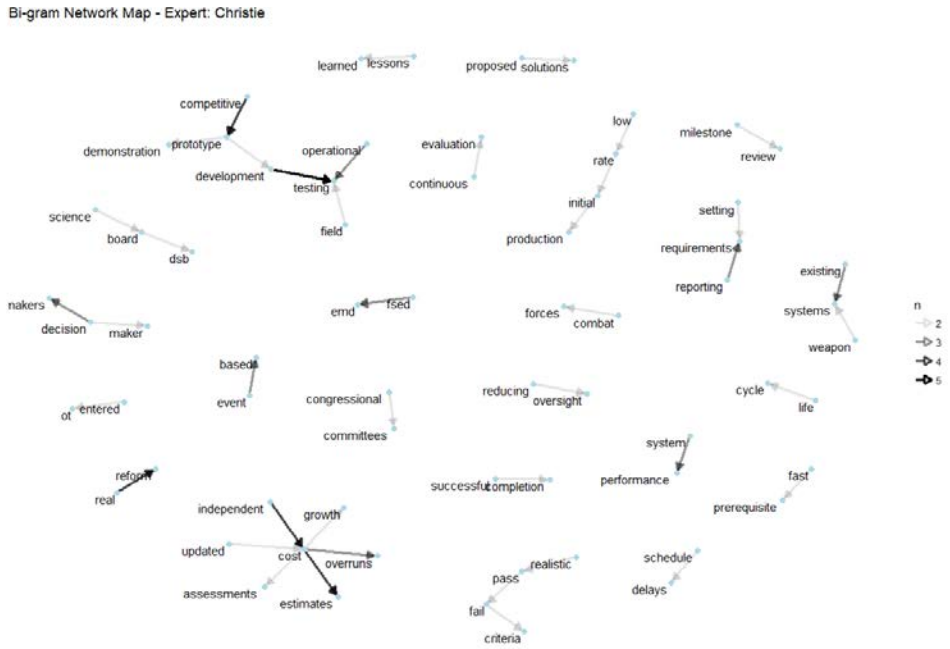

Figure 27: Bi-Gram Network - Expert: Christie

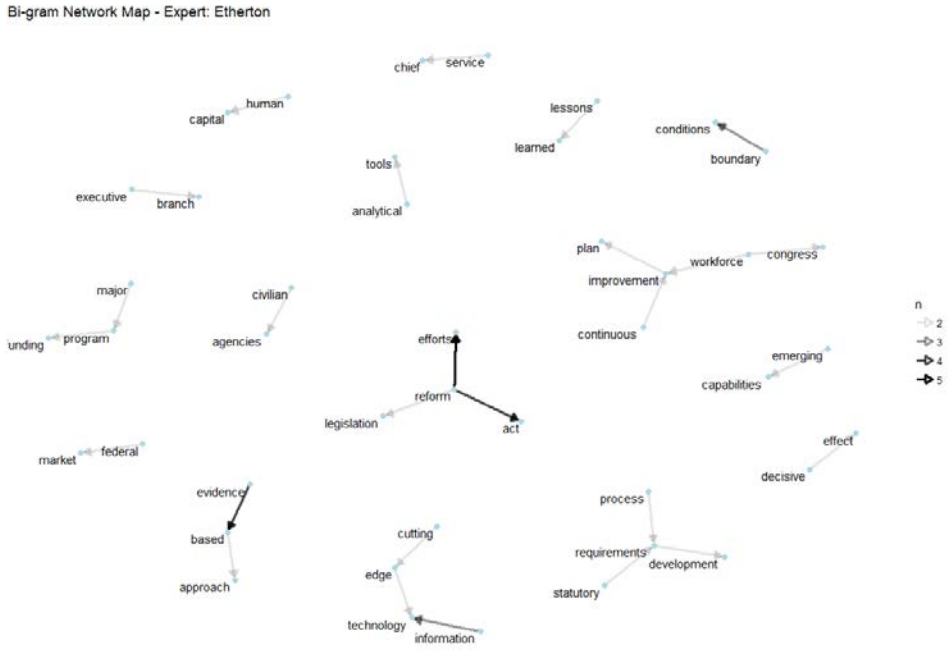

Figure 28: Bi-Gram Network - Expert: Etherton

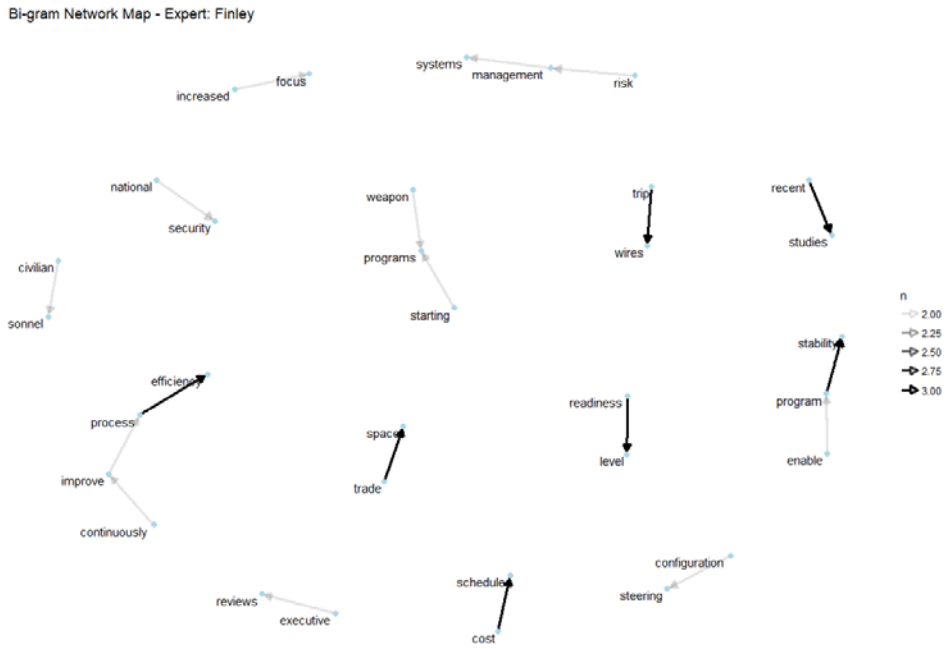

Figure 29: Bi-Gram Network - Expert: Finley

Figure 30: Bi-Gram Network - Expert: Fox, C.

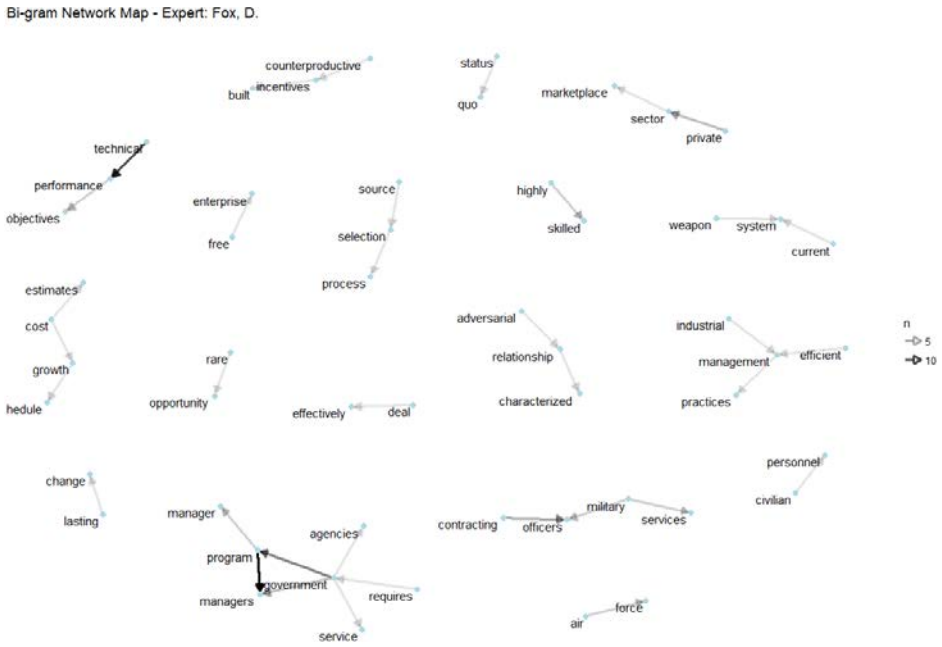

Figure 31: Bi-Gram Network - Expert: Fox, D.

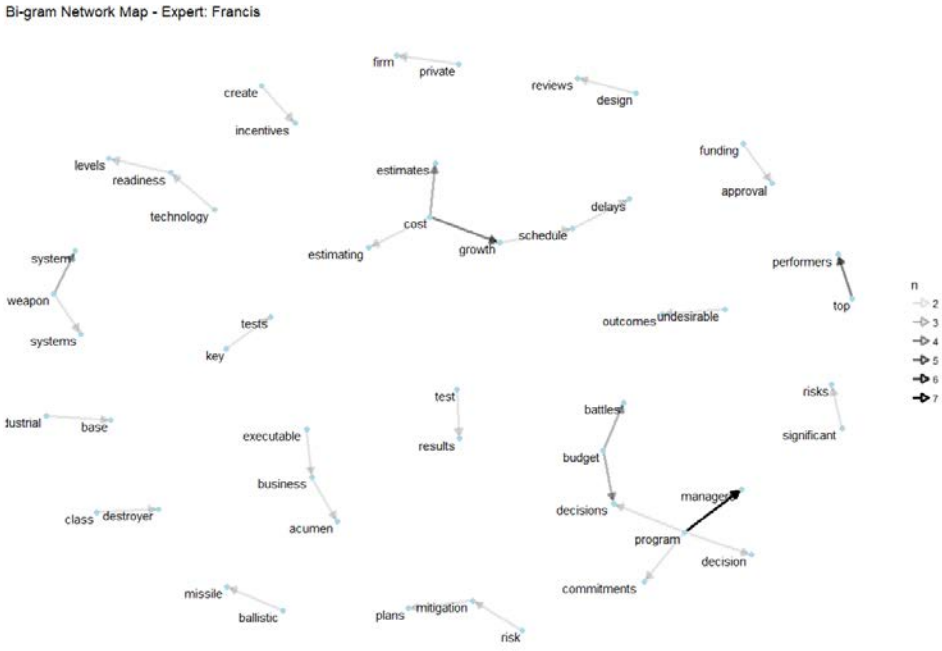

Figure 32: Bi-Gram Network - Expert: Francis

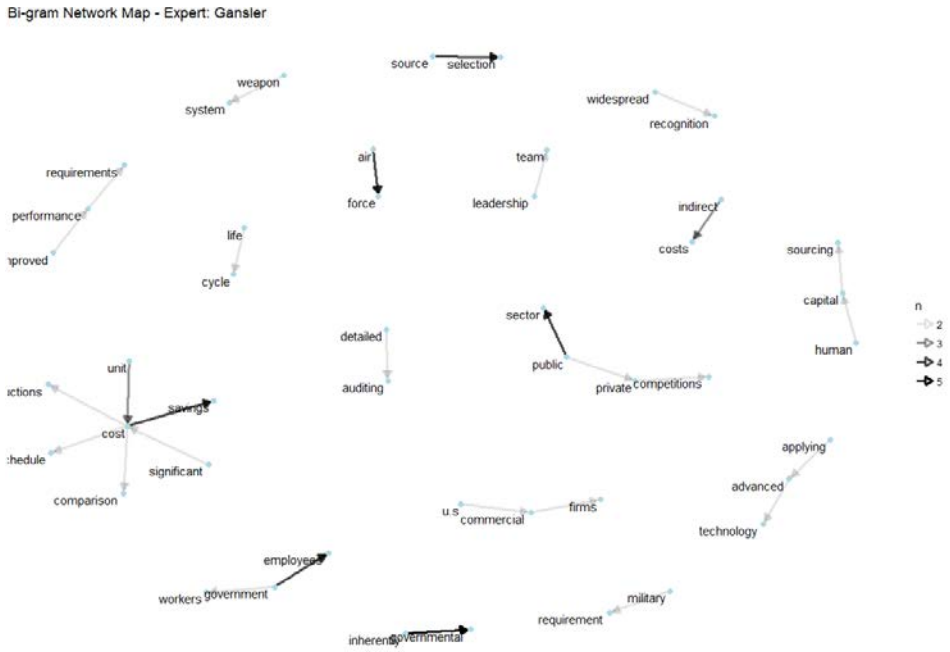

Figure 33: Bi-Gram Network - Expert: Gansler

Figure 34: Bi-Gram Network - Expert: Gilmore

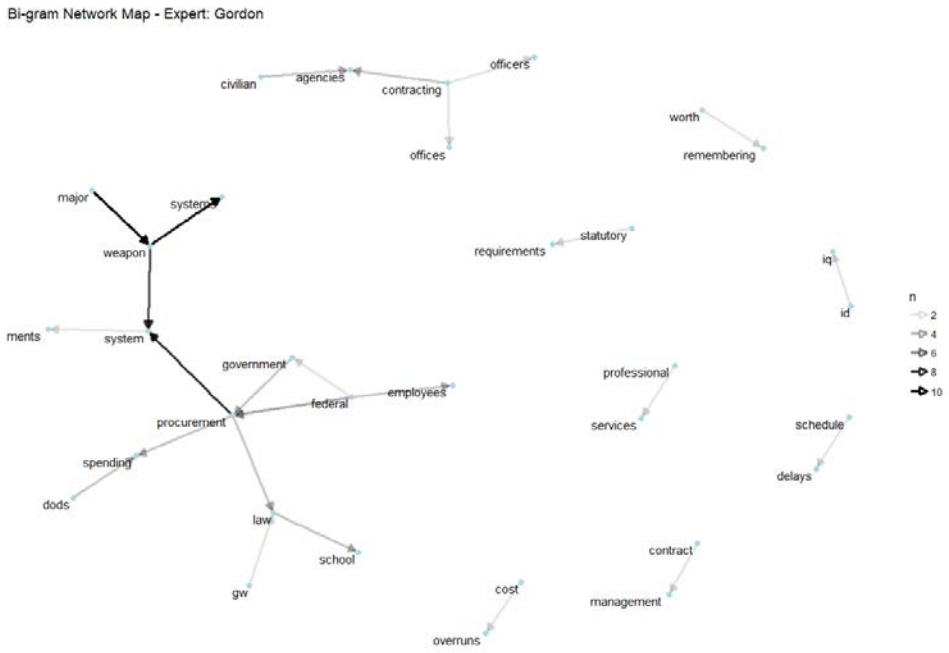

Figure 35: Bi-Gram Network - Expert: Gordon

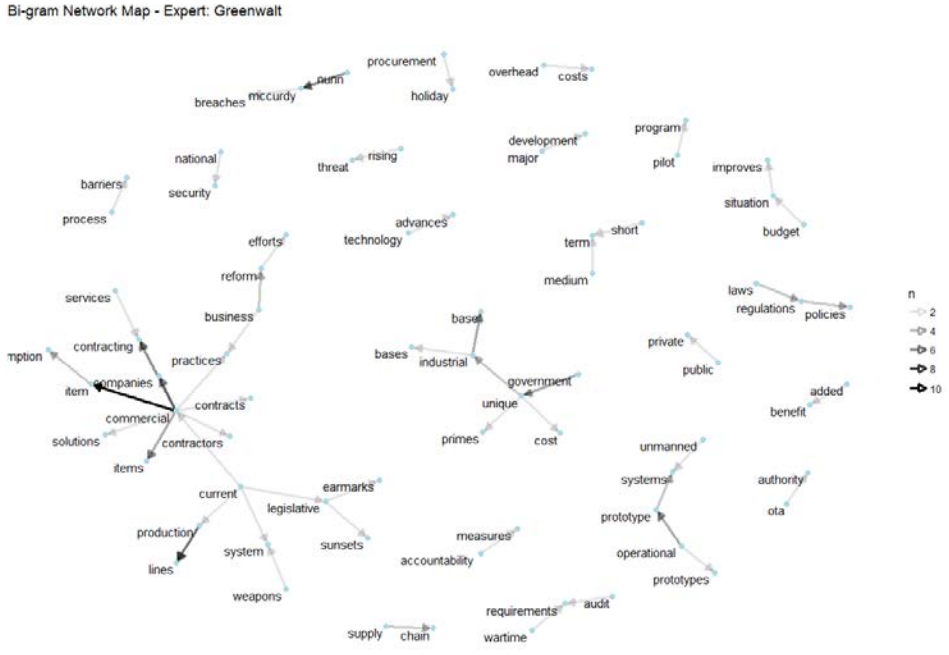

Figure 36: Bi-Gram Network - Expert: Greenwalt

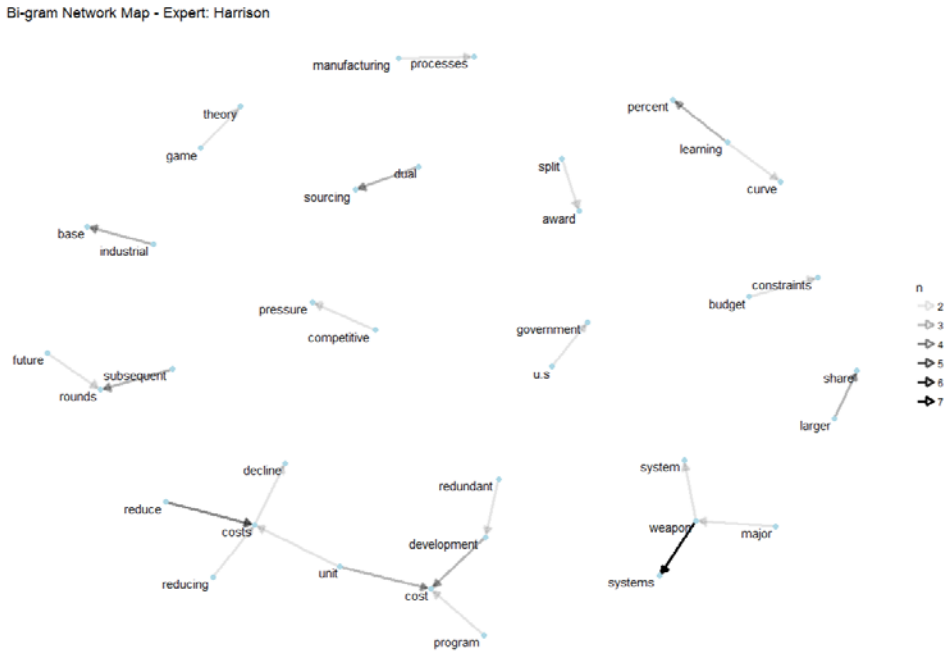

Figure 37: Bi-Gram Network - Expert: Harrison

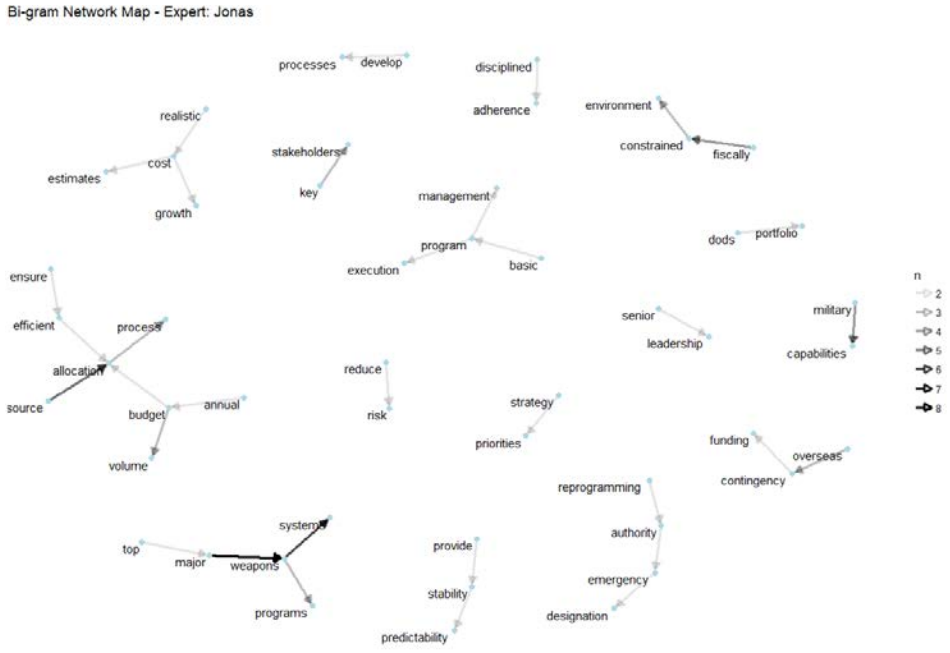

Figure 38: Bi-Gram Network - Expert: Jonas

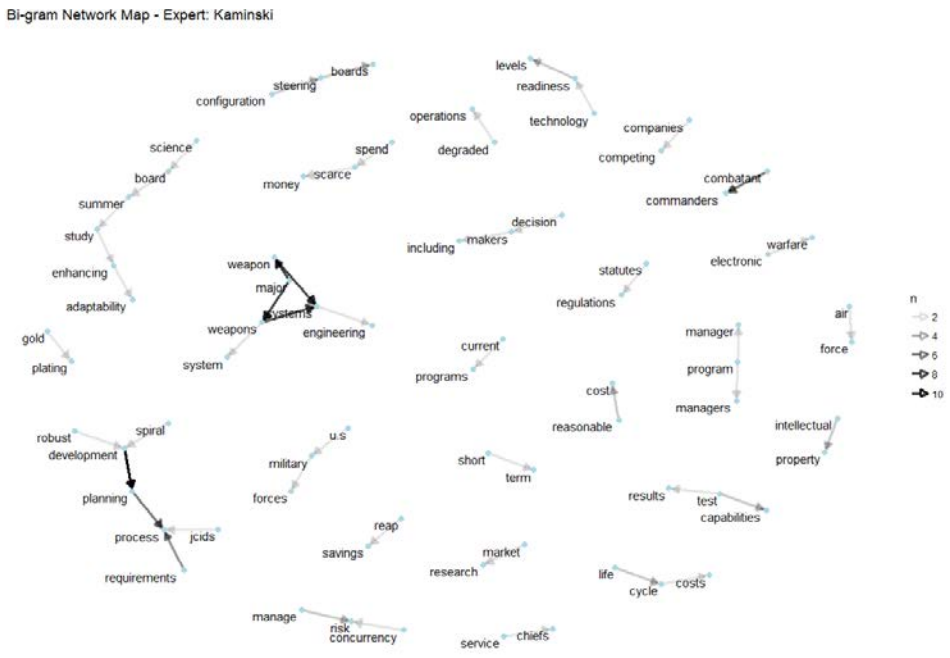

Figure 39: Bi-Gram Network - Expert: Kaminski

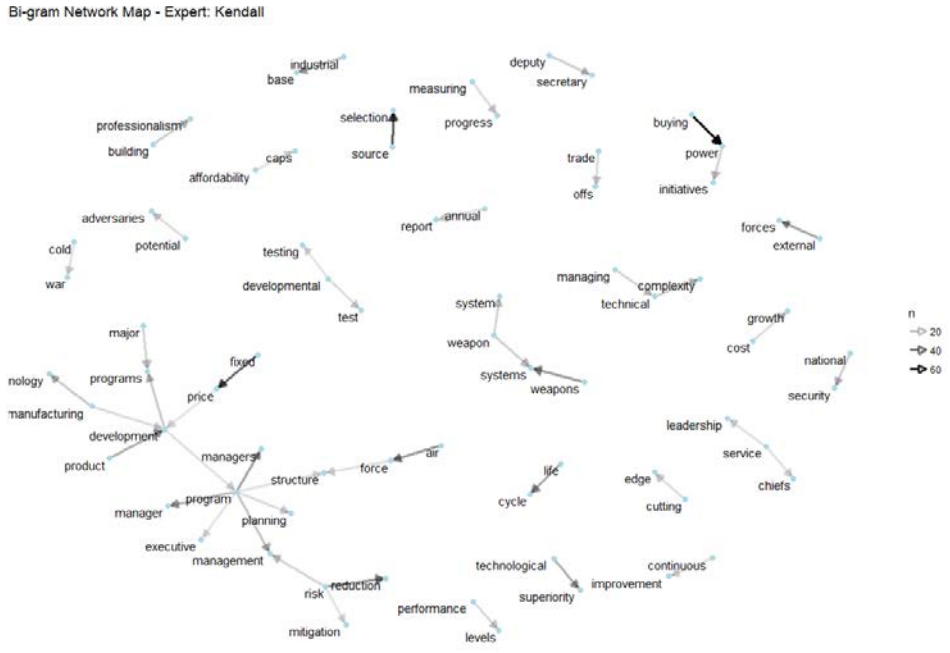

Figure 40: Bi-Gram Network - Expert: Kendall

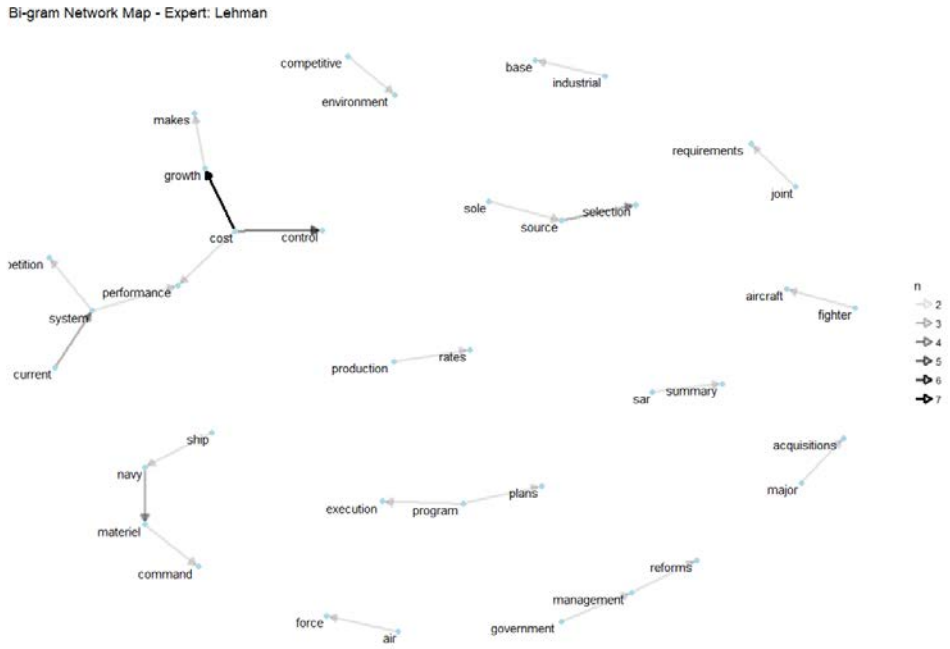

Figure 41: Bi-Gram Network - Expert: Lehman

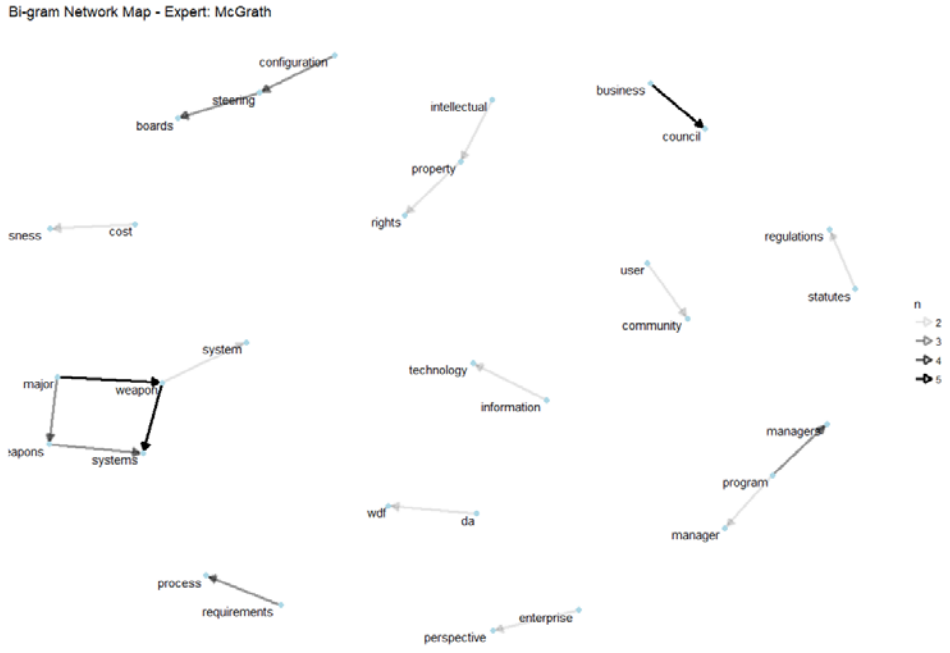

Figure 42: Bi-Gram Network - Expert: McGrath

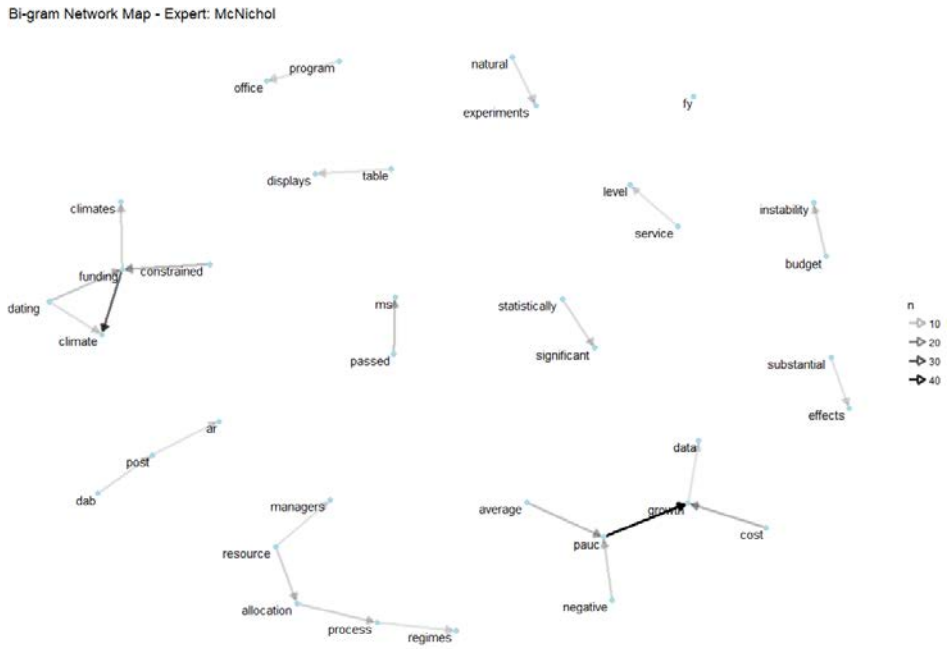

Figure 43: Bi-Gram Network - Expert: McNichol

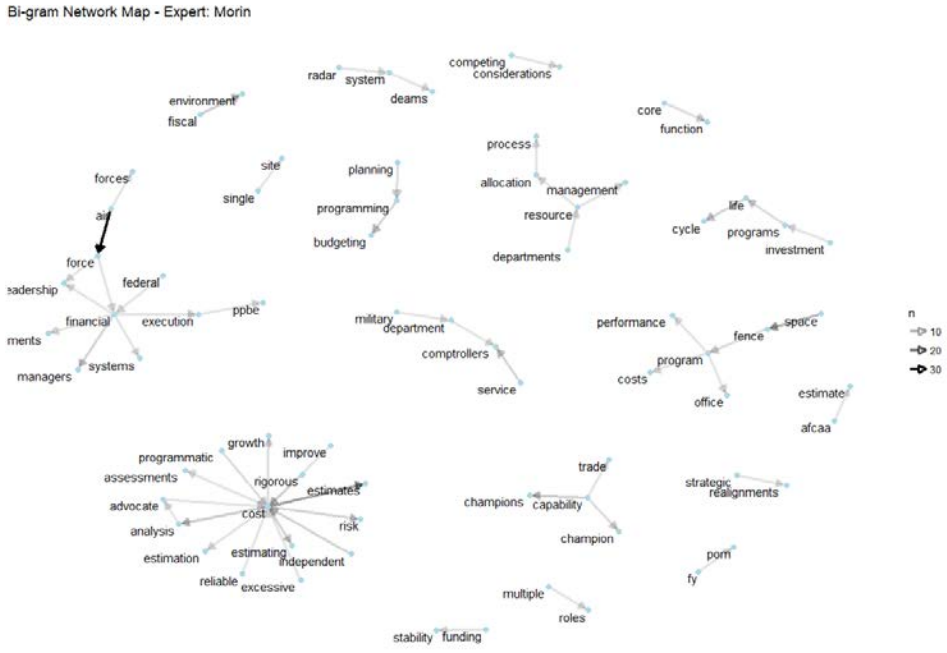

Figure 44: Bi-Gram Network - Expert: Morin

Figure 45: Bi-Gram Network - Expert: Oliver

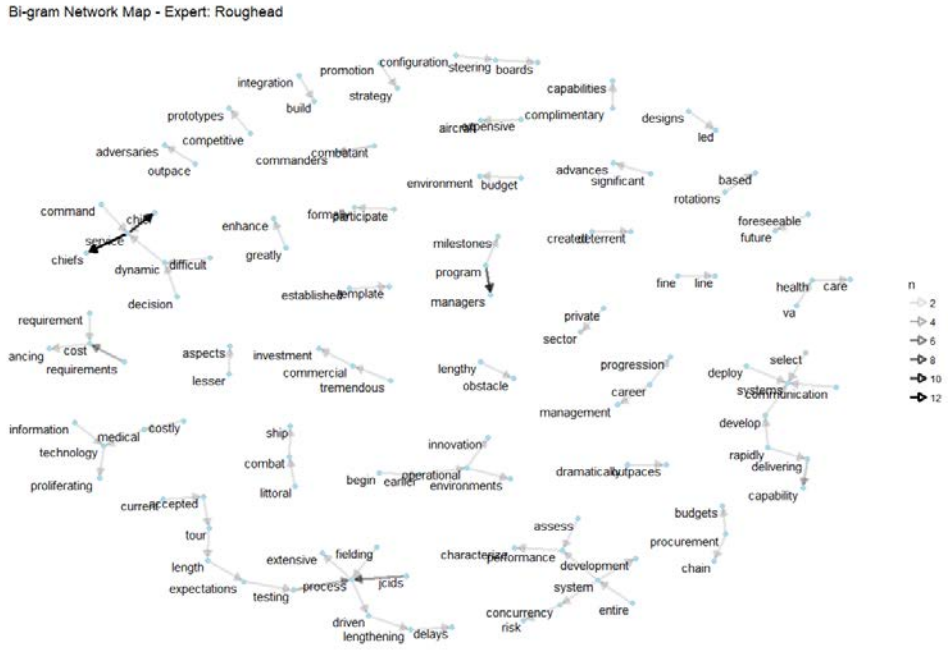

Figure 46: Bi-Gram Network - Expert: Roughead

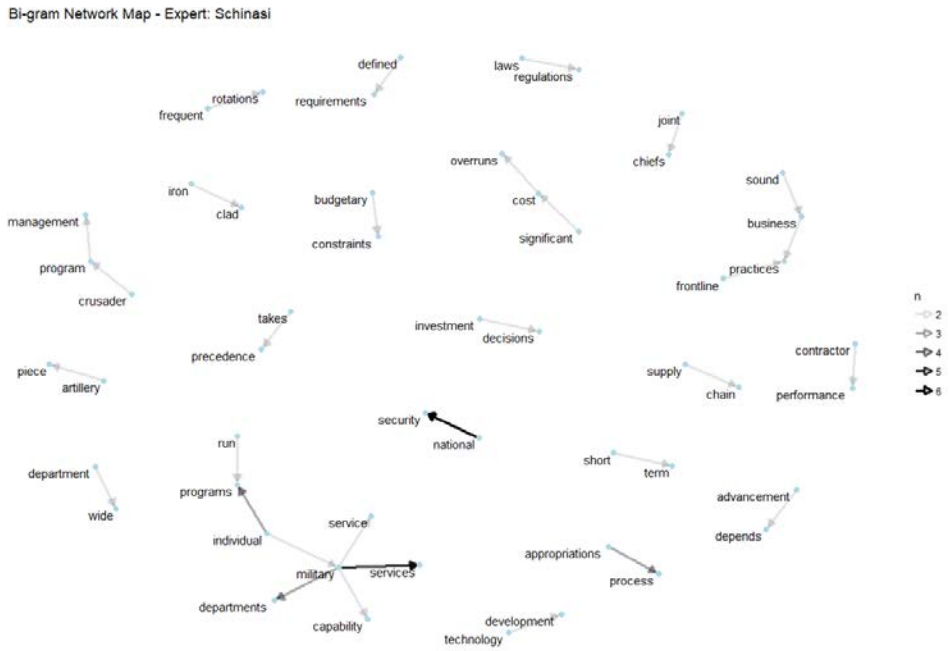

Figure 47: Bi-Gram Network - Expert: Schinasi

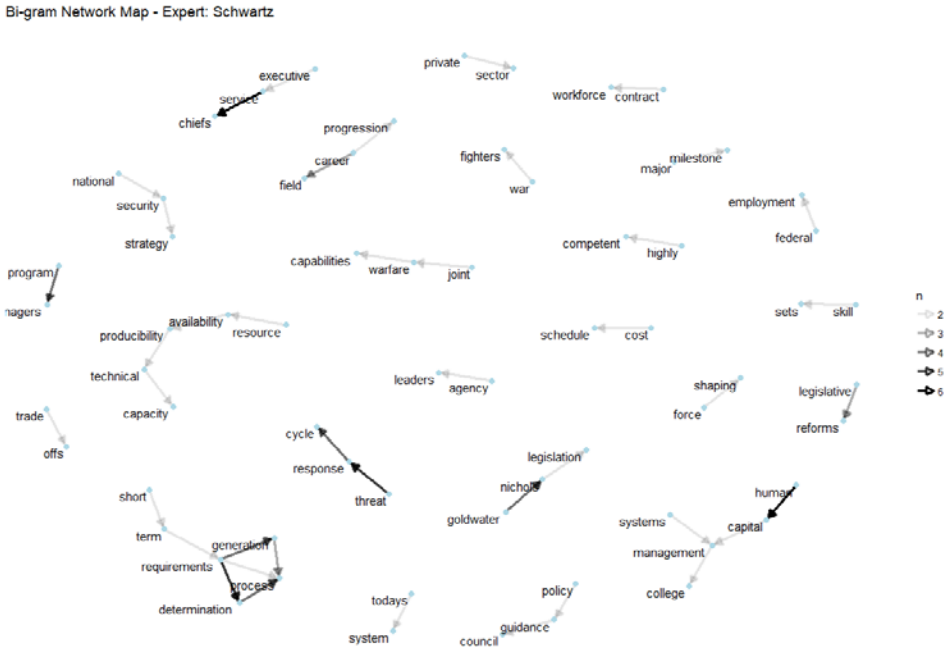

Figure 48: Bi-Gram Network - Expert: Schwartz

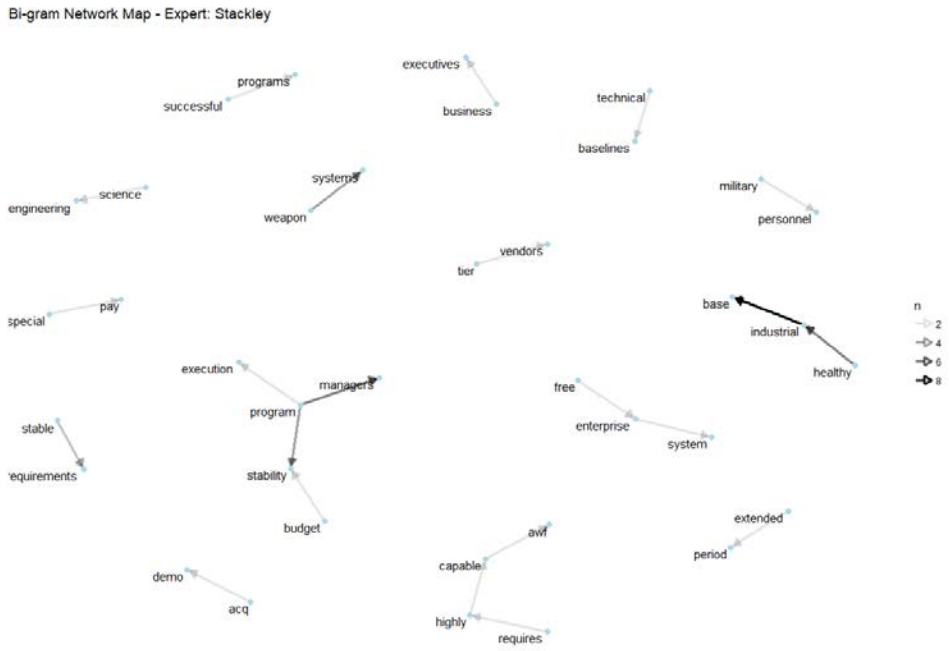

Figure 49: Bi-Gram Network - Expert: Stackley

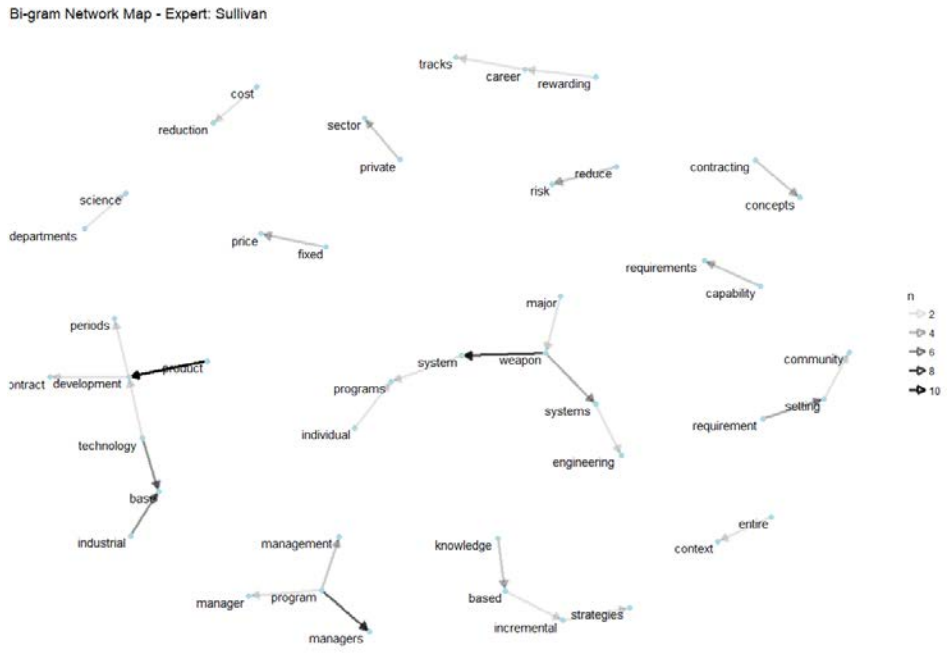

Figure 50: Bi-Gram Network - Expert: Sullivan

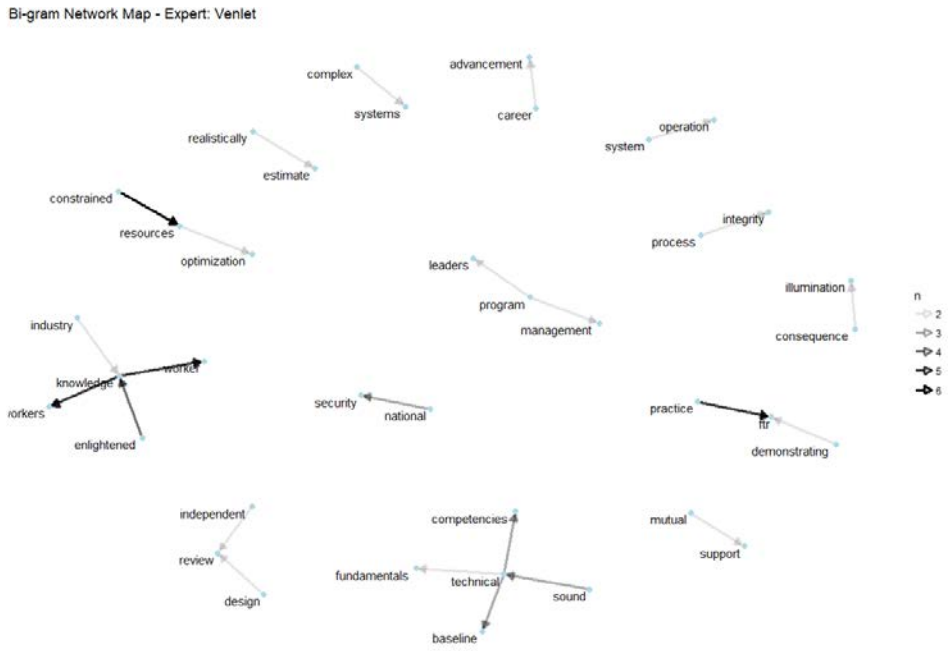

Figure 51: Bi-Gram Network - Expert: Venlet

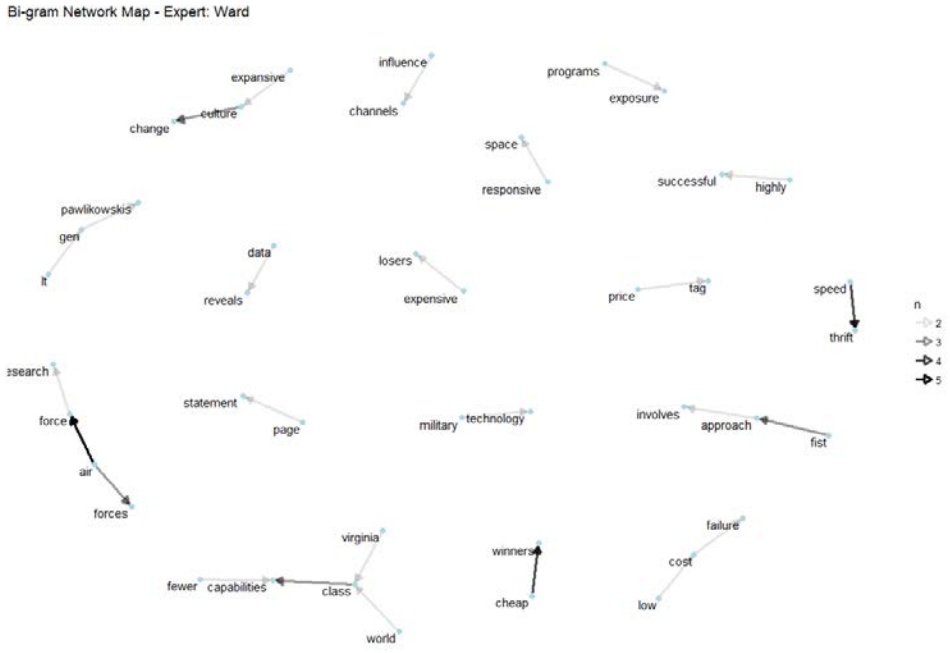

Figure 52: Bi-Gram Network - Expert: Ward

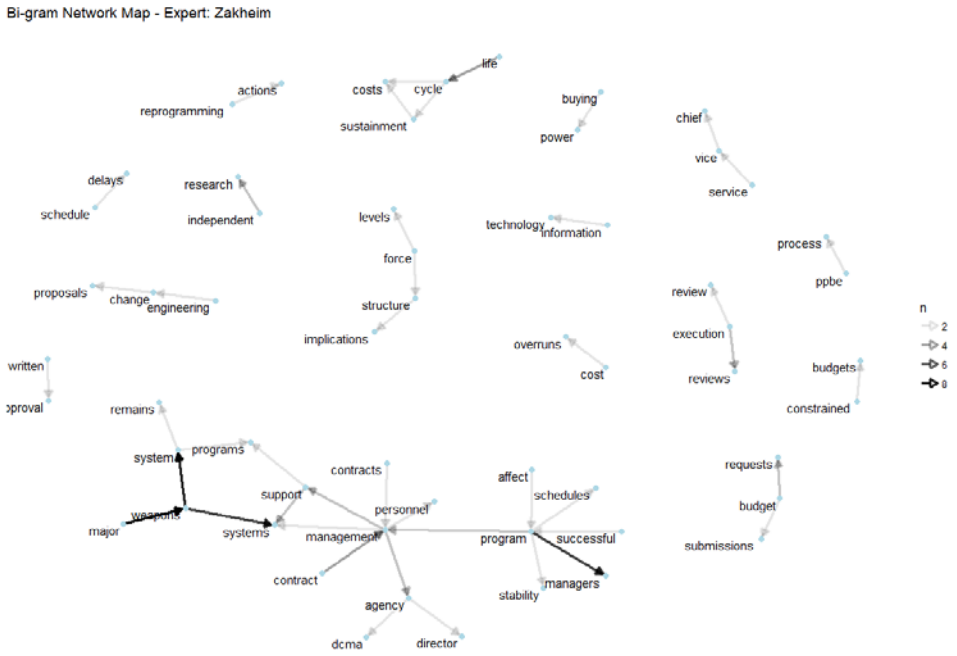

Figure 53: Bi-Gram Network - Expert: Zakheim

4. Word Frequency Percentage

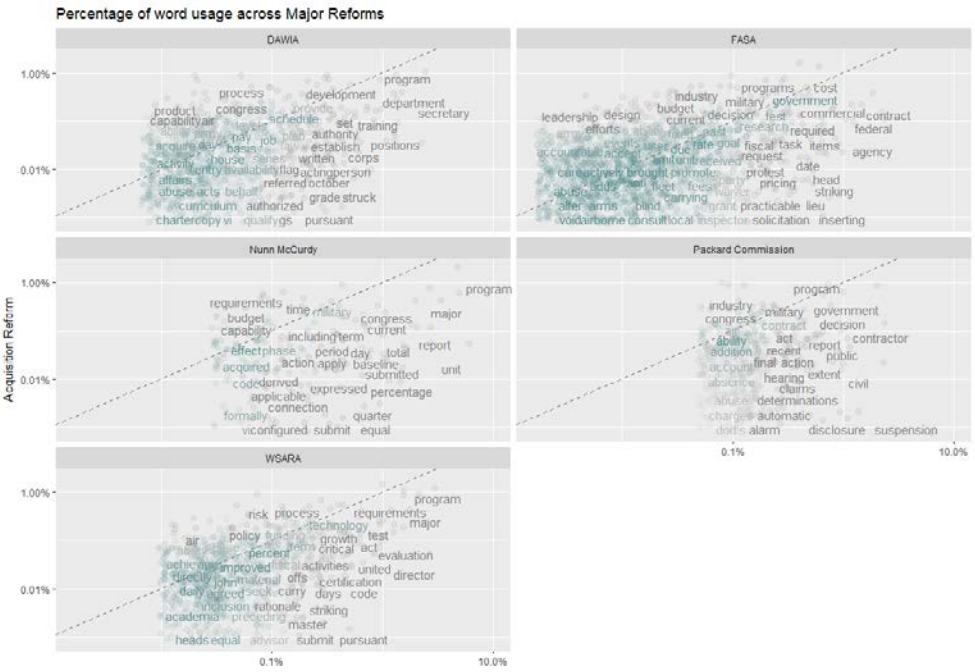

Figure 29: Word Frequency Percent - Reforms

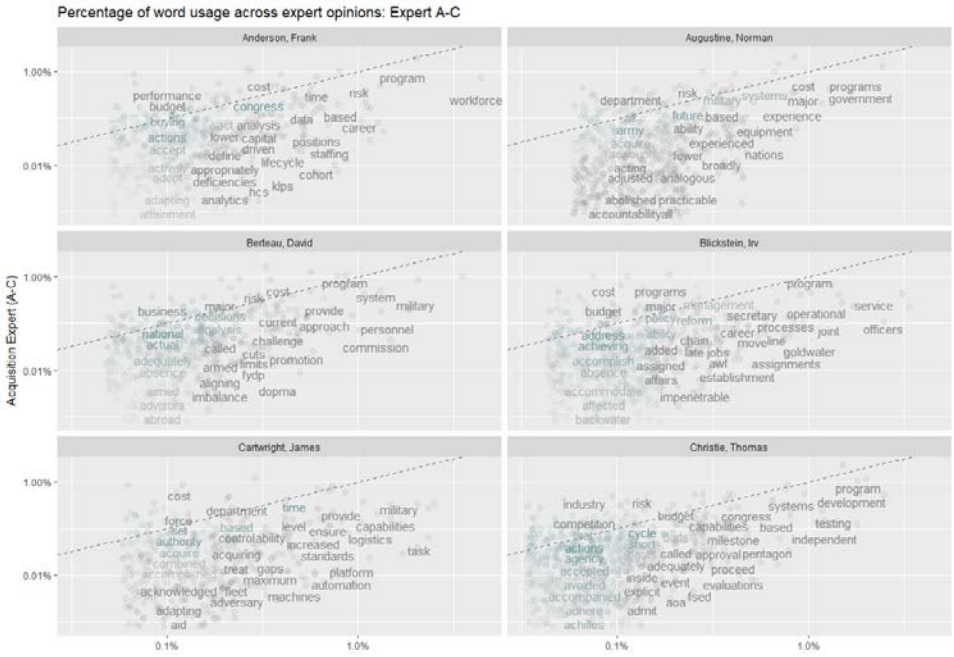

Figure 30: Word Frequency Percent - Experts A-C

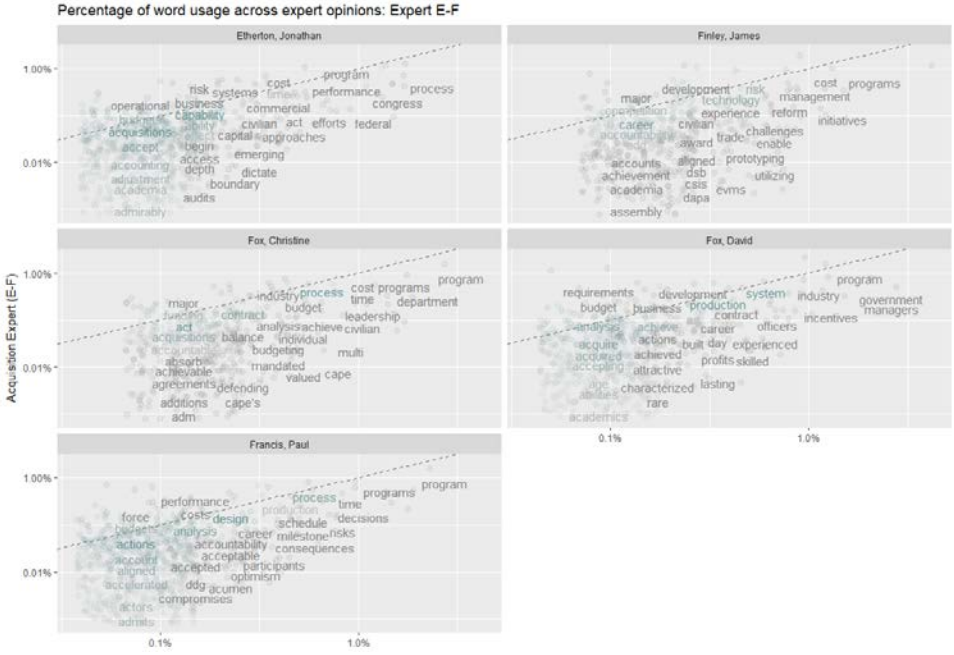

Figure 31: Word Frequency Percent - Experts E-F

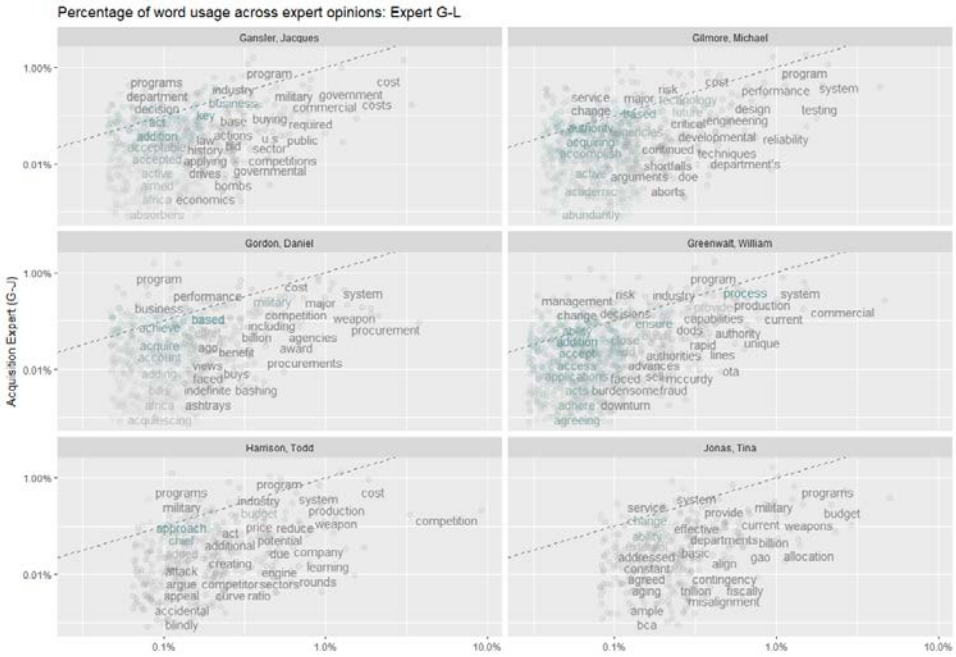

Figure 32: Word Frequency Percent - Experts G-L

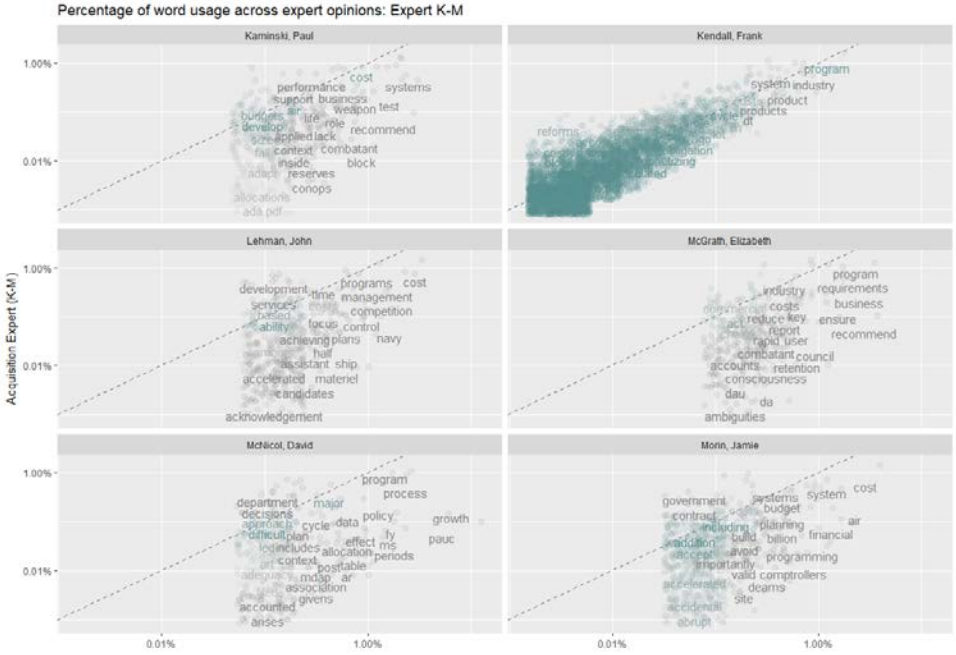

Figure 33: Word Frequency Percent - Experts K-M

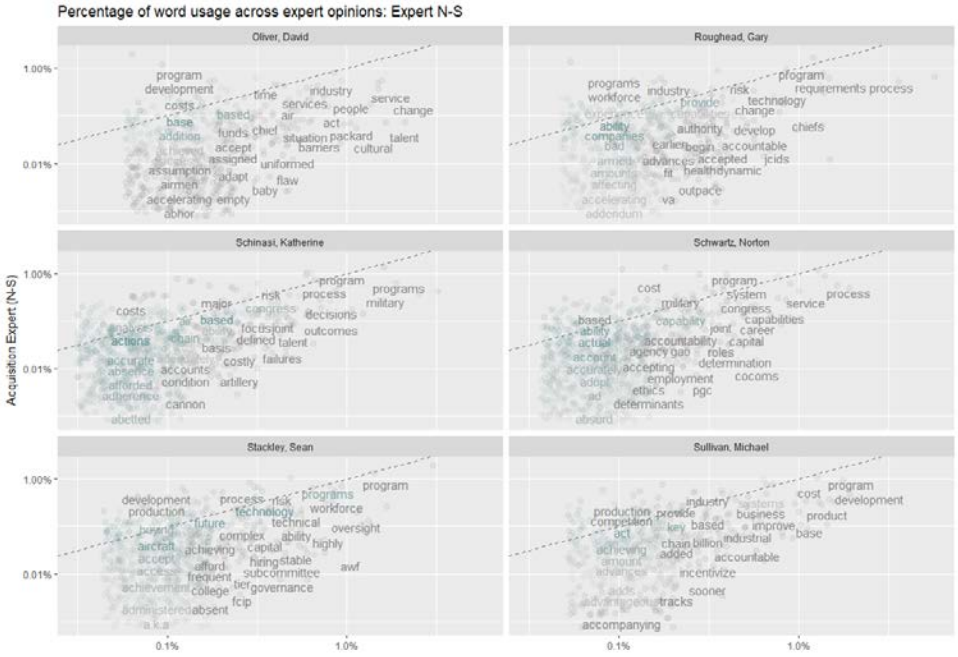

Figure 34: Word Frequency Percent - Experts N-S

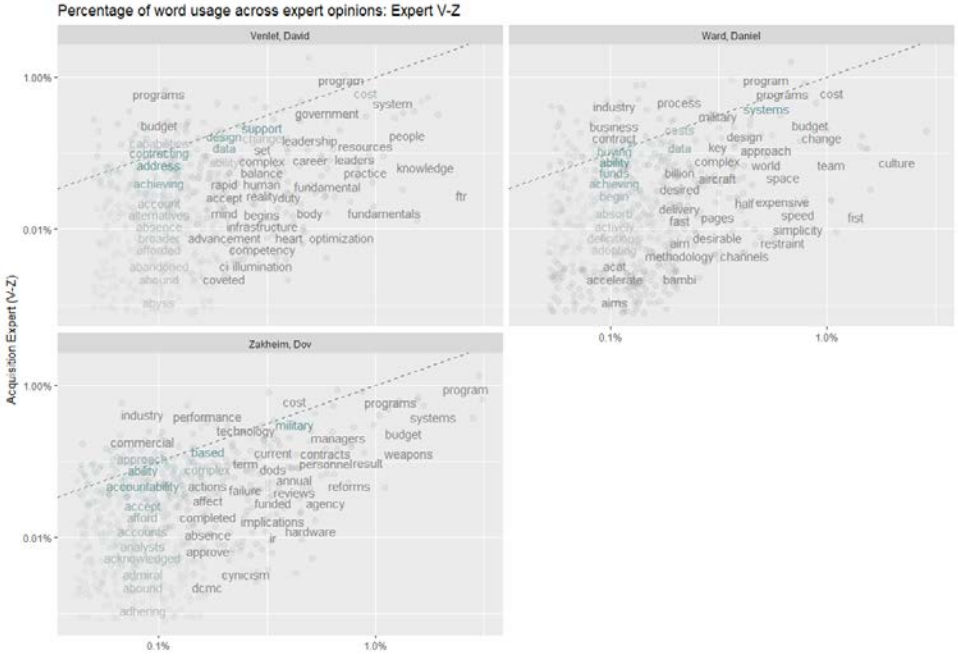

Figure 35: Word Frequency Percent - Experts V-Z

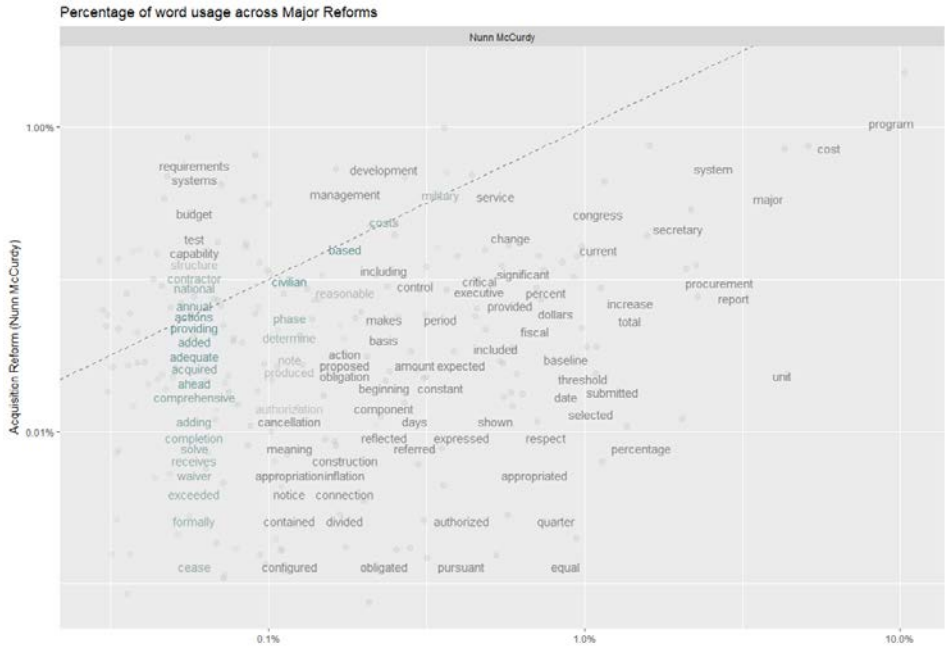

Figure 54: Word Frequency Percent - Reform: Nunn McCurdy

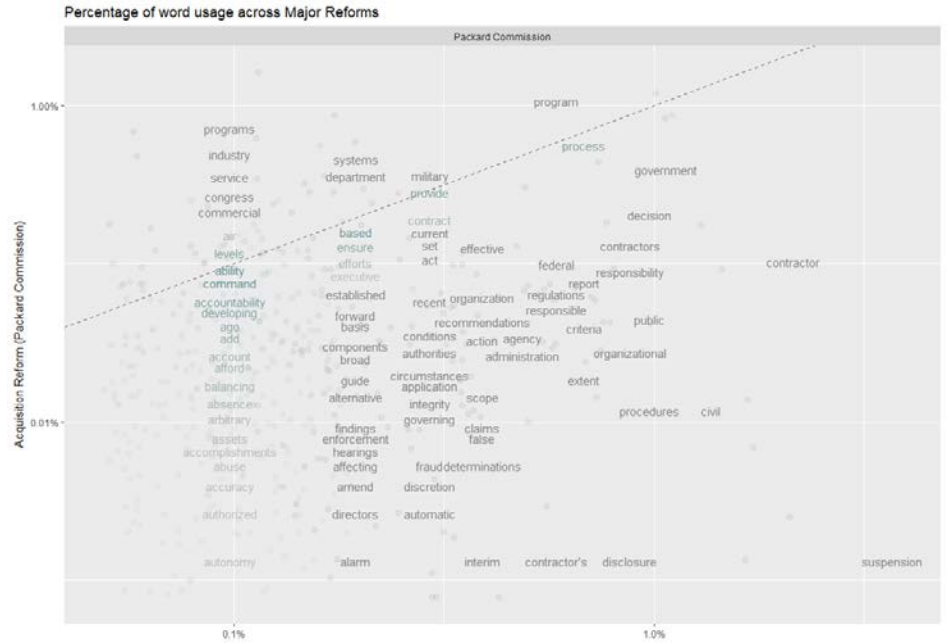

Figure 55: Word Frequency Percent - Reform: Packard Commission

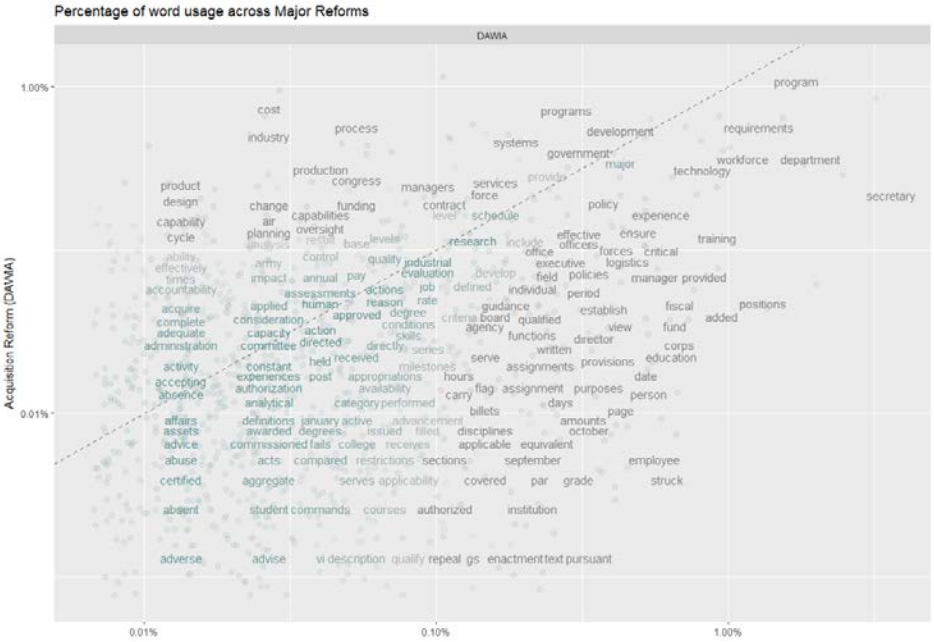

Figure 56: Word Frequency Percent - Reform: DAWIA

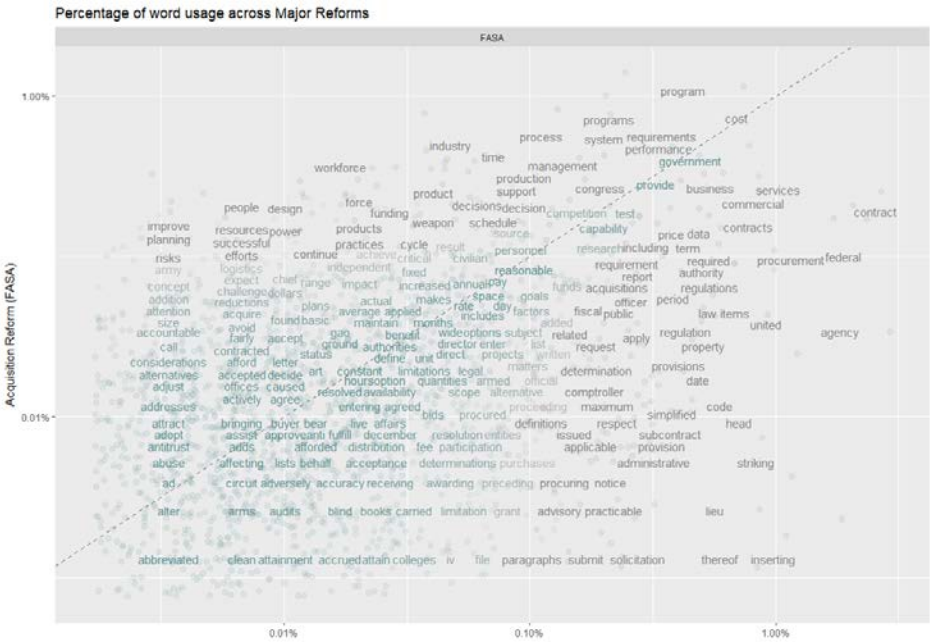

Figure 57: Word Frequency Percent - Reform: FASA

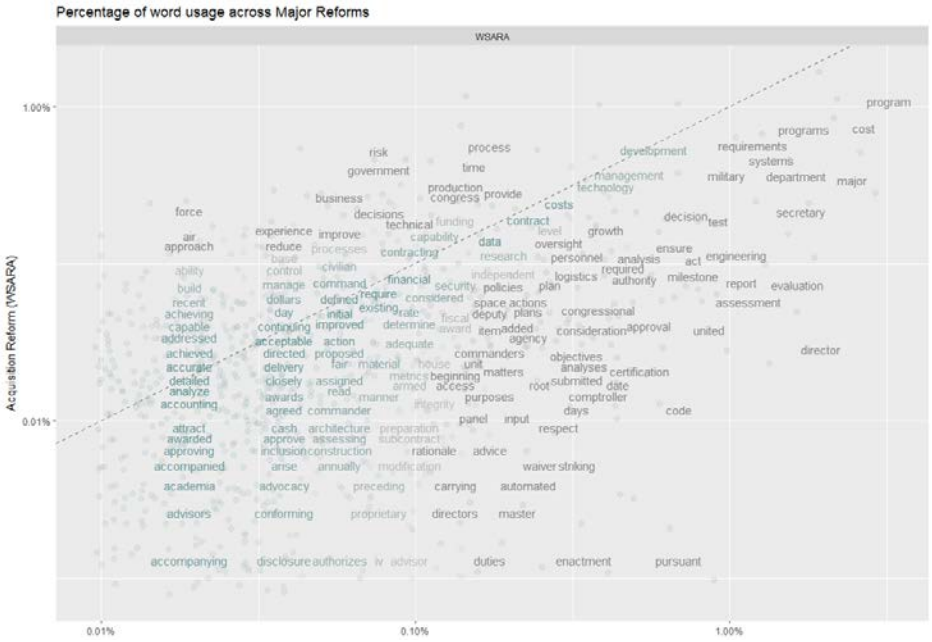

Figure 58: Word Frequency Percent - Reform: WSARA

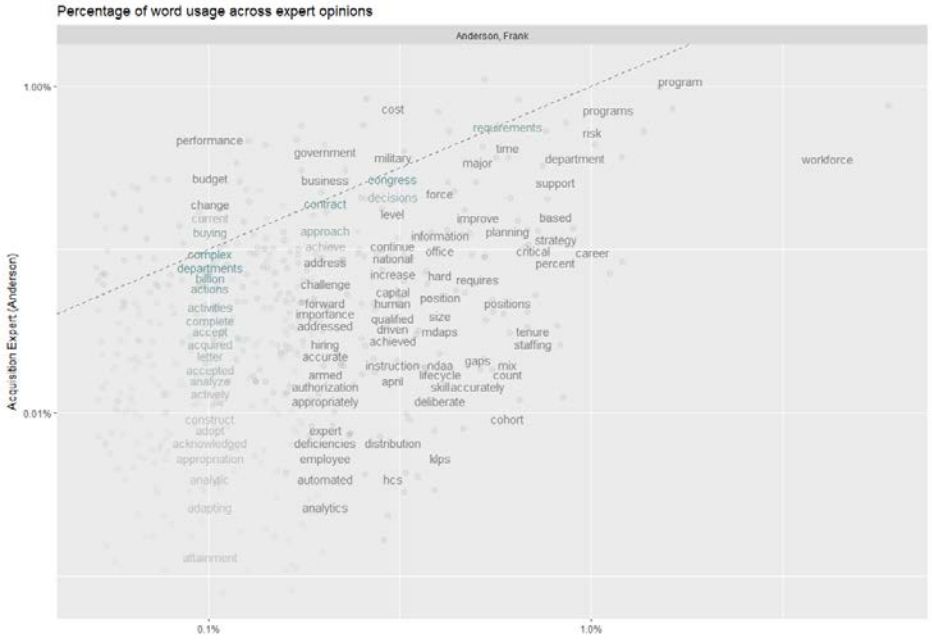

Figure 59: Word Frequency Percent - Expert: Anderson

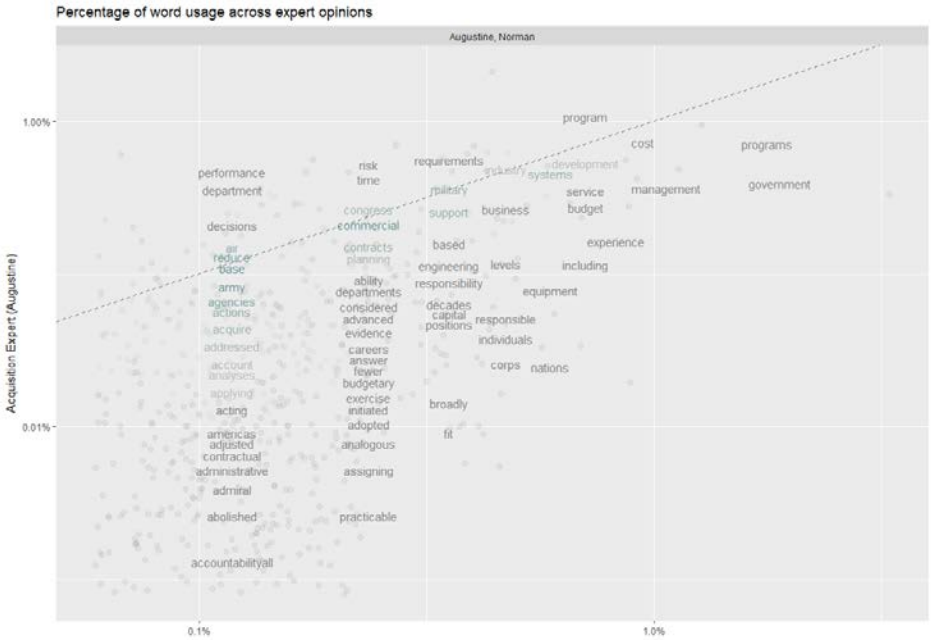

Figure 60: Word Frequency Percent - Expert: Augustine

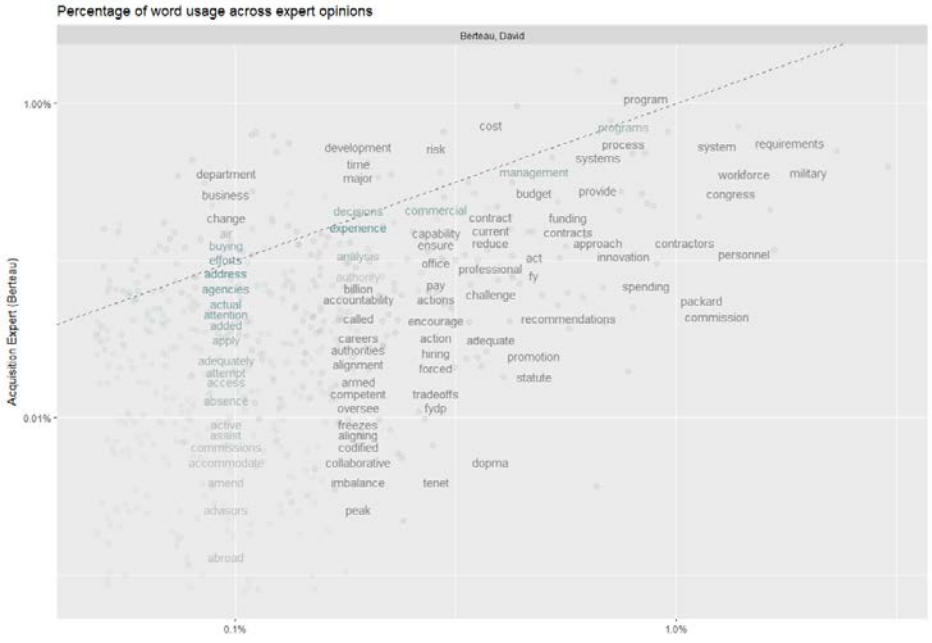

Figure 61: Word Frequency Percent - Expert: Berteau

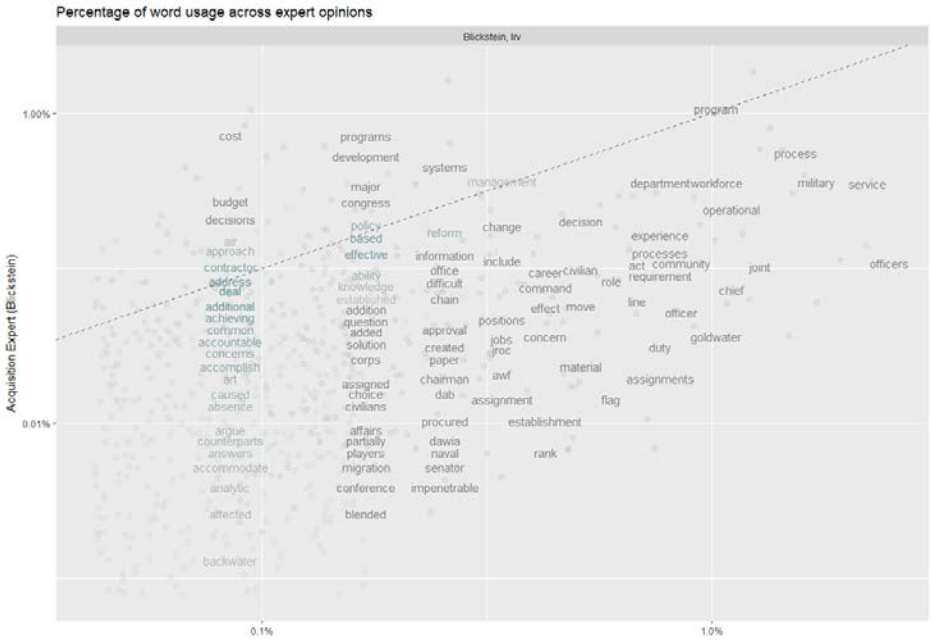

Figure 62: Word Frequency Percent - Expert: Blickstein

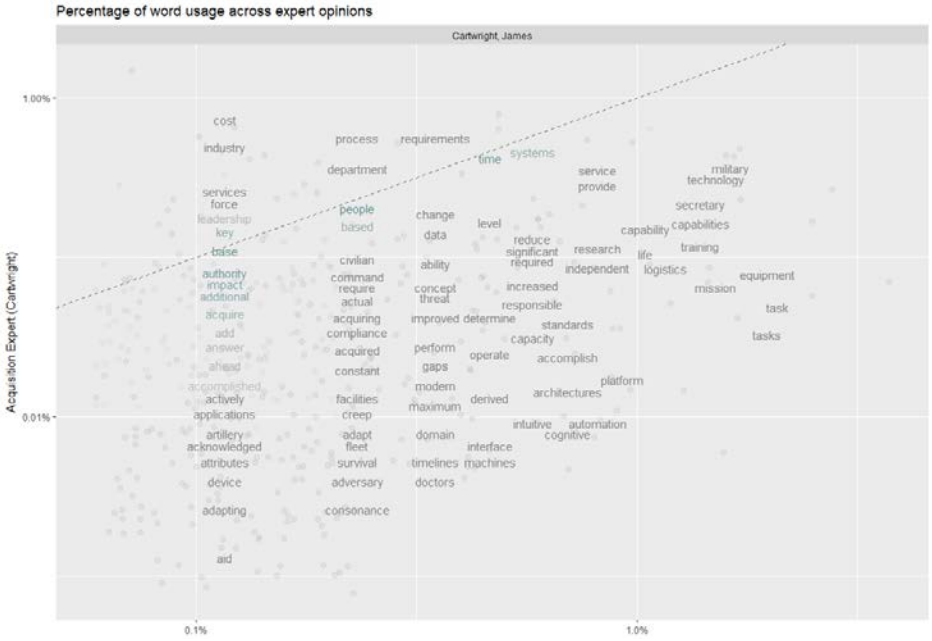

Figure 63: Word Frequency Percent - Expert: Cartwright

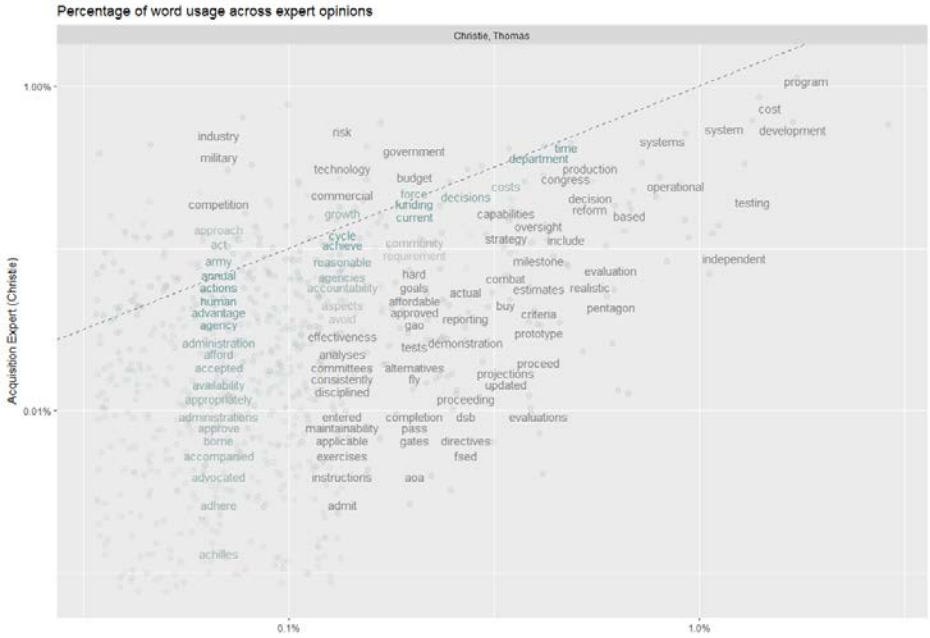

Figure 64: Word Frequency Percent - Expert: Christie

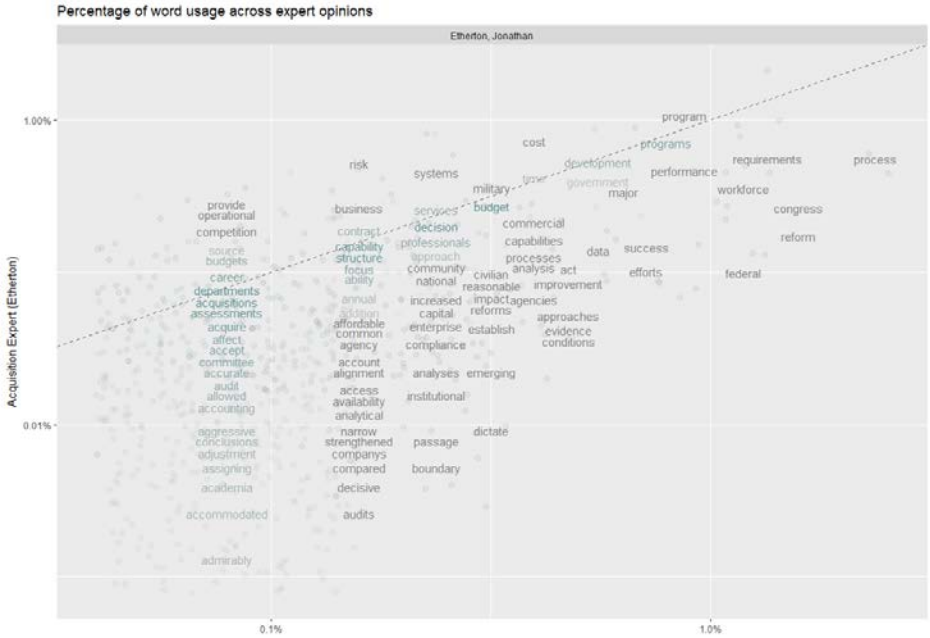

Figure 65: Word Frequency Percent - Expert: Etherton

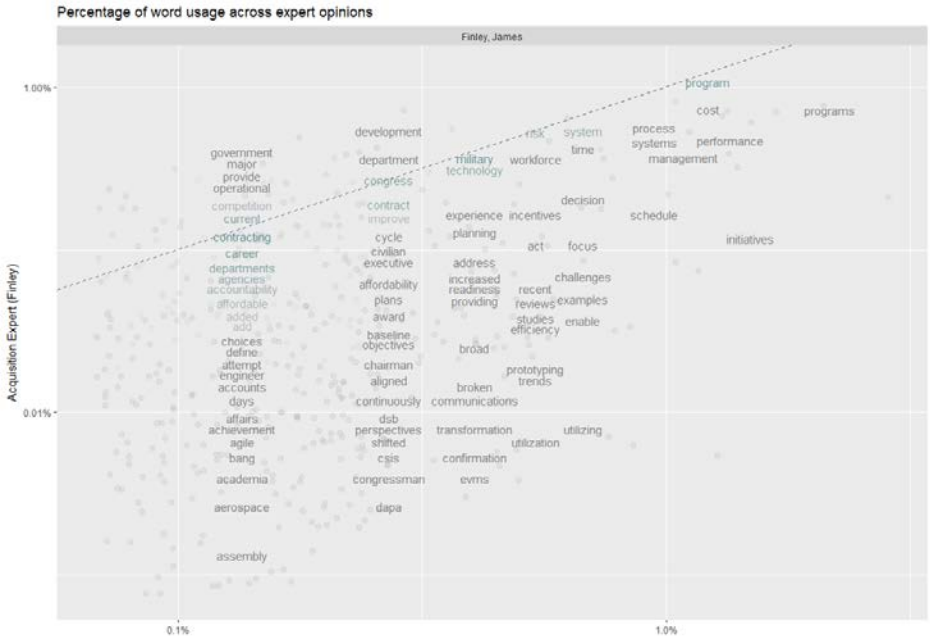

Figure 66: Word Frequency Percent - Expert: Finley

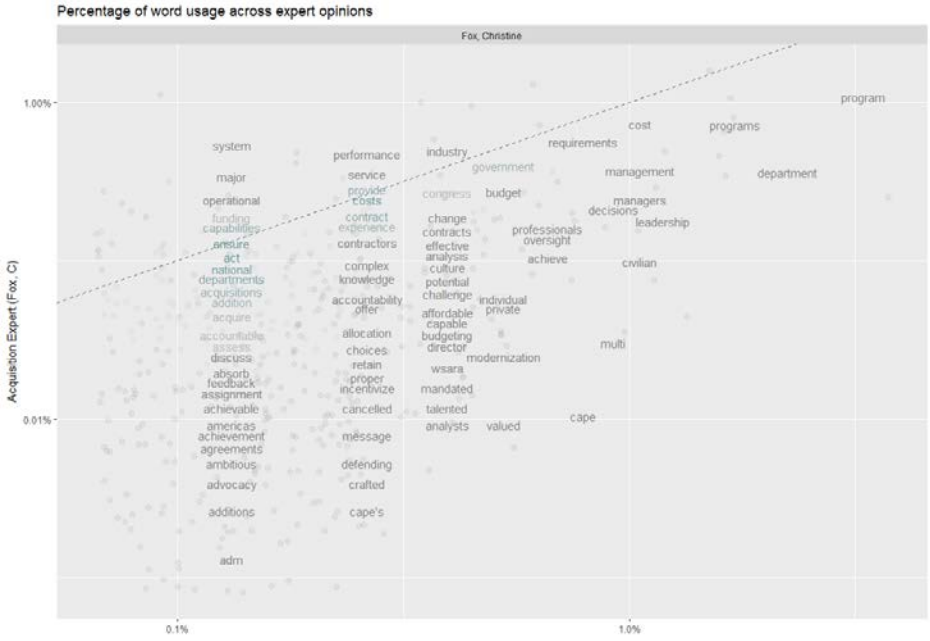

Figure 67: Word Frequency Percent - Expert: Fox, C.

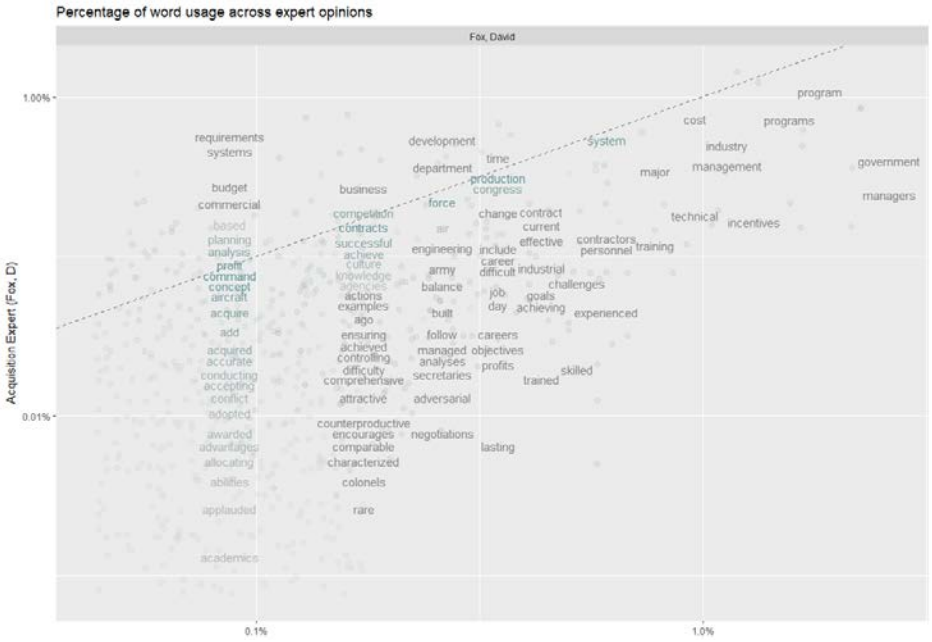

Figure 68: Word Frequency Percent - Expert: Fox, D.

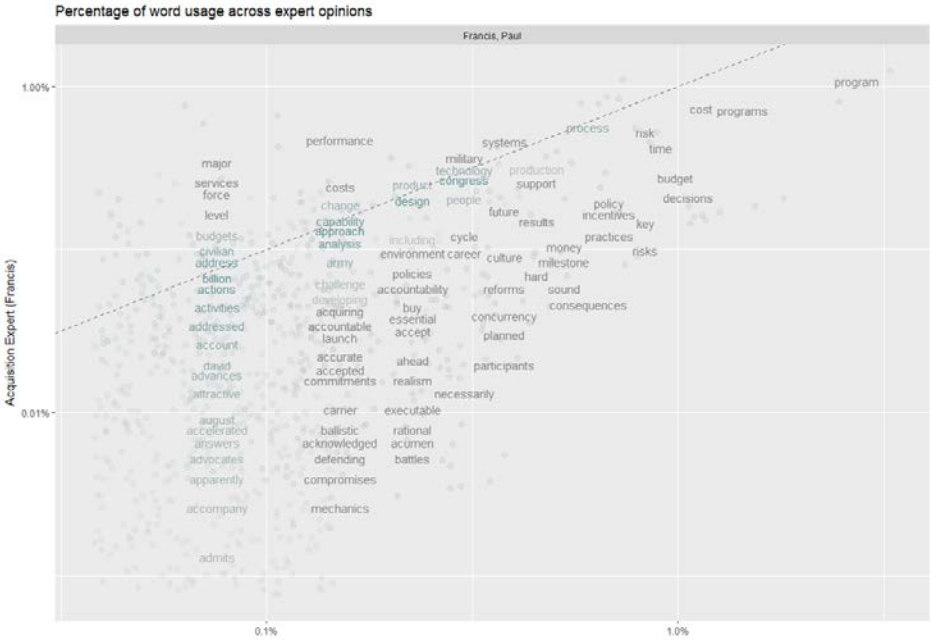

Figure 69: Word Frequency Percent - Expert: Francis

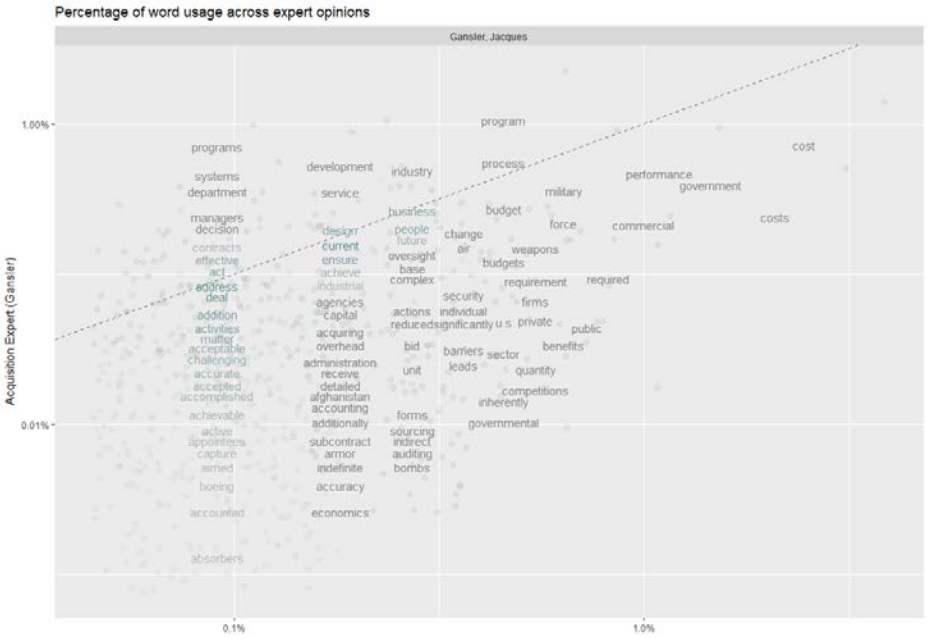

Figure 70: Word Frequency Percent - Expert: Gansler

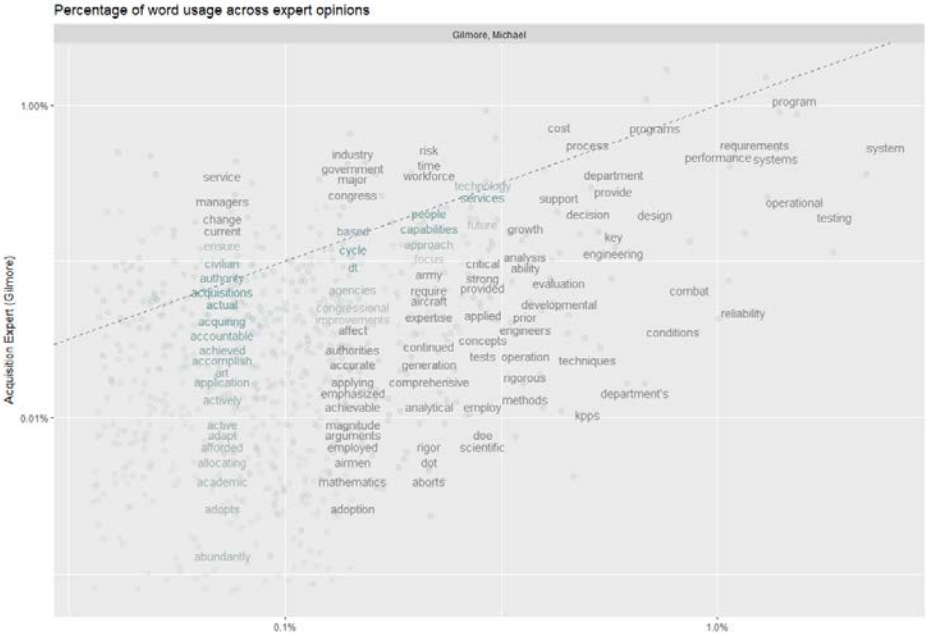

Figure 71: Word Frequency Percent - Expert: Gilmore

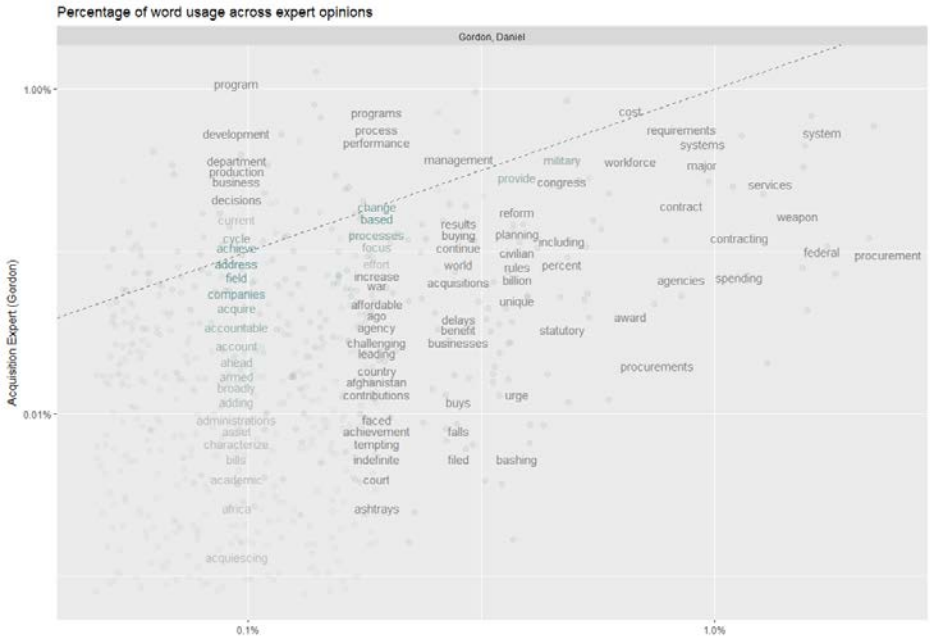

Figure 72: Word Frequency Percent - Expert: Gordon

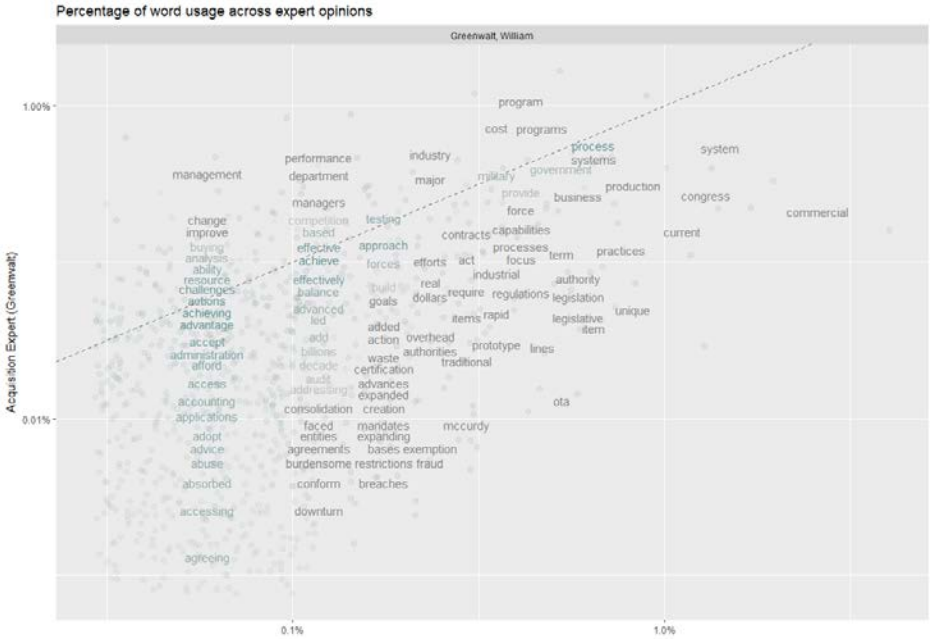

Figure 73: Word Frequency Percent - Expert: Greenwalt

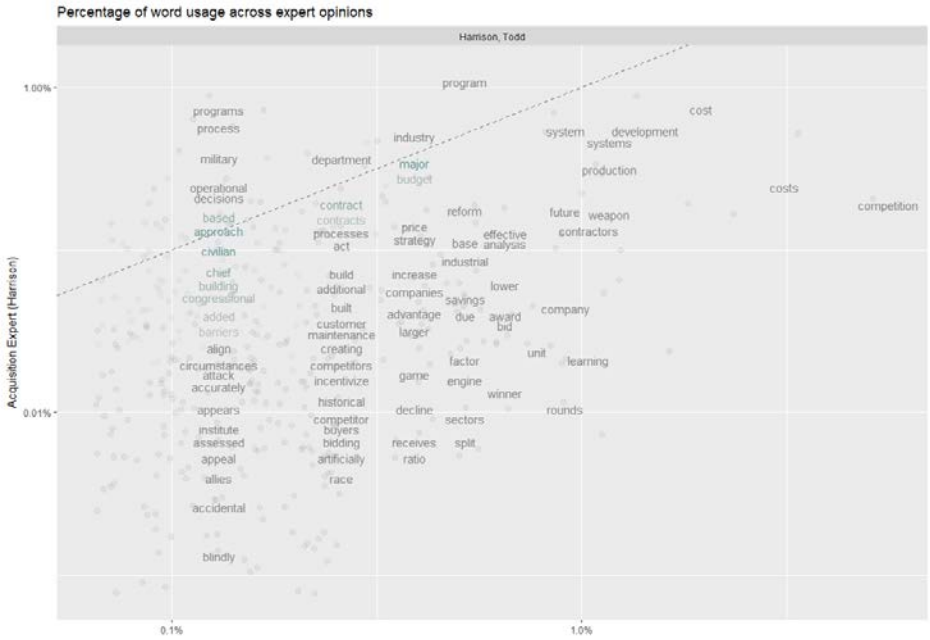

Figure 74: Word Frequency Percent - Expert: Harrison

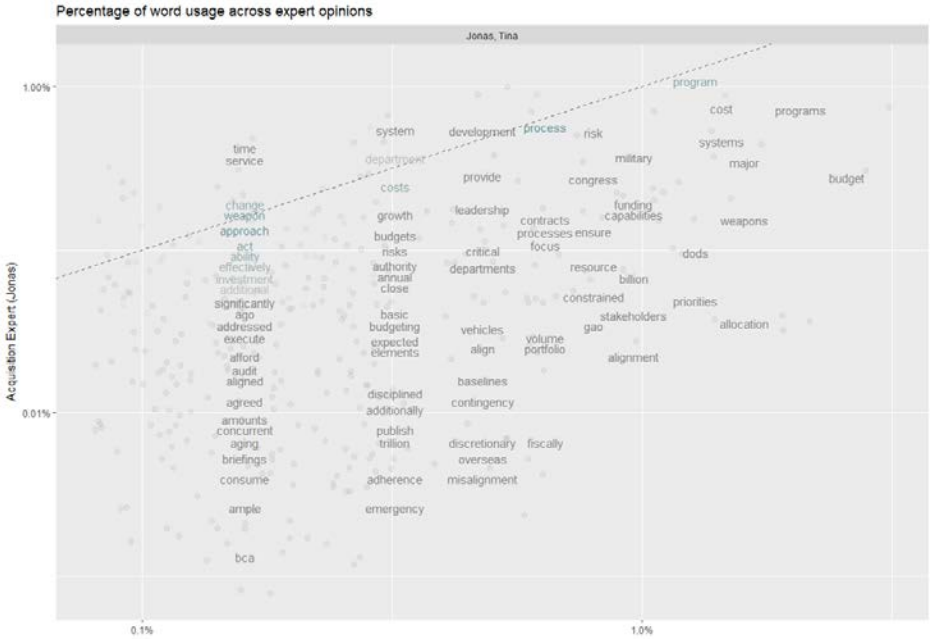

Figure 75: Word Frequency Percent - Expert: Jonas

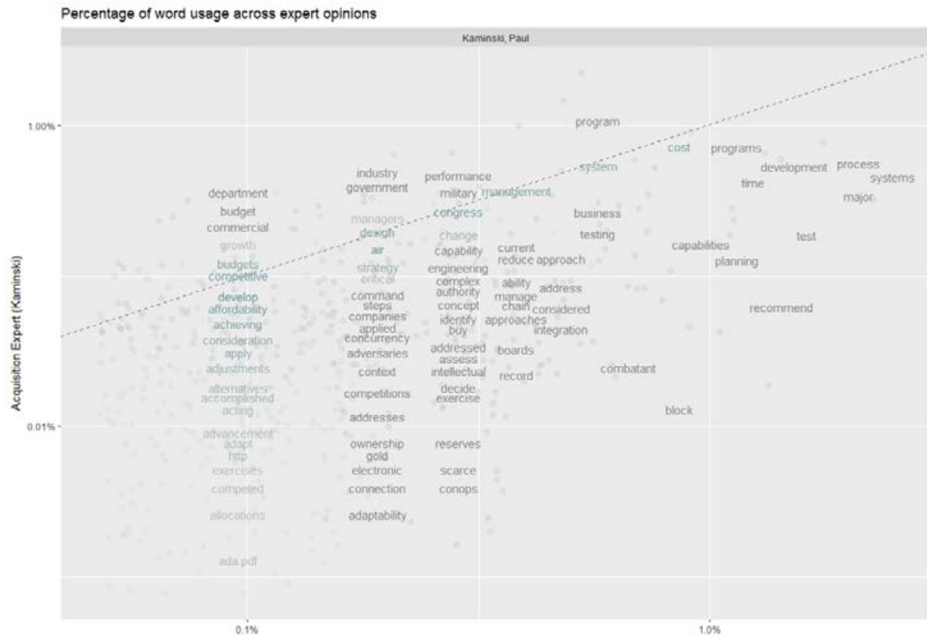

Figure 76: Word Frequency Percent - Expert: Kaminski

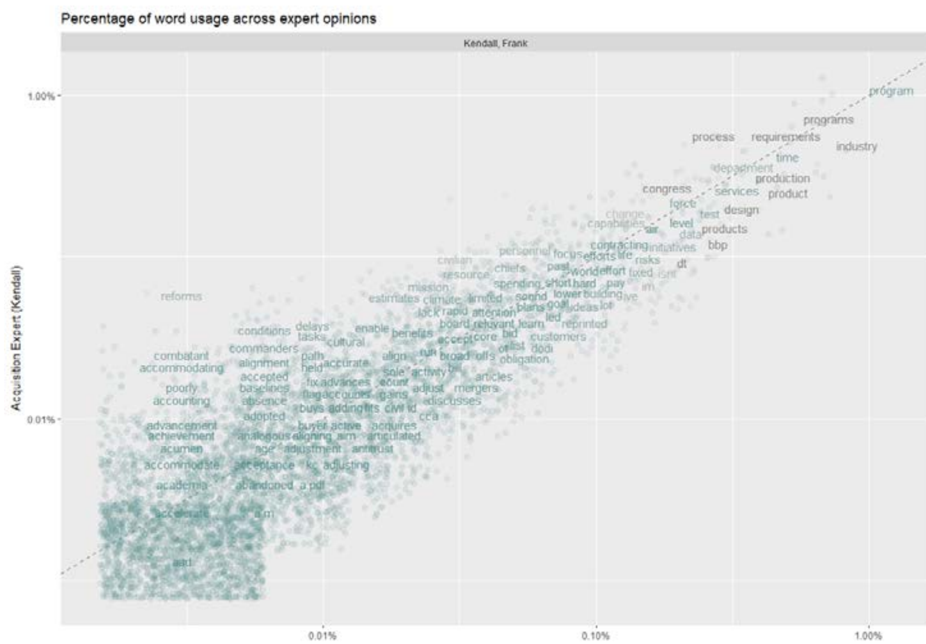

Figure 77: Word Frequency Percent - Expert: Kendall

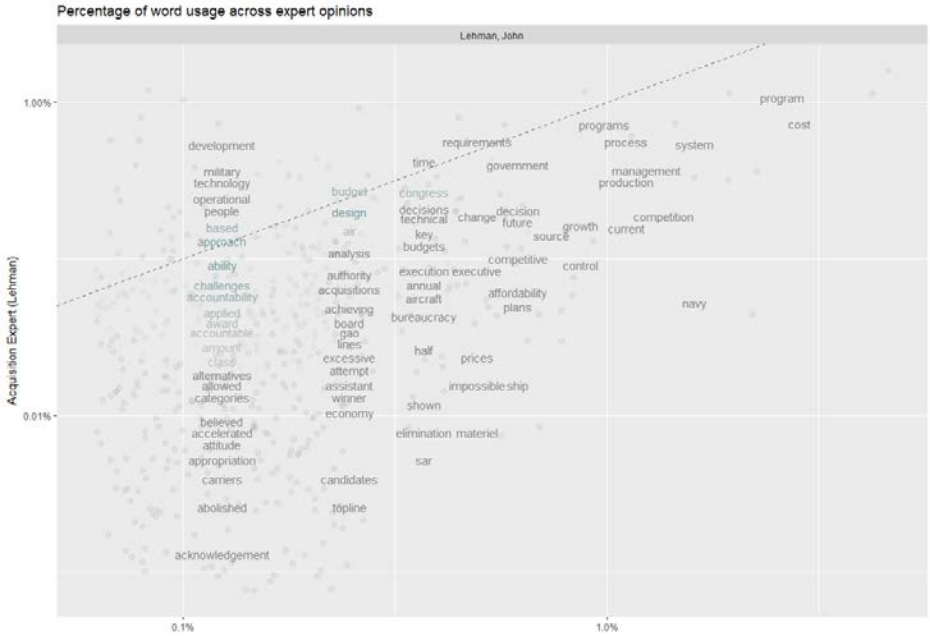

Figure 78: Word Frequency Percent - Expert: Lehman

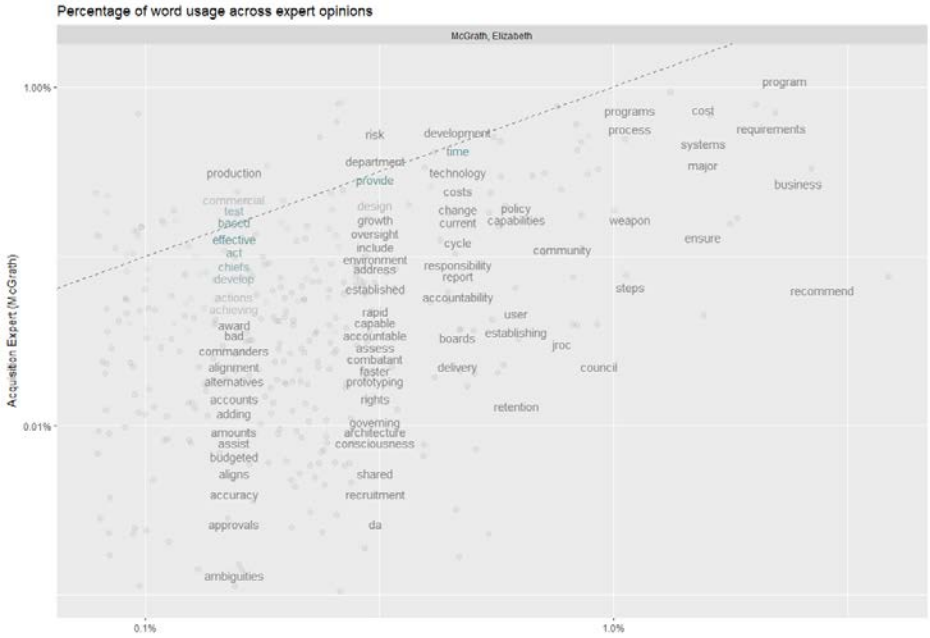

Figure 79: Word Frequency Percent - Expert: McGrath

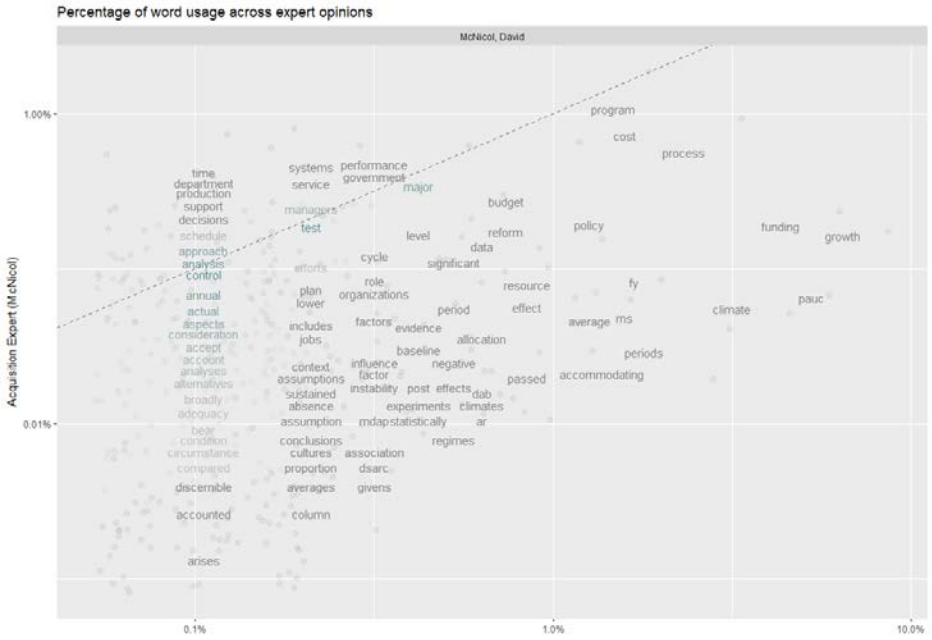

Figure 80: Word Frequency Percent - Expert: McNicol

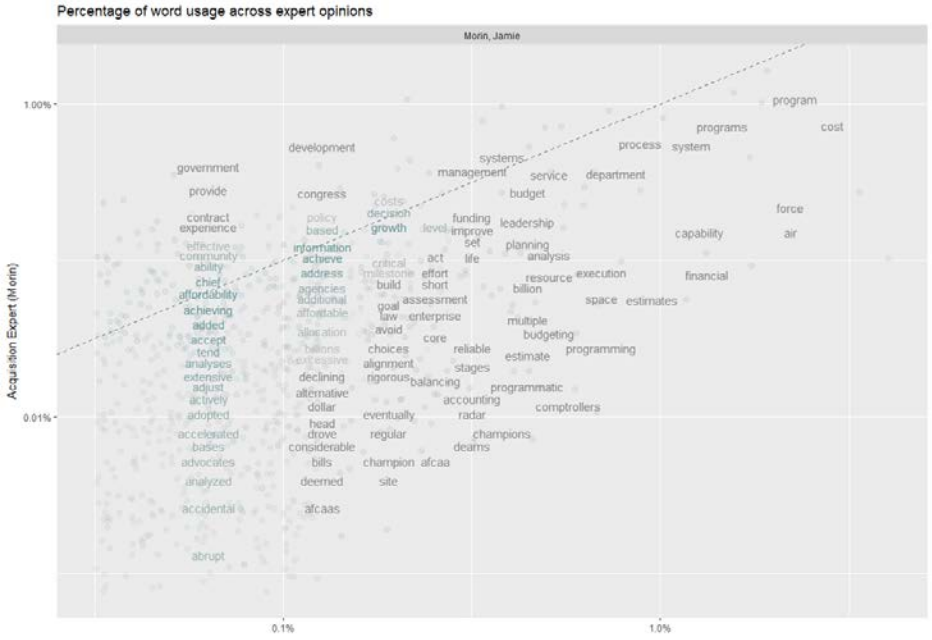

Figure 81: Word Frequency Percent - Expert: Morin

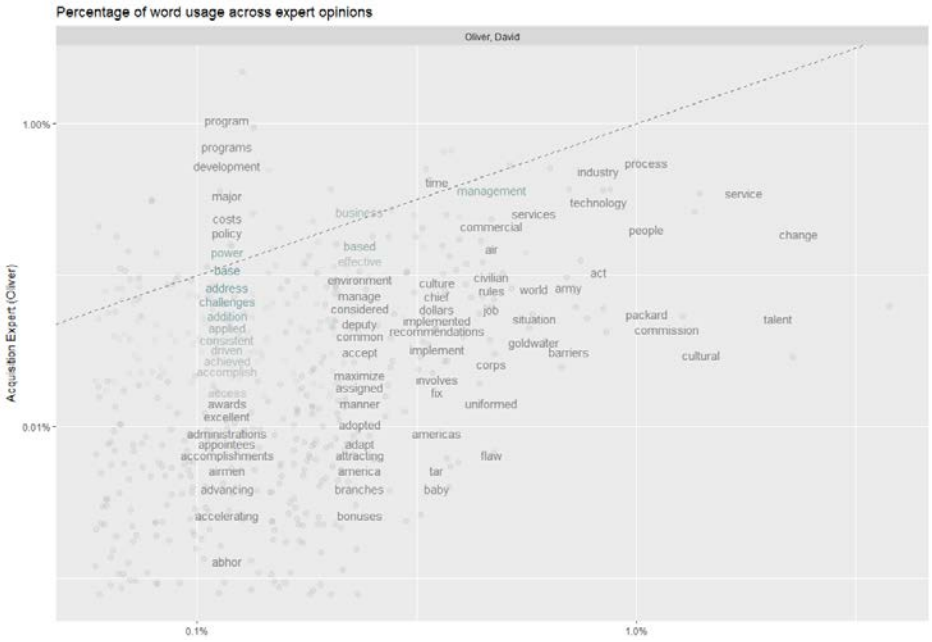

Figure 82: Word Frequency Percent - Expert: Oliver

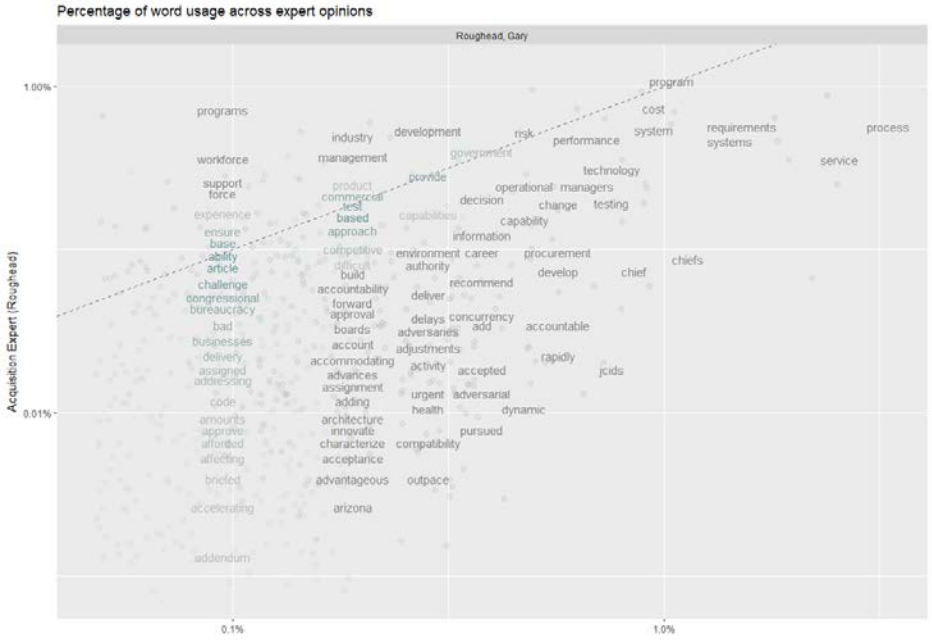

Figure 83: Word Frequency Percent - Expert: Roughead

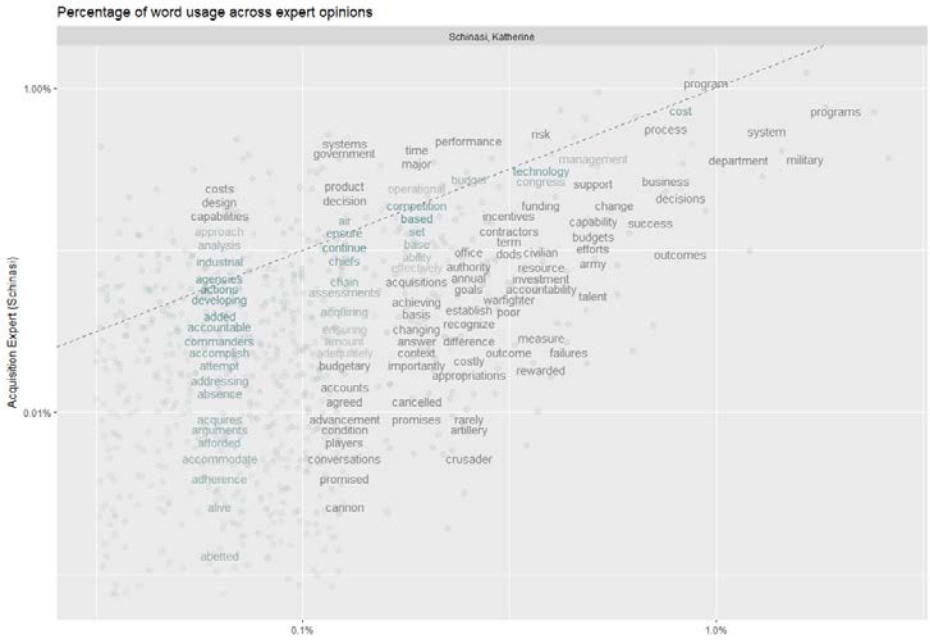

Figure 84: Word Frequency Percent - Expert: Schinasi

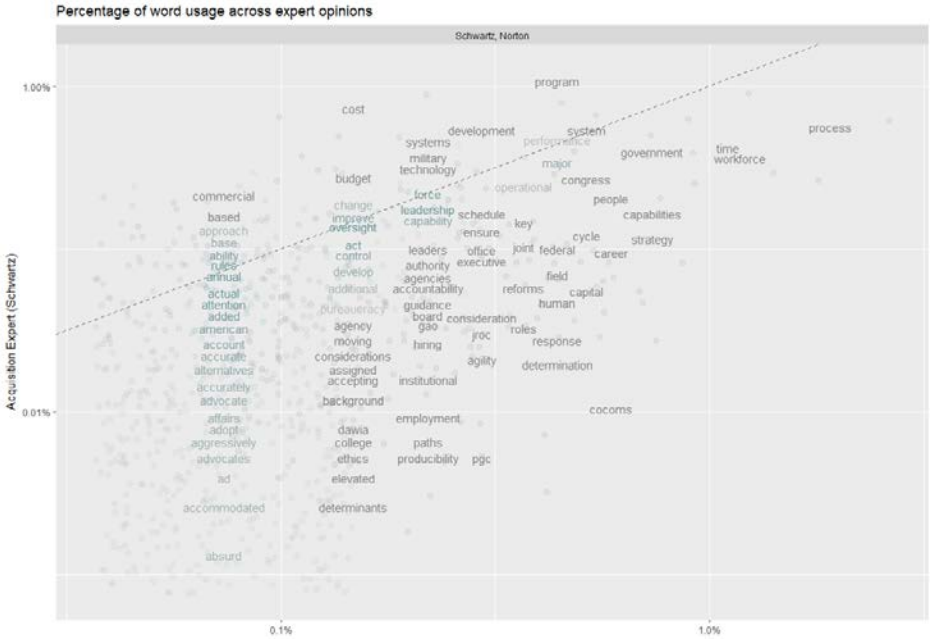

Figure 85: Word Frequency Percent - Expert: Schwartz

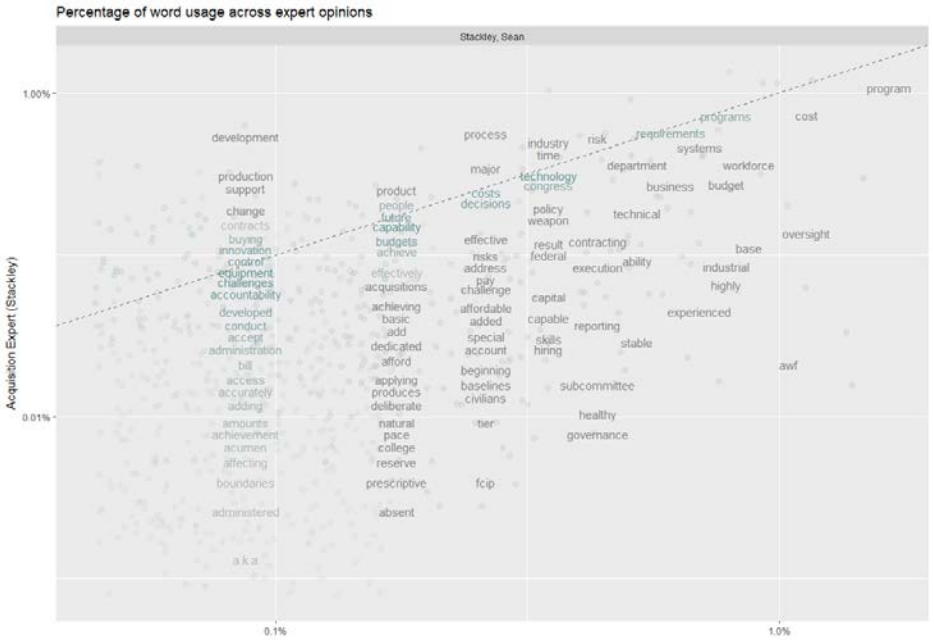

Figure 86: Word Frequency Percent - Expert: Stackely

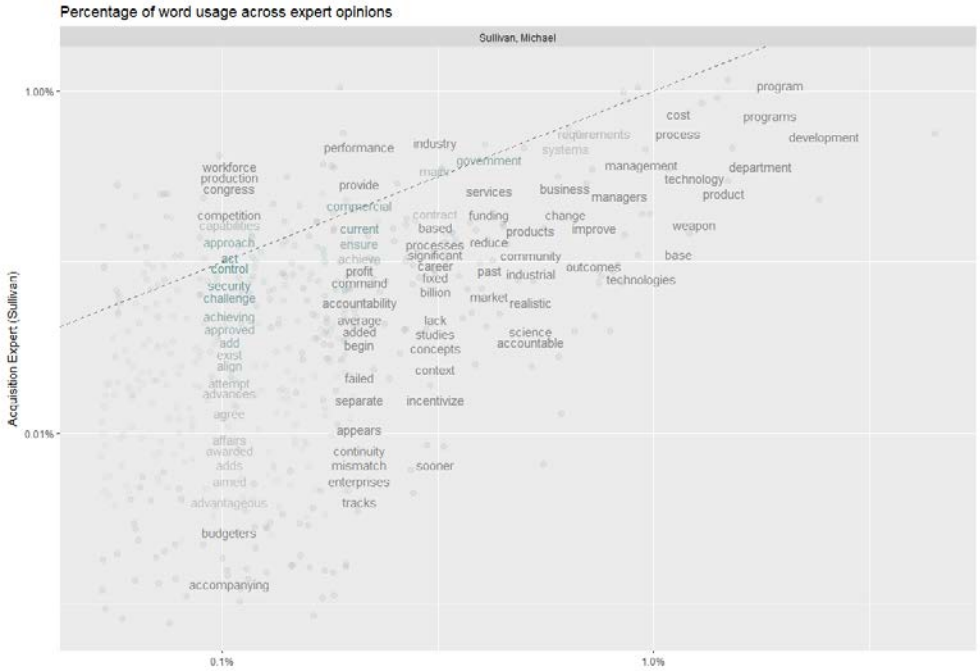

Figure 87: Word Frequency Percent - Expert: Sullivan

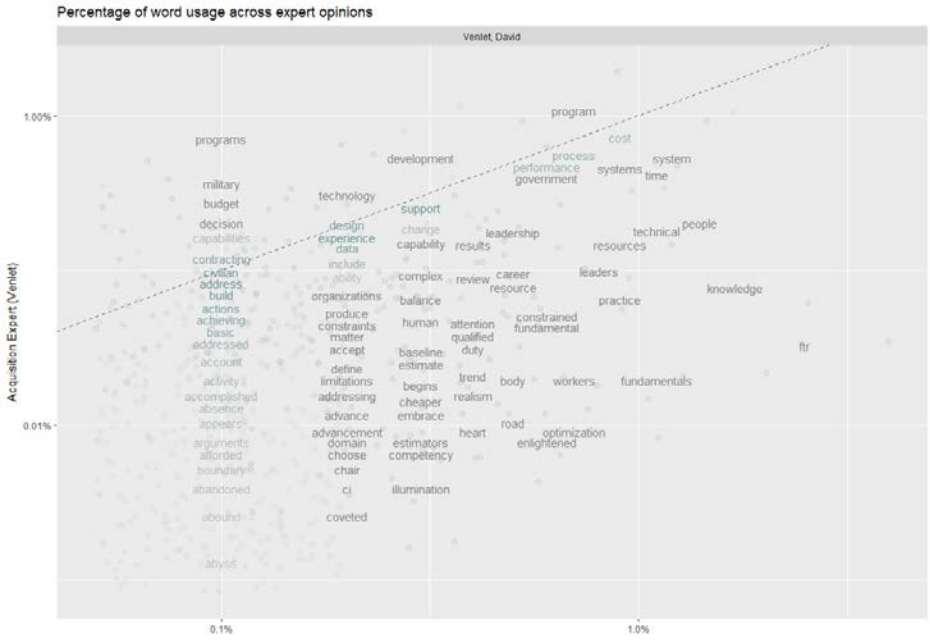

Figure 88: Word Frequency Percent - Expert: Venlet

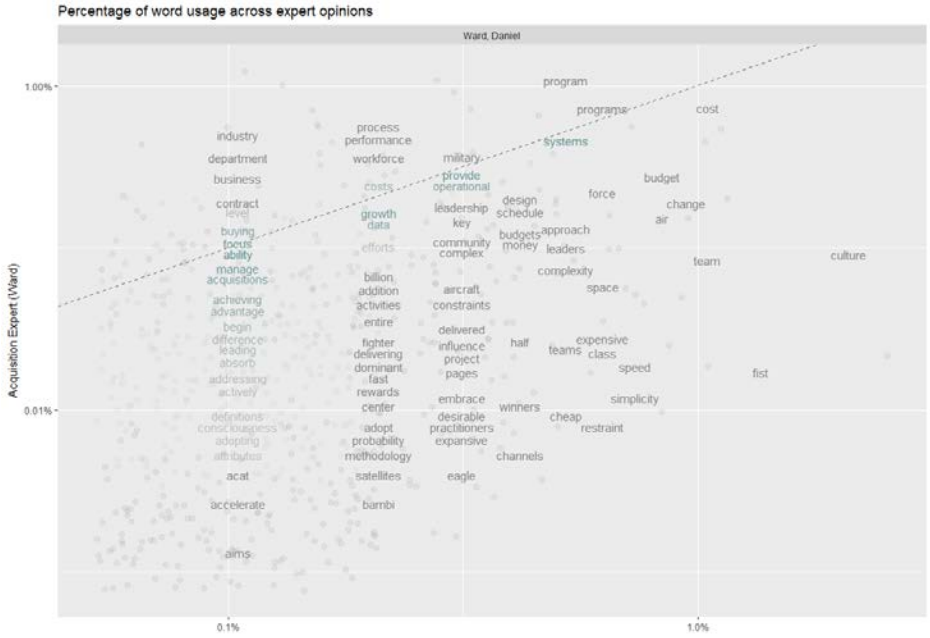

Figure 89: Word Frequency Percent - Expert: Ward

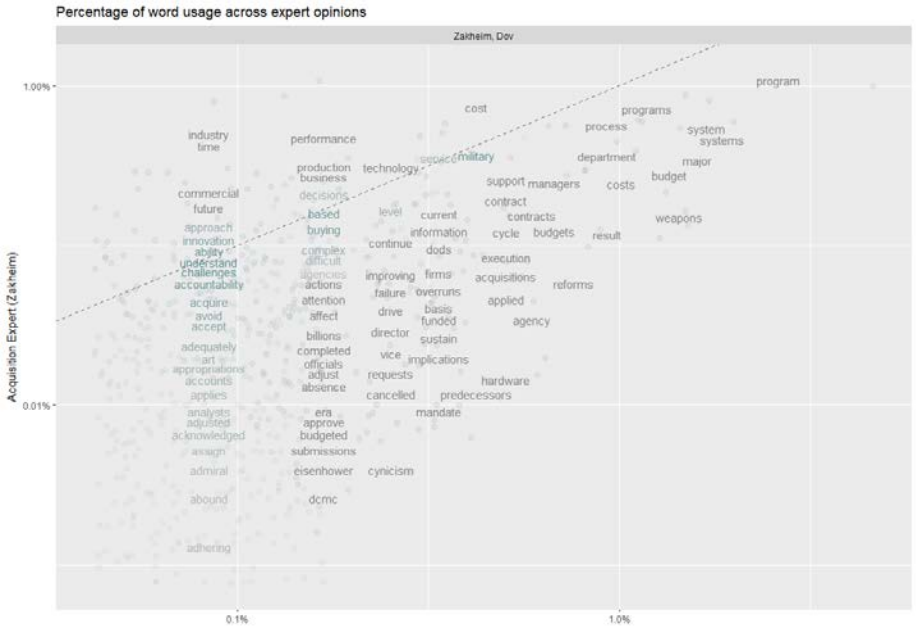

Figure 90: Word Frequency Percent - Expert: Zakheim

5. Term Frequency-Inverse Document Frequency (tf-idf)

a. Zipf's Law

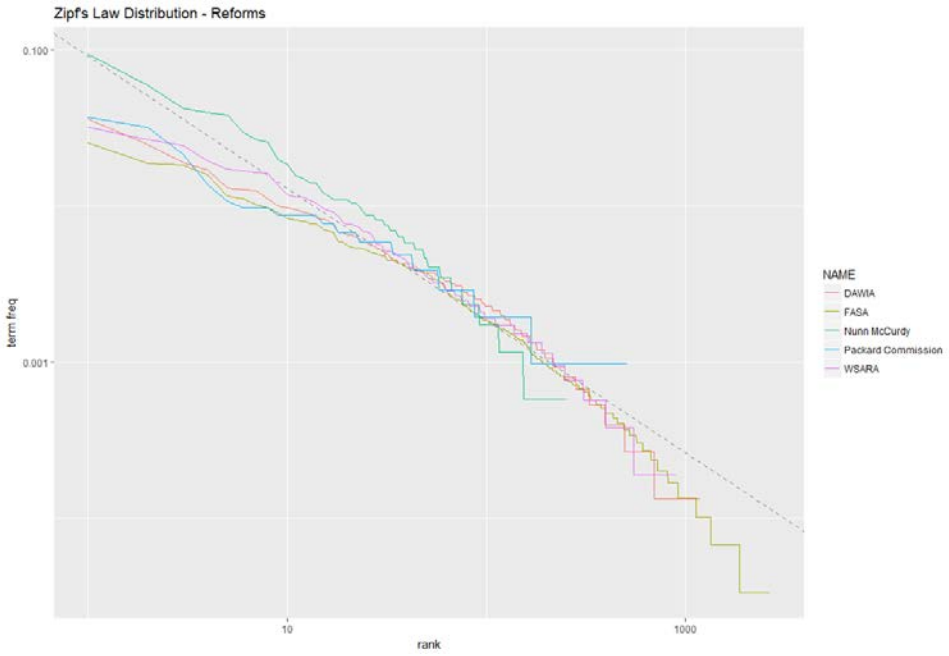

Figure 91: Zipf's Law - Reforms

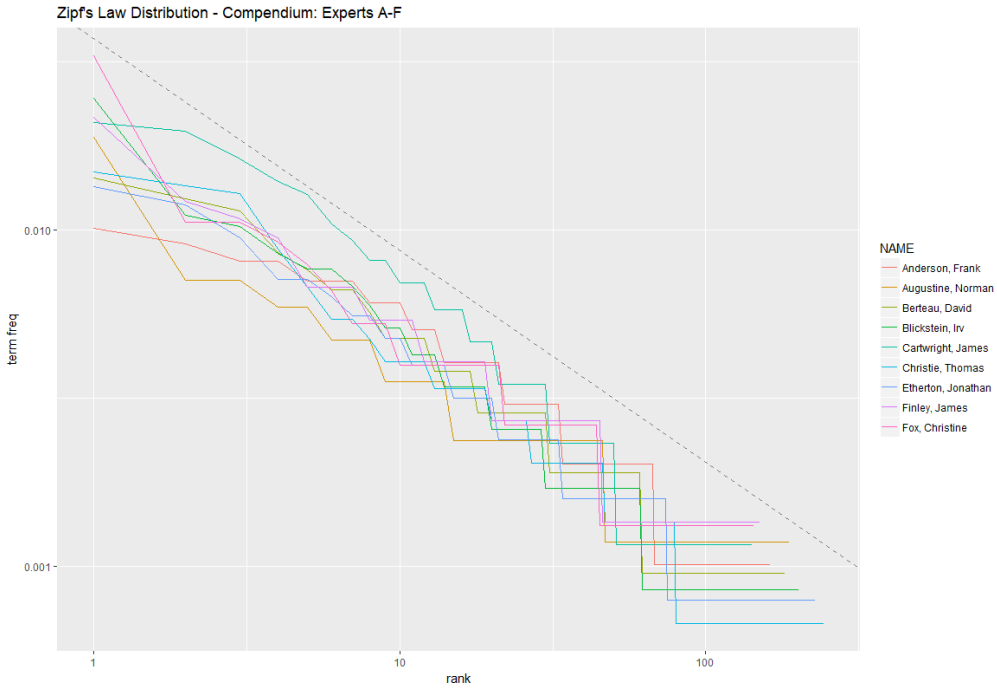

Figure 92: Zipf's Law - Experts A-F

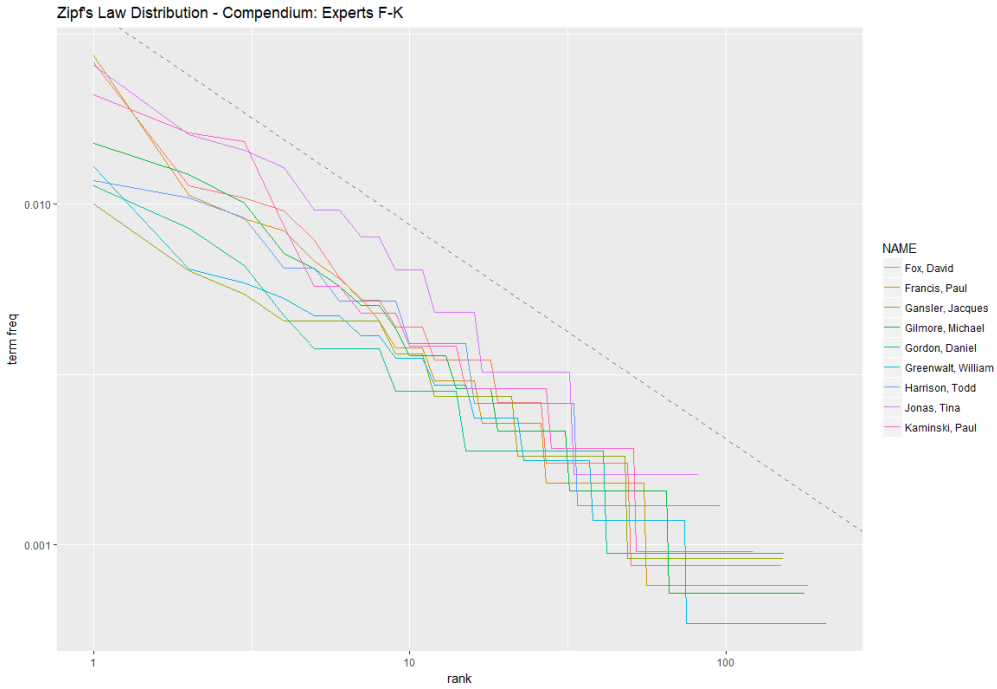

Figure 93: Zipf's Law - Experts F-K

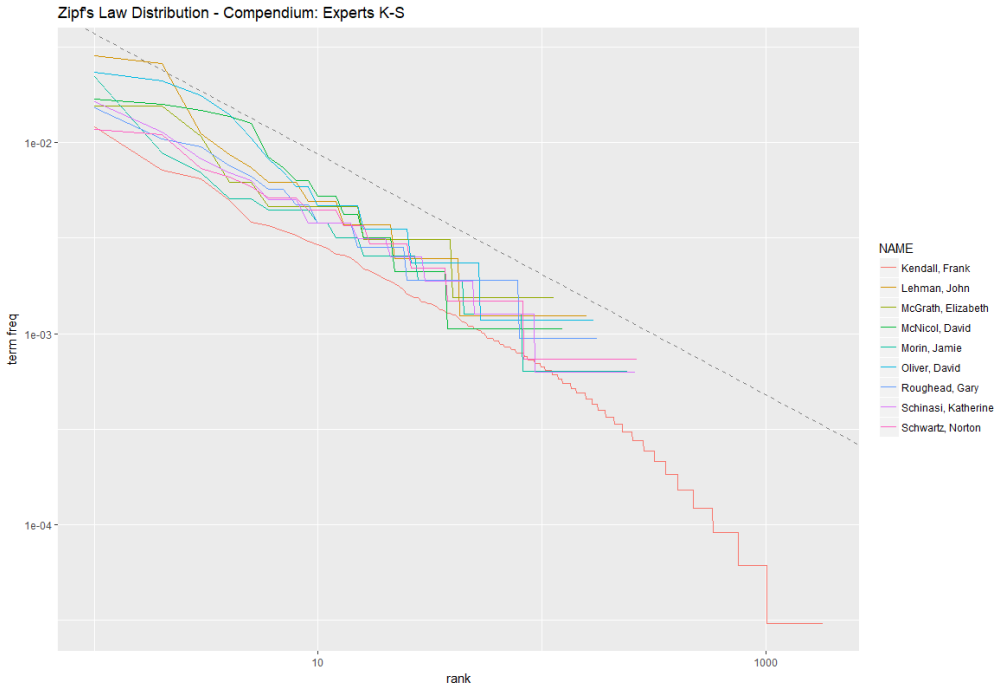

Figure 94: Zipf's Law - Experts K-S

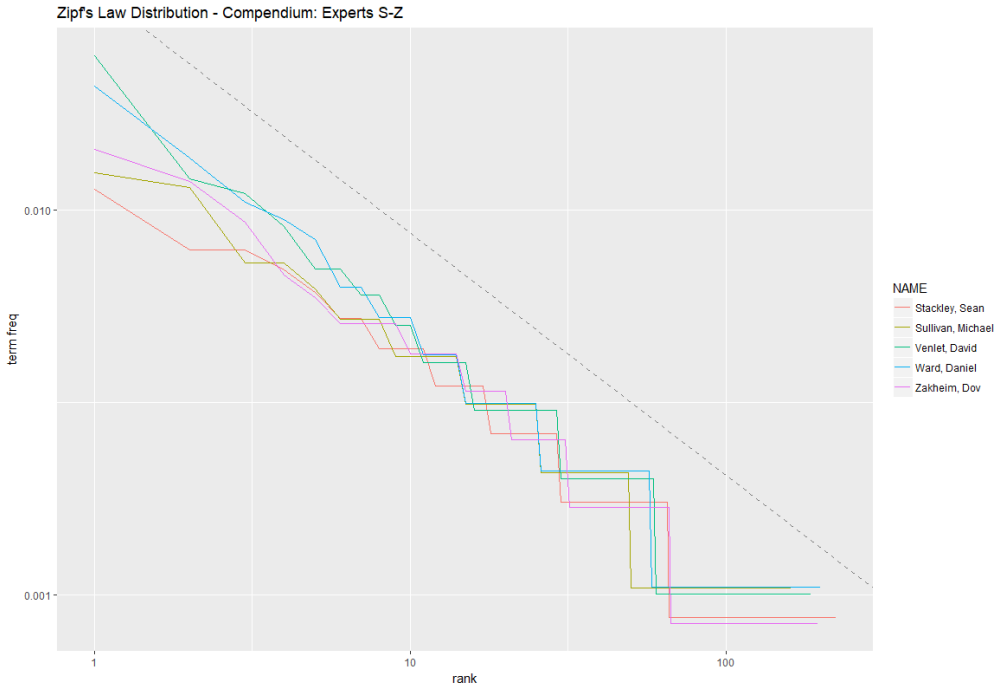

Figure 95: Zipf's Law - Experts S-Z

b. tf-idf (Individual Words)

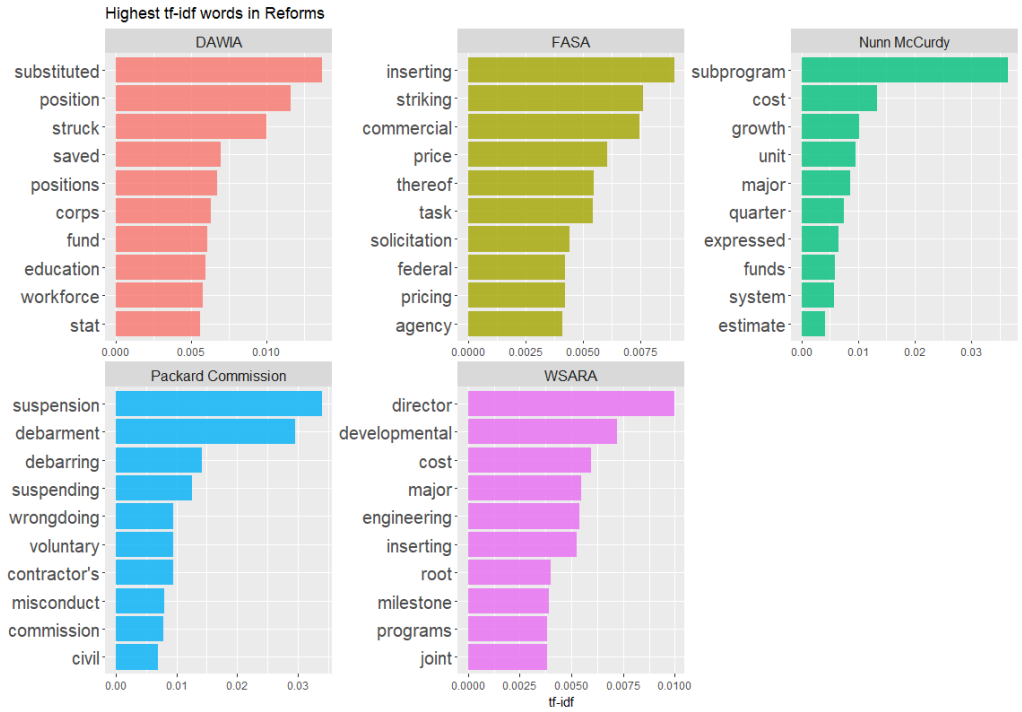

Figure 96: tf-idf Reforms

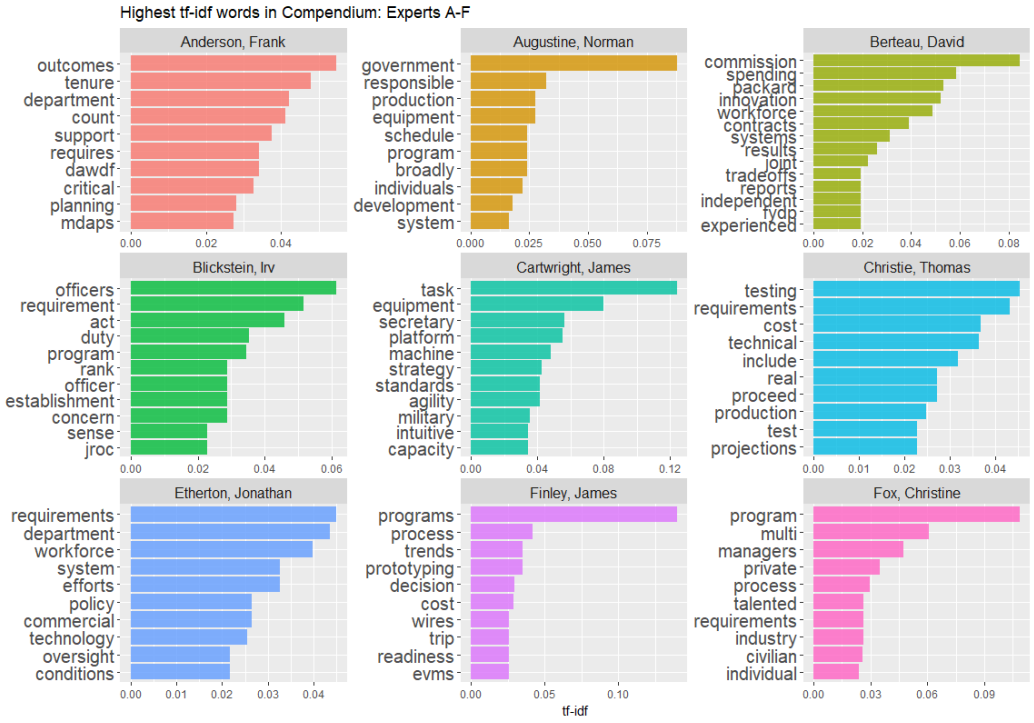

Figure 97: tf-idf Experts A-F

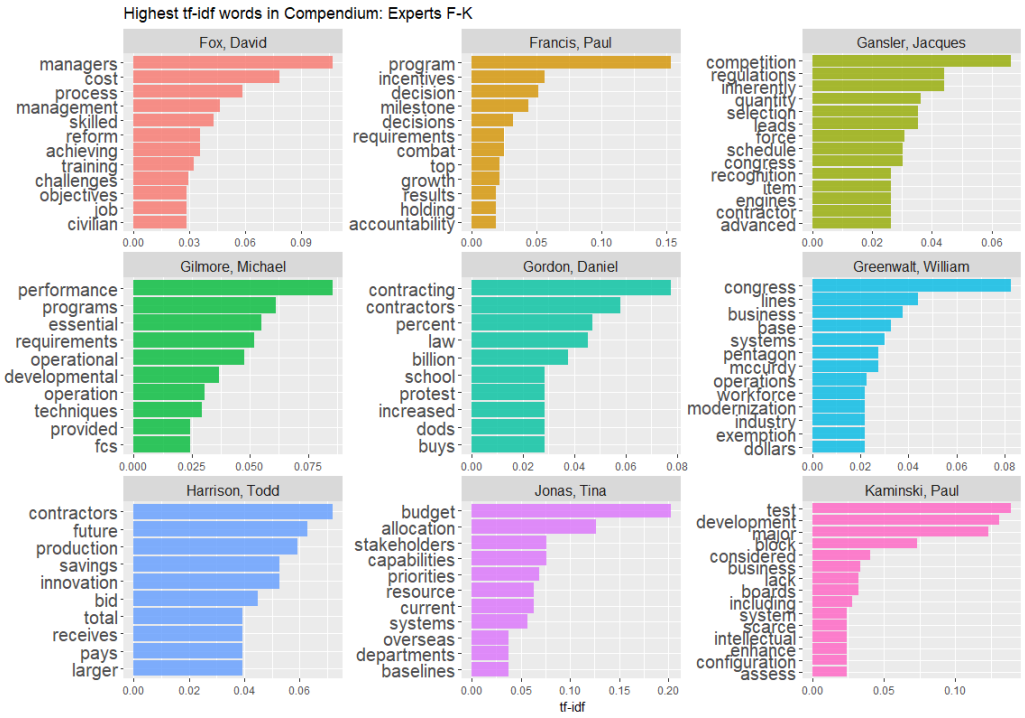

Figure 36: tf-idf Experts F-K

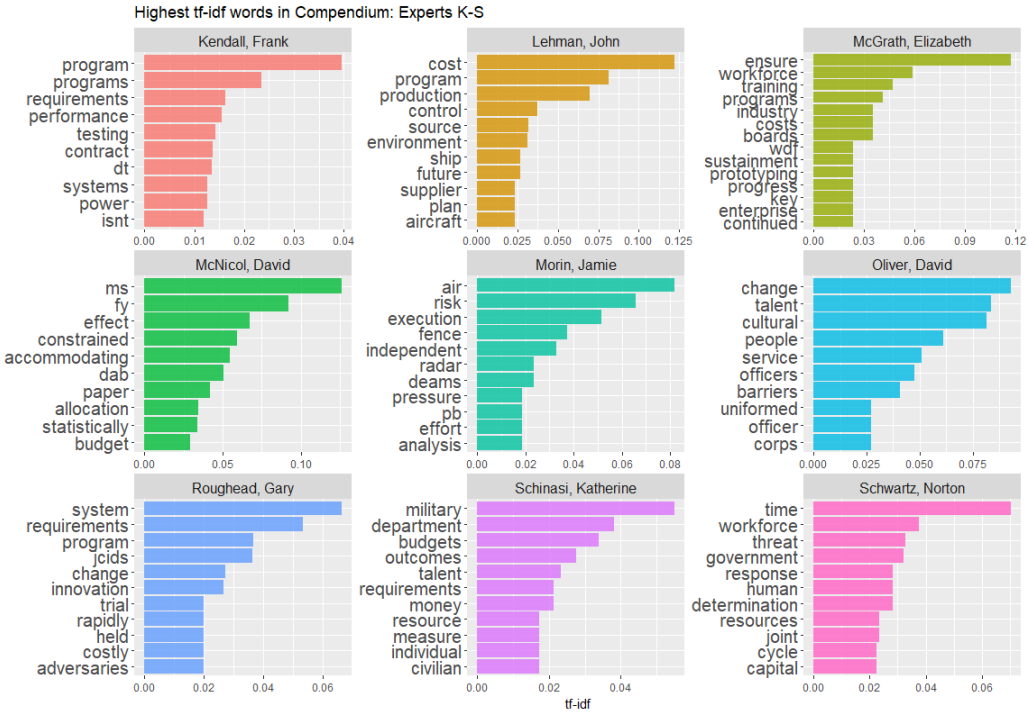

Figure 98: tf-idf Experts K-S

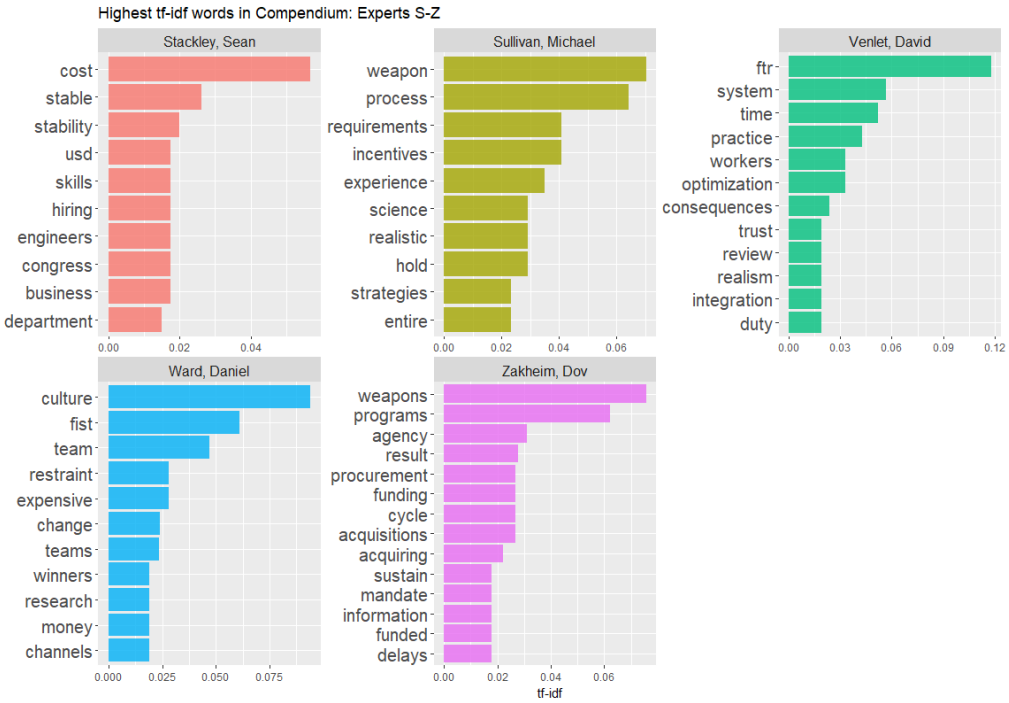

Figure 99: tf-idf Experts S-Z

c. tf-idf (Bi-Gram)

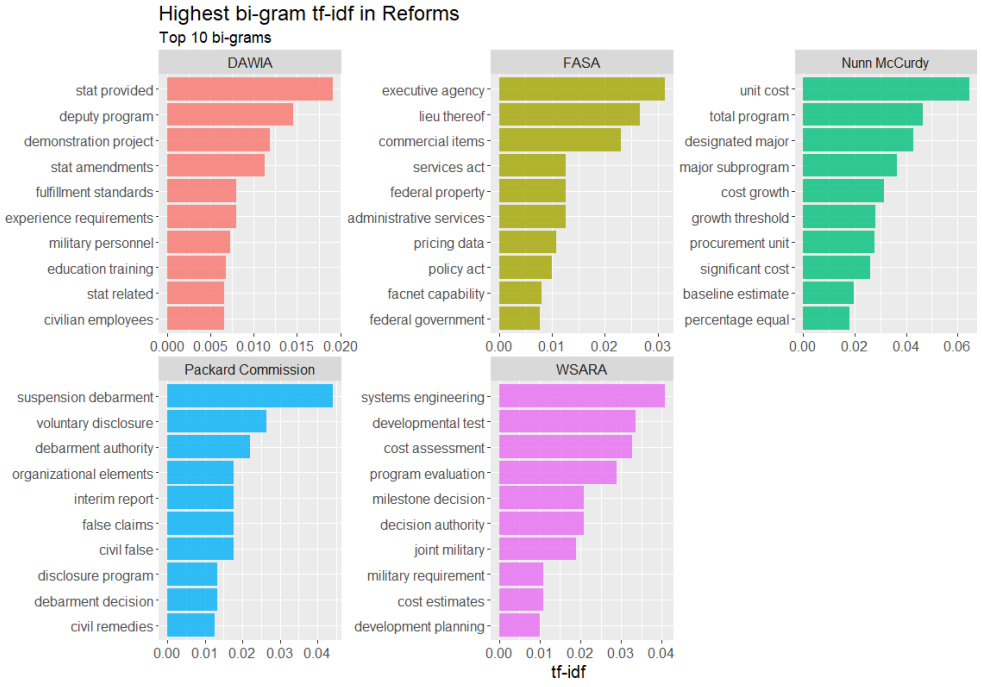

Figure 100: Bi-Gram tf-idf - Reforms

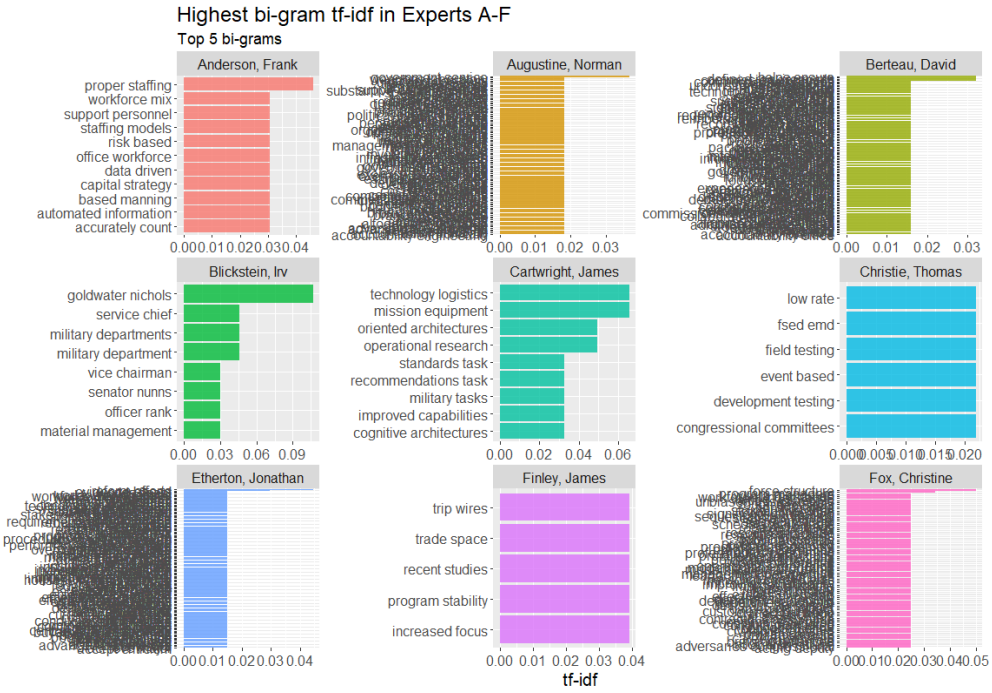

Figure 101: Bi-Gram tf-idf - Experts A-F

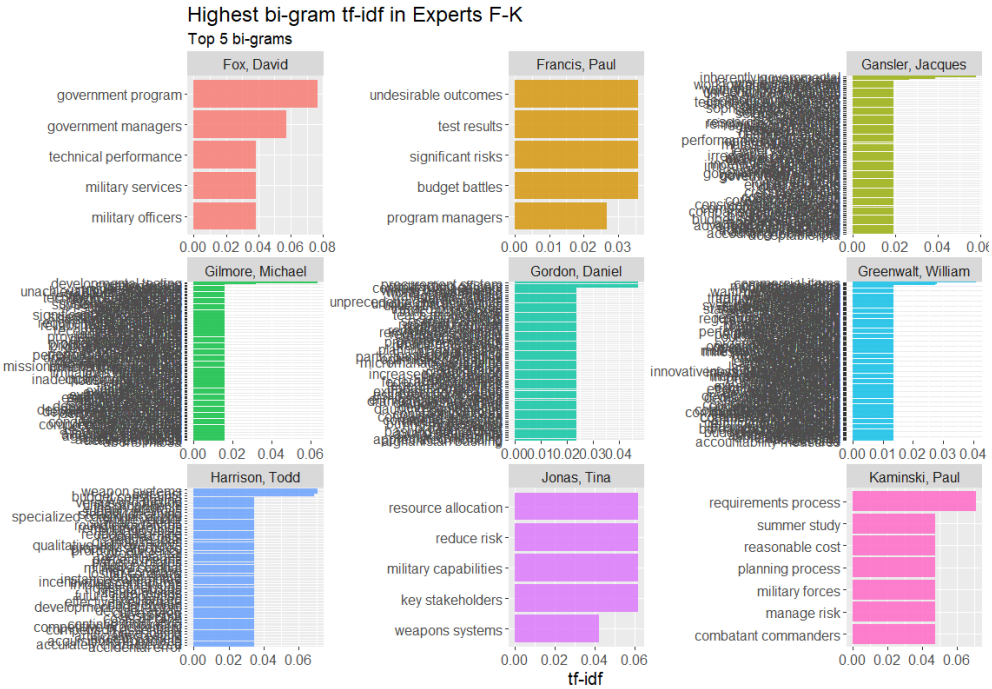

Figure 102: Bi-Gram tf-idf - Experts F-K

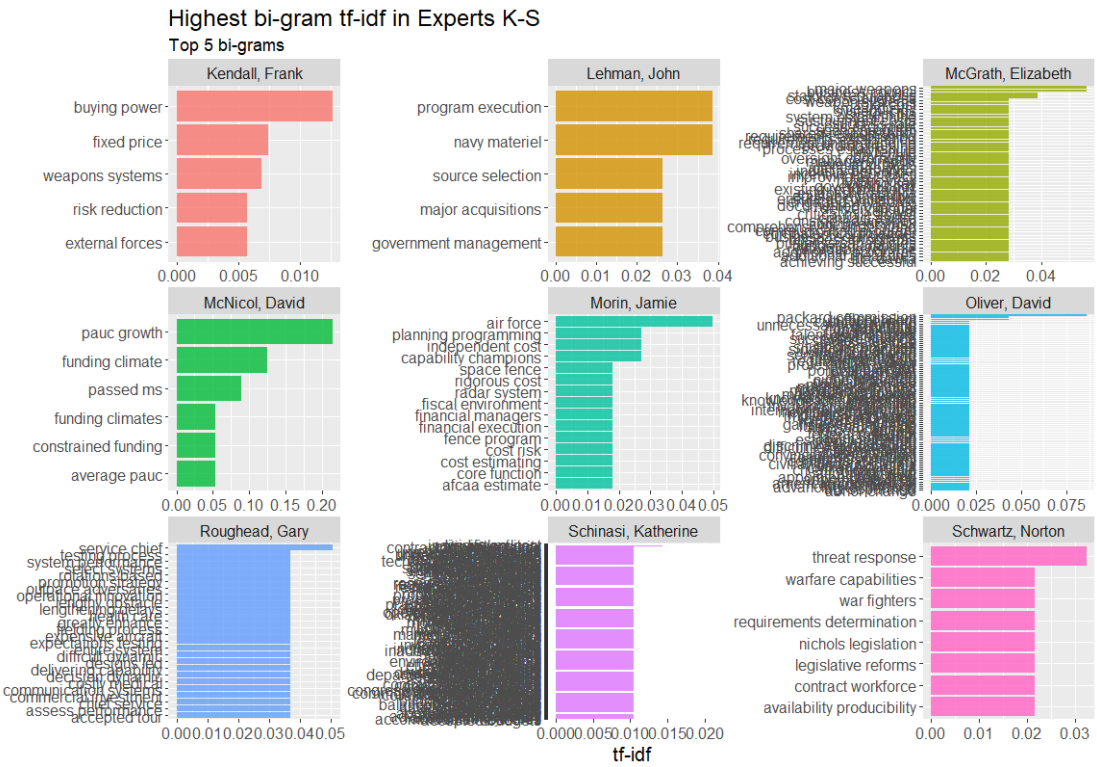

Figure 103: Bi-Gram tf-idf - Experts K-S

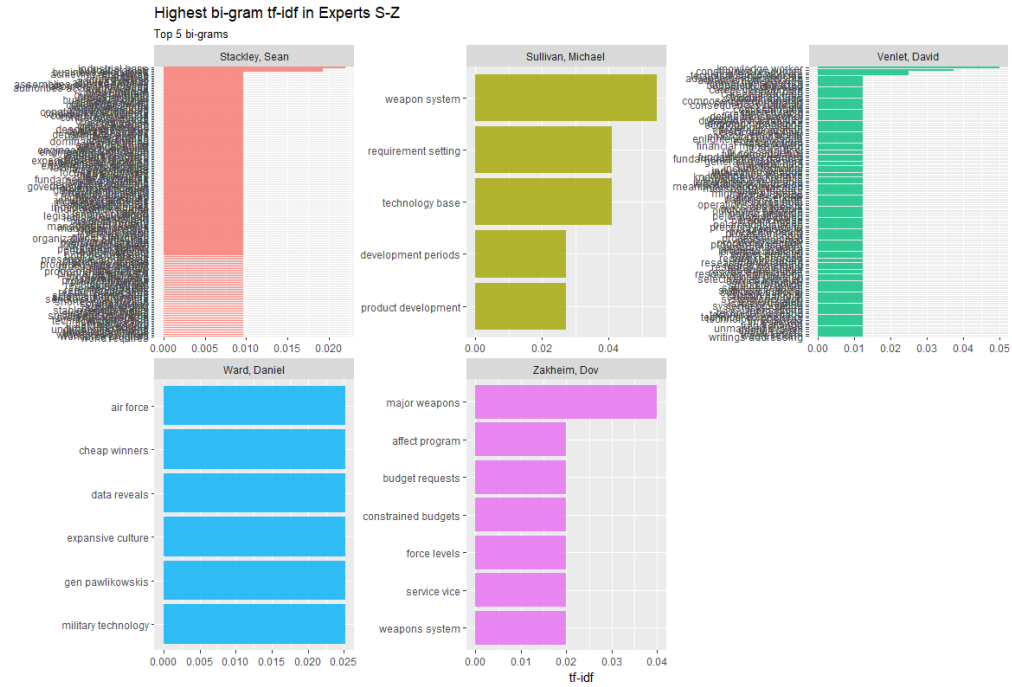

Figure 104: Bi-Gram tf-idf - Experts S-Z

Appendix D: Text Mining - Sentiment Analysis Results

Appendix D Table of Contents

1. Basic Sentiment Analysis

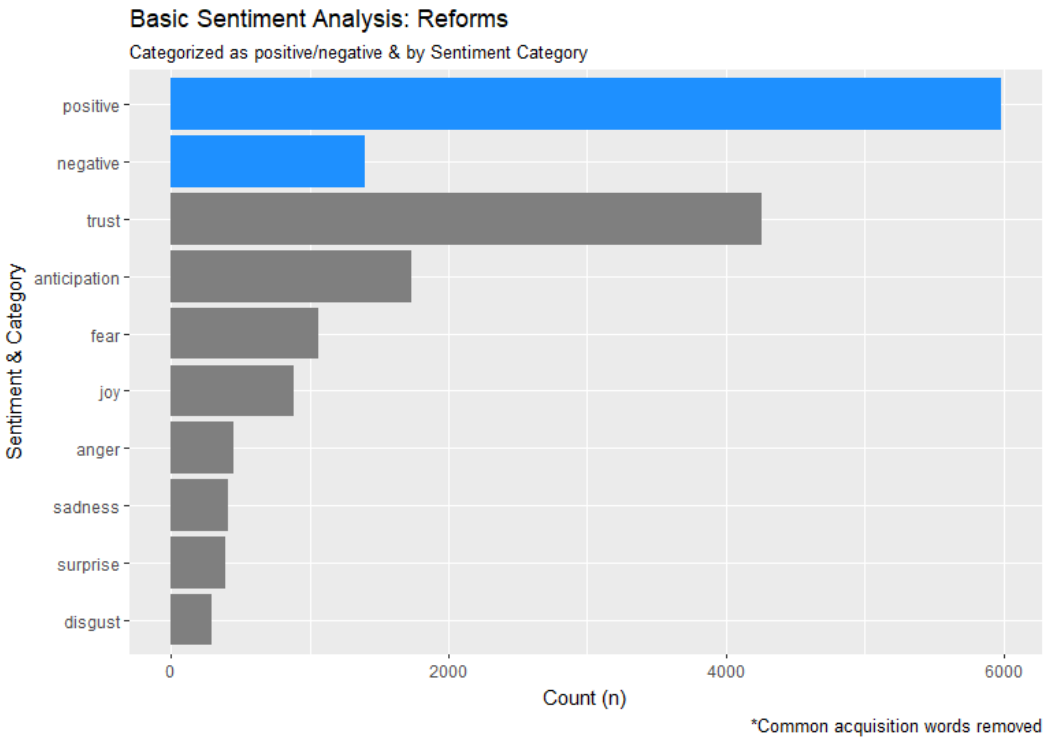

Figure 37: Basic Sentiment - Reforms

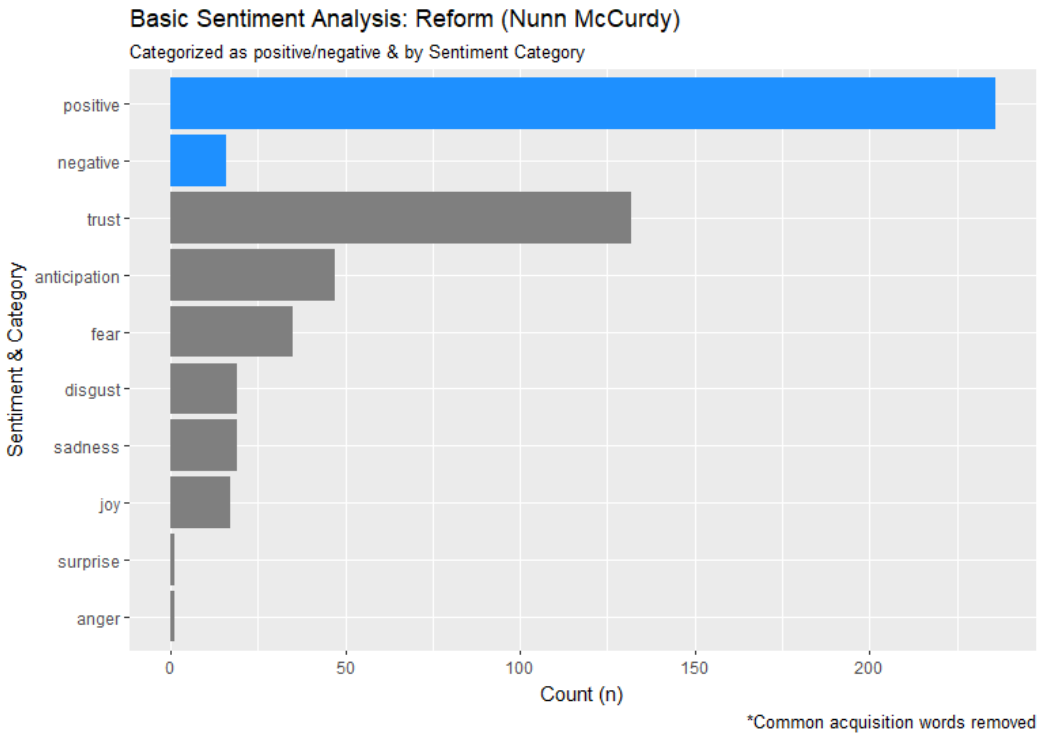

Figure 38: Basic Sentiment - Reform: Nunn McCurdy

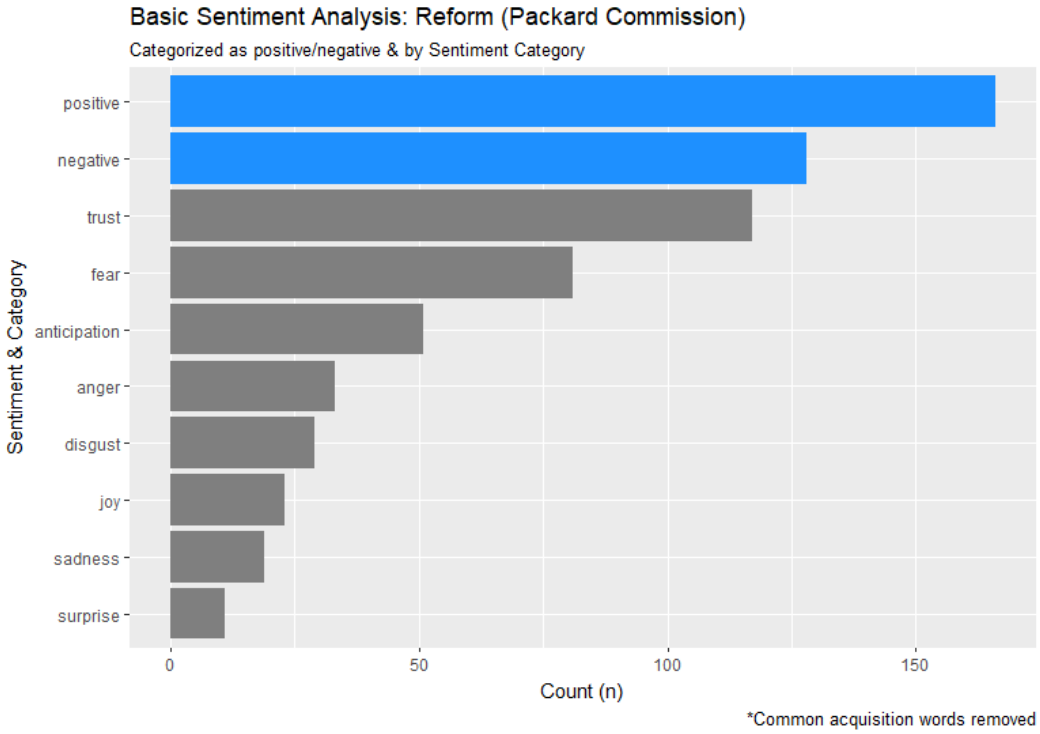

Figure 39: Basic Sentiment - Reform: Packard Commission

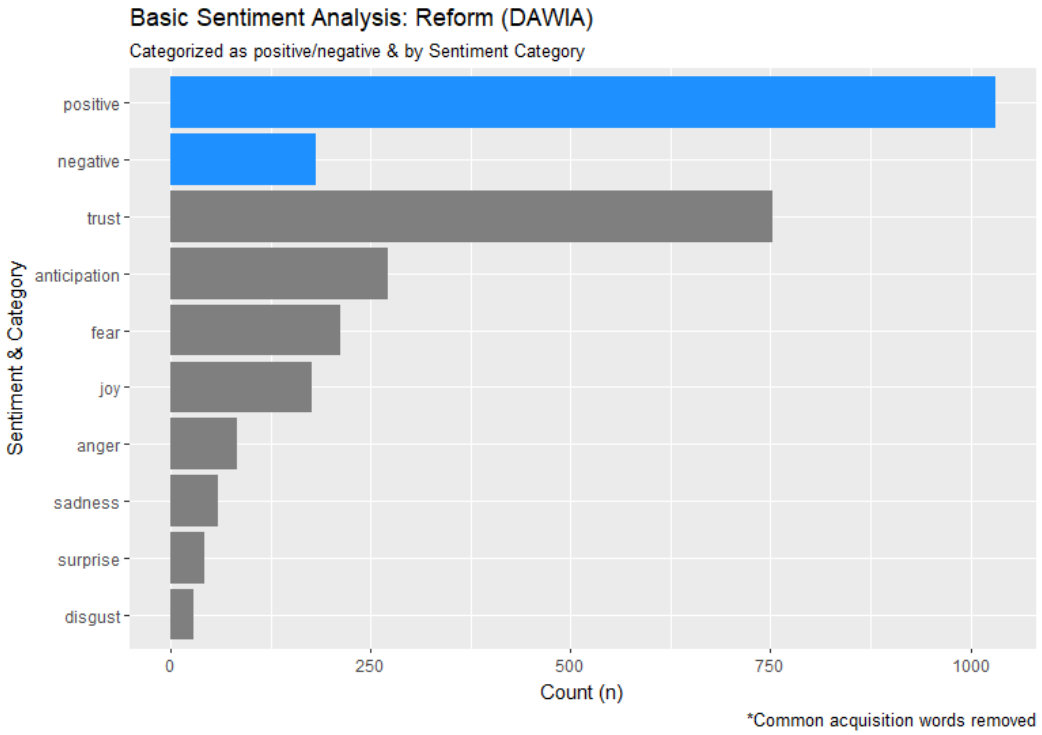

Figure 40: Basic Sentiment - Reform: DAWIA

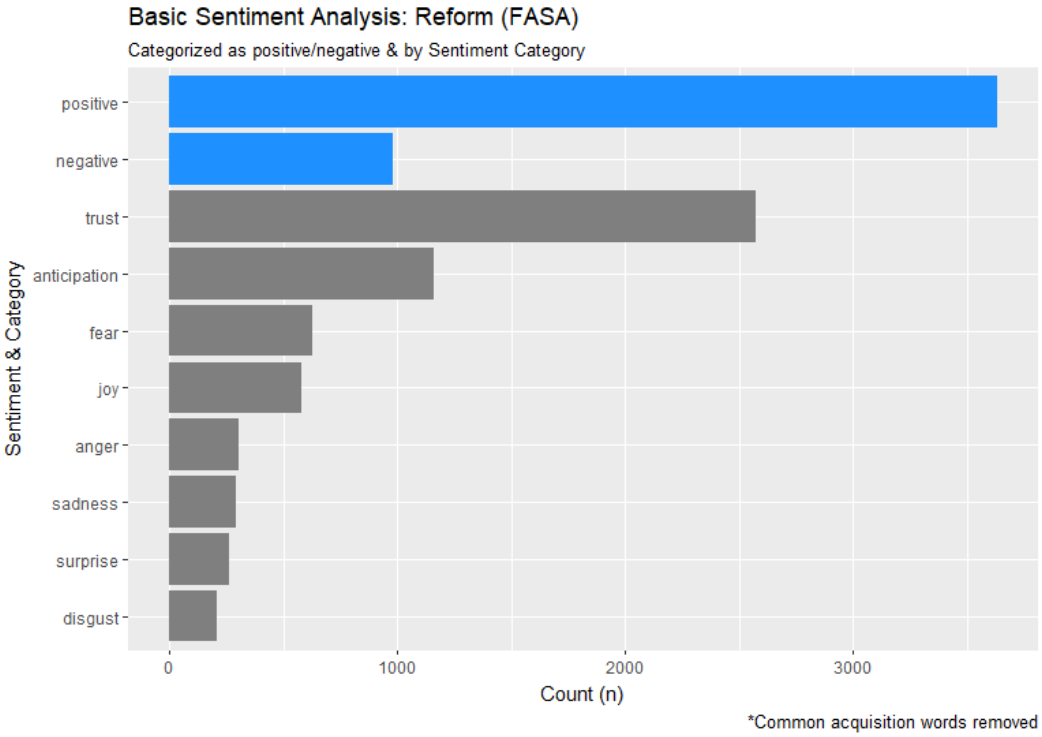

Figure 41: Basic Sentiment - Reform: FASA

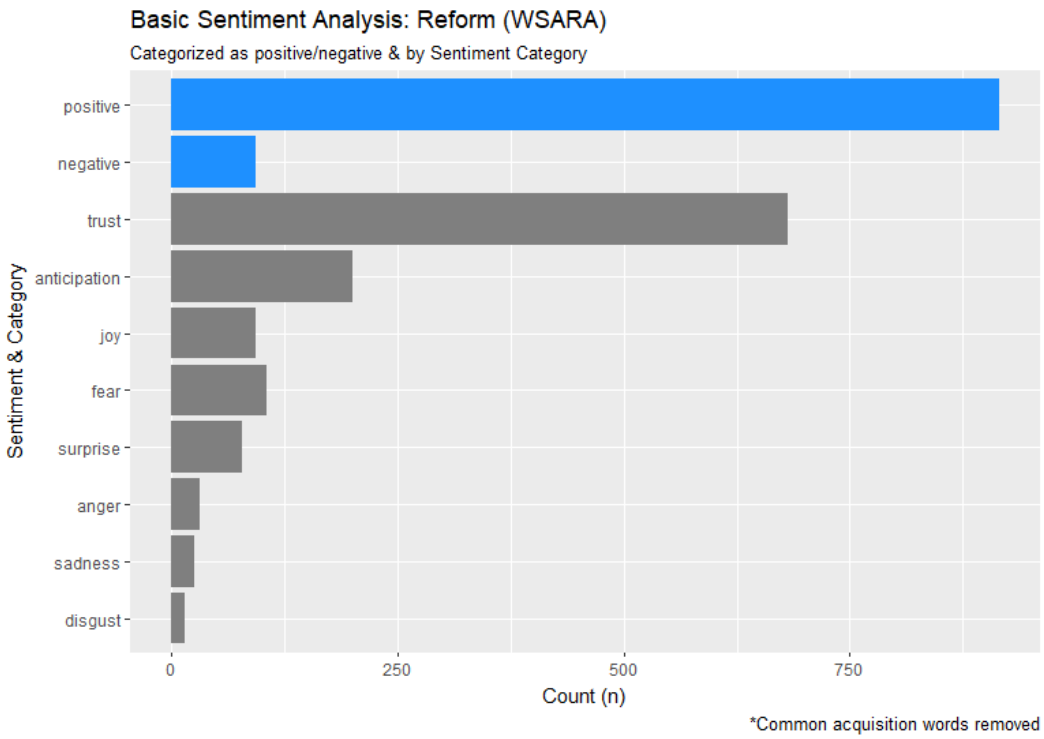

Figure 42: Basic Sentiment - Reform: WSARA

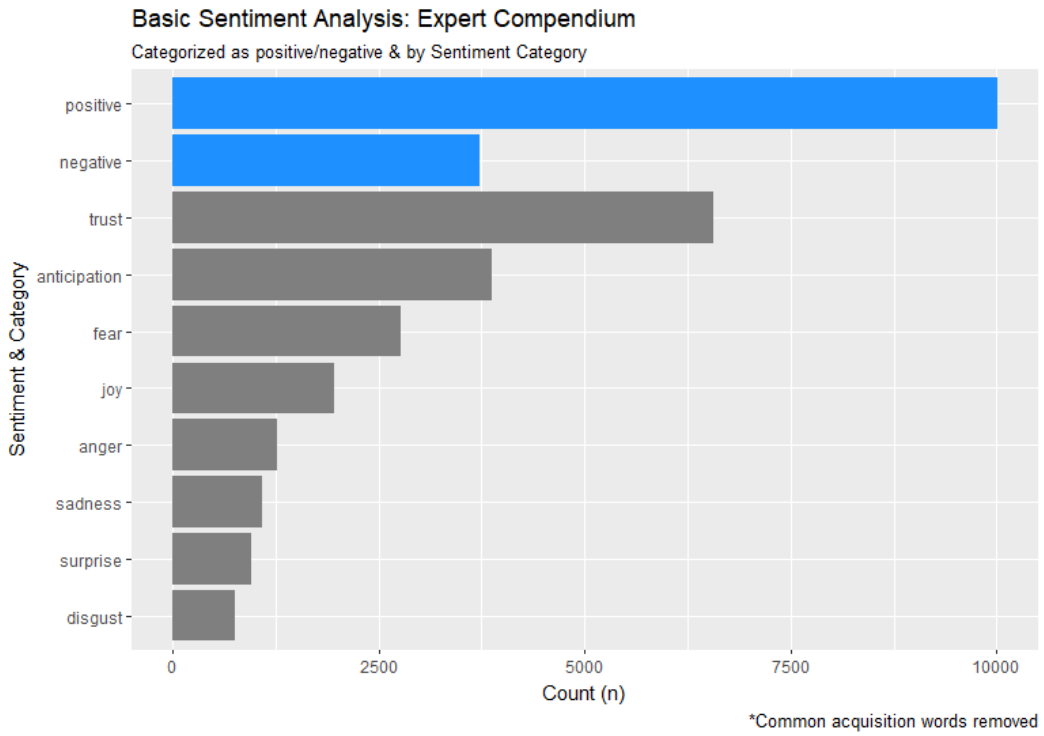

Figure 43: Basic Sentiment - Experts

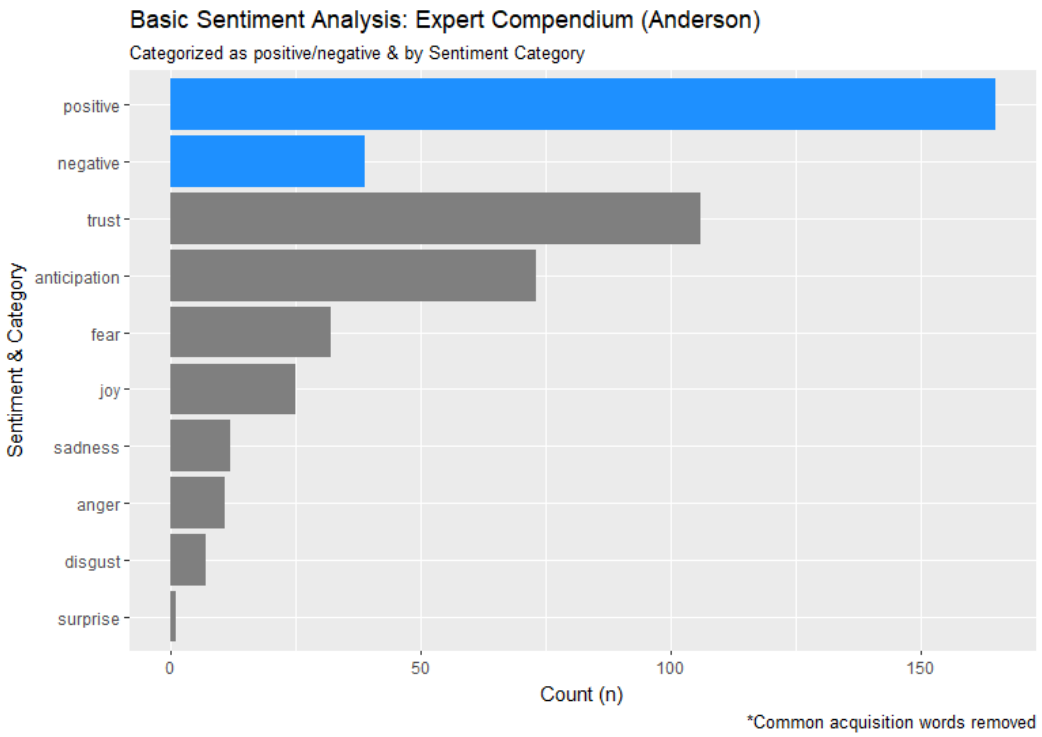

Figure 44: Basic Sentiment - Expert: Anderson

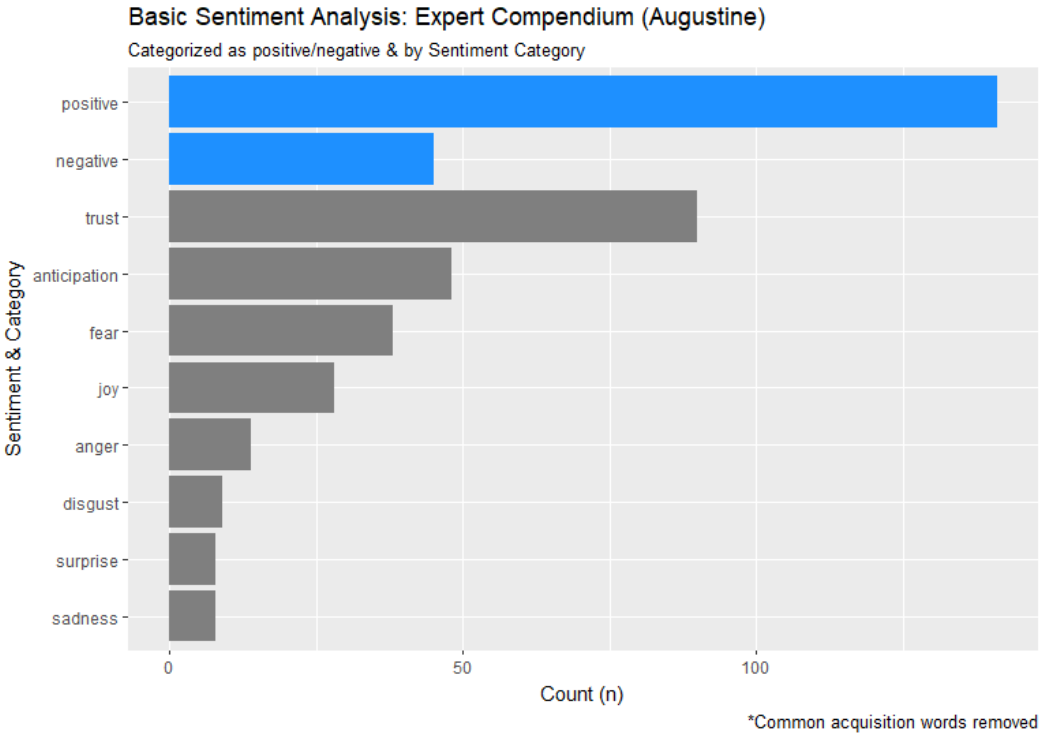

Figure 45: Basic Sentiment - Expert: Augustine

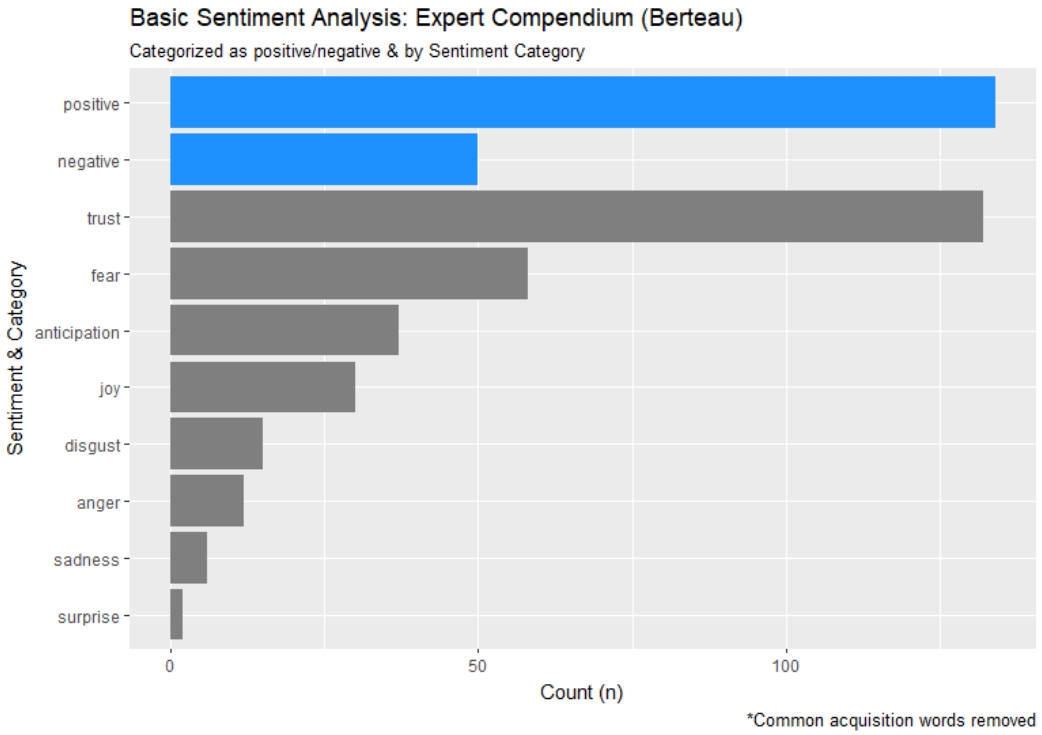

Figure 46: Basic Sentiment - Expert: Berteau

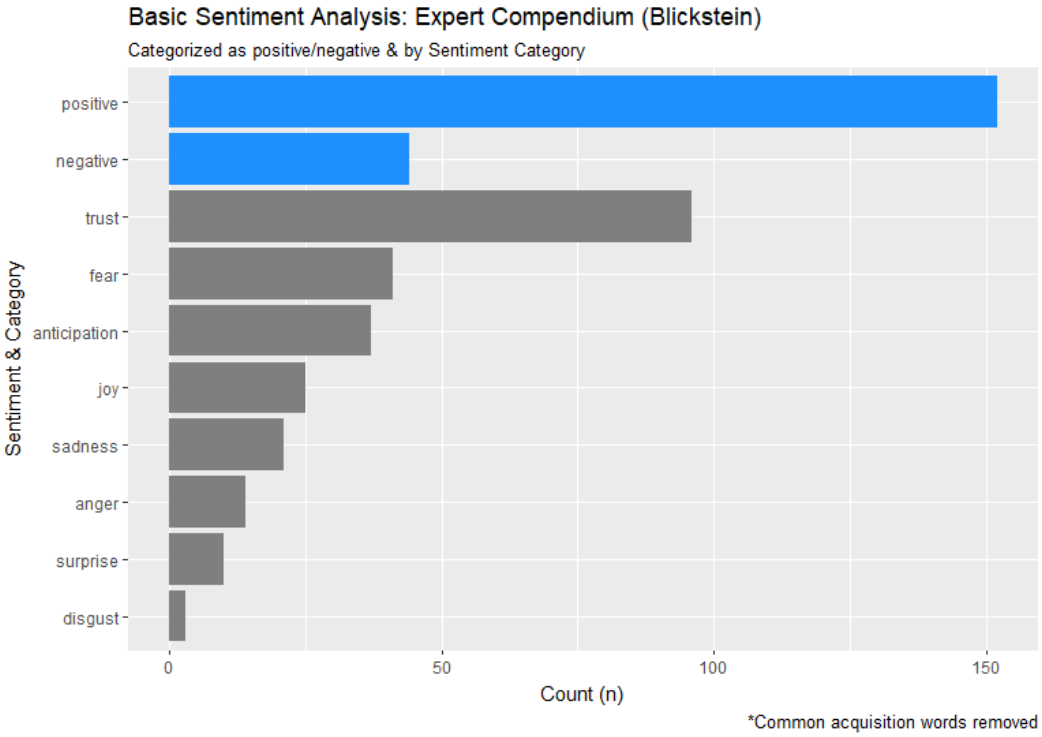

Figure 47: Basic Sentiment - Expert: Blickstein

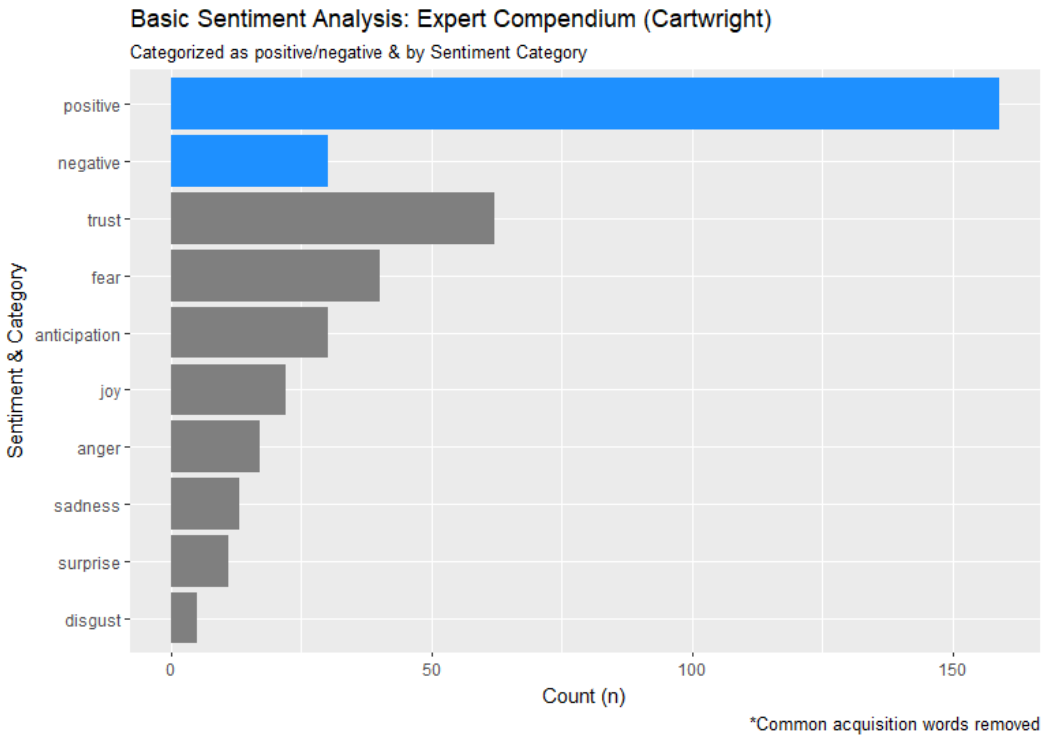

Figure 48: Basic Sentiment - Expert: Cartrwight

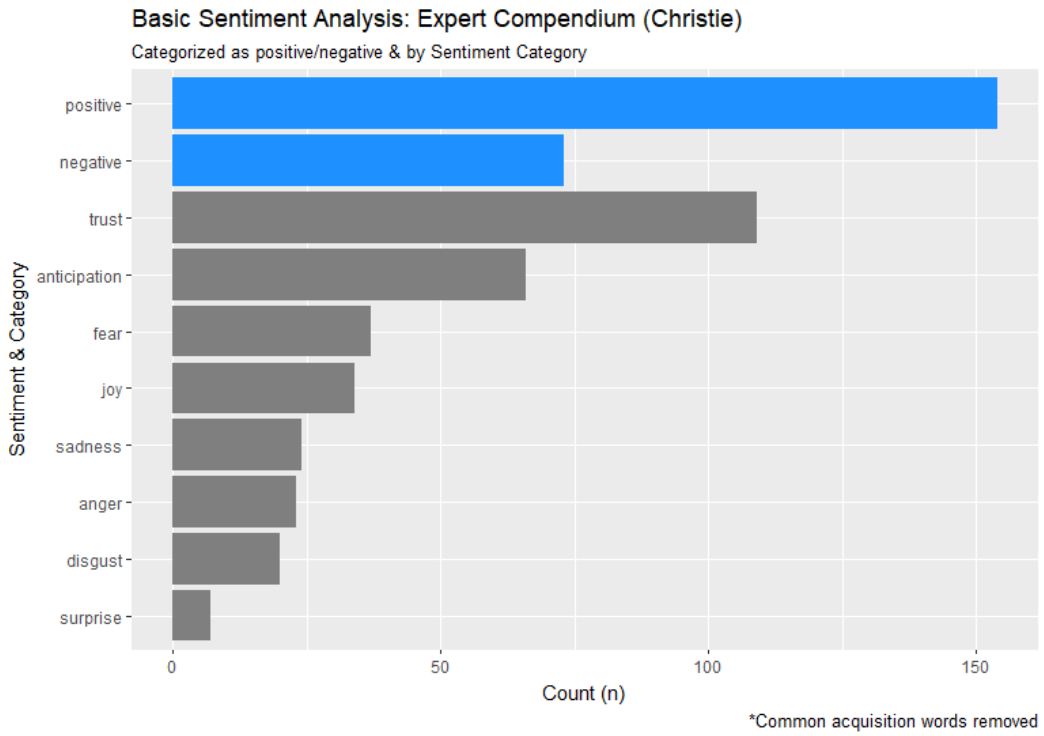

Figure 49: Basic Sentiment - Expert: Christie

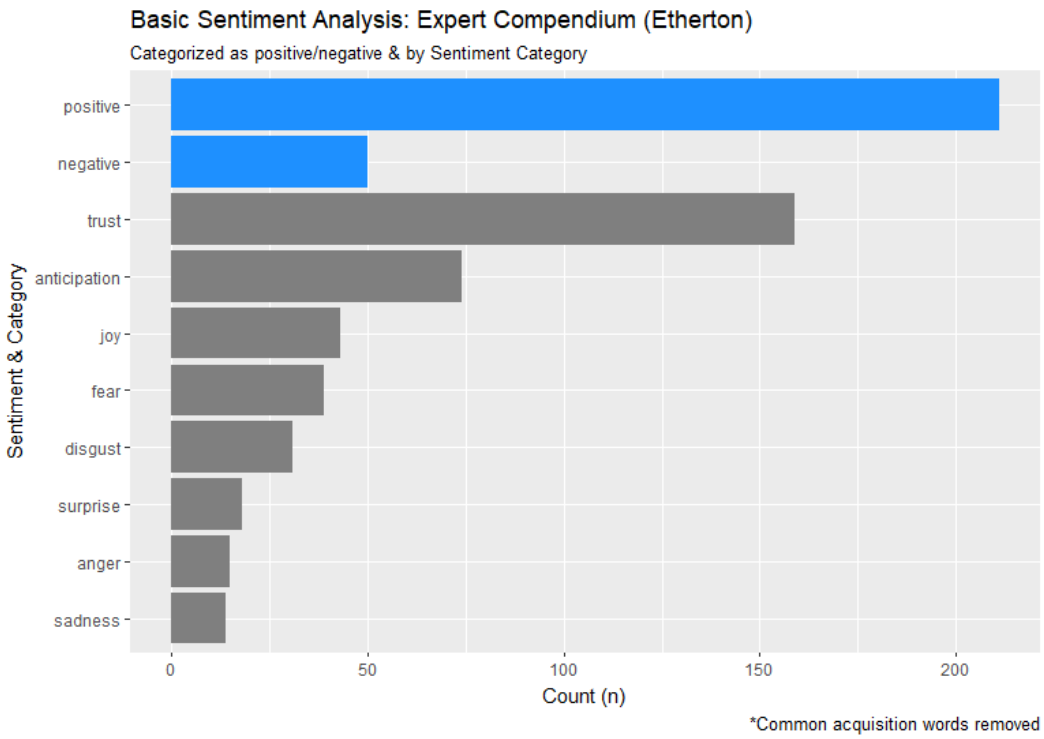

Figure 50: Basic Sentiment - Expert: Etherton

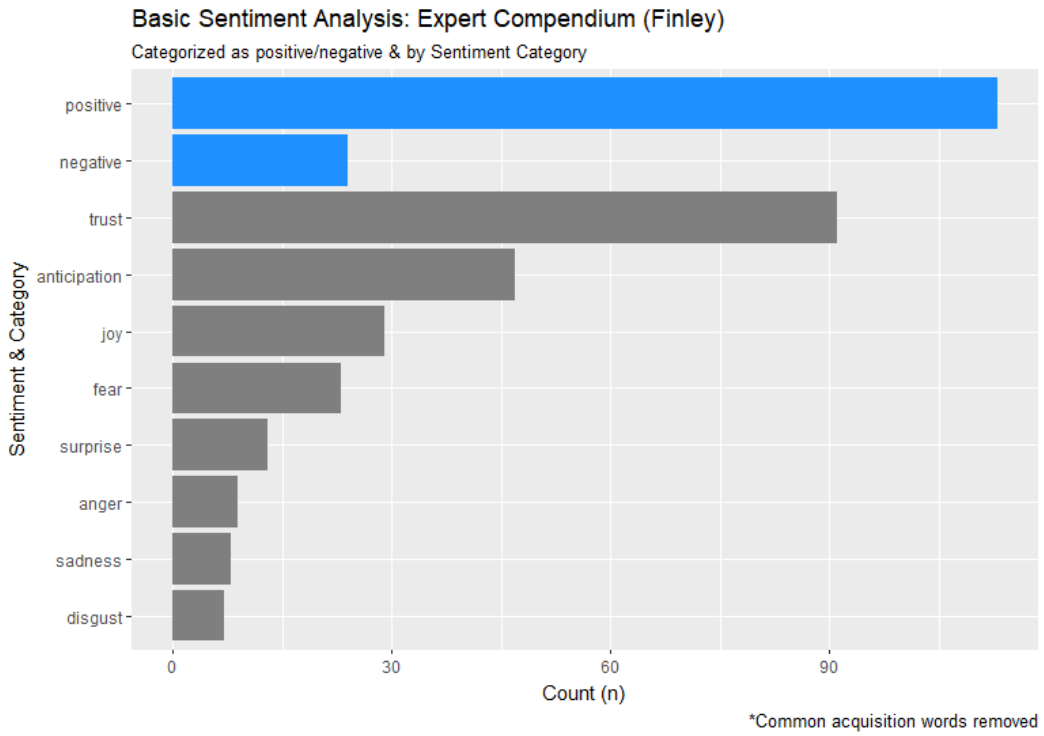

Figure 51: Basic Sentiment - Expert: Finley

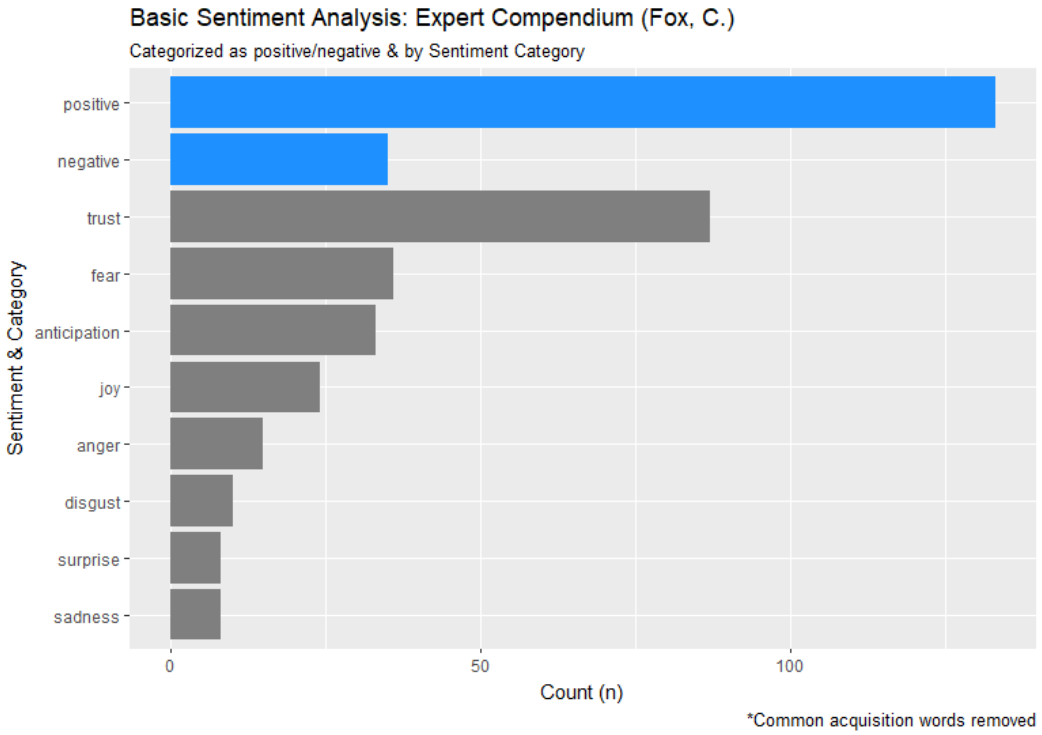

Figure 52: Basic Sentiment - Expert: Fox, C.

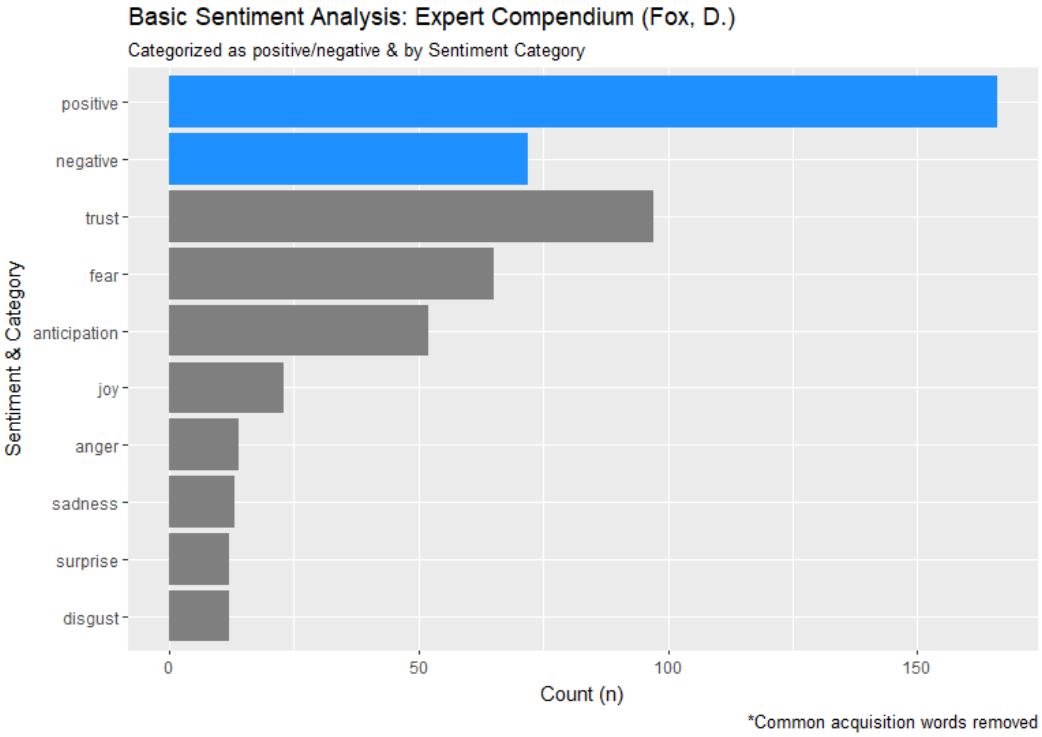

Figure 53: Basic Sentiment - Expert: Fox, D.

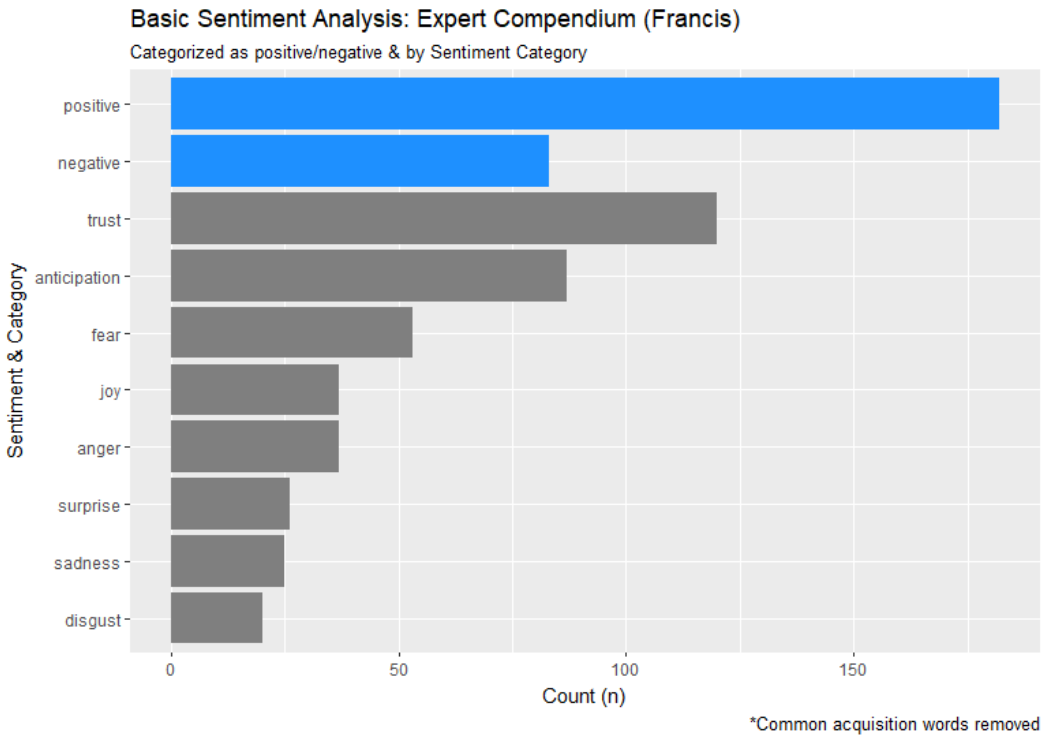

Figure 54: Basic Sentiment - Expert: Francis

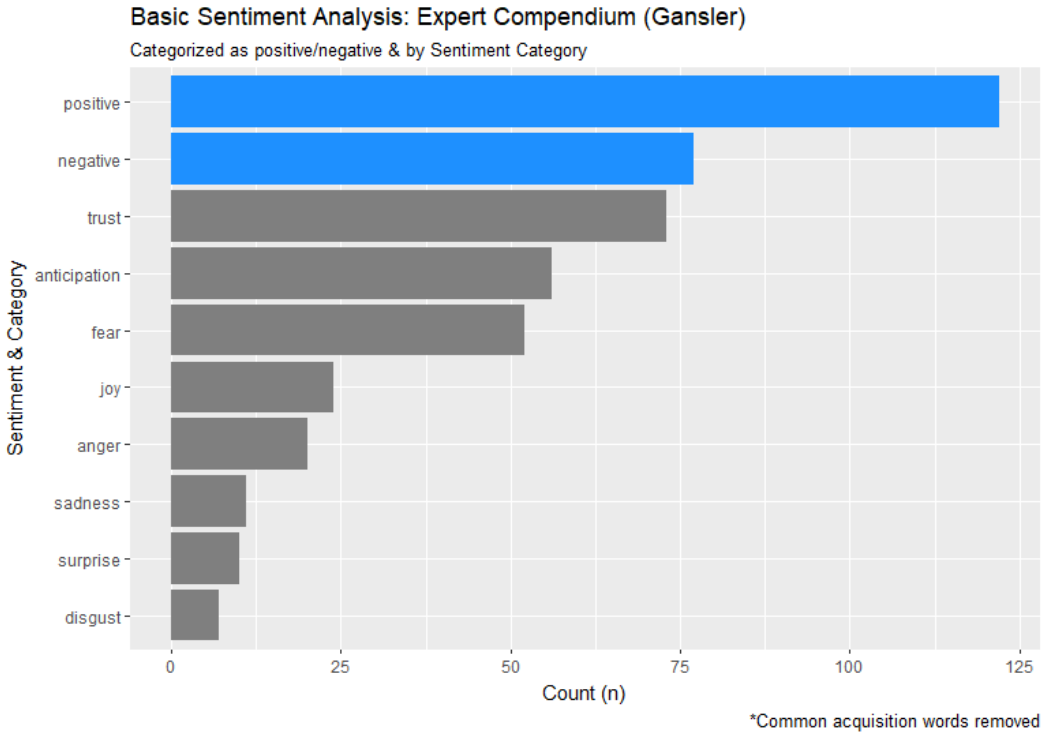

Figure 55: Basic Sentiment - Expert: Gansler

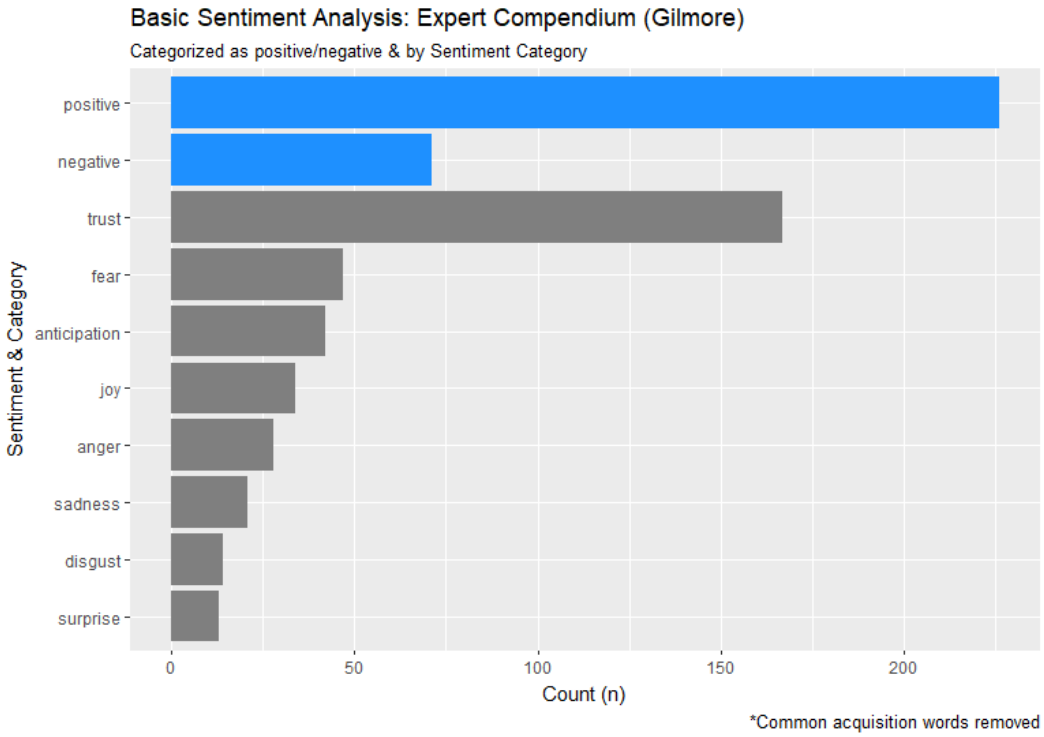

Figure 56: Basic Sentiment - Expert: Gilmore

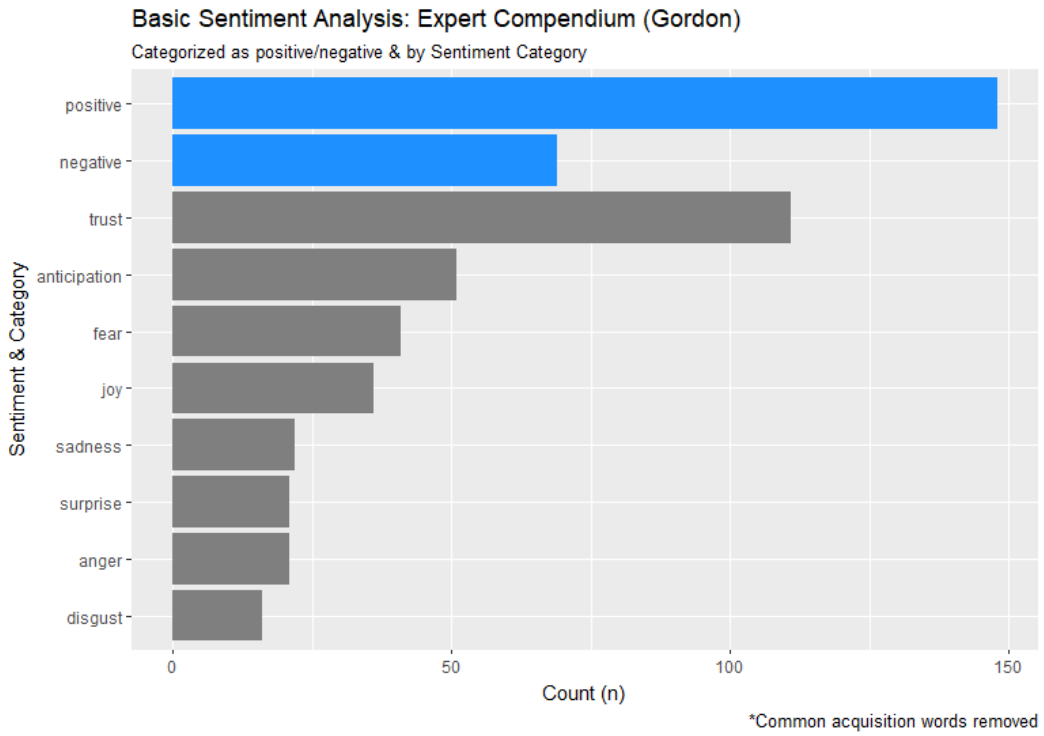

Figure 57: Basic Sentiment - Expert: Gordon

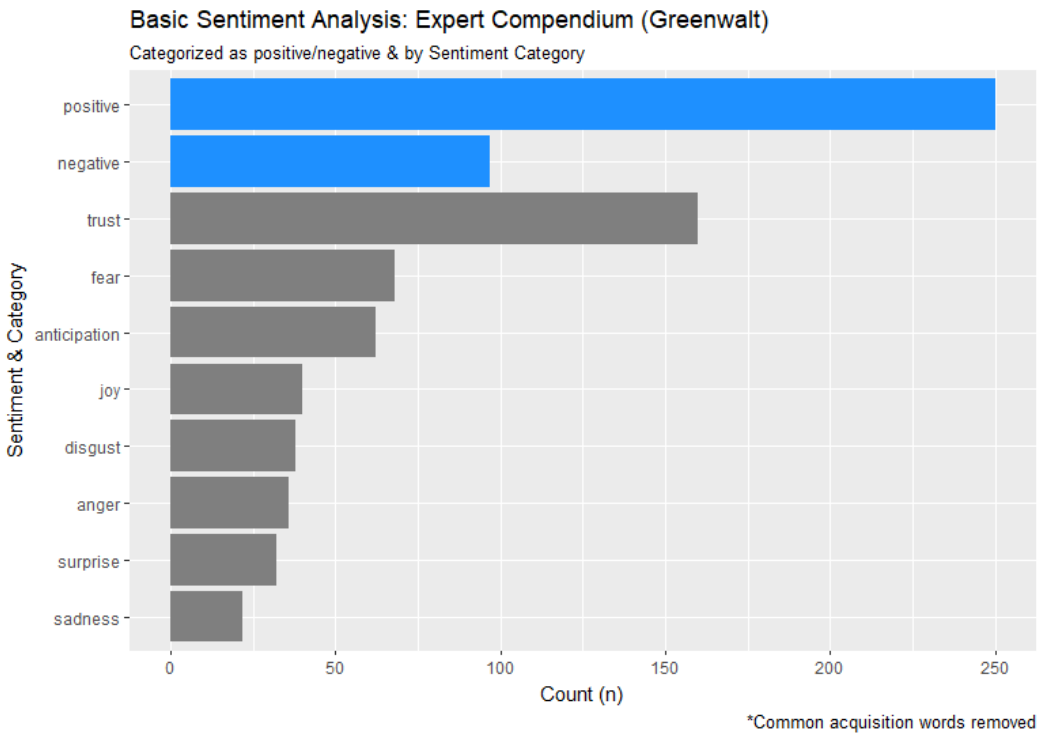

Figure 58: Basic Sentiment - Expert: Greenwalt

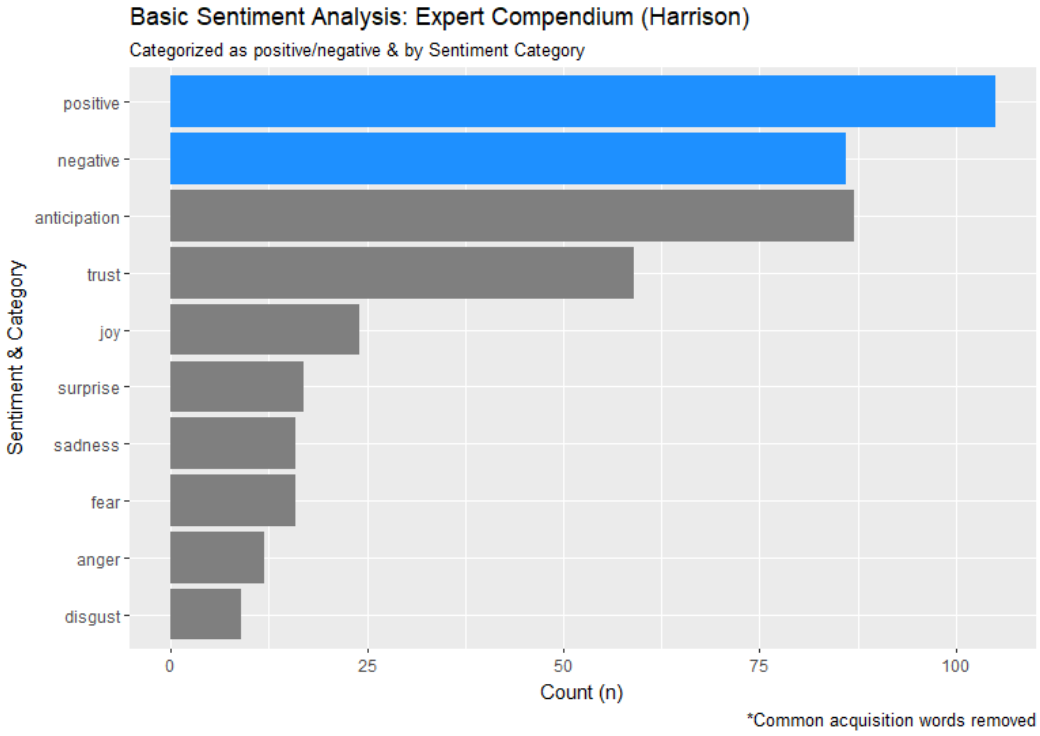

Figure 59: Basic Sentiment - Expert: Harrison

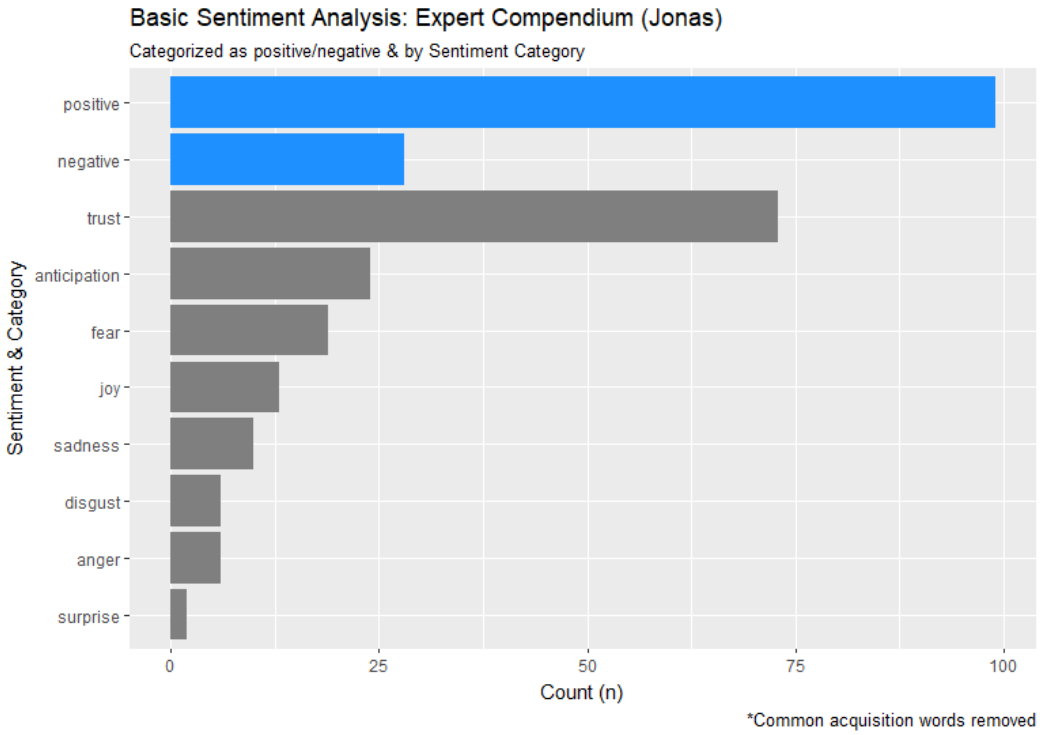

Figure 60: Basic Sentiment - Expert: Jonas

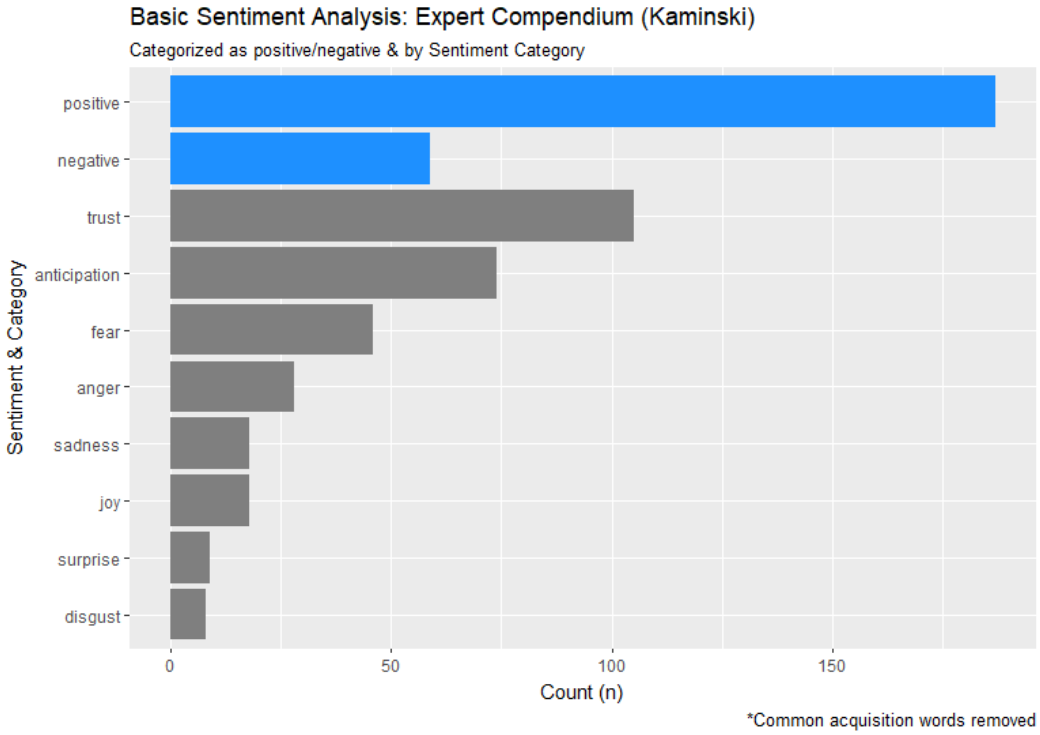

Figure 61: Basic Sentiment - Expert: Kaminski

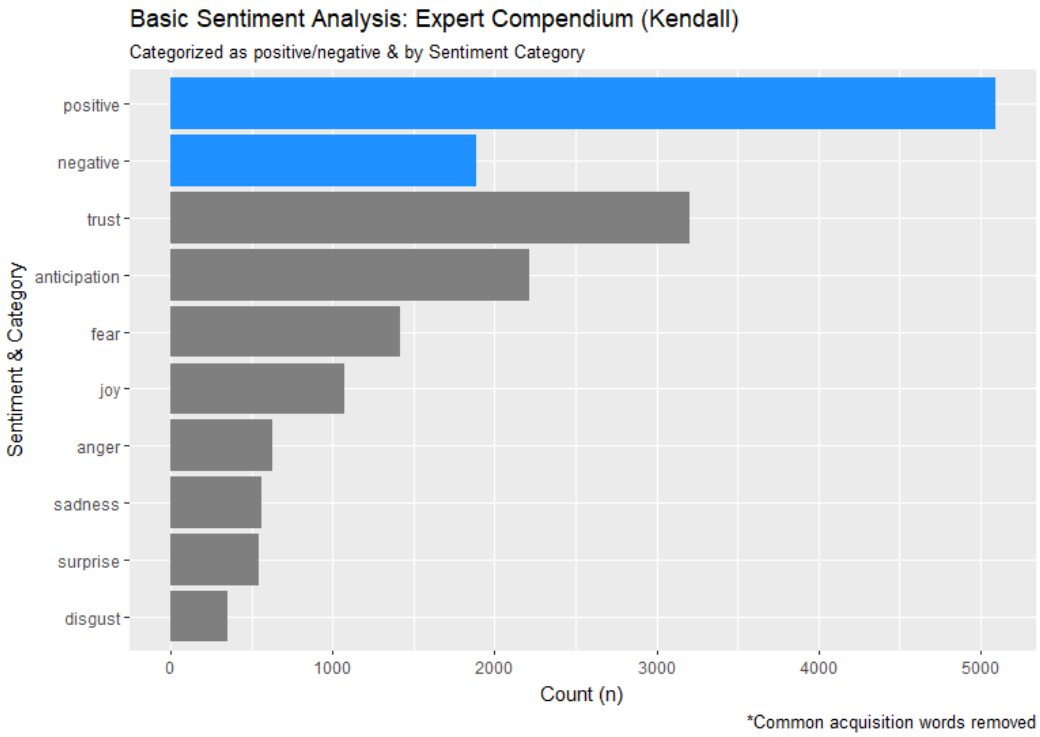

Figure 62: Basic Sentiment - Expert: Kendall

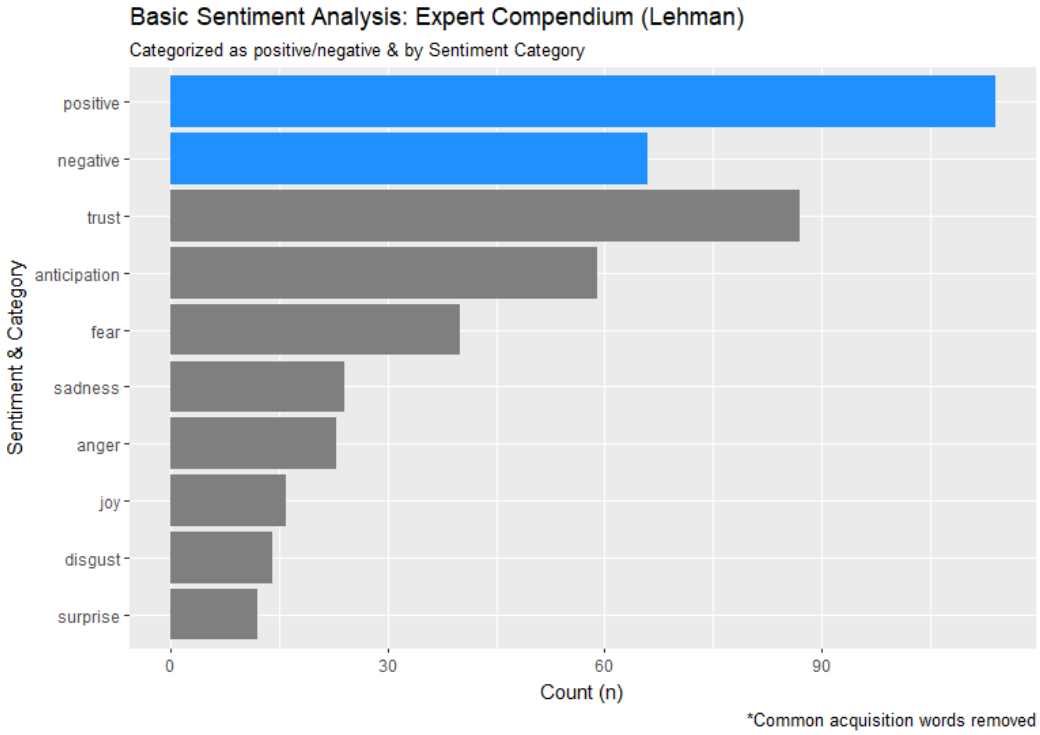

Figure 63: Basic Sentiment - Expert: Lehman

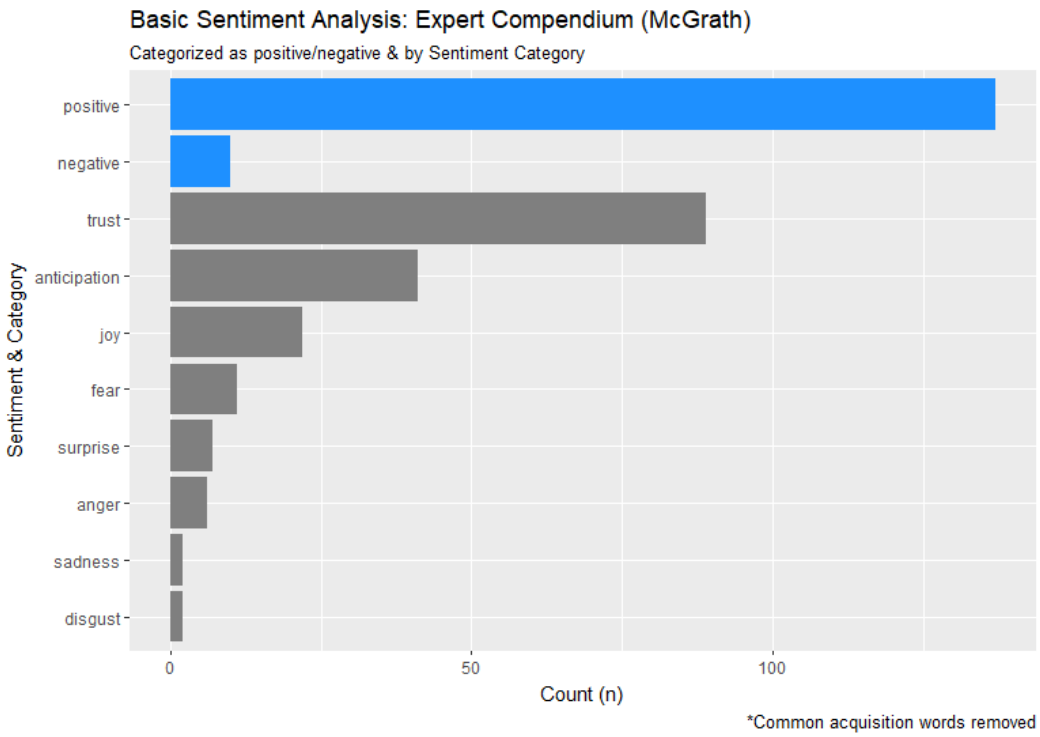

Figure 64: Basic Sentiment - Expert: McGrath

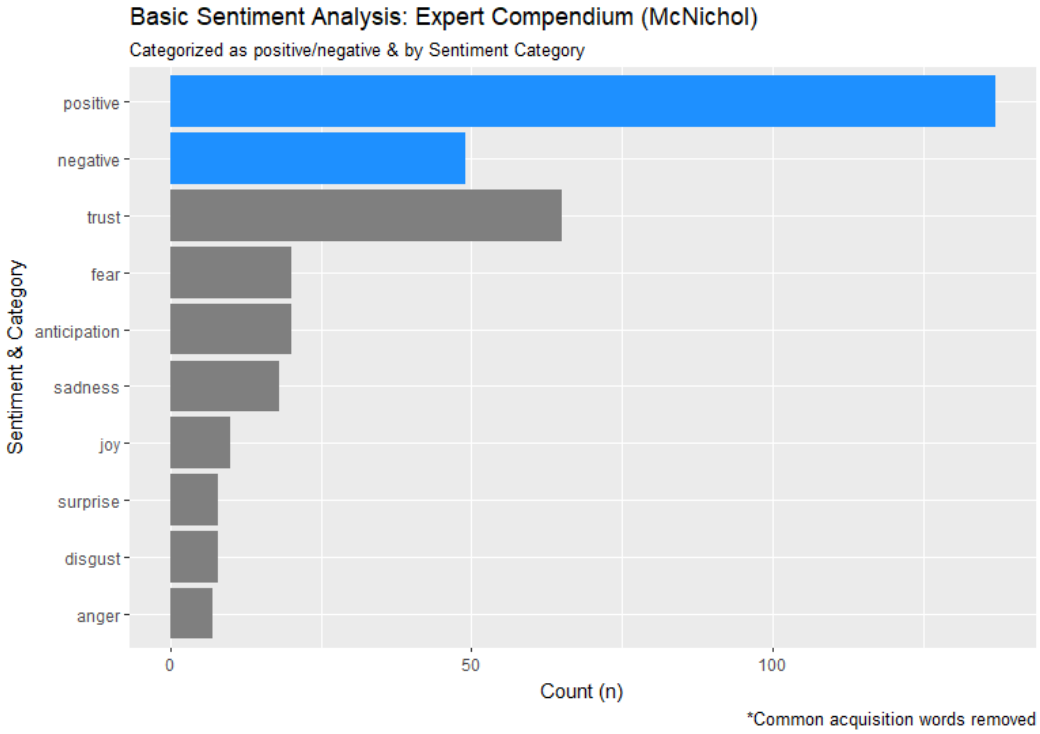

Figure 65: Basic Sentiment - Expert: McNichol

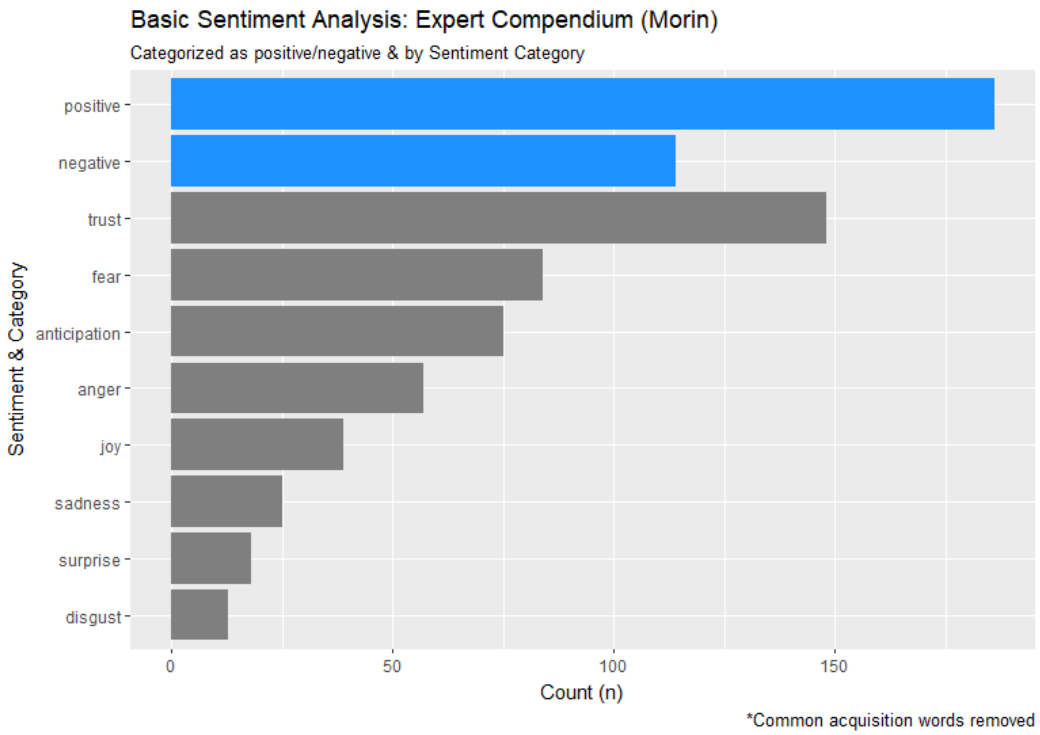

Figure 66: Basic Sentiment - Expert: Morin

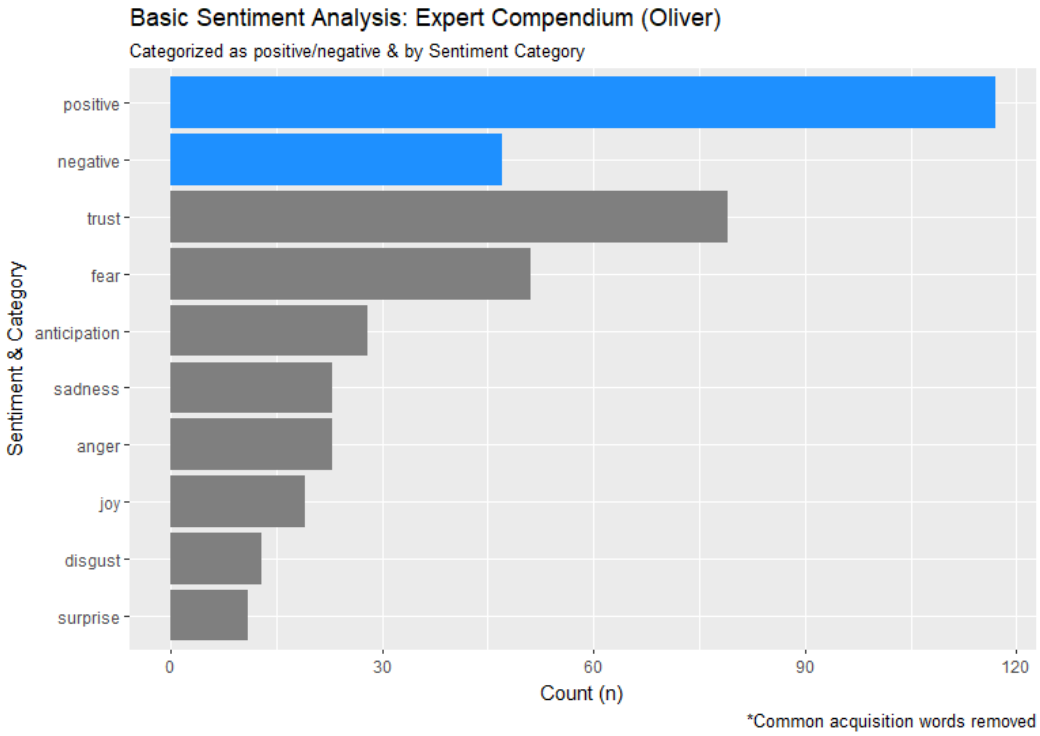

Figure 67: Basic Sentiment - Expert: Oliver

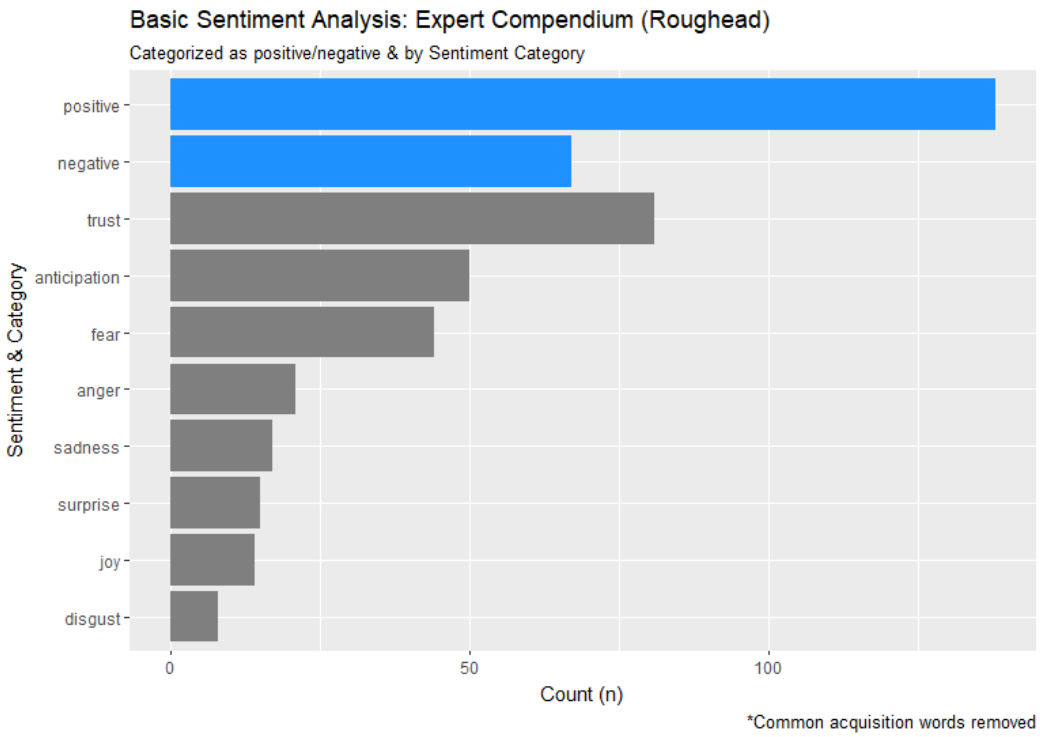

Figure 68: Basic Sentiment - Expert: Roughead

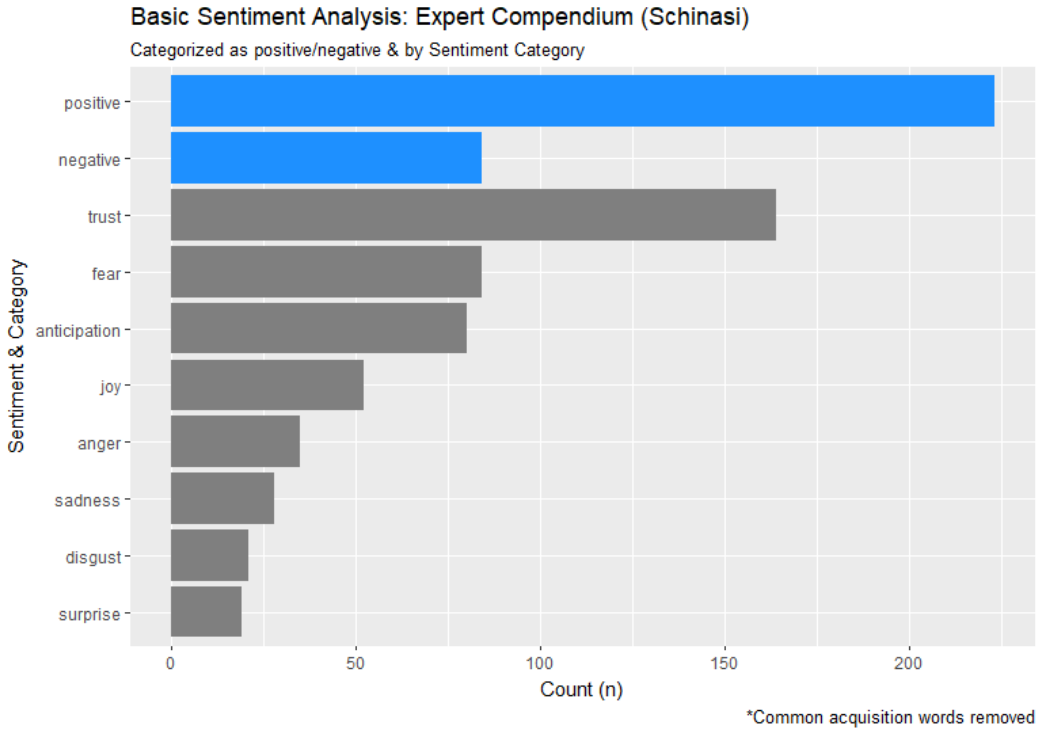

Figure 69: Basic Sentiment - Expert: Schinasi

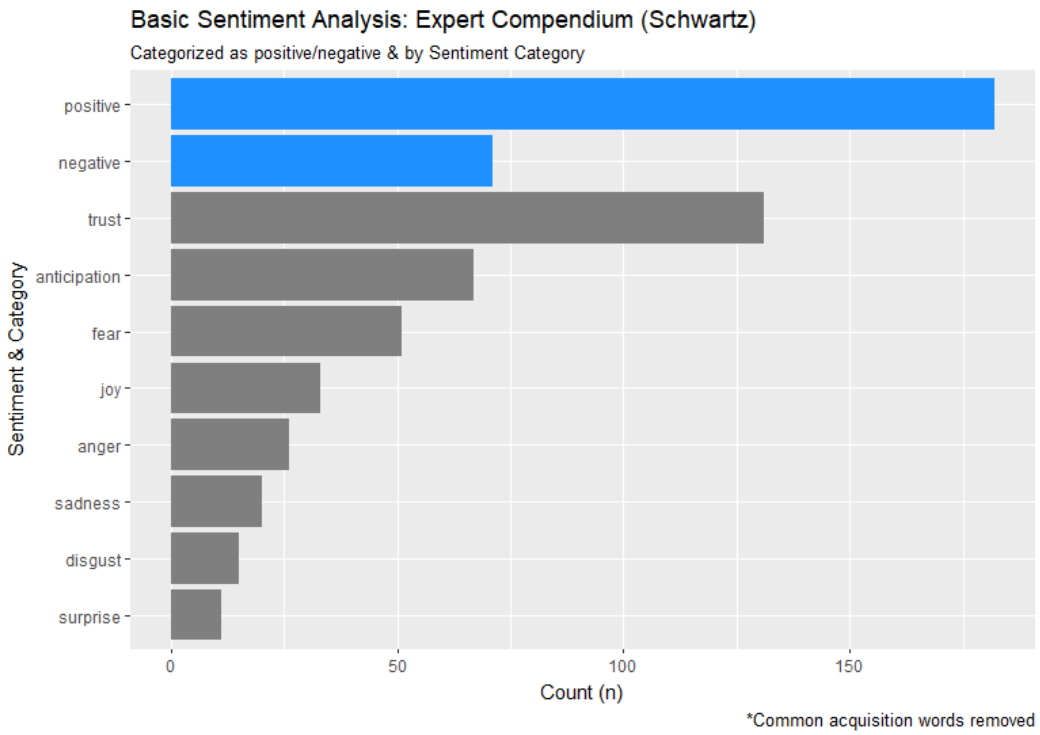

Figure 70: Basic Sentiment - Expert: Schwartz

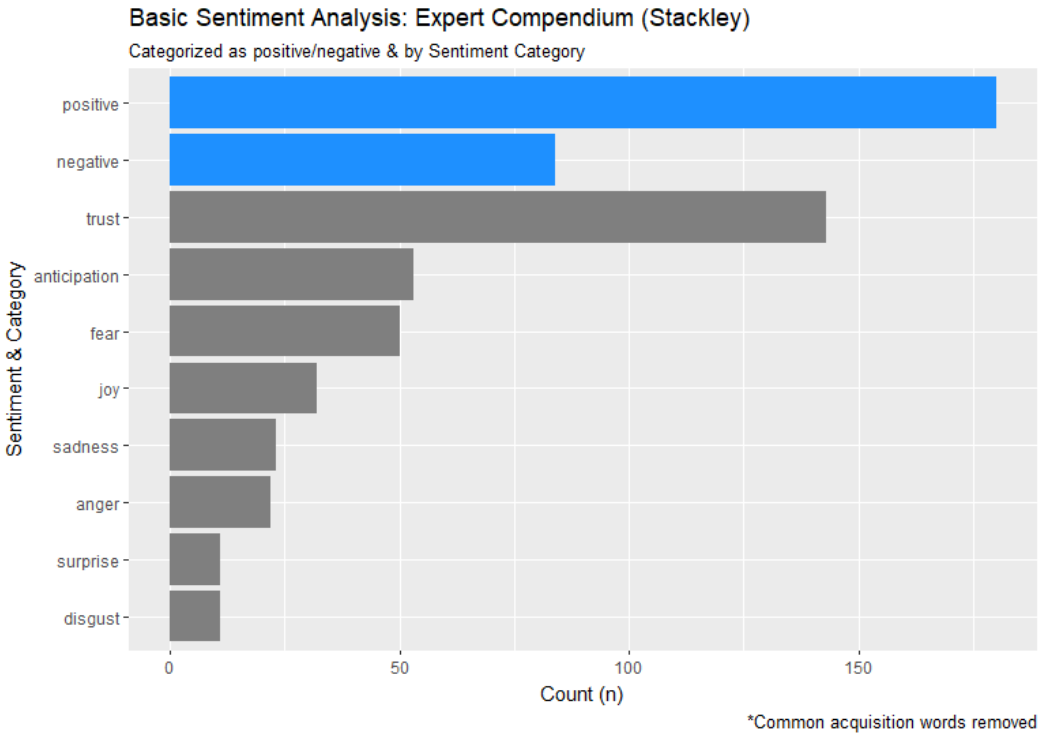

Figure 71: Basic Sentiment - Expert: Stackley

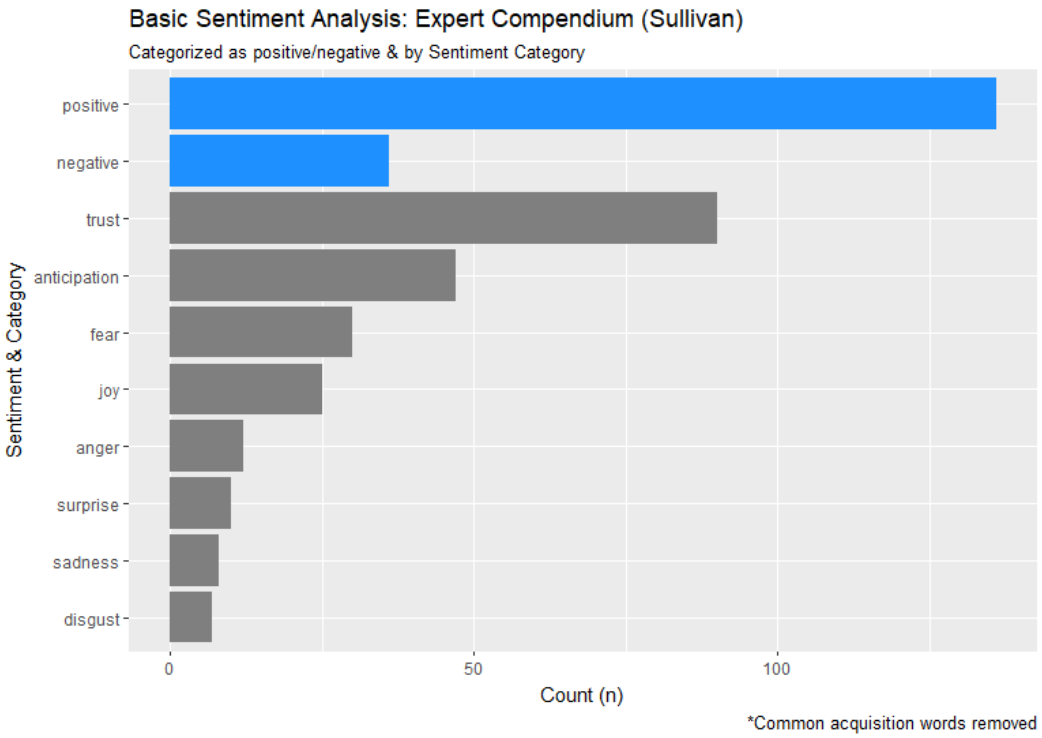

Figure 72: Basic Sentiment - Expert: Sullivan

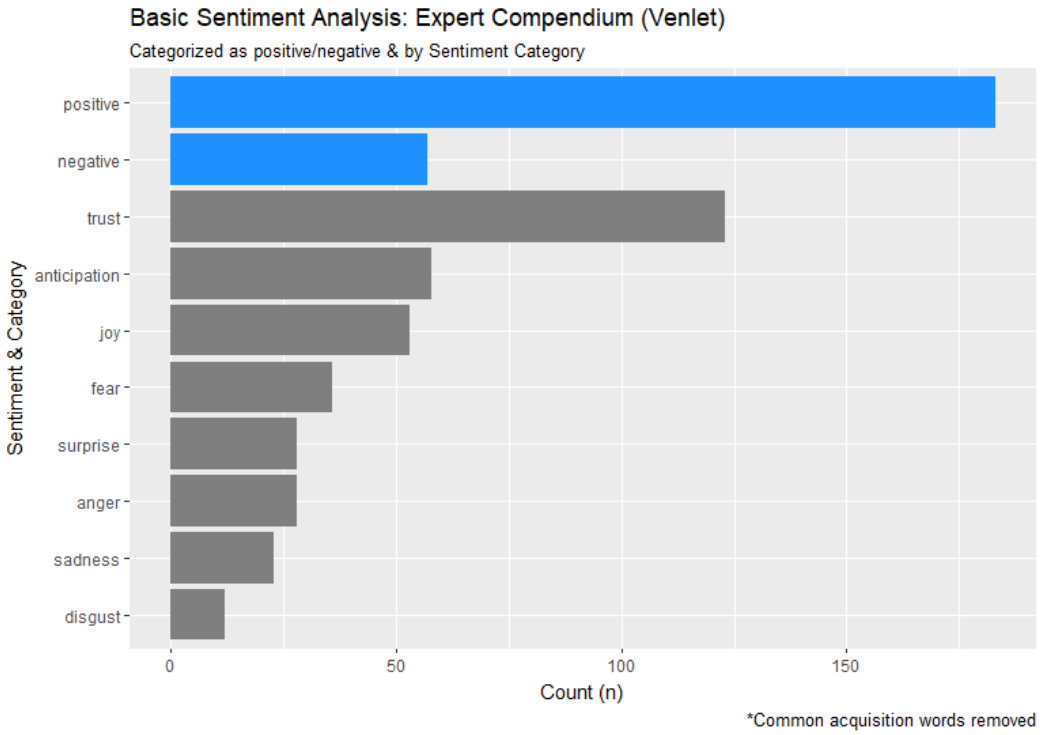

Figure 73: Basic Sentiment - Expert: Venlet

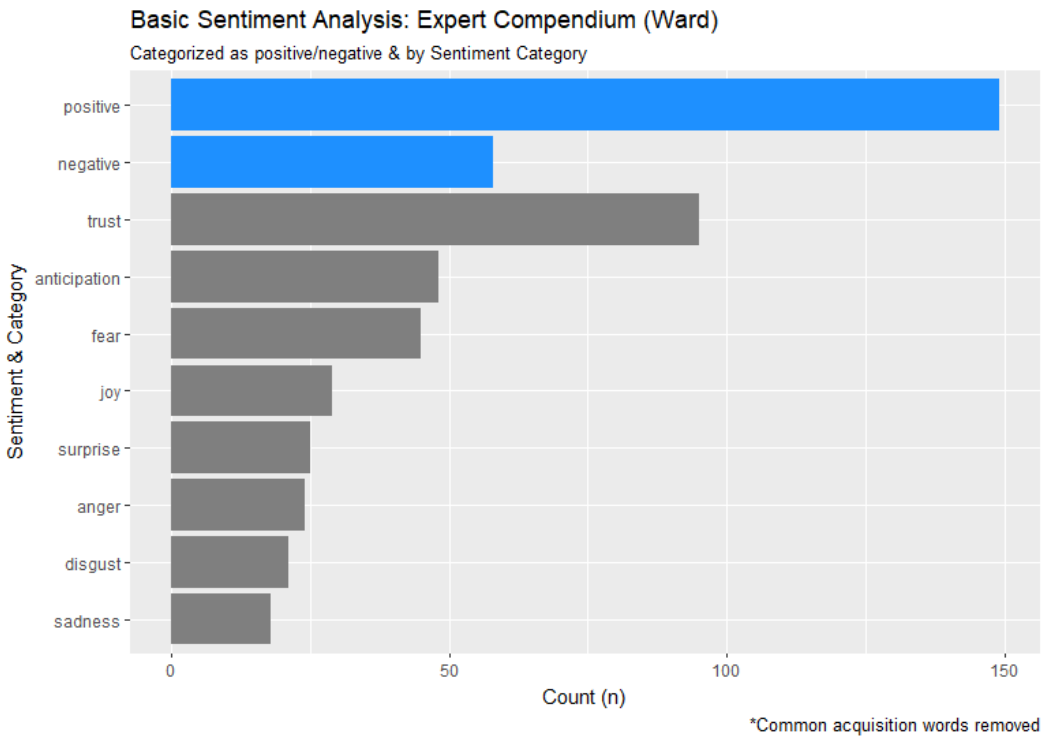

Figure 74: Basic Sentiment - Expert: Ward

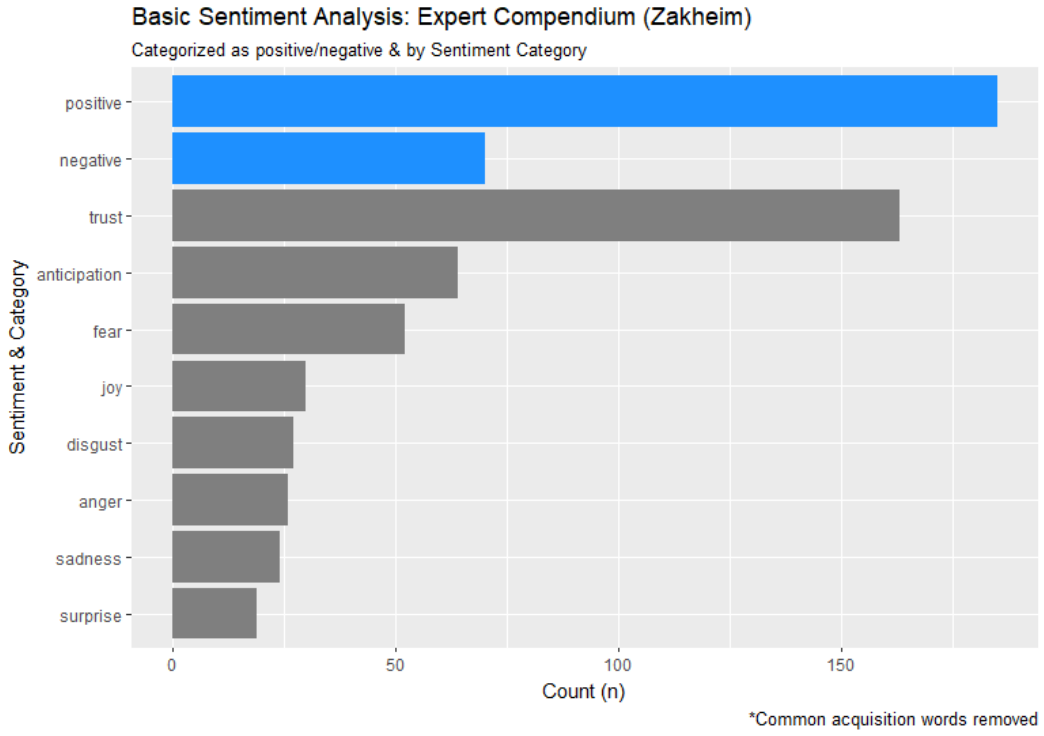

Figure 75: Basic Sentiment - Expert: Zakheim

2. Sentiment Progression (by Paragraph)

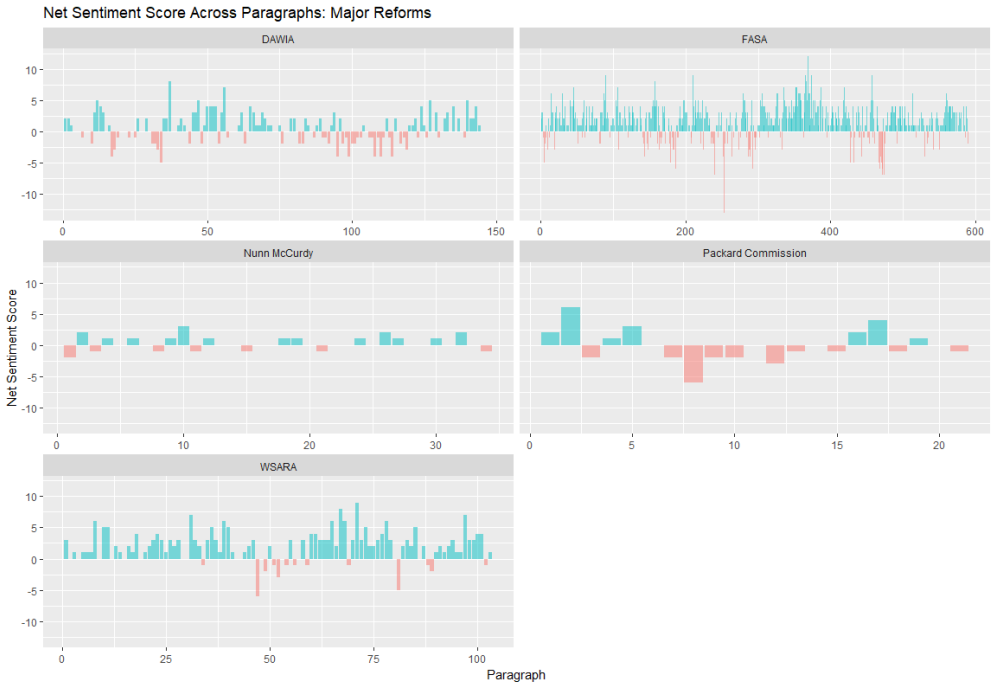

Figure 76: Sentiment Progression (by Paragraph) – Reforms

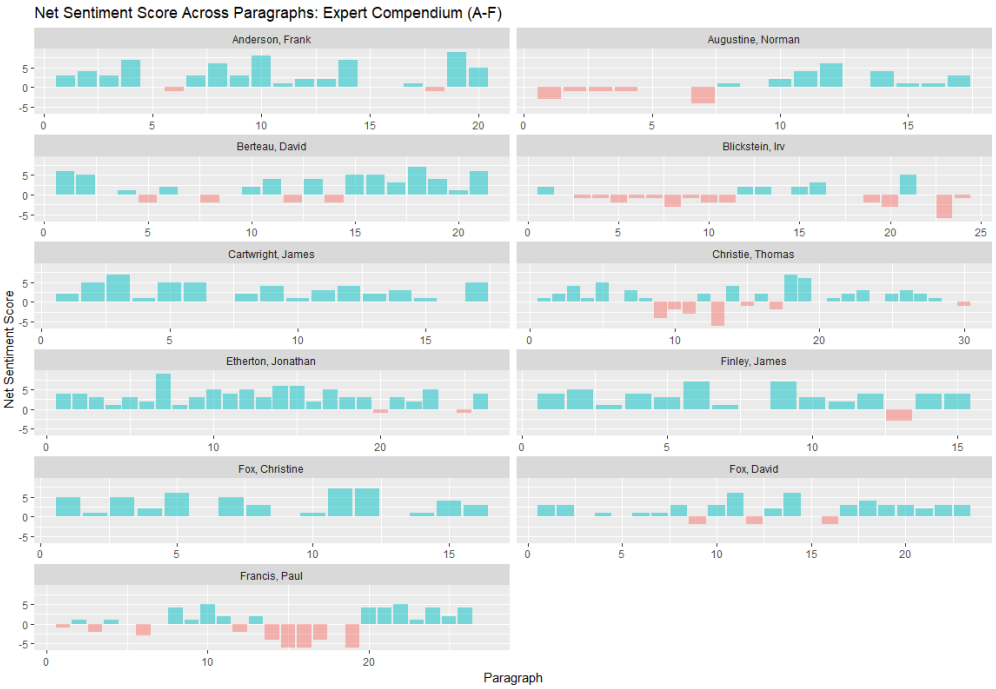

Figure 77: Sentiment Progression (by Paragraph) - Experts A-F

Figure 78: Sentiment Progression (by Paragraph) - Experts G-L

Figure 79: Sentiment Progression (by Paragraph) - Experts M-Z

3. Sentiment Progression (by Sentence)

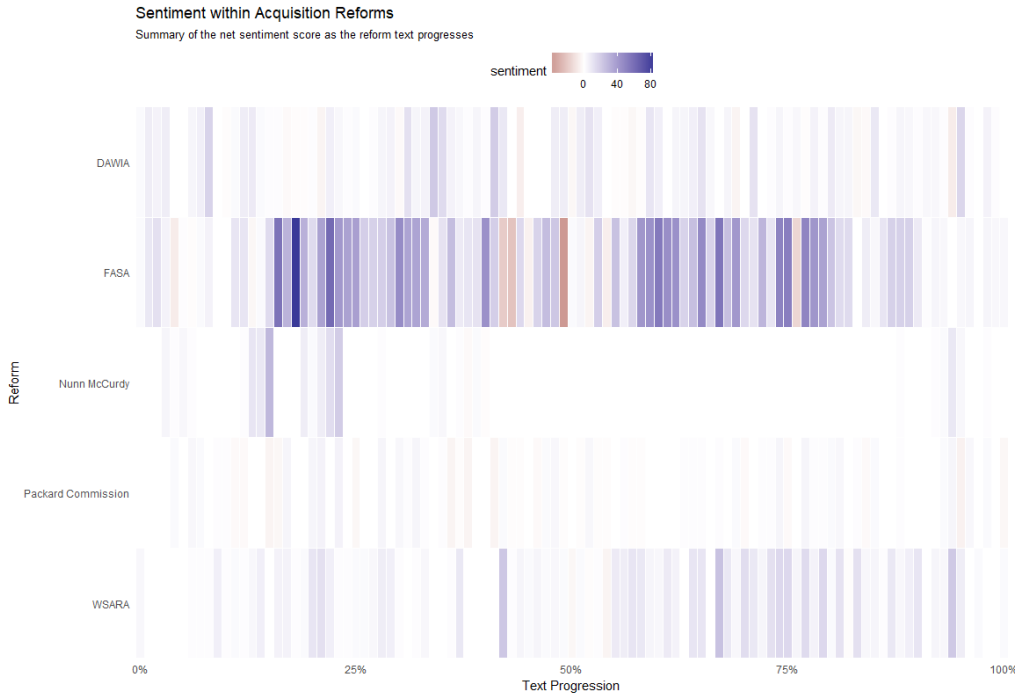

Figure 80: Sentiment Progression (by Sentence) – Reforms

Figure 81: Sentiment Progression (by Sentence) - Reforms (except FASA)

Figure 82: Sentiment Progression (by Sentence) - Reforms (FASA only)

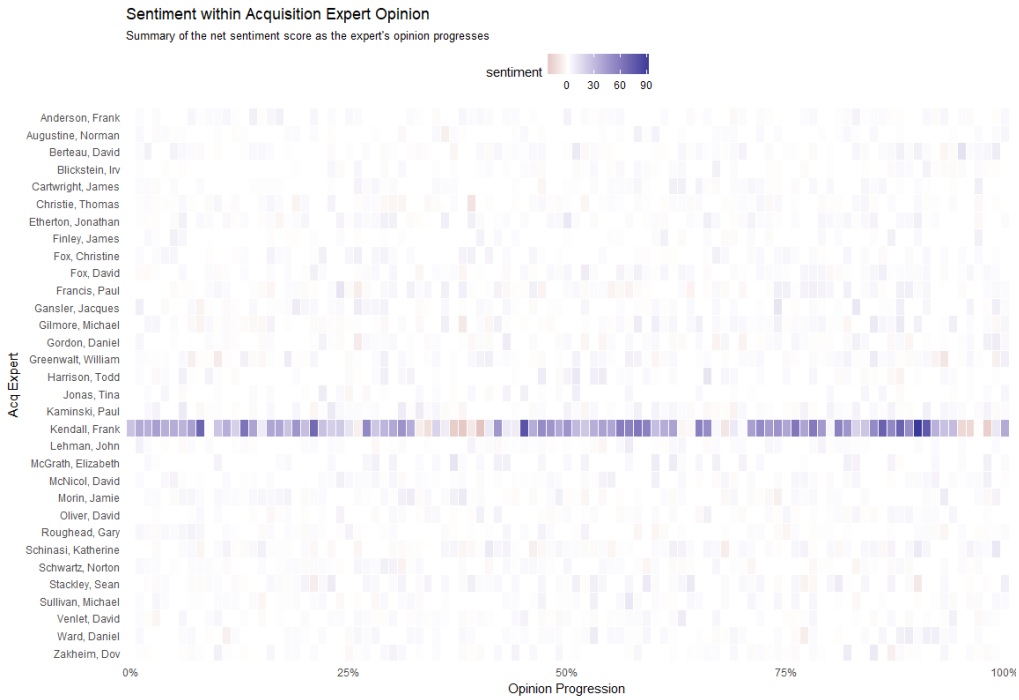

Figure 83: Sentiment Progression (by Sentence) - Experts

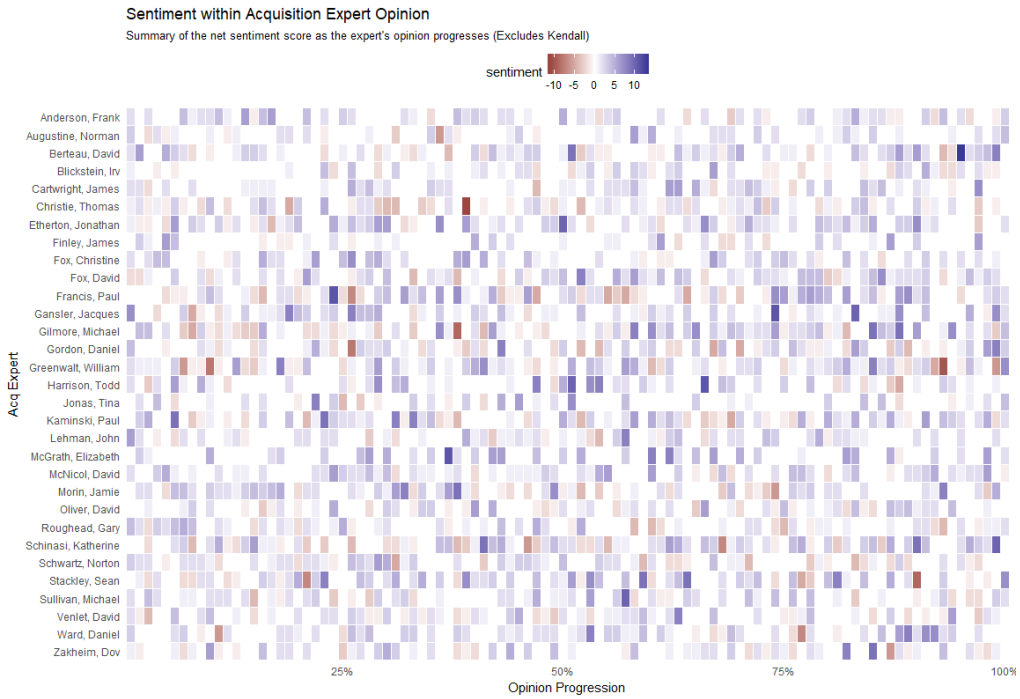

Figure 84: Sentiment Progression (by Sentence) - Experts (except Kendall)

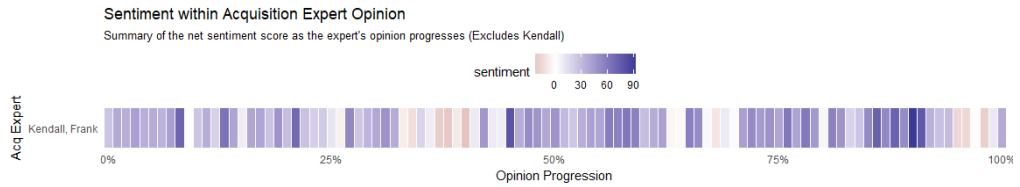

Figure 85: Sentiment Progression (by Sentence) - Experts (Kendall only)

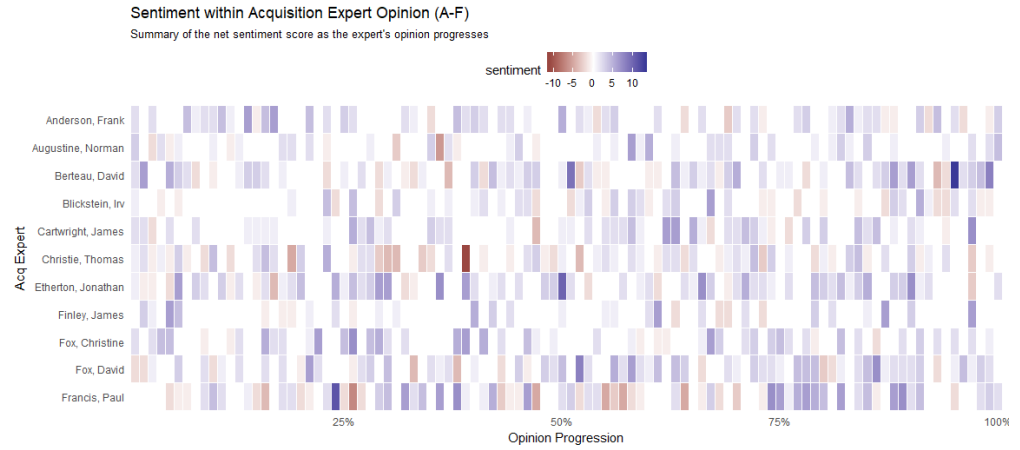

Figure 86: Sentiment Progression (by Sentence) - Experts A-F

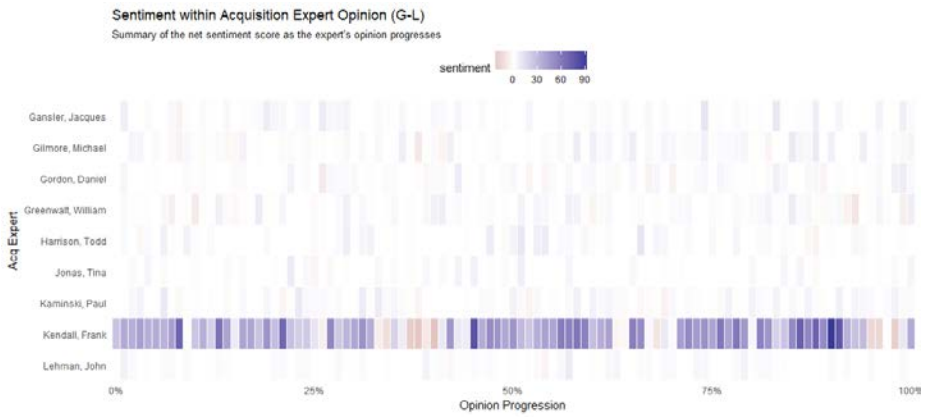

Figure 87: Sentiment Progression (by Sentence) - Experts G-L

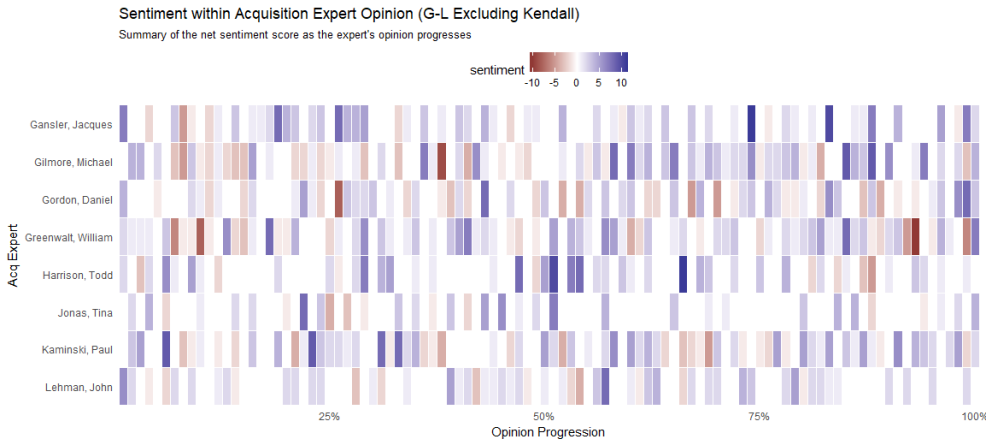

Figure 88: Sentiment Progression (by Sentence) - Experts G-L (except Kendall)

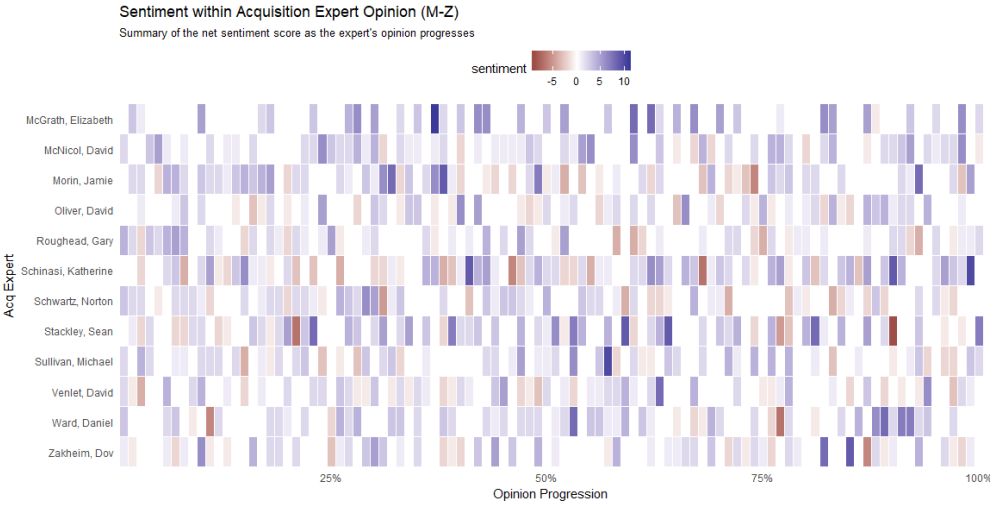

Figure 89: Sentiment Progression (by Sentence) - Experts M-Z

4. Sentiment Preceded by Negation Words

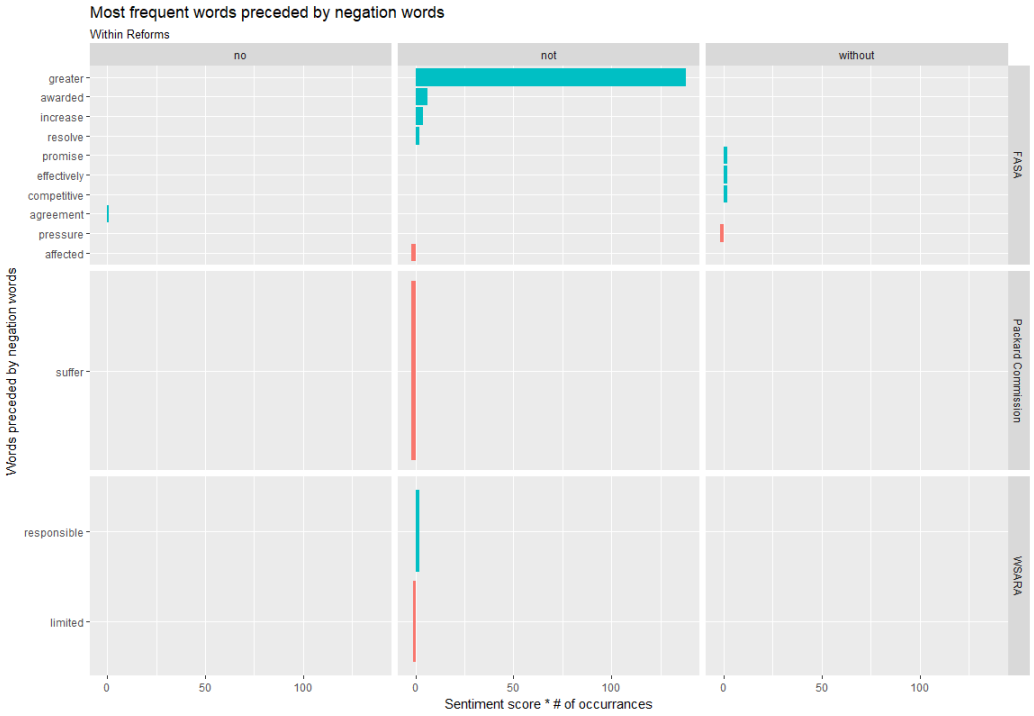

Figure 90: Sentiment Preceded by Negation Words – Reforms

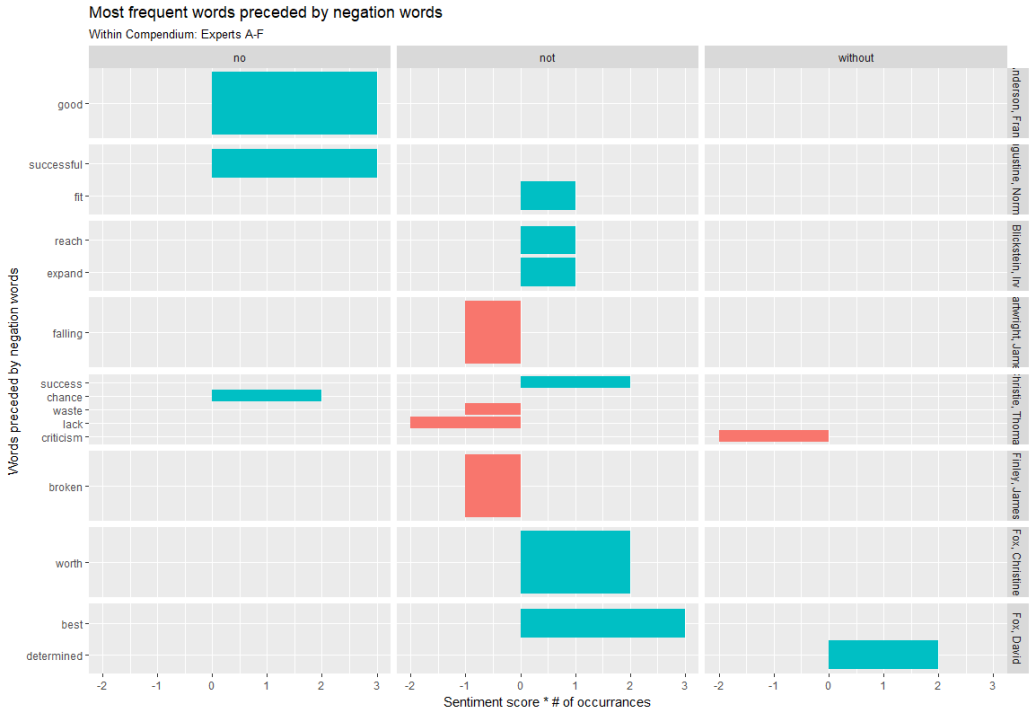

Figure 91: Sentiment Preceded by Negation Words - Experts A-F

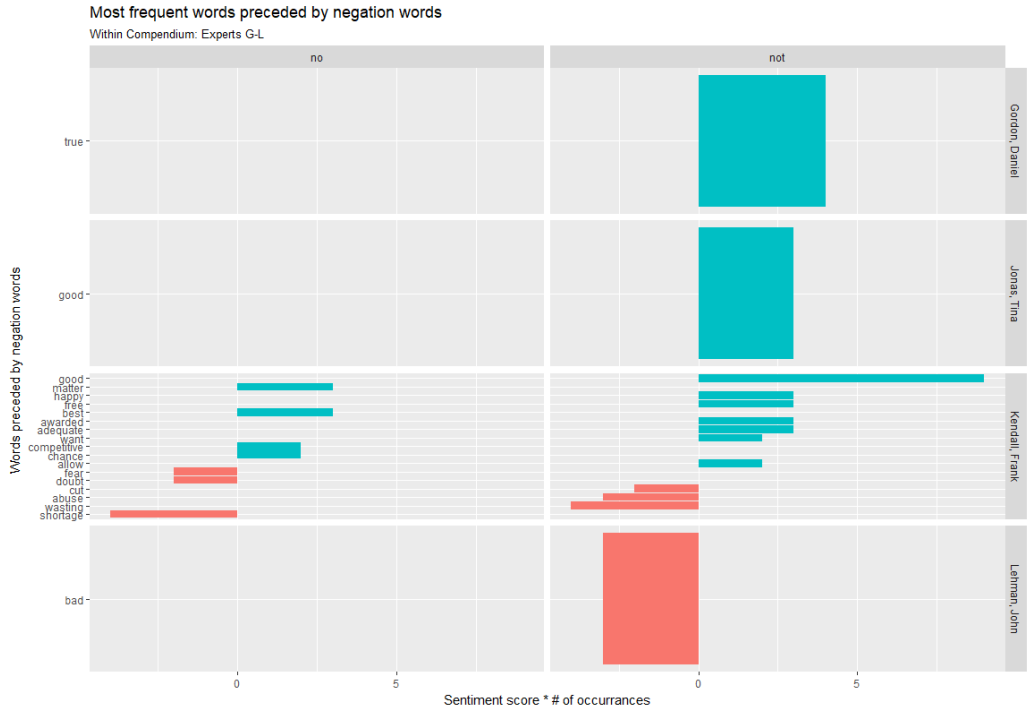

Figure 92: Sentiment Preceded by Negation Words - Experts G-L

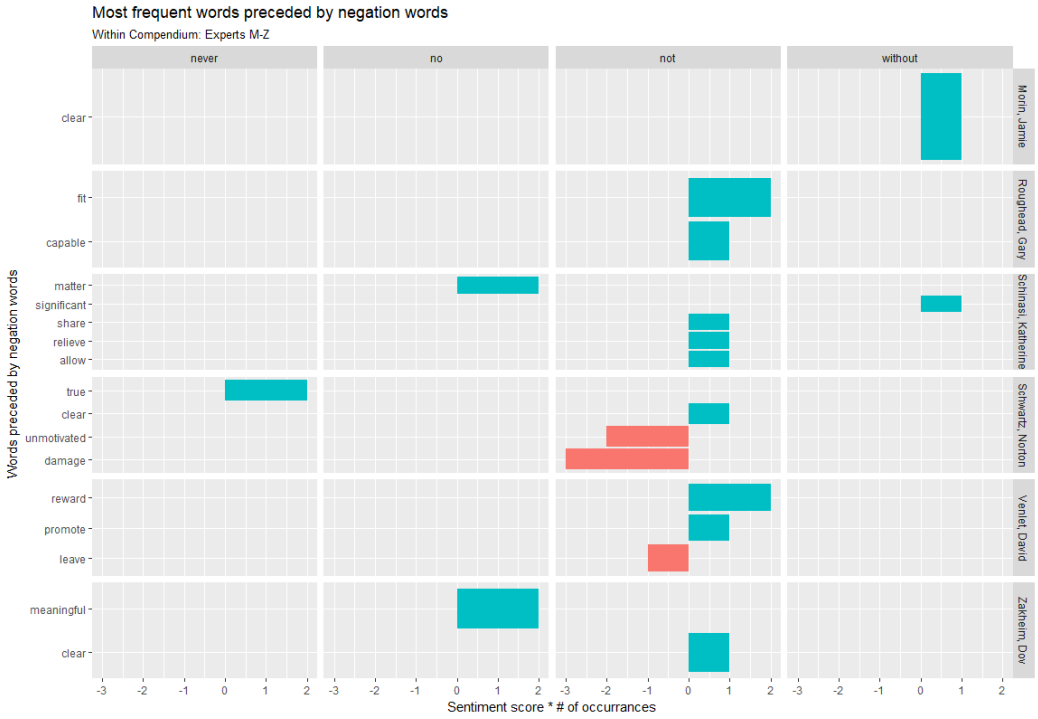

Figure 93: Sentiment Preceded by Negation Words - Experts M-Z

Appendix E: Text Mining - Topic Modeling Results

Appendix E Table of Contents

1. LDA Tuning

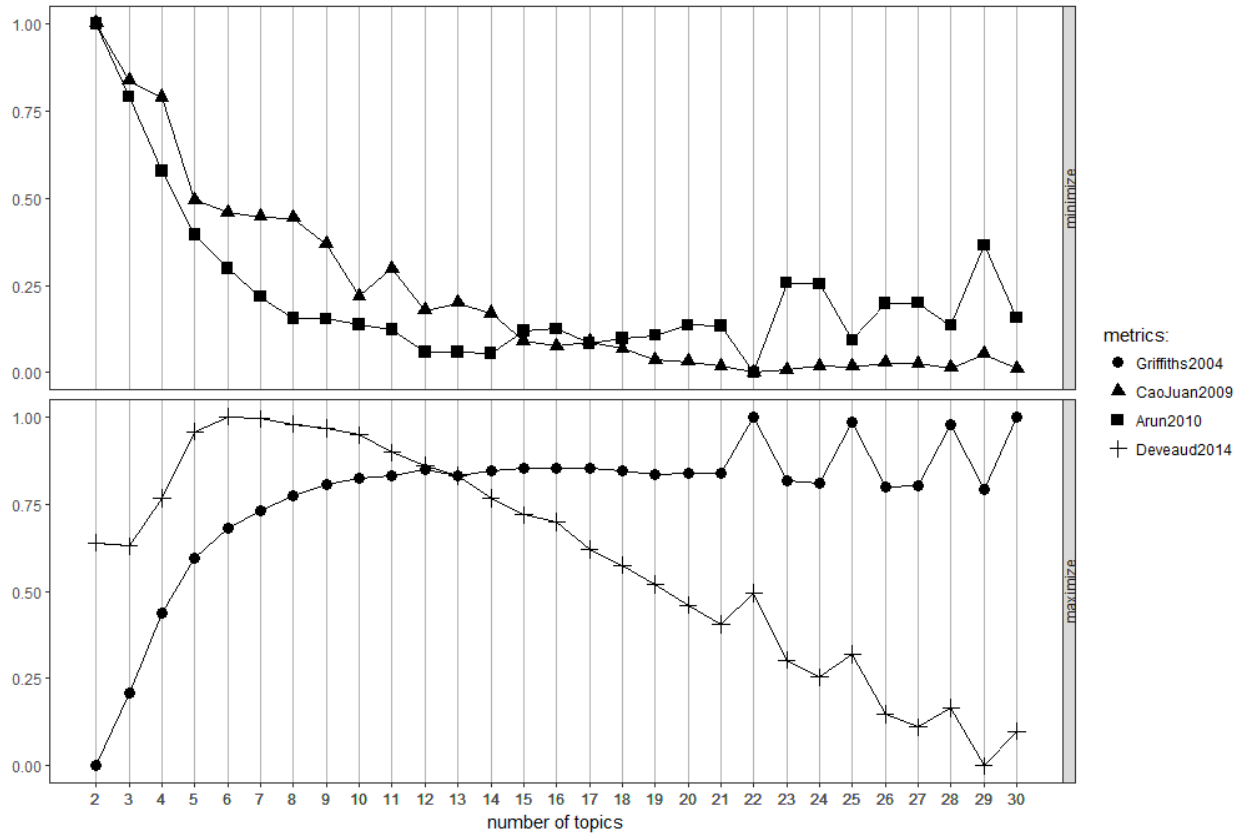

Figure 94: LDATune All Data - 6-10 topics

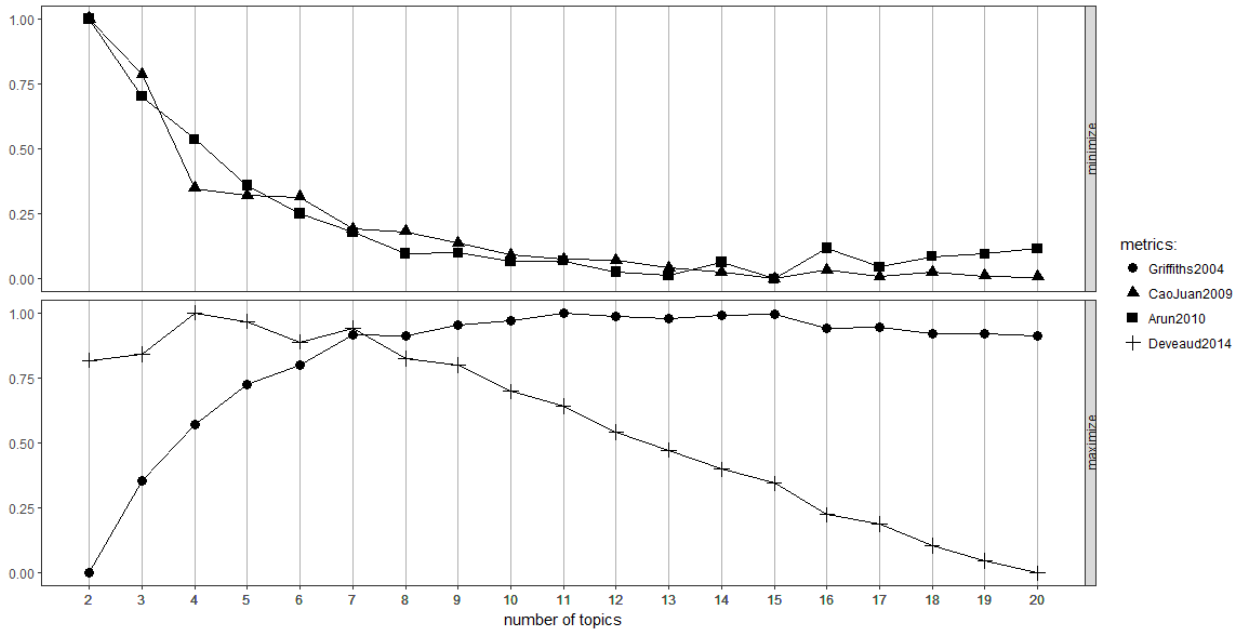

Figure 95: LDATune Experts - 5-8 topics

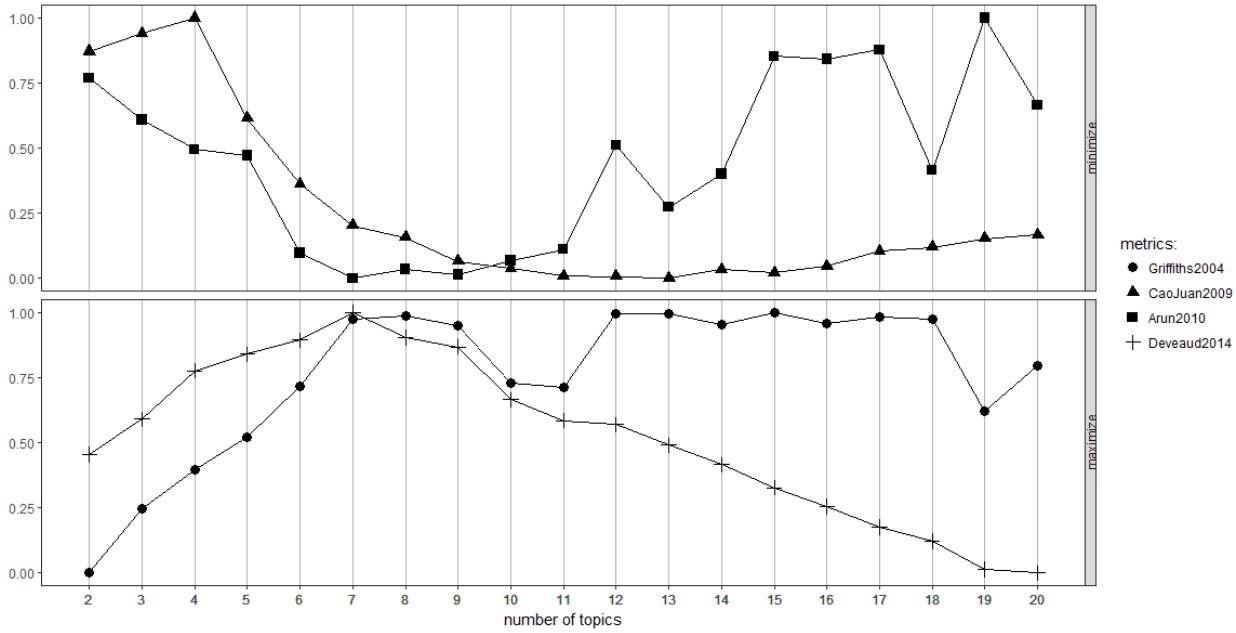

Figure 96: LDATune Reforms - 7-9 topics

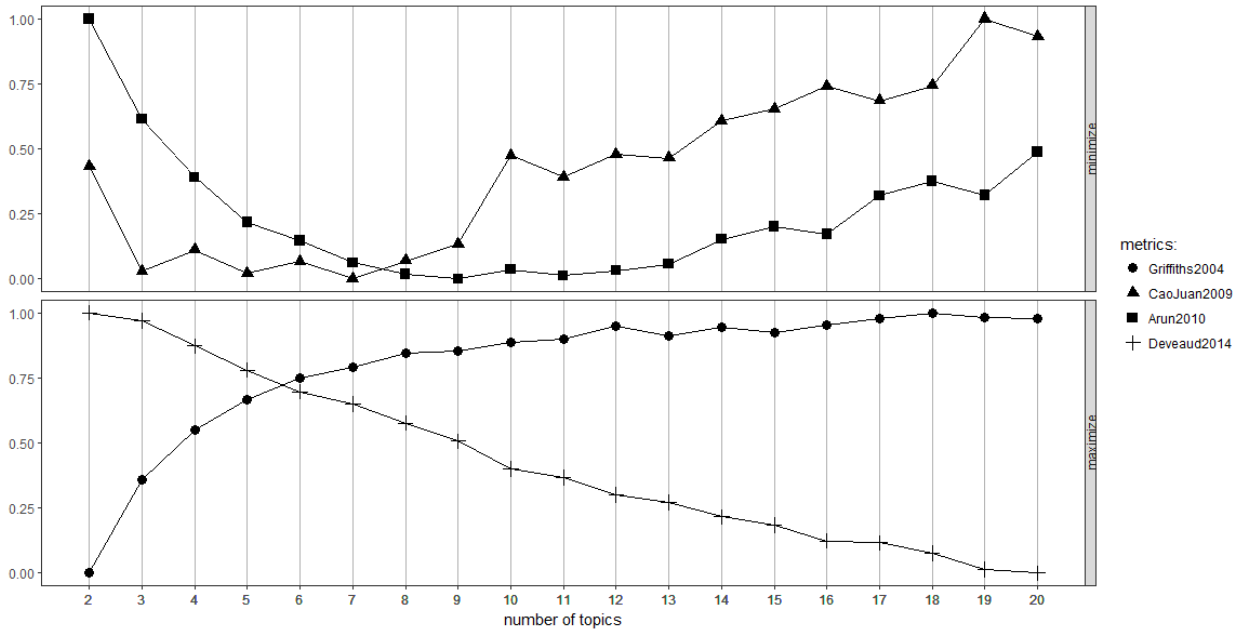

Figure 97: LDATune Grounded Theory Comparison (Gansler) - 4-8 topics

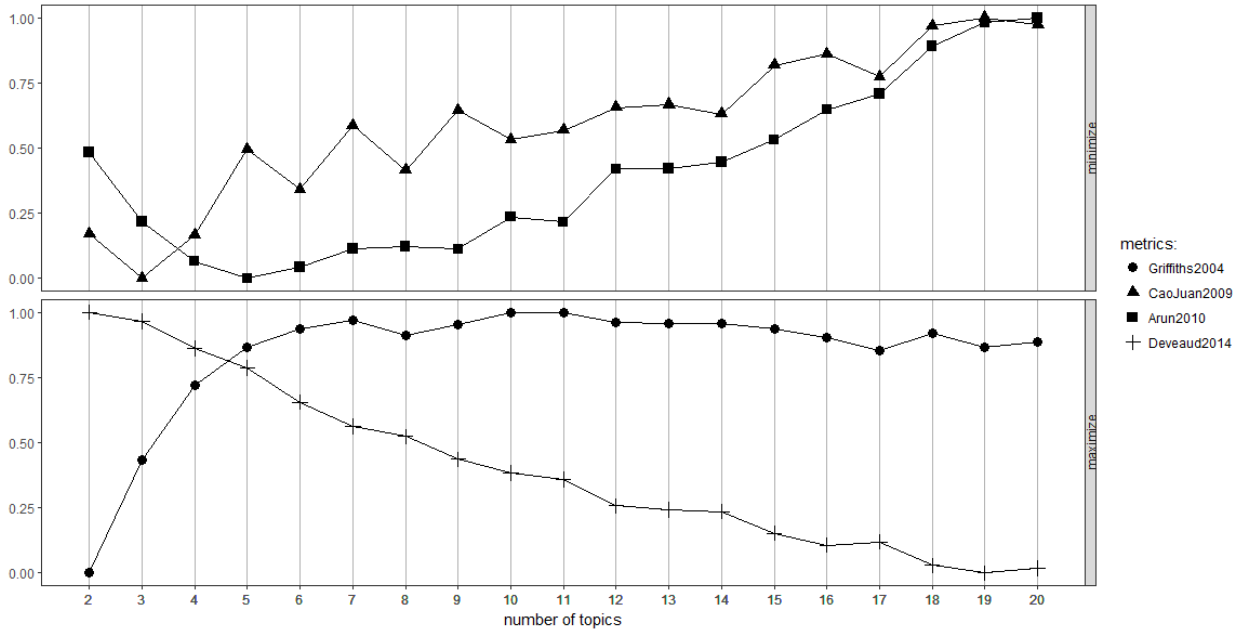

Figure 98: LDATune Grounded Theory Comparison (WSARA) - 4-6 topics

2. Topic Models

a. All Data

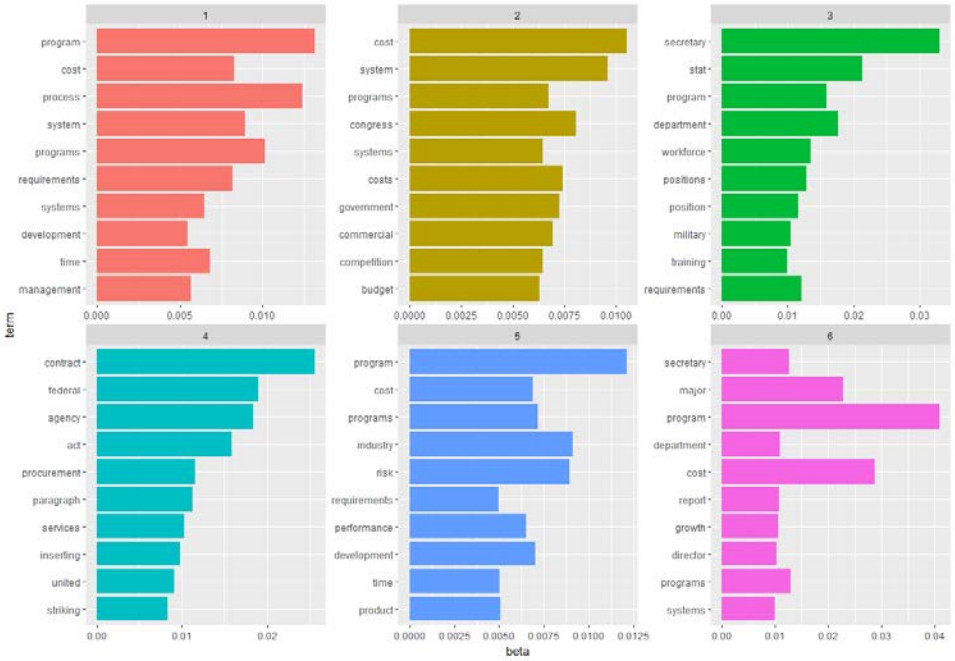

Figure 99: Topic Model Beta Probabilities - All Data (6 Topic)

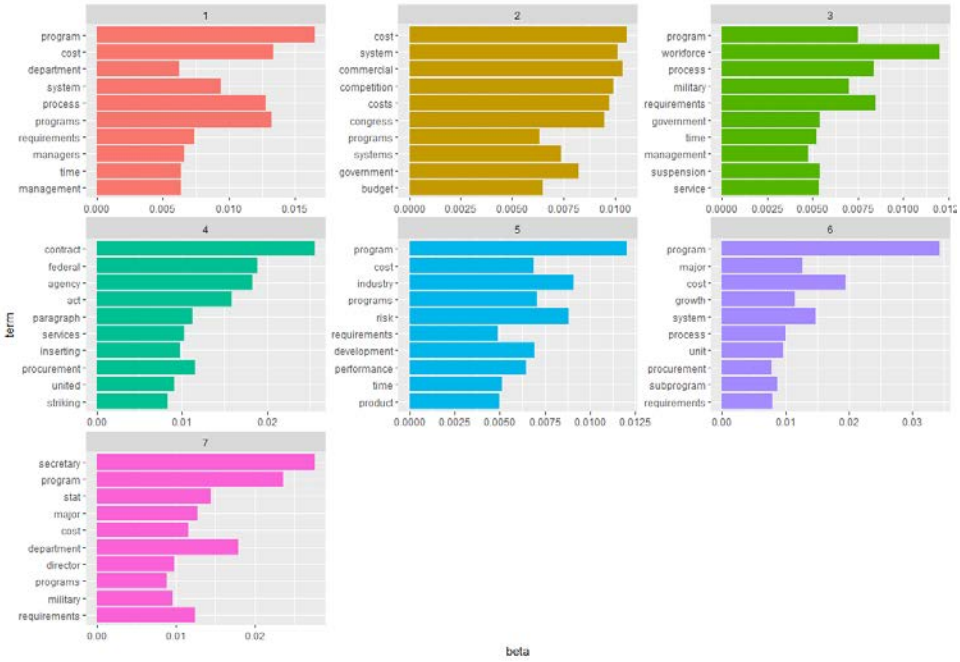

Figure 100: Topic Model Beta Probabilities - All Data (7 Topic)

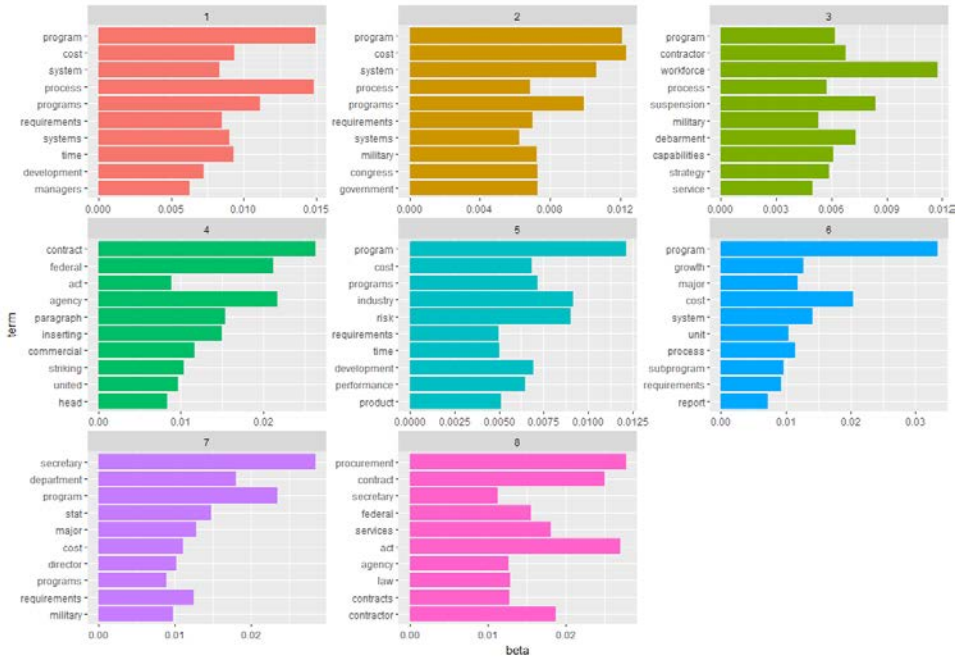

Figure 101: Topic Model Beta Probabilities - All Data (8 Topic)

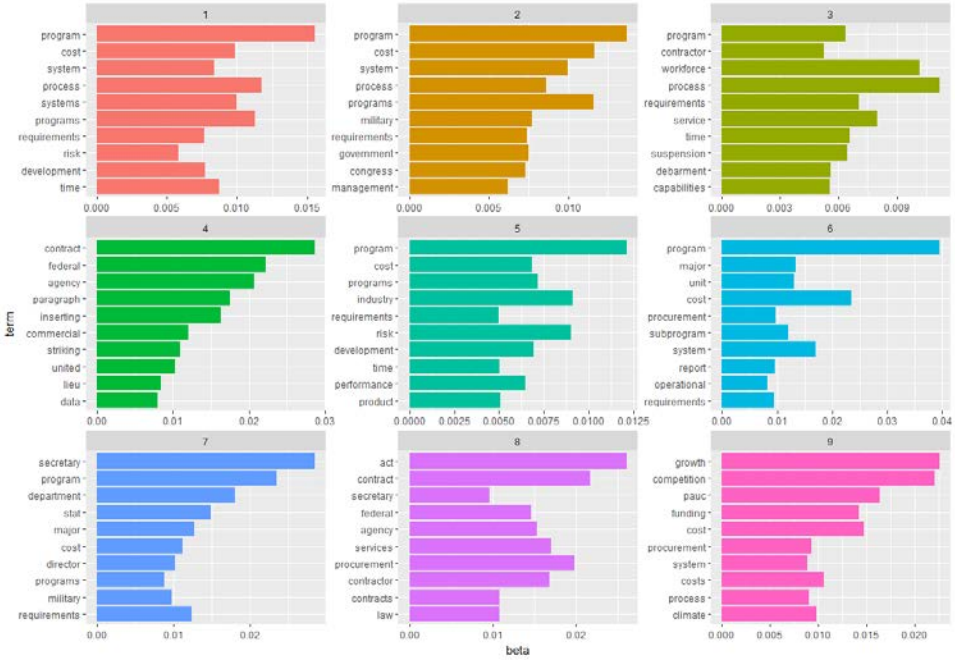

Figure 102: Topic Model Beta Probabilities - All Data (9 Topic)

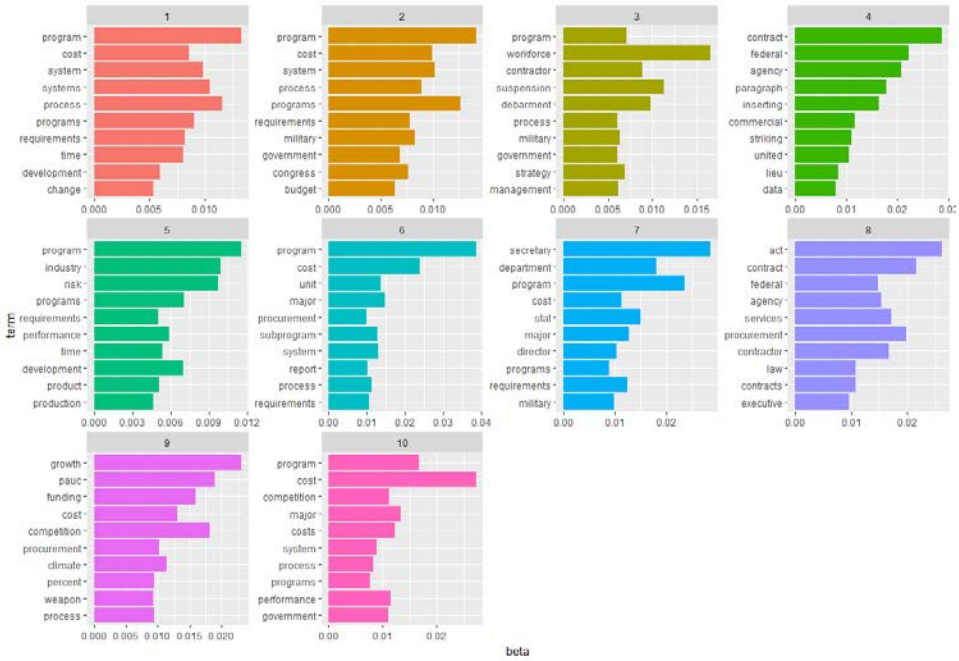

Figure 103: Topic Model Beta Probabilities - All Data (10 Topic)

b. Experts

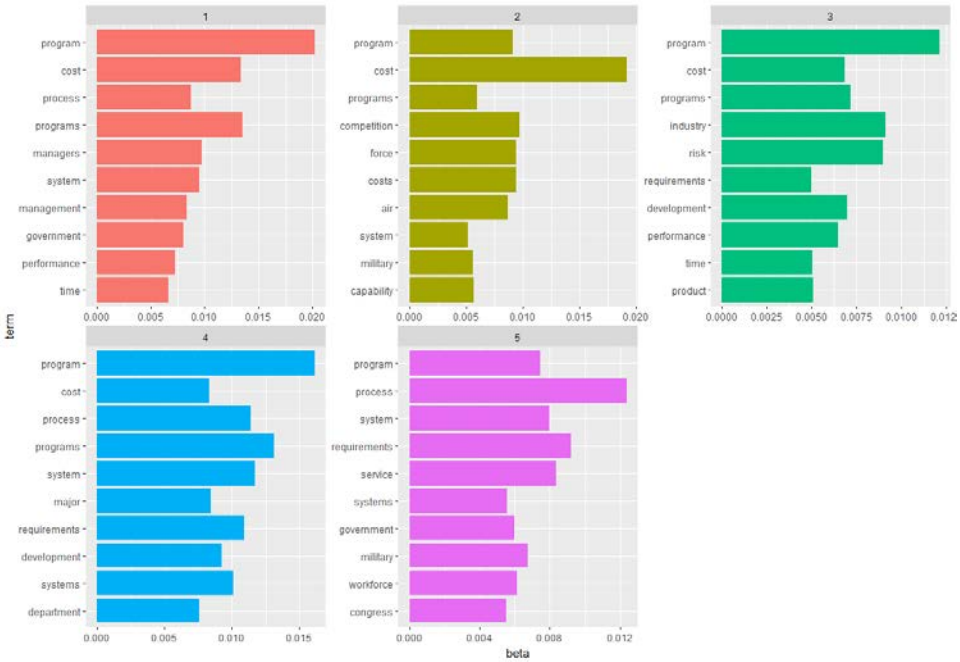

Figure 104: Topic Model Beta Probabilities - Experts (5 Topic)

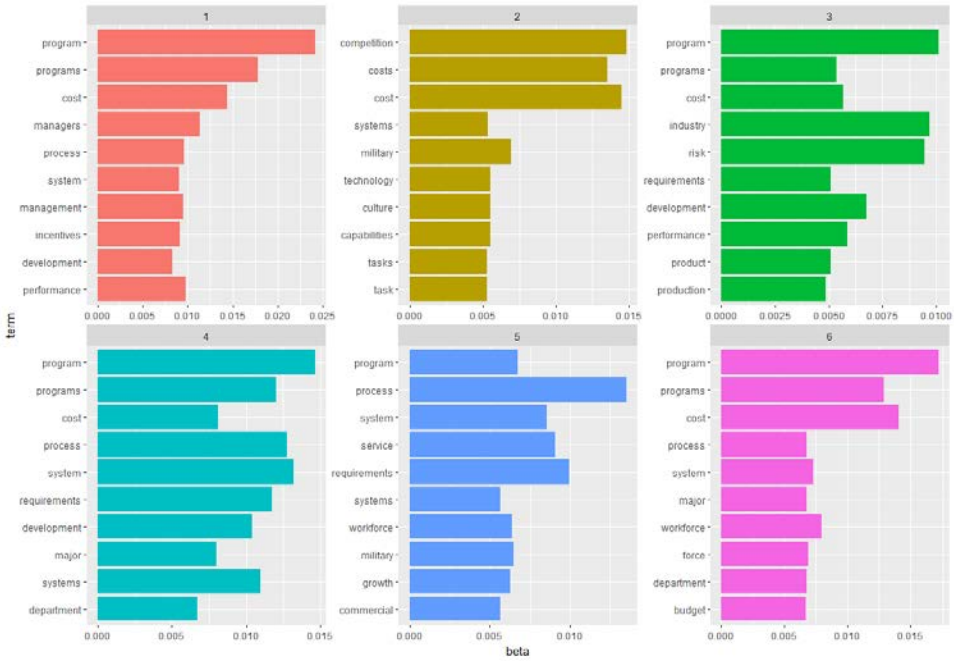

Figure 105: Topic Model Beta Probabilities - Experts (6 Topic)

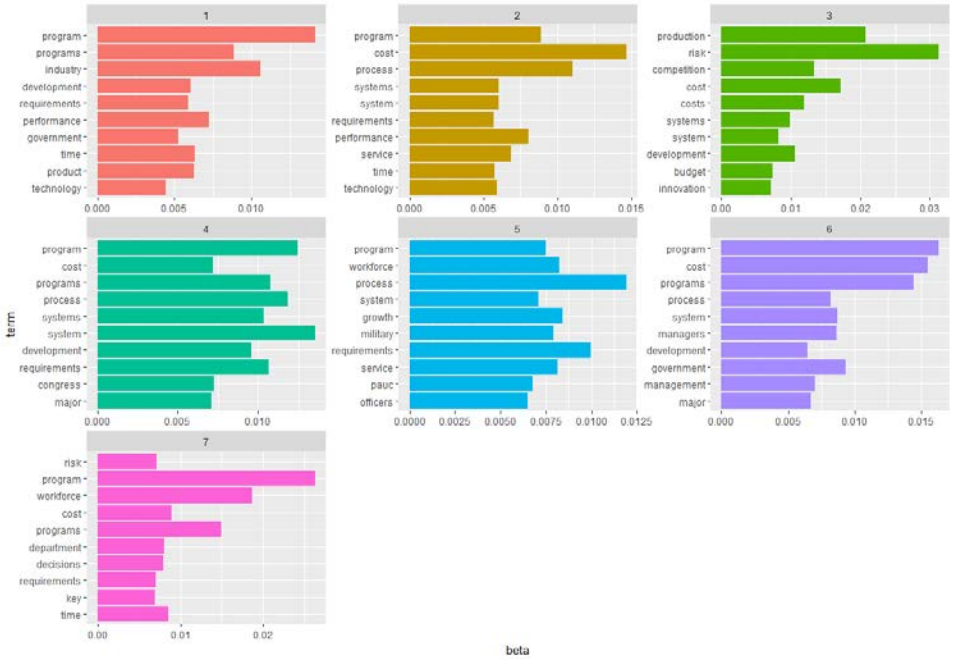

Figure 106: Topic Model Beta Probabilities - Experts (7 Topic)

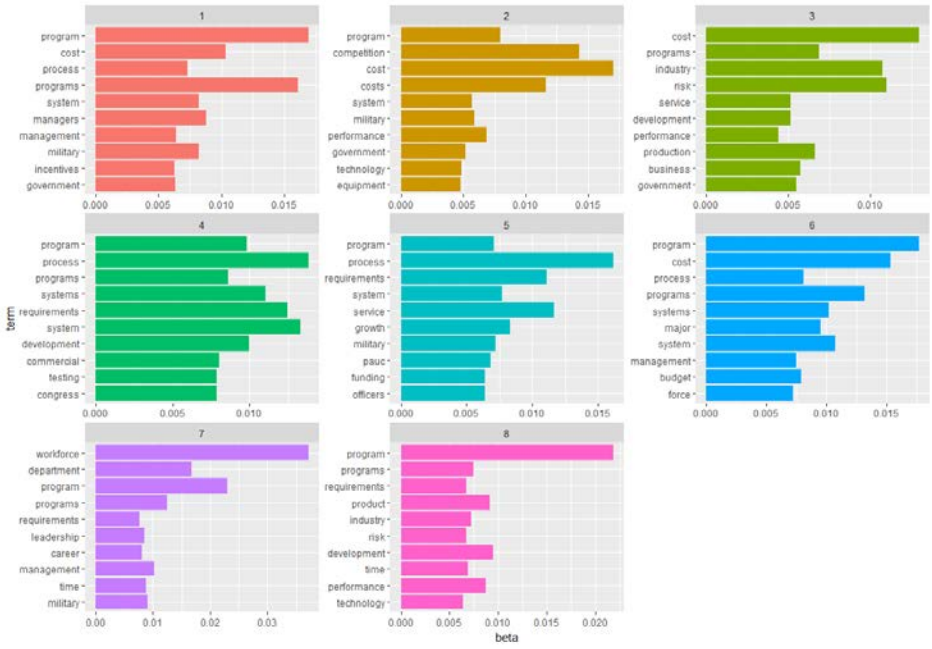

Figure 107: Topic Model Beta Probabilities - Experts (8 Topic) – Best Model

c. Reforms

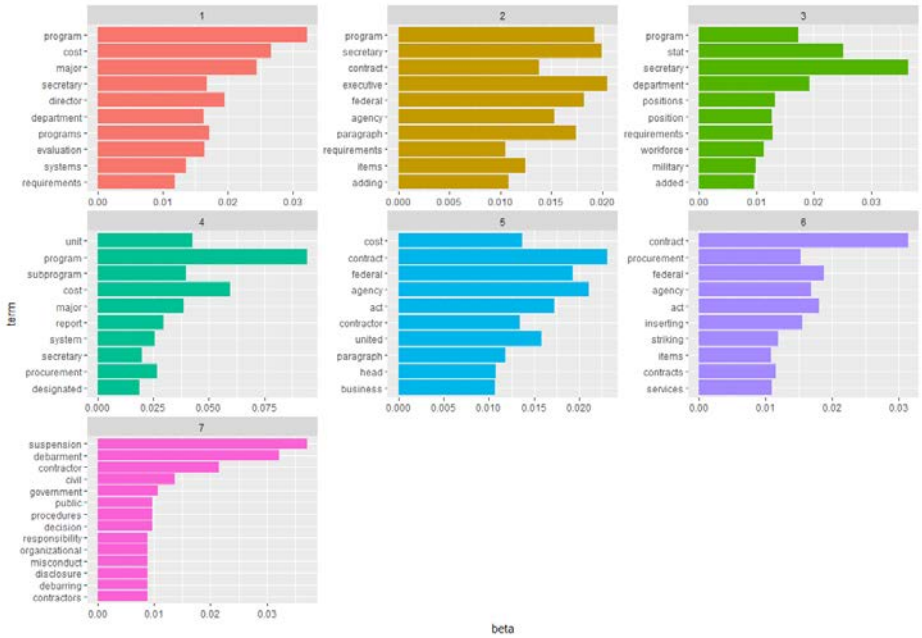

Figure 108: Topic Model Beta Probabilities - Reforms (7 Topic)

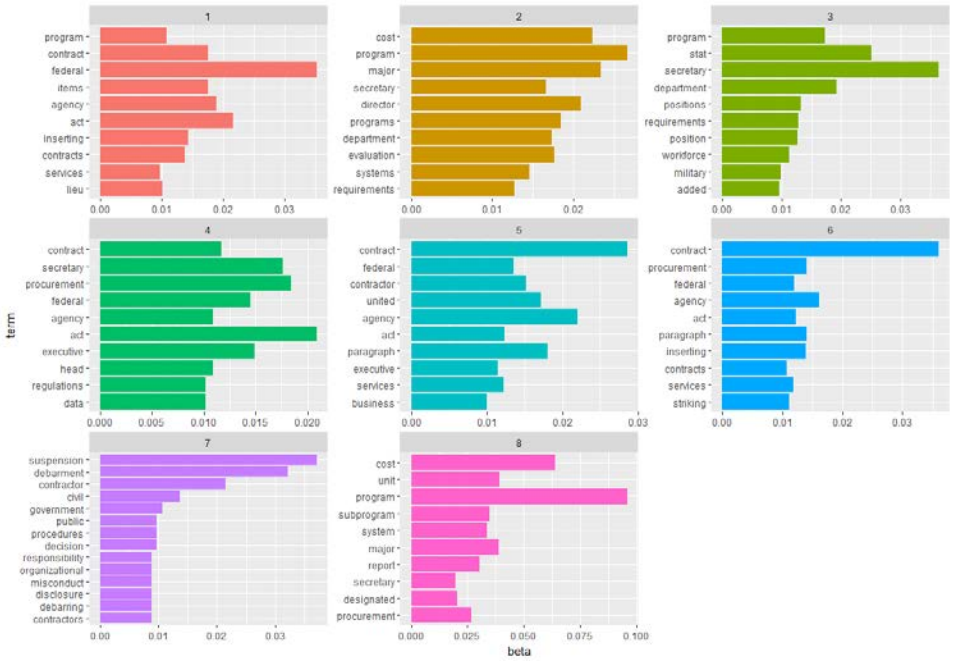

Figure 109: Topic Model Beta Probabilities - Reforms (8 Topic)

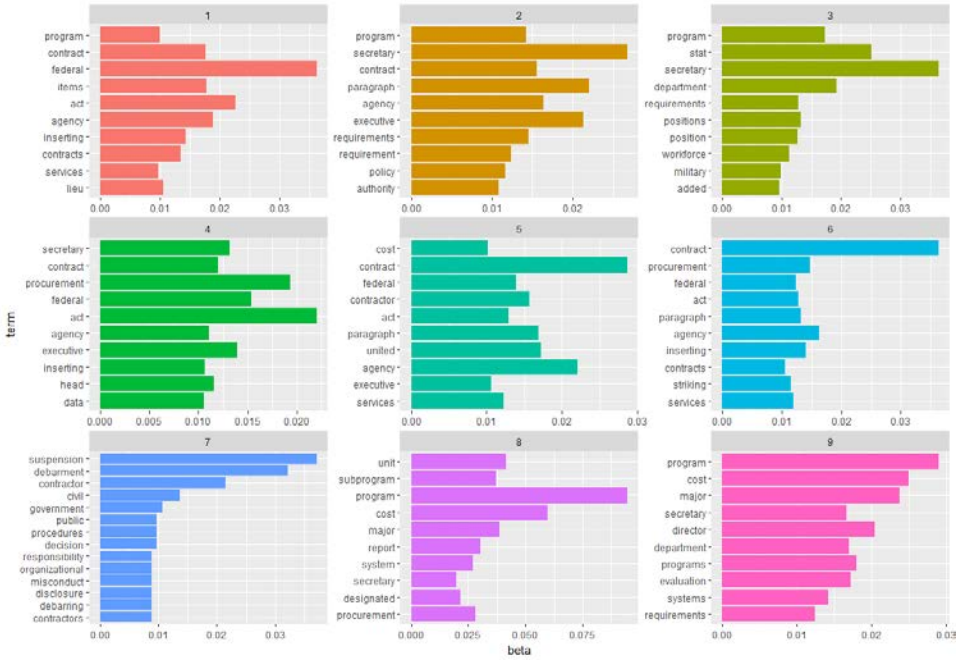

Figure 110: Topic Model Beta Probabilities - Reforms (9 Topic) - Best Model

d. Grounded Theory Comparison (Gansler)

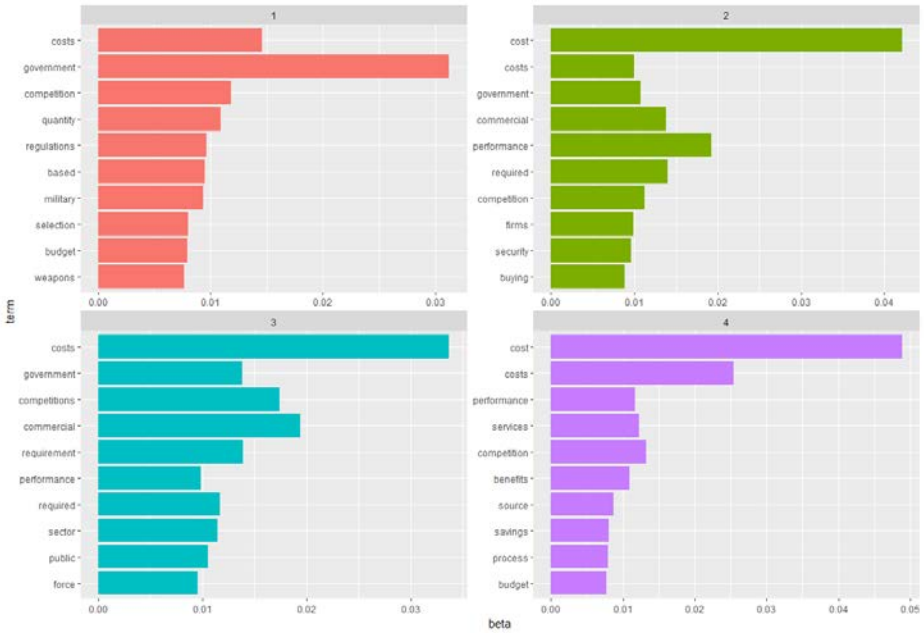

Figure 111: Topic Model Beta Probabilities - Grounded Theory Comparison (Gansler 4 Topic)

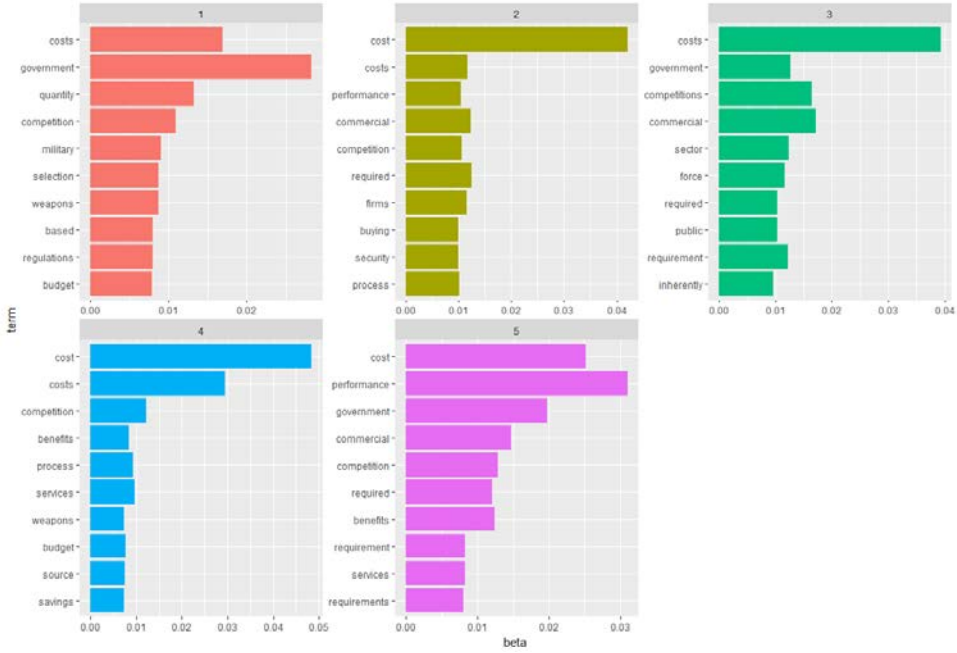

Figure 112: Topic Model Beta Probabilities - Grounded Theory Comparison (Gansler 5 Topic) - Best Model

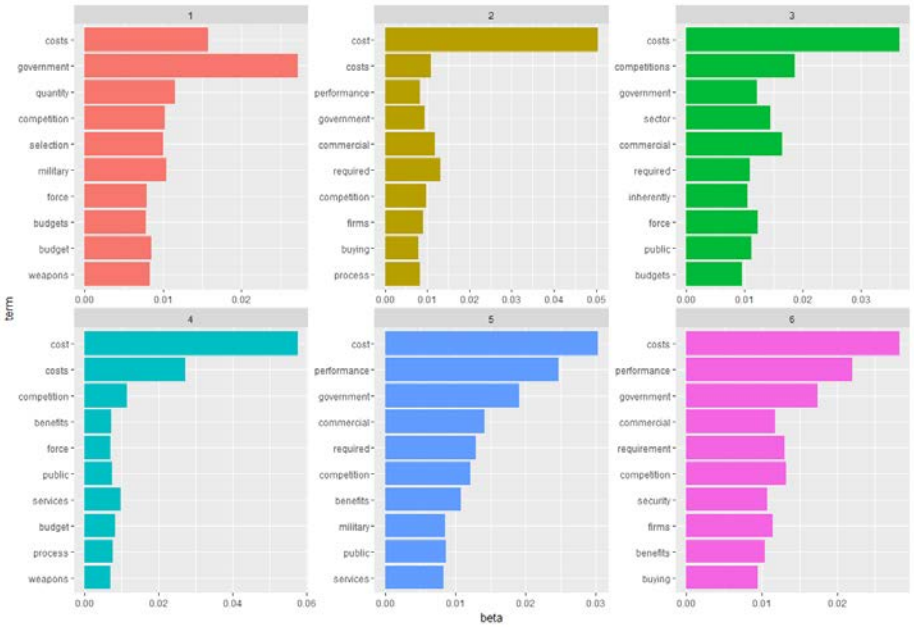

Figure 113: Topic Model Beta Probabilities - Grounded Theory Comparison (Gansler 6 Topic)

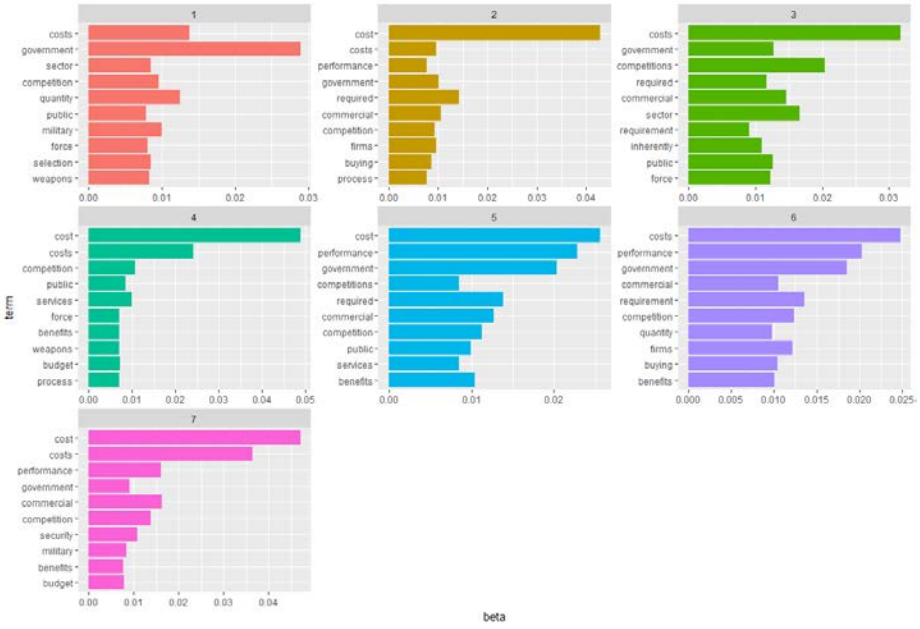

Figure 114: Topic Model Beta Probabilities - Grounded Theory Comparison (Gansler 7 Topic)

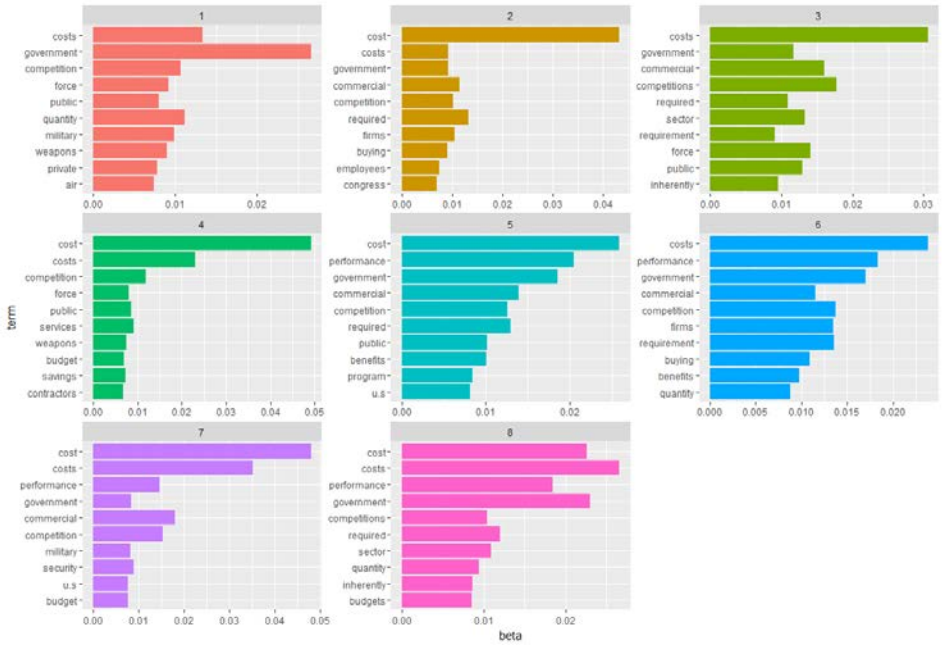

Figure 115: Topic Model Beta Probabilities - Grounded Theory Comparison (Gansler 8 Topic)

e. Grounded Theory Comparison (WSARA)

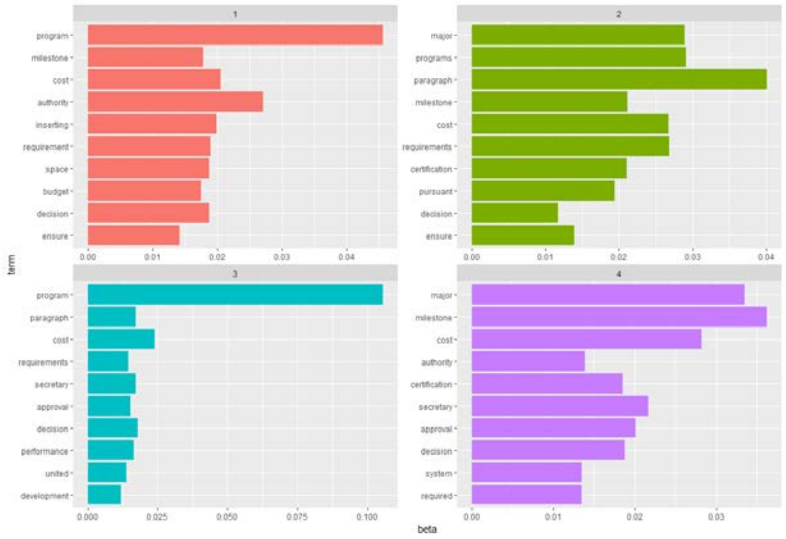

Figure 116: Topic Model Beta Probabilities - Grounded Theory Comparison (WSARA 4 Topic)

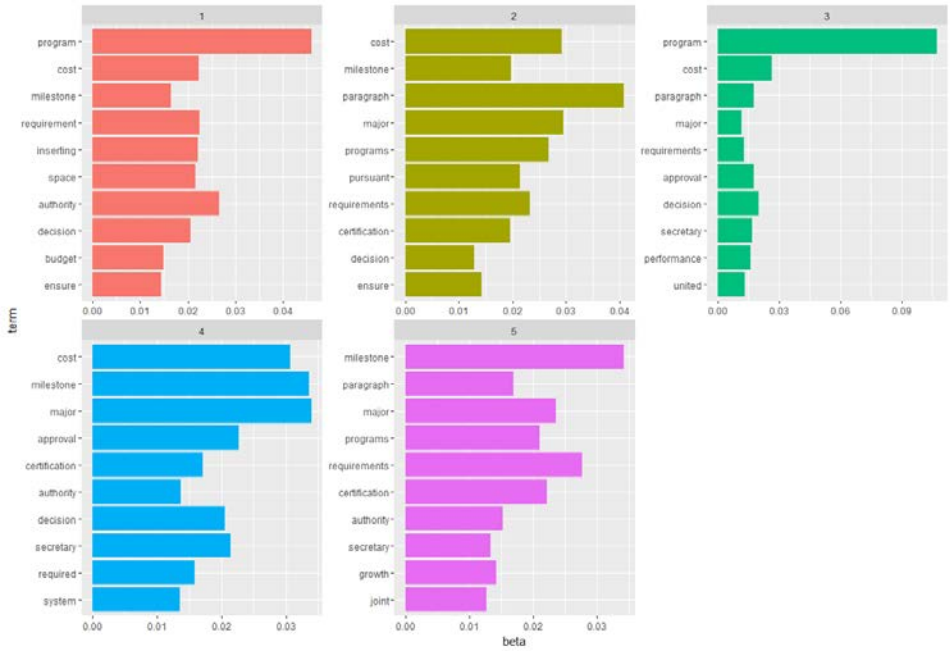

Figure 117: Topic Model Beta Probabilities - Grounded Theory Comparison (WSARA 5 Topic)

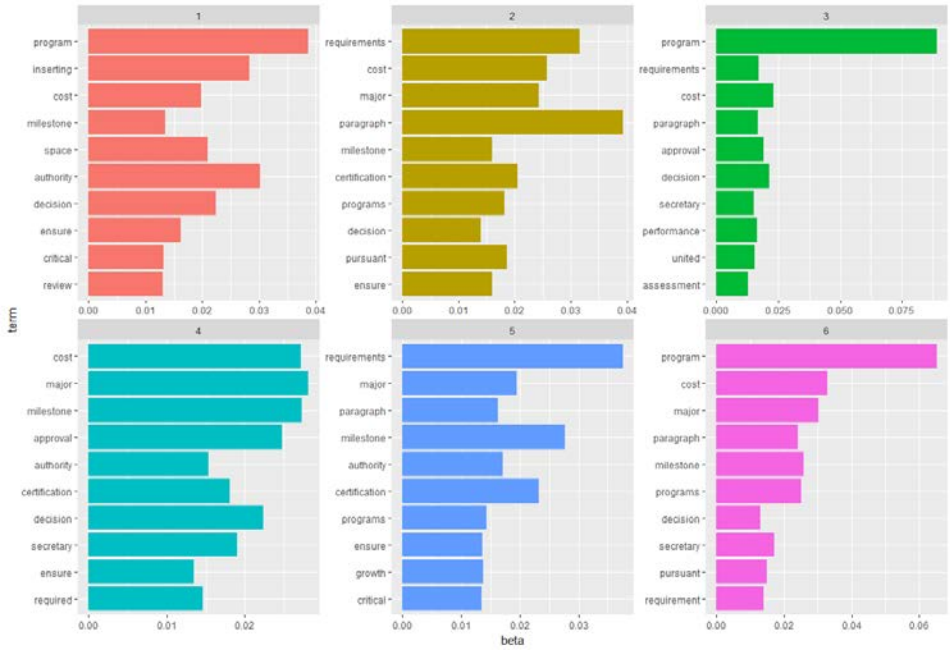

Figure 118: Topic Model Beta Probabilities - Grounded Theory Comparison (WSARA 6 Topic) - Best Model

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
23 Mar 2018	Master's Thesis	Sept 2016 - March 2018

4. TITLE AND SUBTITLE

An Analysis of Major Acquisition Reforms Through Text Mining and Grounded Theory Design

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

McGowin, Amanda L., Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way
Wright-Patterson AFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT-ENV-MS-18-M-224

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Air Force Life Cycle Management Center
ATTN: Shawn Valentine
5135 Pearson Road, Building 10
Wright-Patterson AFB, OH 45433
shawn.valentine@us.af.mil

10. SPONSOR/MONITOR'S ACRONYM(S)

AFLCMC/FZCE

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION STATEMENT A.
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

13. SUPPLEMENTARY NOTES

This work is declared a work of the U.S. Government and is not subject to copyright protection in the United States.

14. ABSTRACT

Cost growth is an established phenomenon within Defense Acquisition that the US Government has attempted to abolish for decades through seemingly endless cycles of reform. Dozens of experts and senior leaders within the acquisition community have published their notions on the reasons for cost growth, nevertheless, legislation has yet to eradicate this presumed conundrum. For this reason, this research is aimed at identifying existing trends within past major Defense Acquisition Reform legislation, as well as in a compendium of views from leaders within the Defense Acquisition community on the efficacy of acquisition reform, to determine the possible disconnect. To accomplish this goal, this research takes a qualitative approach, utilizing various Text Mining methodologies, along with Grounded Theory Design, to analyze the major reforms and expert views. The results of this research corroborate the current literature's claim that past Defense Acquisition reforms have not been able to sufficiently address the root causes of cost growth, and identifies six potential root causes of cost growth.

15. SUBJECT TERMS

Defense Acquisition, Acquisition Reforms, Major Acquisition Reforms, Packard Commission, Nunn McCurdy, FASA, DAWIA, WSARA, Cost Growth, Cost overruns, Grounded Theory, Text Mining, Topic Modeling, LDA, Text Analytics, Qualitative

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dr. Jonathan Daniel Ritschel, AFIT/ENV
U	U	U	UU	233	19b. TELEPHONE NUMBER *(Include area code)* (937) 255-3636 x4484 jonathan.ritschel.2@afit.edu

Reset